Zoonoses of Nonhuman Primates
Metazoan Parasites

Zoonotic Metazoan Parasites
Cestodes
  *Hymenolepis nana*
Trematodes
  *Paragonimus westermani*
  *Schistosoma spp.*
Nematodes
  *Strongyloides stercoralis*
  *Strongyloides fulleborni*
  *Oesophagostomum spp.*

Paragonimiasis

**Agent:** *Paragonimus westermani* (Asian lung fluke)

**Range:** Southeast Asia

**Primate Hosts:**
- Humans
- Crab-eating macaque (*M. fascicularis*)
- Taiwanese rock macaque (*M. cyclops*)

“Shared Pathogen” – both humans and NHP infected from environmental source.
Paragonimiasis

Paragonimus westermani: Life Cycle

Infection by ingestion of encysted metacercariae

Embryonated egg

Aquatic snail 1st intermediate host

Encysted metacercariae in crustacean 2nd intermediate host

Miracidia

Sporocysts Rediae

Cercaria

Embryonated eggs

Unembryonated eggs

Humans ingest inadequately cooked or picked crustaceans containing metacercariae.

Adults in cystic cavities in lungs; eggs which are excreted in sputum. Alternate eggs are swallowed and passed with stool.

Paragonimus westermani

Egg

Adult fluke
Paragonimiasis

Clinical signs
Primates: Mild dyspnea, nonproductive cough
occasional cavitary lung lesions
Humans:
Pulmonary form
Pleuritis, pneumothorax, cough, hemoptysis
Cerebral form
Epilepsy-like disease

Paragonimiasis

Pathogenesis
Migration through tissues
Liver, brain
Encapsulation in lungs
Paragonimiasis

Diagnosis
Eggs in fecal samples

Treatment
Praziquantel

Zoonoses of Nonhuman Primates
Cestodiasis

Agent: *Hymenolepis nana* (Dwarf tapeworm)

Only cestode with **direct life cycle**

Hosts: Humans; Chimps, tarsier, macaques, squirrel monkey, others

Low prevalence (1-4%)

Distribution: Worldwide

Clinical signs: Lowly pathogenic, except heavy infestation
Life Cycle: *Hymenolepis nana*

1. Humans and rodents are infected when they ingest cysticercoid-infected arthropods.
2. Cysticercoid develops in insect.
3. Embryonated egg ingested by humans from contaminated food, water, or hands.
4. Embryonated egg in feces.
5. Oncosphere hatches. Cysticercoid develops in intestinal villus.
6. Autoinfection can occur if eggs remain in the intestine. The eggs then release the hexacanth embryo, which penetrates the intestinal villus continuing the cycle.
7. Adult in ileal portion of small intestine.
8. Eggs can be released through the genital atrium of the gravid proglottids. Gravid proglottids can also disintegrate releasing eggs that are passed in stools.

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Cestodiasis: *Hymenolepis nana*

- **Hymenolepis nana** adult
  - scolex (holdfast)
  - immature proglottids
  - gravid proglottids

- **Hymenolepis nana** scolex (holdfast)

- **Hymenolepis nana** egg

(by P.W. Pappas and S.M. Wardrop)
Zoonoses of Nonhuman Primates
Schistosomiasis

Agents and NHP Hosts

*S. mansoni* – Sub-saharan Africa, Arabia, Neotropics
Baboon, African green monkey

*S. japonica* – Southeast Asia, Japan
Crab-eating macaque

*S. haematobium* - Africa, Middle East
Chimpanzee, Hamadryas baboon

Schistosomiasis

Prevalence in NHP

- *Papio hamadryas* Saudi Arabia 5%
- *Papio hamadryas* Ethiopia 2%
- *Papio anubis* Tanzania 16-47%
- *Papio anubis* Kenya 2%
- *Papio cynocephalus* Kenya 3-21%
Life Cycle: *Schistosoma mansoni*

Infection by cercaria penetrating skin

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**Schistosomiasis**

1. Sporocysts in snail (successive generations)
2. Eggs hatch releasing miracidia
3. Miracidia penetrate snail tissue
4. Cercariae released by snail into water and free-swimming
5. Penetrate skin
6. Circulation
7. Migrate to portal blood in liver and mature into adults
8. Paired adult worms migrate to:
   - mesenteric venules of bowel/rectum (laying eggs that circulate to the liver and shed in stool)
   - venous plexus of bladder

- = Infective Stage
= Diagnostic Stage
**Schistosomiasis**

**Clinical Signs**
- **Nonhuman Primates**
  - Anorexia, bloody stool, hepatomegaly, ascites
- **Humans**
  - Cercarial dermatitis
  - Acute phase – lymphadenopathy, hepato-splenomegaly
  - Chronic phase – portal fibrosis, hepatomegaly
    - Colonic hemorrhage and ulceration
    - Pulmonary granulomas

**Pathogenesis**
- Eggs secrete soluble antigens (DHR)
- Eggs secrete proteolytic enzymes (tissue damage, inflammation, hemorrhage)
- Blockage of smaller veins and arterioles
- Chronic inflammation and scarring
  - Hepatic “pipe-stem” fibrosis

*S. mansoni* egg
**Schistosomiasis**

**Lung granulomas**

**Diagnosis**
- Distinctive eggs in fecal sample

**Treatment**
- Praziquantel

**Egg in liver**

**Eggs in bladder**

*S. mansoni egg*

*S. hematobium egg*
Zoonoses of Nonhuman Primates

Strongyloidiasis

Agent:

*Strongyloides stercoralis* – Human

*Strongyloides fulleborni* – Asian and African NHP

One of the most serious nematode infections of humans and NHPs

*Strongyloides stercoralis*
**Strongyloides stercoralis**

Complex Ecology

Direct cycle:
- Rhabditiform larvae in stool
- Filariform larvae in soil
- Filariform larvae penetrate intact skin

Indirect cycle:
- Rhabditiform larvae in stool
- Free-living adults in soil
- Eggs in soil – free-living or filariform larvae
- Filariform larvae penetrate intact skin

**Strongyloides stercoralis** (cont.)

Autoinfection

- Filariform larvae in GI tract
- External – filariform larvae penetrate perianal tissues
- Internal – filariform larvae penetrate mucosa of colon and rectum
**Strongyloides stercoralis**

Autoinfection – increase worm burden (superinfection)

All cycles
- Larval migration via lymphatics and capillaries to pulmonary capillaries and alveoli
- Up respiratory tract, swallowed, relocate to stomach and small intestine
- Mating in small intestine, fertile females embed in mucosa
- Eggs hatch in intestine, rhabditiform larvae in feces
**Strongyloides stercoralis**

Clinical Signs
- Variable – asymptomatic to severe g.i. disease
- Duodenitis: abdominal pain, nausea, vomiting, diarrhea, anorexia, wt loss, weakness, peripheral blood eosinophilia
- Exacerbations at irregular intervals
- Strongyloidiasis is a chronic disease

Pathology
- Lesions of adult and rhabditiform larvae in mucosa
  - erosive and ulcerative enteritis
- Lesions of filariform larvae (primary and hyperinfection)
  - inflammation, multiple organs
  - necrotizing, ulcerative or granulomatous enteritis
  - hyperinfection – severe colonic lesions
**Strongyloidiasis**

**Diagnosis**
- Rhabditiform larvae in stool samples
- Epigastric abdominal pain with eosinophilia
  - high index of suspicion

**Treatment**
- Thiabendazole vs. adults (not effective against migrating larvae)
- Repeat treatment after 1-2 weeks is necessary

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**Strongyloidiasis  
*Strongyloides fulleborni***

**Hosts:** Old World monkeys
- Not naturally occurring in NW monkeys
- Human infections – Zambia

**Clinical signs**
- NHP – heavy infections – diarrhea (milder than *S. stercoralis*)
- Humans – abdominal pain, diarrhea, anemia

**Pathology**
- Similar to that for *S. stercoralis*
Strongyloidiasis
Prevalence in NHP

<table>
<thead>
<tr>
<th>NHP Species</th>
<th>Location</th>
<th>Prevalence</th>
<th>Sample size (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Papio anubis</em></td>
<td>Uganda</td>
<td>60.7%</td>
<td>124</td>
</tr>
<tr>
<td><em>Papio cynocephalus</em></td>
<td>Kenya</td>
<td>2%</td>
<td>55</td>
</tr>
<tr>
<td><em>Chlorocebus aethiops</em></td>
<td>Kenya</td>
<td>76%</td>
<td>42</td>
</tr>
<tr>
<td><em>Pan troglodytes</em></td>
<td>Tanzania</td>
<td>59%</td>
<td>22</td>
</tr>
</tbody>
</table>

Zoonoses of Nonhuman Primates
Oesophagostomiasis

Agent: *Oesophagostomum spp.*
(Nodular worm)

Most common nematode parasite of Old World NHP

Life Cycle: Direct, no systemic migration
- Infective stage – third stage larva
- Nodules – 4th stage larvae in intestinal submucosa
Oesophagostomiasis

Several species

*O. apiostomum* – Asia
  Hosts: humans, macaques, langurs

*O. aculeatum* – Asia
  Hosts: macaques

*O. bifurcum* – Asia and Africa
  Hosts: Asia – macaques
  Africa – baboon, patas, geunon, chimp
  * most commonly reported human infections

*O. stephanostomum* – Africa, South America
  Hosts: baboon, gorilla, chimp
  Pathogenic –apes (diarrhea, anemia, hypoproteinemia
  Diphtheroid enteritis

Oesophagostomiasis

Clinical

**Primates**

Minor infection – few clinical signs

Heavy infection – diarrhea, wt loss,
  anemia, high mortality

**Humans**

Abdominal pain, tumor-like nodules

May mimic appendicitis, colon cancer, amoeboma

Ectopic sites common
Oesophagostomiasis

Pathology
- Tumor-like nodules (2-4 mm)
- Intestinal submucosa – mainly colon
- Granulomatous disease

Treatment
- Thiabendazole
- Mebendazole, Levamisole less effective