

NEW TICKS RISING: DEVELOPMENTS IN TICKS AND TICK-BORNE DISEASES

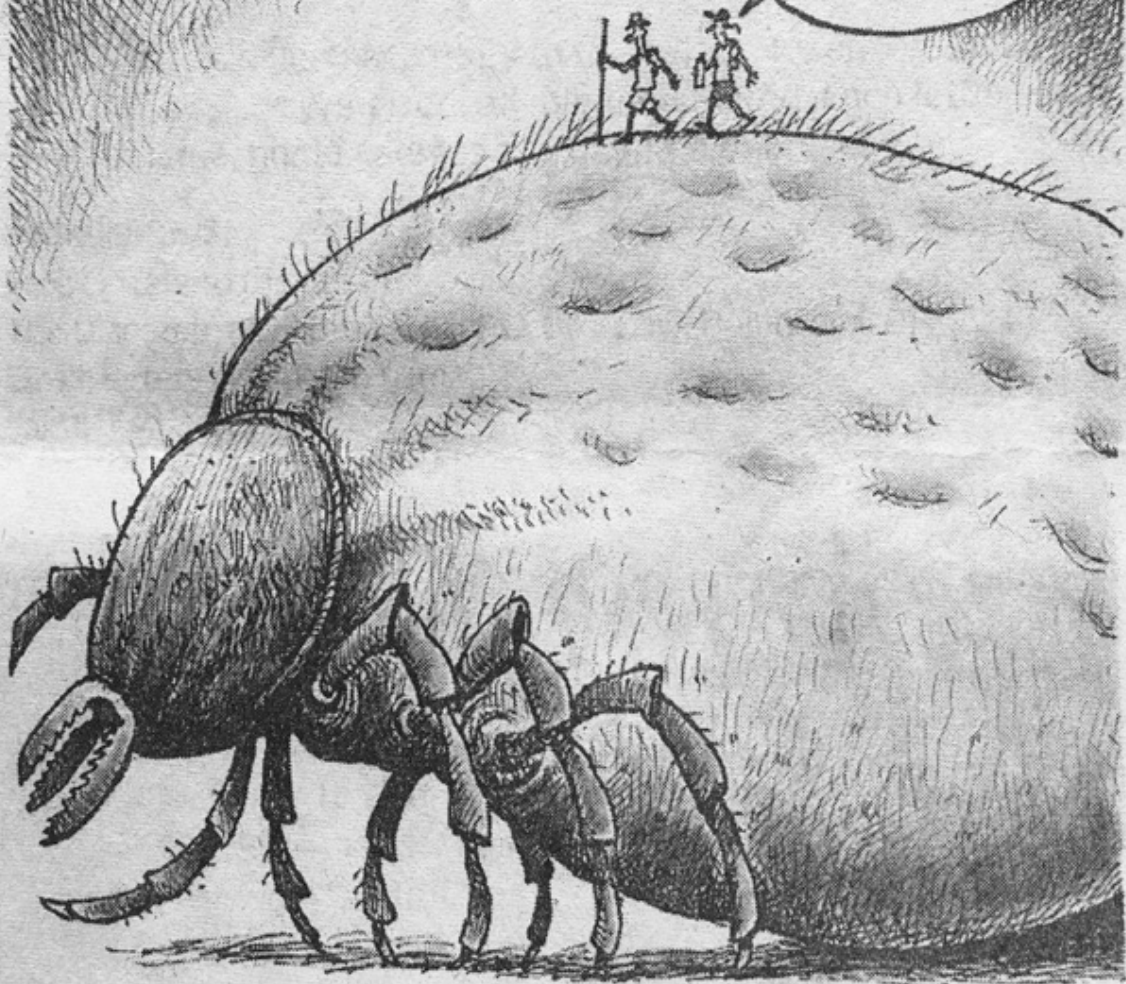
Kirby C. Stafford III, Ph.D.
Chief Scientist, State Entomologist
Department of Entomology
Center for Vector Biology & Zoonotic
Diseases
CT Agricultural Experiment Station
New Haven, CT



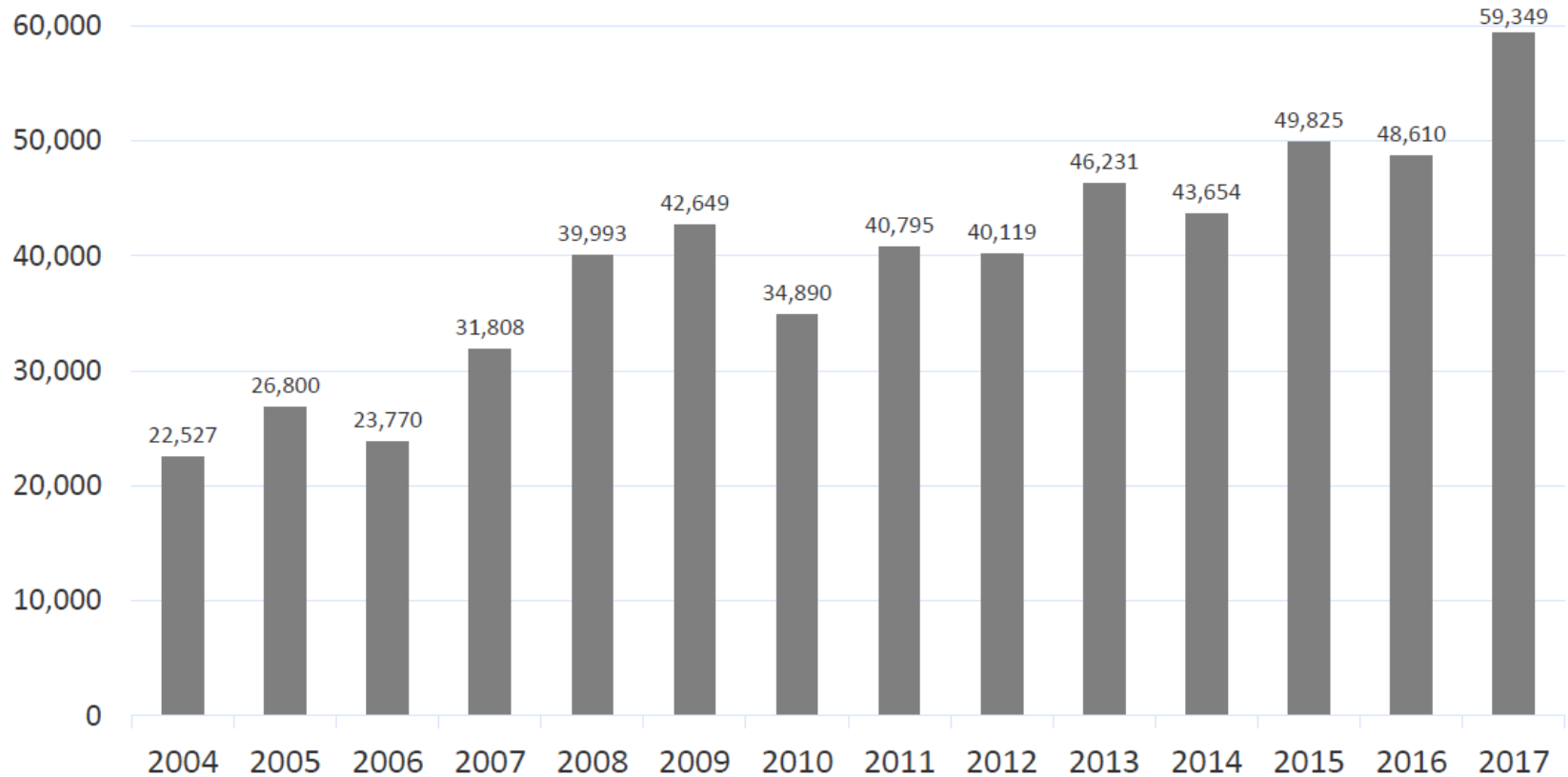
SUPPOSED TO BE
A HUGE TICK
PROBLEM THIS
YEAR ...



HAVEN'T SEEN
ANY YET ...

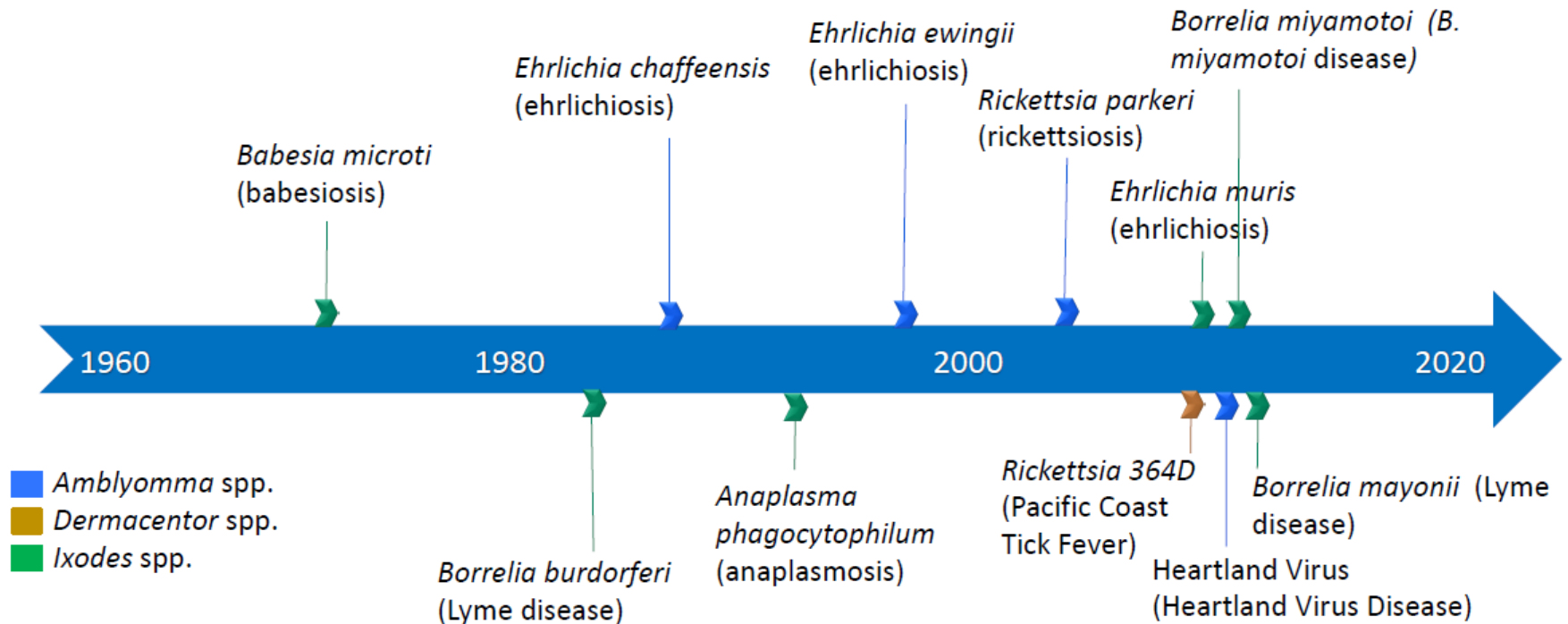


Total tick-borne disease cases, United States, 2004 – 2017



Dr. C. Ben Beard, Deputy Director, Division of Vector-borne Diseases
National Center for Emerging Zoonotic and Infectious Diseases

Discovery of tick-borne pathogens as causes of human disease by year, 1960–2016



- Year represents when tick-borne pathogen was recognized as cause of human disease.
- Adapted from: Paddock CD, Lane RS, Staples JE, Labruna MB. 2016. In: Mack A, Editor. Global health impacts of vector-borne diseases: workshop summary. National Academies Press. p. 221-257.

Dr. C. Ben Beard, Deputy Director, Division of Vector-borne Diseases
National Center for Emerging Zoonotic and Infectious Diseases



TICKS IN CONNECTICUT



- At least 16 species of ticks known in CT (11 in NJ, 16 in NY State)
- 3 species commonly bite humans
- 4 species can transmit disease pathogens
- Plus occasional exotic tick species from foreign travel and new invasive Asian longhorned tick

Woodchuck Tick
Ixodes cookei



Blacklegged Tick
Ixodes scapularis



American Dog Tick
Dermacentor variabilis



Lone Star Tick
Amblyomma americanum



Asian longhorned tick
Haemaphysalis longicornis



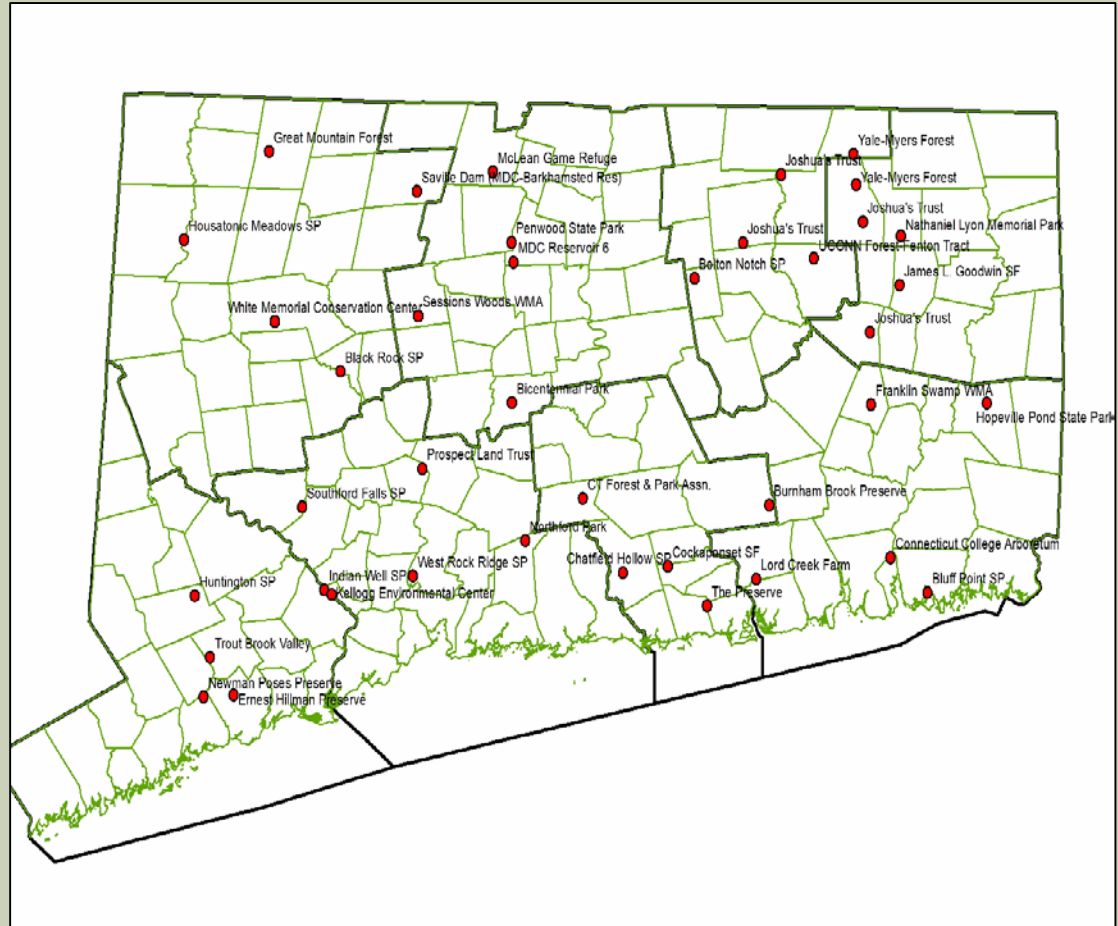
CDC/James Gathany

Others from humans in Connecticut include *I. dentatus*, *R. sanguineus*

ACTIVE SURVEILLANCE

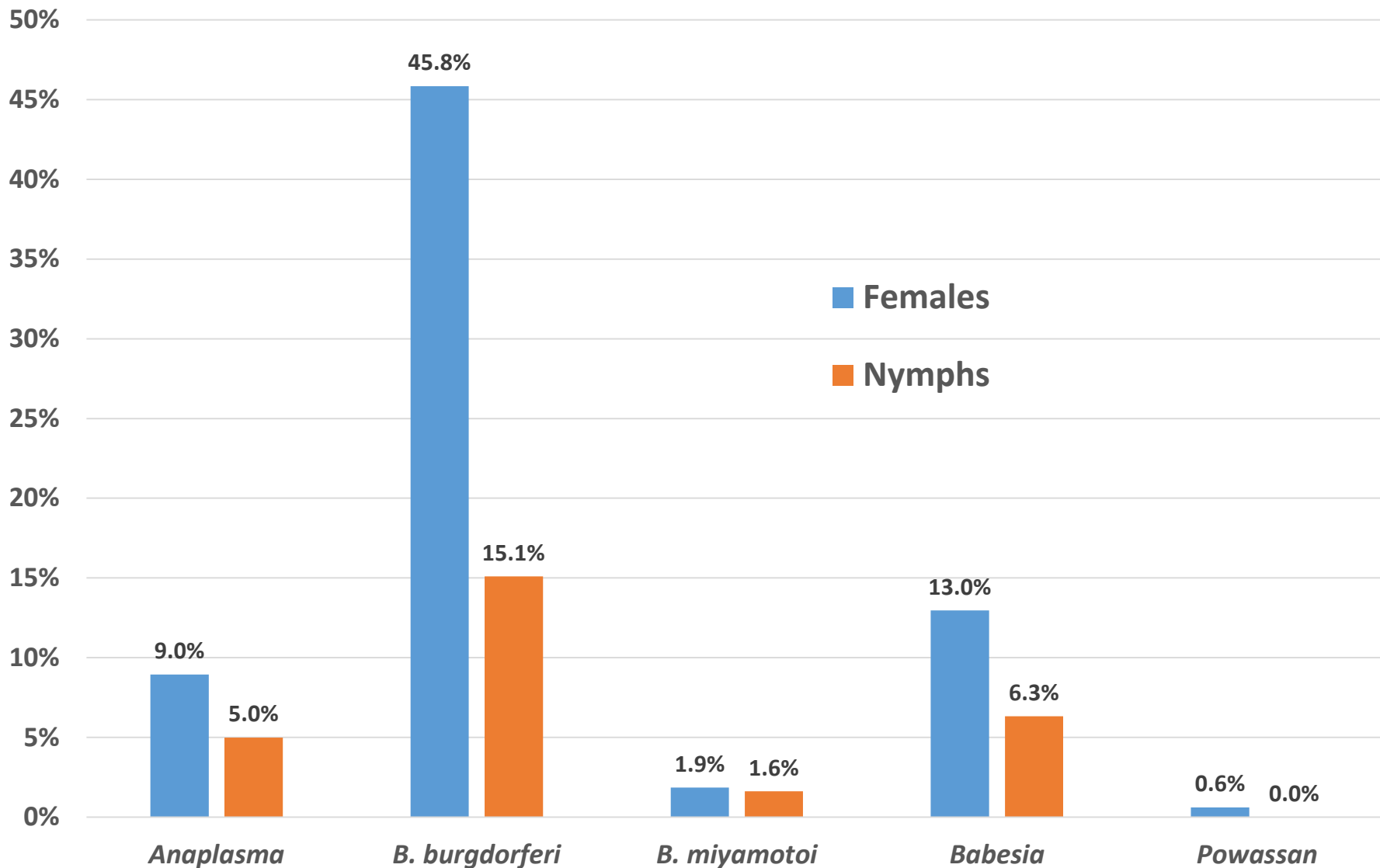
SCOTT WILLIAMS, KIRBY STAFFORD, MEGAN LINSKE, DOUG BRACKNEY, DUNCAN COZENS

- Started in 2019
- Funded ELS* – DPH
- Sample sites 40 locations, through all 8 counties
- In 2019, collected a total of 2,068 blacklegged ticks, 437 American dog ticks, 3 lone star ticks, and 2 Asian longhorned ticks
- Tested at CAES



*Epidemiology and Laboratory Capacity Program CDC

Statewide Infection of *Ixodes scapularis* Adult Females and Nymphs



DRIVERS OF LYME DISEASE EMERGENCE

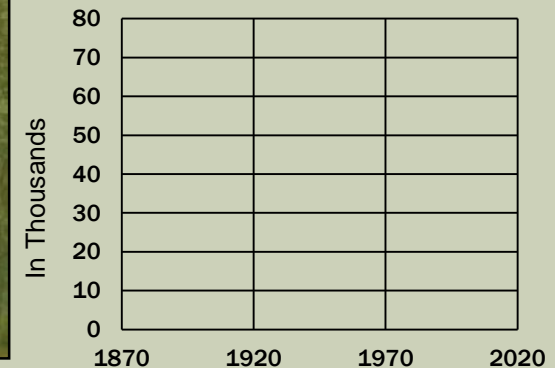
- Reforestation
- Overabundant deer
- Expansion of suburbia into wooded areas
- Abundant habitat around homes for Lyme reservoir hosts
- Increased number of ticks
- Increased exposure opportunities in people



Height Agriculture ca. 1830
Harvard Forest Dioramas

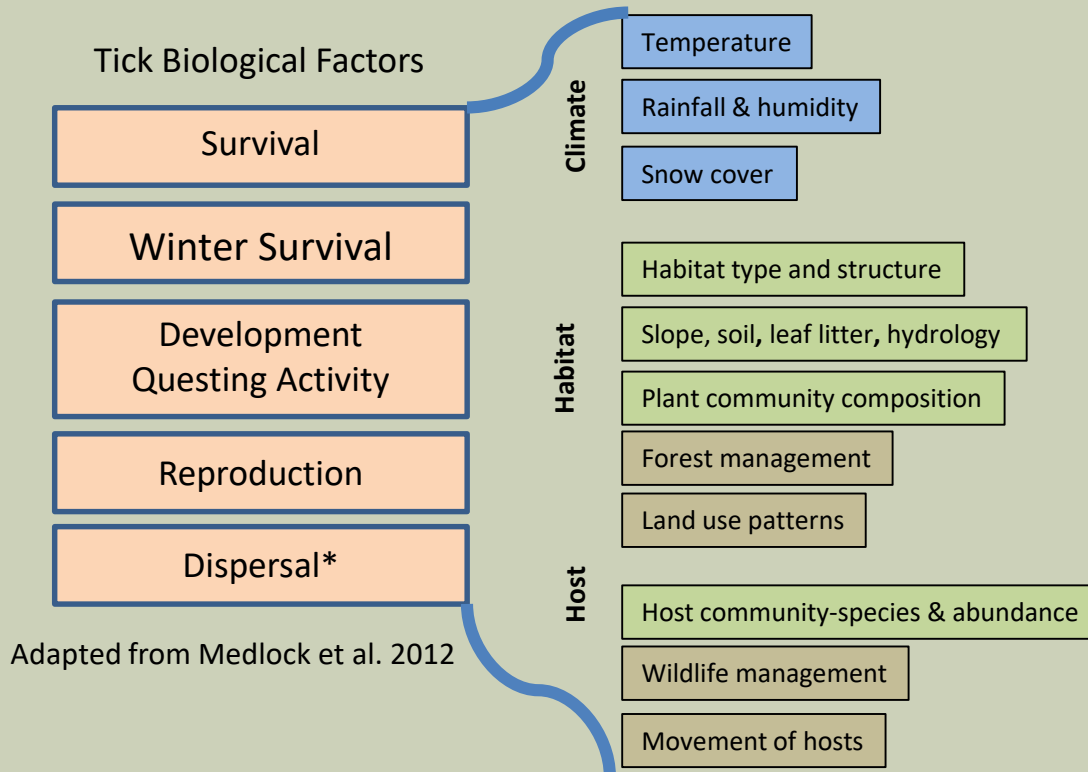


Photo by Skip Weisenburger



DRIVERS FOR CHANGE IN GEOGRAPHICAL DISTRIBUTION OF TICKS

Climatic, Ecological and Anthropogenic Factors



Lone Star Tick
Amblyomma americanum

Asian Longhorned Tick
Haemaphysalis longicornis

Next?
Gulf Coast Tick
Dermacentor maculatum

*includes movement of ticks by humans

LONE STAR TICK

AMBLYOMMA AMERICANUM



95% tick bites in southeastern U.S.

- Bourbon virus
- Ehrlichiosis
Ehrlichia chaffeensis
Ehrlichia ewingii
Panola Mountain ehrlichia
- Heartland virus infection
- Southern Tick-Associated Rash Illness
STARI
- Spotted Fever Group Rickettsia
- Tularemia
- Red Meat Allergy (alpha-gal syndrome)

AMBLYOMMA AMERICANUM

BIOLOGICAL NOTES

- The aggressive lone star tick accounts for ca. 95% of all tick bites in the southeastern United States
- Passing human can pick up hundreds larvae from brushing vegetation that produce erythematous pruritic (itching) papules and attached larvae are small so often treated as a rash
- Nymphal encounter rates can exceed 500 per hour
- Multiple concurrent tick bites from lone star ticks common



Photo: Tom Harkins
From Robyn Nadolny's presentation

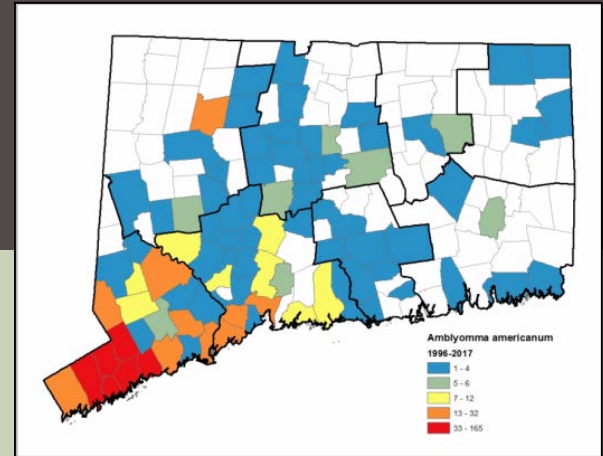


Robyn . Nadolny



Fisher et al. 2006. Arch Dermatol. 142(4):491-494.
doi:10.1001/archderm.142.4.491

MINIMUM TEMPERATURE FACTOR NORTHERN DISTRIBUTION LONE STAR TICK?

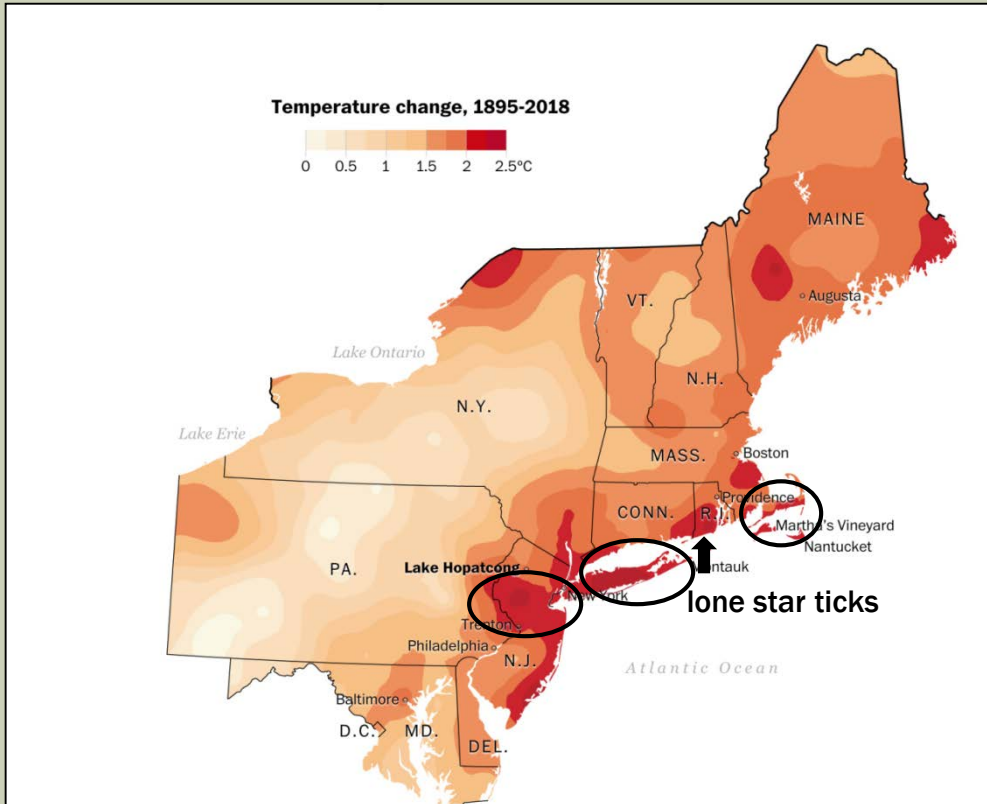


CT data Courtesy CAES TTL

1996-2017



J. Nivolo/DEEP




Map from; Steven Mufson, Chris Mooney, Juliet Eilperin, and John Muyskens. 2°C: Beyond the Limit: Extreme climate change has arrived in America. Washington Post, August 13, 2019.

NOAA data shows that in every Northeast state except Pennsylvania, the temperatures of the winter months of December through February have risen by 2 degrees Celsius since 1895-1896

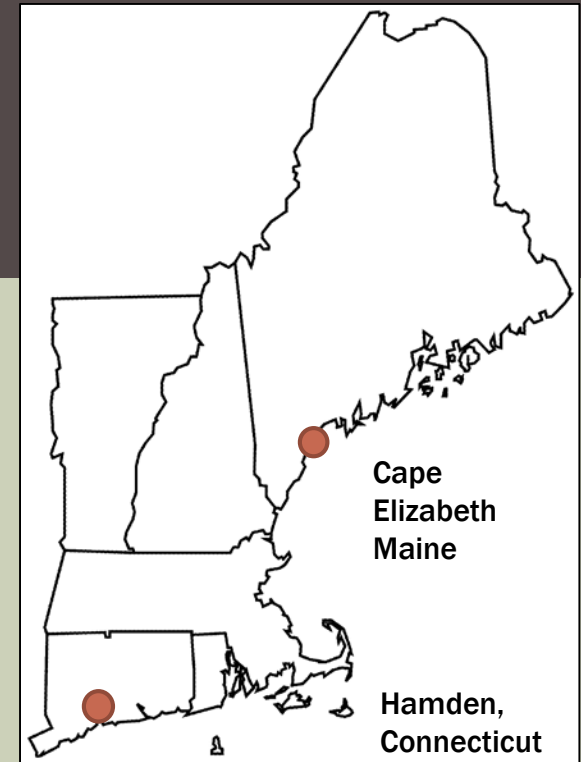
Article

Determining Effects of Winter Weather Conditions on Adult *Amblyomma americanum* (Acari: Ixodidae) Survival in Connecticut and Maine, USA

Megan A. Linske¹, Scott C. Williams^{2,*}, Kirby C. Stafford III¹, Charles B. Lubelczyk³, Elizabeth F. Henderson³, Margret Welch³ and Peter D. Teel⁴

Insects. 2020. 11, 13; doi:10.3390/insects11010013

Ticks placed in vials in tick “pots” buried in the ground in randomized block design with Hobo data loggers.



Four treatment combinations:

Leaf and snow removal (LRSR)

No leaf removal and snow removal (NLSR)

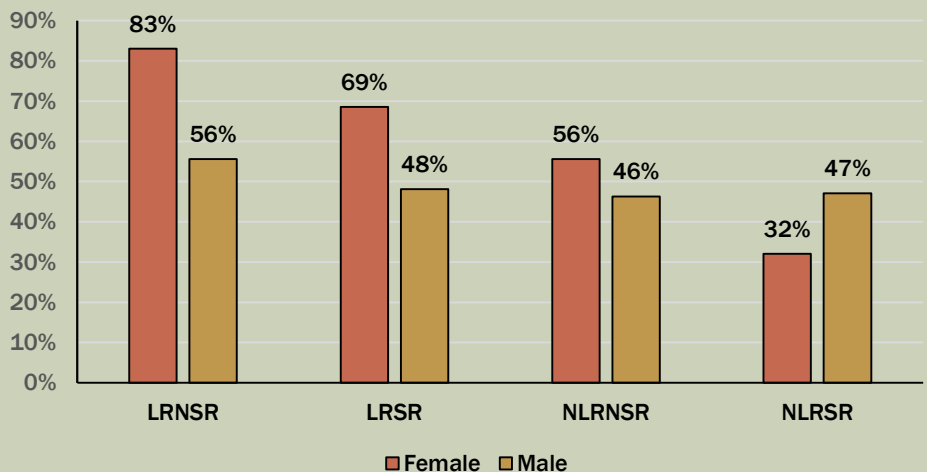
Leaf removal and no snow removal (LRNSR)

No leaf and no snow removal (NLRNSR)

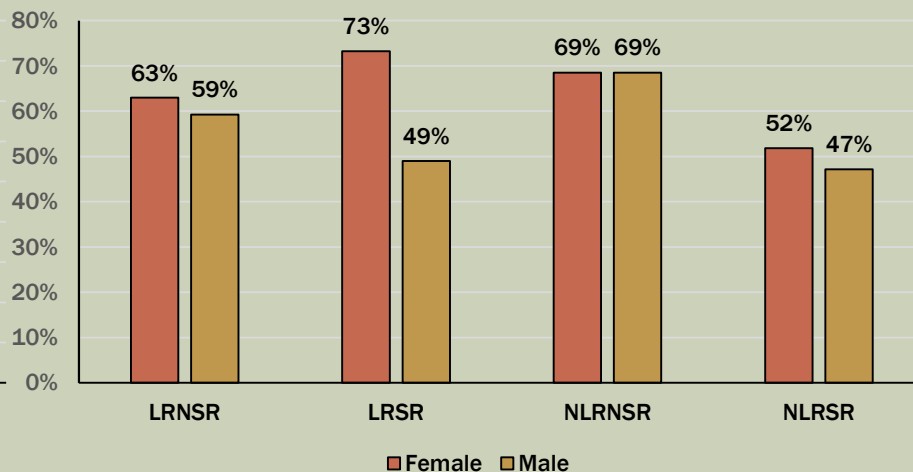
Winters 2016-2017, 2017-2018, 2018-2019

OVERWINTERING SURVIVAL ADULT LONE STAR TICKS - CONNECTICUT

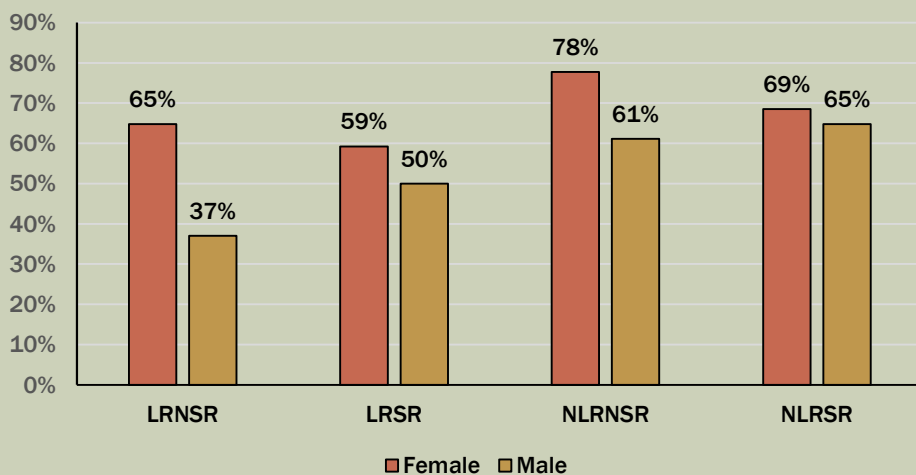
2017 CT



2018 CT



2019 CT



Overwintering survival adult lone star ticks 2016-2017

Connecticut 32-83%

Overwintering survival adult lone star ticks 2017-2018

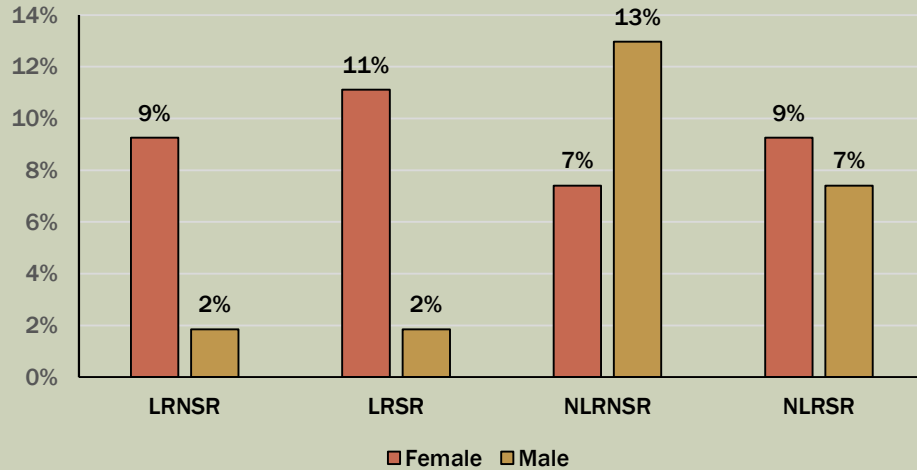
Connecticut 47-73%

Overwintering survival adult lone star ticks 2018-2019

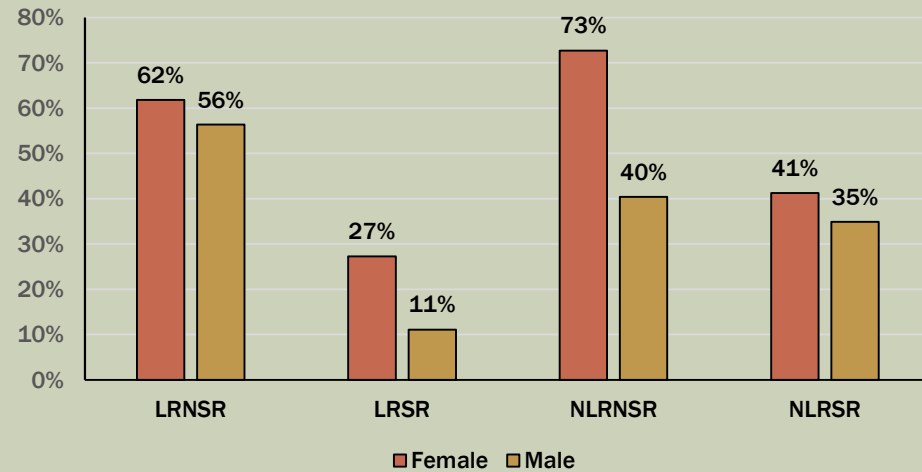
Connecticut 37-78%

OVERWINTERING SURVIVAL ADULT LONE STAR TICKS - MAINE

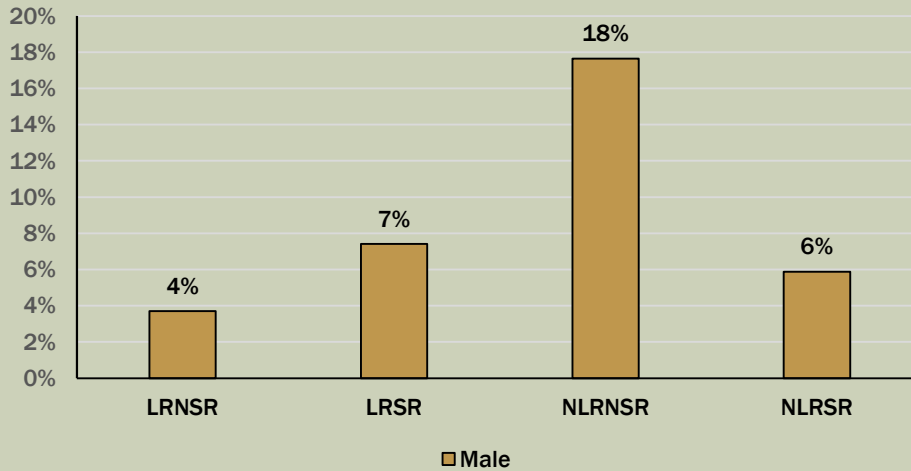
2017 ME



2018 ME



2019 ME



Overwintering survival adult lone star ticks 2016-2017

Maine 2-13%

Overwintering survival adult lone star ticks 2017-2018

Maine 11-73%

Overwintering survival adult lone star ticks 2018-2019

Maine 4-18% (Males)

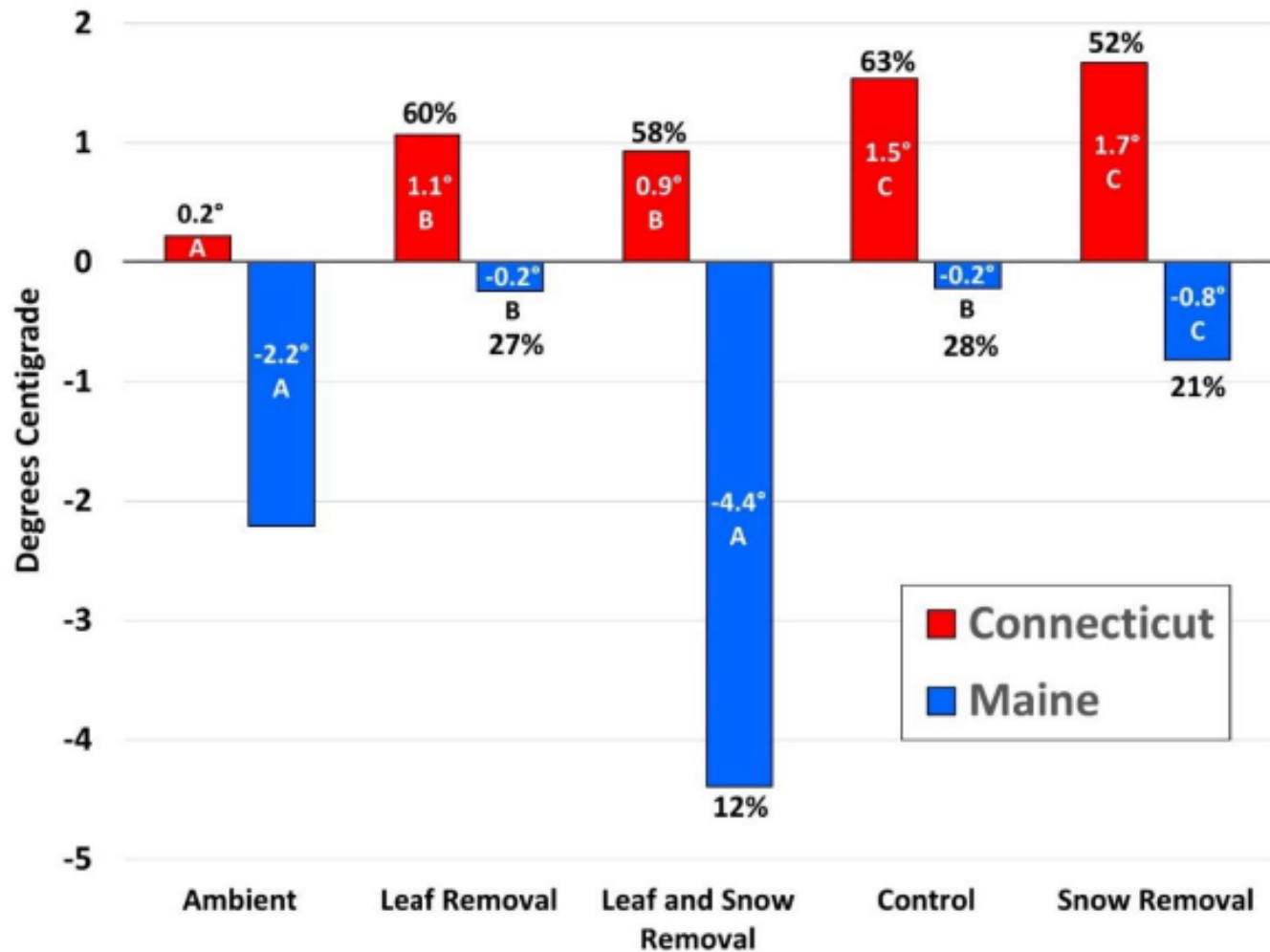


Figure 1. Mean hourly temperature (Centigrade) by treatment for Connecticut and Maine combined for Years 1, 2 and 3. Corresponding percent survival of adult *Amblyomma americanum* listed above and below Connecticut and Maine average temperatures, respectively. Mean temperature with the same letter assignment for each treatment within each state were not significantly different.

CURRENT POPULATIONS OF LONE STAR TICKS IN THE NORTHEASTERN UNITED STATES



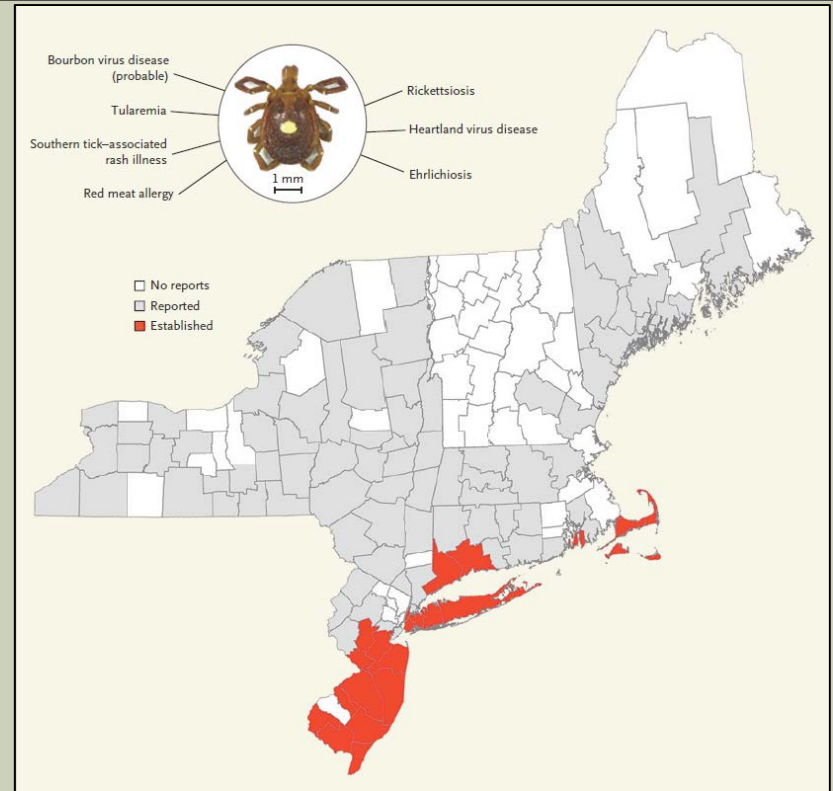
The NEW ENGLAND JOURNAL of MEDICINE

Perspective
DECEMBER 5, 2019

Bracing for the Worst — Range Expansion of the Lone Star Tick in the Northeastern United States

Goudarz Molaei, Ph.D., Eliza A.H. Little, Ph.D., Scott C. Williams, Ph.D., and Kirby C. Stafford, Ph.D.

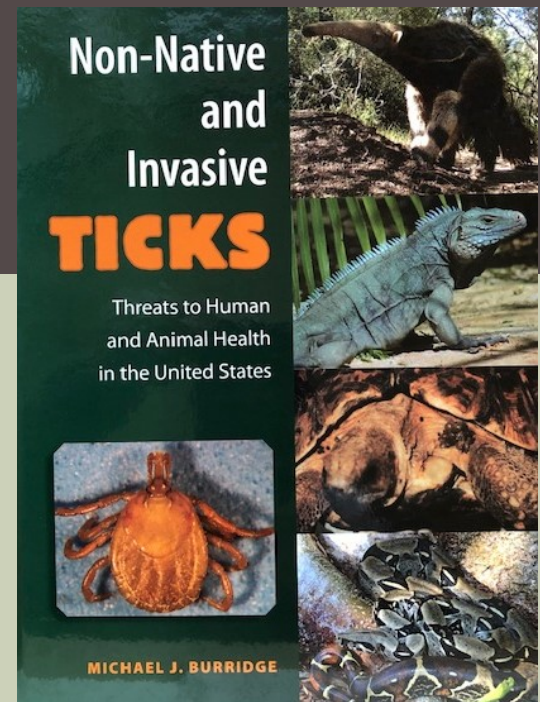
We have shown adult *A. americanum* can survive in Connecticut and to some extent, coastal Maine. Current environmental and climate conditions, especially moderate maritime climates, favor the establishment and expansion of lone star ticks along the New England coast. Inland areas may be still be too harsh for the immature stages. This tick is aggressive and is associated with several human diseases and will rise in importance for the region.



Molaei et al. 2019. N. Eng. J. Med. 381;23: 2189-2192
(December 5, 2019).

EXOTIC TICKS & DISEASE

- Non-native and invasive ticks pose a threat to human and animal health. Ticks come in on people (even baggage), livestock, wildlife, animal products, and through the commercial pet trade.
- Of the approximately 100 tick species introduced into the US, 63 are reported to feed on humans and 23 are vectors for human diseases.
- Global trade animals staggering
- Example: 18.3 million live reptiles imported into the U.S., 1989-1987
- 48 invasive tick species found on wild mammals.



Michael J. BurrIDGE. 2011



Amblyomma variegatum
and these ticks on a cow



SOME EXOTIC TICKS RECOVERED IN CONNECTICUT

Amblyomma dissimile Koch

Rainbow Boa, *Epicrates cenchria*, Colombia, S. America (1981)

Amblyomma hebraeum Koch

Woman (Boutonneuse fever*), South Africa (1996)

Amblyomma cajennense (Fab.)

Woman, Jamaica (1993)

Aponomma quadricavum Schulze

Boa, *Epicrates striatus*, West Indies? (1979)

Aponomma latum (Koch)

Python, *Python regius*, West Africa (1983)

Hyalomma marginatum Koch

Boy, Greece (1992)

Haemaphysalis leachi (Audouin)

Dog, *Canis familiaris*, South Africa (1983)

Rhipicephalus simus Koch

Man (Boutonneuse fever*), Egypt (1979)

Rhipicephalus pulchellus (Gerstaecker)

Girl, Africa, Kenya (2010); Woman, Tanzania (2018)

Amblyomma cajennense (Fab.)

Woman, Costa Rica (2010)

Haemaphysalis longicornis

Drag sampling (2018 and 2019)



Amblyomma hebraeum, one exotic species that has been imported into the U.S. (Photo courtesy J. Occi).



Rhipicephalus pulchellus male, another exotic species that has been imported into the U.S. (Photo Wikipedia).

LONGHORN TICKS FOUND ON THE EAR OF A HUNTERDON COUNTY SHEEP, 2017

Haemaphysalis longicornis



Photo credit: Tadhg Rainey



Photo credit: New Jersey Department of Agriculture



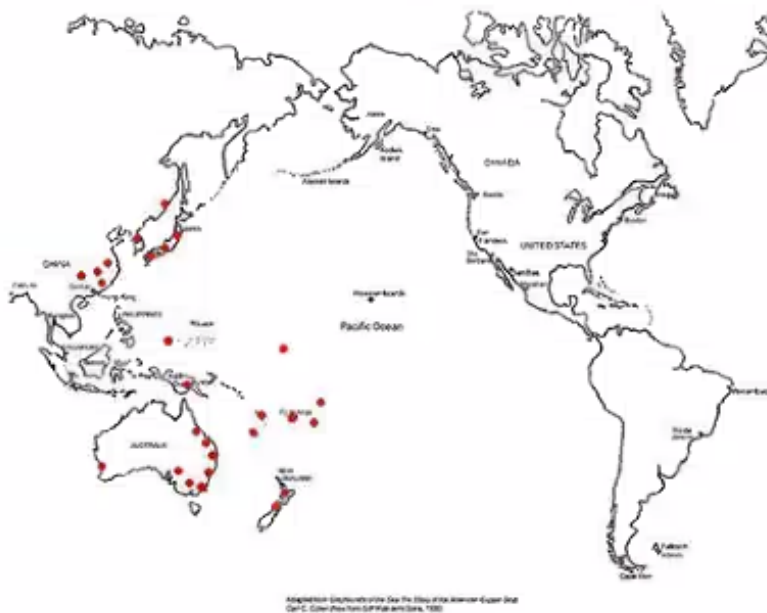
Hanna, the sheep

New Jersey announced [Wed 22 Nov 2017] the discovery of an East Asian tick, also known as a longhorned tick or bush tick [*Haemaphysalis longicornis*], on a farm in Hunterdon County on 9 Nov 2017. The East Asian tick is considered a serious pest to livestock including cattle, horses, sheep, and goats. It can attack humans, pets and wildlife and is a known vector for a number of human and animal pathogens.

THIS PHOTOGRAPH DEPICTS TWO *HAEMAPHYSALIS LONGICORNIS* TICKS, COMMONLY KNOWN AS THE LONGHORNED TICK. THE SMALLER OF THE TWO TICKS ON THE LEFT, IS A NYMPH. THE LARGER TICK IS AN ADULT FEMALE. MALES ARE RARE. THIS TICK CAN REPRODUCE ASEXUALLY.



World distribution of *Haemaphysalis longicornis*



James Gathany/Centers for Disease Control and Prevention



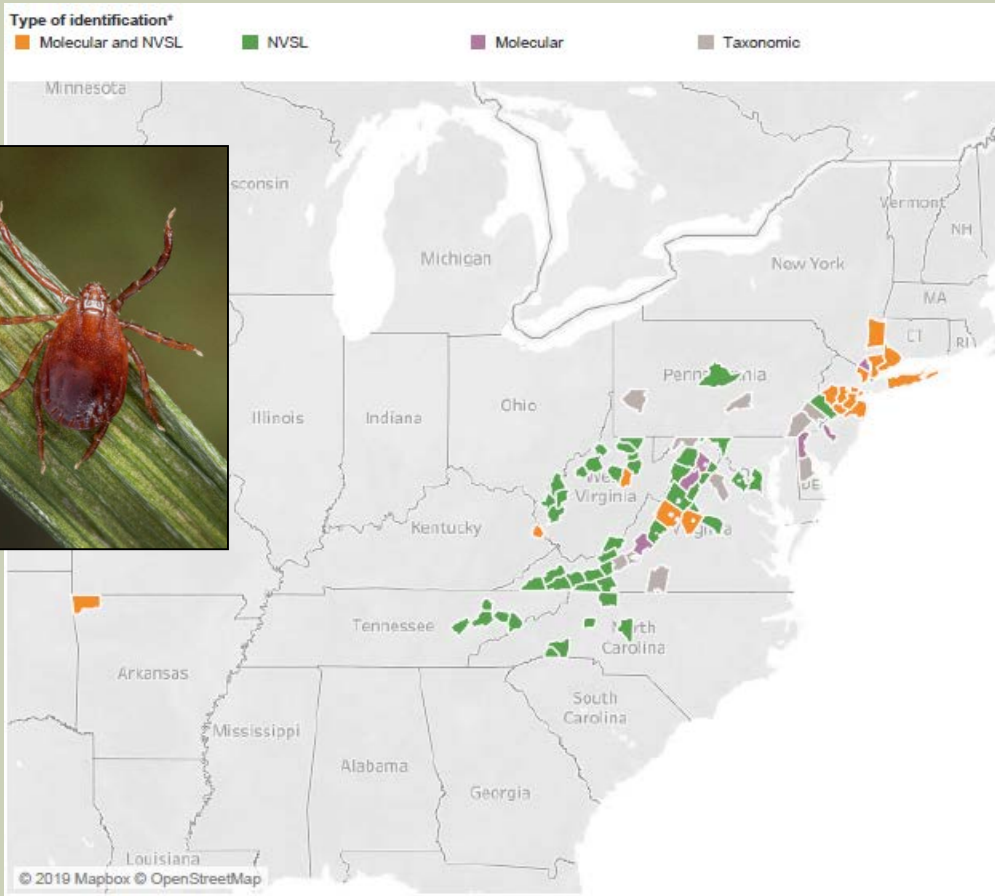
CDC/James Gathany

HAEMAPHYSALIS LONGICORNIS

BASIC FACTS

- A parthenogenetic/bisexual hard tick species
- Bisexual race occurs in Japan, Korea, and China in conjunction with parthenogenetic race
- Three host tick
- Introduced to Australia in late 1800s
- First discovered in New Zealand in 1911
- Exotic introductions, including US, are parthenogenetic (males rare)
- Can build up high focal populations, especially larvae
- Present in the U.S. since at least 2010 (originally identified as *H. leporispalustris*, native rabbit tick in archived sample)
- Confirmed in 82 counties U.S.
- Confirmed in 3 counties NY (Westchester, Rockland, Suffolk) plus NYC (Staten Island)
- Found in variety habitats, short grass, long grass, woods

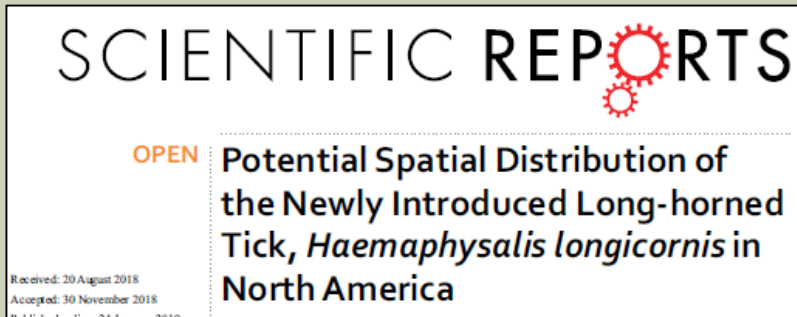
COUNTIES AND COUNTY EQUIVALENTS* WHERE *HAEMAPHYSALIS LONGICORNIS* HAS BEEN REPORTED (N = 63) — UNITED STATES, AS OF MAY 9, 2019



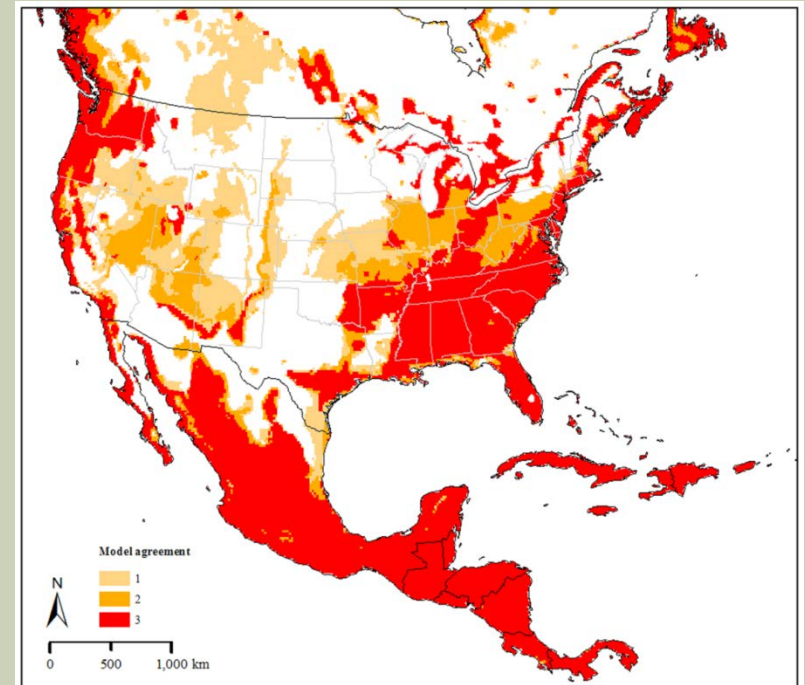
- From August 2017 to May 9, 2019, reported from twelve U.S. states (Arkansas, Connecticut, Delaware, Kentucky, Maryland, New Jersey, New York, North Carolina, Pennsylvania, Tennessee, Virginia, and West Virginia)
- Documented in 82 counties or county equivalents
- Known distribution is expanding as surveillance efforts increase

Source: National Haemaphysalis longicornis Situation Report, US Department of Agriculture, September 10, 2019

Modeled potential distribution in the United States



From: Raghavan, R. K., S. C. Barker, M. E. Cobos, D. Barker, E. J. M. Teo, D. H. Foley, R. Nakao, K. Lawrence, A. C. G. Heath, and A. T. Peterson. 2019. Potential spatial distribution of the newly introduced long-horned tick, *Haemaphysalis longicornis* in North America. *Scientific Reports* 9: 498.

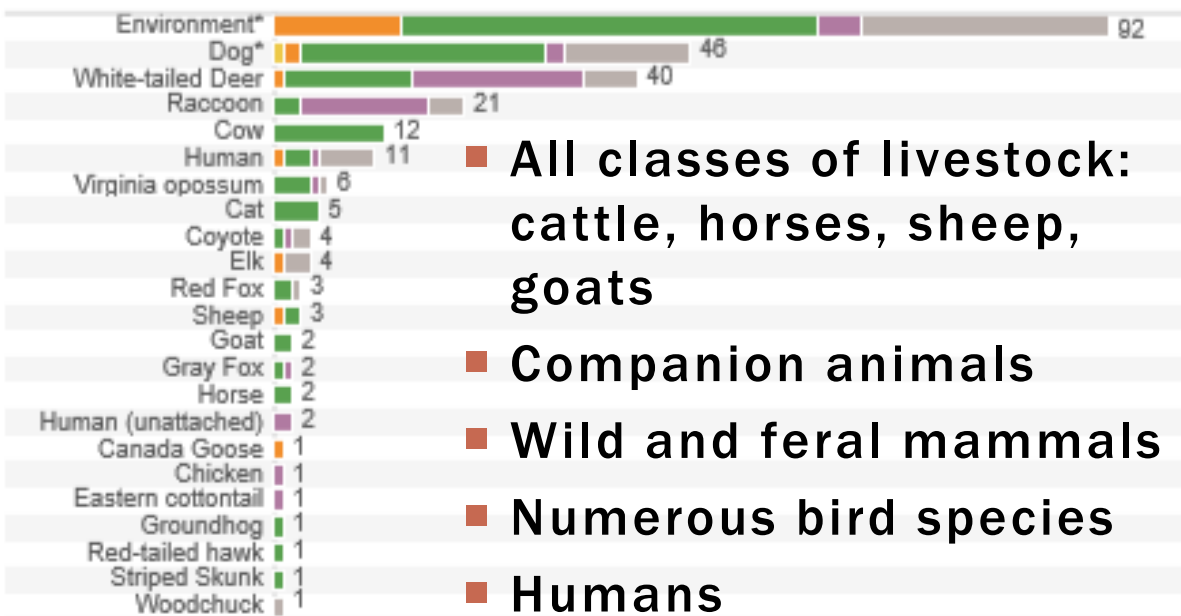


Predicted suitable areas for *Haemaphysalis longicornis* across North America. 1, 2, and 3 represent areas that were predicted to be suitable for the establishment of *H. longicornis* in North America by one, two and three models, respectively. Darker areas represent progressively higher agreement between the models.

ASIAN LONGHORNED TICK POSITIVE HOSTS INFORMATION

Asian longhorned tick positive hosts information

Number of positive hosts



Type of identification (single) - Not aggregated

No identification provided

Molecular and NVSL

NVSL

Molecular

Taxonomic

* Confirmed since last situation report.

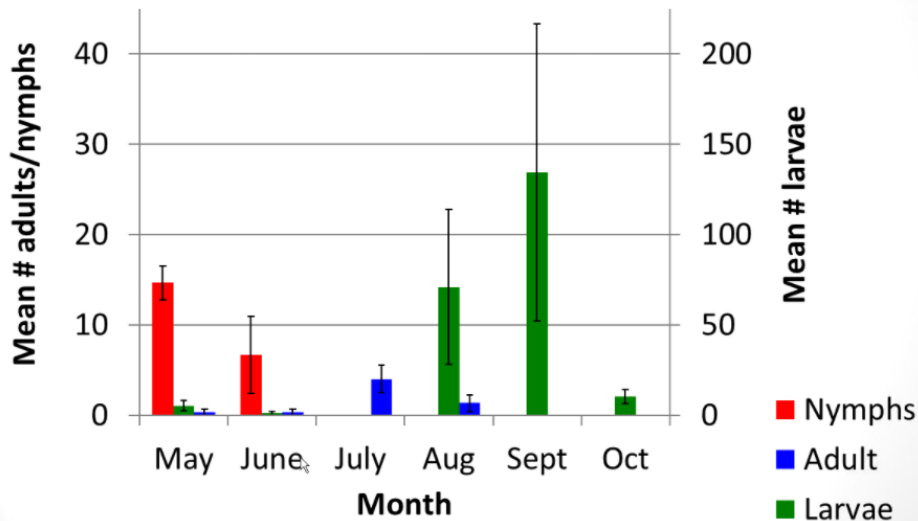
- All classes of livestock: cattle, horses, sheep, goats
- Companion animals
- Wild and feral mammals
- Numerous bird species
- Humans

Source: National Haemaphysalis longicornis Situation Report, US Department of Agriculture, December 17, 2019

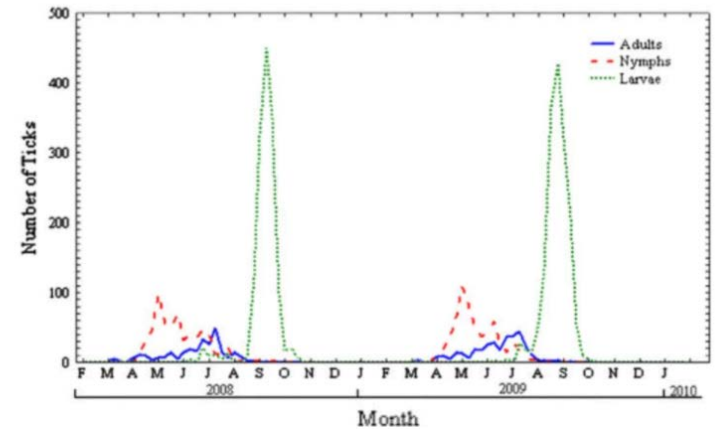
SEASONAL ACTIVITY

Seasonality (NJ)

"positive sites"
N=3



Seasonality (North China)



Zheng et al. 2012 Exp Appl Acarol

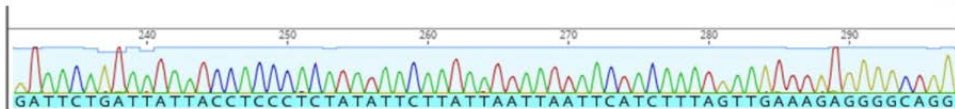
Slide Credit: Andrea Egizi

WHERE DID IT COME FROM? NJ COI BARCODING PROJECT

340 specimens 9 states and 189 sequences from China, Japan, South Korea, Australia and New Zealand

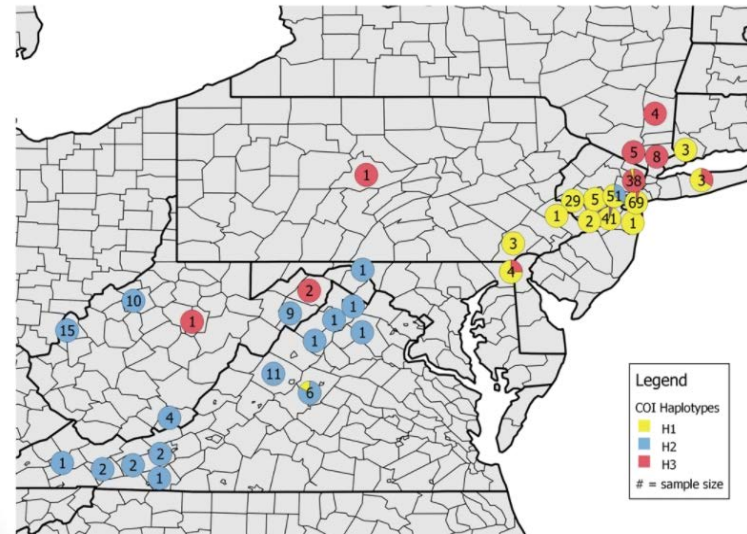
COI barcoding project

- USA- 3 haplotypes
- Internationally- 42 haplotypes, including all 3 found in US
- US haplotypes are parthenogenetic
- East Asian origin seems more likely than Australia/New Zealand but statistical analysis pending



Egizi *et al.* in prep

Phylogeography- US



Egizi *et al.* in prep

Is *H. longicornis* a vector of any human pathogens?

Rickettsia japonica - Japanese spotted fever and SFTV
(severe fever and thrombocytopenia virus) aka
Huaiyangshan (HYS) virus

What has *H. longicornis* been found carrying?

(W. Nicholson CDC)

<i>Anaplasma spp</i>	China, Japan, Korea
<i>Ehrlichia spp</i>	China, Japan, Korea
<i>Rickettsia spp</i>	China, Japan, Korea
<i>Borrelia spp</i>	China, Korea
TBEV	Korea
Thogoto virus	Japan
SFTV	China, Japan, Korea
<i>Babesia spp</i>	China, Japan
<i>Theileria spp</i>	Australia, China

All samples that have been tested so far from US are negative for tick-borne bacteria and viruses (Egizi, Savage)

- Parthenogenic, can build up high focal populations, especially larvae
- Livestock pest
- Reported to have killed cattle in North Carolina

Has not been found on white-footed mice here in the U.S., reservoir host for *B. burgdorferi*

While none have been found infected with any pathogens in the U.S. so far, it is a major vector of important disease pathogens in other parts of the world.



Contents lists available at [ScienceDirect](#)

Ticks and Tick-borne Diseases

journal homepage: www.elsevier.com/locate/ttbdis



Original article

Failure of the Asian longhorned tick, *Haemaphysalis longicornis*, to serve as an experimental vector of the Lyme disease spirochete, *Borrelia burgdorferi* sensu stricto

Nicole E. Breuner^a, Shelby L. Ford^b, Andrias Hojgaard^a, Lynn M. Osikowicz^a, Christina M. Parise^a, Maria F. Rosales Rizzo^a, Ying Bai^a, Michael L. Levin^b, Rebecca J. Eisen^a, Lars Eisen^{a,*}

THEILERIA ORIENTALIS

RESEARCH

Theileria orientalis Ikeda Genotype in Cattle, Virginia, USA

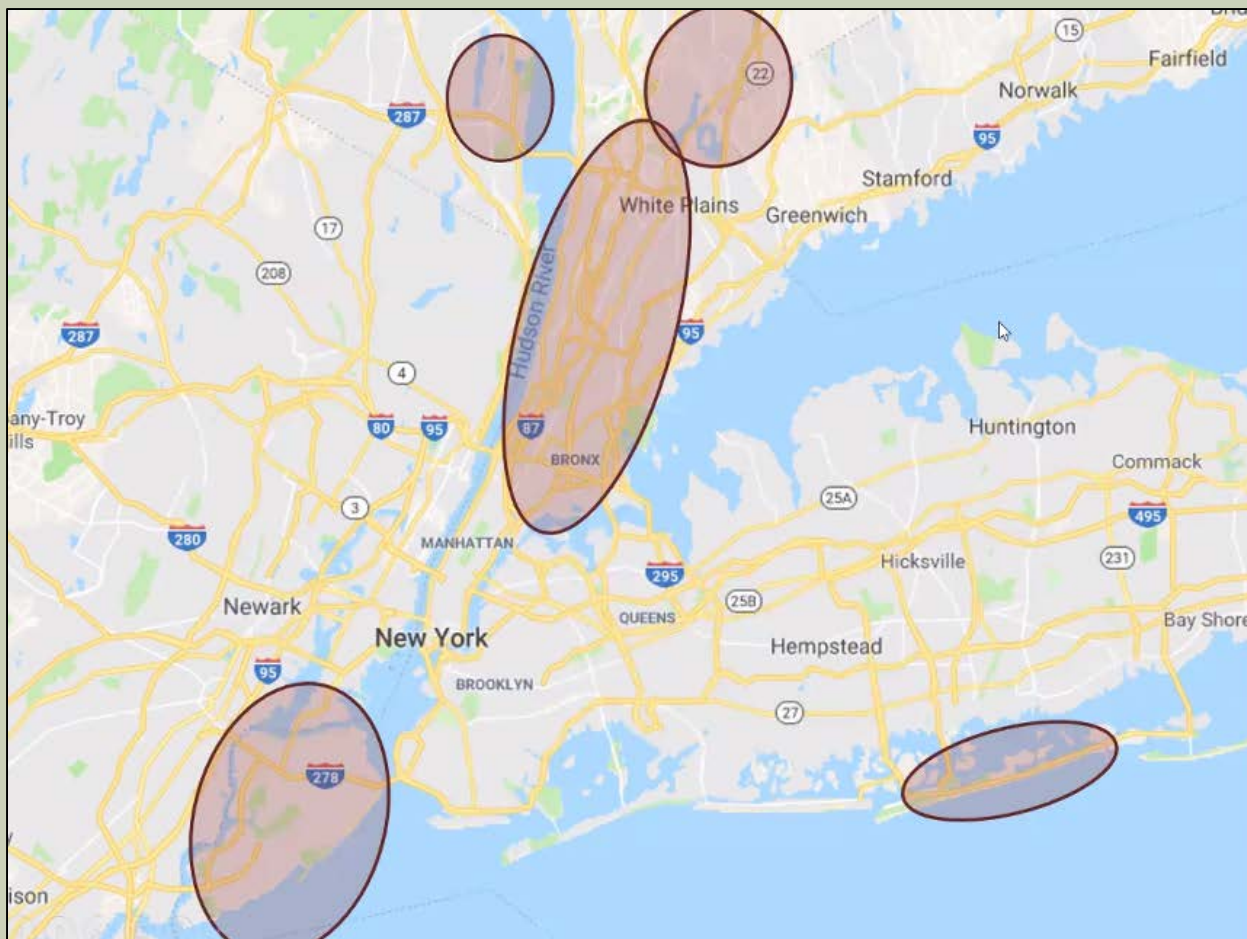
Vanessa J. Oakes, Michael J. Yabsley, Diana Schwartz, Tanya LeRoith,
Carolynn Bissett, Charles Broaddus, Jack L. Schlater, S. Michelle Todd,
Katie M. Boes, Meghan Brookhart, Kevin K. Lahmers

- *Theileria orientalis* Ikeda genotype was detected in Virginia and West Virginia. *Theileria* is a protozoan parasite transmitted by ticks or by direct blood transmission. Clinical signs can include anemia, fever, lethargy, lack of appetite, exercise intolerance and fetus abortion.
- *Theileria orientalis* exerts its major effect due to its piroplasmic form causing destruction of erythrocytes.
- The *Theileria orientalis* genotype Ikeda are known to infect cattle, water buffalo and yaks. *T. orientalis* has worldwide distribution, but while other nonpathogenic *T. orientalis* genotypes are endemic to the United States, detection of *T. orientalis* Ikeda genotype represents an emerging infectious disease with potential major animal and economic impacts.
- The recently discovered Asian Longhorned Tick is the main vector in Asia, Australia and New Zealand.

EXPERIENCE NEW YORK

- Dr. Richard Falco, NYS Health, reported that in 2018 the numbers of Asian longhorned ticks collected exploded.
- June 4, 2018
collected 1 *H. longicornis* nymph
- November 19, 2018
collected 253 nymphs, 406 adults, 126,968 larvae
- Found in variety of habitats: short grass, long grass, woods
- Found in full sun, partial sun, shade/prefers hot and humid
- Larval peak in late summer/early fall; cluster in large numbers
- Feed on deer (Columbia University)
- Not very aggressive; Don't seem to feed readily on people

**Asian
Longhorned
Tick: Where
Found in NY
So Far,
October
2018**
(Note: no farms!)



**From NEVBD Webinar November 19, 2018 with Dr. Allen C.G. Heath,
Dr. Andrea Egizi, and Dr. Richard Falco**

H. LONGICORNIS IN CONNECTICUT

WCSU discovers first specimen of exotic tick in Connecticut

DANBURY, Conn. — Western Connecticut State University researchers have found the first Asian longhorned tick in Connecticut. The invasive species can harm livestock and, where it originates in Asia, can carry deadly diseases. So far the tick is not known to be a danger to humans in the U.S.

Brittany Schappach, a recent WCSU biology department graduate who works as a research assistant for the WCSU Tickborne Disease Prevention Laboratory, collected the tick, *Haemaphysalis longicornis*, on July 3 during weekly tick monitoring for the lab.



Brittany Schappach collects ticks.



East Asian longhorned tick, *Haemaphysalis longicornis*
(Photos by Kitty Prapayotin-Riveros (The CAES))

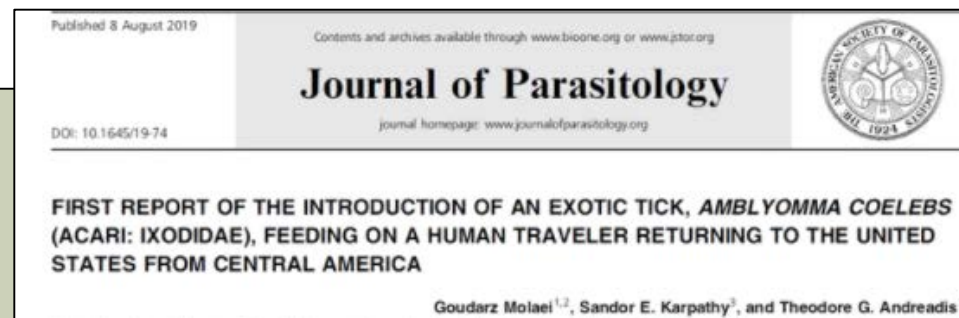
Tick Testing Laboratory at The Connecticut Agricultural Experiment Station Reports the First Evidence of Human Biting by the Exotic East Asian Longhorned Tick in the State

New Haven, CT – The Tick Testing Laboratory at The Connecticut Agricultural Experiment Station (CAES) is reporting the first evidence of human biting by the exotic east Asian longhorned tick, *Haemaphysalis longicornis* in a resident from Fairfield County. The longhorned tick is an invasive species

**One Asian longhorned tick nymph was collected in Fairfield County in 2019.
One ALT larva was collected in New London County in 2019.**

TAKEAWAYS

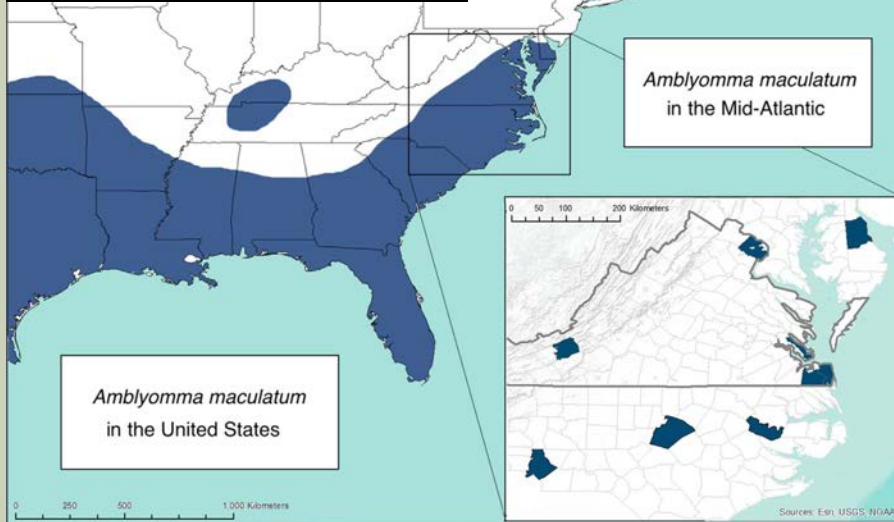
- Native ticks remain the primary disease risk and their range is expanding (Lyme disease is still the major TBD in US).
- Climate change is an important factor in range expansion and geographic distribution of ticks.
- Introduction of exotic, invasive ticks is a threat to humans, pets, livestock and wildlife.
- Need to educate doctors, veterinarians, livestock owners, producers and pet owners about protecting animals from ticks.
- While no *H. longicornis* have been found infected with any pathogens in the U.S. so far, it is a major vector of important disease pathogens in other parts of the world.
- New ticks and tick-borne diseases will be an increasing concern due to geographic expansion of native species and ever present potential introduction of invasive exotic ticks and new pathogens. We need better biosecurity to prevent tick introductions.



AMBLYOMMA MACULATUM THE NEXT TICK MOVING NORTH?



CDC, Christopher Paddock



Published 20 January 2020

Contents and archives available through www.bioone.org or www.jstor.org

Journal of Parasitology

journal homepage: www.journalofparasitology.org



DOI: 10.1645/19-118

DOCUMENTATION OF THE EXPANSION OF THE GULF COAST TICK (*AMBLYOMMA MACULATUM*) AND *RICKETTSIA PARKERI*: FIRST REPORT IN ILLINOIS

Victoria C. Phillips¹, Elliott A. Zielem^{1,2}, Chang-Hyun Kim³, Chris M. Stone³, Holly C. Tuten³, and F. Agustin Jiménez¹

“The Gulf Coast tick, *Amblyomma maculatum*, is of public and veterinary health concern, as it is the primary vector of *Rickettsia parkeri* and *Hepatozoon americanum*, causative agents of Rickettsiosis and American canine hepatozoonosis. The Gulf Coast tick’s range has expanded over the last 50 years into the mid-Atlantic states, and its expansion is expected to continue northward....”

Nadolny, R. M. and H. D. Gaff. 2018. Natural history of *Amblyomma maculatum* in Virginia. *Ticks & Tick-Borne Diseases*.

ACKNOWLEDGEMENTS - CAES TICK TEAM



Heidi Stuber



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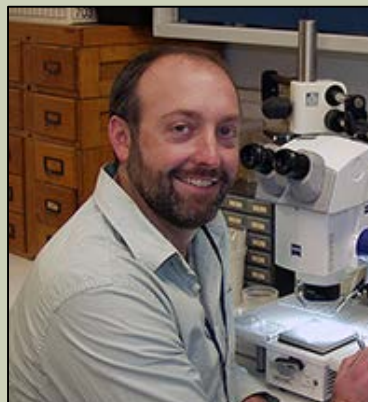
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