Deer, Ticks & Human Disease

A case study of unintended consequences when humans alter ecosystems and wildlife

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Tick-borne pathogens

Human-biting ticks

Reservoir hosts

Definitive hosts

Human disease

The University of Tennessee’s Center for Wildlife Health

Established in 2003
Website: http://wildlifehealth.tennessee.edu
Over the past 150 years, humans have induced dramatic fluctuations in deer numbers in eastern North America. These fluctuations have triggered the emergence and resurgence of zoonotic disease.

Hunting regulated; Forests regenerating

Good hunting, but also unwanted impacts: e.g. deer-vehicle collisions
This increase in deer numbers has triggered outbreaks of several tick-borne disease in humans and their companion animals:

1. Lyme disease
2. Southern Tick Associated Rash Illness
3. Rocky Mountain Spotted Fever

PEDIPALPS and CHELICERAE

PROSOMA

SCUTUM

OPISTHOMA

FOUR PAIRS OF LEGS

Adult female *Ixodes* sp.
Questing behavior
(90% of life is spent off-host)

- Active vs. passive host-finding
- Various stimuli:
  - CO₂, movement,

Females vs. Males

Blacklegged = ‘Deer’  Lone Star  American Dog
Engorgement

Figure 3 - A female adult dog highly parasitized by R. sanguineus.
3-host tick life-cycle
Attachment and feeding

Removal

Barbed chelicerae

Pathogen transmission

- Rickettsia and Ehrlichia – fast transfer
- Lyme disease pathogen – slow transfer (>48h)
  (Borrelia)
Which tick spreads which bacterium?

<table>
<thead>
<tr>
<th>Bacterium</th>
<th>Tick</th>
<th>Disease in humans</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Ehrlichia chaffeensis</em></td>
<td>Lone Star tick</td>
<td><em>Ehrlichiosis</em> (HME)</td>
</tr>
<tr>
<td><em>Ehrlichia ewingii</em></td>
<td></td>
<td><em>Ehrlichiosis</em> (EWE)</td>
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<tr>
<td><em>Borrelia lonestari</em></td>
<td></td>
<td><em>No known disease</em></td>
</tr>
<tr>
<td><em>Rickettsia amblyommi</em></td>
<td></td>
<td><em>No known disease</em></td>
</tr>
<tr>
<td><em>Rickettsia rickettsia</em></td>
<td>American Dog tick</td>
<td>Rocky Mountain Spotted Fever</td>
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<tr>
<td></td>
<td><em>Wood tick</em> = <em>Dermacentor variabilis</em></td>
<td></td>
</tr>
<tr>
<td><em>Rickettsia parkeri</em></td>
<td>Gulf coast tick</td>
<td><em>R. parkeri rickettsiosis</em></td>
</tr>
<tr>
<td><em>Borrelia burgdorferi</em></td>
<td>Blacklegged tick</td>
<td>Lyme disease</td>
</tr>
<tr>
<td><em>Borrelia miyamotoi</em></td>
<td></td>
<td><em>No known disease</em></td>
</tr>
<tr>
<td><em>Anaplasma phagocytophilum</em></td>
<td></td>
<td>Anaplasmosis</td>
</tr>
<tr>
<td><em>Babesia microti</em></td>
<td></td>
<td>Babesiosis</td>
</tr>
</tbody>
</table>

Which ticks bite people? – varies with latitude!

Army Tick Test Program

<table>
<thead>
<tr>
<th>Location</th>
<th>Percentage of human bites</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fort McCoy, WI</td>
<td></td>
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<tr>
<td>Naval Base Groton, CT</td>
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<tr>
<td>Fort Indiantown Gap, PA</td>
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<td>Fort Dix/McGuire AFB, NJ</td>
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<td>Aberdeen PG, MD</td>
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<td>Fort Belvoir, VA</td>
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<td>Fort AP Hill, VA</td>
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<td>Fort Knox, KY</td>
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<tr>
<td>Fort Pickett, VA</td>
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<tr>
<td>Fort Campbell, KY</td>
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<tr>
<td>Fort Jackson, SC</td>
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</tbody>
</table>

Legend:
- **Blue**: *Ixodes scapularis*
- **Red**: *Dermacentor variabilis*
- **Orange**: *Amblyomma americanum*
Nymphal blacklegged tick

Erythema migrans (EM)
‘Bulls-eye’ rash

5cm, expanding?

Post-exposure – Blacklegged tick
Post-exposure – Lone Star tick

Post-exposure – American Dog tick
TBD case rates: increasing…

RMSF, Tennessee

Source: Tennessee Department of Health

TBD case rates: increasing…

Ehrlichiosis and Anaplasmosis, Nationally

Source: CDC
TBD case rates: increasing...

![Bar graph showing increase in Lyme Disease cases](source: CDC)

Humans mainly get Lyme disease from the bite of **nymphal I. scapularis** ticks

(Larvae aren’t infected; adults are easier to see and remove)
Tick species identification matters!

Which tick spreads which bacterium?

Bacteria:
- *Borrelia burgdorferi*
- *ETTLECOHILLIA CROCIATOSUS*
- *R. parkeri*
- *B. duttoni*

Tick Types:
- Lone Star Tick
- Dog Tick
- Dog Tick
- R. parkeri
- Rocky Mountain Spotted Fever
- Babesiosis

Disease in Humans:
- Lyme Disease
- Babesiosis
- NoKnownDisease
- NoKnownDisease
- RockyMountainSpottedFever

Wildlife Biologist discussing one tick species ....
Tick Interview, Knoxville, July 2009 (2:00min)

Vet discussion another tick species ....

Tick Interview, Knoxville, July 2009 (2:00min)

On-screen image of a different species again....
ECOLOGICAL FACTORS DRIVING TBD INCREASE
Ecological Drivers of TBD increase: #1

Habitat and land-use change

Direct effect on no. of hosts

Flow-on effect on no. of ticks

Bobcats increasing in middle TN?

increase and spread of Cytauxzoonosis in domestic cats?
Coyotes increasing in eastern TN?

Ecological Drivers of TBD increase: #2

Climate change

Minor role in TN?
Ecological Drivers of TBD increase: #3

Human activity and land use change

Exposure to ticks

Middle Tennessee: early 90’s development of a “Golfing Oriented” retirement community in a previously forested area

- In 1993, outbreak of illness among residents matching the symptoms of Ehrlichiosis
- CDC initiates outbreak investigation (Standaert et al. 1995)
Tick-borne disease reports in TN
(poor match to actual disease rates)

Total TBD case reports in 2008 = 333 (Source: TDH)
Ehrlichiosis is the main concern in TN  Agent: *Ehrlichia chaffeensis*

- Extremely abundant tick; aggressive!
- *E. chaffeensis* at low (~2%) prevalence in ticks
- *E. ewingii* also present but causes milder disease

*Tick bite records for TN/KY military personnel  (E. Stromdahl, unpubl. data)*

**Amblyomma americanum** – the Lone Star tick – is by far the most common tick in Tennessee

“Seed ticks” = larvae of Lone Star ticks
The most important host of *Amblyomma americanum* is … deer!

MANAGEMENT OPTIONS:

[http://www.tickencounter.org/prevention](http://www.tickencounter.org/prevention)