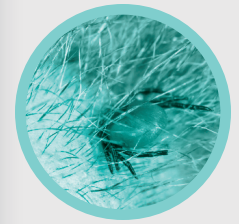


## Parasitology Expertise from the NCVP

**FELINE TICK-BORNE DISEASES**

FELINE FRIENDLY ARTICLE



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Welcome to one of 3 new columns in this issue, brought to you in partnership between the **National Center for Veterinary Parasitology** ([ncvetp.org](http://ncvetp.org)) and **Today's Veterinary Practice**. The mission of the NCVP is to further the discipline of parasitology by bringing together partners from academia and industry to address emerging issues, serving the veterinary profession by developing future leaders in veterinary parasitology, and providing diagnostic and consulting services worldwide. Its goals include to:

- Train graduate veterinarians and other scientists in clinical, applied veterinary parasitology
- Promote outstanding, clinically relevant veterinary parasitology research
- Provide diagnostic veterinary services in clinical parasitology to practicing veterinarians
- Provide balanced, science-based consulting expertise on parasite treatment and prevention strategies.

Ticks on domestic cats are often overlooked as parasites and vectors of disease agents. This oversight results from the belief that cats are fastidious groomers and remove these ectoparasites before attachment. It is also possible that some cats spend a majority of their time indoors, leading owners to believe that the cats are not exposed to ticks. There are a limited number of studies that report feline tick infestations and occurrence of feline tick-borne diseases in the United States. This article will provide updated information about feline ticks and tick-borne diseases in the U.S.

### COMMON TICKS IN CATS (Table 1, page 70)

#### *Amblyomma americanum*

*Amblyomma americanum*, the **lone star tick**, lives in wooded habitats, especially woody areas with large populations of white-tailed deer, in the south central and southeastern U.S., with a range extending along the Atlantic coast from New York to Florida and to Texas and Oklahoma.

In the southeastern U.S., nymphs and adults are most active in late spring, while larvae appear in late summer. All stages of this tick (ie, larvae, nymphs, adults) feed on cats, dogs, livestock, wildlife, and humans.<sup>1</sup> The lone star

tick is an important vector for *Cytauxzoon felis* (cytauxzoonosis),<sup>2,3</sup> *Francisella tularensis* (tularemia),<sup>4</sup> and *Ehrlichia* species (ehrlichiosis) in domestic cats.<sup>5</sup>







#### *Dermacentor andersoni*

*Dermacentor andersoni*, the **Rocky Mountain wood tick**, is distributed throughout the Rocky Mountains in the western part of the U.S. Adults and nymphs are active in the spring and early summer and infest medium- and large-sized mammals, while larvae are most active in the summer and prefer to feed on small mammals.<sup>1</sup> The Rocky Mountain wood tick is a vector for *F tularensis* in domestic cats.<sup>4</sup>

#### *Dermacentor occidentalis*

*Dermacentor occidentalis*, the **Pacific coast tick**, is distributed throughout the western U.S., along the Pacific coast. Adults feed on medium-large mammals, such as cattle, horses, deer, dogs, cats, and humans; immature ticks are thought to feed on small mammals.<sup>6</sup> Adults and nymphs are most active during late winter and early spring, while larvae are active from summer through winter, with peak activity in July.<sup>7</sup> The Pacific coast tick is a vector for *F tularensis* in cats.<sup>4</sup>

TABLE 1.  
**Identification of Hard Ticks That Commonly Infest Domestic Cats in the U.S.**

ADULT TICKS WITH LONG MOUTH PARTS (longer than wide)		
<i>Amblyomma americanum</i> (lone star tick)		<ul style="list-style-type: none"> <li>• Ornate scutum</li> <li>• <b>Male:</b> White to yellow markings on scutum</li> <li>• <b>Female:</b> Characteristic white spot on dorsal surface</li> </ul>
<i>Ixodes scapularis/pacificus</i> (black-legged tick/ western black-legged tick)		<ul style="list-style-type: none"> <li>• Inornate scutum, black legs</li> <li>• <b>Male:</b> Significantly smaller than females</li> <li>• <b>Female:</b> Reddish abdomen</li> <li>• <i>I scapularis</i> and <i>I pacificus</i> cannot be differentiated morphologically</li> </ul>
ADULT TICKS WITH SHORT MOUTH PARTS (almost as wide as long)		
<i>Dermacentor variabilis</i> (American dog tick)		<ul style="list-style-type: none"> <li>• Ornate scutum</li> </ul>
<i>Rhipicephalus sanguineus</i> (brown dog tick)		<ul style="list-style-type: none"> <li>• Inornate scutum</li> </ul>
NYMPH		
<i>Amblyomma americanum</i> (lone star tick)		<ul style="list-style-type: none"> <li>• 8 legs (4 pairs)</li> <li>• No genital pore</li> <li>• Smaller than adults</li> </ul>
LARVA		
<i>Amblyomma americanum</i> (lone star tick)		<ul style="list-style-type: none"> <li>• 6 legs (3 pairs)</li> <li>• No genital pore</li> </ul>

#### *Dermacentor variabilis*

*Dermacentor variabilis*, the **American dog tick**, is found in grassy meadows and along trails in forested areas throughout the eastern, south central, and western U.S. Larvae and nymphs actively feed on small mammals in late winter and spring, while adults feed on cats, dogs, livestock, wildlife, and humans. Adult *D variabilis* are most active in late spring and early summer.<sup>1</sup> The American dog tick can be a vector for *C felis*,<sup>8</sup> *F tularensis*,<sup>4</sup> and *Ehrlichia* species<sup>5,9</sup> in cats.

#### *Ixodes scapularis*

*Ixodes scapularis*, the **black-legged tick** or **deer tick**, is most abundant in dense, humid, wooded habitats, and widespread throughout most of the eastern, south central, and midwestern U.S. Immature stages usually feed on small mammals,

lizards, and birds. Seasonal activity peaks for nymphs and larvae in May through August and July through September, respectively. Adults feed on medium- and large-sized animals, especially white-tailed deer, and become most active during October and May.<sup>1,10</sup> The black-legged tick is a vector for *Borrelia burgdorferi*<sup>11,12</sup> and *Anaplasma phagocytophilum* (anaplasmosis)<sup>9,13</sup> in cats.

#### *Ixodes pacificus*

*Ixodes pacificus*, the **western black-legged tick** or **deer tick**, is found in western North America, primarily along the Pacific coast. Habitats, feeding targets, and seasonal activities are similar to those for *I scapularis*.<sup>1</sup> The western black-legged tick is a vector for *B burgdorferi*<sup>11,12</sup> and *A phagocytophilum* in cats.<sup>9,13</sup>

#### *Rhipicephalus sanguineus*

*Rhipicephalus sanguineus*, the **brown dog tick**,

is a common tick found throughout the world. Although dogs are its primary host, this tick also feeds on other animals, including cats<sup>14</sup>; those living in homes with infested dogs are at an increased risk. All motile stages of this tick can be found on the same host. Seasonal activity peaks in summer; however, the brown dog tick can remain active throughout the year when home infestations occur.<sup>1</sup> Species of *Ehrlichia* are thought to be transmitted to cats by the brown dog tick.<sup>9,15</sup>

### FELINE TICK-BORNE DISEASES (Table 2)

#### Cytauxzoonosis

**Transmission.** Cytauxzoonosis—a *C felis* infection transmitted by *A americanum*<sup>2,3</sup> and *D variabilis*<sup>8</sup>—is the most severe disease transmitted by ticks to domestic cats.<sup>15</sup>

TABLE 2.  
Antibiotics Recommended for Treatment of Tick-Borne Disease Agents in Cats

DRUGS	DOSAGES	TICK-BORNE AGENTS
Doxycycline	10 mg/kg PO Q 12–24 H for 28–30 days	<i>Anaplasma phagocytophilum</i> <i>Ehrlichia canis</i> -like agent <i>Borrelia burgdorferi</i>
Atovaquone	15 mg/kg PO Q 8 H	<i>Cytauxzoon felis</i>
Azithromycin	10 mg/kg PO Q 24 H	<i>Cytauxzoon felis</i>
Gentamicin	5–6.6 mg/kg SC, IV, or IM Q 24 H for 7–14 days	<i>Francisella tularensis</i>

Infected bobcats are the wild animal reservoirs and chronically infected domestic cats are the urban reservoirs. Cytauxzoonosis is seen in domestic cats throughout the central, southeastern, and south central U.S., including Missouri, Arkansas, Florida, Georgia, Louisiana, Mississippi, Oklahoma, Texas, Kentucky, North Carolina, South Carolina, Tennessee, Alabama, Kansas, Illinois, Ohio, and Virginia.<sup>16–18</sup>

Seasonal activity of ticks is a key component in the transmission of *C felis* to cats because the number of cytauxzoonosis cases increase when *A americanum* is more active.<sup>19</sup> In addition, outdoor cats living in the wooded habitats, where reservoir hosts and ticks are present, are at higher risk for *C felis* infection.<sup>17</sup> Neither age nor breed predisposition for infection in cats has been documented.

**Diagnosis.** Infection with *C felis* in domestic cats causes severe, acute disease characterized by fever, inappetence, anorexia, dyspnea, and icterus. The disease progresses quickly, with fatalities reported 1 to 7 days after clinical signs. Diagnosis of cytauxzoonosis was historically based on observation of *C felis* piroplasms in stained thin blood smears by light microscopy; however, the current gold standard is detection of *C felis* DNA extract from anticoagulated whole blood by polymerase chain reaction (PCR) amplification, which allows detection of infection prior to onset of clinical signs.<sup>20</sup>

**Treatment.** Recommended treatment for cytauxzoonosis is atovaquone (15 mg/kg PO Q 8 H), along with azithromycin (10 mg/kg PO Q 24 H) and excellent nursing care.<sup>21</sup> Historically, imidocarb dipropionate was used, but is no longer recommended due to its lack of efficacy and side effects.<sup>21</sup>

In cats that are too ill for oral medication, consideration should be given to administration of azithromycin intravenously as a slow infusion. However, this is off-label use of the

human intravenous azithromycin preparation. Azithromycin is administered at the same dose orally and intravenously.

### Feline Granulocytotropic Anaplasmosis

**Transmission.** Infection with *A phagocytophilum* in cats causes feline granulocytotropic anaplasmosis. In the U.S., *A phagocytophilum* is transmitted by *I scapularis* and *I pacificus*. Although *A phagocytophilum* is a common tick-borne disease agent of deer, dogs, and humans in the northeastern part of the U.S., feline anaplasmosis is under recognized. In a survey of 460 blood samples collected throughout the U.S., 20 (4.3%) had antibodies against *A phagocytophilum*.<sup>22</sup>

**Diagnosis.** Clinical signs of feline anaplasmosis include fever, lethargy, anorexia, joint pain, lameness, enlarged lymph nodes, weight loss, periodontal disease, conjunctivitis, and neurologic signs.<sup>13,23</sup> Diagnosis can be based on clinical signs, history of tick exposure, and microscopic detection of morulae within neutrophils in acutely infected cats. However, morulae may be difficult to find as rickettsemia can be low.

Recently, serologic methods, such as an immunofluorescence assay (IFA) and enzyme-linked immunosorbent assay (ELISA) followed by PCR, are preferred for diagnosis confirmation. However, several studies noted negative PCR results from cats that were clinically ill and antibody positive.<sup>22–24</sup> These confounding results in DNA and antibody-based diagnoses may be due to *A phagocytophilum* being sequestered in low numbers in tissues, or infected cats quickly clearing the rickettsial agent.

**Treatment.** Recommended treatment of cats with anaplasmosis includes supportive care, fluid therapy, and doxycycline (10 mg/kg PO Q 24 H for 28 days).<sup>9,13</sup>

### Tularemia

**Transmission.** Tularemia—an infection caused by *Francisella tularensis*—is a notifiable zoonotic disease that occurs naturally in the U.S.<sup>20</sup> Cats, dogs, and humans are exposed to *F tularensis* through direct contact with infected wildlife, vectors, or contaminated environment; cats are more susceptible to tularemia than dogs.

Throughout the U.S., *F tularensis* transmission to cats occurs via bites from infected *A americanum*, *D andersoni*, *D occidentalis*, and *D variabilis*. Cats can also be exposed to the disease from hunting and eating infected wildlife, such as cottontail rabbits, hares, and rodents.

**Diagnosis.** Clinical signs in cats include fever, anorexia, marked depression, dehydration, lymphadenopathy, splenomegaly, hepatomegaly, icterus, and acute oral or lingual ulcers. Diagnosis is most commonly based on clinical signs and confirmed by a titer rise in specific serum antibodies.

**Treatment.** Treatment of choice is gentamicin (5–6.6 mg/kg SC, IV, or IM Q 24 H for 7–14 days).<sup>4</sup>

### Lyme Borreliosis

**Transmission.** Lyme borreliosis is caused by infection with the spirochete, *B burgdorferi*. Despite antibodies to *B burgdorferi* being found in cats from endemic areas, a distinct clinical entity has not been described. However, cats are hosts for the tick vectors, *I scapularis* and *I pacificus*, and a prevalence of antibodies to *B burgdorferi* (up to 47%) has been reported in endemic areas of the northeastern U.S.<sup>11</sup>

**Diagnosis & Treatment.** Cats experimentally infected with *B burgdorferi* showed signs of lameness and multilocalized inflammation, such as arthritis and meningitis.<sup>12</sup> Recommended treatment for suspected Lyme borreliosis in cats is doxycycline (10 mg/kg PO Q 12–24 H for 28–30 days).<sup>11,12,23</sup>

### Feline Monocytotropic Ehrlichiosis

**Transmission.** Feline monocytotropic ehrlichiosis is caused by infection with an *Ehrlichia canis*-like agent.<sup>5</sup> Pathogenesis of feline ehrlichiosis is still unknown, and even though a large number of suspected feline ehrlichiosis cases have been reported, *E canis*-like DNA has been demonstrated from only a few infected cats.<sup>5</sup>

**Diagnosis.** Clinical signs include fever, lethargy, inappetence, weight loss, and polyarthritis. Diagnostic criteria for feline ehrlichiosis have not yet been established, although positive serology and organism detection in blood support the diagnosis.

**Treatment.** For cats with suspected clinical ehrlichiosis, administration of doxycycline (10 mg/kg PO Q 24 H for a minimum of 28 days) is recommended.<sup>5,9</sup>

### Tick Toxicity/Paralysis

**Transmission.** Tick paralysis—induced by compounds secreted in the saliva of feeding ticks—is a serious and potentially fatal neurologic disease affecting domestic animals, companion animals, and humans. This disease has been reported worldwide, including North America, Europe, Asia, South Africa, and eastern Australia.<sup>1</sup>

Most studies have focused only on humans and dogs; cases in cats have been limited. However, tick paralysis in cats, caused by infestation with *I holocyclus* and *I cornuatus*, is considered a common condition in Australia.<sup>19,25</sup> While cases of feline tick paralysis have not been reported in the U.S., canine cases are common and are associated with infestation by *D variabilis*, which infests cats.<sup>1</sup>

**Diagnosis.** Common clinical signs include hindlimb weakness, ataxia, pupillary dilation, and dysphonia or aphonia due to laryngeal paralysis. Additionally, retching, vomiting or regurgitation, and bladder voiding dysfunction may occur. Diagnosis in cats is generally determined by detection of ticks, along with typical clinical signs.<sup>26</sup>

### Removing Ticks from Cats

If only a few ticks are present on a cat, manually remove individual ticks with forceps and gloved hands. When cats are heavily infested with ticks, or too fractious to handle, sedation may facilitate tick removal and acaricide application.

To remove an intact tick:

1. Use fine forceps to grasp the tick as close to the skin surface as possible.
2. Pull the tick straight upward slowly and steadily.
3. Save the removed tick in a vial with isopropyl or 70% ethanol for identification.

Certain methods, such as suffocation with petroleum jelly, heat from matches, and acetone (finger nail polish remover), should *never* be used to remove a tick. These methods are not effective, may interfere with tick identification, and may increase the likelihood of pathogen transmission through regurgitation.<sup>27,31</sup>

TABLE 3.  
Parasiticides Recommended for Controlling Ticks in Cats<sup>32-34</sup>

DRUGS	DOSAGES	TICKS
Etofenprox (combined with fipronil, (S)-methoprene, or pyriproxyfen)	15%–55% spot-on	<i>A americanum</i> , <i>D variabilis</i> , <i>I scapularis</i> , <i>R sanguineus</i>
Fipronil	0.29% spray 9.7% spot-on	All stages of <i>A americanum</i> , <i>D variabilis</i> , <i>I scapularis</i> , <i>R sanguineus</i>
Flumethrin (combined with imidacloprid)	4.5% flumethrin + 10% imidacloprid collar	All stages of <i>A americanum</i> , <i>D variabilis</i> , <i>I scapularis</i> , <i>R sanguineus</i>

**Treatment.** The 3 key components for treating cats affected by tick paralysis are (1) removal of tick(s), (2) administration of canine-derived tick antitoxin serum (TAS), and (3) supportive care. Recovery time varies depending on severity of disease. Prognosis for cats is better than that for dogs.<sup>26</sup>

**CONTROLLING & PREVENTING TICKS (Table 3)**

To reduce the risk of tick infestation and tick-borne disease, we recommend:

1. Keeping cats indoors
2. Year-round use of approved acaricidal products for all pets in the household
3. Home hygiene and environmental management.

**Acaricides**

Acaricides should be applied to both outdoor and indoor cats because:

- Indoor cats are still at risk for *R sanguineus* infestation
- Other pets and humans can transport ticks into the home.

Currently, etofenprox, fipronil, and flumethrin are approved acaricides for use on cats.<sup>27</sup>

- Etofenprox is compounded as a 3.6% spot-on for cats.
- Fipronil is available as a 0.29% alcohol-based spray and 9.7% solution for spot-on

administration to cats.<sup>28</sup>

- Flumethrin is available as a combination product of 10% imidacloprid and 4.5% flumethrin.<sup>29</sup>

Application of the 10% imidacloprid/4.5% flumethrin collar was shown to protect cats against the transmission of *C felis* from infected *A americanum*.<sup>30</sup>

**Management of Home & Environment**

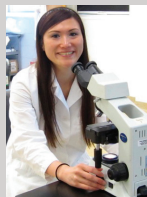
Home hygiene and environmental management are essential for controlling ticks.

- When a home or kennel has been infested by ticks (*R sanguineus*), acaricidal sprays, such as cyfluthrin, permethrin, or other pyrethroids, can be used to treat the environment.<sup>27</sup>
- Tick populations around homes may be reduced by eliminating areas that provide adequate tick habitats, such as tall grass, shrubs, litter, bushes, and ground cover.
- Since most ticks are susceptible to desiccation, altering the landscape to increase sunlight and lower humidity through cleaning, mowing, and/or burning reduces the number of ticks. These changes—in this bullet and the previous one—also reduce the presence of wildlife that carries and transports ticks.<sup>27,31</sup>
- Chemical products, including carbaryl, cyfluthrin, permethrin, and s-fenvalerate, can help control outdoor tick populations. These



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acaricides should be applied to the perimeter of a yard rather than broadcast over a large area.<sup>27</sup>

- Products or substances used for environmental control of ticks should not be used on cats, unless they are specifically labeled for that use.

ELISA = enzyme-linked immunosorbent assay; IFA = immunofluorescence assay; PCR = polymerase chain reaction; TAS = tick antitoxin serum

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