A Field Guide to the Arthropods of the Human Body

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Case 1

- A six-year-old boy presented to his pediatrician with a non-migratory furuncle (boil) on his scalp.
- Patient had been in Belize for a family vacation a few weeks prior.
- Originally treated for *Staphylococcus*-caused boil.
- However a couple days later, a parent noticed a ‘worm-like’ object protruding from the boil.
- The patient revisited the pediatrician, and a small incision was made at the boil, and a larva was removed.
- The larva was sent to the DPDx Team at the CDC, Atlanta for diagnostic assistance.
Diagnosis: furuncular myiasis caused by *Dermatobia hominis*

- *Dermatobia hominis* is an obligatory myiasis-causing species from Central and South America, the Caribbean.
- Intricate life cycle involving vector transmission by a blood-sucking fly.
- Clinically manifests as a non-migratory furuncle/boil at the vector’s bite site.
- Removal is curative.
- Identification made by form of posterior spiracles and patterns of cuticular spines (not present on posterior 3 segments)
Life Cycle of *Dermatobia hominis*
Myiasis

- Infestation or colonization by fly larvae (maggots), most commonly by members of Oestridae (bot flies) or Calliphoridae (blow flies).
- Most species have typical fly life cycle of egg, three larval instars, pupa, adult.
- Clinically, myiasis is divided into three categories: obligatory, facultative, or incidental.
- Can colonize most body sites, most-commonly skin, but also eyes, ears, respiratory tract.
- Removal is usually curative; a species-level identification is not necessary for patient management.
- Bacteremia has been associated with some species that manifest as facultative myiasis.
- Maggot therapy – use of sterile fly larvae to remove dead tissue from patients (e.g., burn victims, diabetic patients).
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.
Myiasis – sites of infection

- **Furuncular myiasis** – manifests as a boil on the skin, contains a single larva. Most commonly seen with species that cause obligatory myiasis.
- **Wound myiasis** – colonization of pre-existing wounds of skin or soft tissue.
- **Ophthalmomyiasis** – colonization of the eye.
- **ENT myiasis** – colonization of the ears, nose, and throat. Can represent facultative myiasis (if pre-existing wound) or obligatory myiasis (usually zoonotic species).
- **Creeping eruption** – manifests as a wandering early instar larva in the dermis.
- **Sanguinivorous myiasis** – blood-feeding without colonization (e.g., Congo floor maggot, *Auchmeromyia senegalensis*).
- **Intestinal myiasis**
- **Urinary myiasis**
Morphology of Myiasis-causing Fly Larvae

CU: cuticular spines

MD: mandibles

SP: spiracular plate
  - SL: slits
  - BU: button
  - PE: peritreme
Dermatobia hominis
Cochliomyia hominovorax
Cordylobia anthropophaga
Cuterebra sp.
Cuterebra sp., third-instar larva
*Lucilia* spp.
Sarcophaga spp.

Image courtesy of Kamran Kadkhoda
Musca domestica

Image courtesy of Bobbi S. Pritt
Case 2

- A 65-year-old man from Canada presented with pruritus on his chest; he noted that even with frequent bathing the symptoms persisted.

- Examination by the PCP revealed possible arthropod ectoparasites, measuring approximately 1.5 mm in length, on his chest hair.

- Specimens were collected and sent to the Microbiology Lab for examination.
Diagnosis: Pthiriasis caused by the pubic louse, *Pthirus pubis*.

- Caused by the pubic louse, *Pthirus pubis*.
- Usually reside in pubic region, but may be found anywhere hairy on the body, preferably coarse hair.
- Usually asymptomatic; itching can occur due to allergies to lice saliva.
- Contagious, direct sexual contact or fomites (rare).
- All stages occur on the human host.
- Control measures include proper hygiene, refraining from multiple sexual partners.
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).
- Control measures include good house-keeping, hygiene.
Life Cycle of *Pthirus pubis*
Pediculus humanus

Pthirus pubis
Pediculus humanus

Pthirus pubis
Case 3

- A 55-year-old male presented with month-long history of a painful, itchy erythematous rash of the lower back, groin, periumbilical region, chest, and elbows.

- HIV-negative and no other known conditions of being immunocompromised, nor undergoing steroid therapy.

- Other household contacts asymptomatic.

- Initially diagnosed as generalized ostraceous psoriasis and treated with methotrexate, 6% liquor carbonis detergens, 3% salicylic acid, 0.05% clobetasol cream.

- Without resolution, skin scrapings were taken for mycological and parasitological examination.
Skin Scrapings: Microscopic Findings
Skin Scrapings: Microscopic Findings

End
Diagnosis: 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 sever 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
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.
Case 4

- A 45-year-old male from Massachusetts found arthropods attached to his leg after spending a day in the local woods for nature photography.

- The organisms were removed and sent to the State Entomologist for identification.
End
Identification: deer tick, *Ixodes scapularis*

- Commonly referred to as ‘deer ticks’, ‘black-legged ticks’.
- Vectors of *Babesia* spp. (babesiosis), *Borrelia burgdorferi, B. mayonii* (Lyme disease), *Borrelia miyamotoi, Anaplasma phagocytophilum* (HGA), Powassan virus
- Mouthparts long, in relation to basis capituli.
- Inornate dorsal shield.
- No festoons or eyes.
- Inverted U-shaped anal groove (may be difficult to see in engorged specimens).
**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)
  
  -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 spp.
Ixodes – Degree of Engorgement
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, rickettsial, and parasitic diseases.
- Implicated in tick paralysis and tick toxicoses.
## Bacterial and 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, Ixodes</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</em>, B, mayonii</td>
<td>Ixodes</td>
</tr>
<tr>
<td><em>Borrelia miyamotii</em> Disease</td>
<td><em>Borrelia miyamotii</em></td>
<td>Ixodes</td>
</tr>
<tr>
<td>Tick-borne relapsing fever</td>
<td><em>Borrelia duttoni</em>, B. hermesi</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>Human granulocytic anaplasmosis</td>
<td><em>Anaplasma phagocytophilum</em></td>
<td>Ixodes</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>VIRAL</td>
<td></td>
</tr>
<tr>
<td>Colorado Tick Fever</td>
<td><em>Dermacentor</em></td>
</tr>
<tr>
<td>Crimean-Congo Hemorrhagic Fever</td>
<td><em>Hyalomma</em></td>
</tr>
<tr>
<td>Tick-borne encephalitis virus</td>
<td><em>Ixodes</em></td>
</tr>
<tr>
<td>Kyasanur Forest Disease</td>
<td><em>Haemaphysalis</em></td>
</tr>
<tr>
<td>Powassan Virus</td>
<td><em>Ixodes, Dermacentor, Haemaphysalis</em></td>
</tr>
<tr>
<td>PARASITIC</td>
<td></td>
</tr>
<tr>
<td>Babesiosis (<em>Babesia spp.</em>)</td>
<td><em>Ixodes</em></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 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.
Hard Tick Anatomy

dorsal shield (scutum)
porose area
basis capituli
palp

hypostome
trochanter
coxa
eye

auricula
genital aperture
spiracular plate
anus
festoons
Amblyomma americanum

- *Francisella tularensis* (tularemia)
- *Ehrlichia ewingii* (HGE)
- *Ehrlichia chaffeensis* (HMG)
Amblyomma maculatum

- *Rickettsia parkeri* (tidewater spotted fever)
**Dermacentor spp.**

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

- Normally a nuisance pest
- *Rickettsia rickettsii* (RMSF)
Hyalomma truncatum

- Crimean-Congo Hemorrhagic Fever virus
- Rickettsia aeschlimannii
- Rickettsia sibirica mongolitimonae

Ornithodoros turicata

- Tick-borne relapsing fever (TBRF) spirochetes, Borrelia sp.
Otobius megnini (spinose ear tick)
Case 5

- A 25-year-old female experienced a painful lesion on her left, big toe, shortly after returning from three-months of field work in Kenya and Uganda.

- She visited her PCP, and while pressure was applied to the lesion...
Microscopic Exam

- Eggs were roughly 600 µm long and lacked any defined internal or external structures (e.g. operculum)
Diagnosis: Tungiasis caused by the chigoe flea, *Tunga penetrans*

- 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.
Tungiasis: Histopathologic Findings
Tungiasis: Histopathologic Findings
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 – Public Health 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</em>, others</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</em>, <em>C. felis</em>, <em>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</em>, <em>H. diminuta</em></td>
<td><em>Ctenocephalides spp.</em>, others</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
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
Acknowledgments

• The Illinois Society for Microbiology
• CDC and the DPDx Team!
• Case 1: CDC Washington D.C. (myiasis)
• Case 2: Cadham Provincial Public Health Laboratory, Winnipeg, Manitoba, Canada (pthiriasis)
• Case 3: Bobbi S. Pritt, Mayo Clinic, Rochester, MN (scabies)
• Case 4: Tom Murray (Ixodes), Bobbi S. Pritt (Amblyomma maculatum), William J. Gerth (Hyalomma), Cynthia Magro (tick histopath); Ryan Jensen (Otobius)
• Case 5: USDA, Manhattan, KS (tungiasis)