Veterinary Parasitology
Arthropod Parasites

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Arthropod Parasites

1. Arachnids
   - Ticks
   - Mites

2. Insects
   - Lice
   - Fleas
   - Flies
Class Insecta

3 orders of veterinary importance:

1. Phthiraptera - The Lice

2. Siphonaptera - The Fleas

3. Diptera - The Flies
Diptera – The Flies

General characteristics
- Exhibit considerable morphological diversity
- 0.5 mm to 10 mm in length

Body is divided into head, thorax and abdomen

1. **Head**
   - Large, well developed and mobile
   - Bears the **mouthparts**
   - Carries large compound eyes
   - A single pair of antennae
   - Top of the head often bears three simple eyes (ocelli)

2. **Thorax**
   - Membranous wings
   - Club-shaped **halteres** (stabilize the fly during flight)
   - 3 pairs of legs

3. **Abdomen**
   - Vary in size & shape
   - Can be modified in association with the genitalia
• **Capitulum** (Gnathosoma)
  – The anterior cephalothorax
    • Fused head and thorax
  – Bears **mouth parts**
    • Chelicerae, palps & hypostome

• **Idiosoma** (“abdomen”)
  – Contains the internal organs
  – Bears the **legs**
    • 3 pairs in larval stage
    • 4 pairs in nymphs & adults
    • Posterior portion may be subdivided into sclerites called festoons

• **Head**
  – Carries the main sensory organs
    • Single pair of antennae
    • Pair of compound eyes
    • Three simple eyes, the ocelli
  – Bears the **mouth parts** (see below)
    • Mandibles, maxillae, labium

• **Thorax**
  – Composed of three fused segments (prothorax, mesothorax & metathorax)
  – Each segment bears a single pair of **legs** (3 pairs total)
  – Two pairs of **wings** may also articulate with the mesothorax & metathorax (if present)

• **Abdomen**
  – Is composed of 9 - 11 segments
  – Bears the external reproductive organs
Mouthparts vary considerably in their form & function

Basic components:

1. Paired maxillae
2. Paired mandibles
3. Labium with a terminal labella (or labellum)
4. Hypopharynx
5. Labrum
1. **Chelicera**  
   - Cut & pierce the host’s skin

2. **Palps**  
   - Sensory, stabilization

3. **Hypostome**  
   - Anchor

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Insects (Fleas, Lice, and Flies)

1. **Mandibles (Jaws)**  
   - Used for cutting, tearing & crushing

2. **Maxillae**  
   - Used in food handling

3. **Labium**  
   - Also used for food handling
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
Life Cycles

**Hemimetabolous**
incomplete development (egg, nymph, adult)
- Arachnida (ticks and mites)
- Phthiraptera (lice)

**Holometabolous**
complete development (egg, larva, pupa, adult)
- Siphonaptera (fleas)
- Diptera (flies)

“F” is for Full
The Flies

Pathology

Adult Flies

1. Biting Flies
   • Account for 50% of the annual losses in US cattle production from all livestock pests
   • Blood feeders → pain & allergic reactions to saliva + acute blood loss
   • Biological or mechanical vectors for disease

2. Non-biting Flies
   • Feed on secretions or scavenge at wounds or body orifices → annoy & 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

Note: The flies of veterinary importance are ectoparasites as adults or as larvae, but are rarely ectoparasites in both stages

- All flies can also cause considerable disturbance to the host
- Biting flies & myiasis flies → dramatic escape responses → self-injury
- Large populations of flies → death by acute blood loss or suffocation after inhalation
The Flies

Ways to control flies:

• Regardless of the species of fly, an integrated approach that incorporates **sanitation, mechanical control, and the use of insecticides** is the best strategy for fly control.

1. **Sanitation:**
   - Since manure and organic matter are common breeding grounds for flies, **regular removal of manure & organic matter** will deter fly populations by reducing the number of eggs laid.

2. **Mechanical control:**
   - Preventing accumulation of water and wet areas reduces fly breeding.
   - Mechanical control of flies in buildings through the use of **screens**.

3. **Insecticides:**
   - Can be delivered by ear tags, dust bags, oilers, sprays, pour-ons, and feed additives.
The Flies

Adult Flies of Veterinary Importance

1. Nematocera (long antennae)
   – Mosquitoes, Black Flies, Gnats & Sand Flies

2. Brachycera (antenna size reduced)
   – Horse Flies & Deer Flies (& Tsetse flies)

3. Cyclorrhapha (circular puparium seam)
   – House flies, Stable Flies & Horn Flies
     (= Muscomorpha, an Infraorder of Brachycera)
The Flies

Adult Flies of Veterinary Importance

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4. **Psychodidae (Phlebotominae)** - Sand Flies
5. **Tabanidae** - Horse Flies & Deer Flies
6. **Glossinidae** – Tse tse flies
7. **Muscidae** - House flies, Stable Flies & Horn Flies
8. **Hippoboscidae** – Sheep Keds (wingless flies)

FYI: Descriptive features of Dipteran Families:
http://www.mdfrc.org.au/bugguide/display.asp?type=3&class=17&subclass=&Order=7&couplet=0
The Flies

1. Mosquitoes – Family Culicidae

3 Genera of importance:
1. Aedes
2. Anopheles
3. Culex

Pathology
• Annoyance
• Bites can induce hypersensitivity
• Blood loss is generally trivial, but swarms can cause anemia & death
• Can ↓ weight gains & ↓ milk production
• Disease vector
  – *Dirofilaria immitis* in dogs
  – Malaria
  – Viral encephalitis
  – West Nile virus (etc.)
World's Deadliest Animals

Number of people killed by animals per year

- 10 Shark
- 10 Wolf
- 100 Lion
- 100 Elephant
- 500 Hippopotamus
- 1,000 Crocodile
- 2,000 Tapeworm
- 2,500 Ascans roundworm
- 10,000 Freshwater snail (schistosomiasis)
- 10,000 Assassin bug (Chagas disease)
- 10,000 Tsetse fly (sleeping sickness)
- 25,000 Dog (rabies)
- 50,000 Snake
- 475,000 Human
- 725,000 Mosquito

Sources: WHO, crocodile-attack.info, Kaspareit et al. (doi.org/10.1371/journal.pmed.0050218); FAO (http://www.fao.org); Nielsen et al. (restitution.org/8CRL7D8UC); Fischer et al. (doi.org/10.1038/s41591-017-0045); Alessandro De Maddalena. All calculations have wide error margins.
The Flies

1. Mosquitoes – Family Culicidae

Life cycle

- Female mosquitoes lay their eggs on the inner, wet walls of water containers (natural or man-made)
- Larvae hatch when water inundates the eggs as a result of rains or the addition of water by people.
The Flies

1. Mosquitoes – Family Culicidae

Control

- Eliminate breeding sites (standing water)
- Screen barns & cages etc.
- Keep animals indoors during peak activity (night, dawn & dusk)
- Repellents (DEET), but require frequent application
The Flies

Adult Flies of Veterinary Importance

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The Flies

2. Black Flies - Family Simuliidae

- *Simulium* is only genus of importance
- Feed on the blood of cattle, horses, sheep, goats, poultry & many other animals including humans.
  - Are pool feeders = imbibe from accumulating pool of blood

**Morphology**

- Adults are black, grey or yellow-brown
- 1-5 mm in length
- Stout bodies & a humped thorax
The Flies

2. Black Flies - Family Simulidae

Pathology

- Female has a very painful bite (disturbance in low #s)
- Saliva contains anticoagulants, enzymes, and histamine
  - Hypersensitivity reactions
- *Simulium* (Black Fly) can cause **Sweet Itch** in horses
  - Pruritic dermatitis & alopecia (mane, tail, dorsal midline)
  - Due to hypersensitivity reaction to saliva
  - *Culicoides* is the “classic” cause (see next section)
- Massive attack in cattle can cause death
  - Anemia
  - Reaction to the salivary toxins and/or histamine → petechial hemorrhage & edema of the larynx & abdomen

- **Vectors**
  - *Leucocytozoon* to domestic & wild birds
  - *Onchocerca* to cattle
The Flies
2. Black Flies - Family Simulidae

Life History

*Females deposit eggs on submerged stones or vegetation in highly oxygenated (moving) water.
The Flies

2. Black Flies - Family Simulidae

Control

- Shelter animals during peak activity (tend to swarm in daylight hours)
  - A 3-walled, roofed shed provides darkness & protection
- Pasture away from running water
- Pesticide or repellent application using sprays, dips, back rubbers etc. or light smudge pots
- Fly sheets/masks/wraps/boots
The Flies

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The Flies

3. Gnats - Family Ceratopogonidae

Small (<2 mm) blood sucking ectoparasites
Also known as no-see-ums or midges

Important Genera:
• *Culicoides*
• *Leptoconops, Forcipomyia*

Life History
• Eggs are deposited in **damp marshy ground**
• Larvae burrow into surface of the substrate where they pass through 4 instars & most species overwinter as larvae
• After pupation, **adults will rarely fly more than 500 m from their breeding site**
• Adults feed in humid weather usually at **sunset or night**
The Flies

3. Gnats - Family Ceratopogonidae

Pathology

- Painful bite, annoyance
- *Culicoides*
  - *Sweet Itch* in horses
  - Pruritic dermatitis (self-trauma) & alopecia
    - Mane & tail, dorsal midline > ears and head > ventral midline
  - Due to hypersensitivity reaction to allergens in saliva
  - As can *Simulium* (Black Fly, see above)
- Vector
  - Bluetongue virus (cattle & sheep)
  - *Onchocerca* (cattle & horses)
  - Viral encephalitis (horses)
  - African Horse Sickness
Pruritus of the tail in horses
1. *Culicoides* hypersensitivity
2. *Simulium* hypersensitivity
3. *Haematopinus asini* (sucking louse)
4. *Psoroptes* Psoroptic mange
5. *Oxyuris equi* (pinworms)
The Flies

3. Gnats - Family Ceratopogonidae

Control
- Avoid activity period
- Eliminate marshy habitat
  - Drain marshes
  - Increase slope of sewage lagoons & drainage ditches to reduce mud
- Insect repellent sprays
  - Marked improvement seen with Insect Bite Hypersensitivity ("Sweet Itch") following a thorough insect control trial for 4 weeks (e.g., permethrin spray)

❖ Intradermal testing (using *Culicoides* and other insect allergens)
  - Can identify many horses with *Culicoides* hypersensitivity
  - Has relatively low sensitivity & specificity
    - Normal horses may also have positive reactions (false positives)
    - Some affected horses (especially those with mainly delayed Type-IV hypersensitivity) will have negative skin tests (false negatives)
The Flies

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The Flies

4. Sandflies - Family Psychodidae
Subfamily Phlebotominae

Only 2 veterinary important genera
- **Phlebotomus** and **Lutzomyia**

**Pathology**
- Adult females suck blood
- Their bite is not always felt, but leaves a small round, reddish bump that starts itching hours or days later.
- Occur in subtropical and tropical regions
- Phlebotominae are best known as vectors of **Leishmania** trypanosomes causing leishmaniases.
  - Old World: **Phlebotomus** spp
  - New World: **Lutzomyia** spp
The Flies

4. Phlebotomine Sandflies
The Flies

4. Phlebotomine Sandflies

Control

• Adults occur in a wide range of habitats
  – Old World - near water in dry semi-arid areas (sandy river banks)
  – New World - in tropical forests and savannas

• Larvae in areas with high levels of organic matter
  – Animal burrows, termite hills, tree holes, and leaf litter (these are good areas for sandfly surveillance)
  – Generalised type of breeding site → larvicides are impractical in sandfly control programmes

• Sandfly control practices = controlling the adults
  – Residual spraying of dwellings and animal shelters (Pyrethroids)
  – Insecticide-treated nets
  – Impregnated dog-collars
  – Personal protection (application of repellents/insecticides)
The Flies

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The Flies

5. Horse & Deer Flies - Family Tabanidae

Only 3 veterinary important genera

- *Tabanus* (Horse Flies),
- *Hematopota* (Horse Flies or Clegs)
- *Chrysops* (Deer Flies or Stouts)

- Large stout-bodied flies
  - Up to 25 mm (the size of a humming bird!)

- Feeding
  - Labellum is retracted & the mandibles, maxillae and labrum penetrate skin → saw-like mandibles move across each other in a scissor-like action → skin wound
  - Saliva (containing anticoagulant) is pumped into the wound → blood pool
  - Blood is sponged up into the food canal (labrum + hypopharynx)

- After feeding
  - Mouthparts are withdrawn
  - The labellum closes → traps a film of blood → mechanical transmission of pathogens
The Flies
5. Horse & Deer Flies

Pathology
• Vicious biters & very painful (up to 0.6 ml/meal) → considerable annoyance & disturbance
• Peak losses of blood of 200 ml/day in cattle have been reported
• Large wounds can become secondarily infected or attract other flies
• Live in wetlands, forests, and other damp areas

• Mechanical vectors
  – Bovine anaplasmosis
  – Anthrax
  – Tularemia
  – Equine Infectious Anemia virus
  – Hog cholera virus
  – Vesicular stomatitis in cattle
The Flies
5. Horse & Deer Flies

Life History
• **Eggs are deposited in wet mud** near rivers or lakes or in **pockets of moist soil**
• Eggs hatch in 4-7 days & larvae quickly moult
• Larvae are aquatic, semi-aquatic or terrestrial
• Larvae require several months to years to pass through 6-13 instars & pupation requires 2-3 weeks
• Most species complete development in 10-42 weeks
• Adults live 2-4 weeks & produce only one generation
• Adults are **active in the daytime along “fly ways”** & tend to wait in moist shady areas for a host to pass by
  – Are attracted by urine, sweat, CO$_2$, body odours etc.

Control
• Avoid flyways during daytime or stable during peak hours
• Repellents can be used effectively
• Tabanids are difficult to kill with insecticides
• Draining mosquito habitat may increase Tabanid habitat
• Black and white patterns with narrow stripes (Zebras)!!?
Why do Zebras have Stripes?
To avoid biting flies!?

Pattern of narrow stripes makes zebras "unattractive" to tabanid flies.

• They key to this effect is in how the striped patterns reflect light.
• Black and brown horses → horizontally polarised light
  – Horseflies were very attracted by these "flat" waves of light.
  – Made the dark-coloured horses very attractive to flies.
• From a white coat → unpolarised light reflected
  – Unpolarised light waves travel along any and every plane and are much less attractive to Tabanid flies.
  – White-coated horses are much less troubled by horseflies than their dark-coloured relatives.
• They painted boards and horses (black/dark, white, and striped) with insect glue & collected the trapped flies every two days
• Conclusion:
  Zebra-striped models attracted the fewest flies!
• For this explanation to be the sole reason that zebras have stripes, they would have to show that tabanid fly bites are a major selection pressure on zebras, but not on horses and donkeys found elsewhere in the world... none of which are stripy (likely multifactorial)
The Flies

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The Flies

6. Tse tse Flies

• **Glossina** spp.
• Mechanical vector
  – Causes of Bovine (African) Trypanosomiasis:
    • *Trypanosoma congoense*, *T. vivax*
    • *T. brucei brucei* (Nagana)

• Note: **NOT** the vector for American Trypanosomiasis
  – Triatomine bug (*Triatoma* sp.)
  – Also known as
    • Kissing bug, reduvid bug, assassin bug
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The Flies
7. Family Muscidae

A. House & Face Flies - Genus Musca
   – *Musca domestica* (house fly)
   – *Musca autumnalis* (face fly)

B. Stables Flies - Genus Stomoxys
   – *Stomoxys calcitrans*

C. Horn Flies - Genus Haematobia
   – *Haematobium irritans*
The Flies
7. Family Muscidae

7A. House & Face Flies

- Important Species:
  - *Musca domestica* (house fly)
  - *Musca autumnalis* (face fly)

**Morphology**
- 6-8 mm in length
- Grey thorax with 4 dark longitudinal stripes
  - Female face flies look very similar to the house fly, while male face flies have abdomens that are yellowish-orange in color.
- Mandibles & maxillae are absent
- The labella are sponging organs used to “mop-up” liquid when feeding
The Flies
7. Family Muscidae
7A. House & Face Flies

Life History
• Eggs are laid in manure/organic matter
  – older manure piles, garbage or rotting
    organic matter (*M. domestica*)
  – fresh manure (*M. autumnalis*)
• Larvae (maggots) go through 3 instars
  within a week & enter the ground to pupate
• Pupation takes 3-5 days & adults emerge
  & are receptive to mating after 36 hours
• Egg to adult takes 7-14 days depending on
  environmental conditions
• 10-12 generations can occur in a summer
  (Multivoltine)
• *M. domestica* → indoor livestock
• *M. autumnalis* → pasture animals
The Flies
7. Family Muscidae
7A. House & Face Flies

Pathology
- Nuisance & annoyance
- *M. autumnalis* (face fly)
  - Feeds on lacrimal, nasal & salivary excretions
  - Congregates in large numbers on the faces of animals
  - Mechanical vector
    - *Moraxella bovis* (Pink Eye)
    - *Thelazia* (ocular nematode of cattle & horses)
- *M. domestica* (house fly)
  - Can feed on exposed blood, sweat, saliva, tears, and other body fluids of animals
  - Mechanical vector
    - *E. coli*, *Salmonella*, *Shigella*, *Campylobacter*, and *Enterococcus*
    - To animals and humans
    - Can mechanically transport protozoan cysts
  - Intermediate host
    - *Draschia megastoma* (gastric habronemiasis)
    - *Habronema* spp. (cutaneous habronemiasis)
    - *Choanotaenia infundibulum* (chicken tapeworm)
The Flies
7. Family Muscidae
7A. House & Face Flies

Control
• Insecticide application
  – Premises, fly breeding sites, & animals
• Fly baits, strips, etc. may also be used
• **Good sanitation** is important
  – Especially in **control of M. domestica**
  – Frequently muck your stalls, barn walkways, paddocks, and harrow manure in the pasture
• If possible, pasture your horse away from cattle or stable your horse during the daytime.
• Fly masks/sheets to help protect your horse.
• Frequent grooming can help clean away facial secretions
The Flies

7. Family Muscidae

7B. Stable Flies

Important species: *Stomoxys calcitrans*

**Morphology**

- Resembles the house fly but has a long, pointed, black proboscis which is used to inflict a painful bite (“bayonet-like”)
- Proboscis pierces the skin and imbibes blood
  - Both the males and the females are bloodfeeders.
The Flies
7. Family Muscidae
7B. Stable Flies

Life History
• Similar to house flies as they lay eggs in rotting organic material & manure in & around farm buildings (not fresh manure)
• Can be found on animals outside, but will follow animals inside to feed
• Active by day & found on hosts only when attempting to feed
The Flies
7. Family Muscidae
7B. Stable Flies

Pathology
- Painful bite
- Very annoying & destructive pest of livestock
- Loss of blood & disturbance $\rightarrow$ ↓body weight (10-15%) & ↓ milk production
- Fly bite dermatitis
- Intermediate host
  - Habronema spp.
- Mechanical vector
  - Anthrax
  - Equine Infectious Anemia (EIA)

Control
- Eliminate breeding sites (rotting material etc.)
- Application of insecticides to premises or animals
The Flies
7. Family Muscidae
7C. Horn Flies

Important species
• *Haematobium irritans*
  – Economically important parasite of cattle >> horses
  – Also called “Buffalo Flies”

Morphology
• About half the size of stable & house flies
• Relatively shorter proboscis
• Piercing type mouthparts like the stable fly
• Grayish in color with two stripes on their thorax
The Flies
7. Family Muscidae
7C. Horn Flies

Life History

- Adults remain on cattle during the warmer parts of the year taking periodic blood meals (obligate permanent ectoparasite)
  - Take up to 40 blood meals/day
- When cattle defecate, the horn flies swarm to the **fresh** droppings to lay eggs then return to the host
  - Usually found congregating on the backs of cattle, only leaving to lay eggs in **freshly** deposited cow pats.
- Eggs are reddish-brown that hatch and feed in the manure pat and pupate underneath or in the surrounding soil around the pat.
- Pupae are brown and require 6 to 8 days to pupate depending on environmental conditions.
- Development is similar to other muscidid flies
The Flies
7. Family Muscidae
7C. Horn Flies

Pathology
- Cause annoyance → ↓ weight gains & ↓ milk production
  - Beef calves that have an average 200 or more horn flies nested on them wean 15 lbs. lighter than calves that have less than 100 horn flies.
  - Yearling steers have been shown to have a reduction in weight gain of 12 to 14% due to horn flies.
- Permanent attachment of flies with periodic feeding can cause significant blood loss
- Inflict a painful bite
- Wounds can attract other flies
- Vector
  - *Stephanofilaria stilesi* (filarial dermatitis)
Control

- Insecticides applied to cattle
  - Back rubbers, dusts, oilers
  - Insecticide impregnated ear tags are very effective because adults remain on the host (resistance has been demonstrated)
- Eprinomectin has good efficacy
- Effective control which has been shown to result in a 4-1 return

*100-200 horn flies per head is the economical threshold for treatment.
The Flies

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The Flies

8. Keds - Family Hippoboscidae

Important Species

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

Morphology

- Tick-like in appearance
- 5-8 mm in length and brown
- Dorsoventrally flattened
- Wingless
- Strong claws
  - Cling to wool or hair
Sheep
• Sheep Keds
  – *Melophagus ovinus* (5-8 mm)

• Pediculosis (Lice)
  – *Bovicola ovis*
  – *Linognathus ovillus*
  – *Linognathus pedalis* (1-8 mm, most 2-3 mm)

• Mange
  – *Psoroptes & Chorioptes* (~200-400 um = <0.5 mm)
The Flies

8. 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
• After the larva is deposited it 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 important
• Keds survive up to 4 days off the host
The Flies

8. Keds - Family Hippoboscidae

Pathology

• Skin irritation → restless sheep → do not feed well & may loose condition

• Wool loss & discolouration (from blood) → wool and leather is downgraded

Control

• Insecticides, ivermectin

• Shearing can reduce numbers
The Flies

Ways to control flies:

• Regardless of the species of fly, an integrated approach that incorporates sanitation, mechanical control, and the use of insecticides is the best strategy for fly control.

1. Sanitation:
   – Since manure and organic matter are common breeding grounds for flies, regular removal of manure & organic matter will deter fly populations by reducing the number of eggs laid.

2. Mechanical control
   – Preventing accumulation of water and wet areas reduces fly breeding.
   – Mechanical control of flies in buildings through the use of screens.

3. Insecticides
   – Can be delivered by ear tags, dust bags, oils, sprays, pour-ons, and feed additives.