Tick-Borne Infections Council of North Carolina, Inc.

NEWSLETTER 2019, Volume 1

A Happy & Healthy New Year to You!

Quote: - "November 14th, 2018 – A federal advisory committee established by the 21st Century Cures Act, issued its first report today. This new report focused on Lyme Disease, which is the most commonly reported tick-borne illness in the USA." Read the report at: www.hhs.gov/sites/default/files/tbdwg-report-to-congress-2018.pdf

Highlights…

- **See the special section for Anglophiles below**
- **Lyme disease bacteria or related strains have been found in parts of South America**
- **Call for better tests for Lyme disease**
- **Lone star ticks live for 70 days in water!**
- **Heartland virus, cases, and lone star ticks**
- **A type of deer fly (ked) carries a Lyme disease associated spirochete**
- **Coconut oils investigated as repellants, not on market yet**
- **7.3% of tested southern deer positive for Heartland virus**
- **Where are baby black-legged ticks hiding in Texas?**
- **How various treatment options help in chronic Lyme disease**
- **Lyme disease and a certain kind of bone loss in mice**
- **Results of a large Pennsylvania study on Lyme disease**
- **Multiple articles on Canada**

Scroll down to see these features and more!

State Vector-Borne Disease Working Group 2019 Meeting Schedule

No dates available as yet from the state.

(Check with us before going to confirm date as they occasionally change.)

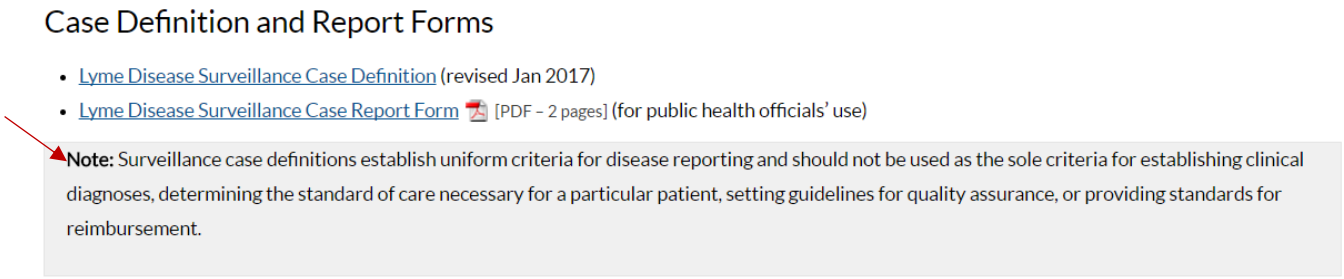
Location:
Office of the Chief Medical Examiner Photo ID required.
4312 District Drive
Raleigh, NC 27607

Links to Letters to Medical Providers from the State Department of Public Health on Lyme Disease and Rickettsial Diseases

Links to the letters the state Department of Public Health issues every year to medical providers on Lyme disease and the Rickettsial diseases such as RMSF are on the home page of our website: tic-nc.org.

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

Go to: www.cdc.gov/lyme/healthcare/index.html. (The links below in a clip of the website are not active.) Scroll down and find "Case Definition and Report Forms". See the grey box with "Note" containing the disclaimer.



Case Definition and Report Forms

- Lyme Disease Surveillance Case Definition (revised Jan 2017)
- Lyme Disease Surveillance Case Report Form [PDF – 2 pages] (for public health officials' use)

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.

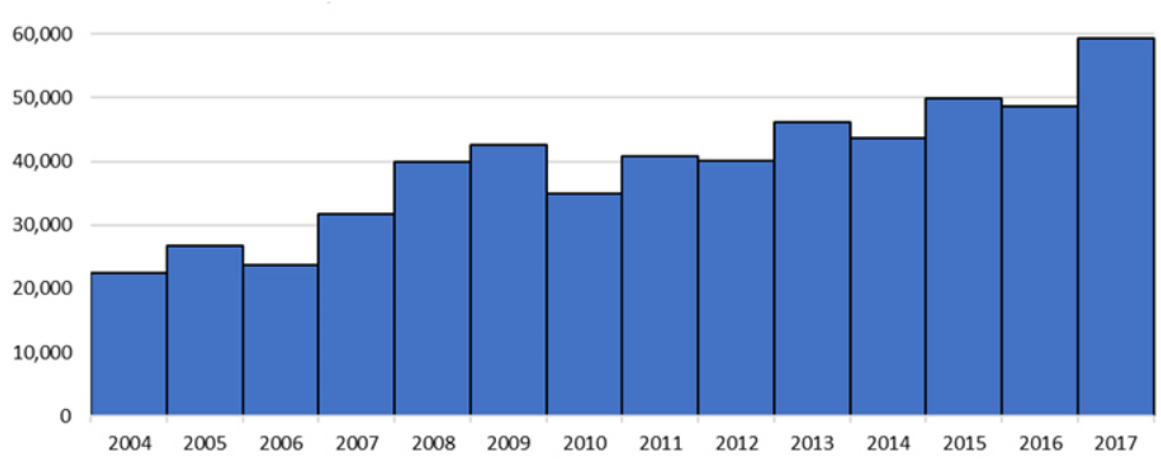
Accessed and copied 15 August 2017.

From the CDC-- Total Reported Cases of Tickborne Disease, 2004–2017: Numbers more than doubled since 2004

In 2017, state and local health departments reported a record number of cases of tickborne disease to CDC, 59,349 cases, up from 48,610 in 2016. From: www.cdc.gov/ticks/data-summary/index.html. Also see: www.cdc.gov/vitalsigns/vector-borne/index.html

Reported Tickborne Diseases, U.S.		
Reported Tickborne Diseases, U.S.	**2016**	**2017**
Lyme Disease (confirmed and probable)	36,429	42,743
Anaplasmosis/Ehrlichiosis†	5,750	7,718
Spotted Fever Rickettsiosis§	4,269	6,248
Babesiosis§§	1,910	2,368
Tularemia	230	239
Powassan virus	22	33
Total	**48,610**	**59,349**

For more detailed data about each disease, including state totals, see the Notifiable Infectious Diseases and Conditions Annual Data Tables.
For more information about increasing numbers of infections from mosquito, tick, and flea bites, see the May 2018 issue of Vital Signs.



Reported cases of confirmed and probable Lyme disease, anaplasmosis/ehrlichiosis, spotted fever rickettsiosis (including Rocky Mountain spotted fever), babesiosis, tularemia, and Powassan virus disease all increased between 2016 and 2017.

State tick research

No research report available.

NC TBIs 2017 final, 2018 probable/confirmed

Disease	Total Cases/Confirmed cases by year of report 2017†	Total preliminary confirmed and probable Events in NCEDSS created between 1/1/2018 - 8/9/2018*	Total Events Reviewed and closed by NC DPH 1/1/17 - 8/9/2018	Total Events Still Under Investigation by LHD 1/1/18 - 8/9/2018	Total Events created in NCEDSS 1/1/18 - 8/9/2018
Lyme Disease	298/71C	81/35C	530	102	632
RMSF	521/6C	418/6C	2039	282	2321
Ehrlichiosis	72/18C	51/8C	192	18	210
Anaplasmosis	10/4C	9/4C	29	4	33

** Note 2018 data are preliminary*

Source: State Department of Public Health

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:
Various places in Asheville
including Biltmore Park YWCA
Lower Half State Natural Area Children's Event
Pittsboro Urgent Care
Pittsboro Discount Pharmacy
Brevard, NC
Various sites in the Blue Ridge Mountains

Talks:
Governors Club Cares, Chapel Hill NC

Report from the State or Vectorborne Disease Work Group meeting

First documented human bite from the new invasive long-horned tick. Three counties are now known to have these ticks. Date collected: 26 August 2018, Winston Salem.

NVSL Sample ID: 7790490
Animal ID:
Sample ID: 2018-025
Case No: T18-1320
Host: *Homo sapiens*

Collection Location: Forsyth County, NC

Location on Host: on chest
No. Animals in Lot:
No. Animals Infested: 1

Tentative Parasite Identification by: AMB
Haemaphysalis longicornis Neumann, longhorned tick (Ixodida: Ixodidae)

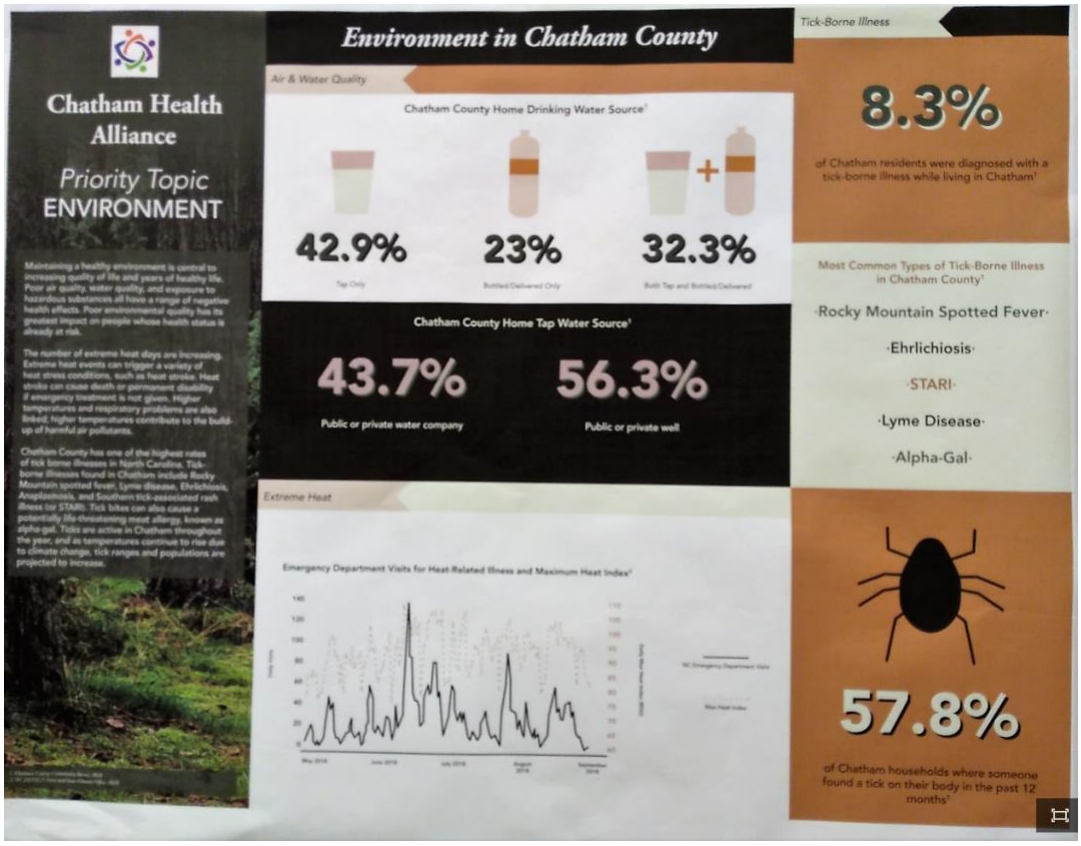
Parasite Identification by: James Mertins
Haemaphysalis longicornis Neumann, longhorned tick (Ixodida: Ixodidae)
1 female

Remarks: This specimen documents the first known collection of this exotic tick species from Forsyth County, NC, marking the third proven infested county in the state.

TIC-NC Activities

Chatham Health Alliance Meeting, October 2, 2018

TIC-NC was one of the sponsors. We are grateful to the Alliance for including tick data in their survey.



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TIC-NC's booklet was featured in an article called "A New Perspective on North Carolina's Tickborne Illnesses." This was published in:

NORTH CAROLINA HEALTH NEWS
News. Policy. Trends. North Carolina.

www.northcarolinahealthnews.org/2018/10/19/a-new-perspective-on-north-carolina-tick-borne-illnesses/

⁂ North Carolina and South ⁂

Failure to test for Ehrlichia may have missed ~13% of people presenting with possible tickborne infections at UNC medical clinics

Ehrlichia infections, North Carolina, USA, 2016

Incidence of spotted fever group *Rickettsia* (SFGR), which include the causative agent of Rocky Mountain spotted fever (RMSF), is high in North Carolina, USA (*1*). Entomologic studies, however, suggest that the principal vector in this state is the lone star tick (*Amblyomma americanum*), which is a major vector for *Ehrlichia chaffeensis* and *E. ewingii* (*2*,*3*). The clinical spectrum of *Ehrlichia* infection, which causes nonspecific signs and symptoms including fever, headache, and malaise, resembles that of RMSF (*4*,*5*). Therefore, we examined clinical practice patterns associated with the evaluation and treatment of patients suspected of having tickborne illness to determine if *Ehrlichia* infection causes underrecognized tickborne illness in North Carolina.

Nearly two thirds of persons suspected of having tickborne illness in central North Carolina, USA, were not tested for *Ehrlichia*. Failure to test may have resulted in a missed diagnosis for ≈13% of these persons, who were therefore substantially less likely to receive antimicrobial treatment and to have follow-up testing performed. Boyce RM et al. Emerg Infect Dis. 2018 Nov. https://doi.org/10.3201/eid2411.180496. Entire paper free of charge at: wwwnc.cdc.gov/eid/article/24/11/18-0496_article.

Alpha gal (meat allergy) and chiggers?

Could chiggers be contributing to the prevalence of galactose-alpha-1, 3-galactose sensitization and mammalian meat allergy?

Clinical Implications. Patients may report "chigger" bites before galactosealpha-1,3-galactose sensitization. It remains unclear whether mammalian meat allergy can be caused by the bites of true chiggers, which are red, or if the bites are actually due to the often confused larval "seed ticks." *Stoltz et al.* The Journal of Allergy and Clinical Immunology: In Practice**.** doi.org/10.1016/j.jaip.2018.07.014**.**

Also known as berry bugs, harvest mites, red bugs, scrub-itch mites, and aoutas, chiggers are the most well-known denizens of the Trombiculidae family.

Beefing Up Biosecurity: Survey of Ticks (Acari: Ixodidae) Currently Threatening the Tennessee Beef Cattle Industry, and a Proposed Monitoring Strategy for Invasive Ticks

Tick-borne diseases are poised to devastate the North American cattle industry if infected ticks invade the country either by importation of an infested-animal or with natural host migration. Our research

objectives were to identify sources for invasive-tick monitoring and use those sources to describe seasonal and regional impacts on infestation prevalence and burden of ticks on beef cattle. Throughout the state of Tennessee, we sampled 25% of the total herd size (or 10 animals) at three university-operated research and education centers (RECs) (sentinel sites), six livestock auctions (check-stations), and nine Extension agents at 21 producer locations (tick scouts) from 2015 to 2016. From 1,817 sampled cattle 740 ticks (Acari: Ixodidae) were collected including 573 *Amblyomma americanum* (L.) (77.4%), 125 *A. maculatum* Koch (16.9%), 35 *Dermacentor variabilis* (Say) (4.7%), and 3 *Ixodes scapularis* (Say) (0.4%). Western and middle Tennessee were significantly different in infestation prevalence and burden of *A. maculatum*. For *A. maculatum* and the species total, infestation prevalence and burden were greater in spring than fall. Auctions (check stations) and RECs (sentinels) had the greatest infestation prevalence of *A. maculatum*, and the greatest burden of *A. maculatum* and *D. variabilis*.

High-risk locations clustered in western and middle Tennessee, with low-risk locations in middle and eastern Tennessee. Results from this study provide knowledge necessary to initiate control measures, including seasonal phenology and regional distribution of current tick threats. Use of RECs as sentinel sites and routine tick surveillance at livestock auctions serving as check stations should be used for mitigating invasive tick threats.
Theuret & Fryxell, *Journal of Medical Entomology*, https://doi.org/10.1093/jme/tjy131.

35 cases of Heartland virus reported, Lone star tick is vector

Heartland Virus Epidemiology, Vector Association, and Disease

First identified in two Missouri farmers exhibiting low white-blood-cell and platelet counts in 2009, Heartland virus (HRTV) is genetically closely related to severe fever with thrombocytopenia syndrome virus (SFTSV), a tick-borne phlebovirus producing similar symptoms in China, Korea, and Japan. Field isolations of HRTV from several life stages of unfed, host-seeking Amblyomma americanum, the lone star tick, implicated it as a putative vector capable of transstadial transmission.

Laboratory vector competence assessments confirmed transstadial transmission of HRTV, demonstrated vertical infection, and showed co-feeding infection between A. americanum. A vertical infection rate of 33% from adult females to larvae in the laboratory was observed, while only one of 386 pools of molted nymphs (1930) reared from co-feeding larvae was positive for HRTV (maximum-likelihood estimate of infection rate = 0.52/1000).

Over 35 human HRTV cases, all within the distribution range of A. americanum, have been documented. Serological testing of wildlife in areas near the index human cases, as well as in widely separated regions of the eastern United States where A. americanum occur, indicated many potential hosts such as raccoons and white-tailed deer…. A more complete assessment of the natural transmission cycle of HRTV coupled with serosurveys and enhanced HRTV disease surveillance are needed to better understand transmission dynamics and human health risks. Brault et al. *Viruses* **2018**, *10*(9), 498; doi.org/10.3390/v10090498. Entire paper is free of charge.

7.3% of tested southern deer positive for Heartland virus

Heartland Virus Exposure in White-Tailed Deer in the Southeastern United States, 2001-2015

Heartland virus (HRTV) is a North American phlebovirus suspected to be transmitted by the lone star tick Amblyomma americanum. White-tailed deer (WTD) have been shown to develop HRTV-neutralizing antibodies following experimental infection. To further define the geographic distribution of HRTV through retrospective sampling of WTD, sera from the WTD herd health serum archive at the Southeastern Cooperative Wildlife Disease Study between 2001 and 2015 were analyzed using serum neutralization.

Of 783 serum samples tested, 57 (7.3%) were positive for HRTV-neutralizing antibodies. Deer with moderate to heavy tick burdens were more likely seropositive. Seropositive samples were obtained from deer originating from states with documented human cases of HRTV-associated disease. Seropositive samples were identified from years before the recognition of the first human case in 2009. Overall, this study indicates that WTD in the southeastern United States have been exposed to HRTV as early as 2001 and that the presence of seropositive animals corresponds roughly with reported human HRTV-associated disease. Clarke et al. The American Journal of Tropical Medicine and Hygiene, 2018. doi.org/10.4269/ajtmh.18-0555.

Soft-body ticks found in Texas are transmitting tickborne relapsing fever, a bacterium related to Lyme disease

Detection of Tickborne Relapsing Fever Spirochete, Austin, Texas, USA

In March 2017, a patient became febrile within 4 days after visiting a rustic conference center in Austin, Texas, USA, where Austin Public Health suspected an outbreak of tickborne relapsing fever a month earlier. Evaluation of a patient blood smear and molecular diagnostic assays identified Borrelia turicatae as the causative agent. We could not gain access to the property to collect ticks. Thus, we focused efforts at a nearby public park.

TBRF is typically considered a disease of outdoor enthusiasts and impoverished persons living in primitive conditions (1–3,11,15,26). However, our study suggests emergence of B. turicatae in urban areas. The location where ticks were collected was in a densely populated region of the city. However, the maintenance of this pathogen in nature remains unclear. The elusive life cycle of O. turicata ticks also poses challenges in understanding the ecology of B. turicatae. Furthermore, given the nonspecific clinical manifestations of disease, the public health effect of B. turicatae remains vague. Our findings indicate that surveillance efforts should be increased in Austin, Texas, to evaluate emergence of TBRF. Bissett et al. (2018). *Emerging Infectious Diseases*, *24*(11), 2003-2009. doi.org/10.3201/eid2411.172033.

Where are baby black-legged ticks hiding in Texas?

Searching for the Immature Stages of *Ixodes scapularis* (Acari: Ixodidae) in Leaf Litter and Soil in Texas

The standard tick collection methods of flagging and dragging are successful for collecting all stages of the blacklegged tick, *Ixodes scapularis* (Say) (Acari: Ixodidae), in the northern United States. However, for unknown reasons, these methods are unsuccessful for collecting the immature stages of *I.*

scapularis in the southern United States. Thus, a different collection strategy was employed to search for the immature stages of *I. scapularis* in the southern state of Texas.

Monthly sampling of three types of microhabitats potentially harboring ticks was conducted for 17 mo at the Big Thicket National Preserve. Samples of leaf litter, topsoil, and subsoil were placed within Berlese funnels to determine if the immature stages of *I. scapularis* are residing in these layers.

No ticks were found in any of the 600 substrate samples examined. Along nearby trail edges in the same area, 656 adult *I. scapularis* (an average of 22.6 per 1,000 m^2), as well as 268 immatures of other species (i.e., *Amblyomma americanum* (Linnaeus) (Acari: Ixodidae) and *Dermacentor variabilis* (Say) (Acari: Ixodidae)) were collected using flagging and dragging. These results suggest that unlike speculations from previous studies in the southern United States, the immature stages of *I. scapularis* may not be residing in the leaf litter and soil layers in Texas.

We hypothesize that they may be residing in their host's nests and burrows. Perhaps *I. scapularis* in the south is exhibiting a stage specific mixed host-seeking strategy by residing in nests and burrows as immatures, contributing to the geographical difference in Lyme disease prevalence between the northern and southern United States. MacKensie et al. *Journal of Medical Entomology*, tjy157, doi.org/10.1093/jme/tjy157.

Special Section for Anglophiles

Part of a public health poster for England. Entire English 'tool kit' for education public:

www.gov.uk/government/publications/tick-bite-risks-and-prevention-of-lyme-disease
A toolkit for local authorities and environmental organisations to assist with messaging around public awareness of ticks and Lyme borreliosis has recently been produced by PHE

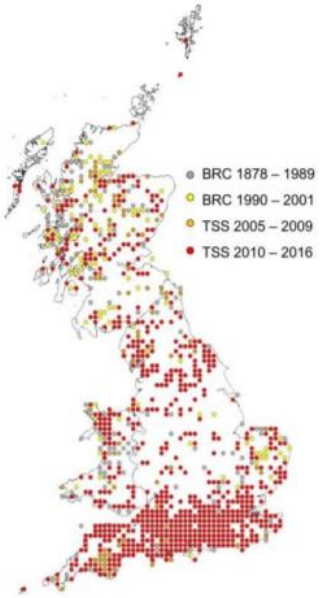


Figure 5. Distribution of *Ixodes ricinus* ticks in Great Britain (after [79]).

https://www.mdpi.com/1660-4601/15/10/2145
Local authorities are now being encouraged to use this toolkit to develop local tick awareness materials for local campaigns. Gathering further evidence concerning the factors affecting the distribution of I. ricinus in urban greenspace is consequently crucial. Other ticks and diseases in the UK are discussed in the paper.

Figure 6. Main habitats for *Ixodes ricinus* ticks in woodland, grazed grassland. Ticks are collected by blanket dragging vegetation.

◘◘ National Section ◘◘

Large Pennsylvania study found annual incidence of Lyme disease 4-7 times higher than official numbers and 21% of patients had lingering symptoms after treatment

Epidemiology of Lyme disease in Pennsylvania 2006–2014 using electronic health records

Lyme disease is the most common vector-borne disease in the United States. Electronic health record (EHR)-based research on Lyme disease is limited. We used Geisinger EHR data from 479,344 primary care patients in 38 Pennsylvania counties in 2006–2014 to compare EHR-based Lyme disease incidence rates to surveillance incidence rates, evaluate individual and community risk factors for incident Lyme disease, and to characterize the proportion of cases with diagnoses consistent with post-treatment Lyme disease syndrome in the EHR ($PTLDS_{EHR}$).

We primarily identified Lyme disease cases using diagnosis codes, serologic testing order codes, and medication orders but also completed subgroup analyses among those with positive serology and those with both diagnosis code and antibiotic treatment… We identified 9,657 cases of Lyme disease, including 1,791 cases with positive serology and 4,992 cases with both diagnosis code and antibiotic treatment.

Annual incidence rates in the EHR were 4.25 to 7.43 times higher than surveillance… Within 4 to 52 weeks after Lyme disease diagnosis, 20.8% (n = 735) of cases with a diagnosis code and treatment had a diagnosis of malaise or fatigue, pain, or cognitive difficulties not present in the past 26 weeks… Moon et al. doi.org/10.1016/j.ttbdis.2018.10.010. Use link for entire abstract.

Call for better tests for Lyme disease

Direct diagnostic tests for Lyme disease

Borrelia burgdorferi was discovered to be the cause of Lyme disease in 1983, leading to seroassays. The 1994 serodiagnostic testing guidelines predated a full understanding of key B. burgdorferi antigens and have a number of shortcomings. These serologic tests cannot distinguish active infection, past infection, or reinfection. Reliable direct-detection methods for active B. burgdorferi infection have been lacking in the past but are needed and appear achievable. New approaches have effectively been applied to other emerging infections and show promise in direct detection of B. burgdorferi infections. Schutzer at al. *Clinical Infectious Diseases*, ciy614, doi.org/10.1093/cid/ciy614.

Report of Non-Lyme, Erythema Migrans Rashes from New Jersey with a Review

Erythema migrans (EM) rashes once considered pathognomonic of Lyme disease (LD) have been reported following bites of arthropods that do not transmit LD and in areas with no LD. Also, EM rashes have been reported in association with organisms other than members of *Borrelia burgdorferi* sensu lato complex. Arthropod saliva has chemicals that have effects on the host and pathogen transmission. Tick saliva has protein families similar to spiders and scorpions and even substances homologous to those found in snakes and other venomous animals. Ticks "invertebrate pharmacologists" have a sophisticated arsenal of chemicals that assist in blood feeding, pathogen transmission, and suppressing host defenses. No organisms have been isolated from many EM rashes. We propose that tick salivary toxins may play a role in the causation of rashes and laboratory abnormalities in tick-borne diseases. The role of tick salivary toxins needs further exploration.

Cases of Lyme-like EM rashes referred to as STARI (Southern Tick-Associated Rash Illness) following bites of the lone star tick, *Amblyomma americanum*, in the United States have been reported predominantly in Southeastern Missouri and a few in South Carolina, North Carolina, Georgia, and one case each in Mississippi and Long Island, New York. Although there is one report of *Borrelia lonestari* in a patient with a rash, biopsies of 31 cases of STARI, with cultures and PCR, failed to show a relationship. Distribution of *A. americanum*, whose bites are associated with STARI, now extends along the East Coast of the United States, including New Jersey, up to the Canadian border. As far as we are aware, there have been no prior reports of Lyme-like rashes in New Jersey. In this study, we

present case examples of 2 Lyme-like rashes, variations of EM rashes, and a brief review of studies that suggest a role of tick salivary toxins in tick-borne diseases. Kannagara & Patel. Vector-Borne and Zoonotic Diseases. https://www.liebertpub.com/doi/10.1089/vbz.2018.2278

A type of deer fly (ked) has been found to carry a Lyme disease associated spirochete and Anaplasma, transmission ability to humans is unknown

Deer Ked: A Lyme-Carrying Ectoparasite on the Move

Lipoptena cervi, known as the deer ked,* is an ectoparasite of cervids traditionally found in northern European countries such as Norway, Sweden, and Finland. Although rarely reported in the United States, this vector recently has been shown to carry Borrelia burgdorferi and Anaplasma phagocytophylum from specimens collected domestically. Importantly, it has been suggested that deer keds are one of the many disease-carrying vectors that are now found in more expansive regions of the world due to climate change. We report a rare sighting of L cervi in Connecticut. Additionally, we captured a high-resolution photograph of a deer ked that can be used by dermatologists to help identify this disease-carrying ectoparasite. Kelsey and Finch. Cutis. 2018;102:121-122.

*The deer ked, an ectoparasite of cervids is usually in Norway, Sweden, and Finland. It has been occasionally found in the US for over 100years. The main host is thought to be the white-tailed deer (Odocoileus viginianus). When it finds a host, the deer ked sheds its wings, crawls into the fur and has a blood meal.

Borrelia Miyamotoi: An Emerging Tick-Borne Pathogen

B. miyamotoi was detected in *Ixodes scapularis* ticks in Connecticut in 2001, but the first human case in the United States was not reported until 2013. Unlike with Lyme disease, patients in the United States with *B. miyamotoi* infections typically do not have skin lesions and instead present with a non-specific febrile illness, potentially associated with leukopenia, thrombocytopenia and elevated liver function tests. Highly immunocompromised patients may develop chronic meningitis. Untreated patients with *B. miyamotoi* infections may experience a limited number of recurrent episodes of fever, similar to other relapsing fever borrelia infections. The same antibiotic regimens used to treat Lyme disease (e.g., 10-14 day courses of oral doxycycline or amoxicillin) are effective for *B. miyamotoi* infection, although parenteral therapy with ceftriaxone would be preferred for infected patients with chronic meningitis.

… In conclusion, *B. miyamotoi* is a relapsing fever borrelia that is present in all species of Ixodes ticks that transmit *B. burgdorferi* infection, but a much lower proportion of these ticks are infected with *B. miyamotoi* compared with Lyme borrelia. *B. miyamotoi* infection can cause a febrile illness in association with leukopenia, thrombocytopenia and abnormal liver function tests. Highly immunocompromised patients with infection due to *B. miyamotoi* may alternatively develop chronic meningitis. How frequently *B. miyamotoi* infections are asymptomatic and self-resolving is an important question. Available data indicate that symptomatic *B. miyamotoi* infections respond to the same antibiotics used to treat Lyme disease. Wormser at al. The American Journal of Medicine, doi.org/10.1016/j.amjmed.2018.08.012.

Another way to look at how much various treatment options help in chronic Lyme disease

Removing the Mask of Average Treatment Effects in Chronic Lyme Disease Research Using Big Data and Subgroup Analysis

Lyme disease is caused by the bacteria borrelia burgdorferi and is spread primarily through the bite of a tick. There is considerable uncertainty in the medical community regarding the best approach to treating patients with Lyme disease who do not respond fully to short-term antibiotic therapy. These patients have persistent Lyme disease symptoms resulting from lack of treatment, under-treatment, or lack of response to their antibiotic treatment protocol. In the past, treatment trials have used small restrictive samples and relied on average treatment effects as their measure of success and produced conflicting results.

To provide individualized care, clinicians need information that reflects their patient population. Today, we have the ability to analyze large data bases, including patient registries, that reflect the broader range of patients more typically seen in clinical practice. This allows us to examine treatment variation within the sample and identify groups of patients that are most responsive to treatment.

Using patient-reported outcome data from the MyLymeData online patient registry, we show that sub-group analysis techniques can unmask valuable information that is hidden if averages alone are used. In our analysis, this approach revealed treatment effectiveness for up to a third of patients with Lyme disease. This study is important because it can help open the door to more individualized patient care using patient-centered outcomes and real-world evidence.
Johnson et al. *Healthcare* **2018**, *6*(4), 124; doi.org/10.3390/healthcare6040124. Paper available free of charge.

Relapsing fever Borrelia in California: a pilot serological study

Background: Borrelia spirochetes are tick-borne Gram-negative bacteria that cause disease in humans and animals. Although many studies have focused on Borrelia burgdorferi (Bb), the agent of Lyme disease, recent studies have examined the role of Relapsing Fever Borrelia (RFB) in human disease. In this pilot study, we have evaluated serological reactivity against Bb and RFB in patients residing in California.

Methods: Serological testing for reactivity to Bb and RFB antigens was performed in 543 patients with suspected tick-borne illness using a Western blot technique. Further evaluation of a subset of 321 patients residing in California was obtained. Serum samples were tested for IgM and IgG antibodies reactive with Bb and RFB, and samples were classified by county of residence according to Bb reactivity alone, RFB reactivity alone, and dual reactivity against Bb and RFB. Seroreactivity was ranked in counties with the highest absolute number and the highest prevalence of positive samples.

Results: Of the 543 total serum samples, 32% were positive for Bb, 22% were positive for RFB, and 7% were positive for both Bb and RFB. Of the 321 serum samples from patients residing in California, 33% were positive for Bb, 27% were positive for RFB, and 11% were positive for both Bb and RFB. In the California cohort, the highest rates of positive serological testing for Bb were found in Santa Clara, Alameda, and Contra Costa counties, while the highest rates of positive serological testing for RFB were found in Santa Clara, Alameda, Marin, and San Francisco counties. The highest rates of

dual reactivity against Bb and RFB were found in Contra Costa, Alameda, and San Francisco counties. Among the 24 counties with patients who were tested, Bb seropositivity alone was found in four counties, RFB seropositivity alone was found in two counties, and seropositivity for both Bb and RFB was found in 14 counties.

Conclusion: Results of this pilot study suggest that seroreactivity against Bb and RFB is widespread in California, and dual exposure to Bb and RFB may complicate the diagnosis of tick-borne disease. Greater awareness of RFB and broader screening for this tick-borne infection is warranted. Middleveen et al. International Journal of General Medicine 2018:11 373–382. Entire paper free of charge at https://www.dovepress.com/relapsing-fever-borrelia-in-california-a-pilot-serological-study-peer-reviewed-article-IJGM.

Detecting more strains of the Lyme disease bacteria

Genotyping and quantifying Lyme pathogen strains by deep sequencing of the outer surface protein C (*ospC*) locus

Mixed infection of a single tick or host by Lyme disease spirochetes is common and a unique challenge for diagnosis, treatment, and surveillance of Lyme disease. Here we describe a novel protocol for differentiating Lyme strains based on deep sequencing of the hypervariable outer-surface protein C locus (*ospC*). Improving upon the traditional DNA-DNA hybridization method, the next-generation sequencing-based protocol is high-throughput, quantitative, and able to detect new pathogen strains. We applied the method to over one hundred infected *Ixodes scapularis* ticks collected from New York State, USA in 2015 and 2016.

Analysis of strain distributions within individual ticks suggests an overabundance of multiple infections by five or more strains, inhibitory interactions among co-infecting strains, and presence of a new strain closely related to *Borreliella bissettiae*. A supporting bioinformatics pipeline has been developed. The newly designed pair of universal *ospC* primers target intergenic sequences conserved among all known Lyme pathogens. The protocol could be used for culture-free identification and quantification of Lyme pathogens in wildlife and potentially clinical specimens as well. Zhenmao et al. Journal of Clinical Microbiology. 2018 10.1128/JCM.00940-18. https://jcm.asm.org/content/56/11/e00940-18

International & General Section

Lone star ticks live for 70 days in water

Assessing the underwater survival of two tick species, *Amblyomma americanum* and *Amblyomma maculatum*he hard (ixodid) ticks *Amblyomma americanum* and *Amblyomma maculatum* are found throughout the southeastern United States. To study the effects of water inundation, which is an increasingly common phenomenon in many coastal areas, unfed adult *A. americanum*and *A. maculatum* ticks were tested for survival by submergence in three water conditions: freshwater, brackish water, and saltwater. The results demonstrated a significant difference in survival between the two species in all three water conditions, with *A. maculatum* ticks surviving a shorter time underwater

than *A. americanum* ticks. There is also a significant difference in *A. americanum* survival among the different water conditions, with the highest mortality in saltwater and the lowest in freshwater. *Amblyomma americanum* ticks survived the longest in freshwater (70 d), followed by brackish water (64 d), and the shortest survival was in saltwater (46 d), while the longest any *A. maculatum* tick survived was 24 d in freshwater. These findings demonstrate that any short-term flooding events, e.g., less than a week, would not likely eliminate these species of ticks in the flooded area. Bidder et al. doi.org/10.1016/j.ttbdis.2018.08.013.

Another species of Lyme disease found in Canada – Borrelia bissettii

Canadian Journal of Microbiology, e-First Article

Identification of Borrelia bissettii in Ixodes scapularis ticks from New Brunswick, Canada
Ms. Julie Lewis, Dr. Vett Lloyd
https://doi.org/10.1139/cjm-2018-0376

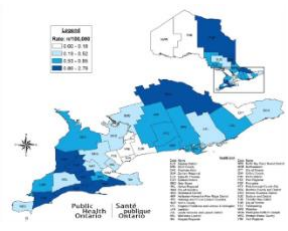
ABSTRACT

Lyme disease is a tick-borne disease that is emerging in Canada. The disease is caused by spirochetes of the Lyme borreliosis group, which is expanding as new species are discovered. In Canada, Lyme disease risk has so far been assessed primarily by detection of Borrelia burgdorferi sensu stricto. From Ixodes scapularis ticks collected between 2014-2016 in New Brunswick, Canada, 7 were shown to be infected with B. bissettii by nested PCR and sequencing of 5 B. bissettii genes. As different Borrelia species are associated with different clinical manifestations and are not detected with the same diagnostic tests, the identification of a previously undocumented or underreported pathogenic Borrelia species has important implications for public and veterinary medicine.

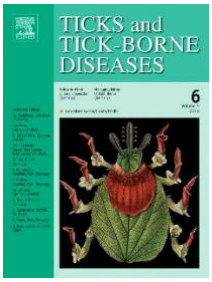
Lone star ticks are now established in Ontario, distribution is scattered

Occurrence and distribution of *Ambylomma americanum* as determined by passive surveillance in Ontario, Canada (1999–2016)

The lone star tick, *Amblyomma americanum*, is spreading northward from its historical stronghold in the southeastern United States. As a vector and biting pest, public and veterinary health officials must remain vigilant of the lone star tick's expanding range. We use ticks submitted to Public Health Ontario Laboratory (1999–2016) to describe the spatial and temporal dynamics of *A. americanum* in Ontario, as well as submitter demographics. We identified 847 *A. americanum* submissions during the surveillance period, with 773 (91.3%) non-travel-related and 74 (8.7%) travel-related submissions. Annual A. *americanum* submissions increased over the surveillance period.



Approximately 91% of non-travel-related submissions were adult ticks and 9% were nymphs. The highest submission rates were from individuals living in the Eastern and South West regions of the province… The majority of travel-related submissions were from travellers returning from the southeastern United States (i.e., Florida, North Carolina, South Carolina, Tennessee, Texas)… Given the relatively rapid expansion of blacklegged ticks, *Ixodes scapularis*, populations in Ontario, we expect climate change to facilitate the range of expansion of *A. americanum* into the province. We propose an algorithm for identifying *A. americanum*-risk areas, which will aid public and veterinary health officials when assessing the risks posed by lone star ticks. Nelder et al. doi.org/10.1016/j.ttbdis.2018.10.001. Entire article is free of charge.



Borrelia, Ticks, Birds, and Canada

Extensive Distribution of the Lyme Disease Bacterium, *Borrelia burgdorferi* Sensu Lato, in Multiple Tick Species Parasitizing Avian and Mammalian Hosts across Canada

Lyme disease, caused by the spirochetal bacterium, *Borrelia burgdorferi* sensu lato (Bbsl), is typically transmitted by hard-bodied ticks (Acari: Ixodidae). Whenever this tick-borne zoonosis is mentioned in medical clinics and emergency rooms, it sparks a firestorm of controversy. Denial often sets in, and healthcare practitioners dismiss the fact that this pathogenic spirochetosis is present in their area.

For distribution of Bbsl across Canada, we conducted a 4-year, tick–host study (2013–2016), and collected ticks from avian and mammalian hosts from Atlantic Canada to the West Coast. Overall, 1265 ticks representing 27 tick species belonging to four genera were collected. Of the 18 tick species tested, 15 species (83%) were positive for Bbsl and, of these infected ticks, 6 species bite humans. Overall, 13 of 18 tick species tested are human-biting ticks.

Our data suggest that a 6-tick, enzootic maintenance cycle of Bbsl is present in southwestern B.C., and five of these tick species bite humans. Biogeographically, the groundhog tick, *Ixodes cookei*, has extended its home range from central and eastern Canada to southwestern British Columbia (B.C.). We posit that the Fox Sparrow, *Passerella iliaca*, is a reservoir-competent host for Bbsl. The Bay-breasted Warbler, *Setophaga castanea*, and the Tennessee Warbler, *Vermivora peregrina*, are new host records for the blacklegged tick, *Ixodes scapularis*. We provide the first report of a Bbsl-positive *Amblyomma longirostre* larva parasitizing a bird; this bird parasitism suggests that a Willow Flycatcher is a competent reservoir of Bbsl. Our findings show that Bbsl is present in all provinces, and that multiple tick species are implicated in the enzootic maintenance cycle of this pathogen. Ultimately, Bbsl poses a serious public health contagion Canada-wide. Scott et al. *Healthcare* **2018**, *6*(4), 131; doi.org/10.3390/healthcare6040131. Entire article free of charge.

Incidence of notified Lyme borreliosis in Germany, 2013–2017 ~56,500 cases

Lyme borreliosis (LB) is the most commonly reported tick-borne disease in Germany. In 9/16 states, notification of erythema migrans (EM), acute neuroborreliosis (NB) and Lyme arthritis (LA) is mandatory… Altogether, we observed 56,446 cases. Disease onset peaked yearly in July… Hospitalization was recorded for 10% of LA and 71% of NB cases. LB remains an important public health concern in Germany with marked regional variation. To facilitate early diagnosis and treatment, health authorities should raise awareness among physicians and promote prevention

strategies among the general population: tick-bite-protection, prompt tick removal and medical https://www.nature.com/articles/s41598-018-33136-0

Better drugs for Lyme disease: focus on the spirochete

Twenty-five years ago, the AIDS epidemic was wreaking havoc around the world. Although "HIV denialists" threatened to undermine research efforts to combat the epidemic, development of targeted antiviral therapy eventually provided effective treatment for the disease. Now the Lyme disease epidemic is wreaking havoc around the world, and "Lyme denialists" are undermining efforts to combat the epidemic. Drawing on our experience with the AIDS epidemic, there is a significant need to develop targeted therapy to control the Lyme disease epidemic. Stricker and Middleveen. Infection and Drug Resistance 2018. Entire article free of charge at: doi.org/10.2147/IDR.S176831.

Coconut oils investigated as repellants, not on market yet

Better than DEET Repellent Compounds Derived from Coconut Oil

Hematophagous arthropods are capable of transmitting human and animal pathogens worldwide. Vector-borne diseases account for 17% of all infectious diseases resulting in 700,000 human deaths annually. Repellents are a primary tool for reducing the impact of biting arthropods on humans and animals... In the present study, we report fatty acids derived from coconut oil which are novel, inexpensive and highly efficacious repellant compounds. These coconut fatty acids are active against a broad array of blood-sucking arthropods including biting flies, ticks, bed bugs and mosquitoes. Zhu et al. *Scientific Reports* Vol 8, Article #: 14053 (2018).

Saliva of ticks is arguably the most complex saliva of any animal

Wonders of tick saliva

Saliva of ticks is arguably the most complex saliva of any animal. This is particularly the case for ixodid species that feed for many days firmly attached to the same skin site of their obliging host. Sequencing and spectrometry technologies combined with bioinformatics are enumerating ingredients in the saliva cocktail. The dynamic and expanding saliva recipe is helping decipher the wondrous activities of tick saliva, revealing how ticks stealthily hide from their hosts while satisfying their gluttony and sharing their individual resources. This review takes a tick perspective on the composition and functions of tick saliva, covering water balance, gasket and holdfast, control of host responses, dynamics, individuality, mate guarding, saliva-assisted transmission, and redundancy. It highlights areas sometimes overlooked – feeding aggregation and sharing of sialomes, and the contribution of salivary gland storage granules – and questions whether the huge diversity of tick saliva molecules is 'redundant' or more a reflection on the enormous adaptability wonderous saliva confers on ticks. Nuthall. Ticks and Tick-borne Diseases, doi.org/10.1016/j.ttbdis.2018.11.005.

Lyme disease and a certain kind of bone loss in mice

The Lyme Disease Pathogen Borrelia burgdorferi Infects Murine Bone and Induces Trabecular Bone Loss

Lyme disease is caused by members of the Borrelia burgdorferi sensu lato species complex. Arthritis is a well-known late-stage pathology of Lyme disease, but the effects of B. burgdorferi infection on bone at sites other than articular surfaces are largely unknown. In this study, we investigated whether B. burgdorferi infection affects bone health in mice. In mice inoculated with B. burgdorferi or vehicle (mock infection), we measured the presence of B. burgdorferi DNA in bones, bone mineral density (BMD), bone formation rates, biomechanical properties, cellular composition, and two- and three-dimensional features of bone microarchitecture. B. burgdorferi DNA was detected in bone…

… deterioration of trabecular bone was not dependent on inhibition of osteoblast function but was more likely caused by blockade of osteoblastogenesis, reduced osteoblast survival, and/or induction of osteoblast death. Together, these data represent the first evidence that B. burgdorferi infection induces bone loss in mice and suggest that this phenotype results from inhibition of bone building rather than increased bone resorption. Tang et al. Infect Immun 85:e00781-16. doi.org/10.1128/ IAI.00781-16.

Lyme disease bacteria or related strains have been found in parts of South America

Borrelia Infection in Latin America

Lyme disease (LD) is a multisystemic inflammatory disease caused by pathogenic spirochetes, belonging to the genospecies complex Borrelia burgdorferi sensu lato (Bbsl). Around the world, distinct species of Ixodes tick vectors transmit different species of Borrelia. Despite the rising recognition and occurrence of tick-borne disease in Latin America, serology has proven to be inconclusive in detecting suspected LD cases.

Recently, new Bbsl strains or new related species have been described in Brazil, Uruguay, and Chile. This could explain the lack of confirmatory tests, such as indeterminate Western blots (WBs) and polymerase chain reactions, in detecting suspected LD cases in this region of the world. Future studies will need to determine the extension of novel Bbsl species infections in ticks, reservoirs, and humans in Latin America. The existence of these new Borrelia genomic species should prompt the development of innovative diagnostic and clinical approaches. Robles et al. Rev Invest Clin. 2018;70(4):158-163. https://www.ncbi.nlm.nih.gov/pubmed/30067716. In Spanish.

Epidemic of RMSF on the USA-Mexican border

Molecular Confirmation of Rocky Mountain Spotted Fever Epidemic Agent in Mexicali, Mexico

Since 2008, a large epidemic of Rocky Mountain spotted fever has been emerging among humans and dogs in Mexicali, adjacent to the United States in Baja California, Mexico. We molecularly confirmed the causative agent; this information can be used to study the origin and dynamics of the epidemic. In 2015, the Mexican Ministry of Health declared the epidemic an epidemiologic emergency, which as of 2018 has affected ≈4,000 persons. In 2014, a fatal human case in Imperial County, CA, USA, was probably associated with the Mexicali epidemic. Tinoco-Gracia et al. 2018), *Emerging Infectious Diseases. 24*(9), 1723-1725. dx.doi.org/10.3201/eid2409.171523. Entire article free of charge: wwwnc.cdc.gov/eid/article/24/9/pdfs/17-1523.pdf.

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Tick-Borne Infections Council of North Carolina is a non-profit 501(c)3 organization formed to improve the recognition, treatment, control, and understanding of tick-borne diseases in North Carolina. We are all-volunteer and appreciate donations.

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