Tick-Borne Infections Council of North Carolina, Inc.

# NEWSLETTER 2022, Volume 1

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Quote: "As 23% of emerging infectious diseases globally are spread by blood-feeding arthropods, such as ticks, managing and monitoring tick distributions and their overlap and potential contact with humans is vital to decrease the risk of zoonotic disease transmission." Philson et al. *Journal of Science Policy & Governance,* https://doi.org/10.38126/JSPG190109 #scipol via @scipoljournal.

## Highlights…

- Urban parks in a city in England present a Lyme disease danger
- History of the lone star tick: Original scientific description of the lone star tick and its geographical distribution
- Heartland virus infects person in New York
- Arkansas Updates Tick Distributions and Pathogen Prevalence of Spotted Fever
- α-Gal patients who have only mild GI symptoms
- Longhorned tick in Pennsylvania found to have human pathogen
- Borrelia pathogen found in lizards in the Czech Republic
- Treatment of Morgellons disease with doxycycline
- Lyme disease as a cause of eye disease: a report from Ukraine
- Emergence of blacklegged ticks in a Maine forest over the last 10 years
- 8,000 fewer cases of Lyme disease were registered in Poland than in years before the pandemic

- Rickettsia parkeri-Infected Gulf coast ticks on Staten Island
- About 36% of ticks found on mice in Maryland positive for the Lyme disease bacteria
- Lyme infections increased most rapidly in young children and overall expanded geographically in Finland

**Special notice:**

## COVID-19 vs. Tick-Borne Diseases: How to Tell the Difference

People are getting outside more due to the pandemic. The link below is to an article from New York but is pertinent to NC. We would add that here ticks are active all year, so even in the winter on a warmer day it is possible to contract a tick-borne infection (TBI).

Second, knowledge or evidence of a tick bite is not as easy as this article would imply. Many people that contract a TBI have no knowledge or evidence easy to see on their skin of a tick bite.

Third, respiratory symptoms in Covid may not always occur quickly so that even several weeks can go by with a person sick from a TBI, not Covid. Sometimes, respiratory symptoms with Covid may be minimal. There are cases now reported in the medical literature of late treatment for TBIs due to this confusion. We at TIC-NC are aware of several such cases. (Comments by the newsletter editor M. Herman-Giddens) https://healthmatters.nyp.org/how-to-protect-yourself-from-ticks/

Tentative 2022 Vector-borne Working Group meeting dates: None announced.
(Check with us before going to confirm date as they occasionally change.)

**Location:**
Office of the Chief Medical Examiner Photo ID required.
4312 District Drive
Raleigh, NC 27607

**Link to Notice to Medical Providers from the State Department of Public Health on Lyme Disease and Rickettsial Diseases:** "Annual Update on Diagnosis and Surveillance for Tickborne Diseases" The state has started issuing only one letter. Please see the home page of our website to access. www.tic-nc.org.

To look at the (state) NCDHHS's tick data, go to epi.dph.ncdhhs.gov/cd/diseases/ticks.html.

# From the CDC

## Where To Find CDC Case Definitions and the CDC's Statement that the Surveillance Case Definitions Are "not to be used as the sole criteria for establishing critical diagnosis"

### Case Definition and Report Forms

### The surveillance definition of Lyme disease was revised in January 2022.

See https://www.cste.org/resource/resmgr/ps/ps2021/21-ID-05_Lyme_Disease.pdf for the rationale behind the changes.

- ndc.services.cdc.gov/case-definitions/lyme-disease-2022/
- www.cdc.gov/lyme/resources/lymediseasecasereportform.pdf (for public health officials' use)

### The surveillance definition of Rocky Mountain spotted fever/spotted fever rickettsiosis was revised in 2020.

- ndc.services.cdc.gov/case-definitions/spotted-fever-rickettsiosis-2020/

> **Note:** Surveillance case definitions establish uniform criteria for disease reporting and should not be used as the sole criteria for establishing clinical diagnoses, determining the standard of care necessary for a particular patient, setting guidelines for quality assurance, or providing standards for reimbursement.

Accessed and copied 16 February 2022.

## From North Carolina: State tick research and/or reports

The 2020 tick bone disease surveillance summaries are now complete.

- **NC Surveillance Summary Reports**
  - Ehrlichiosis Surveillance Summary: 2020 (105 cases confirmed & probable)
  - Spotted Fever Group Rickettsiosis Surveillance Summary: 2020 (190 cases confirmed & probable)
  - Lyme Disease Surveillance Summary: 2020 (272 cases confirmed & probable)
  - Tick Borne Disease Surveillance Summaries: 2019 (PDF, 1MB)

**Note**: By the *former* CDC definition, six counties had confirmed cases of Lyme disease in two persons who had not traveled out of the county for 30 days after their tick exposure. **Therefore, these counties were endemic for Lyme disease by the former CDC definition: Wake, Guilford, Haywood, Alleghany, Buncombe, and Wilkes.** Counties with one case of locally acquired Lyme disease were: Cleveland (2008), Wilson (2009), Pitt (2009), Carteret (2009), Gates (2011), Perquimans (2011), Rowan (2013), Union (2013), Caldwell (2013), Franklin (2014), Stanley (2014), Duplin 2014.

### TIC-NC Talks and Materials Distributed

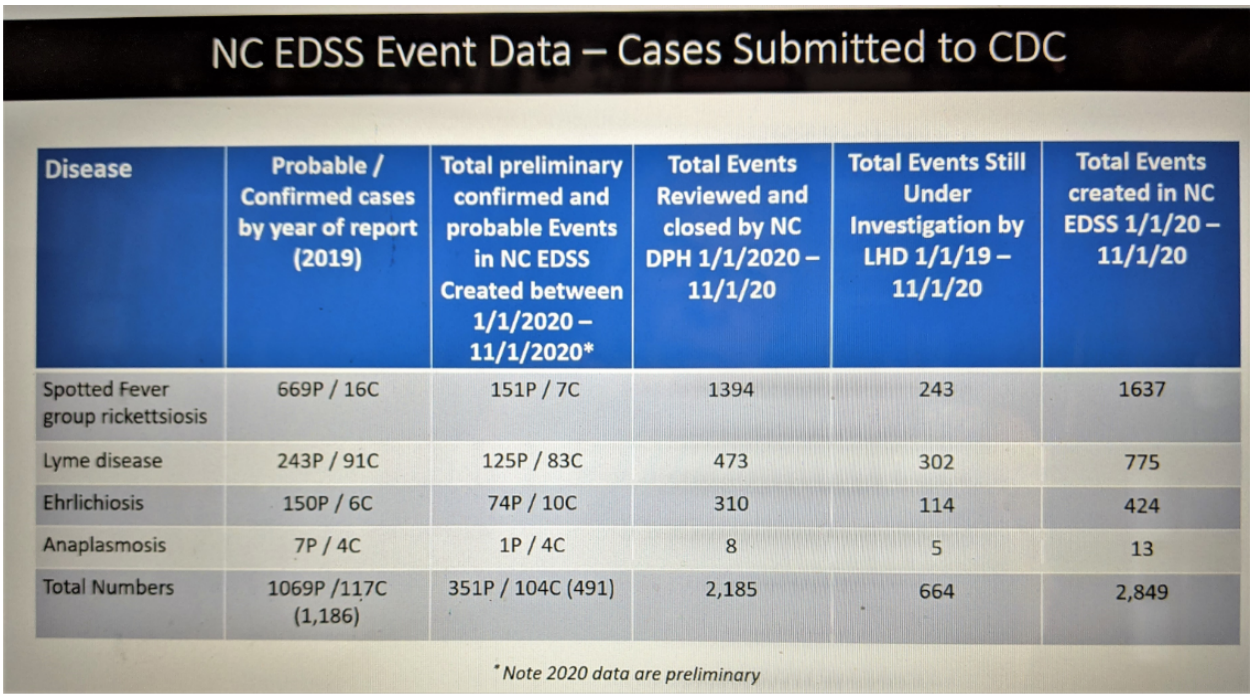
**Brochures/booklets:** Distribution continues when we find opportunities.

**Grant:** Chatham County Public Health Department and the Tick-borne Infections Council of North Carolina, Inc are partnering to conduct a pilot intervention to help keep outdoor workers safer from tick bites and tick-borne infections. We have purchased the materials and assembled the "Tick Removal Kits" which will be distributed to farmworker families. Next steps include meeting with farmworker coordinators and getting text translated into Spanish. See photos below.

## Report from the State or Vectorborne Disease Work Group meeting

# NC TBIs 2019 final, 2020 to November probable/confirmed

Similar data for 2020 are not available. See 2020 totals above.



NC EDSS Event Data – Cases Submitted to CDC

| Disease | Probable / Confirmed cases by year of report (2019) | Total preliminary confirmed and probable Events in NC EDSS Created between 1/1/2020 – 11/1/2020* | Total Events Reviewed and closed by NC DPH 1/1/2020 – 11/1/20 | Total Events Still Under Investigation by LHD 1/1/19 – 11/1/20 | Total Events created in NC EDSS 1/1/20 – 11/1/20 |
|---|---|---|---|---|---|
| Spotted Fever group rickettsiosis | 669P / 16C | 151P / 7C | 1394 | 243 | 1637 |
| Lyme disease | 243P / 91C | 125P / 83C | 473 | 302 | 775 |
| Ehrlichiosis | 150P / 6C | 74P / 10C | 310 | 114 | 424 |
| Anaplasmosis | 7P / 4C | 1P / 4C | 8 | 5 | 13 |
| Total Numbers | 1069P /117C (1,186) | 351P / 104C (491) | 2,185 | 664 | 2,849 |

*Note 2020 data are preliminary

TIC-NC Activities


TIC-NC sign at campground

Tick Removal Kits ready to go

Piedmont Health Farmworker Coordinator, Nereyda Damaso, showing packages with health and medical equipment for farm families.

## North Carolina and South

**The Original Scientific Description of the Lone Star Tick (Amblyomma americanum, Acari: Ixodidae) and Implications for the Species' Past and Future Geographic Distributions**

Amblyomma americanum L. is an important vector in North America originally described by Linnaeus based on Pehr Kalm's 1754 report. While Kalm's 'Travels into North America' is well known, his 1754 report remains obscure. Some authors were skeptical that Kalm referred to A. americanum because he encountered them at sites farther north outside of the species' range. However, the details in 1754 report leave no doubt that Kalm described lone star ticks. In this historical review, we provide support for Kalm's identification using a modern translation of his 1754 report and other sources. We also delineate distributional changes of lone star ticks from the pre-colonization era to the present and interpret them in the context of large-scale anthropogenic changes in the landscape. In this framework, the lone star tick's current northward expansion is a recolonization of their former range. Extensive deforestation and extirpation of their principal host species, white-tailed deer, led to A. americanum's disappearance from the northern parts of its range by the 20th century. Subsequent recolonization by second-growth forest and increases in white-tailed deer populations by the mid-20th century is now allowing A. americanum to reclaim its former range. These changes in the land appear to be the driving force behind A. americanum's present expansion. Understanding this species' history and the factors contributing to its current expansion will enable better predictions about its future distribution and potential to transmit human pathogens. Rochlin I, et al. Journal of Medical Entomology, XX(X), 2022, 1–9 https://doi.org/10.1093/jme/tjab215.

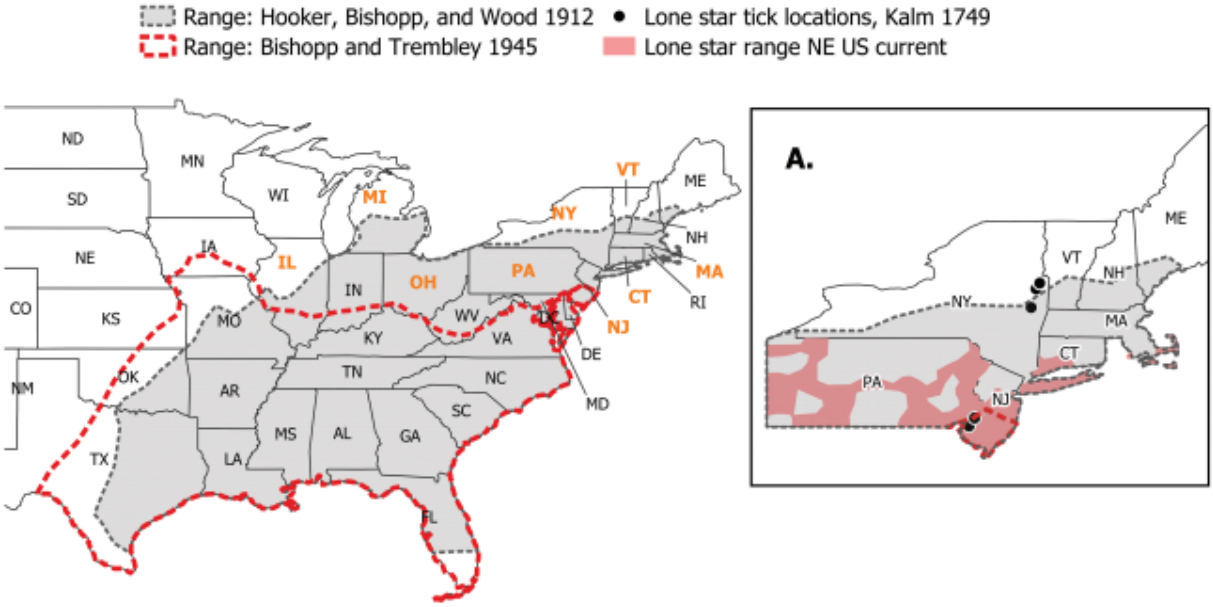



Fig. 1. Historical range of lone star (A. americanum) ticks in the US. Maps for the 1912 range (grey background) and the 1945 range (red dashed line) were georeferenced and digitized from the respective publications (Hooker et al. 1912, Bishopp and Trembley 1945). Northern states with A. americanum records from 18th to early 20th centuries are indicated with bold orange text. Inset A. Current distribution (1990–2020) of A. americanum in northeastern US (pink background). Georeferenced and digitized from (Schulze et al. 2011, Molaei et al. 2019, Pak et al. 2019). Kalm's locations (black dots) and the historical ranges are also indicated. All data were processed using QGIS v. 3.10.8. Cartographic state boundary files were downloaded from US Census Bureau (www.census.gov).

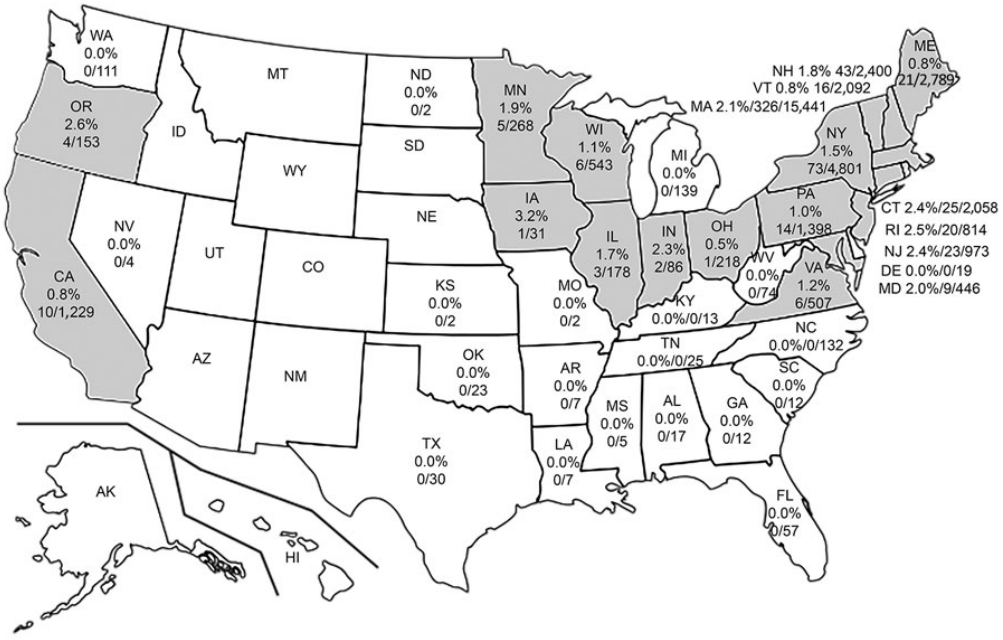
## Borrelia miyamotoi in Human-Biting Ticks, United States, 2013–2019

*Borrelia miyamotoi*, a relapsing fever group spirochete (*1*), was first isolated from *Ixodes persulcatus* ticks in Japan in 1995 and later detected in *Ixodes* ticks in the United States and Europe. Although *B. miyamotoi* bacteria have been mainly detected in *I. ricinus* species complex ticks that transmit *B. burgdorferi* worldwide, the vector specificity needs further study because investigators have found *B. miyamotoi* in multiple tick species. *B. miyamotoi* has 3 geographically distinct genotypes: Asian, European, and American. In the United States, *B. miyamotoi* bacteria have been found in field-collected *I. scapularis* ticks in the northeastern and northern midwestern regions, where the average infection rate is 1.9%... However, an expanded geographic study of the prevalence of *B. miyamotoi* in human-biting ticks, its genotypes, and concurrent infections with other tickborne pathogens is warranted.

Human-biting ticks were submitted to the public tick testing program at the University of Massachusetts (Amherst, Massachusetts, USA) during May 2013–December 2019… We received and tested 39,198 ticks found on humans for *B. miyamotoi* during May 2013–December 2019. Of those, 38,855 (99.12%) ticks originated from the continental United States, comprising 18 tick species. Although *Ixodes* ticks are the main vectors for *B. miyamotoi*, we did not detect *B. miyamotoi* DNA in *I. affinis*, *I. angustus*, *I. cookei*, *I. dentatus*, *I. marxi*. *I. muris,* or *I. spinipalpis* ticks. We detected *B. miyamotoi* in *I. pacificus* (14/1,497, 0.94%) and *I.*

*scapularis* (594/34,621, 1.72%) ticks… Of 594 *B. miyamotoi*–positive *I. scapularis* ticks, 351 (59.09%) had concurrent infections.

*B. miyamotoi* was found in 19 states; infection rates were 0.5%–3.2%. In the western United States, *B. miyamotoi* was found in *I. pacificus* ticks in Oregon and California (14/1,497, 0.94%). Although *I. scapularis* ticks are distributed across the eastern United States, no *B. miyamotoi*–positive ticks were detected south of Virginia. *B. miyamotoi*–positive ticks were concentrated in the Northeast and upper Midwest (594 of 34,621, 1.72%). Lyme disease remains the principal public health concern; the causative agent, *B. burgdorferi* (11,287/34,621; 32.60%, 95% CI 32.1%–33.1%), was 19 times more prevalent than *B. miyamotoi* (594/34,621, 1.72%) in *I. scapularis* ticks… Xu G, et al. *Emerging Infectious Diseases*, *27*(12), 3193-3195. https://doi.org/10.3201/eid2712.204646.




*Borrelia miyamotoi* positivity rates in human-biting *Ixodes scapularis* and *I. pacificus* ticks, United States, 2013–2019. Gray shading indicates states in which *B.miyamotoi*was detected... ED note: *B. miyamotoi* **has been found in NC** from other work.

## α-Gal patients who have only mild GI symptoms

### The α-Gal Mammalian Meat Allergy Manifesting With Isolated Gastrointestinal Symptoms

A syndrome of delayed-onset mammalian meat allergy, mediated by IgE antibodies specific for the oligosaccharide galactose-α-1,3-galactose (α-Gal), was first described in 2009. Bites from *Amblyomma americanum* (the lone star tick) are a dominant cause of α-Gal IgE sensitization, which explains the high prevalence of the "α-Gal syndrome" (AGS) in the southeastern USA. Urticaria and pruritus are classic manifestations of AGS, however many patients also develop gastrointestinal (GI) symptoms.

Increasingly we are aware of patients with AGS who present only with GI symptoms. Here we sought to describe the characteristics of these patients. Nathan R, et al. The American Journal of Gastroenterology:doi: 10.14309/01.ajg.0000774624.08687.83.

## Collaborating With Community Scientists Across Arkansas to Update Tick Distributions and Pathogen Prevalence of Spotted Fever Group *Rickettsia* and *Ehrlichia*

Tick-borne diseases (TBD) in humans have dramatically increased over recent years and although the bulk of cases are attributable to Lyme Disease in the Northeastern US, TBDs like spotted fever rickettsiosis and ehrlichiosis heavily impact other parts of the country, namely the mid-south.

…We report on a community science effort to survey ticks across Arkansas to obtain updated data on tick distributions and prevalence of human tick-borne disease-causing pathogens in the most commonly encountered ticks. During a 20-mo period, Arkansans submitted 9,002 ticks from 71 of the 75 counties in the state. *Amblyomma americanum* was the most common tick species received, accounting for 76% of total tick submissions.

Nearly 6,000 samples were screened for spotted fever group *Rickettsia* (SFGR) and *Ehrlichia*, resulting in general prevalence rates of 37.4 and 5.1%, respectively. In addition, 145 ticks (2.5%) were infected with both SFGR and *Ehrlichia*. Arkansas Department of Health reported 2,281 spotted fever and 380 ehrlichiosis cases during the same period as our tick collections. … Our investigation demonstrated the utility of community science to efficiently and economically survey ticks and identify vector-borne disease risk in Arkansas. Dowling APG, et al. *Journal of Medical Entomology*, 2021, tjab196, https://doi.org/10.1093/jme/tjab196.

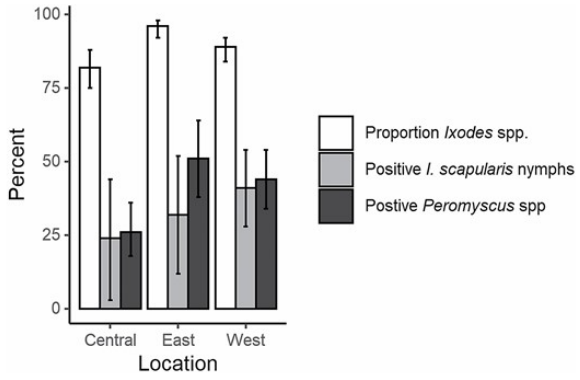
## *Borrelia burgdorferi* (Spirochaetales: Spirochaetaceae) Infection Prevalence and Host Associations of Ticks Found on *Peromyscus spp.* in Maryland

Lyme disease, caused by *Borrelia burgdorferi* sensu stricto and most commonly transmitted by *Ixodes scapularis* Say (Ixodida: Ixodidae), is the most common tick-borne disease in Maryland. Because *B. burgdorferi s.s.* is maintained in enzootic cycles among wild mice (*Peromyscus spp*) and *Ixodes spp* ticks, differing patterns of parasitism of ticks on mice could impact the infection prevalence with *B. burgdorferi*.

We determined the infection prevalence of *Peromyscus spp* as well as questing and partially engorged nymphal ticks collected at six sites on private land in five counties in Maryland from May to August 2020. Questing nymph infection prevalence (NIP) was 14%. We trapped 1258 mice and collected 554 ticks and 413 ear tissue samples… We detected a significant difference amongst the proportion of attached *Ixodes* and the location of trapping. Similarly, the prevalence of *B. burgdorferi* infected *Peromyscus spp* mice varied between locations (average mouse infection prevalence was 40%), with the highest prevalence in locations where *Ixodes* were the most commonly found ticks.

The *B. burgdorferi* infection prevalence in partially engorged *I. scapularis* nymphs retrieved from *Peromyscus spp* was ~36% which lends further support to the host infection prevalence. Local differences in distribution of infected vectors and reservoirs are important factors to consider when planning interventions to reduce Lyme disease risk. Poje JE, et al. *Journal of Medical Entomology*, 2021, https://doi.org/10.1093/jme/tjab206.

Fig. 2.




The percent of identified ticks that were Ixodes spp. (white), the percent of on-mouse *I. scapularis* nymphs (grey) that were PCR positive for *B. burgdorferi* with 95% confidence intervals for the sample proportion. Estimated percent of mice (black) that were PCR positive for *B. burgdorferi* with 95% confidence intervals based on generalized linear mixed model estimates.

## Cold wars and climate change: how host-pathogen interactions at low temperatures shape ectotherm success in changing environments.

Changing winters will play an integral role in the outcome of infection and the transmission of disease in ectotherms. Ectotherms must balance investment in immunity with the response to cold, and winter triggers reconfigured states of immunity. Warmer and more variable temperatures during winter may change how insects and other arthropods invest in immune activity, impacting both energy use and protection against pathogens. Further, infection itself may modify host survival of low temperatures during the winter, and thus the spread and risk of disease in the growing season – including in vectors, such as ticks. For example, warming conditions in simulated winter conditions permitted black-legged ticks, *Ixodes scapularis*, to become active throughout the winter, which is likely to impact energy use and/or risk of contact with new hosts. Further, ticks infected with *Borrelia burgdorferi* were more likely to become active following exposure to subzero temperatures, compared to uninfected ticks. Thus, infection may improve the ability to recover from cold and variable winter conditions may favour the ability of infected ticks to find hosts and continue to spread disease. Overall, the impact of changing winters on ectotherm success may be mediated through infection, and winter is likely

to play a role in shifting disease dynamics. Ferguson, LV; et al., The Society for Integrative and Comparative Biology, Abstract S4-4, Annual Meeting, Jan 2022.

## Serologic evidence of selected vector-borne pathogens in non-owned dogs in the southeast US

Vector-borne pathogens (VBP) associated with ectoparasitism are of concern for animal health, and there are many gaps in surveillance and reporting data. The purpose of this study was to test for four VBPs in a subset of non-owned dogs from county humane societies in Alabama and Georgia that were admitted to the Auburn University College of Veterinary Medicine Hoerlein Spay/Neuter Program for health exams and routine procedures, including bloodwork and testing with the 4Dx® SNAP® Plus (IDEXX Laboratories, Inc., Westbrook, Maine). Visualized ectoparasites were noted and preserved for identification and analysis.

> From May–October 2019, residual blood (n = 114) was used for preparing blood smears and DNA extraction and PCR. Out of 114 samples, 35.1% (40/114) were seropositive for one or more VBP: Dirofilaria immitis antigen (20.2%; 23/114) and Ehrlichia spp. antibodies (20.2%; 23/114); six VBD-positive dogs (15%) tested positive for both. No dogs had detectable antibodies to Borrelia burgdorferi or Anaplasma spp. (0%; 0/114). Microfilariae of D. immitis were present in 7 blood smears, all from dogs that were D. immitis antigen positive. Morulae or DNA of Ehrlichia or Anaplasma spp. were not identified in any sample. Fleas were documented in 20.4% (23/113) of dogs, 9.7% (11/113) were infested with ticks, predominantly Amblyomma americanum, and co-infestations were noted in 2.7% (3/113). Our data indicate that there is substantial VBP risk in Alabama and Georgia, and that the reservoir potential of domestic animals, especially non-owned animals, along with potential wildlife reservoirs warrants further investigation. Perrigreno AN, et al. Veterinary Parasitology: Regional Studies and Reports, https://doi.org/10.1016/j.vprsr.2022.100685.

Editor's (M. Herman-Giddens) comment: No dogs were found to be positive for *Borrelia burgdorferi* or *Anaplasma* spp; however, it is important to note that if the proportion of blacklegged ticks in the area infected with *Borrelia burgdorferi* or *Anaplasma* is only 2% or less, as in seen in some parts of the south, the researchers would have needed to test about 150 ticks to have a 95% chance of finding a positive.

# ◘◘ National Section ◘◘

## Longhorned tick in Pennsylvania found to have human pathogen

### First detection of human pathogenic variant of *Anaplasma phagocytophilum* in field-collected *Haemaphysalis longicornis*, Pennsylvania, USA

The Asian longhorned tick, *Haemaphysalis longicornis*, an invasive species associated with human pathogens, has spread rapidly across the eastern USA. Questing *H. longicornis* ticks recovered from active surveillance conducted from 1 May to 6 September, 2019 throughout Pennsylvania were tested for rickettsial pathogens. Of 265 ticks tested by PCR for pathogens, 4 (1.5%) were positive for *Anaplasma phagocytophilum*. Sequence analysis of the 16S rRNA gene confirmed two positives as *A. phagocytophilum*–human agent variant. This is the first reported detection of *A. phagocytophilum*–human pathogenic strain DNA in exotic *H. longicornis* collected in the USA. Price KJ et al. Zoonoses and Public Health, https://doi.org/10.1111/zph.12901.

## Rickettsia parkeri-infected Gulf coast ticks on Staten Island

### Established Populations of *Rickettsia parkeri*-Infected *Amblyomma maculatum* Ticks in New York City, New York, USA

We sought to determine the habitat associations and pathogen status of *Amblyomma maculatum* ticks in New York City (NYC), New York, USA, a newly expanded portion of their range.

We collected 88 ticks from two NYC parks on Staten Island, one of the five boroughs of NYC, and compared our findings with similar habitat in Brooklyn, New York during the same time period (April 30–September 1). We tested 76 for pathogens.

We found adult and immature ticks in native and invasive grasses at Freshkills and Brookfield parks on Staten Island. No *A. maculatum* ticks were found in Brooklyn. 52.6% of ticks tested were infected with *Rickettsia parkeri*—the etiological agent of *R. parkeri* rickettsiosis. This high rate of *R. parkeri* in a dense urban center is of concern to the medical community, who should be aware of this species' presence and the symptoms of *R. parkeri* rickettsiosis. Ramírez-Garofalo JR, et al. Vector-Borne and Zoonotic Diseases, https://doi.org/10.1089/vbz.2021.0085.

## Study finds a high diversity of tick-borne bacteria and protozoa across an expanding urban area in the U.S. Great Plains.

### Effect of Urbanization on Presence, Abundance, and Coinfection of Bacteria and Protozoa in Ticks in the US Great Plains

Urbanization alters components of natural ecosystems which can affect tick abundance and tick-borne disease prevalence. Likely due to these changes, tick-borne pathogen prevalence has increased in many U.S. urban areas. Despite the growing public health importance of tick-borne diseases, little is known about how they are influenced by urbanization in North America,

especially in the central U.S. where several pathogens occur at or near their highest levels of incidence nationally.

To determine whether urban development influences tick infection with bacteria and protozoa, we collected ticks at 16 parks across a gradient of urbanization intensity in Oklahoma City, Oklahoma, USA and tested them using a variety of PCR assays. Adult ticks tested positive for *Rickettsia parkeri*, *R. amblyommatis*, *R. rhiphicephali*, '*Candidatus* R. andeanae', *Ehrlichia chaffeensis*, *E. ewingii*, Panola Mountain Ehrlichia, '*Borrelia lonestari*', *Theileria cervi*, *Babesia* spp. Coco, and *Cytauxzoon felis*. These results indicate the presence of a high diversity of tick-borne bacteria and protozoa across an expanding urban area in the U.S. Great Plains.

Although there appeared to be some risk of encountering tick-borne microorganisms across the entire urbanization gradient, *E. chaffeensis*, *E. ewingii*, and *T. cervi*-infected ticks and microbe diversity decreased with increasing urbanization intensity. We identified a low rate of coinfection between different microorganisms, with coinfected ticks mainly collected from sites in the least-urbanized areas. This study suggests the need for awareness of tick-borne disease risk throughout urban areas in the central U.S. and highlights a need for studies of tick host habitat use and movement in cities. Noden at al. *Journal of Medical Entomology*, tjab228, https://doi.org/10.1093/jme/tjab228.

## *Borrelia burgdorferi* (Spirochaetales: Spirochaetaceae) Infection Prevalence (~36%) and Host Associations of Ticks Found on *Peromyscus spp.* in Maryland

Lyme disease, caused by *Borrelia burgdorferi* sensu stricto and most commonly transmitted by *Ixodes scapularis* Say (Ixodida: Ixodidae), is the most common tick-borne disease in Maryland. Because *B. burgdorferi s.s.* is maintained in enzootic cycles among wild mice (*Peromyscus spp*) and *Ixodes spp* ticks, differing patterns of parasitism of ticks on mice could impact the infection prevalence with *B. burgdorferi*…

We trapped 1258 mice and collected 554 ticks and 413 ear tissue samples. The prevalence of infested *Peromyscus spp* varied based on host age and sex, with older and male mice more likely to be infested… Similarly, the prevalence of *B. burgdorferi* infected *Peromyscus spp* mice varied between locations (average mouse infection prevalence was 40%), with the highest prevalence in locations where *Ixodes* were the most commonly found ticks.

The *B. burgdorferi* infection prevalence in partially engorged *I. scapularis* nymphs retrieved from *Peromyscus spp* was ~36% which lends further support to the host infection prevalence. Local differences in distribution of infected vectors and reservoirs are important factors to consider when planning interventions to reduce Lyme disease risk. Poje JE, et al., *Journal of Medical Entomology*, 2021; https://doi.org/10.1093/jme/tjab206.

## Host contributions to the force of Borrelia burgdorferi and Babesia microti transmission differ at edges of and within a small habitat patch

In the northeastern United States, the emergence of Lyme disease has been associated, in part, with the increase of small forest patches. Such disturbed habitat is exploited by generalist species, such as white-footed mice, which are considered the host with the greatest reservoir capacity for the agents of Lyme disease (*Borrelia burgdorferi* sensu stricto) and human babesiosis (*Babesia microti*). Spatial risk analyses have identified edge habitat as particularly risky.

Using a retrotransposon-based quantitative PCR assay for host bloodmeal remnant identification, we directly measured whether the hosts upon which vector ticks fed differed at the edge or within the contiguous small habitat patch. Questing nymphal deer ticks, *Ixodes dammini*, the northern clade of *Ixodes scapularis*, were collected from either the edge or within a thicket on Nantucket Island over 3 transmission seasons and tested for evidence of infection as well as bloodmeal hosts. Tick bloodmeal hosts significantly differed by site as well as by year. Mice and deer were identified most often (49.9%), but shrews, rabbits and birds were also common.

Ticks from the edge fed on a greater diversity of hosts than those from the thicket. Surprisingly, mice were not strongly associated with either infection at either sampling site (OR<2 for all). Although shrews were not the most common host utilized by ticks, they were highly associated with both infections at both sites (OR= 4.5 and 7.9 *B. burgdorferi* and 7.9 and 19.0 *B. microti*, edge and thicket). We conclude that reservoir hosts may differ in their contributions to infecting ticks between edge and contiguous vegetated patches. Goethert HK & Telford SR. Appl Environ Microbiol. doi: 10.1128/aem.02391-21.

## Tick-Borne Disease Prevention Behaviors Among Participants in a Tick Surveillance System Compared with a Sample of Master Gardeners

Theory-based approaches to health communication and behavior are increasingly applied to interventions that address poor public tick-borne disease prevention knowledge and practices. We sought to understand the tick-borne disease prevention behaviors among participants in a crowdsourced passive tick surveillance system that employs theory-based messages about tick bite risk and prevention strategies. We administered an electronic survey to a randomly selected sample of passive surveillance system users and compared their responses to those from a nationwide sample of Master Gardeners (MG), a group with heighten tick exposure due to outdoor activity.

Over 80% of TickSpotters respondents, and over 75% of MG respondents encountered a tick in the past year. Among both groups, tick checks were the most frequently practiced prevention behavior, with over 70% of people performing them most or all the time after outdoor activity. A greater proportion of MGs used skin repellents such as DEET or picaridin than TickSpotters users, but more than 70% of respondents from both groups reported that they never or only sometimes use permethrin-treatment on clothing, and nearly half of both groups reportedly used

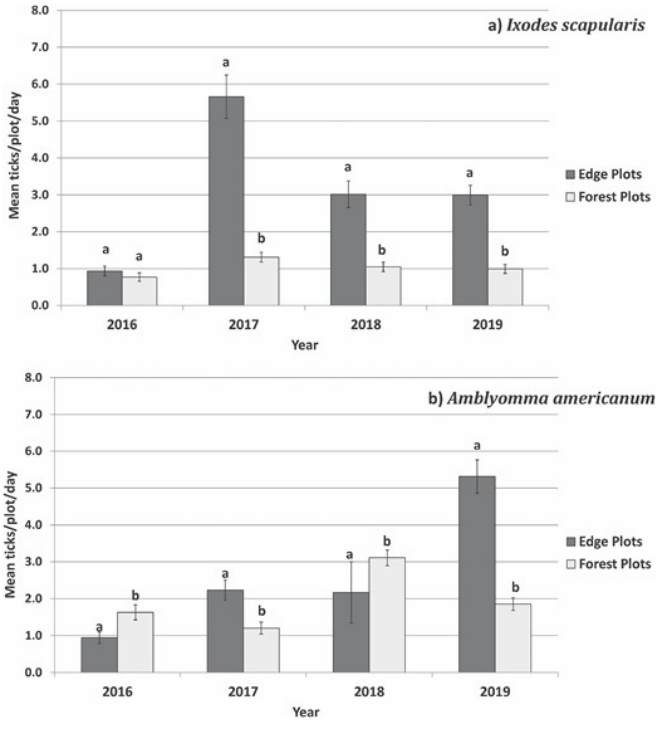
no peridomestic tick treatments. TickSpotters respondents overwhelmingly reported recording tick encounter information and saving specimens for identification and testing, while only a small percentage of MGs monitored their tick encounters.

These findings suggest that while both TickSpotters and MG groups appear to be practicing some important tick bite prevention behaviors, there remain areas that could benefit from targeted theory-based interventional approaches. Kopsco HL & Mather TN. Journal of Community Health, doi.org/10.1007/s10900-021-01041-9.

## Daily Variation in Sampled Densities of *Ixodes scapularis* and *Amblyomma americanum* (Acari: Ixodidae) Nymphs at a Single Site—Implications for Assessing Acarological Risk

The public health challenge posed by tick-borne disease (TBD) has increased efforts to characterize the spatial and temporal distribution of ticks and associated pathogens to better focus tick control strategies and personal protection measures. We describe variability in nymphal *Ixodes scapularis* Say and *Amblyomma americanum* (L.) density derived from daily drag sampling at a single location in New Jersey over 4 yr and explore how observed differences in daily collections might affect the estimation of acarological risk. We found significant variability in the density of host-seeking nymphs that could suggest substantially different rates of human-tick encounters depending on sampling date, habitat, and ambient weather conditions.

The spatial and temporal variability in the distribution of 2 sympatric tick species with different host preferences and questing strategies, suggests that to produce results that are comparable among sites across the area sampled, surveillance efforts may be limited to shorter collection seasons, fewer sites or less sampling effort (fewer plots or fewer visits) per site, and a geographic scope that minimizes the potential temporal and spatial biases indicated here.




Our results illustrate that evaluation of models of tick distribution or relative acarological risk based on surveillance data requires a full description of the diversity of habitats sampled and the conditions under which sampling is performed. The array of factors that affect tick host-seeking and that could bias

interpretation of sampling results emphasizes the need to standardize sampling protocols and for more caution when interpreting tick sampling data collected over large temporal and spatial scales. Schulze TL & Robert AJ. *Journal of Medical Entomology*, 2022; tjab213, https://doi.org/10.1093/jme/tjab213.

## Biomarker selection and a prospective metabolite-based machine learning diagnostic for Lyme disease

We provide a pipeline for data preprocessing, biomarker selection, and classification of liquid chromatography–mass spectrometry (LCMS) serum samples to generate a prospective diagnostic test for Lyme disease. We utilize tools of machine learning (ML), e.g., sparse support vector machines (SSVM), iterative feature removal (IFR), and *k*-fold feature ranking to select several biomarkers and build a discriminant model for Lyme disease. We report a 98.13% test balanced success rate (BSR) of our model based on a sequestered test set of LCMS serum samples. The methodology employed is general and can be readily adapted to other LCMS, or metabolomics, data sets. Kehoe et al. *Sci Rep* 12, 1478 (2022). https://doi.org/10.1038/s41598-022-05451-0.

## Emergence of *Ixodes scapularis* (Acari: Ixodidae) in a Small Mammal Population in a Coastal Oak-Pine Forest, Maine, USA

In the United States, surveillance has been key to tracking spatiotemporal emergence of blacklegged ticks [*Ixodes scapularis* Say (Ixodida:Ixodidae)] and their pathogens such as *Borrelia burgdorferi* Johnson, Schmid, Hyde, Steigerwalt & Brenner (Spirochaetales: Spirochaetaceae), the agent of Lyme disease. On the Holt Research Forest in midcoastal Maine, collection of feeding ticks from live-trapped small mammal hosts allowed us to track the emergence and establishment of *I. scapularis*, 1989–2019. From 1989–1995, we collected only *I. angustus* Neumann (Ixodida: Ixodidae)(vole tick), *Dermacentor variabilis* Say (Ixodida: Ixodidae) (American dog tick), and *I. marxi* Banks (Ixodida: Ixodidae) (squirrel tick) from seven species of small mammals.

The most abundant tick host was the white-footed mouse [*Peromyscus leucopus* Rafinesque (Rodentia:Cricetidae)] followed by the red-backed vole (*Myodes gapperi* Vigors (Rodentia: Cricetidae)). Emergence of *I. scapularis* was signaled via the appearance of subadult *I. scapularis* in 1996. Emergence of *B. burgdorferi* was signaled through its appearance in *I. scapularis* feeding on mice in 2005.

There was a substantial increase in *I. scapularis* prevalence (proportion of hosts parasitized) and burdens (ticks/host) on white-footed mice and red-backed voles in 2007. The ~11-yr time-to-establishment for *I. scapularis* was consistent with that seen in other studies. White-footed mice comprised 65.9% of all captures and hosted 94.1% of the total *I. scapularis* burden. The white-footed mouse population fluctuated interannually, but did not trend up as did *I.*

*scapularis* prevalence and burdens. There were concurrent declines in *I. angustus* and *D. variabilis*. We discuss these results in the broader context of regional *I. scapularis* range expansion. Susan P Elias SP, et al. *Journal of Medical Entomology*, 2021; tjab209, https://doi.org/10.1093/jme/tjab209.

## Establishment of Amblyomma americanum populations and new records of Borrelia burgdorferi-infected Ixodes scapularis in South Dakota

Tick-borne diseases are an emerging public health threat in the United States, but surveillance is lacking in some regions. To advance current knowledge of the ecology of ticks and tick-borne diseases in South Dakota, we conducted a survey in the summer of 2019, focusing on the eastern counties of the state. We collected and identified 266 ticks and a subset were tested for the presence of Borrelia burgdorferi by polymerase chain reaction (PCR). Dermacentor variabilis, a ubiquitous species in the state, was the most commonly identified tick, present in all counties surveyed.

However, we also identified 15 Amblyomma americanum from three different locations, providing the first evidence of established populations in the state and expanding the range of this species. In addition, we identified 22 Ixodes scapularis from five different locations, confirming a previous report of an established population in the state. Two adult I. scapularis from two different sites were found to harbor B. burgdorferi, including an individual from Lincoln County, suggesting the ongoing presence of the pathogen in tick populations in the state and representing its southwestern-most detection in the midwest United States. These findings provide important information for assessing and monitoring the public health risk from tick-borne diseases in an area where surveillance is lacking. Black H, et al. Journal of Vector Ecology, Vol. 46 Issue 2, p143-147.

## Heartland Virus Transmission, Suffolk County, New York, USA

During 2018, Heartland virus RNA was detected in an *Amblyomma americanum* tick removed from a resident of Suffolk County, New York, USA. The person showed seroconversion. Tick surveillance and white-tailed deer (*Odocoileus virginianus*) serosurveys showed widespread distribution in Suffolk County, emphasizing a need for disease surveillance anywhere *A. americanum* ticks are established or emerging. Dupuis A P, et al. Emerging Infectious Diseases, 27(12), 3128-3132.

## International & General Section

## Urban woodland habitat is important for tick presence and density in a city in England

Urban green spaces provide an opportunity for contact between members of the public and ticks infected with pathogens. … Several sites were visited across the English city of Bath during 2015 and 2016. Tick presence was confirmed in all habitats surveyed, with increased likelihood in woodland and woodland edge. Highest nymph densities were also reported in these habitats, along with grassland during one of the sampling years.

Adult ticks were more likely to be infected compared to nymphs, and the highest densities of infected nymphs were associated with woodland edge habitat. In addition to Lyme borreliosis causing *Borrelia* genospecies, *Borrelia miyamotoi* was also detected at several sites.

This study adds to the growing evidence that urban green space habitats present a public health risk from tick bites, and this has implications for many policy areas including health and wellbeing, climate adaptation and urban green space planning. Kayleigh M, et al. Ticks and Tick-borne Diseases, doi.org/10.1016/j.ttbdis.2021.101857.

## Lyme infections increased most rapidly in young children and overall expanded geographically in Finland

### Changes in the Epidemiology of Zoonotic Infections in Children: A Nationwide Register Study in Finland.

Zoonotic infections are difficult to recognize in children. The age distributions and seasonal occurrences of these infections vary substantially, even among those transmitted by the same vectors, and their epidemiology may change over time. The aim was to report the incidences and trends of Borrelia burgdorferi, Puumala virus, Francisella tularensis and tick-borne encephalitis (TBE) virus infections in the pediatric population (age 0-19) of Finland.

… An increasing trend in the incidences of B. burgdorferi and TBE was observed. Borrelia expanded geographically northward and inland. Tularemia follows a 2-4-year epidemic cycle and rates are similar across age groups. Puumala incidences are highest in the older children.

Borrelia infections increased most rapidly in children 5-9 years of age and overall expanded geographically in Finland. Tularemia epidemic cycles were shorter than those previously reported… Kuitunen I & Renko M. The Pediatric Infectious Disease Journal, 28 Dec 2021,

## Role of Birds in Tick-Borne Diseases

Ticks are considered as the second most potential source of vector-borne diseases to humans. Migratory birds are long-distance transporters of ticks and have been accounted for carrying different human pathogens such as tick-borne encephalitis virus, Crimean Congo Hemorrhagic Fever (CCHF) virus, *Anaplasma marginale, Babesia divergens, Anaplasma phagocytophilium, Ehrichia,* and *Borrelia burgdorferi*. The majority of the cases of human parasitism are identified with hard ticks compared to soft ticks. *Ixodes persulcatus* and *Ixodes ricinus* are the most important vectors for tick-borne pathogens in Asia and Europe, respectively…

The most commonly used serologic tests for TBD diagnoses are enzyme-linked immunosorbent assay (ELISA), indirect immunofluorescent assay (IFA), and western blot. Microscopy and PCR offer good choices and use of immunodominant epitopes can improve protein-based diagnostic methods. Treatment modalities, such as doxycline, are available for bacterial and parasitic infections are no specific antiviral treatment available but not for viral infections. Malik YS, et al. In: Role of Birds in Transmitting Zoonotic Pathogens. Livestock Diseases and Management. Springer, Singapore. https://doi.org/10.1007/978-981-16-4554-9_19.

## A borrelia pathogen found in lizards in the Czech Republic

### First isolation of *Borrelia lusitaniae* DNA from green lizards (*Lacerta viridis*) and *Ixodes ricinus* ticks in the Czech Republic

This study aimed to reveal whether green lizards (*Lacerta viridis*), common hosts of tick larvae and nymphs, might be involved in the transmission cycle of Borrelia *burgdorferi* sensu lato in the Czech Republic. Green lizards were sampled in two areas at the Tiché Údolí Nature Reserve (site A: 50.1482 N, 14.3669E; site B: 50.1476 N, 14.3745 E), Central Bohemian Region, Czech Republic.

The skin biopsy specimens and attached ticks (if any) were collected from 52 captured lizards. Also, questing ticks from both areas were collected by flagging. The touchdown polymerase chain reaction and gel electrophoresis revealed *Borrelia lusitaniae* in three lizard tissue samples. Most lizards (19/30, 63%) had at least one *Borrelia* positive tick. *Borrelia lusitaniae* formed 92% (34/37) and 59% (17/29) of all borreliae detected in larvae and nymphs, respectively. *Borrelia lusitaniae* (6/10, 60%) was also the major pathogen in questing nymphs from site B. At site A, 13% (2/16) of questing nymphs were positive for *B. lusitaniae*.

Based on our data, it can be assumed that *B. lusitaniae* is a common pathogen at lizard sites in the Czech Republic, and further research to prove this hypothesis is therefore highly recommended. As lizards often inhabit urban areas, the data presented may also contribute to raising awareness of the possible spread and risk of *Borrelia* infection. Musilova L, et al. Ticks and Tick-borne Diseases, https://doi.org/10.1016/j.ttbdis.2021.101887.

## Treatment of Morgellons disease with doxycycline

Morgellons disease (MD) is a rare dermatopathy characterized by nonspecific symptoms and the production of multicolored fibers and granular tissue from diffuse skin ulcerations which are described as being either pruritic or painful. The etiology of MD is currently unknown; previous studies have suggested both psychiatric and infectious causes, with increasing interest over the previous decade in elaborating a possible pathogenesis for the disease secondary to infection by Borrelia species.

We report a middle-aged Caucasian female who developed symptoms of MD in the days following exposure to a tick bite after spending an afternoon hiking through a wooded area. She was subsequently treated with a course of Doxycycline and found on two-week follow-up to have complete remission of her symptoms. This case report further supports the theory for an infectious etiology of MD and encourages future studies into its pathophysiology. Zhang F, et al. Clinical Case Reports, https://doi.org/10.1002/ccr3.5148.

## A case of ocular lesions in a patient with both tickborne borreliosis and toxoplasmosis from Ukraine

The prevalence of tick borne borreliosis has increased significantly in recent years. There have been reports on conjunctivitis, anterior uveitis, optic neuritis and other inflammatory eye diseases caused by Borrelia species. This case of successful treatment of focal chorioretinitis caused by Borrelia burgdorferi/Toxoplasma gondii co-infection indicates that elucidating etiology and administering etiological therapy are essential for successful treatment outcomes.

Since there are few reports in the literature describing the ocular manifestations of Lyme disease, borreliosis is infrequently suspected by ophthalmologists as an etiologic factor in the development of inflammatory eye disease. Consequently, an enzyme immunoassay for Borrelia burgdorferi is not used in a routine diagnostic evaluation of patients with inflammatory eye disease.

Specific Borrelia burgdorferi antibody serology is required to elucidate the etiology of ocular inflammation if a patient has a history of tick bites even in the absence of symptoms of Lyme disease. In addition, one should take in account that ocular infections are frequently mixed in nature. Sakovych VM, et al. Journal of Ophthalmology (Ukraine) - 2021 - Number 6 (503).

## 8,000 fewer cases of Lyme disease were registered in Poland than in years before the pandemic

### The Impact of a Pandemic COVID-19 on the Incidence of Borreliosis in Poland

Lyme disease is the most common tick-borne disease, caused by spirochetes of the genus Borrelia, transmitted by ticks of the Ixodes genus in Poland. The purpose of this analysis was whether the COVID-19 outbreak had a significant impact on the number of reported Lyme disease cases.

The data included in the World Health Organization (WHO) and the data from the "Reports on incidence of infectious diseases, infections and poisoning in Poland" presented by the Department of Epidemiology NIZP-PZH were analyzed.

To the end of 2020, there were registered 12, 524 Lyme disease cases. In the same period, in 2018 and 2019 were registered, respectively, 20, 150 and 20, 614 Lyme disease cases. The overall number of Lyme disease cases in 2018 and 2019 was at a similar level. The monthly increase in the number of cases was also at a similar level. The year 2020 in January and February was characterized by the same increase in the number of cases as in previous years. The difference started to be noticeable in March and the lowered growth compared to the previous years has been maintained to this day. In December, about 8,000 fewer cases of Lyme disease were registered than in previous years.

The reduced number of cases of Lyme disease coincided with the beginning of the COVID-19 epidemic in Poland in March 2020. Every year, the incidence of Lyme disease in Poland is at a similar level with a similar monthly increase. The outbreak of the COVID-19 pandemic had a significant impact on the number of cases recorded, which could have catastrophic consequences for people who did not receive treatment in the right time. Piotrowski M & Rymaszewska A, Acta Parasitol. doi: 10.1007/s11686-021-00495-0.

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