Surveillance for Ticks and Tick-Borne Pathogens

Project Leaders
Saravanan Thangamani, UTMB
Donald Bouyer, UTMB

Western Gulf Center of Excellence for Vector-Borne Diseases
Co-investigators/Collaborators:

Pete Teel, Texas A&M
Lucas Blanton, UTMB
David Walker, UTEP
Beto Perez de Leon, USDA
Chris Vitek, UTRGV
Kenneth Waldrup TDHS
Bruno Travi, UTMB
Peter Melby, UTMB
Surveillance for ticks and tick-borne pathogens

Specific aim 1: To fill the gaps in our current knowledge on the geographic expansion of *A. americanum* and other *Amblyomma* species ticks and the pathogens they transmit.

Specific aim 2: To develop a sensitive point-of-care (POC) diagnostic test for the tick borne pathogens.
First tick to be described in the United States in 1754.

Aggressive and nondiscriminatory biting habits at all life stages.

Until the 1990s, *Amblyomma americanum* was regarded primarily as a nuisance species with minor relevance as a vector of zoonotic pathogens affecting humans.

Beginning 1990s, more zoonotic pathogens affecting humans were demonstrated to be vectored by *A. americanum*.

The recent discovery of Heartland virus and Bourbon virus with a high case-fatality rate further highlights the emerging role of *A. americanum* as a major vector of public health concern.
## Tick-borne infections in the United States

<table>
<thead>
<tr>
<th>Disease</th>
<th>Agent (s)</th>
<th>Vector(s)</th>
<th>Intracellular/Extracellular</th>
<th>Chronic/Prolonged/Acute</th>
<th>Life-threatening</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lyme borreliosis</td>
<td><em>Borrelia burgdorferi</em></td>
<td><em>Ixodes scapularis, Ix. pacificus</em></td>
<td>E</td>
<td>Acute &gt;&gt; Chronic</td>
<td>No</td>
</tr>
<tr>
<td>Babesiosis</td>
<td><em>Babesia microi</em></td>
<td><em>Ix. scapularis</em></td>
<td>I</td>
<td>Prolonged</td>
<td>Seldom</td>
</tr>
<tr>
<td>Rocky Mountain spotted fever</td>
<td><em>Rickettsia rickettsii</em></td>
<td><em>Dermacentor variabilis, D. andersoni, A. americanum Rhipicephalus sanguineus</em></td>
<td>I</td>
<td>Acute</td>
<td>Yes</td>
</tr>
<tr>
<td>Maculatum disease</td>
<td><em>R. parkeri</em></td>
<td>Amblyomma maculatum, A. americanum</td>
<td>I</td>
<td>Acute</td>
<td>No</td>
</tr>
<tr>
<td>Human monocytotropic ehrlichiosis</td>
<td><em>Ehrlichia chaffeensis</em></td>
<td><em>A. americanum, D. variabilis, Ix. pacificus</em></td>
<td>I</td>
<td>Acute</td>
<td>Yes</td>
</tr>
<tr>
<td>Ewingii ehrlichiosis</td>
<td><em>E. ewingii</em></td>
<td><em>A. americanum, D. variabilis</em></td>
<td>I</td>
<td>Acute</td>
<td>No</td>
</tr>
<tr>
<td>Human granulocytotropic anaplasmosis</td>
<td><em>Anaplasma phagocytophilum</em></td>
<td><em>Ix. scapularis, Ix. pacificus</em></td>
<td>I</td>
<td>Acute</td>
<td>Yes</td>
</tr>
<tr>
<td>Tick-borne relapsing fever</td>
<td><em>Borrelia turicatae, B. hermsi</em></td>
<td><em>Ornithodoros turicatae, O. hermsi</em></td>
<td>E</td>
<td>Prolonged</td>
<td>Yes</td>
</tr>
<tr>
<td>Tularemia</td>
<td><em>Francisella tularensis</em></td>
<td><em>D. andersoni, D. variabilis, A. americanum</em></td>
<td>I/E</td>
<td>Acute</td>
<td>Rare</td>
</tr>
<tr>
<td>Powassan/Deer tick virus encephalitis</td>
<td>Powassan and deer tick viruses</td>
<td><em>Ix. scapularis, D. andersoni</em></td>
<td>I</td>
<td>Acute</td>
<td>No</td>
</tr>
<tr>
<td>Colorado tick fever</td>
<td>Colorado tick fever virus unknown</td>
<td><em>A. americanum</em></td>
<td>unknown</td>
<td>unknown</td>
<td>Known</td>
</tr>
<tr>
<td>Southern tick-associated rash illness (START)</td>
<td>Heartland virus</td>
<td><em>A. americanum</em></td>
<td>I</td>
<td>unknown</td>
<td>Yes</td>
</tr>
<tr>
<td>Heartland virus disease</td>
<td><em>Heartland virus</em></td>
<td><em>A. americanum</em></td>
<td>I</td>
<td>unknown</td>
<td>Yes</td>
</tr>
<tr>
<td>Bourbon virus disease</td>
<td><em>Bourbon virus</em></td>
<td><em>A. americanum</em></td>
<td>I</td>
<td>unknown</td>
<td>Yes</td>
</tr>
</tbody>
</table>
The lone star tick, *Amblyomma americanum*, is the most common tick reported to parasitize humans in the Southeastern and South Central United States.

Spatial Distribution of counties in which *A. americanum* is established or reported, cumulative from 1890-present. Springer et al. 2014
Amblyomma americanum collections 1990-2013 compiled from the State-Federeal Tick Surveillance Program (TAHC & USDA, APHIS, VS) by Pete D. Teel, Texas A&M AgriLife Research, College Station, TX
Tick Collection: Sites

Natural Regions of Texas

- Blackland Prairies
- Coastal Sand Plains
- Edwards Plateau
- Gulf Coast Prairies & Marshes
- High Plains
- Llano Uplift
- Oak Woods & Prairies
- Piney Woods
- Rolling Plains
- South Texas Brush Country
- Trans Pecos

Source: Preserving Texas' Natural Heritage, LBJ School of Public Affairs Policy Research Project Report 31, 1978
## A. americanum: Seasonal activity in Texas

<table>
<thead>
<tr>
<th>STAGE</th>
<th>ACTIVITY PERIOD</th>
<th>PEAK ACTIVITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adults</td>
<td>March to November</td>
<td>April to May</td>
</tr>
<tr>
<td>Nymphs</td>
<td>March to November</td>
<td>March to May, September to November</td>
</tr>
<tr>
<td>Larvae</td>
<td>June to October</td>
<td>August to September</td>
</tr>
</tbody>
</table>
Sampling sites will be selected within state parks, state forests, or other public access natural areas. Maps of these public access areas were will be used to select areas for sampling.

Sampling will be performed on rain-free days, avoiding early morning and midday hours to minimize the potentially confounding effects of heavy dew and extreme heat on sampling efficiency.

Weather and GPS coordinates for each collection site will be recorded.
Tick Collection: Dragging

To closely resemble the risk incurred by a person walking through vegetation, ticks will be collected by drag sampling.

Drags will be made from white flannel cloth with metal bolts sewn at the bottom to weight the material.

Collectors will pull the drag using a nylon rope secured to a 3 foot wooden dowel with the goal of maximizing ground contact.

The cloth will be inspected every 20 mins, and all nymphs and adults from each drag will be collected for further processing.
Flagging is a method by which a flannel cloth attached to a wooden dowel is swept across and within dense vegetation.

Flannel cloth will be examined every 15 seconds to minimize tick detachment.

Each flagging site will be sampled for 15 minutes (sixty 15-second drag samples) without repeat of the same area.
Tick trapping: CO2 traps

- Container with dry ice bait
- Plywood board
- Masking tape
Tick Collection:

Ticks will be identified to species and stage and sorted into separate bar-coded vials.
Screening for tick-borne pathogens

1. Collect and identify ticks
2. Split ticks into two halves
3. DNA and RNA extraction
   - Screen for Rickettsial / bacterial agents
   - Screen for known and unknown viral agents
4. Cryopreservation: Bacterial/Rickettsial/virus culture from positive samples
5. Minimum infection rates (MIR) and Maximum likelihood estimates (MLE)
Point-of-care (POC) diagnostic test for the tick-borne pathogens

Recombinase Polymerase Amplification (RPA) platform coupled with lateral flow detection for POC use.

Successfully developed for Zika virus.

Questions?