

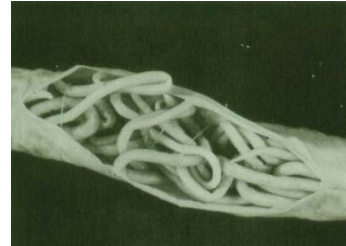
Invertebrate parasites

- Ph. Nematoda (50% parasitic)
- Ph. Platyhelminthes (80%)
- Ph. Annelida (10%, Subcl. Hirudinea)
- Ph. Acanthocephala (100%)
- Ph. Nematomorpha (100%)
- ? Myxozoa (100%)

Themes: human ecology, complex life cycles



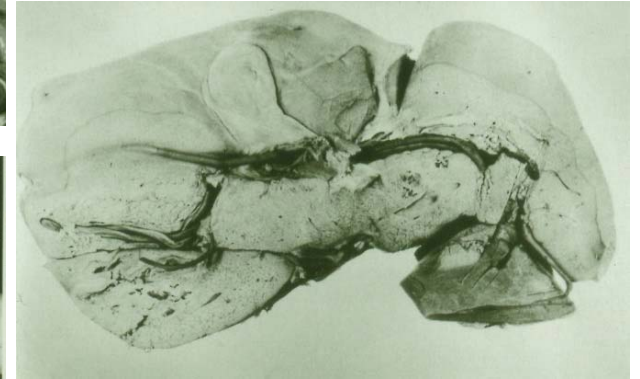
cat intestine



pig intestine

1) Nematodes: roundworms (*Ascaris*)

- intestinal, chyme feeders
- disease: malnutrition and migration
- ingestion of eggs from feces
- largest: sperm whale placenta, 9 m!



migratory phase (human liver)

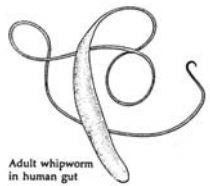
Invertebrates in history!

Richard III, King of England, debilitated and killed in battle

Infected: 1.25 billion humans (25%)

3 million in N.A.

Deaths: 20,000 per year

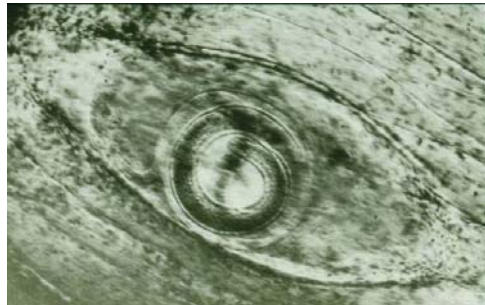


Adult whipworm in human gut

Nematodes:

whipworms

- gastrointestinal, blood feeder
- malnutrition
- from contaminated food or water



trichina worms

- intestinal blood feeders
- migrate, encyst in muscle
- smallest nematode parasite

Whipworm infections: >500 million (10%)
deaths: 100,000 per year

Trichinosis infections: 40 million (<1%)

filarial worms

- no free-living stage
- vector: mosquito



river blindness



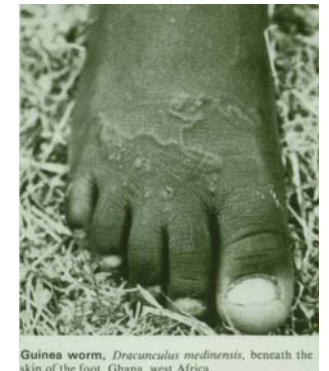
elephantiasis

Filarial infections: 300 million/year

Elephantiasis: 100 million

River blindness: 40 million

Nematodes: guinea worms

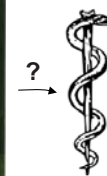


Guinea worm, *Dracunculus medinensis*, beneath the skin of the foot. Ghana, west Africa.

- intermediate host: copepod
- egg release at skin wound
- removal can take weeks



Using a matchstick to wind *Dracunculus medinensis* out of an infected human leg.



The Rod of Asclepius:



The Staff of Hermes

People infected annually:

>3.5 million (1990)

3190 (2009)

148! (2013)

25! (2016)

But...600 dogs (2016)

Nematodes: pinworms

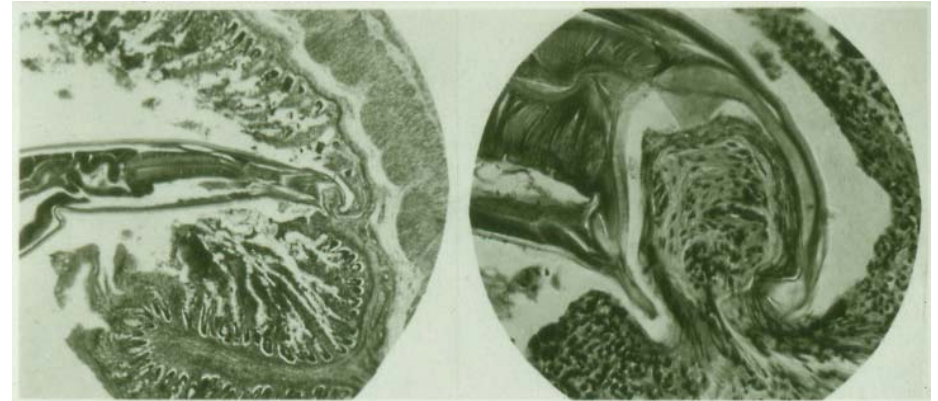
- mild intestinal effects
- non-tropical, esp. children NA & Europe
- transmission: itching and re-infection



Infection: >500 million (10%)
Most common North America, Europe

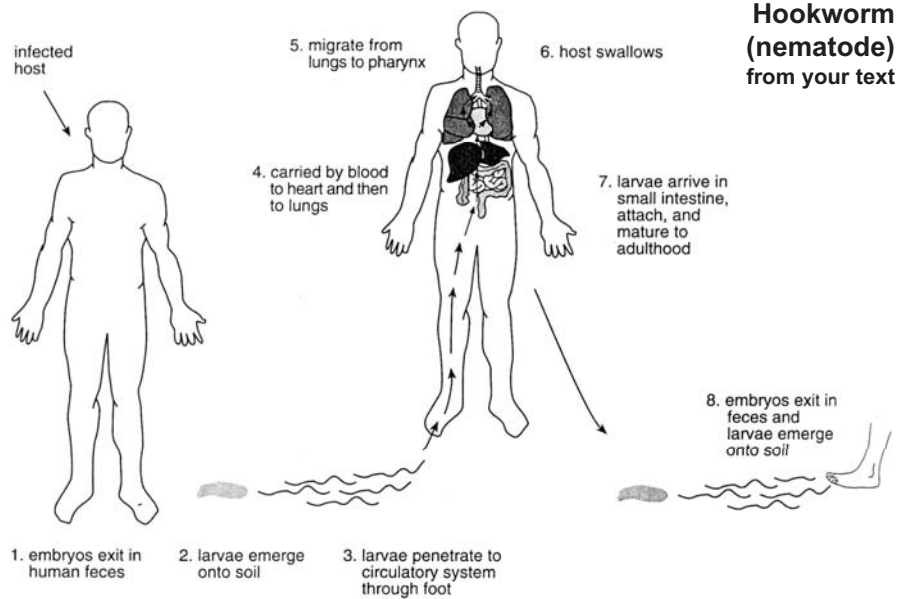
Nematodes: hookworms

- intestinal blood feeders
- ill-health, anemia, weakness to other infection



Hookworm attached to intestinal wall, in section of preserved material. *Left*, anterior portion of worm, including muscular sucking pharynx. Close-up, *right*, shows the worm firmly holding in its mouth cavity a small portion of the host's intestinal lining. When actively feeding, the worm **sucks 120 to 200 times per minute**. *Necator americanus* takes about 0.013 to 0.1 ml blood per worm per day. *Ancylostoma duodenale*, 0.15 to 0.25 ml. In a well-nourished adult, an infection with fewer than about **50 worms** has little effect, but heavier infections produce measurable to severe **anemia**. The results are more serious in a person, especially a child, simultaneously suffering from some degree of malnutrition.

Infected: > 1 billion (20-25%)



Indirect effects: loss of food production

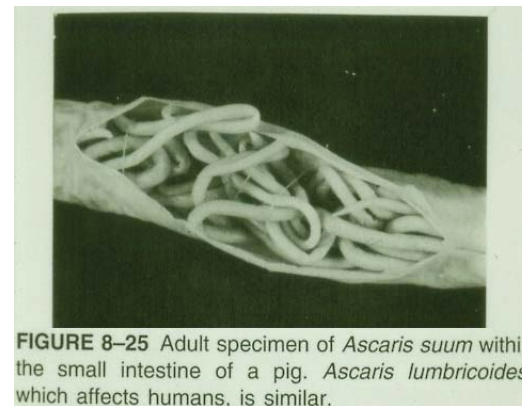


FIGURE 8-25 Adult specimen of *Ascaris suum* within the small intestine of a pig. *Ascaris lumbricoides*, which affects humans, is similar.



female nematode tapped into root

Costs: millions of \$\$, heavy use of preventative drugs

2) Flatworms: a. trematodes

Monogeneans
e.g., fish gill ectoparasite



Digeneans
e.g., human liver fluke

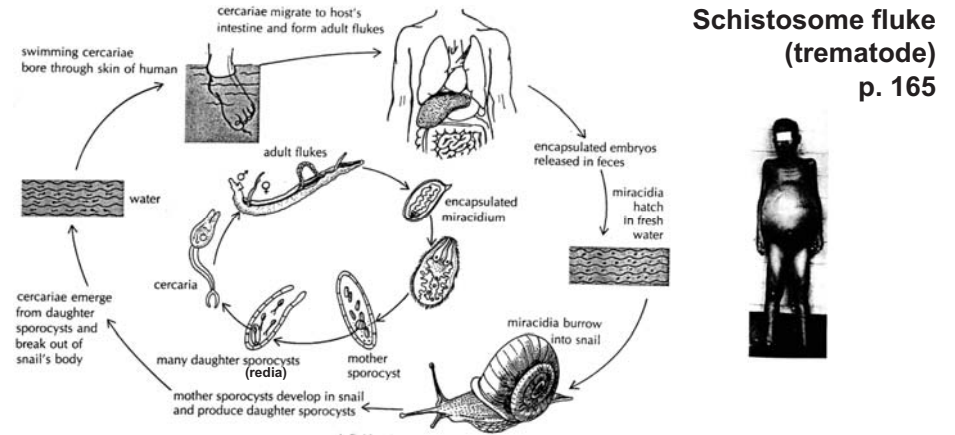


schistosome worms (male/female)

Schistosomiasis: 200 million
deaths: >1 million/year



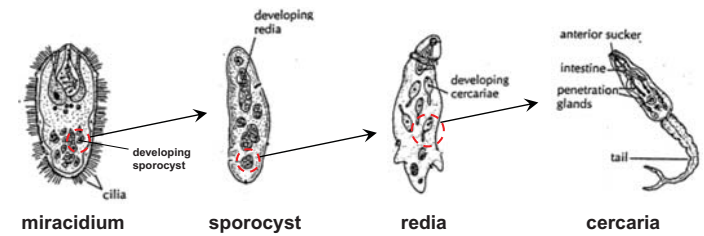
Distended bellies typical of infection
by *Schistosoma japonicum*



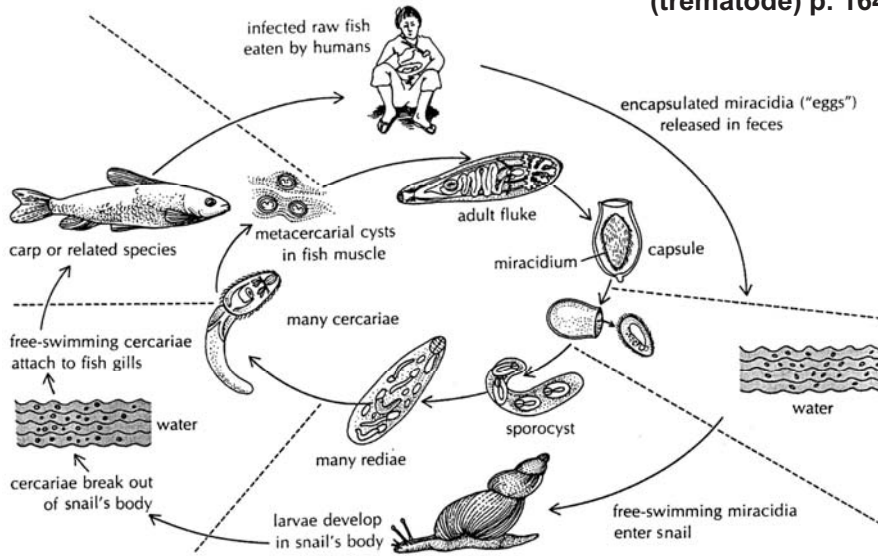
Schistosome fluke
(trematode)
p. 165



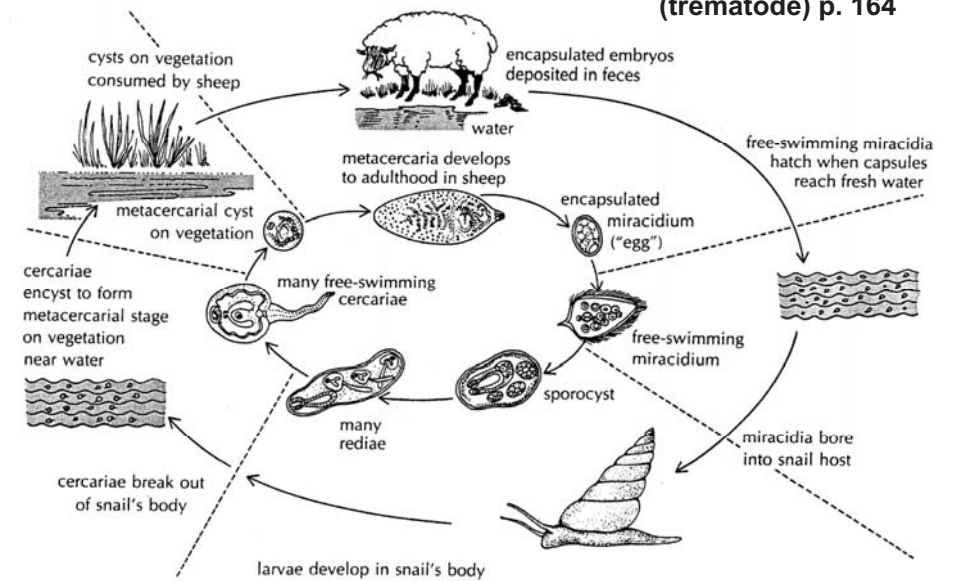
Asexual amplification
(100x each)



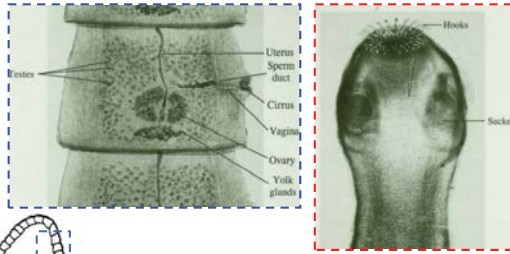
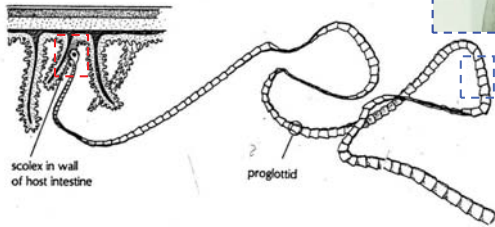
Human liver fluke
(trematode) p. 164



Sheep liver fluke
(trematode) p. 164



Flatworms: b. cestode tapeworms



- loss of digestive system
- intestine-like integument
- largest: sperm whales, 30 m!
- intermediate host (for cats: fleas; for humans: beef, pork, fish)

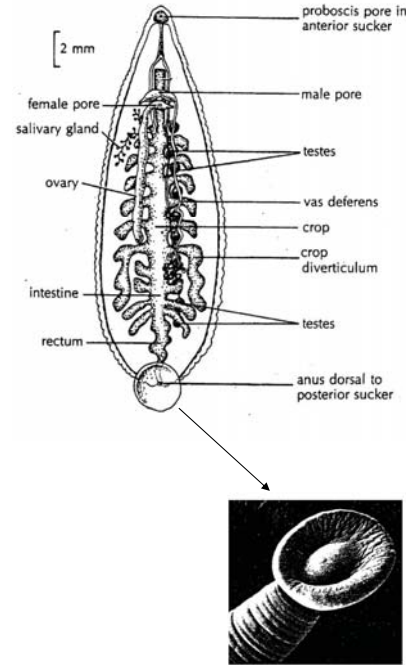


Removal of tapeworm from a child is not a big event in some parts of the world. (L. Braithwaite)

Bladder worms in brain of a 34-year-old woman, who was brought to the hospital with a history of seizures. These became more frequent until 3 days before her death, when convulsions set in every half-hour. Her brain (shown in longitudinal section) contains 100 to 150 bladders.

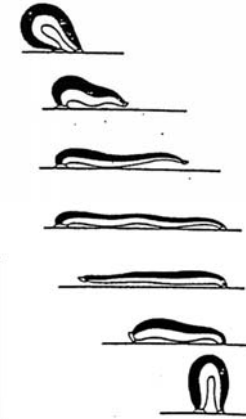


Infected: 135 million (2.5%)



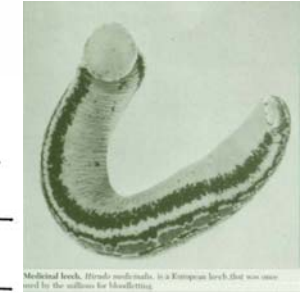
3) Ph. Annelida (Subcl. Hirudinea)

- land or water-based ectoparasites
- engorge on blood meals
- changes in coelom, locomotion



Entire scalp reattached with surgery and leeches

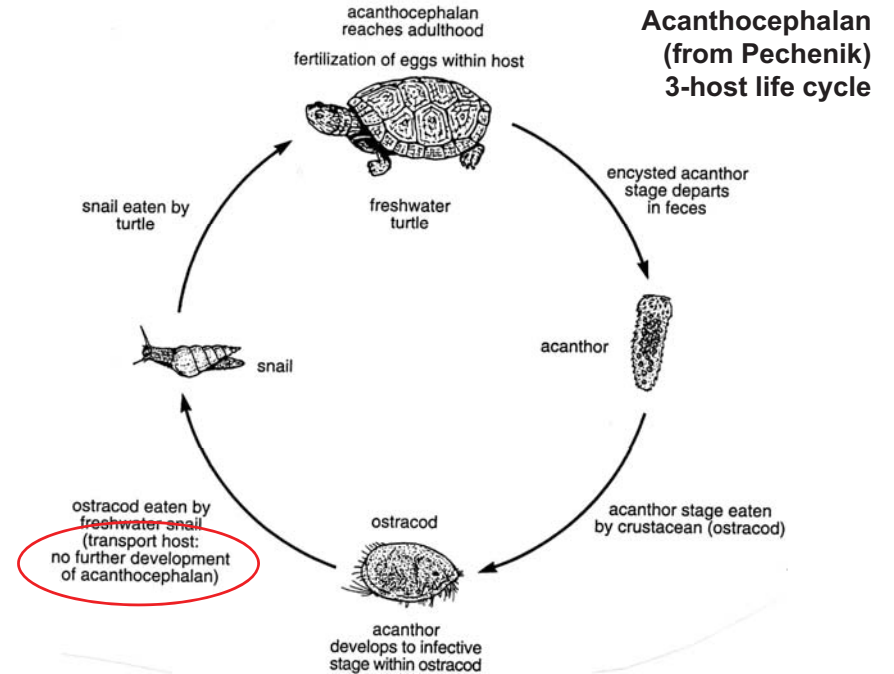
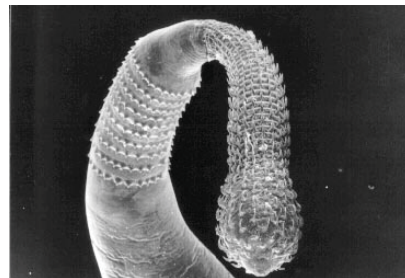
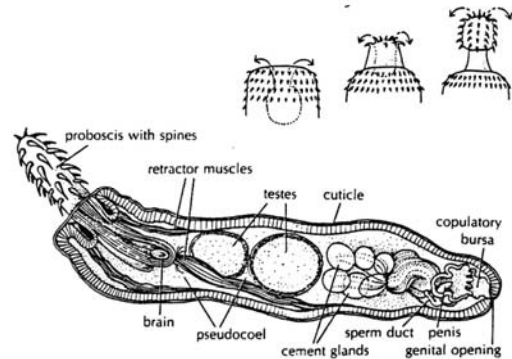
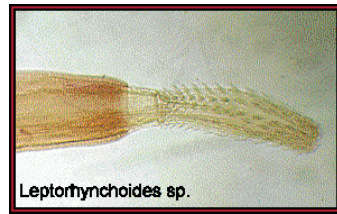
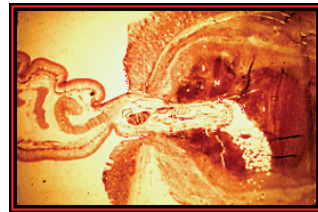
LOS ANGELES — Doctors combined microsurgery and leeches to reattach the skin and hair of a woman who was scalped on her eyelids to the back of her neck by an industrial blender.



Three holoparasitic taxa

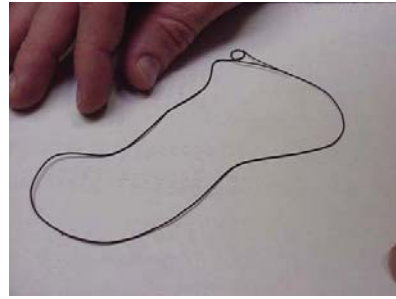
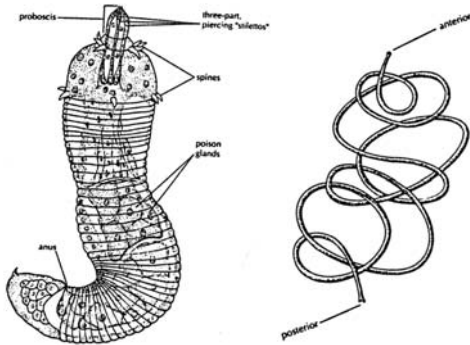
4) Ph. Acanthocephala

- parasite of vertebrate gut
- loss of digestive system
- microcrustacean, snail intermediate hosts
- alter behavior of hosts



Three holoparasitic taxa

5) Ph. Nematomorpha



juvenile

- arthropod parasite
- ingestion & absorption
- grim fate for host
- control host behavior
- intermediate hosts

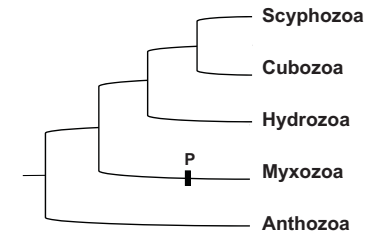
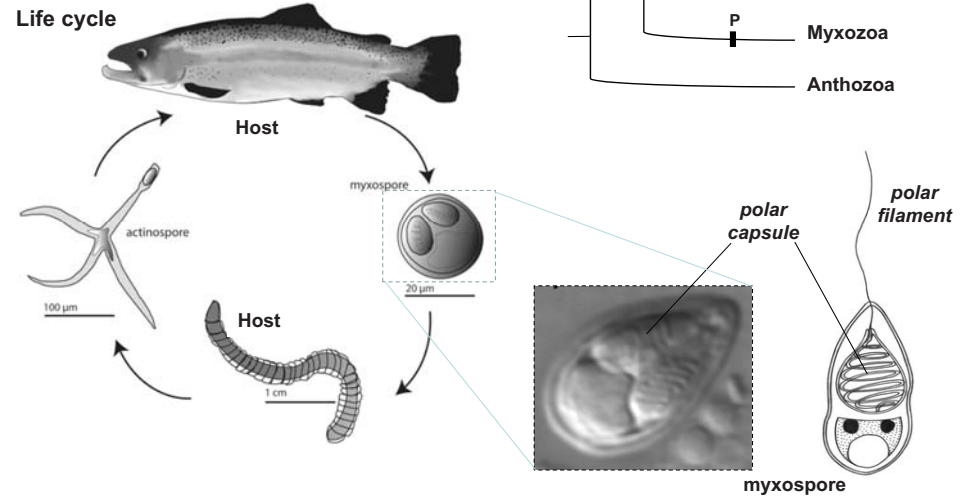
adult

- free-living
- non-feeding (loss of digestive system)

Three holoparasitic taxa

6) ? Myxozoa

Life cycle



Chang et al. 2015 PNAS

