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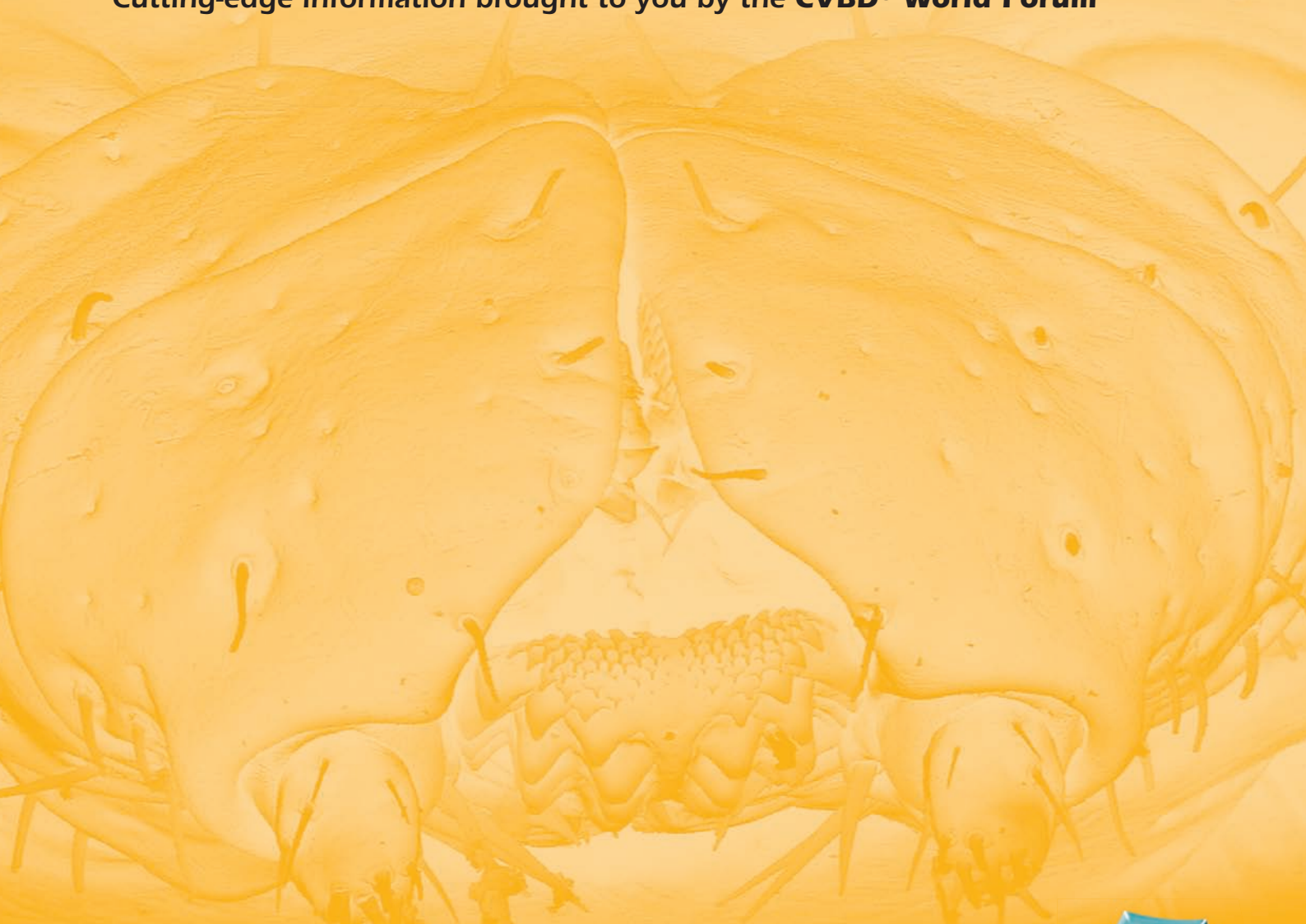
**CVBD<sup>®</sup>**

**DIGEST**

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# The Brown Dog tick – dogs' ubiquitous enemy

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## Quick Digest

### From endemic ...

- The Brown Dog tick *Rhipicephalus sanguineus*, the most widely distributed tick in the world, is active in tropical and subtropical regions as well as increasingly in temperate regions.
- It is highly adapted to living and developing in and around domestic dwellings in both rural and urban areas.

### ... to non-endemic areas

- Global warming could result in the further establishment of tick populations in non-endemic regions, like northern temperate Europe.
- Veterinarians in Northern Europe often find Brown Dog ticks attached to dogs returning from a southern holiday location.

### From host specificity...

- All three stages of the Brown Dog tick suck blood predominantly on dogs.
- In *R. sanguineus* females, the feeding process lasts between two days and several weeks, with alternating periods of salivation, blood sucking and regurgitation.
- Male ticks remain on the dog for a longer period, taking multiple intermittent blood meals.

### ... to zoonosis

- The Brown Dog tick can occasionally parasitize other vertebrate hosts, including humans and small animals such as rabbits and other rodents.
- The human infestation has more often been described in European countries than South American countries.

### Disease transmission

- The Brown Dog tick may be regarded as a true Pandora's Box, capable of transmitting several diseases to dogs, including babesiosis, ehrlichiosis, rickettsiosis, and hepatozoonosis to dogs.
- *R. sanguineus* has been described as a vector for the human rickettsioses, Rocky Mountain spotted fever (*Rickettsia rickettsii*) and Mediterranean spotted fever (*R. conorii*).

### Prevention

- Prevention of tick bites is crucial to minimize disease transmission.
- Treatment with an ectoparasiticide product with repelling and killing activity against ticks presents the best option for prevention of bites.

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## The Brown Dog tick – dogs' ubiquitous enemy

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The Brown Dog tick *Rhipicephalus sanguineus* is perhaps the most widely distributed tick in the world, being active throughout the year not only in tropical, subtropical regions but also increasingly in temperate climates. Highly adapted to living and developing in and around domestic dwellings it is found in both rural and urban areas, living alongside its main host the domestic dog. Prevalence and infestation levels within the dog population vary widely with factors such as season and geographical location, indicating that this is a tick very capable of adopting different strategies for survival.

The Brown Dog tick *Rhipicephalus sanguineus* is an established vector of several bacterial, viral, protozoal and helminth pathogens resulting in an array of canine vector-borne diseases (CVBDs), including but not limited to ehrlichiosis, babesiosis, rickettsiosis and hepatozoonosis. Although *R. sanguineus* parasitizes mainly dogs, it will also bite other mammals, including humans, particularly in highly infested environments. Changes in the feeding patterns of *R. sanguineus* at higher temperatures suggest that global warming may act not only to broaden this tick's geographical distribution, but also to increase

the risk of human parasitism and disease transmission. Thus, control of this tick and the prevention of associated tick-transmitted pathogens are of great importance for veterinarians and increasingly for public health.

### Tick Family and Diversity

The role of ticks as vectors or reservoirs of different pathogens remains the focus of extensive research and concern to medical and veterinary professionals. Acarids may be regarded as a true Pandora's Box, capable of transmitting various pathogens, including bacteria, viruses, protozoa and helminths that represent a large proportion of CVBD.

**Note:** Ticks are capable of transmitting various pathogens including bacteria, viruses, protozoa and helminths and the majority of CVBDs.

Ticks are obligate blood-feeding arthropods that require an animal host to survive and reproduce. The two major tick families are: Ixodidae or hard ticks and Argasidae, soft ticks. Hard ticks are named so because of their sclerotized dorsal plate (scutum). The scutum is present on all mobile stages of the



**Fig. 1** Electron microscopy of Brown Dog tick from the A) dorsal and B) ventral side C) Complete dorsal view (light microscopy) of an adult male tick (With kind permission of Filipe Dantas-Torres, Bari, Italy)

tick and differs in shape and other characteristics between tick genera. *Rhipicephalus sanguineus*, commonly known as the “Brown Dog tick” or “kennel tick”, belongs to the family Ixodidae and is probably the most important for veterinarians globally. The Argasidae or soft ticks are of leathery appearance and have a capitulum located underneath the body which cannot be seen from above. Soft ticks are generally nest inhabitants, associated with rodents, birds, or bats but several species also attack humans and transmit diseases.

### The Brown Dog Tick: Morphology and Distribution

Generally, ticks are morphologically distinguished by at least six different features:<sup>1</sup> shape, size, color, mouth parts (capitulum), dorsal shield (scutum) and festoons (posterior abdominal grooves that look like a string of pearls).

*R. sanguineus* ticks have a characteristic reddish-brown coloration, an elongated body shape and short palps. They have eyes, festoons and a hexagonal basis capitulum which is an identifying characteristic (see Fig. 1A and B).

Adult males are flat, about 2–3 mm long, reddish-brown with tiny pits scattered over the back. Prior to taking a blood meal, the females resemble the males in size and shape, but swell markedly in size (>1 cm) on engorgement with the enlarged portion of the body changing in colour to gray-blue or olive.<sup>2</sup> The six-legged larvae and the nymphs are of smaller size (larvae <1 mm in length, nymphs <2 mm long) (see Fig. 1C).

### Distribution

*R. sanguineus* is distributed almost globally, particularly within the latitudes of 35° S and 50° N (as reviewed by Dantas-Torres, 2008)<sup>2</sup>, so that it is abundant in tropical and subtropical regions as well as in moderate to warm climate zones. In tropical and subtropical areas, the ticks are active throughout the year, in moderate to warm regions at least from late spring to early autumn. It has been shown that the Brown Dog tick can develop well under various conditions in terms of temperature (20–35 °C) and relative humidity (35–95 %).<sup>3</sup> However, at low temperatures (e.g., 10 °C), engorged larvae and nymphs may undergo a diapause.

**Note:** *R. sanguineus* is distributed almost globally, particularly within the latitudes of 35° S and 50° N. It is abundant in tropical and subtropical regions as well as in moderate to warm climate zones.

It has been suggested that global warming could result in the establishment of populations of the *R. sanguineus* group in non-endemic regions, like northern temperate Europe.<sup>4,5</sup> It is not unusual currently for veterinarians in northern European countries to detect a Brown Dog tick attached to dogs returning from a southern holiday location.

*R. sanguineus* is an endophilic tick that prefers a dry and warm environment and is adapted to indoor living. Thus, ticks are closely associated with homes, kennels or yards where dogs and people are present. The main host for this tick are domestic dogs living in urban as well as rural regions.<sup>6,7,8</sup> In general, the rate of tick infestation is higher among



**Fig. 2** Developmental stages of the the Brown Dog tick. A) Female oviposition, B) larvae, and C) nymphs  
(With kind permission of Filipe Dantas-Torres, Bari, Italy)



free-ranging dogs than pet dogs<sup>7</sup>, and houses with gardens are found to be a more suitable environment than the surrounds of large buildings.<sup>9</sup>

Most of the time ticks do not reside on the dog but rather in the environment in refuges like crevices and cracks of rocks and outside stone walls in warm regions and in heated housing and garages in colder ones.<sup>10</sup>

## Ecology/Biology – Life cycle

Ticks have four life stages: egg, larva, nymph and adult. Larvae and nymphs moult to the next stage following digestion of a blood meal. After feeding on the host, the adult female tick produces a single large batch of eggs and dies.

**Note:** An average of 1,500 – 4,000 eggs is laid by the female tick. Depending on conditions like temperature and humidity, larvae will hatch from 6 days up to some weeks.

Mating of *Rhipicephalus* ticks occurs solely while adult ticks are on the host animal. The male parasite climbs onto the female and transfers the spermatophore to the female genital aperture.<sup>11</sup> The ingestion of blood is considered a major stimulus for spermatogenesis and oogenesis in male and female ticks, respectively. The engorged female then drops to the ground and after a period of three days to some weeks deposits her eggs. An average of 1,500 – 4,000 eggs is laid by the female Brown Dog tick (see Fig 2A).<sup>12,13</sup> Depending on conditions like temperature and humidity, larvae will hatch from the eggs from six days to some weeks (see Fig 2B). The six-legged, tiny light brown larvae need to attach to a host in order to get a blood meal. Larvae feed to repletion on one host, drop to the ground and moult to a nymph which closely resembles the adult tick with eight legs (see Fig 2C). After feeding on a host, the engorged nymphs drop to the ground and moult to adult ticks.

For both larvae and nymphs, the moulting process is dependant on environmental conditions. At low temperatures, larval and nymphal moulting as well as successful oviposition and egg hatch are unlikely.<sup>3,15</sup> The higher the temperature, the shorter the moulting period becomes.<sup>3</sup>



Fig. 3 Tick infestation of a dog  
(With kind permission of Filipe Dantas-Torres, Bari, Italy)

## Infestation

The prevalence of tick infestations on dogs is highly variable, depending for instance on geographic region, density of the dog population and application of acaricides.

**Note:** Males can remain on the host for a longer time, taking multiple blood meals intermittently. They do not enlarge with feeding as females do.

Ticks detect their hosts by several means: odors (including carbon dioxide, ammonia and lactic acid), body heat, moisture, vibration, and for some species, visual cues like a shadow. Ticks cannot fly or jump, so when they are approached by a potential host, they must make direct contact with that host. Once on the dog, *Rhipicephalus* ticks can attach anywhere on the animal, although they prefer the ears, inguinal and axilla regions, inter-digital spaces and the back. The tick attaches to the host by using its chelicerae to pierce the skin and subsequently inserts its hypostome and chelicerae into the epidermis (see Fig. 3). The feeding process lasts between two days and several weeks for Brown Dog tick females<sup>12,15</sup> comprising alternating periods of salivation, blood sucking and regurgitation.<sup>16</sup> This is of great importance for the transmission of pathogens during the blood meal. Tick saliva contains a variety of substances that facilitate the tick's attachment and the blood-feeding process and also suppress the immune and inflammatory

response of the host allowing them to remain attached for an extended period of time. Male ticks can remain on the host for a longer period of time than females, taking multiple intermittent blood meals and do not enlarge with feeding as females do.

After feeding and dropping off the host, the Brown Dog tick hides in all kinds of cracks and crevices closely associated with yards, homes and kennels, but also small animal hospitals or pet bedding areas. In case of highly infested homes, *R. sanguineus* ticks can be found crawling on carpets, walls, and furniture.<sup>17,18</sup>

The tick burden of individual dogs living together can vary greatly. Some might be infested by a single tick, while others host hundreds. The reasons for this are not well-understood but the age and breed of the dog may be factors contributing to this phenomenon. Young dogs have been reported to show higher infestations than older ones.<sup>8,19</sup> A recent study has shown that *R. sanguineus* displays distinct

behavioural patterns in response to odors from different dog breeds.<sup>20</sup>

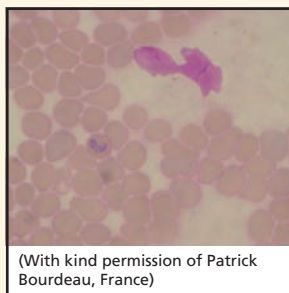
*R. sanguineus* can occasionally parasitize other vertebrate hosts including humans.<sup>21,18</sup> Immature stages can be found on rodents and other small mammals while adults seem to prefer larger animals. Infestation of cats, rabbits, wild canids and rodents have been reported. The human infestation has more often been described in European countries than South American countries.<sup>22,23</sup>

### Transmission of canine diseases

Pathogens of veterinary significance transmitted by *R. sanguineus* include *Babesia canis*, *Ehrlichia canis* and *Hepatozoon canis* – the etiological agents of canine babesiosis, canine monocytic ehrlichiosis and canine hepatozoonosis, respectively (INFO BOX 1).<sup>2</sup> It has been suggested, but not definitely proven that *R. sanguineus* ticks may transmit other pathogens, such as *Anaplasma platys*<sup>24</sup> and *Leishmania infantum*.<sup>25</sup>

## INFO BOX 1

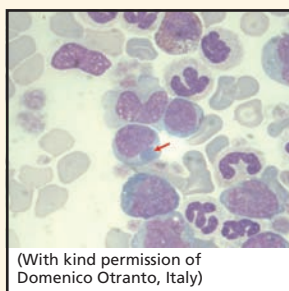
### IMPORTANT CVBDs TRANSMITTED BY *R. SANGUINEUS*



(With kind permission of Patrick Bourdeau, France)

**Babesiosis** is a parasitic infection caused by protozoa of the genus *Babesia*, e.g. *B. canis* or *B. gibsoni*. The protozoa invade erythrocytes causing hemolysis and consequently the complex disease,

babesiosis, which varies in severity from subclinical infection through to generalised organ failure and death. The most common clinical finding in dogs is hemolytic anemia (see also Digest No. 4, 2009).



(With kind permission of Domenico Otranto, Italy)

**Ehrlichiosis** is caused by obligate intracellular bacteria, *Ehrlichia* spp. which have tropism for hematopoietic cells. Canine monocytic ehrlichiosis (CME), a potentially

fatal disease in dogs, is caused by *E. canis*. Infection is often lifelong even following antibiotic treatment. Chronically infected dogs may remain asymptomatic or develop severe illness. Thrombocytopenia is the most consistent hematologic finding of ehrlichiosis (see also Digest No. 7, 2010).



(With kind permission of Gad Beneth, Israel)

**Hepatozoonosis** is caused by two apicomplexan species: *Hepatozoon canis* and *Hepatozoon americanum*. *H. canis* infection results in mild disease whereas

*H. americanum* almost always causes severe disease leading to debilitation and death. Marked neutrophilia is a consistent hematologic finding in *H. americanum* infection. Transmission is via ingestion of the infected tick or parts thereof (see also Digest No. 6, 2009).

Pathogens are passed from the female tick to her progeny (transovarial) and through successive life stages of the tick (transstadial). Thus, *R. sanguineus* ticks can serve both as a vector and reservoir of some pathogens (e.g. *Rickettsia conorii*). The prevalence of disease within *R. sanguineus* ticks varies by geographical region.

**Note:** The prevalence of infection of *R. sanguineus* ticks with the different pathogens is strongly dependent on the geographic region.

## Public Health Impact

*R. sanguineus* ticks have been described as vectors of *Rickettsia rickettsii*, the etiological agent of Rocky Mountain spotted fever (RMSF) in different regions of the United States<sup>25,26,27,17</sup> and as reservoirs of *R. conorii*, the etiological agent of Mediterranean spotted fever.<sup>28</sup>

## Prevention/Tick Control Strategies

For effective tick control, consideration should be given both to ticks on the dog and in the environment. Therefore, different measures are required including a regular search for ticks on the dog, treatment of the dog, indoor and outdoor treatment.

### Treatment of the dog

The prevention of tick bites is crucial to reduce the risk of tick-borne protozoal, bacterial and viral diseases (TBDs). The longer the tick feeds on the host, the more likely that it transmits pathogens. For most tick-borne pathogens, a pre-activation period of about 4–48 hours is assumed before they are transmitted to the host.<sup>30,38</sup> Thus, dogs should be searched regularly for ticks and those found removed as soon as possible. The use of fine-tipped tweezers or special tick removal devices allows removal without squeezing the tick body. In areas where diseases like Rocky Mountain spotted fever are endemic, extra care should be taken to avoid the contact with tick fluids which might contain *Rickettsia* and other pathogens.

## INFO BOX 2

### EMERGING *R. SANGUINEUS* THREAT IN THE U.S.

Original article<sup>29</sup> by Jennifer McQuiston, Rickettsial Zoonoses Branch, Center for Disease Control and Prevention, Atlanta, USA.

"Some new aspects of RMSF disease ecology are emerging. Beginning in 2003, a focus of RMSF was identified in eastern Arizona associated with transmission from *Rhipicephalus sanguineus*, the Brown Dog tick. This outbreak represented the first time this tick species was recognized as a vector for *R. rickettsii* transmission in the United States, although the tick had been previously reported to transmit the agent in Mexico and some parts of Latin America.

Since the initial outbreak, the problem has expanded and now appears firmly established

as an enzootic focus in eastern Arizona. In eastern Arizona the annual incidence is more than 400 cases per million persons, or over 60 times the national rate.

The ecologic cycle for *R. sanguineus*-associated *R. rickettsii* is less well understood than that of the traditional *Dermacentor*-associated cycle.

Transovarial transmission occurs, but additional animal reservoirs have not been identified.

Although *R. sanguineus* has been found on a number of mammalian hosts, the strong preference of this tick to feed on dogs for each of its life cycles suggests that dogs could possibly contribute to maintaining the infection in this region."



Child's right hand and wrist displaying the characteristic spotted rash of Rocky Mountain spotted fever (CDC)



For preventive treatment of dogs, products with both acaricidal activity and repellent properties are preferred.

**Note:** The prevention of tick bites is crucial to reduce the risk of tick-borne protozoal, bacterial and viral diseases. The longer the tick feeds on the host, the more likely it is that it transmits pathogens.

#### Indoor and outdoor treatment

The level of environmental infestation may be reduced by removing tick refuges. Cracks and crevices should be sealed, grass and weeds should be kept cut short and debris on the property removed. A variety of products with acaricidal activity is available for indoor and outdoor treatment. The application should be done carefully with light, spot treatments in places where ticks are known to be hiding.

**Note:** Depending on the level of environmental infestation and conditions, some additional outdoor treatment might be required. Detection and elimination of tick refuges are important, but can be difficult.

#### Vaccination

Vaccines targeting the tick vector would contribute greatly to the prevention of tick infestations and disease transmission and to some degree have been demonstrated with the development of vaccines that reduce *Boophilus* spp. infestations on cattle.<sup>31,32,33</sup>

However, an "anti-tick" vaccine for use in dogs is currently not available and does not seem likely in the near future. Dogs do not appear to develop immunological activity against ticks. The development of vaccines targeting the tick-transmitted pathogens may be an appropriate alternative strategy.





## INFO BOX 3

### R. SANGUINEUS CONTROL ON DOGS

The tick control provided by modern ectoparasitocides has become a pivotal part of canine preventive health care. However field studies evaluating tick efficacy and associated reduction in disease transmission risk under real life conditions are rare. In 2005 Otranto and colleagues performed a detailed field study evaluating tick infestation in dogs over a period of 2 months.<sup>35</sup> They monitored kennels in Southern Italy in a region heavily infested by

the Brown Dog tick. These dogs were divided into three groups, two of which were treated at day 0 and day 28 with imidacloprid (10%)/permethrin (50%) and fipronil (10%)/(S)-methoprene (12%) respectively, and the third left untreated as a control group. At days 28 and 56, adult and immature ticks on the dogs were collected and counted. Results in immature ticks were observed as shown below (Fig. 4).

Days post-treatment	Imidacloprid (10%)/permethrin (50%)		Fipronil (10%)/(S)-methoprene (12%)		Untreated control
	Immature tick count	% efficacy	Immature tick count	% efficacy	Immature tick count
28	15.1	98.5	230.8	77.4	1,021.4
56	0.8	99.9	105	81.3	560.3

Fig. 4 Mean tick load of, and percentage efficacy against, immature ticks in groups treated on days 0 and 28 with imidacloprid 10%/permethrin 50% and fipronil 10%/methoprene 12% versus untreated controls.

The authors proposed that the significant difference in efficacy observed between the treatment groups against immature ticks could be due to a reduction below effective levels of the active ingredient fipronil and/or to a higher efficacy of permethrin against this stage of tick due to its repellent activity.

**Immature ticks, like adults, carry a disease transmission risk and are important for maintenance of populations in the environment.**

The reduction of disease transmission risk of *Ehrlichia canis*, *Anaplasma platys* (although presumably transmitted by *R. sanguineus*, the role of ticks in the transmission of *A. platys* has not been proven) and *Babesia* spp. associated with the Brown Dog tick has also been investigated in large scale field studies (see Fig. 5).<sup>36,37</sup> These have shown that by using an acaricide with repellent activity, the transmission of tick-borne diseases can be significantly reduced.

CVBD	Reduction in infection (%)
<i>Ehrlichia canis</i>	94.6
<i>Babesia</i> spp.	94.4
<i>Anaplasma platys</i>	81.9

Fig. 5 Reduction of transmission risk for different CVBD® pathogens<sup>5</sup> in a field study of kennel dogs in South Italy. Imidacloprid (10%)/permethrin (50%) was administered each 21\* days for 12 months. Overall tick efficacy against *R. sanguineus* was 97.9%.<sup>37</sup>

\* The 3-week treatment interval was in accordance with EU label indications for sand flies. Previously published data showed no difference in protection against *L. infantum* and *E. canis* transmission using either a 2- or 4-week interval.

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