The Flies

Pathology

Adult Flies:
1. **Biting Flies**
   - In the USA, account for 50% of the annual losses in cattle production from all livestock pests
   - Blood feeders (puncture the skin directly) → pain & allergic reactions to saliva
   - Acute blood loss (livestock have been killed by swarms of biting flies)
   - Biological or mechanical vector for disease

2. **Non-biting Flies**
   - Feed on secretions or scavenge at wounds or body orifices
   - Cause annoyance & disturb host
   - Mechanical vectors for many pathogens

Larval Flies:
3. **Myiasis Flies**
   - Lay eggs on tissues or in wounds of the host
   - Larvae invade tissues
   - Can cause significant damage to the host

- All flies can also cause considerable disturbance to the host
- Biting flies & myiasis flies → dramatic escape responses → self-injury
- Large populations of flies can also cause death by suffocation after inhalation
The Flies
Life History:
All flies have a holometabolus life cycle:
• Egg → Larvae → Pupae → Adult

1. Eggs
   – Most flies are oviparous
     • Oval eggs laid in batches
   – A few species are ovoviparous
     • Eggs hatch in oviduct & female deposits larvae

2. Larvae (maggots)
   – 3-5 larval stages
   – Soft, legless & segmented
   – In some species are parasitic = MYIASIS

3. Pupae
   – Visible external appendages
   – Develops within a cocoon or puparium

4. Adults
   – Duration of the life cycle & length of time adults live vary between species

Note: The flies of veterinary importance are ectoparasites as adults or as larvae, but are rarely ectoparasites in both stages
Keds - Family Hippoboscidae
Pages 58-59

Important Species

• *Melophagus ovinus*
  – a wingless blood-sucking continuous ectoparasite of sheep & goats (a fly that doesn’t fly)

Morphology:

• Tick-like in appearance
• Brown in colour
• 5-8 mm in length
• Dorsoventrally flattened
• Wingless
• Strong claws
  – Cling to wool or hair
Keds - Family Hippoboscidae

Life History:

- Female deposits 1 fully developed larvae at a time
  - Egg hatches inside her body
  - Is nourished through 3 larval stages
- Once deposited larva immediately pupates (female glues it to wool)
- Emerges as an adult in 19-24 days
- Adult females live 4 months
  - produce 12-15 larvae
- Transmission by direct contact
  - Ewe to lamb is most important
- Keds survive ~ 4 days off the host
Keds - Family Hippoboscidae

Pathology:
- Bite = blood sucking
- Skin irritation $\rightarrow$ restless sheep $\rightarrow$ do not feed well & may loose condition
- Wool loss & discolouration (from blood) $\rightarrow$ wool & leather downgraded

Control:
- Insecticides, ivermectin
- Shearing can reduce numbers
Myiasis
pages 59-65

- Infestation of the tissues or organs of animals by dipteran fly larvae
- Fly larvae feed directly on necrotic or living tissue of the host

Classification:
1. Obligatory myiasis
   - A living host is required to complete development
     (will not survive without a living host)

2. Facultative myiasis
   - Living host tissue is not required to complete development

3. Accidental myiasis
   - Rare chance events of myiasis (i.e. accidental ingestion of fly eggs)

FYI: Myiasis is caused by cyclorrhaphous dipteran larvae. Cyclorrhapha means 'circular-seamed flies', which refers to the circular aperture through which the adult escapes the puparium.
Morphology of the larvae:

- Larva (maggot) usually pointed anteriorly, conical & divided into 12 segments
  - Head, 3 thoracic segments, 8 abdominal segments
- Cuticle - soft & unsclerotized,
  - may be covered in scales or spines
- Larva is legless
  - May have protuberances that aid in locomotion
- Paired mouth-hooks protrude from the atrial cavity (atrium)
  - pre-oral cavity anterior to the functional mouth
- Paired anterior spiracles located just behind the head & paired posterior spiracles on the 12th segment
  - Posterior spiracles used in identification
Identification Key for agents of wound myiasis

Examine larva for body processes

- "Hairy maggot"
- Typical "smooth" maggot

Chrysomya albiceps
Chrysomya rufifacies

Closed peritreme

- Sinucus slits
- Straight slits

Musca species
Calliphora species
Lucilia species

Open peritreme

- Posterior spiracles not in cavity
- Posterior spiracles in cavity

Sarcophaga species
Wohlfahrtia species

Dorsal tracheal trunks pigmented in posterior segments

Phormia species
Prototormia species
Cochliomyia macellaria

Dorsal tracheal trunks not pigmented

Chrysomya species

Life History:

• Eggs deposited
  – On animal
  – On vegetation
    • “Wait” for passing host to encounter
    – Hatch in ~ 24 hours

• 3 larval stages follow
  – Feeding occurs

• After 3\textsuperscript{rd} stage larva finishes feeding drops off host & finds a suitable place to pupate
  – Usually burrows into the ground

• After pupation, adults emerge
  – May or may not feed before mating & depositing eggs
Pathology

• Vary depending on # of larvae, species of fly & site of infestation

• General signs
  – Irritation
  – Discomfort
  – Pruritus
  – Weight loss
  – Reduced fertility

• Heavy infestations → severe tissue damage, hemorrhage, anaphylaxis, toxemia, &/or 2° bacterial infections → death (if not treated)
Pathology

- **Classical description of myiasis (FYI ONLY)**
  - according to the part of the host that is infected
- For example:
  1. Dermal
  2. Sub-Dermal
  3. Cutaneous
    - Creeping (where larvae burrow through or under the skin)
    - Furuncular (where a larva remains in 1 spot causing a boil-like lesion)
  4. Nasopharyngeal (nose, sinuses or pharynx)
  5. Ophthalmic or ocular
  6. Auricular
  7. Gastric, rectal, or intestinal/enteric
  8. Urogenital
Bots & Warbles – Family Oestridae

1. *Oestrus*
2. *Gasterophilus*
3. *Hypoderma*
4. *Cuterebra*
Bots & Warbles – Family Oestridae

• Obligate parasites
• Highly host specific
• Larvae have posterior spiracular plates containing numerous small pores
  – 3rd stage larvae are air-breathers
• Adult flies have primitive or non-functional mouthparts & are short-lived
**Oestrus ovis** – Nasal bot fly

**Morphology:**

- **Larvae**
  - Immature are white, 1 mm in length
  - Mature become yellow or brown, ~20 mm

- **Adult flies**
  - Grey, 10-12 mm in length
  - Small black spots on the abdomen
  - Reduced (knob-like) mouthparts
Life History

- Oviviparous females deposit larvae (up to 25 at a time) in or on the nostrils of host
- Larvae crawl into the nasal passages & sinuses
  - Attach to the mucus membranes
  - Feed on mucus & desquamated cells
- 1st stage larvae overwinter in the sinus cavities of the host until the spring
- Eventually mature to 3rd stage larvae & enter the nasal cavities where they crawl or are sneezed out of the nose
- Pupate in/on the ground
- Development ~25-35 days in warmer months
Pathology

• Irritation & inflammation caused by the larvae → **sticky mucoid nasal discharge**, sneezing, nose rubbing or head shaking

• Larvae-positing females cause annoyance → sheep bunch together with **heads towards the centre** or sheep will **run in panic** → less grazing time & reduced weight gain

Treatment

• Ivermectin
Gasterophilus

- Obligate parasites of horses & donkeys
- Important species in North America
  - *Gasterophilus nasalis* (Throat Bot fly)
  - *Gasterophilus intestinalis* (Horse Bot Fly)
  - *Gasterophilus hemorrhoidalis* (Nose Bot Fly)

Morphology:
- Adults ~11-15 mm in length
- Resemble a honeybee
- Long curved ovipositor
- Non-functional mouthparts
Life History

• Eggs attached to the hairs of the host in a particular body region
  – *G. nasalis* - intermandibular skin
  – *G. intestinalis* – forelegs
  – *G. hemorrhoidalis* - lips

• Eggs hatch
  – *G. nasalis* - Spontaneously
  – *G. hemorrhoidalis* - in response to moisture
  – *G. intestinalis* - in response to temperature
  • In response to the horse licking its legs
Life History

• Eggs hatch

• **Larvae enter the mouth** → migrate through the tongue & interdental spaces → feed on tissue exudates & develop

• 2\textsuperscript{nd} stage larvae **enter the stomach** & develop to 3\textsuperscript{rd} stage larvae → **attach to the stomach or duodenum mucosa by the mouth hooks in areas above the fluid line** (3\textsuperscript{rd} stage larvae are air breathers!) = **gastric bots**

• Bots attach → develop (up to 12 months) → **detach & are passed in the feces**

• Larvae pupate in the soil & adults emerge in 2 weeks to 2 months
Gasterophilus

**Gasterophilus intestinalis**
- Reddish larvae
- Favour **cardiac region** of stomach
- Cluster at boundary of glandular & non-glandular epithelium

**Gasterophilus nasalis**
- Yellowish larvae
- Attach around the **gastric pylorus** & sometimes the duodenum
Gastric bots: The two species typically encountered are *G. nasalis* & *G. intestinalis*. *G. nasalis* is farthest from the nose, *G. intestinalis* is farthest from the intestine.
Pathology

• **Light infestations little effect**
• Larval oral migration can cause irritation (stomatitis)
  – 2° infections may cause oral or sinus tracts
  – May produce pain upon eating
• **Main pathology caused by gastric larvae**
  – Attach by oral hooks to the lining of the stomach → erosions & ulcerations at the site of attachment + a hyperplastic reaction around it (chronic gastritis)
  – **Little evidence that this results in clinical disease**
    (i.e. typically **incidental findings** when they are observed)
• Bots **may** cause...
  – reduced weight gain, disruption of digestion, ulceration & stomach rupture
• Heavy infestations of bots in the pyloric region of the stomach (i.e. *G. nasalis*) could cause partial obstruction of the pylorus → **intermittent colic**
• Humans may become infested with larvae (migrate through oral tissues but do not complete the life cycle) by “horse kissing”
Treatment & Control

• **Washing legs** with **warm water** will induce hatching of *G. intestinalis* & wash away the larvae

• **Trimming or removing hairs with nits or eggs**
  – Clippers or **bot knife**
  – Repeat as eggs noticed on animals

• **Topical treatments of pesticides**
  – Kill eggs/larvae

• **Systemic pesticides** to kill larvae
  – Periodic use throughout the season
  – Final application 1 month before killing frost
  – **Macrolides**
    • at least 1 treatment annually at the end of bot fly season
  – Ivermectin
    • effective against oral & gastric larvae
  – Moxidectin
    • effective against gastric stages
Hypoderma
- warbles, heel flies, or cattle grubs

- *Hypoderma lineatum* - Common Cattle Grub
  - occurs in USA & parts of Canada

- *Hypoderma bovis* - Northern Cattle Grub
  - occurs in Northern USA & Canada

**Morphology:**
- Adults 13-15 mm in length
- Bee-like in appearance
- Lack mouthparts
Life History

- Adult females deposit **eggs on the hairs of the lower legs** (heels → “heel fly”) of cattle
- **Eggs hatch → larvae penetrate the skin** directly or through the hair follicle → **migrate through the tissues** (2-4 months) → preferred tissue for development
  - **H. lineatum** (B)
    - Esophageal submucosa
  - **H. bovis** (A)
    - Epidural tissues of the spinal canal
- Larvae develop for another 3 months → **migrate to dorsal subcutaneous tissues** → cause a **small swelling (warble) & cut air holes in the hide** (dorsal spiracles at air hole)
- Moult twice (2 months) → warble enlarges (~1 inch) & larvae **enlarge the air holes** → **exit & drop to ground to pupate**
  - **H. lineatum**
    - warbles appear in January & February
  - **H. bovis**
    - warbles appear in March
Pathology

• Carcasses trimmed & downgraded d/t warbles
  – Hide damage = ↓ value as leather
• Ovipositing females result in **dramatic avoidance behaviour** in cattle
  – “gadding” can result in **self injury & ↓ grazing**
    • Cattle panic d/t fast-moving flies
    • Run wildly in effort to escape
      – Flies neither bite nor sting
• Heavy infestations result in **poor weight gain, delayed time to first lactation & long-term production losses**
• Anaphylactic shock can result from **warble being crushed** during removal
Treatment & Control

- **Systemics**: ivermectin, doramectin, moxidectin
- Organophosphates to kill larvae early in migration
- **Treat cattle after adult fly activity ceases & before larvae reach sensitive tissues**
  - Correct time varies with geographic region
  - Treating when larvae have reached tissues around esophagus & spinal cord can result in serious tissue & nerve damage → bloat, ataxia or paralysis
- **Manual removal**: inject 1 ml of 3% \( \text{H}_2\text{O}_2 \) into air hole & grub will emerge in about 15 seconds!
  - Note: Piercing grub during procedure can result in fatal anaphylactic shock!
**Cuterebra** - rodent or rabbit bot fly

- Fly larvae infest the skin of rabbits, squirrels, chipmunks, mice, rats,  
  - occasionally dogs, cats & ferrets

**Morphology:**
- Adults rarely seen  
  - Resemble a bumblebee with vestigial mouthparts
- 2\textsuperscript{nd} instar larvae are grey to cream coloured & ~ 0.5–1.0 cm long
- 3\textsuperscript{rd} instar larvae are dark, thick, heavily spined (~2.5 cm)  
  - Stage most commonly seen by veterinarians
Life History

- Females deposit **eggs around the openings of animal nests, burrows, along runways of the normal hosts**, or on stones or vegetation in these areas (5-15 eggs/site)
- **Eggs hatch instantly when animals run by** (respond to **heat** of nearby host) & **larvae attach**
- Larvae **enter the body through the mouth or nares during grooming or, less commonly, through open wounds**
- After penetration, the **larvae migrate to various species-specific subcutaneous locations on the body**, where they develop & communicate with the air through a breathing pore
- **After ~30 days, the larvae exit the skin**, fall to the soil & pupate
- **Cats & dogs** are **often infested** when trying to **stick their heads down a rabbit burrow entrance** (August-October)
  - Free-roaming cats >>> indoor cats
Pathology

• Warbles usually found **subcutaneous connective tissues** of the **cervical skin** in **cats, dogs & ferrets**
• Lesions usually develop in the **summer**
• Typically **presents as a fistulous swelling**
  – ~1 cm in diameter
• Hair is often matted over the lesion
• **Cats may aggressively groom the area**
• Most common **differential diagnoses** are an **abscess, foreign body or tumor**
• **Aberrant migrations** may occur
  – Head, brain, nasal passages, pharynx & eyelids
  – Usually **fatal if the brain is involved**
Treatment

- **Complete surgical removal** (if possible) & wound treatment
- Explore suspect lesions for possible larvae
  - Carefully enlarge fistula (breathing pore) with forceps
  - Usually **only 1 larva per lesion**
- Parasite may retreat into the opened pore
  - Can try covering the fistula (breathing pore) with white petroleum jelly for 10–15 minutes before grasping the parasite
- **Larva should be removed in one piece**
  - Recurrent abscesses = residual infection or remaining pieces
- **Do not squeeze the lesion!**
  - Rupture of larva → chronic foreign body reaction +/− 2° infection
  - Anecdotal reports of larval rupture causing anaphylaxis
- Wound should be thoroughly flushed with sterile saline, debrided (if necessary) & allowed to heal by granulation (may heal slowly)
- CNS cuterebriasis (usually fatal)
VPM-122 Final Week

- **Monday April 10**
  - 1330-1420H - Arthropod Lab Review, Lecture B
  - 1430-1630H - Arthropod Lab & Review Lab

- **Thursday April 13**
  - 0830H-0920H – Arthropod Lecture Exam Review

- **Saturday April 15**
  - 1300-1400H Lab Exam – cumulative (20%) – 215N
  - 1400-1600H Lecture Exam – Arthropods ONLY (20%) – Lecture A