Ticks & Lyme Disease: An Update

Kirby C. Stafford III, Ph.D.
Vice Director, State Entomologist

- Lyme Disease
- Rocky Mountain Spotted Fever
- Tularemia
- Anaplasmosis, Ehrlichiosis

Arboviral Encephalitis
- West Nile, EEE, St. Louis, WEE

Malaria (travelers overseas)

Others: Human Babesiosis, Powassan Encephalitis, Tick-borne Relapsing Fever, Colorado Tick Fever, Plague
Lyme Disease – United States, 1982-2007

Reported Cases of Lyme Disease -- United States, 2006

1 dot placed randomly within county of residence for each reported case

Year

*preliminary numbers 2007

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Lyme disease cases by surveillance method and year, Connecticut, 1984-2007

Data CT DPH
Legend For 2002 & 2007

- 0
- 1 - 49
- 50 - 99
- 100 - 299
- 300 - 599
- 600 - 999
- 1000 - 1999
- 2000 +

Lyme Disease Incidence, CT

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Ixodes scapularis nymph & female
Larvae hatching from egg mass

Female tick

K. Stafford
White-footed mouse, birds
Eastern chipmunk & shrews

K. Stafford

J. Occi
Three-host Tick Life-cycle

1. Larvae
2. Nymphs
3. Adults

Engorged female laying eggs

Kirby Stafford, CT Agricultural Experiment Station
Seasonal Activity of *Ixodes scapularis*

![Graph showing seasonal activity of Ixodes scapularis with peaks for nymphs, larvae, and adults.](image)
Ixodes scapularis tested by CAES by polymerase chain reaction (PCR) methods

<table>
<thead>
<tr>
<th>Stage</th>
<th>Year</th>
<th># identified</th>
<th># positive/tested</th>
<th>% positive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nymph</td>
<td>2005</td>
<td>3675</td>
<td>817/3654</td>
<td>22.4</td>
</tr>
<tr>
<td>Nymph</td>
<td>2006</td>
<td>1888</td>
<td>165/1032</td>
<td>16.0</td>
</tr>
<tr>
<td>Nymph</td>
<td>2007</td>
<td>954</td>
<td>228/620</td>
<td>36.8</td>
</tr>
<tr>
<td><strong>Nymph</strong></td>
<td><strong>Total</strong></td>
<td><strong>6517</strong></td>
<td><strong>1210/5306</strong></td>
<td><strong>22.8</strong></td>
</tr>
<tr>
<td>Female</td>
<td>2005</td>
<td>2234</td>
<td>789/2184</td>
<td>36.1</td>
</tr>
<tr>
<td>Female</td>
<td>2006</td>
<td>2835</td>
<td>355/1271</td>
<td>27.9</td>
</tr>
<tr>
<td>Female</td>
<td>2007</td>
<td>1544</td>
<td>251/767</td>
<td>32.7</td>
</tr>
<tr>
<td><strong>Female</strong></td>
<td><strong>Total</strong></td>
<td><strong>6613</strong></td>
<td><strong>1395/4222</strong></td>
<td><strong>33.0</strong></td>
</tr>
</tbody>
</table>

PCR Analysis: Beth Alves, CAES
Tick Management

- Personal Protection Measures
- Host reduction or exclusion
- Host-targeted acaricides
- Habitat or vegetative modifications
- Area-wide chemical control
- Biological & natural control
Bite Prevention

Tick Checks

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Host-targeted Tick Control

Lyme Disease in northeast primarily a residential risk

Estimated 75% picked up outdoors at home as follows*:
Play 47%
Yard Work 18%
Gardening 12%
Neighborhood 4%

2% nymphs on the lawn and 82% are within 3 m of the lawn edge with woods, stone walls, etc.

*Data: Stamford Health Department
Area-Wide Application of Acaricides
Potential Entomopathogenic Fungi for Tick Control

- Fungus *Beauveria bassiana*
- Fungus *Metarhizium anisopliae*

Wide host range.
Produce conidia (asexual spores)
Conidia adhere to cuticle, germinate, penetrate and produce hyphae and toxins.

*M. anisopliae* on female *I. scapularis* (Photo: Stafford)
Applications with Commercial Formulations of the Fungus *Beauveria bassiana* and *Metarhizium anisopliae Strain 52*

<table>
<thead>
<tr>
<th></th>
<th>Average % reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1999</td>
</tr>
<tr>
<td>Naturalis T&amp;O (B. bassiana)</td>
<td>73.7</td>
</tr>
<tr>
<td>BotaniGard ES (B. bassiana)</td>
<td>74.5</td>
</tr>
<tr>
<td>Pyrethroid bifenthrin (Talstar)</td>
<td>85.0</td>
</tr>
<tr>
<td>Tick-Ex (<em>M. anisopliae</em>) (70%)</td>
<td>-</td>
</tr>
<tr>
<td>Tick-Ex (<em>M. anisopliae</em>) (70%)</td>
<td>-</td>
</tr>
<tr>
<td>Tick-Ex (<em>M. anisopliae</em>) (48%)</td>
<td>-</td>
</tr>
</tbody>
</table>

*0% reduction in second trial, 71% nymphs one plot*

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Stafford, K.C. unpublished data.
Press Release
October 2, 2006

Novozymes Expands Product Portfolio with Efficacious Biological Insecticide for Deer Ticks, Lyme Disease

- Novozymes Biologicals Inc. acquired Connecticut-based Earth BioSciences, Inc.
- Novozymes incorporate EBS into ROOTS® Plant Care Group.
- Includes *Metarhizium anisopliae*-based microbial bioinsecticides, which will strengthen Novozymes’ position in ....natural pest technologies.
- Company will make additional investments to bring these new technologies to market and begin production.
- *M. anisopliae* Strain52
- Save for non-targets honey bees green lacewings lady beetles parasitic Hymenoptera earthworms
- **Company Plans:** Launch 2009
- CAES Anuja Bharadwaj Kirby Stafford
Mortality nymphal and adult *I. scapularis* walking on *Metarhizium anisopliae EC* treated surface, 30 minute exposure (2 rates shown) (Bharadwaj & Stafford)

<table>
<thead>
<tr>
<th>Rate of Application</th>
<th>Weeks posttreatment</th>
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<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>N</td>
<td>100.0</td>
</tr>
<tr>
<td>A</td>
<td>45.5*</td>
</tr>
</tbody>
</table>

*Note: exposure at 2.6 x 10^5 resulted in 0% mortality for adults*
Mean number of nymphs/100 m² from control, low and high rate treated sites in 2007, May through mid August at TAHD, CT
Percent Control with *M. anisopliae*, 2007

<table>
<thead>
<tr>
<th></th>
<th>1&lt;sup&gt;st&lt;/sup&gt; Application</th>
<th>2&lt;sup&gt;nd&lt;/sup&gt; Application</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>May 8-9</td>
<td>June 30, July 2</td>
</tr>
<tr>
<td>(8 May-June 28)</td>
<td>7 weeks</td>
<td>(June 29-Aug 20)</td>
</tr>
<tr>
<td>Low Rate</td>
<td>39.8</td>
<td>36.5</td>
</tr>
<tr>
<td>11 sites</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High Rate</td>
<td>9.9</td>
<td>77.8</td>
</tr>
<tr>
<td>9 sites</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Percent mortality due to mycosis in yellow mealworms at 30 days post collection of leaf litter from Torrington home sites following 1st spray application.

Mortality due to mycosis (%)

- Control
- Lower Rate
- Higher Rate

Days of sampling after *M. anisopliae* application:
- 7
- 22
- 34
- 48
Current and Future Tick Control Research

• Current Options
  Landscape practices
  Chemical insecticides (environmental concerns for some)
  Host-targeted acaricides (little implementation, cost)
  Deer management (suitable some areas)
• Anti-tick vaccines to antigens in tick saliva (basic research)
• Oral Lyme disease vaccines via bait to reservoir hosts (rodent targeted vaccine)
• Biological & natural tick control
  Entomopathogenic fungi
  Essential oils from Alaska yellow cedar
# RFP Lyme disease Research

| RFA-CK-08-001 | National Center for Zoonotic, Vector-Borne, and Enteric Diseases (NCZVED) | Announcement 10/26/2007 | Proposal Due 12/10/2007 | Field Trials to Evaluate Efficacy of Natural Products for the Control of the Tick Vectors of Lyme Disease Spirochetes  
Awarded CAES  
Start 4/1/2008 |
|----------------|-------------------------------------------------|--------------------------|--------------------------|---------------------------------------------------------------|
*Borrelia burgdorferi* (Lyme Borreliosis) |
Essential Oil Compounds from Alaska Yellow Cedar

- Nootkatone Alaska yellow cedar most effective
- Eremophilane sesquiterpene, $LC_{50} = 0.0029\%$
- Nootkatone extract grapefruit also effective
- $LC_{50} = 0.0061\%$ (also good repellent activity)
- Carvacrol, monoterpenes, $LC_{50} = 0.0068\%$
- Nootkatone food grade flavor additive and essential oils cedar used in soap industry

Tick Management Handbook

An integrated guide for homeowners, pest control operators, and public health officials for the prevention of tick-associated disease

Revised Edition

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