Ticks are not insects; they are large mites

Phylum Arthropoda; Subphylum Chelicerata; Class Arachnida; Subclass Acari; Superorder Parasitiformes; Order Ixodida

*Carios jerseyi*, found in amber excavated in New Jersey, is estimated to be 90 million years old
Arthropods as vectors

- **Ticks and mites**: *viruses* (tickborne encephalitis, Colorado tick fever, Crimean-Congo hemorrhagic fever); *bacteria* (rickettsioses, spirochetoses, ehrlichioses, tularemia); *protozoa* (piroplasmoses, trypanosomiases, hepatozoonosis); *helminths* (Dipetalonema rugosicauda)
- **Mosquitoes**: *viruses* (yellow fever, EEE, hundreds of others); *bacteria* (tularemia?); *protozoa* (malaria); *helminths* (filariases)
- **Flies** (deer flies, tsetse flies): *bacteria* (tularemia); *protozoa* (trypanosomiases); *helminths* (loaisis)
- **Sandflies, midges and blackflies**: *viruses* (pappataci fever, bluetongue); *protozoa* (leishmaniases, malaria); *helminths* (onchocerciasis)
- **Fleas**: *bacteria* (plague, bartonellosis, murine typhus); *protozoa* (trypanosomiases); *cestodes* (dipylidium)
- **Lice**: *bacteria* (typhus, bartonellosis, relapsing fever)
- **Bugs**: *protozoa* (trypanosomiasis)
Attributes of ticks that make them good vectors

- Extended life cycle with 2 or more opportunities for acquiring infection
- Host specificity (1-host ticks with very narrow host range; 2 host ticks allow zoonotic bridge)
- Long duration of feeding allows for possibility of low dose inocula
- High reproductive potential (BRN of pathogen can be great)
- Exploit disturbed environments
Other reasons to be interested in ticks

• Role as pests
• Dermatitis/ hypersensitivity
• Toxic reactions
  – Tick paralysis: acute ascending flaccid paralysis, like Guillain-Barre syndrome; patients become ataxic and may require ventilation
  – Small protein toxin acts presynaptically and inhibits Ach release
• Exsanguination- secondary anemia
  – Tick infested cows give less milk, cattle grow more slowly, generally less healthy
Zoonoses to consider as differential diagnoses for febrile patients from Massachusetts

- **Tick borne:** Lyme, Babesia microti, human granulocytic ehrlichiosis, Powassan fever, tularemia, Rocky Mountain spotted fever
- **Mosquito borne:** Lacrosse encephalitis, Jamestown Canyon virus, Eastern equine encephalitis, West Nile virus, Cache Valley virus
- **Flea borne:** cat scratch disease, Rickettsia felis
- **Mite borne:** rickettsialpox
- **Louse borne:** epidemic typhus, trench fever
- **Rodent borne:** hantavirus (Seoul and Sin Nombre groups)
- **Agents in search of an emerging disease:** Borrelia cf. miyamotoi, Bartonella vinsonii, deer tick virus, MO-1 babesia, Anaplasma bovis
• “Nantucket Fever” (babesiosis) – first case in 1969

• Fever, chills, muscle aches, headache, night sweats, fatigue, brown urine

• Caused by protozoan similar to malaria, long known as parasite of rodents
• Outbreak of arthritis in children in Old Lyme; odd rashes precede arthritis, usually after bug bite
• Lyme arthritis and erythema migrans caused by spiral bacteria (spirochetes) transmitted by deer ticks
• Nantucket fever cases often preceded by “spider bite”
CYTtocetes Microti, N.G., N.F., A PARASITE DEVELOPING IN GRANULOCYTES AND INFECTIVE FOR SMALL RODENTS

By KENNETH R. TYGGER
Medical School of Harvard University, Boston, Mass.

(With Plates X and XI, containing Figs. 1–56)

A MUSCULOUS OF UNUSUAL TYPE, HENCEFORTH DESIGNATED Cytocete Microti, was discovered by the author in the blood of field voles (Microtus pennsylvanicus) which had been inoculated with a suspension in saline of pooled, mortarground liver and spleen tissue of a number of voles of the same species and of another white-footed or deer mouse (Peromyscus leucopus). This organism occurred...
Holarctic distribution of Lyme disease

<table>
<thead>
<tr>
<th>Study author</th>
<th>Site</th>
<th>#subjects</th>
<th>incidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hanrahan</td>
<td>Fire Island, NY</td>
<td>129</td>
<td>3.1</td>
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<tr>
<td>Steere</td>
<td>Great Island, MA</td>
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<td>1.1</td>
</tr>
<tr>
<td>Lastavica</td>
<td>Ipswich, MA</td>
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<tr>
<td>Feder</td>
<td>East Lyme, CT</td>
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<td>2.7</td>
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<tr>
<td>Miller</td>
<td>Westchester, NY</td>
<td>774</td>
<td>2.5</td>
</tr>
<tr>
<td>Krause</td>
<td>Block I., RI</td>
<td>553</td>
<td>2.0</td>
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<tr>
<td>Telford</td>
<td>coastal MA, RI</td>
<td>360</td>
<td>1.7</td>
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<tr>
<td>Wormser</td>
<td>Westchester, NY</td>
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<td>3.9</td>
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<tr>
<td>Steere</td>
<td>Northeast</td>
<td>10,936</td>
<td>0.7</td>
</tr>
<tr>
<td>Sigal</td>
<td>Northeast</td>
<td>10,305</td>
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</table>

median 2.5
Massachusetts Lyme Disease Incidence Rates
By Town (2005)

<table>
<thead>
<tr>
<th>County</th>
<th>Confirmed Cases (#)</th>
<th>Incidence Rate (per 100,000)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barnstable</td>
<td>229</td>
<td>101.1</td>
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<tr>
<td>Berkshire</td>
<td>66</td>
<td>50.1</td>
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<tr>
<td>Bristol</td>
<td>148</td>
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<tr>
<td>Dukes</td>
<td>90</td>
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<tr>
<td>Essex</td>
<td>254</td>
<td>34.4</td>
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<tr>
<td>Franklin</td>
<td>24</td>
<td>33.2</td>
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<tr>
<td>Hampden</td>
<td>118</td>
<td>25.6</td>
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<tr>
<td>Hampshire</td>
<td>68</td>
<td>44.3</td>
</tr>
<tr>
<td>Middlesex</td>
<td>444</td>
<td>30.4</td>
</tr>
<tr>
<td>Nantucket</td>
<td>29</td>
<td>285.2</td>
</tr>
<tr>
<td>Norfolk</td>
<td>252</td>
<td>38.6</td>
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<tr>
<td>Plymouth</td>
<td>320</td>
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<tr>
<td>Suffolk</td>
<td>45</td>
<td>6.9</td>
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<tr>
<td>Worcester</td>
<td>238</td>
<td>30.4</td>
</tr>
<tr>
<td>State Total</td>
<td>2341</td>
<td>36.3</td>
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</tbody>
</table>

* County was unknown for 16 cases

Canine Lyme disease

- 8 year old Lab/German shepherd mix worries foot over the course of a week (March 2005); no evidence of trauma
- Prior to moving to Grafton in 2003, lived in Boston
- Frontline used during tick season; no Lyme vaccine
- 1 engorged adult deer tick removed during spring 2004; no signs or symptoms in the interim
- Abrupt onset of swelling, cannot put weight on left rear foot; inappetence, neediness, depression
- Did not improve (no treatment) within a week
- Western blot positive; negative IFAT for HGE
- Doxycycline 100 mg p.o. b.i.d. 21 days; no improvement for 8 days; sudden improvement of swelling when corticosteroid was added and within 2 days foot returns to normal and limp disappears
- July 2005 swelling reappears but not as bad; foot is favored but weight could be placed on it; no other signs or symptoms; no treatment; foot returns to normal within a week
HUMAN BABESIOSIS ON NANTUCKET ISLAND, USA: DESCRIPTION OF THE VECTOR, *IXODES (IXODES) DAMMINI*, N. SP. (ACARINA: IXODIDAE)

By Andrew Spielman*, Carlton M. Clifford*, Joseph Piesman* and Melvin D. Corwin*
Understanding the life cycle of the tick is critical to efforts to reduce their density. Adult ticks (male and female) are around from October through the winter, disappearing at the end of May. They feed only on larger animals, usually deer. If the female feeds successfully, she will lay eggs that hatch in July. The larvae that come out of the eggs look for something small, like mice or birds (but will feed on anything, even deer) during August and September. If they feed successfully, the engorged (fed) larvae turn into nymphs the following spring, emerging to feed on virtually anything, including humans, during May, June, and July. If they feed successfully, they turn into adult ticks and the cycle is completed.

Sam Telford III, 7/27/2005
Dog/wood ticks (Dermacentor variabilis)

- Most common tick in New England
- Found in grassy sites (beach grass)
- Raccoons, skunks, foxes, coyotes are definitive hosts
- Small mammals (mice, voles) feed immature ticks
- Transmits tularemia and RMSF
- Only adult ticks (large, about ¼ inch) feed on humans: season of activity April-July

www.uky.edu/.../entfacts/struct/amdogtik.gif
Why coastal New England, and why the 1970s?

- Changes in the landscape – forest to farm to forest
- Increased development and recreational use in reforested sites
- Burgeoning deer herds
The pictures on the right are from Peter Dunwiddie's nice before and after book of Nantucket...showing Polpis Road in the 1880s and in the 1980s. The heavy brush that has grown up is vital to the ticks (which need high humidity) and a great place for mice to breed and deer to browse. One could reduce ticks over the longterm by promoting a return to the pastoral landscape that Nantucket used to be, but this will never happen. And, wish as we all might, the tourists and developers will not go away either. That leaves deer as the focus for intervention.

Sam Telford III, 7/27/2005
Deer feed most adult deer ticks


Deer tick egg mass = 2000 larvae

<table>
<thead>
<tr>
<th>Host</th>
<th>No. present on site</th>
<th>No. ticks per host</th>
<th>% of all ticks</th>
</tr>
</thead>
<tbody>
<tr>
<td>deer</td>
<td>24</td>
<td>38.3</td>
<td>94</td>
</tr>
<tr>
<td>Raccoon</td>
<td>51</td>
<td>0.7</td>
<td>3.7</td>
</tr>
<tr>
<td>possum</td>
<td>8</td>
<td>1.2</td>
<td>1.0</td>
</tr>
<tr>
<td>cat</td>
<td>11</td>
<td>0.1</td>
<td>0.1</td>
</tr>
</tbody>
</table>
Deer are the main reproductive hosts for the deer tick. Although many other animals may be infested, in this site on Long Island it is clear that deer were feeding more than 90% of the adult deer ticks. The importance of this is that one engorged female deer tick, left picture, may lay 2000 or more eggs. Why Nantucket is not 10 feet deep in deer ticks is the focus of the Telford lab's current Lyme ecology research.

Sam Telford III, 7/27/2005
The Great Island experiment: surveillance for Lyme and babesiosis cases
We bled Great Island residents (150-200 of them) each summer from 1983 until 1994 and tested them for new antibodies to Lyme disease spirochetes. In addition, we asked residents to report to us any unexplained fever or physician diagnosed tickborne infection. Only a handful of cases have been reported there since the late 1980s. Although some of the success can be attributed to awareness stimulated by our active work there, we interpret this data as evidence for a reduction in risk.

Sam Telford III, 7/27/2005
What to do about deer ticks?

- The Great Island experiment and other published reports demonstrate that deer reduction will reduce tick density and thereby risk for the deer tick-transmitted infections.

- A target density of 6-8 deer/square mile comes empirically from such studies as well as from mathematical modelling. Such a density is similar to the 10-15 deer/square mile target density for MassWildlife management objectives.

- There are currently no other practical and economical means of reducing deer herds other than hunting. Hunting is preferable to sharpshooting because it is less catastrophic to a site’s ecology and provides economic benefit to communities.
Modes of intervention

• **At the level of the individual:**
  – Repellants and toxicants (permethrin, deet)
  – Appropriate clothing
  – Tick check
  – Education and awareness
  – Vaccination?
  – Habitat avoidance
Host-seeking behavior

- Nidicolous: nest-dwelling
- Non-nidicolous: host seeking
- Passive questing-ambush predators
- Active hunter ticks-crawl or run toward host
  - Can detect movement, heat, shadows, odors, CO2
Modes of intervention

• At the level of communities
  – Habitat management (brush clearing, fire, dessicants)
  – Education and awareness
  – Spraying
  – Host-targeted acaricides (Damminix, 4-poster)
  – Deer reduction

American Lyme Disease Foundation

Extend hunting season to help defeat public health problem

Forty years ago Nantucket’s deer population was far smaller than it is today. And 40 years ago Nantucket’s human population was a third of what it is today in the winter. But as the number of people living on the island has grown and spread out from the center of town into the outskirts and beyond – into land that was once open moors and hayfields – so too has the deer population grown.

That wouldn’t be as much of an issue if it weren’t for the fact that in those 40 years, Nantucket has also seen an explosion in tick-borne diseases from babesiosis to Lyme and newly discovered diseases which can be debilitating and sometimes deadly consequences. There is a connection.

K. Stafford

CAUTION

You may unknowingly pick up the tick that transmits Lyme Disease on this property or elsewhere on Nantucket.

For your protection, stay on roads or mowed trails, keep out of shrub thickets and tall grass, and carefully check for ticks when you get home.

FOR ADDITIONAL INFORMATION CONTACT THE NANTUCKET HEALTH DEPARTMENT (508-228-2208)