Introduction to Veterinary Parasitology

- Some terms used in parasitology
- Types of relationships
- Overview of some parasites
- Parasite life cycles
- Classification of parasites
- Diagnosis of parasitism
- Treatment of parasitism
OBJECTIVE 1

Describe the various symbiotic relationships between two species of organisms
TLO

• Students understand the various relationships, terminologies and can explain them
Definitions

- **Parasitology** – study of parasites & parasitism
- **Symbiosis** – any association between at least 2 different living organisms of different species
  - **Host** – usually larger of 2 species, harbors symbiont
  - **Symbiont** – smaller of 2 species, obtains food, and habitat from host
# Types of Relationships

<table>
<thead>
<tr>
<th>Relationship</th>
<th>Host</th>
<th>Symbiont</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mutualism</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Commensalism</td>
<td>0</td>
<td>+</td>
</tr>
<tr>
<td>Phoresis</td>
<td>0?</td>
<td>+</td>
</tr>
<tr>
<td>Parasitism</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Predation</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Competition</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
1. Phoresis (Phoresy)

- Phoresis means “to carry.”
- A type of symbiotic relationship in which one organism (the smaller phoront) is mechanically carried on or in another species (host).
2. Commensalism

• Means “eating at the same table”

• Occurs when one member of the associating pair, usually the smaller, receives all the benefit and the other member is neither benefited nor harmed

Branchiobdelid worm attached to a crayfish
3. Mutualism

- Occurs when each member of the association benefits the other.
- Mutuals are metabolically dependent on one another; one cannot survive in the absence of the other.
- Often included as a special subcategory of mutualism is **cleaning symbiosis**.

The Oxpecker (*Buphagus spp*) and the Zebra: the birds get to eat ticks and other ectoparasites while the Zebra gets free pest control.
4. Parasitism

- *Parasitos* (*para:* beside; *sitos:* grain or food)

- Definitions of parasitism have traditionally focused upon some ecological aspect of the parasite-host interaction

Anterior end of a hookworm
More about symbiosis
The Parasite

Location on the Host
Amount of Time on the Host
Types of Parasites
Location on the Host

Ectoparasite \textit{(Infestation)}
Endoparasite \textit{(Infection)}
Location on the Host

• **Ectoparasite**
  – On outside surface of body of host
  – Examples – fleas, mosquitoes, horse flies
  – animals tick.mp4
  – Roebuck(doe)-Ecto-parasites-Hypoderma sp_.mp4

• **Endoparasite**
  – Live in body of host
  – Examples – roundworms, whipworms, heartworms
  – Barbers Pole Worm.mp4
Amount of Time on Host

Temporary
Stationary
Permanent
Temporary

• Visits host for food
• Examples
  – Ticks
  – Mosquitoes
  – Slow Motion Mosquito Flight
Stationary

• Spends definite period of time in or on host

• Most parasites

• Periodic – leaves host to complete development (example – *Cuterebra*)

[Link to Removing A Fly(Cuterebra) Larvae From A Dog's Skin.mp4]
Cuterebra
Permanent

• Spends entire life on host, except when transferring to another host

• Examples Nasal mites a tale (and then one) (4).mp4
  – Ear mites
  – Lice
Types of Parasites

Incidental (Accidental) Parasite
Erratic (Aberrant) Parasite
Obligate Parasite
Facultative Parasite
Pseudo parasite
Spurious parasite
Incidental Parasite

• Accidental parasite
• Appears in unusual hosts
• Examples –
  – Heartworms in man
  – Crab louse in dogs
Erratic Parasite

• Aberrant parasite
• Seen in unusual locations in hosts
• Examples –
  – Heartworm in eye
  – Cuterebra in brain
Obligate Parasite

- Must lead parasitic existence
- No free-living stages
- Examples
  - Lice
  - Ear mites
  - Some mites
Facultative Parasite

• Free-living organism that can become parasitic in certain hosts

• Examples

• Chigger mite larvae (microscopic)Harvest mites (Chiggers) found on my poor dog.mp4

• Ringworm in cats, calves
Pseudoparasite

- Organisms that appear to be parasites, but are not
- Examples – grain mites in fecal samples, pollen grains and air bubbles
Fig. 1.10. Examples of pseudoparasites. (A) Pine pollen is a common pseudoparasite found in fecal samples of many animals (400×). (B) Adult free-living nematodes are also commonly found in fecal samples collected from the ground. These nematodes can rapidly invade fecal material. The presence of adults and variation in size and morphology (indicating different stages of the life cycle) are helpful in distinguishing these worms from parasitic larvae.
Spurious parasites


**Fig. 1.15.** Spurious parasites are parasite eggs or cysts from another host that are acquired through predation or coprophagy and have merely passed through the digestive tract of the animal being tested. (A) Tapeworm egg found in a fecal sample from a calf. Although the configuration of hooks inside this egg clearly identifies it as a tapeworm, it is most likely a rodent or bird tapeworm egg. (B) Spurious parasites are common in samples from dogs that ingest fecal material. Eggs of livestock strongylid species can be found in feces of manure-eating dogs. Ruminant and equine strongylid eggs look like canine hookworm eggs but are larger.
The Host

Intermediate
Paratenic
Definitive (Final)
Incidental (Accidental)
Intermediate Host

• Immature (non-sexual) parasite undergoes development in this host

• Example – heartworm larva in mosquito

• Control of this part of life cycle CRUCIAL to preventing parasite infection!
Paratenic Host

• Intermediate host that serves as a “transport” host for parasitic larva
• Final host must eat this host for adult parasite to develop
• Examples – fleas or mice for certain tapeworms
Definitive Host

• Final host
• Harbors adult (sexually mature) parasite
• Often a carnivore (dogs & cats)
• Intermediate host carried parasite to this host
Incidental Host

• Accidental host
• Wrong host species for this parasite
• If man – parasite is a zoonosis
  – Raccoon roundworms
  – Heartworms in cats.
Objective 2

Discuss types of parasitic life cycles
At the end of this topic students should understand the various stages in the life cycle of a parasite
Life Cycles

Direct

Indirect
Life Cycles Overview

• Definition
  – The entire sequence of stages in the life of a parasite, from adults of one generation to adults of the next

• Parasite may be “Species Specific”
  – Affect only 1 species of host
  – Lice – species specific; fleas – not

• 2 types
  – Direct life cycles
  – Indirect life cycles
Direct Life Cycles

• Parasite transfers from one host to another host of same species
  – Dog to dog to dog, etc.
• No intermediate hosts
• Examples – fleas, whipworms
Direct Life Cycle – Fleas

Fleas

- Adult fleas lay eggs on damp ground, in carpets and air ducts, and behind paneling.

Eggs hatch into larvae that molt three times.

The third molt produces a white larva that spins a cocoon in which the larva pupates for up to one year.
Direct Life Cycle – Whipworms

The dog swallows eggs on toys, food dishes, etc.

An infective larva develops inside the egg but does not hatch until the egg is swallowed.

Eggs are passed in the feces.

The adult whipworm imbedes in the wall of the large intestine and cecum (appendix).
Indirect Life Cycles

• Parasite requires at least 1 intermediate host to complete its life cycle
• Intermediate host harbors immature parasite
• Definitive host harbors adult parasite
• Examples – heartworms, all tapeworms, flukes

• Client Education – Best way to stop life cycle is to eliminate intermediate host
Indirect Life Cycles

- Always have **intermediate** hosts
**Indirect Life Cycle – Tapeworms**
**Indirect Life Cycle – Heartworms**

![Diagram of heartworm life cycle]

- Infected mosquitoes deposit heartworm larvae into the animal's hemolymph by puncturing the animal's skin.
- Mature females release microfilariae into the bloodstream where they are picked up by mosquitoes.
- Larvae migrate to subcutaneous tissues where they mature to a young-adult stage.
- Young adults migrate to the pulmonary arteries and heart.
Parasites with Both Life Cycles

- Some parasites have both a direct as well as indirect life cycle
- Examples – roundworms, hookworms
**Both**

Direct and Indirect Life Cycles
Both Direct and Indirect Life Cycles – Hookworms
Objective 3

Discuss Parasite Transmission

Passive
Active
Inoculative
At the end of this topic students should understand the various means by which parasites are transmitted
Passive vs. Active Transmission

• Definition – how parasites transfer from one host to another

• Passive transmission
  – Parasite does not travel to host
  – Usually ingested
  – Example – ascarids (roundworms)

• Active transmission
  – Parasite travels to host and/or aggressively penetrates host
  – Examples – fleas, hookworm larvae
Inoculative Transmission

• Intermediate host “injects” parasite into definitive host
  – Called “vector”
  – Often takes blood from definitive host
  – Often has “sucking mouthparts”
  – Examples – mosquitoes, ticks, fleas?
Inoculative Transmission

• Blood-suckers! [Image: Mosquito Sucking Blood]

[HIGH RESOLUTION OFFICIAL VIDEO.mp4]
Harmful Effects of Parasites
Harmful Effects of Parasites

• Blood loss
  – Hookworms, fleas

• Hypersensitivity (allergy)
  – Flea allergy dermatitis (FAD)
    • 15% of dogs & cats
  – Heartworms? Eosinophilia as high as 20%

• Toxicity
  – Maggots
Harmful Effects of Parasites

• Secondary invasion of pathogens
  – Bacterial infections after primary disease has begun
    • Example – generalized demodectic mange

• Disease transmission
  – Parasite vectors – carry disease to host

• Worry
  – Horse flies in the barn
Disease Vectors

- Mosquitoes
  - Heartworms
  - West Nile Virus
  - Equine encephalitis
  - Equine infectious anemia (EIA)
- Ticks
  - Lyme disease
  - Rocky mountain spotted fever
- Fleas
  - Feline infectious anemia?
Objective 4

Describe the Linnaean Classification Scheme used to name and categorize organisms
At the end of this, students will be able to describe the taxonomy of parasites
Taxonomy

Scientific Classification of Parasites
Definitions

• **Taxonomy** – Branch of biology dealing with identifying, naming, and classifying species

• **Taxon** – One of the groups that organisms are classified into

• **Species** – Group of similar organisms capable of interbreeding and producing fertile offspring
Classification of Parasites

- Kingdom
  - Phylum
- Class
  - Order
    - Family
      - Genus
        - Species
LINNAEAN CLASSIFICATION SCHEME: (Carolus Linnaeus (1707-1778) aka Carl Linnaeus)

1. Kingdom
2. Phylum
3. Class
4. Order
5. Family
6. Genus
7. Species

Mnemonic: “King Philip came over for good spaghetti”
Worms!
Insects, Ticks, and Mites
Protozoa
Classification of Parasites

• Kingdom Protista – single-celled organisms
• Kingdom Animalia
• Phylum
  – Platyhelminthes – flatworms – tapeworms
  – Archelminthes – nematodes
  – Arthropoda – animals with exoskeleton
    • Class Crustacea – no parasites here!
    • Class Insecta – fleas, flies, lice
    • Class Arachnida – ticks, mites
The Kingdoms

• **Protista** – Single-celled organisms
  – *Amoeba*
  – *Coccidia*
  – *Giardia*
  – *Toxoplasma*

• **Animalia** – Multi-cellular animals
  – Most parasites we will cover are here
  – Most animals are free-living, not parasitic
PARASITE TAXONOMY
PARASITIC WORMS

• Phylum-Platyhelminthes (“flatworms”, “flukes” and “tapeworms”)
• Phylum-Nemathelminthes (“roundworms”)
• Phylum-Acanthocephala (“thorny-headed worms”) - lesser importance in Vet. Medicine
• Phylum-Annelida (“segmented worms”, “night crawlers”) - lesser importance in Vet. Medicine
• Phylum-Arthropoda (“tongue worms”)
3 Phyla of Kingdom Animalia

- These 3 phyla have the parasites we will cover this semester
  - **Phylum** Platyhelminthes (Cestoda and Trematoda) – flatworms
  - **Phylum** Nemathelminthes (Nematoda) – roundworms (nematodes)
  - **Phylum** Arthropoda – arthropods
  - **Helminth** = “worm”
  - **Anthelmintic** – wormer
Platyhelminthes – Flat Worms

• Characteristics
  – Flat
  – All hermaphrodites – need only 1 worm to continue life cycle

• Free-living – Planaria

• Parasites –
  – Cestodes – all tapeworms
  – Trematodes – flukes
Nemathelminthes – Nematodes

• Characteristics
  – Round ("roundworms")
  – Separate male & female worms – Need at least 1 of each sex to continue life cycle

• Examples
  – Dog & cat ascarids (roundworms)
  – Hookworms (strongyles in horses)
  – Whipworms
  – Heartworms
Arthropoda

- Characteristics
  - Jointed appendages
  - Exoskeleton (made of chitin)

- 3 classes in this phylum
  - Class crustacea – crustaceans – no parasites!
  - Class arachnida – arachnids
  - Class insecta – insects
Class Arachnida

- Most free-living, some parasites
- Most live on land
- Characteristics
  - No wings
  - Most adults have 8 legs
- Examples
  - Spiders!
  - Scorpions
  - Ticks
  - Mites
Arachnids

- Spiders – free-living
- Scorpions – free-living
- Ticks – parasites
- Mites – free-living & parasites
Scientific Names of Organisms

• Composed of 2 Latin names
  – 1\textsuperscript{st} name – \textit{Genus}
  – 2\textsuperscript{nd} name – \textit{species}

• Genus species
  – \textit{Genus} name italicized, capitalized
  – \textit{species} name italicized, NOT capitalized

• If italics are not used, each name must be underlined separately
Examples of Parasites of the Digestive Tract

<table>
<thead>
<tr>
<th>Ascarids (Roundworms)</th>
<th>Host Species</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Toxocara canis</em></td>
<td>Dog only</td>
</tr>
<tr>
<td><em>Toxocara cati</em></td>
<td>Cat only</td>
</tr>
<tr>
<td><em>Toxascaris leonina</em></td>
<td>Dog, cat</td>
</tr>
<tr>
<td><em>Parascaris equorum</em></td>
<td>Horse</td>
</tr>
</tbody>
</table>
## Parasites of the Digestive Tract

<table>
<thead>
<tr>
<th><strong>Hookworms</strong></th>
<th><strong>Host Species</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Ancylostoma</em> spp.</td>
<td>Dog, cat</td>
</tr>
<tr>
<td><em>Uncinaria stenocephala</em></td>
<td>Dog, cat</td>
</tr>
<tr>
<td><em>Strongylus vulgaris</em></td>
<td>Horse</td>
</tr>
<tr>
<td><em>Strongylus</em> spp.</td>
<td>Horse</td>
</tr>
</tbody>
</table>
Parasites of the Digestive Tract

<table>
<thead>
<tr>
<th>Whipworms</th>
<th>Host Species</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Trichuris vulpis</em></td>
<td>Dog only</td>
</tr>
<tr>
<td><em>Trichuris suis</em></td>
<td>Pig</td>
</tr>
</tbody>
</table>
# Parasites of the Digestive Tract

<table>
<thead>
<tr>
<th>Tapeworms</th>
<th>Host Species</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Dipylidium caninum</em></td>
<td>Dog, cat</td>
</tr>
<tr>
<td><em>Taenia spp.</em></td>
<td>Dog, cat</td>
</tr>
<tr>
<td><em>Echinococcus granulosus</em></td>
<td>Dog only</td>
</tr>
<tr>
<td><em>Diphyllobothrium latum</em></td>
<td>Dog, cat</td>
</tr>
</tbody>
</table>
# Parasites of the Digestive Tract

<table>
<thead>
<tr>
<th>Protozoa</th>
<th>Host Species</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Isospora</em> spp.</td>
<td>Dog, cat</td>
</tr>
<tr>
<td><em>Eimeria</em> spp.</td>
<td>Dog, cat</td>
</tr>
<tr>
<td><em>Giardia</em> spp.</td>
<td>All animals, man</td>
</tr>
<tr>
<td><em>Toxoplasma gondii</em></td>
<td>Cat</td>
</tr>
<tr>
<td><em>Trichomonas</em> spp.</td>
<td>Dog, horse</td>
</tr>
</tbody>
</table>
External Parasites – Class Insecta

• Fleas
  – *Ctenocephalides canis*
  – *Ctenocephalides felis*

• Lice

• Flies
  – Mosquitoes
  – Horse flies, deer flies, stable flies
  – Maggots
  – *Cuterebra* larvae
  – Screwworms
External Parasites – Class Arachnida

• Ticks
  – *Rhipacephalus sanguineus*
  – *Amblyomma americana*
  – *Ixodes* spp. – Lyme disease tick
  – *Dermacentor* spp.

• Spiders
  – **NO SPIDERS ARE EVER PARASITES!!!**
# External Parasites – Class Arachnida

<table>
<thead>
<tr>
<th>Mites</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Otodectes cynotis</strong></td>
<td>Ear mite</td>
</tr>
<tr>
<td><strong>Demodex spp.</strong></td>
<td>Demodectic mange mite</td>
</tr>
<tr>
<td><strong>Sarcoptes scabiei</strong></td>
<td>Sarcoptic mange mite</td>
</tr>
<tr>
<td><strong>Cheyletiella spp.</strong></td>
<td>Walking dandruff mite</td>
</tr>
<tr>
<td><strong>Notoedres cati</strong></td>
<td>Cat mange mite</td>
</tr>
<tr>
<td><strong>Trombicula alfreddugesi</strong></td>
<td>Chigger mite</td>
</tr>
</tbody>
</table>
### Parasites of Other Organ Systems

<table>
<thead>
<tr>
<th>Parasite</th>
<th>Organ System</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Diocotophyma renale</em></td>
<td>Giant kidney worm</td>
</tr>
<tr>
<td><em>Capillaria plica</em></td>
<td>Bladder worm</td>
</tr>
<tr>
<td><em>Capillaria aerophila</em></td>
<td>Lung worm</td>
</tr>
<tr>
<td><em>Paragonamus kellikoti</em></td>
<td>Lung fluke</td>
</tr>
<tr>
<td><em>Spirocercia lupi</em></td>
<td>Esophagus worm</td>
</tr>
<tr>
<td><em>Physaloptera rara</em></td>
<td>Stomach worm</td>
</tr>
<tr>
<td><em>Linguatula serrata</em></td>
<td>Nasal cavity</td>
</tr>
</tbody>
</table>
Introductory Recaps

• **Parasitism** occurs in varying degrees:

1. parasitiasis- here the parasite is present in or on the animal host, and is potentially pathogenic but the animal does not show any outward clinical signs of disease
Introductory Recaps cont.

• **Parasitism** occurs in varying degrees:
  1. parasitosis- here the parasite is present in or on the body of the animal and does produce obvious injury or harm to the host manifesting in clinical signs of parasitism.
Objective 5

Identify laboratory procedures used to diagnose parasites
At the end of this, students understand the basic laboratory procedures for diagnosing parasite infections/infestations
Common Laboratory Tests

1. Fecal Examination (Direct smear, floatation and sedimentation)
2. Blood Testing: Thin smear and thick smear
3. Skin Tests: deep and superficial skin scrapings
References

- Online databases
- Veterinary Clinical Parasitology 8\textsuperscript{th} Edition
- Veterinary parasitology, Reference Manual 5\textsuperscript{th} Edition
- Veterinary parasitology, 3\textsuperscript{rd} Edition