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
     • "phthir" meaning lice
     • "aptera" meaning wingless

  2. Siphonaptera - the fleas
     • "siphon" meaning a tube or pipe
     • "aptera" meaning wingless.

  3. Diptera - the flies
     • "di" meaning two
     • "ptera" meaning wings
Arthropod features:

1. Segmentation
2. Exoskeleton
3. Jointed limbs
4. Tagmatisation
5. Haemocoel
6. Dorsal blood vessel
7. Ventral nerve cord
• **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
  – 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

• **Abdomen**
  – Is composed of 9 - 11 segments
  – Bears the external reproductive organs
1. **Chelicera**
   - Cut & pierce the host’s skin

2. **Palps**
   - Sensory, stabilization

3. **Hypostome**
   - Anchor

- Palps grasp the skin, chelicerae cut the skin, then the hypostome is pushed into the wound to help anchor the tick.
- Blood and lymph are sucked up from the lacerated tissues. Saliva is secreted while the tick is feeding (contains anticoagulants and disposes of excess water).

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

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

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

- In addition an anterior labrum covers the mouth and a tongue-like hypopharynx arises from the floor of the mouth - these are not appendages but serve important feeding functions.
- The mouthparts of the insects are highly specialized in relation to their diet.
Lice (Phthiraptera)

- Superbly adapted insect ectoparasites of birds & mammals
- Spend their entire life on the host
- Are highly host-specific
  - Some prefer specific anatomical regions

Morphology

- Segmented body divided into head, thorax, abdomen
- Three pairs of jointed legs
- Dorsoventrally flattened
- Wingless
- Sensory organs are not well developed
  - Antennae are short
  - Eyes are vestigial or absent
Lice (Phthiraptera)

Divided into two groups:

1. The Anoplura - the sucking lice
   - *anoplos* 'unarmed'
   - *oura* 'tail'

2. The Mallophaga - the chewing lice
   - *mallos* 'lock of wool'
   - *phagos* 'eating'
Order Phthiraptera

Traditionally been divided into two suborders:
The sucking lice (Anoplura) and the chewing lice (Mallophaga)

FYI: Four suborders are now recognized:
1. **Anoplura** – The sucking lice (mammals only)
   - *Haematopinus, Linognathus*

2. **Ischnocera** - Antennae stick out from head
   - Mostly avian chewing lice
   - One family parasitizes mammals
     - *Trichodectes, Felicola, Bovicola*

3. **Amblycera** - Antenna in pits on side of head
   - A primitive suborder of chewing lice
   - Widespread on birds
     - *Menopenon, Menacanthus*
   - Also live on South-American and Australian mammals
     - *Heterodoxus*, guinea pig lice

4. **Rhynchophthirina**
   - Parasites of elephants and warthogs
Sucking Lice (Anoplura)
- Head is narrower than thorax & elongated
- Adults 0.5 - 8 mm in length
- Mouth parts are highly modified
  - Composed of 3 stylets which form a set of fine cutting structures
- Hosts are placental mammals
- “Crab-like” claws on the tarsus
  - Cling to hairs of the host,
  - The diameter of the claw is related to the diameter of the host’s hair shaft → host specificity

Chewing Lice (Mallophaga)
- Heads are large, wider than thorax & rounded
- Usually 2 - 3 mm in length
- Have mandibulate mouthparts typical of chewing insects
  - Feed on feathers, hair, and skin
  - Some feed on blood
- Hosts are birds and mammals
- The species that feed on birds typically have 2 claws on the end of each tarsus; those that feed on mammals typically have just 1 claw
Lice (Phthiraptera)

- Hemimetabolus development
  - Simple life style
  - Egg → Nymph → Adult
  - Juveniles morphologically similar to adults
- Adult female lice cement 1 - 2 eggs (nits) per day to the hair shaft of the host
- Eggs these hatch into nymphs in 1 - 2 weeks
- Nymphs feed & develop through 3 - 5 nymphal stages over the next 1 - 3 weeks, eventually moulting to adults
- Egg to adult can take
  - 2-3 weeks in good conditions
  - Up to 4 - 6 weeks
- Lice only live 1 - 2 days off the host & are transferred from one host to another by direct contact
Pediculosis

Pathogenesis

Direct effects
• Heavy infestations $\rightarrow$ pruritus, alopecia & self-wounding
  – Rough/pulled haircoat or wool
  – Underlying problem? Malnourished?
    • ↓body condition $\leftrightarrow$ ↑lice population
• Reduced vigour & weight loss
• Sucking lice $\rightarrow$ anemia

Indirect effects
• Vectors
  – Typhus & relapsing fever in humans
  – Pox virus in pigs (mechanical vector)
  – Anaplasmosis in cattle
• Intermediate host
  – *Dipylidium caninum*
Pediculosis

Diagnosis

• Observation
  – Lice on the skin
  – Nits on the hairs

• Part hair to see skin
  – +/- Comb

• Acetate tape strips
Pediculosis

Treatment & Control
• Lice are easily killed by a variety of treatments

Dogs & Cats
• Insectidal (e.g. carbaryl or permethrin containing) shampoo, dips, sprays or powders
• Fipronil, selamectin, imidacloprid, imidacloprid+moxidectin
• Treat all pets in household
• Bedding & grooming equipment should be disinfected.

Livestock
• Topical or systemic insecticides
• Ivermectin, moxidectin, doramectin
• Imidacloprid for sheep (less common)
• Lactating dairy cattle: carbaryl, eprinomectin
Lice of Veterinary Importance

I. Anoplura (sucking lice - mammals)
   1. Haematopinus
   2. Linognathus
   3. Solenopotes
   4. Polypax
   5. Pediculus, Phthirus

II. Mallophaga (chewing/biting lice)
   1. Trichodectes
   2. Heterodoxus
   3. Felicola
   4. Bovicola (know species names!)
   5. Menopon
   6. Menacanthus
The Lice

**Dogs**
- Chewing Lice:
  - *Trichodectes canis*
  - *Heterodoxus spinigier*
- Sucking Lice:
  - *Linognathus setosus*

**Clinical signs**
- Uncommon in dogs
- Pruritus, scaling, crusts, matted coat, alopecia
- Severe infestations with *Linognathus* can produce anemia
- *Trichodectes* may transmit *Dipylidium caninum*
The Lice

Cats

• Chewing Lice:
  – *Felicola subrostratus* (only!)

Clinical signs

• Pruritus, scaling, crusts, matted coat, alopecia
• Lice are **not** a common finding in pet cats
• Usually in outdoor, stray, feral, or wandering cats
• Pet cats: farm cats, cats with contact with feral cats, cats that have recently gone missing (roaming)
• Cats in a multiple-cat facility (cattery, animal shelter, etc.)
The Lice

Horses

• Chewing Lice:
  – *Bovicola equi* *(Damalinia equi)*

• Sucking Lice:
  – *Haematopinus asini*

Clinical signs

• Pruritus, scaling, crusts, alopecia

• More common in winter months
The Lice

Cattle

- Chewing Lice:  
  - *Bovicola bovis*
- Sucking Lice:  
  - *Linognathus vituli*
  - *Haematopinus eurysternus*
  - *Solenopotes capillatus*

Clinical signs

- Pruritus, alopecia
- The sucking lice are found on the head, neck, withers, tail, groin, axila & ventrum
- *Bovicola* is found on neck, withers & tail
- Heavy infestations can cause anemia & weight loss & are usually due to poor management situations (therefore treating the lice will not solve the problem)
The Lice

Pigs

• Sucking Lice:  
  – *Haematopinus suis*

Clinical signs

• Pruritus, scaling, crusts & anemia (in heavy infestations)
• Commonly found around ears, axillae & groin
• Vector for swine pox virus
The Lice

Sheep

• Chewing Lice:
  – *Bovicola ovis*

• Sucking Lice:
  – *Linognathus ovillus*
  – *Linognathus pedalis*

Clinical signs

• Pruritus & wool damage, loss of production

• Infestation with *L. pedalis* (the foot louse) causes foot stamping & biting of the limb
The Lice

Poultry

• Chewing Lice:
  – *Menopon gallinae*
  – *Menacanthis stramineus* (many others)

Clinical signs

• Lice are important ectoparasites on domestic birds
• Pruritus, scratching & feather damage
• Reduced egg production & viability
<table>
<thead>
<tr>
<th>Host</th>
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The Lice

Humans (FYI)

- Sucking Lice:
  - *Pediculus humanus capitus*,
  - *Pediculus humanus humanus*,
  - *Phthrius pubis*

- Pets & livestock are **not** sources of human infestations (head, body, or crab louse)

- During heavy infestations fomites (such as bedding, towels & clothing) may act as means of transmission (mechanical vector) & lice may be recovered from the dog. However, the dog is never the culprit or reservoir of human lice!
The Lice

• Rats (FYI)
  – *Polyplax spinulosa*, the spined rat louse (sucking louse)
  – Rat to rat spread of typhus

• Guinea pig (all biting lice, FYI)
  – *Gliricola porcelli* (1 to 1.5 mm), the slender guinea pig louse
  – *Gyropus ovalis* (1 to 1.2 mm), the oval guinea pig louse (less common)
  – *Trimenopon hispidum* (very rare)
Class Insecta

- 3 orders of veterinary importance
  1. **Phthiraptera - the lice**
     - "phthir" meaning lice
     - "aptera" meaning wingless
  2. **Siphonaptera - the fleas**
     - "siphon" meaning a tube or pipe
     - "aptera" meaning wingless.
  3. **Diptera - the flies**
     - "di" meaning two
     - "ptera" meaning wings
The Fleas

Common species

1. *Ctenocephalides felis* - cat flea
   - most dog and cat fleas in NA
2. *Ctenocephalides canis* - dog flea
3. *Pulex irritans* - human flea
4. *Xenopsylla cheopis* - Oriental rat flea
5. *Echidnophaga gallinacea*
   - poultry “sticktight” flea
6. *Ceratophyllum niger*
   - Western chicken flea
The Fleas – Order Siphonaptera

I. Order Siphonaptera = Fleas

- *Ctenocephalides felis* - "cat" flea
- *Ctenocephalides canis* - "dog" flea
The Fleas

Morphology
• 2-3mm long (1-6 mm)
• Wingless
• Laterally compressed
• Adapted for jumping and clinging to host
• The two species can be separated by the characteristics of the head and setae on the hind legs:
  – *C. canis* has a head that is strongly-rounded anteriorly, and have hind tibiae with eight setae bearing notches;
  – *C. felis* has a more-elongate head and hind tibiae with six setae bearing notches.
  – Both species possess pronotal and genal combs (ctenidia).
The Fleas

Life cycle and epidemiology

- Ave. life cycle = 14 - 28 days
- Female takes blood meal and mates on host → lay eggs  
  - 500 eggs/female/lifetime.
- Eggs hatch in 2 to 12 days
- The larvae feed on organic matter → undergo 2 molts → form pupae
- Pupae feed on blood dropped by adults ("red scab" in flea dandruff)
- Pupae hatch (7 days to 1 year)
- Adult flea seeks a blood meal.  
  - Unfed fleas can survive for 2 months  
  - Fed fleas will live for a year
The Fleas

Life cycle and epidemiology

Holometabolous life cycle

- Undergo complete metamorphosis with a pupa stage
- Eggs → larvae → pupae → adults
- Adults are the infective stage and diagnostic stage
The Fleas

Pathology

• Flea bite dermatitis
  – Low numbers = an annoyance
  – ↑ # of fleas → ↑ dermatitis
  – Heavy infestation
    • Anemia and death

• Flea allergy dermatitis
  – Hapten in fleas’ saliva
    • Antigenic when fixed to host protein
  – Increased scratching or itchiness (pruritus) → pruritus-induced self trauma
  – Loss of hair, hairs that appear broken,
  – Crusts and erosions, and pimple-like bumps.
  – Thickened skin with darkened areas can be seen in severe cases.
  – Hot spots sometimes can be seen along the dog’s back and tail base.
    • Circular, red, oozing, painful sores
  – Can be perpetuated by a single flea!
The Fleas

**Flea dirt looks like salt & pepper.**
Flea eggs ~ salt; Flea feces ~ pepper.
Flea feces varies from tiny black dots to tubular structures about 1/2 mm long.

If you are not sure it is flea dirt, put the suspected material in a light colored table or counter top or paper towel. Add one or two drops of water, and wait about 30 seconds. If it is flea dirt, the water will turn reddish brown as the blood residue goes into the solution.

On **wet paper towel**, **red stains** will become apparent if you gently wipe the flea dirt across its surface.
The Fleas

Pathology

- Intermediate hosts
  - *Dipylidium caninum*
  - *Dipetalonema reconditum*

- Vectors
  - Plague (*Yersinia pestis*)
  - Typhus (*Rickettsia typhi*)
Between 2000 and 2009, **more than 20,000 people** became infected with bubonic plague. People contracted the disease via rodents, bad camel meat, and sick herding dogs. The biggest burden was in Africa: Congo 10,581 cases, Madagascar 7,182 cases, & Zambia 1,309 cases.


Flea Control

Host has:
- Adults on body + eggs in hair or feathers

Environment:
- Eggs + Larvae + Pupae + Adults

Majority of fleas usually in environment!

Integrated control program:
Includes the **host** AND the **environment**.

1. **Control on host**
   - Dips, sprays, powders, shampoos, flea collars, and systemics

2. **Clean up host’s environment**
   - This step begins by laundering and steam cleaning/vacuuming:
     - Wash pet bedding in hot water to kill flea larvae. If animals sleep with family members, all bedding must be washed.
     - Steam clean or vacuum carpets thoroughly everywhere the infested pet is allowed to roam.
   - Use chemicals to treat environment
     - Residuals or knockdown, Insect growth regulators
     - Focus on locations where pets go in and out of the house, sleep and rest, jump off beds, sofas and chairs, and spend time with family members.
Flea Control - Host

1. **Advantage** ® (Imidacloprid) is applied to the coat and kills adult fleas by inhibiting post-synaptic nerve transmission. It is effective for 1 month and **kills prior to biting. It is especially useful for the allergic cat or dog**, in situations where one or more animals in a household roam or come into contact with other flea infested animals. Control usually dramatic.

2. **Frontline** ® (Fipronil) **same as above with greater staying power on coat**. Stands up well to repeat washing. Grooming activity of cats may make it necessary to shorten time between doses to three weeks for Frontline and Advantage in the case of the allergic animal.

3. **Program** ® (Lufenurone) is a chitin synthesis inhibitor that lacks adultacidal activity and controls by preventing egg hatching and larval development. It is useful for the control of fleas in a totally confined situation.

4. **Revolution** ® (Selamectin) topical to control heartworm, fleas, other ecto- and endoparasites. **More expensive than other treatments, but it is effective against more parasites.**

5. **K9 Advantix** ® - Imidacloprid complements the activity of permethrin. Each affects parasite nerve cells at different sites. Fleas, ticks, mosquitos. **Because it contains permethrin it is highly toxic for cats. Avoid using this produce in combination dog/cat households where cats groom dogs. Treated dog should avoid close contact with cats for 24 hr post application.**

6. **Capstar** ® (nitempyram)- Same chemical class as imidacloprid (Advantage). Oral nitempyram starts working within 15 minutes. Within 30 minutes, adult fleas are dislodged. All of the fleas were killed within eight hours.
The Fleas

1. *Ctenocephalides felis* - the cat flea

- The most important species on dogs & cats
  - 93% of fleas on dogs
  - 99.8% of fleas on cats
- The major cause of flea allergy dermatitis (FAD)
- Ubiquitous & parasitizes a wide range of hosts
  - cats, dogs, cattle & humans
- Sloping elongated front of head
- Genal & pronotal comb
- About 2.5 mm long
- Life cycle completed in 12 - 14 days - 174 days depending on conditions
- Only a few fleas required to cause great misery to host
- One bite can cause allergic reaction in sensitized host (FAD)
The Fleas

2. *Ctenocephalides canis* - the dog flea

- Closely related & morphologically similar to cat fleas
- Relatively uncommon compared to *C. felis*
- Can also cause FAD
- Has **more rounded head** than the cat flea
- Also possesses both genal & pronotal combs
  - **BOTH** have a Mustache & a Mullet!
The Fleas

Common species

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   - most dog and cat fleas in NA
2. *Ctenocephalides canis* - dog flea
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5. *Echidnophaga gallinacea*
   - poultry “sticktight” flea
6. *Ceratophyllus niger*
   - Western chicken flea
The Fleas

3. *Pulex irritans* - the human flea (FYI)

- Attacks a wide array of hosts
  - Including humans, dogs & swine
- Lacks genal & pronotal combs
- Has a smoothly rounded head
- A single ocular bristle below the eye
- Breeds rapidly in pigsties & is most important species in farm areas
The Fleas

4. *Xenopsylla cheopis* - the Oriental rat flea

- Genus of rodent fleas that attacks humans
- Lacks combs
- Has smoothly rounded head
- A bristle in front of the eye
- A vertical rod on the mesothorax (*Pulex* does not)

**Vector**
- *Yersinia pestis* (Bubonic Plague)
- *Rickettsia typhi* (Typhus)
The Fleas

5. *Echidnophaga gallinacea* - the sticktight flea

- Flea of poultry
- Can attack all kinds of domestic animals
  - Dogs, cats, rabbits, horses & humans
- Small fleas (~1.5 mm long)
- No genal or pronotal combs
- Have a sharply angled front of head
- Fleas remain attached to host
  - Female fleas burrow into the skin
  - Can remain attached for 2 - 6 weeks
  - Skin around the point of attachment can become ulcerated
- Eggs are laid in the ulceration or drop to the ground
- Sticktight fleas are significant parasites of poultry & can cause anemia, ocular ulcerations (+/- blindness)
- In dogs, they are found in poorly haired areas of the ventrum, scrotum, interdigital areas & around the pinnae of the ears
The Fleas

6. *Ceratophyllus niger* –
The Western Chicken Flea

- Common throughout Western Canada, USA & Alaska
- Genal comb is absent
- Has a pronotal comb
- Is about 4 mm long (much larger than sticktight flea)
- Does not attach permanently to its host like the sticktight flea
- Important flea of poultry
  - But will attack dogs, cats & humans
- Chicken fleas are less common than mites and poultry lice
The Fleas

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