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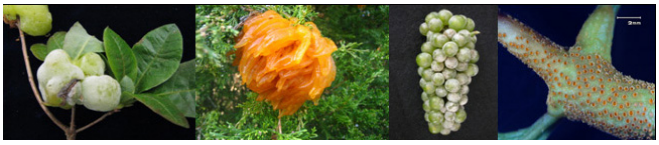

FACT SHEET

Prevention of Ticks and Tick-Associated Disease in Companion Animals

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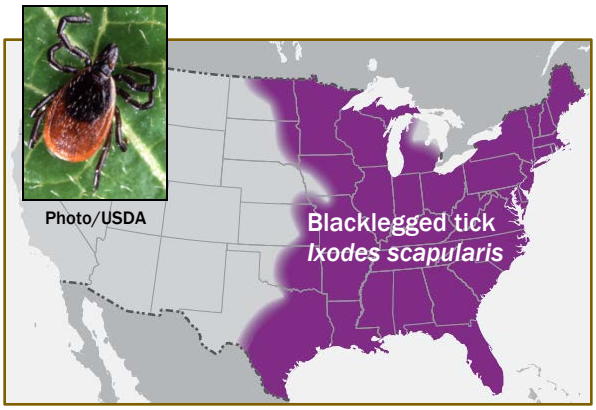
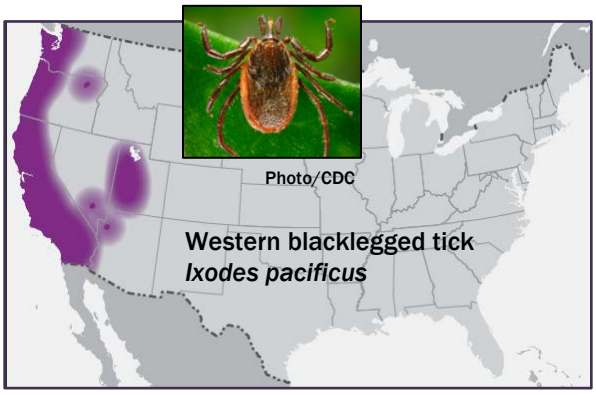
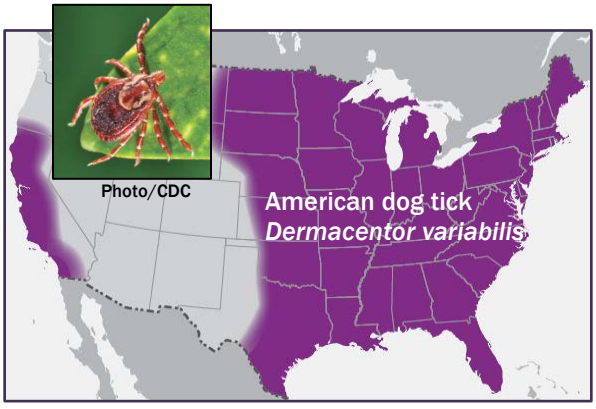
Ticks and a number of tick-associated diseases can affect companion animals, particularly dogs and cats. With the emergence and geographic expansion in the distribution of tick-borne pathogens, the prevention of tick bite and disease in companion animals is more important than ever. The most common ticks found infesting dogs and cats in the United States (U.S.) are the blacklegged tick (*Ixodes scapularis*), American dog tick (*Dermacentor variabilis*), Rocky Mountain wood tick (*Dermacentor andersoni*), lone star tick (*Amblyomma americanum*), Gulf Coast tick (*Amblyomma maculatum*), Western blacklegged tick (*Ixodes pacificus*), brown dog tick (*Rhipicephalus sanguineus*), occasionally the Pacific Coast tick (*Dermacentor occidentalis*), and the spinose ear tick (*Otobius megnini*). The ticks encountered will vary regionally (see maps of approximate distribution for seven species[a]) and depend on travel history. For example in the northeast, the primary ticks on dogs and cats are *I. scapularis* and *D. variabilis*. In Florida, the primarly species on dogs is the brown dog tick and on cats, the lone star tick. A summary of the major diseases associated with ticks and companion animals is provided in Table 1.

[a] Tick distribution maps from Biggs et al. 2016. MMWR. 65(2):1-44 (Used with permission).





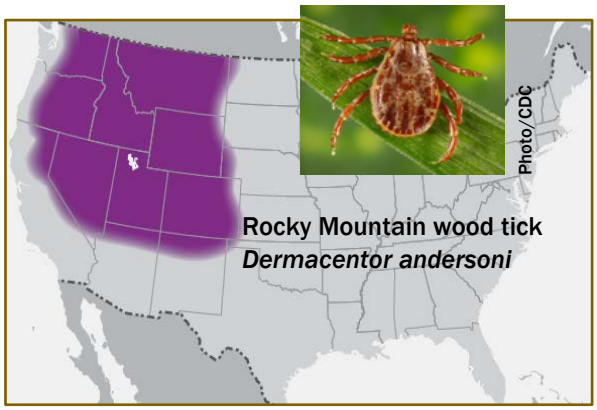


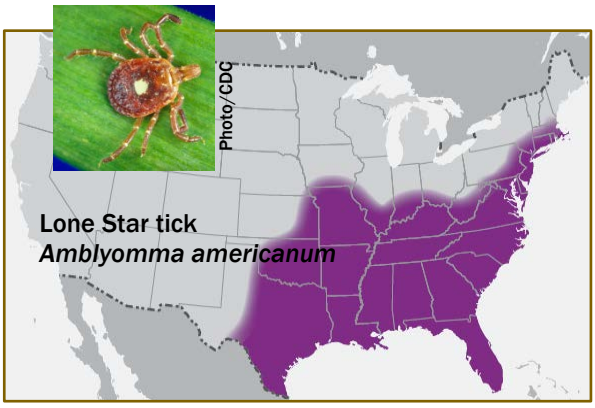
The Ticks

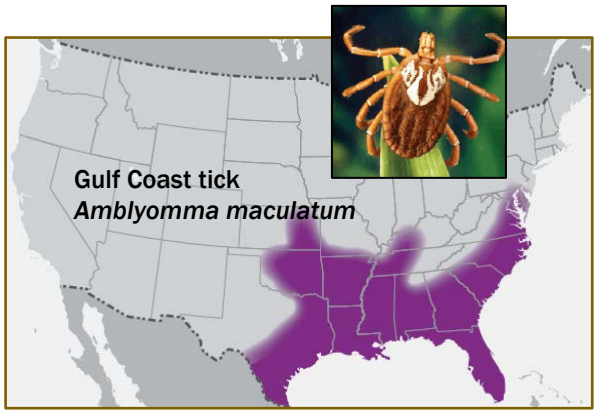
The ticks covered in this factsheet have a three-host life cycle, with each of the three developmental stages obtaining a single blood meal from different individual host animals. After hatching, larvae feed to repletion on one animal, drop to the ground and molt into nymphs. The nymphs must find and attach to another host, engorge, drop to ground, and molt into an adults. The adult female ticks then feed on a third animal, become engorged, drop to the ground to lay eggs. The larvae and nymphs of three-host ticks generally feed on small to medium-sized hosts, while adult ticks feed on medium to larger sized animals.

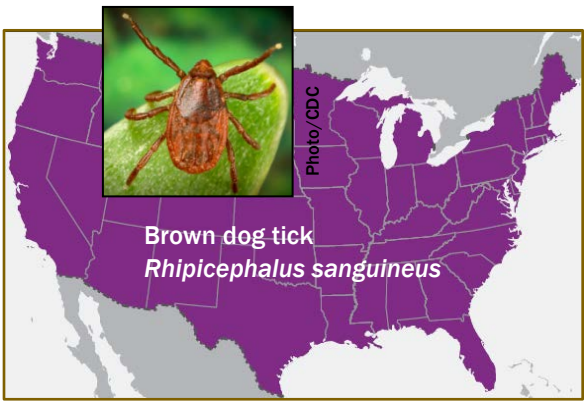
Blacklegged Tick (aka deer tick): The majority of human Lyme disease cases are associated with the small nymphal stage during the summer months. Unfed female blacklegged ticks have a reddish body and a dark brown dorsal scutum (plate) located behind the mouthparts. Length of the female tick is about 1/10 of an inch (2.5 mm), roughly the size of a sesame seed. The larvae and nymphs feed primarily on rodents and birds, particularly white-footed mice (*Peromyscus leucopus*), but will feed on virtually any host. White-tailed deer (*Odocoileus virginianus*) are the principal host for the adult stage of the tick, which feeds on a variety of medium to large-sized mammalian hosts.

Western Blacklegged Tick: The western blacklegged tick is the principal vector for Lyme disease to humans in the western, coastal United States. Superficially, it looks like the blacklegged tick in the east and only a specialist can tell them apart. It is found along the Pacific Coast in the western half of Washington and Oregon, almost all of California, and in parts of Utah, Nevada, Idaho, Arizona, and New Mexico.

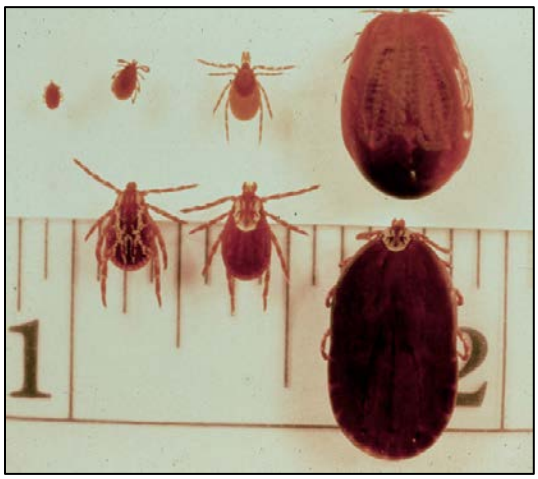








American Dog Tick: This tick is a known vector for the agents of Rocky Mountain spotted fever (RMSF) and tularemia and can cause tick paralysis. Adult American dog ticks are reddish brown in color with silvery-gray or whitish markings on the back or upper body. Dogs are the preferred hosts of adult ticks, but they also feed readily on other medium to large mammals. Only adults of the American dog tick feed on people and their pets – records of nymphs from humans are rare. Meadow voles (*Microtus pennsylvanicus*), white-footed mice, and other rodents are major hosts for the tick larvae and nymphs. In Connecticut and Massachusetts, adults become active from mid-April to early May, peak in May and June, and may remain a nuisance until around mid-August.



Comparison blacklegged tick (top row) with American dog tick (bottom row)

Rocky Mountain Wood Tick: This tick is a known vector for the agents of Rocky Mountain spotted fever and Colorado tick fever. The Rocky Mountain Wood tick is found in western North America from British Columbia and Saskatchewan south through North Dakota to northern New Mexico, Arizona, and California. It is the tick associated with the majority of cases of tick paralysis. This tick is found mainly in sagebrush-type habitats and at higher elevations (4,000-10,000 feet).

Lone Star Tick: Previously considered mainly an aggressive nuisance pest, this tick is currently associated with at least six human diseases, including ehrlichiosis and the new red meat allergy. The lone star tick is named from the conspicuous spot on the end of the scutum of the female tick. The lone star tick is the most common human biting tick in the southeastern United States. Its established range extends northward to Long Island, NY, Cape Cod, MA, and parts of coastal CT. Originating from migrating birds, the tick can occasionally be found in more northern states during the summer.

Gulf Coast Tick: Primarily considered a veterinary pest, the Gulf Coast tick will also feed on humans and is a vector for spotted fever rickettsiosis (*Rickettsia parkeri*). This tick is distributed along the Gulf and Atlantic coasts as far north as Virginia, and the south-central states into Oklahoma and Kansas. Its range also extends into Mexico and South America. The Gulf Coast tick is associated mainly with grass and scrub habitats, thorny mesquite/acacia scrubland, and coastal prairie habitats. This tick resembles the American dog tick and may be confused with that tick.

Brown Dog Tick: The brown dog tick or kennel tick is found almost worldwide and throughout the United States. The tick is more abundant in the southern states and can be the most predominant tick on dogs in many areas. Domestic dogs are the principal host for all three stages of the tick. Adult ticks feed mainly inside the ears of the dog, in the axillae (i.e., “armpit”), head and neck, and between the toes, while the immature stages feed almost anywhere, particularly along the neck and back, but also legs, chest, and belly. People may be attacked and there have been increasing reports of this tick feeding on humans. This tick is closely

associated with yards, homes, kennels and small animal hospitals where dogs are present, particularly in pet bedding areas. Brown dog ticks may be observed crawling around baseboards, up walls or other vertical surfaces of infested homes seeking protected areas, such as cracks, crevices, spaces between walls or wallpaper, to molt or lay eggs. The brown dog tick can complete its life cycle completely indoors and in the North, this tick is found almost exclusively indoors in homes or kennels.

Tick-Associated Diseases of Companion Animals

Lyme Disease

Lyme disease, caused by the bacterium *Borrelia burgdorferi*, may be the most common canine tick-borne disease, but domestic animals (cats, horses, cows, and goats) can become infected and some will develop clinical disease. Lameness and swollen joints, fever, lymph node enlargement, reduced appetite, and a reluctance to move are the usual symptoms in these animals. Clinical disease is more common in dogs and relatively uncommon in cats. Most dogs (up to 70-90% of unvaccinated animals) in a Lyme disease endemic area will become infected (based on positive serology) due to their high exposure to ticks and only about 5% will become clinically ill.

Symptoms and treatment. Limb and joint arthritis is the most frequent sign in canine Lyme disease; cardiac, neurological, ophthalmic, and a unique renal involvement is less common. Lyme nephropathy in dogs often results in the death of the animal from renal failure, even with aggressive treatment. Clinical illness in symptomatic dogs generally appears weeks or months after infection. A highly sensitive and specific C6 peptide assay based on antibodies to the VlsE protein is widely used by veterinarians to test for Lyme disease (a version is also used for human testing). Animals are treated with antibiotics (tetracycline or penicillin-group antibiotics) and nonsteroidal anti-inflammatory drugs for relief of Lyme arthritis. Doxycycline is the standard treatment for Lyme disease in dogs and it is also effective for treating anaplasmosis, ehrlichiosis, and RMSF. Most dogs' arthritis responds dramatically to antibiotic treatment within days, followed by a complete recovery. Chronic disease is rare, and a lack of response to therapy may suggest another illness. Other disease processes, which should be ruled out, include rheumatoid arthritis, infectious arthritis's, and other tick-borne diseases such as spotted fever rickettsioses and ehrlichiosis. Some research has shown that *Borrelia* infection and antibody titers may persist in dogs after efficacious treatment, although this was not associated with disease. It is not clear if a reoccurrence of disease is due to another tick exposure or from the initial infection. Some data suggest that treatment in the absence of clinical disease for some seropositive dogs may be indicated. Canine serological surveys have been found to correlate with human disease incidence for several pathogens and a potential indicator for emerging areas of risk as pets are often infected before human cases are detected. Attached ticks on dogs can also provide a measure of human risk of tick exposure.

Other Tick-Associated Diseases

Canine babesiosis is caused by several species of *Babesia*. Infection can be asymptomatic or range from mild illness and anemia to severe disease and death. Severity of disease depends on the species of *Babesia* and age and health of the dog. *Babesia canis* was reclassified into three species; *B. vogeli* (worldwide), *B. canis* (Europe), and *B. rossi* (Africa). *Babesia vogeli* is transmitted by the brown dog tick and is widely distributed

through tropical and subtropical regions worldwide and into more temperate areas where the tick vector is found. This pathogen is passed transovarially and all three stages of the brown dog tick can transmit *B. vogeli*. *Babesia conradae* is a relatively new species described from California. Outside of Asia, including the U.S., *B. gibsoni* is associated mainly with dog breeds used for illegal fighting. It is transmitted mainly from bites between infected and non-infected animals.

Dogs, like humans, are susceptible to several tick-borne spotted group rickettsial pathogens, including the agent of Rocky Mountain spotted fever (RMSF), *Rickettsia rickettsii*, and the agents that cause anaplasmosis and ehrlichiosis. In dogs, RMSF can be severe or fatal and symptoms include fever, lethargy, decreased appetite, tremors, a maculopapular skin rash on ears and exposed skin, and petechiae (red or purple spots) on the gums and mouth muscoa. The tick vectors in the U.S. are the American dog tick, brown dog tick and Rocky Mountain wood tick.

Canine anaplasmosis, vectored by the blacklegged tick, is caused by *A. phagocytophilum*, which also causes anaplasmosis in humans. Clinical presentation is similar to *B. burgdorferi* infection with fever, lethargy, and polyarthritis. Infectious cyclic thrombocytopenia of dogs is caused by *Anaplasma platys*, which uniquely infects blood platelets. Found worldwide, the vector is likely the brown dog tick. Disease in dogs is generally mild and the animals usually clear the infection but *A. platys* can result in bleeding or bleeding under the skin and may present more severe anemia and thrombocytopenia with co-infection with *Ehrlichia canis*.

Dogs are susceptible to infection by several *Ehrlichia* species, including *E. chaffeensis*, *E. ewingii*, and *E. canis*. Canine monocytic ehrlichiosis is caused mainly by *Ehrlichia canis*, whose primary vector is considered to be the brown dog tick with distribution worldwide. This canine pathogen can cause severe and fatal disease in dogs and human cases similar to infection with *E. chaffeensis* have been described. Canine granulocytic ehrlichiosis is caused by *E. ewingii* that was first described in 1971. The lone star tick is the principal vector for both *E. chaffeensis* and *E. ewingii*. Based on serological surveys, infection prevalence is highest in southcentral and southeastern states with the greatest exposure being to *E. ewingii*. Doxycycline is the treatment of choice for spotted fever rickettsiosis, anaplasmosis, and ehrlichiosis in dogs. Amoxicillan and other beta-lactam antibiotics are not effective against rickettsial pathogens.

The Gulf Coast tick is the principal vector for American canine hepatozoonosis caused by the protozoan *Hepatozoon americanum*, although brown dog ticks are suspected vectors too. Dogs acquire infection by ingesting a tick containing sporulated oocysts as they do not migrate to the tick's salivary glands or mouthparts. Gametocytes contained in neutrophils or monocytes in the dog's blood are picked up by feeding ticks. The disease is debilitating and often fatal. It is distributed through the southern states where the Gulf Coast tick is found.

Feline cytauxzoonosis, caused by *Cytauxzoon felis*, is a protozoal infection of wild and domestic cats transmitted by the lone star tick and possibly the American dog tick. Cytauxzoonosis in domestic cats is a severe febrile disease with a very high mortality rate. Most cats die within a week of illness onset. Bobcats, *Lynx rufus*, can be persistent carriers and have been considered the primary reservoir host, although some domestic cats can also be chronically infected and serve as reservoirs. The pathogen's distribution roughly corresponds

with that of the lone star tick in southeastern, southcentral, and mid-Atlantic States. Prevention largely is dependent on controlling ticks on pets and minimizing outdoor exposure.

Prevention

The prevention of Lyme disease and other tick-associated diseases in dogs, and in some cases, humans relies on avoiding tick habitat, reducing tick exposure on the animal with an ectoparasiticide (collar, spray or topical), daily tick checks, environmental control, and use of one of the canine Lyme disease vaccines available.

Electronic fencing systems can help confine dogs to an area where the animal is less likely to pick up ticks or where other tick control measures have been implemented. If the pet is not allowed to freely roam into wooded areas, it is less likely to pick up ticks. Animals can carry ticks into the home. However, studies to determine whether pet owners may be at increased risk of Lyme disease have been inconclusive. Ticks, once attached or fed, will not seek another host unless groomed off before completion of feeding. Dogs and cats should be checked daily for ticks, but the immature stages may be virtually impossible to detect in longhair or dark-hair animals. Outdoor activities with companion animals also may increase the exposure of pet owners to ticks.

Photos courtesy Pfizer Central Research

Checking a dog for ticks and an engorged blacklegged tick on a cat (photos courtesy Pfizer Central Research).

Canine Lyme vaccines. There are several types of canine Lyme vaccines: a whole-cell killed bacterin, bivalent bacterin, or a subunit recombinant OspA vaccine. The canine Lyme vaccines can provide increased protection for dogs living in or traveling to Lyme disease endemic areas with a likely exposure to ticks. Immunization prior to exposure is likely to be most helpful and the benefit of vaccination for seropositive dogs is unclear.

Depending upon the vaccine, an initial dose can be given as early as 12 weeks of age with a second required dose 2-4 weeks later. A single dose will not immunize a seronegative dog. Estimates of the efficacy of the vaccines generally range from 50-80% and the protection will decline with time. An annual booster is needed. Products include:

- Whole-cell, bivalent, Bactrin vaccines
  LymeVax®
  Duramune® Lyme
  Novibac® Lyme
- Inactivated rOspA vaccine
  Recombitek® Lyme (no adjuvents)

Your veterinarian should be consulted about the use of a canine Lyme vaccine, tick bite prevention, and treatment of tick-associated diseases in your animals.

Acaricide use on animals. A variety of products can repel, kill, or prevent attachment of ticks on animals. Many over the counter (OTC) products are available and others only through your veterinarian. Chemical products to protect dogs from ticks are available as topical spot-ons, sprays, collars, dusts, and shampoos (Table 2). Some products have been shown to prevent transmission of Lyme disease by killing the ticks prior to transmission. In response to an outbreak of Rocky Mountain

spotted fever, a combination of an area application of an acaricide (cyfluthrin + imidacloprid) and long-lasting tick collars (flumethrin + imidacloprid) with protection rated for 7-9 months, along with some animal care practices, in a community program significantly reduced brown dog ticks on dogs (to < 1% vs. 64% of dogs in the untreated community) and reduced tick activity in that community.

Contact should be avoided between cats and dogs when dogs have been treated with products containing the pyrethrioids permethrin, deltamethrin, and cyphenothrin, or the formamidine compound amitraz immediately after treatment. Cats are particularly susceptible to pyrethrin and pyrethroid poisoning.

Topical Treatments. Pet OTC products containing permethrin are widely available and inexpensive. The protection from the fipronil-permethrin combination is rapid and efficacious. However, warnings against use on cats may be overlooked and treating a cat with a permethrin canine product can be fatal. Keep cats away from dogs for at least 72 hours after application of spot-on products that contain high concentrations of permethrin. Acaricides for use on cats are limited to fipronil, imidacloprid, and flumethrin, and they are effective in controlling ticks. Some companies have product versions that add insect growth regulators for flea control on dogs and cats (pyriproxyfen and S-methoprene). Spot-on materials dissolve in the oils on the skin, spread over the body, and collect in sebaceous glands and hair follicles for long-term protection that is not affected by bathing or water immersion. Selemectin is an avermectin compound that is also active against a number of internal parasites.

Oral Treatments. The isoxazolines, a new class of ecto-parasiticides, are systemic oral medications that offer the ease of a single oral dose (dogs) and lasts for 3-4 weeks (afloxolaner, fluralaner, and sarolaner). Follow label directions to minimize the chances for an adverse reaction to the product in your pet and do not combine products without the advice of your veterinarian.

Precautions. Different products can contain the same or similar active ingredients, which could result in an overdose of the animal. Follow weight and age restrictions or guidelines and use the product designed for specific size animals. Do not treat kittens or puppies unless the product is specifically labeled for that use. If there is an adverse reaction, immediately bathe the pet with mild soap and rinse with large amounts of water and consult your veterinarian.

Warning. Most products are for canine use only and are quite toxic to cats. Exposure to even small amounts of concentrated pyrethroids like permethrin can cause severe and fatal poisoning in cats. Read and follow the manufacturer's label and instructions. Only use products specifically labeled for cats on cats.

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Table 1. Ticks and tick-associated diseases of companion animals.

Disease[a]	Pathogen[b,c]	Tick vector(s)	Common name
Anaplasmosis	*Anaplasma phagocytophilum*	*Ixodes scapularis*	Blacklegged tick (deer tick)
		Ixodes pacificus	Western blacklegged tick
Lyme disease	*Borrelia burgdorferi*	*Ixodes scapularis*	Blacklegged tick
		Ixodes pacificus	Western blacklegged tick
Canine babesiosis	*Babesia vogeli*	*Rhipicephalus sanguineus*	Brown dog tick
Canine ehrlichiosis	*Ehrlichia chaffeensis*	*Amblyomma americanum*	Lone star tick
	E. ewingii	*Amblyomma americanum*	Lone star tick
	E. canis	*Rhipicephalus sanguineus*	Brown dog tick
Hepatozoonosis	*Hepatozoon americanum*	*Amblyomma maculatum*	Gulf coast tick
Cytauxzoonosis	*Cytauxzoon felis*	*Amblyomma americanum*	Lone star tick
RMSF	*Rickettsia rickettsia*	*Dermacentor andersoni*	Rocky Mountain wood tick
		Dermacentor variabilis	American dog tick
		Rhipicephalus sanguineus	Brown dog tick

Table 2. Ectoparasiticides for control of ticks on dogs and/or cats. Some formulations also contain active ingredients [e.g., (S)-methoprene, and pyriproxyfen] that specifically target fleas.

Active Ingredient(s)[a]	Trade Name(s)[b,c]	Product	Pet
Amitraz	Preventic®	Collar	Dogs only
Afoxolaner	NexGard™	Oral (chewable)	Dogs only
Deltamethrin	Scalibor®	Collar	Dogs only
Fipronil	Frontline®	Topical or spray	Dog & cat versions
Fipronil	Sentry® Fiproguard	Topical	Dog & cat versions
Fipronil	Effipro® Cats	Topical	Cats
Fipronil, pyriproxyfen	Effipro® Plus Cats	Topical	Cats
Fipronil, permethrin	Effitix® Dogs	Topical	Dogs only
Fipronil, permethrin, pyriproxyfen	Effitix® Plus Dogs	Topical	Dogs only
Fipronil, amitraz	Certifect®	Topical	Dogs only
Fipronil, cyphenothrin	Parastar® Plus	Topical	Dogs only
Fipronil, (S)-methoprene	Ectoadvance® Plus	Topical	Dogs only
Fipronil, cyphenothrin, (S)-methoprene,	Frontline Tritak Dogs	Topical	Dogs
Fipronil, etofenprox, (S)-methoprene	Frontline Tritak Cats	Topical	Cats
Fipronil, (S)-methoprene, pyriproxyfen	Frontline Gold	Topical	Dog & cat versions
Flumethrin, imidocloprid	Seresto®	Collar	Dog & cat versions
Fluralaner	Bravecto® Dogs	Oral (chewable)	Dogs
Fluralaner	Bravecto® Cats	Topical	Cats
Permethrin	Defend Exspot	Topical	Dogs only
Permethrin	Proticall®	Topical	Dogs only
Permethrin, indoxacarb (for fleas)	Activyl® Tick Plus	Topical	Dogs only
Permethrin, imidocloprid	K9 Advantix®	Topical	Dogs only
Permethrin, imidacloprid, pyriproxyfen	K9 Advantix® II	Topical	Dogs only
Permethrin, dinotefuran, pyriproxyfen	Vectra3D®	Topical	Dogs only
Selamectin[b]	Revolution®	Topical	Dogs
Sarolaner	Simparica™	Oral (chewable)	Dogs only

[a]Fipronil, imidacloprid, and flumethrin are labeled for dogs and cats, etofenprox is used on cats, other products are for use on dogs.

[b]Selamectin is labeled only for American dog tick on dogs (cat version is labeled for fleas, worms, ear mites, not ticks). Most products last up to 1 month. The collars are rated for 3 to 8 months, depending on product.

[c]**Mention of a product does not constitute an endorsement by The Connecticut Agricultural Experiment Station (CAES) and is for informational purposes only.** The list of active ingredients and brand names are subject to change and does not include all versions of some active ingredients or products.

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