Bitten by Change: The Unfolding Story of Emerging Tick Risks in the United States

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Overview

Ticks pose an increasing health risk to people and pets, primarily as vectors of numerous bacterial, protozoal and viral pathogens[1,2]. In most areas in the U.S., ticks present a year-round threat, thus there is no true risk-free time of year as relates to ticks and tick-borne diseases. Further, the geographic distribution and density of several medically important tick species that bite pets and people continue to expand and increase. As ticks move into new areas, the pathogens they carry also move into these new areas. Along with the intensifying and expanding range of domestic tick species, introduction and establishment of foreign tick species into the U.S. presents an added an omnipresent threat, highlighted by the introduction of the Asian longhorned tick, *Haemaphysalis longicornis*[3]. In the absence of an arsenal of tick-borne pathogen vaccines, a comprehensive way to protect pets against ticks and reduce their risk of developing a tick-borne disease is year-round use of an effective tick control product.

Why do we care about ticks?

We care about ticks for a variety of reasons, including because they: i) are nuisance pests, ii) can cause direct injury (e.g. anemia, paralysis), iii) can initiate allergic responses (e.g. alpha-gal syndrome), and iv) can transmit pathogens. A list of ticks commonly found infesting dogs (and people) and their general geographic distributions in the U.S. is provided in **Table 1**.

In the U.S., ticks are the most common arthropod vectors of disease for people and pets, capable of transmitting a variety of bacterial, protozoal, and viral pathogens. **Table 2** includes a list of the most common tick-borne pathogens reported in pets and people in the U.S. and the tick species associated with their transmission. For most of the listed pathogens, the tick initially acquires the pathogen from an infected wildlife host reservoir and then maintains that pathogen through the remainder of its individual life span, capable of transmitting the pathogen when it feeds on its next host. Few of the listed pathogens are vertically transmitted passed from the female tick to her progeny (notable exceptions include many of the viral pathogens, and some *Rickettsia* species). An excellent resource of monitoring where pets and people are at greatest risk for three major tick-borne diseases (Lyme disease, anaplasmosis, ehrlichiosis) is the Companion Animal Parasite Council[2]. The CDC also has excellent information on the clinical signs and case incidence of tick-borne diseases of concern for people[4]. It's important to remember that people and pets often share similar risk factors for encountering ticks and being infected with a tick-borne pathogen (most of which are zoonotic – the pathogen can infect people and animals)[7]. Because of these shared risk factors, a pet that tests positive for a tick-borne pathogen means that pet has been in an area with infected ticks, which means that the pet owner was also likely in an area with infected ticks. Direct transmission of tick-borne pathogens between pets and people is exceedingly rare.

Table 1. Ticks commonly in U.S.[5]

Common name	Scientific name	Geographic distribution in the U.S.
Black-legged tick (aka: deer tick)	*Ixodes scapularis*	Widely distributed in throughout eastern half of the U.S.
Western black-legged tick	*Ixodes pacificus*	Pacific coast
Lone star tick	*Amblyomma americanum*	Widely distributed in eastern, southeastern, and southcentral U.S.
American dog tick	*Dermacentor variabilis*	Widely distributed in east of Rocky Mountains
American dog tick	*Dermacentor similis*	West of Rocky Mountains, Pacific coast
Rocky Mountain wood tick	*Dermacentor andersoni*	Rocky Mountain states
Brown dog tick	*Rhipicephalus sanguineus*	Distributed throughout U.S. Prefers to infest dwellings.
Gulf coast tick	*Amblyomma maculatum*	Coasts areas of east coast, Gulf Coast, and south-central U.S.
Asian longhorned tick	*Haemaphysalis longicornis*	Eastern U.S., eastern central U.S.

Table 2. Tick-borne diseases most commonly reported from dogs and cats in the U.S.

Tick-borne disease	Pathogen name	Tick vector[Ω]	Zoonotic potential*
BACTERIAL			
Anaplasmosis	*Anaplasma phagocytophilum*	Black-legged tick	Yes
	Anaplasma platys	Brown dog tick	Unclear
Ehrlichiosis	*Ehrlichia canis*	Brown dog tick	Rare
	Ehrlichia ewingii	Lone star tick	Yes
	Ehrlichia chaffensis	Lone star tick	Yes
Lyme disease	*Borrelia burgdorferi*	Black-legged tick	Yes
Rocky Mountain spotted fever	*Rickettsia rickettsia*	American dog tick, Rocky Mountain wood tick, Brown dog tick	Yes
Spotted-fever rickettsiosis	Other spotted fever group Rickettsia species	American dog tick, Rocky Mountain wood tick, Brown dog tick, Lone star tick	Yes
Southern tick-associated rash illness (STARI)	*Borrelia lonestari* (?)	Lone star tick	Yes
Tick-borne relapsing fever	*Borrelia hermsii*	*Ornithodoros* species (soft tick)	Yes
	Borrelia turicatae	*Ornithodoros* species (soft tick)	Yes
Tularemia	*Francisella tularensis*	American dog tick, Rocky Mountain wood tick, Lone star tick	Yes
PROTOZOAL			
Babesiosis[€]	*Babesia gibsoni*	Brown dog tick	No (canids only)
	Babesia canis	Brown dog tick	No (canids only)
	Babesia conradae	Brown dog tick	No (canids only)
Cytauxzoonosis	*Cytauxzoon felis*	Lone star tick, American dog tick, Rocky Mountain wood tick	No (felids only)
Canine hepatazoonosis	*Hepatazoon americanum*[¥]	Gulf coast tick	No (canids only)

	Hepatazoon canis	Brown dog tick	No (canids only)
VIRAL			
Bourbon virus disease	Bourbon virus	Lone star tick	Yes
Colorado tick fever	Colorado tick fever virus	Rocky Mountain wood tick	Yes
Heartland virus fever	Heartland virus	Lone star tick	Yes
Powassan virus disease	Powassan virus	Black-legged tick	Yes

[Ω]Unless otherwise noted, tick-transmission of the pathogen occurs during the tick feeding process via tick saliva
*Can infect people and other animals
[€]Transmission of canine babesiosis can also occur via direct blood-to-blood transmission or dog bites between dogs. Human babesiosis in the U.S. is caused by *Babesia microti* (not infectious to dogs or cats).
[¥]Dog must eat an infected tick to become infected

What factors influence where ticks live?

To survive, ticks require hosts and environments with suitable temperature and humidity. The ticks that most commonly bite pets and people can be found in areas with tall grass, tree canopy, or other vegetative ground cover. These types of environments help regulate temperature extremes and improve humidity in addition to providing habitat for the wildlife species that ticks most commonly use as hosts. Places where wildlife species are active are places where ticks are more likely to be found. A notable exception is the brown dog tick, *Rhipicephalus sanguineus*, which preferentially utilize dogs as hosts for all life stages.

New Tick on the Block: Asian longhorned tick

The Asian longhorned ticks, *Haemaphysalis longicornis* was first observed in the U.S. in fall 2017 infesting sheep in New Jersey[6]. Since it's first identification, the Asian longhorned ticks is now found in 20 states in the U.S.[7] A unique characteristic of this tick species is that its parthenogenic (females can reproduce without males). In the U.S. there are 3 main clonal lineages of this tick species which suggests at least three separate introductions of this tick into the U.S.[8] Preferred habitat of the Asian longhorned tick are areas with tall grass and wooded areas. Asian longhorned ticks will infest and feed on a wide variety of hosts including livestock, wildlife, companion animals, and people. Factors facilitating the expansion of this tick species across the U.S. include its reproductive strategy (parthenogenic), animal movement (i.e. cattle, horse, wildlife, pets), and abundant areas with suitable habitat[9]. Health concerns for hosts infested with Asian longhorned ticks include: mass infestation potential leading to severe blood loss or exsanguination and pathogen transmission. Recent studies have demonstrated that Asian longhorned tick cannot transmit agents of Lyme disease or anaplasmosis[10-11]; however, it can support infection and transmission of *Rickettsia rickettsii*[12] and several tick-borne viral pathogens including Powassan virus, and Heartland virus[13-14]. For cattle, Asian longhorned tick, is a significant vector of Theileria orientalis, a protozal pathogen that causes a disease that clinically resembles and be misdiagnosed as bovine anaplasmosis[15].

Moving to a town near you: Expanding ranges of endemic tick species

Ixodes species: *Ixodes scapularis* are most densely concentrated in the northeast and upper Midwest of the U.S. but continue to expand southward and westward[16]. Western populations of *Ixodes* species have continued to expand but at a slower rate than eastern U.S. *Ixodes* populations.

Amblyomma americanum: The lone star tick is most densely concentrated in the southeast U.S. but continues to expand northward and westward, now found as far north as Maine and as fard west as western Kansas and Nebraska[17].

Dermacentor variabilis: Populations of American dog ticks are projected to re-double their populations northward in the northern U.S. and into Canada in response to warming climate trends[18].

Amblyomma maculatum: Gulf coast tick populations are most densely concentrated in the Gulf Coast regions in the U.S.; however, this tick has undergone wide population expansion into the Midwest and Great Plains through movement of livestock (e.g. cattle), into the eastern coastal regions through the movement of migratory birds, and central eastern U.S. through the movement of feral swine populations[19].

Impending tick threats for the U.S.

The U.S. is under constant threat for introduction of foreign tick species that could significantly impact U.S. livestock species and food security. Some of the foreign tick species that pose a risk if introduced into the U.S. are presented in Table 3. Each of these ticks are associated with pathogens that could impact livestock production and some could serve as additional vectors for current endemic tick-borne pathogens.

Table 3. Impending tick threats for the U.S.

Tick species	Common name	Pathogen(s)	Geographic distribution
Boophilus (Rhipicephalus) microplus	Cattle fever tick	*Babesia bovis, Babesia bigemina, Anaplasma marginale*	Texas quarantine zone, Central and South America
Boophilus (Rhipicephalus) annulatus	Cattle fever tick	*Babesia bovis, Babesia bigemina, Anaplasma marginale*	Central and South Amercica
Amblyomma varigatum	Tropical bont tick	Ehrlichia ruminantium	Caribbean, Africa
Rhipicephalus appendiculatus	Brown ear tick	Theilaria parva	Africa
Ixodes ricinus	Castor bean tick	Anaplasma phagocytophilum, Borrelia burgdorferi sensu lato	Europe

References

1. Centers for Disease Control and Prevention. Ticks. Accessed: Feb. 16, 2024. Url: https://www.cdc.gov/ticks/index.html
2. Companion Animal Parasite Council. Accessed: Feb. 16, 2024. Url: https://capcvet.org/
3. USDA Animal and Plant Health Inspection Service. The Asian Longhorned Tick. Accessed: Feb. 16, 2024. Url: https://www.aphis.usda.gov/aphis/maps/animal-health/asian-longhorned-tick

4. Centers for Disease Control and Prevention. Tickborne diseases of the United States. Accessed: Feb. 16, 2024. Url: https://www.cdc.gov/ticks/tickbornediseases/index.html
5. Centers for Disease Control and Prevention. Regions where ticks live. Accessed: Feb. 16, 2024. Url: https://www.cdc.gov/ticks/geographic_distribution.html
6. Rainey T, Occi JL, Robbins RG, Egizi A. Discovery of *Haemaphysalis longicornis* (Ixodida: Ixodidae) parasitizing a sheep in New Jersey, United States. *J Med* Entomol. 2018. 55(3):757-759.
7. APHIS sitrep. https://www.aphis.usda.gov/livestock-poultry-disease/cattle/ticks/asian-longhorned/asian-longhorned-tick-what-you-need-know
8. Egizi A, Bulaga-Seraphin L, Alt E, Bajwa WI, Bernick J, Bickerton M, et al. First glimpse into the origin and spread of the Asian longhorned tick, *Haemaphysalis longicornis*, in the United States. *Zoonoses Public Health*. 2020. 67(6):637-650.
9. Raghavan RK, Barker SC, Cobos ME, Barker D, Teo EJM, Foley DH, et al. Potential spatial distribution of the newly introduced long-horned tick, *Haemaphysalis longicornis* in North America. *Sci Rep*. 2019. 9(1):498.
10. Bruener NE, Ford SL, Hojgaard A, Osikowicz LM, Parise CM, Rizzo MFR, et al. Failure of the Asian longhorned tick, *Haemaphysalis longicornis*, to serve as an experimental vector of the Lyme disease spirochete, *Borrelia burgdorferi* sensu stricto. *Ticks Tick Borne Dis*. 2020. 11(1):101311.
11. Levin ML, Stanley HM, Hartzer K, Snellgrove AN. Incompetence of the Asian longhorned tick (Acari: Ixodidae) in transmitting the agent of human granulocytic anaplasmosis in the United States. *J Med Entomol*. 2021. 58(3):1419.
12. Stanely HM, Ford SL, Snellgrove AN, Hartzer K, Smith EB, Krapiunaya I, et al. The ability of the invasive Asian longhorned tick *Haemaphysalis longicornis* (Acari: Ixodidae) to acquire and transmit *Rickettsia rickettsii* (Rickettsiales: Rickettsiaceae), the agent of Rocky Mountain Spotted Fever, under laboratory conditions. *J Med Entomol*. 2020. 57(7):1635-1639.
13. Raney WR, Perry JB, Hermance ME. Transovarial transmission of Heartland Virus by invasive Asian longhorned ticks under laboratory conditions. *Emerg Infect Dis*. 2022. 28(3):726-729.
14. Raney WR, Herslebs EJ, Langohr IM, Stone MC, Hermance ME. Horizontal and vertical transmission of Powassan Virus by the invasive Asian longhorned tick, *Haemaphysalis longicornis*, under laboratory conditions. *Front Cell Infect Microbiol*. 2022. 12:923914.
15. Dinkel KD, Herndon DR, Noh SM, Lahmers KK, Todd SM, Ueti MW, et al. A U.S. isolate of *Theilaria orientalis*, Ikeda genotype, is transmitted to cattle by the invasive Asian longhorned tick, *Haemaphysalis longicornis*. *Parasit Vectors*. 2021. 14(1):157.
16. Eisen RJ, Eisen L, Beard CB. County-scale distribution of *Ixodes scapularis* and *Ixodes pacificus* (Acari: Ixodidae) in the continental United States. *J Med Entomol*. 2016. 53(2):349—386.
17. Monzon JD, Atkinson EG, Henn BM, Benach JL. Population and evolutionary genomics of *Amblyomma americanum*, an expanding arthropod disease vector. *Genome Biol Evol*. 2016. 8(5):1351-1360.
18. Minigan JN, Hager HA, Peregrine AS, Newman JA. Current and potential future distribution of the American dog tick (*Dermacentor variabilis*, Say) in North America. *Ticks Tick Borne Dis*. 2018. 9(2):354-362.

19. Sonenshine DE. Range expansion of tick disease vectors in North America: Implications for spread of tick-borne disease. *Int J Environ Res Public Health*. 2018. 15(3):478.