What’s Bugging You?  
A Practical Guide to Arthropod Ectoparasites

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First Coast ID/CM Symposium  
Palm Coast, FL  
February 3, 2018
How are Arthropods Medically Important?

• Parasites: hard and soft ticks; *Demodex*, scabies mites; myiasis-causing fly larvae; fleas; lice; pentastomids

• Blood-feeding insects and vectors of disease causing agents: bed bugs; triatomine bugs; mosquitoes; black flies; horse and deer flies; biting midges; zoonotic mites

• Intermediate hosts for parasites and scalars: freshwater crustaceans (*Paragonimus, Dracunculus*); various insects (*Dipylidium, Hymenolepis*; acanthocephalans; *Gongylonema*); millipedes (acanthocephalans); house flies (enteric bacteria).

• Venomous spiders, scorpions, centipedes

• Stinging insects (bees, ants, wasps); urticating caterpillars; arthropods with poisonous secretions (blister beetles; millipedes)

• Allergic reactions to dust mites and their feces, carpet beetles, etc.
Ticks

• Taxonomy: Acari: Ixodidae (hard ticks) and Argasidae (soft ticks).
• Obligate ectoparasites of terrestrial vertebrates.
• Possess eight legs; eyes present or absent; no wings and no antennae. Ixodid ticks have the mouthparts visible from above and possess a hardened dorsal shield (scutum). Argasid ticks have the mouthparts hidden from above and lack a scutum.
• In ixodid ticks, dorsal shield covers most of the body in the adult males and (approx.) anterior third in adult females and nymphs of both genders.
• Vectors of many viral, bacterial (incl. rickettsial), and parasitic diseases.
• Implicated in tick paralysis and tick toxicoses.
# Bacterial (incl. Rickettsial) Diseases transmitted by Ticks

<table>
<thead>
<tr>
<th>Disease</th>
<th>Etiologic agent(s)</th>
<th>Vector(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tularemia</td>
<td><em>Francisella tularensis</em></td>
<td>Amblyomma, Dermacentor, <em>Ixodes</em></td>
</tr>
<tr>
<td>Boutonneuse Fever</td>
<td><em>Rickettsia conori</em></td>
<td>Rhipicephalus, Amblyomma, Haemaphysalis</td>
</tr>
<tr>
<td>African tick-bite fever</td>
<td><em>Rickettsia africae</em></td>
<td>Amblyomma</td>
</tr>
<tr>
<td>Spotted Fever Rickettsiosis</td>
<td><em>Rickettsia rickettsii</em></td>
<td>Dermacentor, Rhipicephalus, Amblyomma</td>
</tr>
<tr>
<td>Siberian tick typhus</td>
<td><em>Rickettsia sibirica</em></td>
<td>Dermacentor, Hyalomma</td>
</tr>
<tr>
<td>TIBOLA</td>
<td><em>Rickettsia slovaca</em></td>
<td>Dermacentor</td>
</tr>
<tr>
<td>Tidewater spotted fever</td>
<td><em>Rickettsia parkeri</em></td>
<td>Amblyomma</td>
</tr>
<tr>
<td>Lyme borreliosis</td>
<td><em>Borrelia burgdorferi, B, mayonii</em></td>
<td><em>Ixodes</em></td>
</tr>
<tr>
<td><em>Borrelia miyamotoi</em> Disease</td>
<td><em>Borrelia miyamotoi</em></td>
<td><em>Ixodes</em></td>
</tr>
<tr>
<td>Tick-borne relapsing fever</td>
<td><em>Borrelia duttoni, B. hermsii, others</em></td>
<td>Ornithodoros</td>
</tr>
<tr>
<td>Human monocytic ehrlichiosis</td>
<td><em>Ehrlichia chaffeensis</em></td>
<td>Amblyomma</td>
</tr>
<tr>
<td>Human granulocytic ehrlichiosis</td>
<td><em>Ehrlichia ewingii</em></td>
<td>Amblyomma</td>
</tr>
<tr>
<td>EML</td>
<td><em>Ehrlichia muris eauclairensis</em></td>
<td><em>Ixodes</em></td>
</tr>
<tr>
<td>Human granulocytic anaplasmosis</td>
<td><em>Anaplasma phagocytophilum</em></td>
<td><em>Ixodes</em></td>
</tr>
</tbody>
</table>
### Viral and Parasitic Diseases Transmitted by Ticks

<table>
<thead>
<tr>
<th>Disease (agent)</th>
<th>Vector(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>VIRAL</strong></td>
<td></td>
</tr>
<tr>
<td>Colorado Tick Fever</td>
<td>Dermacentor</td>
</tr>
<tr>
<td>Crimean-Congo Hemorrhagic Fever</td>
<td>Hyalomma</td>
</tr>
<tr>
<td>Tick-borne encephalitis virus</td>
<td>Ixodes</td>
</tr>
<tr>
<td>Kyasanur Forest Disease</td>
<td>Haemaphysalis</td>
</tr>
<tr>
<td>Powassan Virus</td>
<td>Ixodes, Dermacentor, Haemaphysalis</td>
</tr>
<tr>
<td><strong>PARASITIC</strong></td>
<td></td>
</tr>
<tr>
<td>Babesiosis (<em>Babesia</em> spp.)</td>
<td>Ixodes</td>
</tr>
</tbody>
</table>
Life Cycle of Hard Ticks: 3 host cycle

1. Adult females drop off host to overwinter.
2. Eggs hatch into six-legged larvae in the Spring.
3. Larvae attach to and feed on first host through Summer into Fall.
4. Engorged larvae leave first host and overwinter and moult into nymphs.
5. Nymphs attach to second host in the Spring.
6. Nymphs molt into adults after leaving second host and attach to third host in the Fall.
What makes a tick a tick?

Haller’s organ

Toothed hypostome
Hard Tick Anatomy

- palp
- basis capituli
- porose area
- dorsal shield (scutum)
- eye
- festoons
- anus
- hypostome
- trochanter
- coxa
- genital aperture
- auricula
- spiracular plate
Ixodes spp. – Medically Important US species

• **Ixodes scapularis**-complex
  -commonly called black-legged tick.
  -vector of *Borrelia burgdorferi, B. mayonii* (Lyme disease); *Borrelia miyamotoi; Babesia microti* (babesiosis); *Anaplasma phagocytophilum* (HGA); *Ehrlichia muris eauclairensis* (EML)
  -distributed in the Northeast, upper Mid-west, and adjacent Canada.

• **Ixodes pacificus**
  -commonly called western black-legged tick
  -vector of *Borrelia burgdorferi* (Lyme disease); *Borrelia miyamotoi; Babesia duncani* (babesiosis); hypersensitivity reactions from bites.
  -distributed coastally from BC to Baja California; also AZ.
Ixodes spp.
Ixodes – Degree of Engorgement
Amblyomma americanum

- ‘Lone Star’ tick
- Distributed in Eastern N.A.
- Vectors of *Francisella tularensis* (tularemia); *Ehrlichia ewingii* (HGE); *Ehrlichia chaffeensis* (HMG)
*Amblyomma americanum*
Amblyomma maculatum

- ‘Gulf Coast’ tick
- Distributed in SE US, west to Arizona
- Vector of *Rickettsia parkeri* (tidewater spotted fever)

Image courtesy of Bobbi S. Pritt, MD
Dermacentor spp.

- *Rickettsia rickettsii* (RMSF)
- *Francisella tularensis* (tularemia)
- Powassan virus
- Colorado Tick Fever virus
- Cause of Tick paralysis
**Rhipicephalus sanguineus**

- ‘Brown dog’ tick
- Nearly worldwide distribution
- Normally a nuisance pest
- *Rickettsia rickettsii* (RMSF)
Hyalomma truncatum

- Native to Africa
- Vectors of: Crimean-Congo Hemorrhagic Fever virus; Rickettsia aeschlimannii; Rickettsia sibirica mongolitimonae

Ornithodoros turicata

- Tick-borne relapsing fever (TBRF) spirochetes, Borrelia sp.
Scabies caused by *Sarcoptes scabiei*

- Caused by the scabies or itch mite, *Sarcoptes scabiei*. Worldwide in distribution.
- Cutaneous parasites that reside in burrows under the skin but above the stratum corneum. All stages reside on the human host.
- Life cycle stages including eggs, 6-legged larval, and 8-legged nymphal and adult stages.
- Causes severe itching, especially upon subsequent infections. Crusted form of disease known as ‘Norwegian scabies’ seen primarily in immunocompromised patients and patients in institutionalized settings.
- Highly-contagious, person-to-person contact, or sometimes via fomites.
- Diagnosis is made by finding mites (and their eggs and feces) in skin scrapings and biopsy specimens.
Life Cycle of *Sarcoptes scabiei*
Sarcoptes scabiei: adults and nymphs
Sarcoptes scabiei: eggs and scybala (feces)
**Demodex spp.**

- Demodicosis caused by follicle mites in the genus *Demodex*; *D. folliculorum* (hair follicles) and *D. brevis* (pilosebaceous glands) most-commonly occur on the forehead, face, nose and eyelids.

- Are not believed to cause disease in humans, but have been associates with skin conditions such as folliculitis, rosacea, blepharitis, others.

- Their presence in skin scrapings may lead to confusion with scabies.

- Long and slender, 0.3 mm in length. Three distinct body regions:
  - Gnathostoma (anterior region containing mouthparts)
  - Podostoma (central area containing 4 pairs of stumpy legs)
  - Opisthosoma (long, posterior half, or more)
Demodex spp.
Avian, rodent mites

- Avian and rodent mites may infest homes and bite people in the absence of, or infestation of, their natural hosts.
- Cannot survive on the human host and eventually die and fall off. Infestations are often short-lived.
- Not vectors of disease in humans; the house mouse mite, *Liponyssoides sanguineus*, has been implicated in transmission of *Rickettsia akari* (rickettsialpox) in NE US.
- Difficult to identify to the genus or species level and best left to experienced entomologist/parasitologist. ID usually not needed for clinical patient management but may be desirable for public health or pest management (of the natural host).
## Avian, rodent mites

<table>
<thead>
<tr>
<th>Mite</th>
<th>Natural Host</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Ornithonyssus bacoti</em> (tropical rat mite)</td>
<td>Rats</td>
</tr>
<tr>
<td><em>Ornithonyssus bursa</em> (tropical fowl mite)</td>
<td>Domestic and wild birds, rarely rodents</td>
</tr>
<tr>
<td><em>Ornithonyssus sylviarum</em> (northern fowl mite)</td>
<td>Birds, especially domestic fowl, pigeons, sparrows, and other anthropophilic species</td>
</tr>
<tr>
<td><em>Laelops echidnina</em> (spiny rat mite)</td>
<td>Rats</td>
</tr>
<tr>
<td><em>Dermanyssus gallinae</em> (chicken mite)</td>
<td>Birds, especially domestic fowl, pigeons, sparrows, and other anthropophilic species</td>
</tr>
<tr>
<td><em>Liponyssoides sanguineus</em> (house mouse mite)</td>
<td>Mice and other rodents</td>
</tr>
<tr>
<td><em>Pyemotes tritici</em> (straw itch mite)</td>
<td>Insects</td>
</tr>
<tr>
<td><em>Cheyletiella</em> species (cheyletiellid mites)</td>
<td>Various mammals and birds, including domestic pets</td>
</tr>
</tbody>
</table>
Ornithonyssus sylviarum
Fleas

- Obligate ectoparasites of the order Siphonaptera.
- Holometabolous life cycle (egg, larva, pupa, adult). Only adults parasitic, larvae are free-living and feed on organic material in bedding or nest of host.
- Adults are laterally compressed, wingless; mouthparts adapted for blood-feeding; specialized muscles in hind legs for jumping.
- Vectors of several bacterial and rickettsial diseases. Diseases may be transmitted by biting (plague) or by the rubbing of flea feces into wounds and cuts (typhus, other rickettsial diseases, *Bartonella*).
- Some are intermediate hosts of helminthic diseases.
- Tungiasis is condition caused by specialized species in the genus *Tunga*. 
# Fleas – Medical Importance

<table>
<thead>
<tr>
<th>Disease</th>
<th>Etiologic agent(s)</th>
<th>Primary vector(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plague¹</td>
<td><em>Yersinia pestis</em></td>
<td><em>Xenopsylla cheopis, others</em></td>
</tr>
<tr>
<td>Feline rickettsiae²</td>
<td><em>Rickettsia felis</em></td>
<td><em>Ctenocephalides sp.</em></td>
</tr>
<tr>
<td>Murine (endemic) typhus²</td>
<td><em>Rickettsia typhi</em></td>
<td><em>Xenopsylla cheopis, C. felis, Nosopsyllus spp.</em></td>
</tr>
<tr>
<td>Cat-scratch disease²</td>
<td><em>Bartonella henselae</em></td>
<td><em>Ctenocephalides felis</em></td>
</tr>
<tr>
<td>Dog tapeworm disease³</td>
<td><em>Dipylidium caninum</em></td>
<td><em>Ctenocephalides spp.</em></td>
</tr>
<tr>
<td>Dwarf tapeworm disease³</td>
<td><em>Hymenolepis nana, H. diminuta</em></td>
<td><em>Ctenocephalides spp., others</em></td>
</tr>
</tbody>
</table>

¹Infection occurs via the bite of the flea  
²Infection occurs when the fleas’ feces are rubbed into abraded skin  
³Infection occurs upon incidental ingestion of fleas
Flea Anatomy
**Ctenocephalides spp.**  
* (cat and dog fleas)

- Presence of genal and pronotal combs, with more than 5 teeth on the genal comb.
- Mesopleuron not divided by sclerotized rod.
- Vectors of *Rickettsia felis* and *Bartonella henselae*; intermediate host of *Dipylidium caninum*, *Hymenolepis* spp.
Xenopsylla cheopis
(Oriental Rat Flea)

- Lacks both pronotal and genal combs
- Mesopleuron divided by sclerotized rod
- Ocular bristle near top of the eye.
- Vector of *Yersinia pestis*
**Pulex irritans**
*(human flea)*

- Lacks both pronotal and genal combs
- Mesopleuron not divided by sclerotized rod
- Ocular bristle inserted below the top of the eye.
- Primarily a nuisance pest; becoming less common in industrialized communities
Tungiasis

• Infection with the chigoe fleas, *Tunga penetrans* and *T. trimamillata*.

• Circumtropical in distribution (*penetrans*) or Amazonian Brazil and Ecuador and Peru (*trimamillata*).

• Females are cutaneous in the human host. Adults usually reside under and between the toes and other areas on the feet.

• Itching and tenderness can start as the gravid female becomes engorged; sever cases can lead to difficulty in walking. Secondary myiasis and bacterial infections are possible.

• Diagnosis is usually made by observing features of flea in biopsy specimens or examination of eggs liberated from lesion.
Life Cycle of *Tunga* spp.
Tunga spp.
Lice

• Obligate ectoparasites of several families of the order Psocodea.

• Two species colonize the human host: *Pediculus humanus* (head-and-body louse) and *Pthirus pubis* (pubic louse); the former divided into *P. h. humanus* (body louse) and *P. h. capitis* (head louse).

• Body louse transmits agents of epidemic typhus (*Rickettsia prowazekii*) and trench fever (*Bartonella quintana*), louse-borne relapsing fever (*Borrelia recurrentis*).

• Incomplete metamorphosis (egg, nymphs [3], adult).

• Mouthparts adapted for sucking blood (human species).

• Morphology: possess 6 legs, one pair of eyes, and one pair of antennae. Wingless, dorsoventrally flattened. Tarsal claws on legs adapted for grasping hair shafts (raptorial).
Life Cycles of Lice

Pediculus humanus capitis

Pthirus pubis
Lice - Morphology
Pediculus humanus - Morphology

- Body longer than broad
- Tarsal claws similar in size on all three pairs of legs.
- No lateral protuberances on abdominal segments.
**Phthirus pubis - Morphology**

- Body nearly as broad as long (thorax wider than abdomen).
- Tarsal claws on front legs smaller than those on middle and hind legs.
- Lateral protuberances on abdominal segments.
Pediculus humanus

Pthirus pubis
Head vs. Pubic Lice: nits (eggs)

Pediculus humanus  Pthirus pubis
Myiasis

- Infestation or colonization by fly larvae (maggots).
- Most-commonly caused by blow flies (Calliphoridae) or bot flies (Oestridae).
- *Dermatobia* (Neotropical); *Cochliomyia* (Neotropical); *Cordylobia* (Afrotropical); *Cuterebra* (Northern Hemisphere), *Oestrus* (sheep-raising areas); *Phormia* (nearly cosmopolitan).
- Cutaneous, ocular, aural (ENT), facultative, intestinal**, urinary**.
- In true myiasis, larvae will consume and damage healthy tissue; facultative myiasis usually results in consumption of dead/dying tissue (i.e., in wounds).
- Removal is usually curative; a species-level identification is not necessary for patient management.
Myiasis – Clinical Divisions

- **Obligatory Myiasis:** The developing larvae are dependent on host tissue for development and are capable of consuming, and often require, healthy host tissue.

- **Facultative Myiasis:** The larvae colonize pre-existing wounds and diseased tissue and feed on dead or decaying tissue (some species that initially cause facultative myiasis may go on to attack healthy tissue as well).

- **Incidental Myiasis:** The human body becomes colonized with normally free-living or saprophagous species.
<table>
<thead>
<tr>
<th>Genus/Species</th>
<th>Geographic Distribution</th>
<th>Clinical Presentation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Calliphoridae</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Auchmeromyia senegalensis</strong></td>
<td>Sub-Saharan Africa; Cape Verde Islands</td>
<td>Sanguinivorous myiasis</td>
</tr>
<tr>
<td><strong>Calliphora spp.</strong></td>
<td>Worldwide</td>
<td>Facultative wound, oral, urogenital myiasis</td>
</tr>
<tr>
<td><strong>Chrysomya bezziana</strong></td>
<td>Old World</td>
<td>Wound, ENT* myiasis</td>
</tr>
<tr>
<td><strong>Cochliomyia hominovorax</strong></td>
<td>Central and South America; the Caribbean</td>
<td>Obligatory wound myiasis; will continue to invade healthy tissue (incl. ENT myiasis)</td>
</tr>
<tr>
<td><strong>Cordylobia spp.</strong></td>
<td>Sub-Saharan Africa</td>
<td>Furuncular myiasis</td>
</tr>
<tr>
<td><strong>Lucilia spp.</strong></td>
<td>Worldwide</td>
<td>Facultative wound myiasis</td>
</tr>
<tr>
<td><strong>Phormia regina</strong></td>
<td>Holarctic (Northern Hemisphere)</td>
<td>Facultative wound myiasis</td>
</tr>
<tr>
<td><strong>Sarcophagidae</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Wohlfahrtia spp.</strong></td>
<td>Northern Hemisphere</td>
<td>Furuncular, wound, ENT myiasis</td>
</tr>
<tr>
<td><strong>Muscidae</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Musca domestica</strong></td>
<td>Worldwide</td>
<td>Facultative wound myiasis</td>
</tr>
<tr>
<td><strong>Oestridae</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Cuterebra sp.</strong></td>
<td>North America</td>
<td>Furuncular, visceral myiasis</td>
</tr>
<tr>
<td><strong>Dermatobia hominis</strong></td>
<td>Central and South America; the Caribbean</td>
<td>Furuncular myiasis</td>
</tr>
<tr>
<td><strong>Gasterophilus spp.</strong></td>
<td>Worldwide</td>
<td>Furuncular myiasis, creeping eruption, ocular infection</td>
</tr>
<tr>
<td><strong>Hypoderma spp.</strong></td>
<td>Worldwide, mostly Northern Hemisphere</td>
<td>Furuncular myiasis, oral myiasis, creeping eruption</td>
</tr>
<tr>
<td><strong>Oestrus ovis</strong></td>
<td>Nearly worldwide in sheep-raising regions</td>
<td>Ophthalmomyiasis</td>
</tr>
</tbody>
</table>

*ENT = Ears/Nose/Throat*
Morphology of Myiasis-causing Fly Larvae

CU: cuticular spines
MD: mandibles
SP: spiracular plate
  • SL: slits
  • BU: button
  • PE: peritreme
Dermatobia hominis
Cochliomyia hominovorax
Oestrus ovis
Cordylobia anthropophaga
Cuterebra sp. [second-instar larvae]
*Cuterebra* sp. [third-instar larvae]
Lucilia spp.
Sarcophaga spp.
Musca domestica
“Pseudoparasites” – drain flies
“Pseudoparasites” – rat-tailed maggots
Bed Bugs

- Two species usually associated with humans: *Cimex lectularius* (cosmopolitan) and *C. hemipterus* (tropics).
- Not effective vectors of disease; symptoms are usually allergic reactions to components of their saliva.
- Casual feeders; do not reside on human host and hide in sheltered areas between feedings. Very reclusive.
- Body dorsoventrally flattened. Adults have six legs and one pair of antennae; wings reduced to shortened wing buds (not capable of flight); piercing-sucking mouthparts.
- Incomplete metamorphosis; all nymphal stages as well as adult feed on humans.
Bed Bugs
Bed Bugs
Bat Bugs
Acknowledgments

- Jane Hata, Mayo Clinic, Jacksonville, FL and First Coast!
- CDC-DPDx [many images, life cycles]
- Bobbi S. Pritt, Mayo Clinic, Rochester, MN (scabies; *Amblyomma maculatum*)
- William J. Gerth (*Hyalomma*)
- USDA, Manhattan, KS (clinical tungiasis)