Lyme Disease /
Lyme Disease /
Lyme Borreliosis

By Simone Swanepoel

Outline

- Taxonomy/ History / Life cycle
- Morphology of agents involved/ Epidemiology & Distribution
- Ecology / Evolution / Genetics / Physiology/Immunology
- Parasite/host relationships
- Symptoms/ Treatment/ Prevention
- Future Research

Introduction

- Leading arthropod-associated disease in the USA
- 24,000 human cases reported in USA (~10 % of physician diagnosed cases)
- 12 states – 95 % of cases (CDC 2005)
- Greatest incidence–Children under 14 & adults over 40
- Summer Months (Morshed et al. 2005)
- Multisystem disorder
- Great imitator – myriad of symptoms
**Taxonomy**

- **Pathogen/Causative agent of disease**
  - Gram-negative spirochetal bacteria
  - *Borrelia burgdorferi* (Barbour 1984)

- **Principal vector**
  - *Ixodes scapularis* (blacklegged tick) & *Ixodes Pacificus* (Padgett and Lane 2001)

- **Principal reservoir**
  - (nymphs)
  - White-footed mouse
  - *Peromyscus leucopus*

- **Principal host**
  - (adults)
  - White-tailed deer, *Odocoileus virginianus*

**Life Cycle**

1. **Engaged ticks for nympha**
2. **Larvae hatch and feed**
3. ** nymphs attack & feed on small mammals and birds**
4. **Nymphs seek females sites**
5. **White-footed mice seek nymphal activity in spring**

**Figure 1.** *B. burgdorferi* bacteria (CDC)

**Figure 2.** Larva, nymph, male and female *I. scapularis* (CDC).

**Figure 3.** *P. leucopus* mouse.

**Figure 4.** *O. virginianus* deer (CDC).
Life Cycle

Figure 5. The enzootic cycle of B. burgdorferi infection in the northeastern US and interaction with human Lyme disease (Journal of Clinical Investigation 2004).

Figure 6. Seasonal activity of I. scapularis larvae, nymphs, and adults (CDC).

Natural History

- 1764 - Reverend Dr John Walker
- 1975 - Disease first recognized as a clinical entity – Lyme, Connecticut (WHO)
- Extensive History in Europe – 20th Century

Morphology of Ixodidae

Figure 7. Hypothetical Male and Female Ixodidae (hard ticks) with key characteristics labeled (CDC).
Tick Bites

Figure 8. Scanning electron micrographs of the mouthparts of the black-legged tick (CDC).

Epidemiology

Figure 9. Reported cases of Lyme Disease in USA ~ 2005 (CDC).

Distribution

Tick Vector

Figure 10. Distribution of the tick species associated with human granulocytic anaplasmosis (HGA), I. scapularis, I. pacificus; and human monocytotropic ehrlichiosis (HME), A. americanum (CDC).
Ecology & Evolution

- Urbanization
- Anthropogenic factors
- B. burgdorferi ~ high strain diversity

<table>
<thead>
<tr>
<th>Three pathogenic species</th>
<th>Principal tick vector</th>
<th>Location</th>
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<tbody>
<tr>
<td>Borrelia burgdorferi</td>
<td>Ixodes scapularis</td>
<td>Northeastern and north central US</td>
</tr>
<tr>
<td></td>
<td>Ixodes pacificus</td>
<td>Western US</td>
</tr>
<tr>
<td>Borrelia garinii</td>
<td>Ixodes ricinus</td>
<td>Europe</td>
</tr>
<tr>
<td>Borrelia afzelii</td>
<td>Ixodes persulicatus</td>
<td>Europe</td>
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<th>Eight minimally pathogenic or nonpathogenic species</th>
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<tr>
<td>Borrelia andersonii</td>
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<td>Borrelia bissetti</td>
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<td>Borrelia valaisana</td>
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<td>Borrelia turda</td>
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<td>Borrelia sinica</td>
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Genetic & Physiological Aspects

- Genome Sequencing (Steere et al. 2004).
- Spirochetes- Change of OpsA to OpsC outer surface protein for mammalian infection.
- Spirochete bind mammalian plasminogen.
- Surface protein of B. burgdorferi - C6 peptide activated MHC class II presentation
Immunology

Parasitism
- Obligate blood-feeders (ticks)
- Require animal host to survive & reproduce
- Wide host range (people/pets/livestock)
- Depends on host for nutritional requirements

Clinical signs & symptoms
- Early localized/disseminated infection
  - Characteristic Erythema Migrans rash (EM rash)/bulls-eye rash
  - Flu-like Symptoms
- Late persistent infection
  - Myriad of chronic disabling symptoms
  - Brain & nerves (neurological symptoms), eyes.
Diagnosis & Treatment of Disease/Symptoms

- EM rash
- Difficult to diagnose
- Over/under diagnosed
- Blood test – antibodies
- ELISA
- Western Immunoblot (Assous et al. 1993)
- False positive/negative (PCR)
- Antibiotics ~ (including tetracyclines/ most penicillins, and many second- and third-generation cephalosporins).
- Early treatment

Figure 12. An algorithm for the diagnosis and treatment of the early events surrounding Lyme disease in the summer months. Serologic testing for Lyme disease has limited utility during the first 1 or 2 weeks of infection, and early treatment, without serologic testing, is recommended (Journal of Clinical Investigation 2004.)

Prevention

- Pesticides (acaricides) / Insect repellent
- Create a tick-safe zone
- Avoid areas with lots of ticks
- Keep ticks off skin: Check skin & clothes for ticks
- Biological Control: landcscaping/integrated pest management/ decrease deer population
- Clothing (light colors & protective)
- Organic approach – Guinea fowl
- Vaccination
Incorporation if recent research

- Chronic Lyme disease
- Long term treatment in humans
- Vaccine
- Deer population

Future- Lyme disease

![Graph showing reported cases of Lyme disease in the United States from 1991 to 2005.](image)

Figure 13. Reported cases of Lyme disease in the United States - 1991-2005 (CDC)

Conclusion

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Works Cited