Laboratory Identification of Medically-Important Arthropod Ectoparasites

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How are Arthropods Medically Important?

- **VECTORS OF DISEASE**
  - Malaria, lymphatic filariasis, Chagas disease, Lyme disease, West Nile Virus, Dengue, Plague, African sleeping sickness, trench fever, relapsing fevers, chikungunya, yellow fever, many many others

- **INTERMEDIATE HOSTS FOR PARASITES**
  - Paragonimiasis, hymenolepiasis, dipylidiasis, dracunculiasis

- **ECTOPARASITES**
  - Scabies, myiasis, demodicosis, pentastomiasis

- **VENOMOUS and STINGING ARTHROPODS**
  - Spiders, scorpions, bees, ants, wasps, stinging caterpillars, blister beetles
What is an Arthropod?

- Invertebrates with a hardened exoskeleton and jointed appendages.
- Development variable, may be gradual or have complete metamorphosis (e.g. egg, larva, pupa, adult)
- One of the most successful groups of animals, over a million species yet relatively few of medical or public health concern
- Major Groups:
  - Insects, arachnids, crustaceans, centipedes, millipedes
Arthropod Body Plan

https://bugguide.net/node/view/37485/bgimage
## Major Groups of Arthropods

<table>
<thead>
<tr>
<th>Major Group</th>
<th>Body Plan</th>
<th>Legs</th>
<th>Wings</th>
<th>Antennae</th>
<th>Development</th>
</tr>
</thead>
<tbody>
<tr>
<td>Insects</td>
<td>3 regions: head, thorax, abdomen</td>
<td>6 as adults; larvae often legless</td>
<td>1-2 functional pairs or absent</td>
<td>1 pair</td>
<td>Incomplete or complete metamorphosis</td>
</tr>
<tr>
<td>Arachnids</td>
<td>Usually 2: cephalothorax and abdomen</td>
<td>8 as adults (tick, mite larvae have 6)</td>
<td>Always absent</td>
<td>Always absent</td>
<td>Gradual</td>
</tr>
<tr>
<td>Crustaceans</td>
<td>Highly variable, often 2</td>
<td>Highly variable, usually at least 10</td>
<td>Always absent</td>
<td>2 pairs</td>
<td>Variable, incomplete metamorphosis</td>
</tr>
<tr>
<td>Centipedes</td>
<td>2: head and body</td>
<td>Many, 1 per body segment</td>
<td>Always absent</td>
<td>1 pair</td>
<td>Gradual</td>
</tr>
<tr>
<td>Millipedes</td>
<td>2: head and body</td>
<td>Many, 2 per body segment</td>
<td>Always absent</td>
<td>1 pair</td>
<td>Gradual</td>
</tr>
</tbody>
</table>
Collection and Submission of Arthropods to the Diagnostic Laboratory

- Arthropods (or parts thereof) should be transported to the lab in a liquid preservative (10% formalin or 70-95% lab grade alcohol).
  - Prevents desiccation that may result in the altering of morphologic features
  - Kills pathogens that might be associated with vectors (e.g. ticks)
- Skin scrapings for scabies can be placed in vials of alcohol if the specimen is to be transported to an off-site reference laboratory.
Ticks

- Obligate parasitic mites.
- Two medically-important families: Ixodidae (hard ticks) and Argasidae (soft ticks).
- Gradual development consisting of (usually) multi-host life cycles, including a larva, one to several nymphs, and adult.
- Vectors of parasitic, bacterial, viral diseases
- Can cause paralysis and have been implicated in ‘meat allergy’ (alpha-gal syndrome)
- Diagnosis is important regarding the genus of tick and the possible vectors in a given geographic area.
  - Also whether or not a tick is engorged and degree of engorgement is reported.
What makes a tick a tick?

Haller’s organ

Toothed hypostome
Ixodid (hard) vs. Argasid (soft) Ticks
Ixodid (Hard Tick) Anatomy
Ticks: Long vs. Short Mouthparts
Life Cycle of a Hard Tick

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.
Ixodes spp. – Medically Important US species

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

• **Ixodes pacificus**

  - commonly called western black-legged tick
  
  - vector of *Borrelia burgdorferi* (Lyme disease); *Babesia duncani* (babesiosis); hypersensitivity reactions from bites.
  
  - distributed coastally from BC to Baja California; also AZ.
Ixodes spp. - Morphology

- 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.
*Ixodes* spp.
*Ixodes* spp.
*Ixodes* – Degree of Engorgement
Amblyomma spp. – Medically important US species

- **Amblyomma americanum**
  - commonly called Lone Star tick
  - vector of *Francisella tularensis*; *Ehrlichia chaffeensis* (HME); *E. ewingii* (HE).
  - distributed central TX north and east to NY; Mexico to South America
  - implicated in alpha-gal syndrome

- **Amblyomma maculatum**
  - commonly called Gulf Coast tick
  - vector of *Rickettsia parkeri* (tidewater spotted fever).
  - distributed Gulf Coast states; AZ (range expanding).
Ambylomma species - Morphology

- Mouthparts long in relation to basis capituli.
- Festoons and eyes present.
- Ornate dorsal shield in **adults** (nymphs and larvae usually **inornate**).
- Round body that often keeps a round shape when engorged
*Amblyomma americanum*

Female (left); male (right)
Amblyomma americanum
Amblyomma americanum - nymph
Amblyomma maculatum
Amblyomma vs. Ixodes - Engorged

Amblyomma

Ixodes
Dermacentor – medically important U.S. species

- **Dermacentor variabilis**
  - commonly known as American dog tick
  - primary vector of *(Rickettsia rickettsii)* RMSF in the eastern U.S.; *Francisella tularensis*; tick paralysis
  - distributed throughout much of the U.S. except in parts of the Rocky Mountains; Central Canada

- **Dermacentor andersoni**
  - commonly known as Rocky Mountain wood tick.
  - primary vector of RMSF in Rocky Mountain region; *Francisella tularensis*; Colorado tick fever virus; tick paralysis.
  - distributed western Plains and Black Hills of SD, Rocky Mountains west to Cascade and Sierra Nevada Mountains (not coastal in the West); into AZ and NM; also adjacent Canada.
Dermacentor spp. - Morphology

- Ornate dorsal shield in **adults**; nymphs and larvae may be **inornate**.
- Mouthparts short in relation to basis capituli (**longer** in immature stages).
- Eyes on dorsal shield.
- Festoons present.
- Species-level identification often requires examination of spiracular plate.
Dermacentor spp.

female

male
Dermacentor spp.
Dermacentor spp.
Dermacentor spp. – spiracular plates

D. andersoni

D. variabilis
**Rhipicephalus sanguineus**

- Commonly known as the ‘brown dog tick’.
- Not an efficient vector of disease but there are reports/outbreaks of RMSF (*Rickettsia rickettsii*).
- Laterally produced, angulate basis capituli.
- Mouthparts short in relation to basis capituli.
- Eyes and festoons present.
- Deeply-cleft front coxae.
Rhipicephalus sanguineus
Rhipicephalus sanguineus
Hyalomma spp.

- Endemic to the Old World (Africa, Asia, southern Europe)
- Vectors of Crimean-Congo Hemorrhagic Fever Virus
Hyalomma truncatum (USA ex: Ethiopia)
Soft Ticks

- *Ornithodoros* spp. in North America are vectors of tick-borne relapsing fever (TBRF) spirochetes; the species name of the *Borrelia* is the same as the species name of the tick!

- *Otobius megnini* (spinose ear tick) – zoonotic tick causing ear infections

- No dorsal shield.

- Mouthparts hidden from above.

- Nymphs and adults do not reside on the host, but rather feed for short periods of time before returning to sheltered location. Complex life cycles with varying numbers of nymphs and feeding cycles.
Soft Ticks
Ornithodoros spp.

- Tick-borne relapsing fever (TBRF) spirochetes, *Borrelia* sp.
**Otobius megnini**

- Commonly known as the ‘spinose ear tick’ of cattle
- Only parasitic in the larval and nymphal stages
- Colonizes host’s ear, causing severe pain and possibly rupture of the tympanum resulting in hearing problems
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.
Collecting and Preparing Skin Scrapings for Scabies

- Mites are more-likely to be found in skin scrapings collected at the end of burrows in nonexcoriated and noninflamed areas. Scrapings should be performed using a sterile scalpel or glass microscopy slide with a drop of mineral or immersion oil applied to the surface (the oil helps the mites adhere to the blade or slide and facilitates transfer to a slide for microscopic examination). The skin should be scraped vigorously at approximately a 90° angle (vigorous meaning there should be some RBCs on the slide but no frank bleeding); the patient should be sampled at a minimum of six different sites. The scrapings can be pooled on a single slide or examined on individual slides; place a coverslip over the slide prior to examination. The scrapings should be screened at 40x or 100x magnification and then evaluated at 200x or 400x magnification for confirmation.

- **Note:** Live *Sarcoptes* mites are highly contagious and gloves and other PPE should be used at all times during collection and examination.
Life Cycle of *Sarcoptes scabiei*
Crusted or “Norwegian” Scabies
Sarcoptes scabiei
Sarcoptes scabiei
Sarcoptes scabiei

feces (=scybala)
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.
Zoonotic Biting 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).
# Zoonotic Biting 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 species</em> (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).
- Some are intermediate hosts of helminthic diseases.
- Tungiasis is condition caused by specialized species in the genus.
- Control is variable; hygiene and good housekeeping; controlling environments of reservoir hosts. Control of reservoir hosts.
Flea Life Cycle

1. Eggs shed by female into environment.
2. Eggs hatch into larvae.
3. Larvae form pupae.
4. Adults hatch from pupae.

CDC
http://www.dpd.cdc.gov/dpdx
# Medical Importance of Fleas

<table>
<thead>
<tr>
<th>Disease</th>
<th>Etiologic agent(s)</th>
<th>Primary vector(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plague&lt;sup&gt;1&lt;/sup&gt;</td>
<td><em>Yersinia pestis</em></td>
<td><em>Xenopsylla cheopis, others</em></td>
</tr>
<tr>
<td>Feline rickettsiae&lt;sup&gt;2&lt;/sup&gt;</td>
<td><em>Rickettsia felis</em></td>
<td><em>Ctenocephalides sp.</em></td>
</tr>
<tr>
<td>Murine (endemic) typhus&lt;sup&gt;2&lt;/sup&gt;</td>
<td><em>Rickettsia typhi</em></td>
<td><em>Xenopsylla cheopis, C. felis, Nosopsyllus spp.</em></td>
</tr>
<tr>
<td>Cat-scratch disease&lt;sup&gt;1,2&lt;/sup&gt; (?)</td>
<td><em>Bartonella henselae</em></td>
<td><em>Ctenocephalides felis</em></td>
</tr>
<tr>
<td>Dog tapeworm disease&lt;sup&gt;3&lt;/sup&gt;</td>
<td><em>Dipylidium caninum</em></td>
<td><em>Ctenocephalides spp.</em></td>
</tr>
<tr>
<td>Dwarf tapeworm disease&lt;sup&gt;3&lt;/sup&gt;</td>
<td><em>Hymenolepis nana, H. diminuta</em></td>
<td><em>Ctenocephalides spp., others</em></td>
</tr>
</tbody>
</table>

<sup>1</sup>Infection occurs via the bite of the flea  
<sup>2</sup>Infection occurs when the fleas’ feces are rubbed into abraded skin  
<sup>3</sup>Infection occurs upon incidental ingestion of fleas
Fleas - Morphology
**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.
**Xenopsylla cheopis**
(Oriental Rat Flea)

- Lacks both pronotal and genal combs
- Mesopleuron divided by sclerotized rod
- Ocular bristle near top of the eye.
**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.
**Xenopsylla vs. Pulex**  
(ocular bristle)

*Xenopsylla cheopis*  
*Pulex irritans*
Tungiasis caused by the chigoe fleas, *Tunga* spp.

- Infection with the chigoe fleas, *Tunga penetrans* and *T. trimamillata*.
- Tropical America and Africa (*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 penetrans
Tunga spp.
Lice

- Obligate ectoparasites of several families of the order Psocodea.
  - Two species of humans: *Pediculus humanus* (head-and-body louse) and *Pthirus pubis* (pubic louse); *P. humanus* has two subspecies: *P. h. humanus* (body louse) and *P. h. capitis* (head louse)
- Incomplete metamorphosis (egg, nymphs [3], adult).
- Mouthparts adapted for sucking blood (human species).
- 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).
- Body lice transmit several pathogens
- Control measures include good house-keeping, hygiene.
Lice - Morphology
Pediculosis – head and body lice

- Head louse (P. h. capitis – entire life cycle on host)
- Body louse (P. h. humanus – eggs laid on fomites, clothing)
**Pediculus humanus**

- Two subspecies: *P. h. humanus* (body louse) and *P. h. capitis* (head louse)

- Transmission of epidemic typhus (*Rickettsia prowazekii*), trench fever (*Bartonella quintana*), louse-borne relapsing fever (*Borrelia recurrentis*).

- Body longer than broad

- Tarsal claws similar in size on all three pairs of legs.

- No lateral protuberances on abdominal segments.
**Pthirus pubis** – pubic lice

- Not vectors of disease
- Life cycle similar to head louse: all stages on human host
- 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.
Adults – *Pediculus vs. Pthirus*

*Pediculus humanus*  
*Pthirus pubis*
Nits: *Pediculus* vs. *Pthirus*

*Pediculus humanus capitis*  
*Pthirus pubis*
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).
Generic Fly Life Cycle

https://commons.wikimedia.org/wiki/File:Musca_domestica_-_life_cycle.png
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.
  - **Intestinal myiasis**
  - **Urinary myiasis**
Bacteremia associated with myiasis

- *Ignatzschineria* spp. and *Providencia stuartii* have been isolated from the alimentary canals of myiasis causing flies.

- *Ignatzschineria larvae* and *I. ureiclastica* have been associated with *Wohlfahrtia magnifica*; *I. larvae* has been isolated from patients with myiasis.

- In the U.S., *I. indica* have been associated with *Lucilia* (syn. *Phaenicia*) *sericata* in diabetic patients with facultative myiasis.

- *Providencia* has also been detected in blood cultures of patients with myiasis caused by *W. magnifica*.

- *Wohlfahrtiimonas chitiniclastica* has been isolated from patients with facultative myiasis caused by *W. magnifica*.

- Many of these patients have other risk factors (poor hygiene, substance abuse, homelessness).
<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>Auchmeromyia</td>
<td>Sub-Saharan Africa; Cape Verde Islands</td>
<td>Sanguinivorous myiasis</td>
</tr>
<tr>
<td>senegalensis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calliphora spp.</td>
<td>Worldwide</td>
<td>Facultative wound, oral, urogenital myiasis</td>
</tr>
<tr>
<td>Chrysomya</td>
<td>Old World</td>
<td>Wound, ENT* myiasis</td>
</tr>
<tr>
<td>bezziana</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cochliomyia</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>hominovorax</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cordylobia spp.</td>
<td>Sub-Saharan Africa</td>
<td>Furuncular myiasis</td>
</tr>
<tr>
<td>Lucilia spp.</td>
<td>Worldwide</td>
<td>Facultative wound myiasis</td>
</tr>
<tr>
<td>Phormia regina</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>Wohlfahrtia spp.</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>Musca domestica</td>
<td>Worldwide</td>
<td>Facultative wound myiasis</td>
</tr>
<tr>
<td><strong>Oestridae</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cuterebra sp.</td>
<td>North America</td>
<td>Furuncular, visceral myiasis</td>
</tr>
<tr>
<td>Dermatobia</td>
<td>Central and South America; the Caribbean</td>
<td>Furuncular myiasis</td>
</tr>
<tr>
<td>hominis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gasterophilus</td>
<td>Worldwide</td>
<td>Furuncular myiasis, creeping eruption, ocular infection</td>
</tr>
<tr>
<td>spp.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypoderma</td>
<td>Worldwide, mostly Northern Hemisphere</td>
<td>Furuncular myiasis, oral myiasis, creeping eruption</td>
</tr>
<tr>
<td>spp.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oestrus ovis</td>
<td>Nearly worldwide in sheep-raising regions</td>
<td>Ophthalmomyiasis</td>
</tr>
<tr>
<td><strong>ENT</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

- Flies have evolved as parasites and require healthy, live tissue as a source of nutrition.
- Most cases manifest as furuncular myiasis; less-commonly eye or ENT involvement.
- Common examples include:
  - *Dermatobia hominis*
  - *Cordylobia* spp.
  - *Cuterebra* spp.
  - *Oestrus ovis*
  - *Wohlfahrtia* spp.
Dermatobia hominis

- Distributed in the American tropics, including Central and South America and 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.
- Identification made by form of posterior spiracles and patterns of cuticular spines (not present on posterior 3 segments).

Image courtesy of the CDC-DPDx
Dermatobia hominis, USA ex: Belize

Images courtesy of the CDC, Washington DC and the CDC-DPDx
Dermatobia hominis; Venezuela

Images courtesy of Dr. Carlos Chaccour, www.parasitewonders.com
Spines lacking on terminal three body segments

Image by Dr. Carlos Chaccour

Image courtesy of Dr. Carlos Chaccour, www.parasitewonders.com
Dermatobia hominis: second instar larva
Cordylobia spp.

- Tropical and subtropical Africa
- Four species, *C. anthropophaga* most common species associated with human myiasis
- Manifests as furuncular myiasis
- Eggs laid in soil or on fomites.

Image courtesy of Dr. Dylan Pillai
Cordylobia anthropophaga
**Oestrus ovis**

- Nearly worldwide in sheep-raising regions.
- Typically resides in the nose and respiratory tract of sheep, goats, other ruminants.
- Females deposit larvae directly on the host.
- Usually manifests as ophthalmmomyiasis in humans.

Image courtesy of the CDC-DPDx
Oestrus ovis; New York ex: Israel

Images courtesy of Carmine Harula, Mt. Sinai Hospital
*Oestrus ovis*
Cuterebra spp.

-Primarily parasites of rodents and lagomorphs.
-Endemic to New World, ~40 species in North America.
-Eggs laid along paths or at burrows of natural host, infection is initiated with contact with larvae in environmental sources.
-Cause furuncular or visceral (respiratory) myiasis in humans.

Images courtesy of the CDC-DPDx
Cuterebra species in natural hosts

Images courtesy of Dr. Bobbi S. Pritt.
Cuterebra sp. [second-instar larvae]
Cuterebra sp. [third-instar larvae]
Facultative Myiasis

- Caused by flies that normally oviposit or larviposit on dead and dying tissues; normally saprophagous or necrophagous species.
- Some species can start with facultative myiasis and then continue to attach healthy tissue as well.

Examples:
- Cochliomyia hominovorax
- Chrysomya bezziana
- Lucilia spp.
- Sarcophaga spp.
- Phormia spp.
- Musca domestica
- Fannia canicularis
**Cochliomyia hominovorax**

- Endemic to American tropics, now primarily in S. America, Caribbean (Cuba, Haiti, D.R., T&T).
- Eradicated from US in 1982; much of Central America in 1990s.
- Recent outbreak in key deer in Monroe County, FL.
- Historically a major livestock pest
- Initially colonizes wounds; can go on to attack healthy tissue

Image courtesy of the CDC-DPDx
Cochliomyia hominovorax
**Lucilia sp.**

- Cosmopolitan flies in the family Calliphoridae
- Saprophagous species; cause facultative myiasis.
- Do not attack healthy tissue
- Utilized in maggot therapy

Image courtesy of Tom Murray
Lucilia species; foot wound
Lucilia spp.
Maggot Therapy

• The use of laboratory-raised, sterile maggots to aid in the debridement of dead tissue.

• Four principal actions: 1) debridement, 2) disinfection of wound, 3) stimulation of healing, and 4) biofilm inhibition and eradication.

• Usually uses the larvae of *Lucilia sericata* and *Protophormia terranova* (the latter of which has feeding secretions which have antimicrobial affects on *Streptococcus* species).
Maggot Therapy

- FDA approval (2004) for:
  - Non-healing necrotic skin and soft tissue wounds
  - Pressure ulcers
  - Neuropathic foot ulcers
  - Non-healing traumatic or post-surgical wounds
- Examples: diabetic and severe burn patients

https://en.wikipedia.org/wiki/Maggot_therapy
**Sarcophaga spp.**

- Many species worldwide
- Normally feed on carrion or rotting meat
- Manifest as facultative myiasis; does not attack healthy tissue.

Image courtesy of Tom Murray
Sarcophaga spp.
**Musca domestica**

- Cosmopolitan in distribution; the ‘house fly’
- Saprophagous species, feeds on a variety of organic material
- Usually manifests as facultative wound or incidental myiasis in humans

Image courtesy of Tom Murray
Musca domestica
Pseudoparasites

- Drain Flies (family Psychodidae)
- Rat-tailed Maggots (family Syrphidae)
- Soldier Flies (family Stratiomyiidae)

The Far Side by Gary Larson
“Pseudoparasites” – drain flies
“Pseudoparasites” – rat-tailed maggots
“Pseudoparasites” – soldier flies
Triatomine (kissing) bugs

- Taxonomy: Hemiptera: Reduviidae: Triatominae
- Hemimetabolous life cycle (egg, nymphs [5], adult)
- Mouthparts piercing-sucking; forewings divided into a basal thickened area (hemelytra) and an outer membranous area; abdomen 11-segmented.
- Several genera and species vectors of *Trypanosoma cruzi* (American trypanosomiasis, Chagas disease).
- Control measures involve good house-keeping.
Triatomine life cycle
Triatoma - Anatomy
Triatoma sp. defecating
Chagas vectors-triatomines

Panstrongylus megistus  Rhodnius prolixus  Triatoma infestans

Figure 2. *Triatoma infestans* (Klug), dorsal view.
Triatoma sanguisuga
Triatoma protracta

Image courtesy of Gary Alpert
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.
- Control strategies involve good housekeeping and sanitation.
Bed bugs - Life Cycle
Bed Bugs
Bat Bugs

Image courtesy of Gary Alpert
Cimicid Key

Mouthparts (beak) extending beyond base of front legs and reaching base of middle legs
*Haematosiphon inodoros* (poultry bug)

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Mouthparts (beak) not reaching base of middle legs

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3rd and 4th antennal segments equal
*Oeciacus, Cimexopsis* (avian cimicids)

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4th antennal segment shorter than 3rd

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Setae along side of pronotum shorter than width of eye
*Cimex lectularius, C. hemipterus* (bed bugs)

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Setae along side of pronotum longer than width of eye
*Cimex adjunctus, C. pilosellus* (bat bugs)
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