ESTABLISHING A VECTOR ECOLOGY SITE TO UNDERSTAND TICK-BORNE DISEASES IN THE SOUTHEASTERN UNITED STATES

Becky Trout Fryxell, Ph.D.
Assistant Professor of Medical & Veterinary Entomol.
Department of Entomology & Plant Pathology
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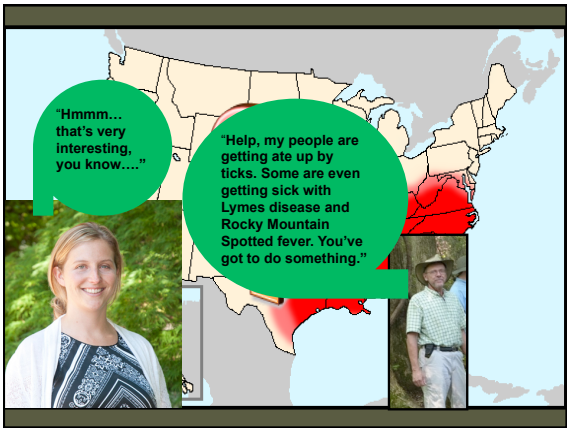
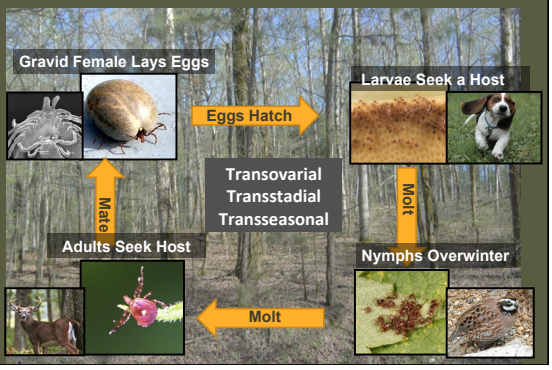
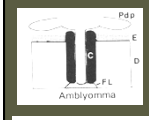
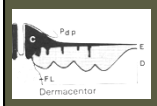


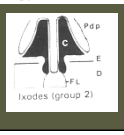
LIFECYCLE & TRANSMISSION



COMPARED TO OTHER ARTHROPODS TICKS ARE SOME OF THE BEST VECTORS

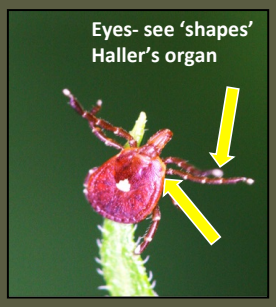


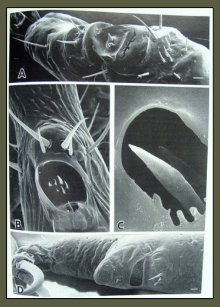




- Live a long time (~2-3yrs)
- Generalist
- Use host for dispersal
- THICK exoskeleton
- Blood Feeding:
  - ALL active life stages
  - Long active blood meals
  - Sneaky (anticoagulants)
  - Penetrate epidermis & can reach circulatory system
  - LOTS of eggs (~1000s)
- Host Finding

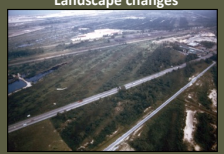
HOST FINDING (QUESTING)





OTHER POTENTIAL REASONS

Landscape changes



Difficulty of diagnosis

Identification of 'new' agents & spread of 'old' agents

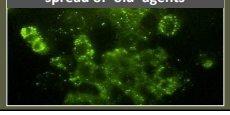
Warming weather trends

SPOTTED FEVER GROUP RICKETTIOSIS (SFGR = *RICKETTSIA*)

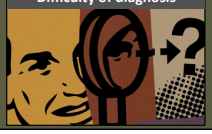
Bacteria	Disease	Symptoms	Treatment
Rickettsia rickettsii	Rocky Mtn. Spotted fever	Rash all over w/in 2-5 days	Doxycycline is first line of treatment
Rickettsia parkeri	American Boutonneuse fever	Variable rash	
Rickettsia amblyommii	Non-pathogenic	No rash	

PROBLEM: SAME DIAGNOSTIC TEST TO IDENTIFY HUMAN ANTIBODY

Identification of 'new' agents & spread of 'old' agents



Difficulty of diagnosis

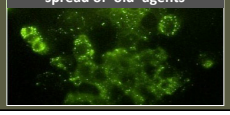


EHRLICHIOSIS (*EHRLICHIA* SPECIES)

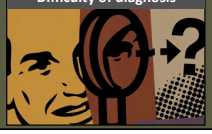
Bacteria	Disease	Symptoms	Treatment
Ehrlichia chaffeensis	Ehrlichiosis	Variable rash	Doxycycline is first line of treatment
Ehrlichia ewingii	Ehrlichiosis		
Ehrlichia muris	Ehrlichiosis		

PROBLEM: SAME DIAGNOSTIC TEST TO IDENTIFY HUMAN ANTIBODY
Not to mention the animal *Ehrlichia* (*canis, ruminantium,* etc.)

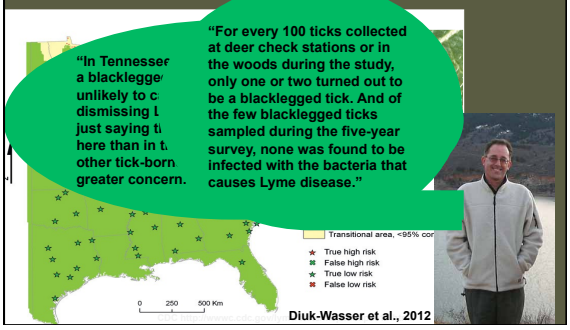
Identification of 'new' agents & spread of 'old' agents



Difficulty of diagnosis



Areas at Risk for Lyme Disease (*Borrelia burgdorferi*)

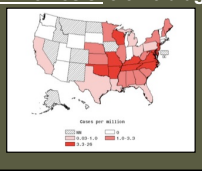
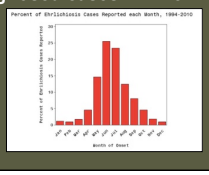


COMMON TN DISEASES

Rickettiosis: 19-63 diagnosed cases / million



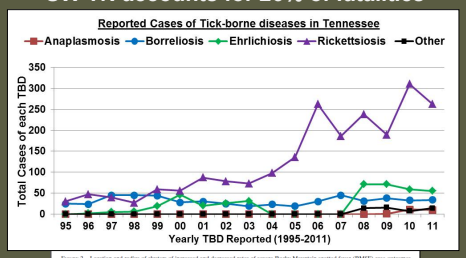

Ehrlichiosis: 3.3-26 diagnosed cases / million


www.CDC.gov

RMSF & SFGR: COMPLEX PUZZLE

2.4% total cases,
SW TN accounts for 26% of fatalities



Adjemian et al. 2009

Can we explain the incidence of t… diseases in Tennessee?

"Help, my people are getting ate up by ticks. Some are even getting sick with Lymes disease and Rocky Mountain Spotted fever. You've got to do something."

1 - *Ixodes scapularis*

2- most abundant tick:
Amblyomma americanum

Led to more questions…

OUR VECTOR ECOLOGY SITE:
AMES PLANTATION RESEARCH & EDUCATION CENTER

Wildlife
Ecology
History
Farming
Livestock
Education

Ames Plantation Research & Education Center

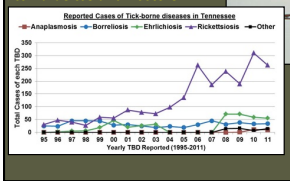
Hunting
- Deer
- Turkey
- Quail

Educational Activities
Bird Dog Trials
- National Championship

OBJECTIVE

To determine if *Ixodes scapularis* is a vector of concern in Tennessee cases of human tick-borne diseases

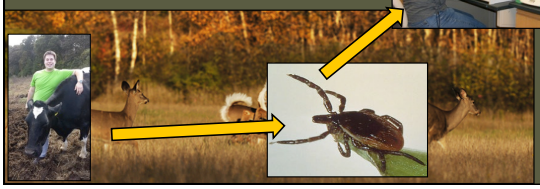
Mays et al. submitted to *Parasites and Vectors*



MATERIALS & METHODS

Ixodes scapularis **collected from deer were screened for *Anaplasma, Babesia, Borrelia, Ehrlichia,* & *Rickettsia***

2011: 17 ticks from 6 deer
2012: 30 ticks from 9 deer



Results: *Babesia* spp.

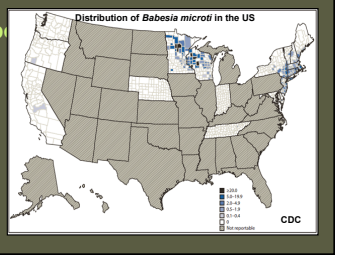
2011

0/17 (0%) ticks positive

***Babesia* spp. absent**

2012

0/30 (0%) ticks p



Results: *Borrelia* spp.

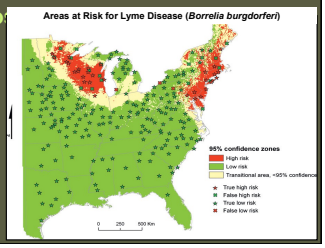
2011

0/17 (0%) ticks positive

***Borrelia* spp. Lyme disease Absent**

2012

0/30 (0%) ticks po



Results: *Ehrlichia/Anaplasma* spp.

2011

1/17 (6%) positive:

Anaplasma phagocytophilum

99% Homologous (EF647585)

Pathogenic *Anaplasma* present & *Ehrlichia* present

2012

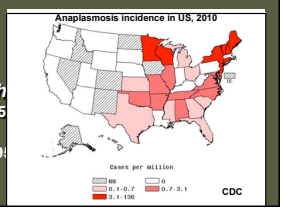
3/30 (10%) positive:

Panola Mountain *Ehrlich*

100% Homologous (HQ65

Ehrlichia ewingii - 2

100% Homologous (AF19



Results: *Rickettsia* spp.

2011

10/17 (59%) positive:

Rickettsia amblyommii- 1

99% Homologous (JF694090)

Rickettsia sp.- 2

>98% Homologo

Ixodes scapular

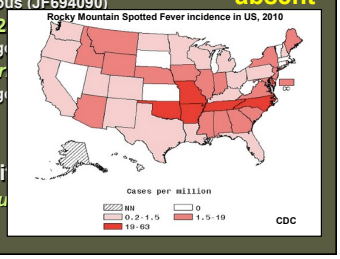
>98% Homologo

Pathogenic *Rickettsia* absent

2012

17/30 (57%) posi

17 *Ixodes scapu*



Can we explain the incidence of tick-borne diseases in Tennessee?

"So not Lyme, but pathogenic *Anaplasma*, what about those Lone Star ticks?"

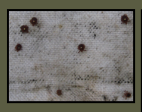
1 - *Ixodes scapularis*

2- most abundant tick: *Amblyomma americanum*

Lone Star tick

CHARACTERIZE THE PATHOGENS WITHIN THE MOST ABUNDANT TICK: *AMBLYOMMA AMERICANUM*

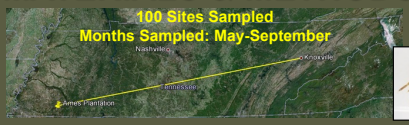
Obj. 1: Identify *Ehrlichia* & *Rickettsia* species
Obj. 2: Investigate seasonal prevalence
Obj. 3: Locate sites with ticks positive for a bacteria




Hendricks et al. *in preparation* for submission to *PLoS Pathogens*
Hendricks et al. *in preparation* for submission to *PLoS One*

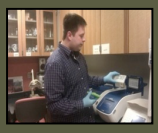
MATERIALS & METHODS

100 Sites Sampled
Months Sampled: May-September



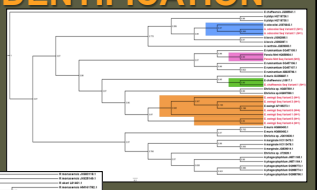
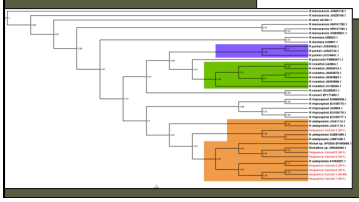
Tick Collection

Screened 942 adult Lone Star ticks for *Rickettsia* and *Ehrlichia* bacteria

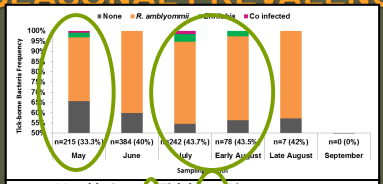
RESULTS: BACTERIA IDENTIFICATION

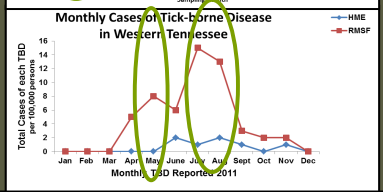
17 / 926 (1.8%) *Ehrlichia* Pos.
Anaplasma odocoilei (2)
Panola Mtn. *Ehrlichia* (2)
E. chaffeensis (1)
E. ewingii (12)
(ALL ARE PATHOGENIC!)

353 / 926 (38.3%) SFGR Pos.
All Sequenced were
R. amblyommii
(NON-PATHOGENIC)

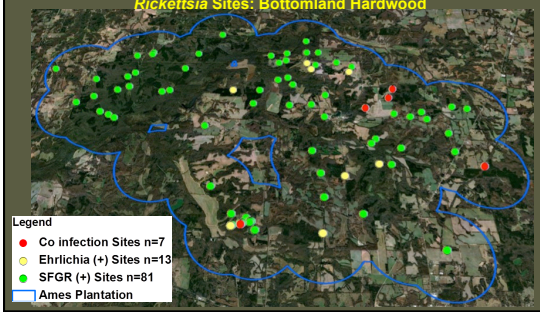
RESULTS: SEASONAL PREVALENCE





RESULTS: SPATIAL DISTRIBUTION

Bacteria Positive Sites: Randomly Distributed
***Ehrlichia* Sites: Pines and Upland Hardwood**
***Rickettsia* Sites: Bottomland Hardwood**



Can we explain the incidence of tick-borne diseases in Tennessee?

"So non-pathogenic *Rickettsia*…& pathogenic *Ehrlichia*, and that *Anaplasma* in both blacklegged & Lone Star ticks. You're not helping us."

1 - *Ixodes scapularis*

most abundant tick:
Amblyomma americanum

ed to more questions…

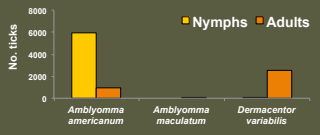
3- Role of other ticks, hosts, habitats…?

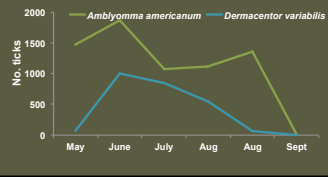
"But wait, we found *A. maculatum!* And a TON of *D. variabilis*. And look at all of these *Ehrlichia!*"

Hendrick's Other Ticks

Tick Collection

9,475 ticks over 6 months



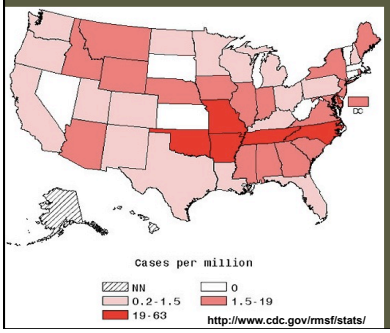


Dermacentor variabilis

- Hendrick's Thesis
  - Questing ticks from 100 sites during 2012
  - Two collection methods: Dry Ice, Drag
  - *Dermacentor variabilis* collected at 99 sites
- Screened 2545 ticks
  - 0 (!) positive for *Anaplasma* or *Ehrlichia*
  - 93/2545 (3.7%!) positive for *Rickettsia*

2013 Tick Crew:
Drew, Sarah, Brian, Casey, Kim

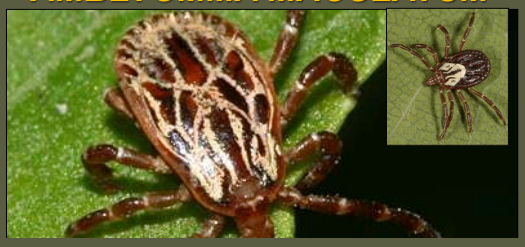
ROCKY MOUNTAIN SPOTTED FEVER



3.7% positive for a SFGR

Sequencing arrived at 10am today…
~R. montanensis
~R. montana
Unclear pathogencity

AMBLYOMMA MACULATUM

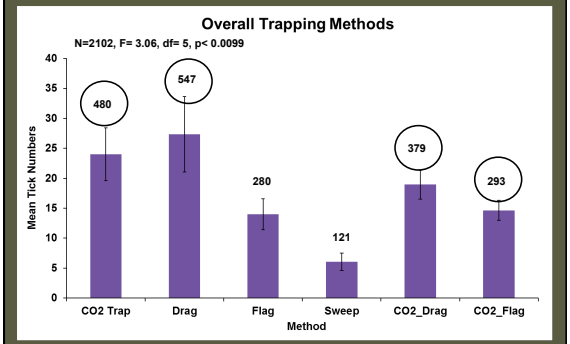


- Hendrick's Thesis
  - Questing ticks from 100 sites during 2012
  - Two collection methods: Dry Ice, Drag
  - Gulf Coast ticks collected at 10 sites

SPECIFYING HABITAT, HOST, AND PATHOGEN ASSOCIATIONS OF THE GULF COAST TICK, *AMBLYOMMA MACULATUM*

Sarah E. Mays

TRAPPING METHODS



MAYS THESIS RESEARCH

Specifying Habitat, Host, and Pathogen Associations of the Gulf Coast Tick, *Amblyomma maculatum*

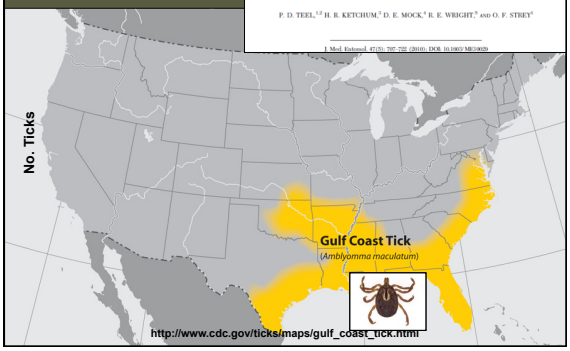
80 sites – different habitats! Different months!

TICK DISTRIBUTION

The Gulf Coast Tick: A Review of the Life History, Ecology, Distribution, and Emergence as an Arthropod of Medical and Veterinary Importance

P. D. TEEL,[1,2] H. R. KETCHUM,[3] D. E. MOCK,[4] R. E. WEIGHT,[5] AND O. F. STREY[6]

J. Med. Entomol. 47(5): 707–722 (2010); DOI: 10.1603/ME10020



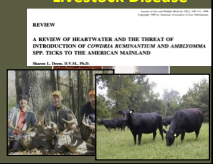
AMBLYOMMA MACULATUM

One Health Concern

Human Disease

Canine Disease

Livestock Disease



Hosts & Habitats

The Gulf Coast Tick: A Review of the Life History, Ecology, Distribution, and Emergence as an Arthropod of Medical and Veterinary Importance

P. D. TEEL,[1,2] H. R. KETCHUM,[3] D. E. MOCK,[4] R. E. WRIGHT,[5] AND O. F. STREY[1]

Population Dynamics of Immature *Amblyomma maculatum* (Acari: Ixodidae) and Other Ectoparasites on Meadowlarks and Northern Bobwhite Quail Resident to the Coastal Prairie of Texas

PETE D. TEEL, SIDNEY W. HOPKINS,[1] WILLIAM A. DONAHUE,[2] AND OTTO F. STREY

Department of Entomology, Texas A&M University, College Station, TX 77843

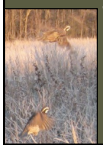
Habitat Wise Tails:

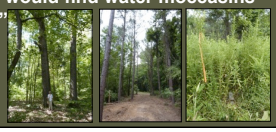
AR: "ON Cattle"

FL: "High-noon on tall grass"

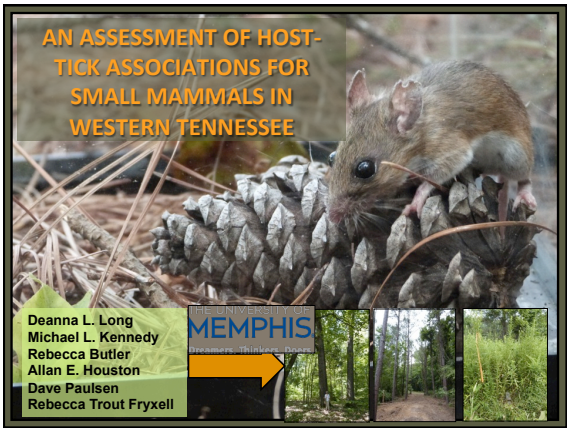
WV: "Wherever you would find water moccasins"

MD: "Near land fills"





AN ASSESSMENT OF HOST-TICK ASSOCIATIONS FOR SMALL MAMMALS IN WESTERN TENNESSEE



Deanna L. Long
Michael L. Kennedy
Rebecca Butler
Allan E. Houston
Dave Paulsen
Rebecca Trout Fryxell

THE UNIVERSITY OF MEMPHIS

Dreamers. Thinkers. Doers.

HABITAT & HOSTS AT AMES(?)

150 traps per night for 3 sets of 3 consecutive nights

CHECKING FOR TICKS

ENGORGED FEMALE TICK ON WHITE-FOOTED DEERMOUSE

TICKS ON HOSTS

Hispid Cotton Rat (*Sigmodon hispidus*) [73]
White-Footed Deermouse (*Peromyscus leucopus*) [160]
North American Deermouse (*Peromyscus maniculatus*) [34]
Cotton Deermouse (*Peromyscus gossypinus*) [1]
Woodland Vole (*Microtus pinetorum*) [16]
Marsh Rice Rat (*Oryzomys palustris*) [1]
Golden Mouse (*Ochrotomys nuttalli*) [7]
House Mouse (*Mus musculus*) [3]

GREATEST ABUNDANCE OF TICKS ON HOSTS IN PINE HABITATS!

2 from White-footed deer mouse & 5 from Hispid Cotton rat

Lone Star tick (*Amblyomma americanum*) [0]
Gulf Coast tick (*Amblyomma maculatum*) [7]
American dog tick (*Dermacentor variabilis*) [455]
Blacklegged tick (*Ixodes scapularis*) [96]

Can we explain the incidence of tick-borne diseases in Tennessee?

1 - *Ixodes scapularis*

2- most abundant tick: *Amblyomma americanum*

Led to more questions…

3- Role of other ticks, hosts, habitats…?

"Agreed."

"But wait, we need to start looking into these different habitats!"

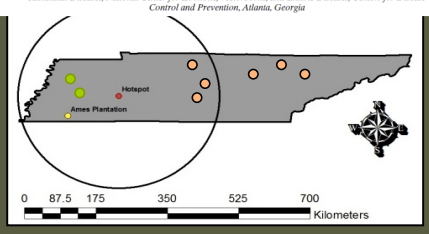
Focus…

Am. J. Trop. Med. Hyg., 80(1), 2009, pp. 72–77

Spatial Clustering by Disease Severity among Reported Rocky Mountain Spotted Fever Cases in the United States, 2001–2005

Jennifer Zipser Adjemian,* John Krebs, Eric Mandel, and Jennifer McQuiston

Epidemic Intelligence Service, Office of Workforce and Career Development; Rickettsial Zoonoses Branch, Division of Viral and Rickettsial Diseases, National Center for Zoonotic, Vectorborne, and Enteric Diseases, Centers for Disease Control and Prevention, Atlanta, Georgia



RESULTS THUS FAR

Tick Species	No. Tested	*Rickettsia* Pos. (%)	*Ehrlichia* Pos. (%)	Co-infection Pos. (%)
Amblyomma americanum	926	345 (37.3%)	9 (1.0%)	8 (0.08%)
Dermacentor variabilis	2545	93 (3.7%)	0 (0%)	0 (0%)
Ixodes scapularis	47	23 (48.9%)	0 (%)	4 (9%)
TOTAL	3518	461 (13.1%)	9 (0.3%)	12 (0.3%)

All *Rickettsia* NON-PATHOGENIC (TBD?)
Many pathogenic *Ehrlichia* species
Anaplasma odocoilei (2), Panola Mtn. *Ehrlichia* (3 positives in 2 species), *E. chaffeensis* (1), *E. ewingii* (14 positive in 2 species), *Anaplasma phagocytophilum* (1)

THE TWIST

Vector-Borne and Zoonotic Diseases

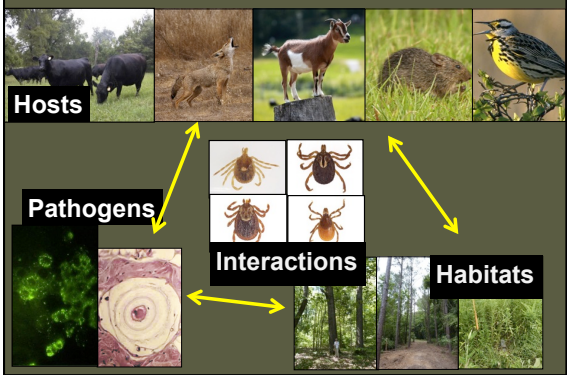
"Rickettsia amblyommii" and R. montanensis Infection in Dogs Following Natural Exposure to Ticks

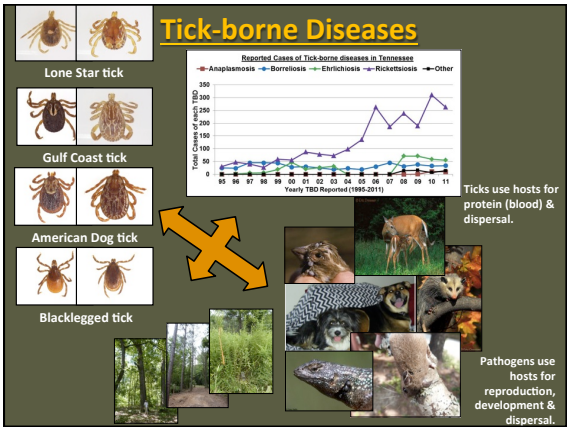
ABSTRACT

To determine the risk of canine infection with spotted fever group (SFG) *Rickettsia* spp. following natural tick exposure, 10 dogs determined to be free of evidence of exposure to or infection with tick-borne disease agents were exposed to ticks via weekly walks in a wooded area in north-central Oklahoma. After each walk, dogs were examined and the number and species of ticks present were recorded. The dogs were then returned to outdoor kennels to allow the infestations and subsequent transmission of any pathogens to proceed. Serum samples and whole blood were collected from each dog twice weekly for 121 days and evaluated via indirect fluorescence antibody (IFA) for antibodies reactive to *Rickettsia rickettsii*, *R. montanensis*, and "*R. amblyommii*," and by PCR for evidence of *Rickettsia* spp. Dogs became infested with a total of 57–108 ticks over the entire 8-week infestation period (weekly average tick infestation=12.0±4.1). The great majority of the ticks present were *Amblyomma americanum* (90.5%), with a small number of *Dermacentor variabilis* and *A. maculatum* also identified. All (10/10) dogs seroconverted to *R. rickettsii*, *R. montanensis*, and "*R. amblyommii*" with mean maximum inverse titers of 1176, 1448, and 6654, respectively, for all dogs in the study. Maximum inverse titers to "*R. amblyommii*" ranged from 4096 to 16,384 and were higher in 9/10 dogs than maximum inverse titers to *R. rickettsii* or *R. montanensis*. Sequence-confirmed SFG *Rickettsia* spp. (*R. montanensis* and "*R. amblyommii*") were occasionally, but not consistently, identified from whole blood by PCR. Taken together, our data suggest that, in areas where *A. americanum* is common, antibodies reactive to *R. rickettsii* in dogs may be due instead to infection with "*R. amblyommii*" or other, closely related SFG *Rickettsia* spp.

CHANGING TICK DISTRIBUTIONS

Next Questions…




Tick-borne Diseases
Lone Star tick
Gulf Coast tick
American Dog tick
Blacklegged tick
Reported Cases of Tick-borne diseases in Tennessee
Anaplasmosis
Borreliosis
Ehrlichiosis
Rickettsiosis
Other
Total Cases of each TBD
Yearly TBD Reported (1995-2011)
Ticks use hosts for protein (blood) & dispersal.
Pathogens use hosts for reproduction, development & dispersal.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