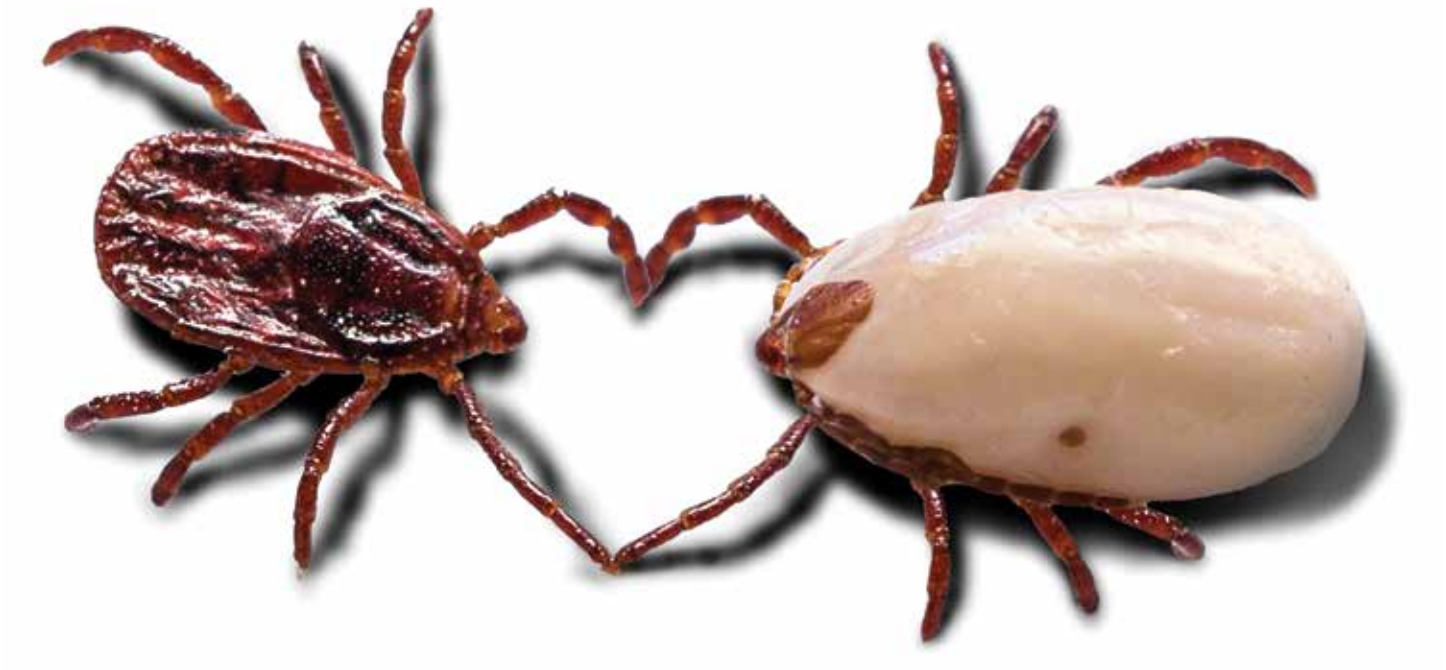

# TICKS ARE SPREADING IN NORTH AMERICA – AND BRINGING NEW DISEASES WITH THEM

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With the return of warm weather across North America, it's time to prepare for the return of mushroom season. And that means taking stock of gear, replacing worn out hiking boots, and adding yet another mushroom guidebook to your collection (despite what your friends tell you, you can never have too many!). And it means steeling yourself for the hazards that go along with outdoor pursuits, including bloodsuckers like ticks. Ticks are small creepy arthropods, and they don't merely steal our precious fluids, they can transmit a startling range of horrible diseases. This makes them a cause for concern for anyone who enjoys spending time in nature. Whether we venture off the beaten path into the wilderness or engage in activities such as mushroom hunting, it is crucial to exercise caution—and be educated. This review will update you on some tick-borne diseases that have been around for years, but also present information on newly emerging ones as well. Table 1 at the end has a quickie overview of all your favorite ticks and diseases; the callout box has information on one particular newly emerging disease that you should be familiar with.

**"Tick-borne diseases are the most important vector-borne disease in North America."**

In North America, ticks are carriers of numerous diseases, with Lyme disease being the most well-known. However, there are several other diseases that necessitate our attention, some of which are incredibly rare but still pose a significant threat to our well-being. Powassan virus, for instance, can be transmitted by ticks within only 15 minutes of biting. This virus is particularly dangerous as it can cause severe neurological damage.

Tragically, about one in every ten individuals who develop severe symptoms of Powassan virus succumb to brain inflammation, resulting in death. Additionally, nearly half of those who recover from the virus experience long-term issues with memory, balance, and speech. Although one death is always a heartbreak, it may seem less worrisome in regions densely populated with millions of people, appearing more like a statistical anomaly.

## Tracking the spread of ticks

Other than Lyme disease, tick-borne diseases are little known to the public and under-recognized by health experts. That's a problem, because research shows tick species are expanding into new areas and carrying greater amounts of pathogens as they move. And it's especially a problem because neither the USA nor Canada has set up a nationwide monitoring system that could identify

where tick species exist, how they are traveling, and what diseases they carry. You may be able to find numbers on disease incidence, thus the pathogen, but not the vector of the pathogen—the tick.

Ticks are complex creatures that survive by feeding on the blood of reptiles, birds, and mammals, including humans. They have intricate life cycles that involve feeding, resting, and metamorphosing into a different form. Tick species are region-specific, which means the diseases they carry are also limited to certain areas, although these boundaries are becoming less defined.

Tick-borne diseases are the most important vector-borne disease in North America. Many of those diseases are newly emerging. I personally remember when Lyme disease was first identified, just a few decades ago—now it is nearly everywhere. It may come as a surprise to many that ticks can transmit 16 different illnesses, as reported by the Centers for Disease Control and Prevention (CDC). The CDC estimated that the occurrence of tick and insect-borne illnesses tripled between 2004 and 2016, with ticks being responsible for at least 75 percent of this increase. It is challenging to determine exact numbers due to various factors, but CDC scientists estimate that over 476,000 Americans are diagnosed and treated for Lyme disease alone each year, based on insurance data.

These discoveries highlight the complexity and rapid spread of tick-borne diseases, underscoring the need for continued research and vigilance in monitoring and prevention efforts. The increase in ticks and tick-borne diseases is believed to be influenced by several factors, including global climate change, habitat fragmentation and loss/change of biodiversity, and changes in deer migration patterns. These factors contribute to the expansion of tick populations and the spread of tick-borne pathogens to new areas. As temperature zones move northward, it's reasonable to think the arachnids will follow. (And

## What is alpha-gal syndrome? Should I be worried?

Alpha-gal syndrome is a condition that causes allergic reactions in individuals after consuming red meat or other products containing the alpha-gal sugar. The exact mechanism of how the syndrome develops is not fully understood, and it is also uncertain how long a tick must be attached to transmit the condition. Typically, a few weeks to a few months after being bitten by a tick, victims of alpha-gal syndrome will start experiencing allergic reactions when they consume red meat (that is, of mammals). This reaction occurs due to the presence of alpha-gal, a sugar that is found in most mammalian meat except for primates. Humans with the syndrome react to this sugar. The allergic reactions usually manifest two to six hours after consuming meat or other products containing alpha-gal.

Currently, there is no known treatment or cure for alpha-gal syndrome. However, individuals can manage the condition by avoiding the consumption of foods that contain alpha-gal sugar. Chicken (and other poultry) and fish are generally safe options as they do not contain this sugar, unlike pork, venison, or beef. In some cases, the antibodies responsible for the allergic reaction may decrease over time, allowing some patients to reintroduce mammalian products into their diet after a few years. However, for others, alpha-gal syndrome may persist throughout their lifetime.

Alpha-gal syndrome is a widely prevalent and rapidly increasing condition. In the past 12 years, there have been over 110,000 suspected cases based on positive lab test results. However, due to a lack of awareness among healthcare providers, this number is believed to be an undercount, with estimations suggesting that up to 450,000 individuals may be living with the syndrome in the USA alone. The majority of alpha-gal cases are concentrated in the South, specifically in states such as Missouri, Arkansas, Tennessee, Kentucky, Virginia, North Carolina, and into the mid-Atlantic region. This geographical distribution coincides with the presence of the Lone Star tick, known to carry the alpha-gal allergen. Last year, Suffolk County, New York (on Long Island), had the most positive test results of any county in the USA. What contributes to such a high incidence of the disease there? There seems to be a high density of Lone Star ticks there, but there is likely more awareness of it in that area, so people are getting diagnosed in a more timely manner. And experts say this is crucial in getting treatment for all tick-borne diseases—early diagnosis.

Lone Star Tick - *Amblyomma americanum*

Blacklegged or Deer Tick - *Ixodes scapularis*

it's not just southern species moving northward, some species are also expanding westward, and still others are moving south.)

One example of the surprising nature of tick-borne diseases is the discovery of the Heartland virus and Bourbon virus. In 2009, CDC researchers investigating an unexplained illness in farmers in Missouri found a previously unknown tick-borne pathogen, later named Heartland virus. During their search, they also discovered another new tick-borne pathogen, Bourbon virus, which had caused a man's death in Kansas.

These emerging diseases can spread unnoticed, as shown by the detection of Heartland virus antibodies in wildlife in 13 states just six years after its initial discovery. Additionally, researchers found that the virus had been present in deer in Georgia since 2001, eight years before the first known human case.

## Lone Star tick and alpha-gal syndrome

The Lone Star tick, primarily found in the South, Midwest, and mid-Atlantic regions of the United States, and very rarely seen in Canada (for now), has been linked to a peculiar and potentially dangerous allergic reaction called alpha-gal syndrome. This syndrome can cause allergies to red meat, dairy products, gelatin, and certain medications with gelatin coatings. Weird, right? But it's definitely real. Briefly, the condition arises from the immune system's response to the sugar alpha-gal, which is present in the meat of most mammals, but not primates. (For more information, see box.)

According to the Centers for Disease Control and Prevention (CDC), over 110,000 individuals in the USA were found to have alpha-gal antibodies between 2010 and 2022. However, researchers believe that the actual number of people living with this condition might be closer to half a million, and the cases are on the rise.

Many healthcare providers are still unaware of this disease, with a CDC survey in 2022 showing that 42 percent had never heard of it. Even among those who were aware, over a third lacked confidence in diagnosing or managing the allergy. People with the syndrome can have various reactions if they consume animals or products containing alpha-gal sugar, ranging from diarrhea to anaphylactic shock. Unfortunately, there is currently no treatment, leading many patients to significantly change their diets for an extended period or permanently.

## And just when you thought things couldn't get worse . . . enter the Asian Longhorned tick

The emergence of *Haemaphysalis longicornis*, commonly known as the Asian Longhorned tick, recently detected in the USA is indeed a matter of concern. The fact that it is the first invasive tick to appear in the country in about 80 years raises potential challenges for both human health and agriculture. While it has not yet been found transmitting disease-causing pathogens to humans in North America, the concern is justified given its track record in Asia. The ability of *H. longicornis* to transmit pathogens raises the risk of potential disease transmission to humans and animals. The impact on animals and livestock is particularly worrisome. Severe infestations of these blood-feeding ticks can weaken animals by depleting their blood supply. (Some headlines have warned of "ticks that can kill cattle" and that they "swarm in such numbers as to bleed a cow to death.") This new invasive tick not only affects the health of individual animals but also poses economic challenges for the livestock industry. The unique ability of *H. longicornis* to reproduce via parthenogenesis, without the need for fertilization, adds another layer of complexity. This reproductive strategy allows females to produce offspring that are essentially clones of themselves, which can contribute to rapid population growth and expansion. Scientists studying this species monitor them via various methods including simply dragging a muslin cloth through pastures; reports have stated 9,000 ticks being collected in just 90 minutes by this method.

Monitoring the species' habitat expansion is crucial for understanding its potential impact on ecosystems, human health, and agriculture. Early detection and surveillance efforts can help in implementing effective control measures and preventing the further spread of this invasive tick species.

***See Table 1. North American tick-borne diseases and pathogens on page 39.***

***Table 1. North American tick-borne diseases and pathogens.***

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| *ANAPLASMOSIS* | *Anaplasmosis* is transmitted to humans by tick bites primarily from the Blacklegged tick (*Ixodes scapularis*) in the Northeast and Upper Midwest, and the Western Blacklegged tick (*Ixodes pacificus*) along the Pacific Coast. |
| *BABESIOSIS* | *Babesiosis* is a malaria-like disease caused by microscopic parasites that infect red blood cells. Most human cases of babesiosis are caused by *Babesia microti*. *Babesia microti* is transmitted by the Blacklegged tick (*Ixodes scapularis*) and is found primarily in the Northeast and Upper Midwest. Also known as piroplasmosis, this disease is caused by a Eukaryotic parasite in the order *Piroplasmida* (phylum *Apicomplexa*). |
| *BOURBON VIRUS* | *Bourbon virus* infection has been identified in a small number of patients in the Midwest and South; it is unknown how widespread the virus may be. |
| *COLORADO TICK FEVER* | *Colorado tick fever* is caused by a virus transmitted by the Rocky Mountain Wood tick (*Dermacentor andersoni*). It occurs in the Rocky Mountain region at elevations of 4,000–10,500 feet. |
| *EHRLICHIOSIS* | *Ehrlichiosis* is transmitted to humans by the Lone Star tick (*Amblyomma americanum*), found throughout the South and East. Erlichiosis is caused by bacteria of the genera *Erlichia* and *Anaplasma* (family *Anaplamataceae*); these bacteria are obligate intracellular parasites. |
| *HEARTLAND VIRUS* | *Heartland virus* infection has been identified in a small number of patients in the Midwest and South; it is unknown how widespread the virus may be. Studies suggest that Lone Star ticks can transmit the virus. |
| *LYME DISEASE* | *Lyme disease* is caused by the bacterium *Borrelia burgdorferi*, transmitted by the Blacklegged tick (*Ixodes scapularis*) in the Northeast and Upper Midwest, and the Western Blacklegged tick (*Ixodes pacificus*) along the Pacific Coast. But there are two other related bacteria to know about. *Borrelia mayonii* infection has recently been described as a cause of illness in the Upper Midwest. It has been found in Blacklegged ticks in Minnesota and Wisconsin. *Borrelia mayonii* is a new species and is the only species besides *B. burgdorferi* known to cause Lyme disease in North America. *Borrelia miyamotoi* infection has recently been described as a cause of illness, also is transmitted by the Blacklegged tick, and has a range similar to that of Lyme disease. |
| *POWASSAN DISEASE* | *Powassan disease* is caused by a virus transmitted by the Blacklegged tick (*Ixodes scapularis*) and the Groundhog tick (*Ixodes cookei*). Cases have been reported primarily from the Northeast and the Great Lakes region. |
| *ROCKY MOUNTAIN SPOTTED FEVER (RMSF)* | *Rocky Mountain spotted fever (RMSF)* also is a rickettsial disease and is transmitted by the American Dog tick (*Dermacentor variabilis*), Rocky Mountain Wood tick (*Dermacentor andersoni*), and the Brown Dog tick (*Rhipicephalus sangunineus*). The pathogen is *Rickettsia rickettsii*, a Gram-negative, intracellular, coccobacillus bacterium. *Rickettsia parkeri rickettsiosis* is transmitted to humans by the Gulf Coast tick (*Amblyomma maculatum*). *364D rickettsiosis* is thought to be caused by *Rickettsia phillipi* and transmitted to humans by the Pacific Coast tick (*Dermacentor occidentalis*). This is a new disease that has been found in California. |
| *STARI (Southern tick-associated rash illness)* | *STARI (Southern tick-associated rash illness)* is transmitted via bites from the Lone Star tick (*Ambylomma americanum*), found in the East and Southeast. This newly emerging disease is similar to Lyme disease, and possibly caused by a species of *Borrelia* bacterium. |
| *TICKBORNE RELAPSING FEVER (TBRF)* | *Tickborne relapsing fever (TBRF)* also seems to be caused by a *Borrelia* bacterium and is transmitted to humans through the bite of infected soft ticks. TBRF has been reported from the Midwest westward through the Rocky Mountain region to the West Coast and Southwest. |
| *TULAREMIA* | *Tularemia* is transmitted to humans by the Dog tick (*Dermacentor variabilis*), the Wood tick (*Dermacentor andersoni*), and the Lone Star tick (*Amblyomma americanum*). Tularemia occurs throughout North America and has been known for a long time. It is caused by the bacterium *Francisella tularensis* and can be spread by other biting arthropods besides ticks. |