FLUKES AND TAPEWORMS OF VETERINARY AND MEDICAL IMPORTANCE

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Platyhelminthes / flat worms

- Contains both the trematodes and cestodes.
- The trematodes (flukes) have an incomplete digestive tract (a mouth but no anus) Flat leaf like unsegmented bodies.
- Sexes separate in Schistosomes while others Hermaphroditic
- There are 2 subclasses of parasitic flukes: Monogenea, whose members are parasitic only as adults.
- Digenea, whose members have two or more hosts in their life cycle, and the first host is a mollusk.
Tape worms/ Cestodes

- Tape like segmented bodies.
- Tapeworms have no mouth, as adults they live in the small intestine of their hosts and absorb nutrients through their tegument (external surface). The tapeworm life cycle involves an intermediate host. In many species the larval stages cause more pathology than the adult worms.
- Head has suckers and some hooks. Hermaphroditic / monoecious.
Trematodes

- **Order Digenea**
- Body flattened dorsal ventrally, have two suckers= anterior sucker- mouth, posterior sucker- ventral surface.
- **Families:**
  - **Fasciolidae**
  - *Fasciola gigantica, F. hepatica*.
  - Large flukes in bile ducts. Broad leaf shaped bodies covered with spines
  - **Paramphistomatidae** =
  - Stomach flukes: Thick fleshy cylindrical parasites with well developed ventral sucker. Found as round bodies in rumen=
    - *Paramphistomum microbothrium*
  - **Schistosomatidae** / blood flukes/ blood worms
  - Elongated and are dioecious. Blood flukes affecting man and animals
  Schistosoma mattheei, S. bovis
  S. japonicum, S. haematobium, S. mansoni = affect man causing Bilhazia
General Life cycle:

• Lay eggs and life cycle indirect requiring an intermediate host.

• Eggs passed out in faeces - miracidium - fresh water snail - sporocyst - radiae - cercariae - leave snail and become encysted on water plants - metacercariae – ingested by host.

• For schistosomes – cercariae enter host directly by skin penetration. Travel thru’ blood to pre direction sites
Metacercariae (on grass) → Eggs (Eggs shed 8-12 weeks after infection) → Cercaria (5-7 weeks) → Miracidium (10-12 days) → Mud Snail
Fasciola gigantica = cattle, F. hepatica = sheep

- **Life cycle**: Adults in bile ducts lay operculated eggs - faeces - miracidium thru’ operculum - snail of genus Lymnea
- Metacercariae excyst in small intestines - intestinal wall - wander in peritoneum - penetrate liver capsule and wander into liver parenchyma. Reach bile ducts where they mature.
- **Pathogenicity**: Depend on number of metacercariae ingested and number reaching liver and maturing.
- A) acute fascioliasis - ingestion of large numbers = severe hemorrhages and destruction of liver parenchyma. Acute hemorrhagic anaemia = death
- B) sub acute = Large numbers over a long time. PMM and submandibular edema
- C) Chronic = develop slowly as immature suck blood. Anaemia, ascites, sub mandibular edema. PM emaciated carcass, enlarged bile ducts, liver cirrhosis. Bile ducts blocked and enlarged, adult flukes in bile ducts.
- **Diagnosis**: Characteristic egg in faeces, PM adults in bile ducts
- **Economic Importance**: Condemnation of Liver at MI
Schistosomiasis: S. bovis, s. matthaei

- Adults in portal and mesenteric veins of cattle and shoats. Transmitted by snails of genus Bulinus
- Eggs= no operculum but have a lateral spine
- Adult males dorsal ventrally flattened, elongated with spiny cuticle. Lateral flaps fold together to form a small canal called Gynaecophoric canal in which the adult female is held. Females elongated and slightly longer than the male.

- **Life Cycle**: As in Fasciola but has two sporocyst stages. Cercariae has hooked tail and penetrates intact skin. Travel thru’ blood to mature in mesenteric arteries.

- **Pathogenesis**: Cercariae penetration, liver= minute whitish granulomas with concentric rings of epitheloid, eosinophils, lymphocytes, plasma and giant cells.
Paramphistomum: P. microbothrium

- Common name= conical/ stomach worms
- Ruminants – reticulorumen
- Eggs operculated- Use snail of Bulinus spp
- Larval stages are parasites of small intestines causing damage as they penetrate to reach reticulorumen.
- Adults – Commensals in reticulo rumen
Adult Paramphistomum sp. attached among rumen villi
Tape worms

• Have general characteristics of flat worms
• Elongate, segmented, ribbon like and generally flattened dorsal ventrally
• Are hermaphroditic and adults are found in small intestines of definitive hosts.
General morphological characteristics

- Individual worms – scolex (head), neck and strobila (proglotids)
- **Scolex** – attachment organ – holdfast structures – suckers, hooks, spines, grooves. Rostellum at the apex with hooks
- **Neck** – area of strobilation- new segments produced.
- **Strobila** – segments with a male and female systems
- The tapeworm grows from proliferating stem cells in the neck, producing several hundred segments called proglottids, which are hermaphroditic and undergo continuous differentiation to eventually form gravid proglottids full of infective eggs.
Adult *Taenia solium* tapeworm

Head or scolex

Proglottid or segment

Gravid proglottid

Mature proglottid
General life cycle

- Indirect except a few like *Hymnolepsis nana*
- Involves definitive and intermediate host(s)
- Adults in SI of Dh produce eggs- faeces- ingested by Ih. Larval forms in eggs- oncosphere
- Travel to predilection site – metacestode
- Variety of metacestodes eg *cysticercus*
- One or more Ih or paratenic host may be involved
- Dh infected by ingesting Ih or its tissues with infective metacestode – develops to adult tape worm in small intestines of Dh
Classification of cestodes

• 11 Orders but only 2 are of vet and med. Importance –
• 1. *Cyclophyllidea* – 4 suckers on scolex –
• 2. *Pseudophyllidea* – have sucking grooves

• Order *Cyclophyllidea* –
• many families, Genera and species of vet and PH importance.
• General Characteristics of Order *cyclophyllidea* scolex – 4 suckers, Rostellum present with or without hooks.
Families in Order Cyclophillidea

- **Taeniidae, Anaplocephalidae, Dilepididae, Davaineidae, Hymnolepididae** and **Mesocestodidae**
- **Family Taeniidae**

**Main characteristics**

Adults in SI of man and carnivores

Intermediate hosts are mammals, Scolex has rostellum armed (double row of hooks) in some species, Gravid segments longer than wide.

Larval stages are Coenurus, cysticercus, strobilocercus and Hydatids and found in tissues and organs of the Intermediate hosts.
## Summary of Cestodes in family Taeniidae

<table>
<thead>
<tr>
<th>Adult spp</th>
<th>Final host</th>
<th>Larval</th>
<th>I. Host</th>
<th>Larval site</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>T. hydatigena</em></td>
<td>Dog</td>
<td>Cysticercus taenuicolis</td>
<td>Sheep, goats, pigs</td>
<td>peritoneum</td>
</tr>
<tr>
<td><em>T. pisiformis</em></td>
<td>Dog</td>
<td>Cysticercus pisiformis</td>
<td>rabbit</td>
<td>peritoneum</td>
</tr>
<tr>
<td><em>T. saginatta</em></td>
<td>Man</td>
<td>Cysticercus bovis</td>
<td>ox</td>
<td>muscles</td>
</tr>
<tr>
<td><em>T. solium</em></td>
<td>Man</td>
<td>Cysticercus cellulosae</td>
<td>Pig, man, dog</td>
<td>muscles</td>
</tr>
<tr>
<td><em>T. ovis</em></td>
<td>Dog</td>
<td>Cysticercus ovis</td>
<td>sheep</td>
<td>muscles</td>
</tr>
<tr>
<td><em>T. Multiceps</em></td>
<td>Dog</td>
<td>Coenurus cerebralis</td>
<td>Sheep, goats</td>
<td>Brain</td>
</tr>
<tr>
<td><em>T. taeniaformis</em></td>
<td>cat</td>
<td>Strobilocercus fasciolaris</td>
<td>Rat / mice</td>
<td>liver</td>
</tr>
<tr>
<td><em>Echinococcus granulosus</em></td>
<td>carnivores</td>
<td>Hydatid cysts</td>
<td>Herbivores + omnivores</td>
<td>Liver, lungs, long bones</td>
</tr>
</tbody>
</table>
**Taenia saginat**a – beef tape worm of man

- Small intestines of man – mature 4 – 10 metres upto 2000 segments
- Has 4 suckers with no rostellum
- Each segment when mature – 100,000eggs
- Adult tapeworm can live up to 25 years
- **Life cycle** – Man the only DH. Eggs passed out in intact segments which are motile – may crawl out of anus and move down the leg. Disintegrate releasing the eggs – eaten by IH mostly cattle (Camel in N. Africa). Oncospheres via blood to hard working muscles – tongue, masseters, diaphragm, heart – *Cysticercus bovis*.
- Man infected by eating raw or under cooked beef. Bladder digested and scolex released and attached in small intestines.
Factors contributing to high incidence

- Eating not well cooked meat
- Poor sanitation – defecation on pastures
- In some areas cattle are coprophagous
- Poor/unsatisfactory meat inspection procedures
- Eggs able to survive in environment for several weeks
- Use of raw or improperly treated sewage as fertilizer
- **Diagnosis:**
  - Proglottids in faeces, around anus, heels and gastrocnemius muscles
  - At meat inspection – beef measles/ cysticercus bovis

**Economic Importance:** Carcass condemnation, downgrading or retention depending on number of cysts
**Taenia solium** – pig / porcine tapeworm

- Small intestines of man the major DH. Others are dogs and monkeys
- Scolex – 4 suckers, rostellum armed 2 rows of hooks
- Metacestode – cysticercus cellulosae/ pig measles/ measly pork
- Life cycle similar to T. saginatta with one exception.
- Its life cycle includes a stage that infects both humans and pigs when viable eggs are accidentally ingested in human fecal matter.
- Man infected by swallowing *T. solium* eggs or transfer of eggs from anus to mouth as may happen in children.
- High prevalence in communities with free range pigs and where raw or undercooked pork is consumed.
Pathogenesis and clinical signs

• Adult worms in Man – Intestinal obstruction and irritation, severe abdominal pains
• Cysticerci – Cellular inflammatory reactions – Cysts in eyes → blindness,
• Cysts in brain (NCC) → epileptic seizures, paralysis
• Cysts in subcutaneous tissue and muscles – swellings under the skin → subcutaneous nodules
• In dogs rabies like signs

• Diagnosis
  Eggs / proglottids in faeces
  CT head scans, radiography, purge
  Sub cutaneous nodules
  Lingual palpation in live pigs - restraining
  Meat inspection
The head (scolex) of a *Taenia solium* tapeworm has four suckers and a double row of about 30 hooks.
Taenia solium cysts on the tongue
Larval *Taenia solium* cysts in pig muscles
Cysticercus

- bladder
- single scolex (immature tapeworm head)
Economic importance

- Condemnation of carcasses
- Downgrading of carcasses
- Cost of treatment
- Hospitalisation of human beings
- Loss of protein
- Cost of fuel for burning carcass -
Control and prophylaxis for Taeniosis and cysticercosis

- Public health education
- Preventing pigs and cattle from eating human faeces
- Treating adult carriers
- Proper meat inspection
- Proper sewage treatment
Free Range Sow and her Piglets
ABANDONED: Pigs rummage through piles of garbage at the Muliro Gardens in Kakamega.
Strategies for Intervention

Cook meat
Control slaughter
Meat inspection

Mass taeniacidal treatment
Improve sanitation

Restrain pigs
Treat pigs
Vaccinate pigs*

Cysticercus

Adult Worm in Small Intestine

Egg

TAENIA SOLIUM LIFE CYCLE
Genus *Echinococcus granulosus*

- Adults in small intestines of carnivores
- Metacestodes – hydatid cysts in herbivores and omnivores in any organ but usually liver and lungs
- **Morphology** – adult 2 – 7 mm, 3 proglottids, terminal more than half length of whole worm. Scolex has 4 suckers, rostellum armed with 2 rows of circular hooks.
- **Life cycle** – eggs passed out in faeces of DH. They are ingested by IH and oncospheres are released in the small intestines - travel thru’ portal system to liver – hydatid cysts – others to lungs
- In man to long bones, brain and eyes where they form fluid filled cysts which increase in size – Hydatid disease
- Two life cycles in Kenya – Domestic cycle – dog- Turkana Sylvatic cycle – wild carnivores and wild animals - maasailand
Figure 1. Coenurus cyst (black arrow) filled with translucent fluid in the brain subcortex of a sheep.
Cysticercus tenuicollis
Cysticercus ovis in Muscle
Family Anoplocephalidae

• Main characteristics
  – Scolex no rostellum or hooks
  – Proglottids wider than long with 1 or 2 sets of genital organs
  – Eggs have three coverings- vitelline membrane, albuminous coat + chitinous membrane. Are pear shaped with a pair of hooked projections
  – Cystic stages are cysticercoids – in mite of the family *Oribatidae*.
  – Infection acquired thru’ herbage
Genus *Anoplocephala*

- Occur worldwide in equines. Several spp
  - *A. magna* – jejunum of horses and donkeys. In large numbers - catarrhal or haemorrhagic enteritis
  - *A. perfoliata* – large and small intestines of horses and donkeys. Localises near ileocecal orifice- small dark depressed ulcerative lesions.
  - Perforations leading to peritonitis
  - Genus *Paranoplocephala*- *P. mamillana*- SI and occasionally stomach of horse
Genus *Moniezia*

- *M. expansa* – SI of ruminants – upto 600cm
- Eggs roughly triangular with well developed pyriform apparatus
- *M. benedeni* – in cattle
- Cysticercoids develop in oribatid mites. Ruminants infected by ingestion of infected mite in herbage
- Infection common in young upto 6 months. Adults – light infections
Genus Stilesia Hepatica

• This is a tape worm which occurs in the bile duct of sheep, goats and wild ruminants.
• Considered non pathogenic.
• Heavy infections are frequently seen in apparently healthy sheep.
• With almost complete occlusion of the bile ducts no clinical signs are observed.
• Approximately 80 % of sheep and goat livers are affected where it occurs
Family Dilepididae

• Main characteristics
  – Smaller than Taeniidae and Anoplocephalidae
  – Well defined rostellum with armed suckers
  – Segments have 1 or 2 sets of genital organs

Genus *Dipylidium caninum*

Small intestines of carnivores and man esp.
Rostellum retractable and armed with 3 or 4 rows
2 sets of genital organs, ovary and vitelline glands
  form mass on either side – bunch of grapes
Mature gravid proglottids – elongate oval shape
Stained gravid segment removed from a dog's small intestine

- Egg packets
- Genital pore

Approx. 8mm
Tapeworms in Chicken

- **Genus Amoebataenia – A. spheroides**
  - SI of domestic fowl. Small upto 4mm long and triangular in shape
  - Rostellum armed. IH are earthworms → cysticeroid. Fowls acquire infection after rains when earthworms come to the surface.

- **Genus Choanotaenia infundibulum**
  - Upper SI of fowl and turkey. Intermediate hosts are house fly – *Musca domestica* and beetles

- **Genus Devainea proglottina** → Duodenum of fowl and pigeon. Microscopic 0.5 – 3mm Molluscs are intermediate hosts
• Genus Raillietina cesticillus- Domestic fowl. Has large scolex with wide armed rostellum. IH are beetles
• Genus Raillietina tetragona – largest tapeworm of the fowl – 25cm in length. In posterior SI. Suckers and rostellum are armed. IH are ants - Cysticercoids
• **Pathogenesis:** Decreased production in intensively managed birds.
• **Diagnosis:** At necrospy – sacrifice a few birds in suspect flock
• Since some cestodes are very small mucosal scrapings should be examined microscopically.
• **Control:** Control of intermediate hosts.
At the Bumala shopping centre, Busia, the sight of pigs rummaging for food is all too common. Some are stray animals, others have owners who let them out for a walk and some sight-seeing at the centre. The Busia Public Health department is very happy with this situation.