

## II. Nematodes:

- round worms: body cavity, primitive organs, only one type of muscle, complete gut.
- See "Invertebrate Biology" by Barnes (now someone else) for a good summary of all this.
- In summary, nematodes can be parasitic in plants and animals. They may be endo- or ectoparasitic in plants, but only endoparasitic in animals.

### A. Zooparasites with one host

**Summary:** Both sexes are parasitic within a vertebrate or invertebrate host. Parasites are usually transmitted by eggs or newly hatched young. Many important groups.

#### Examples:

*Ascaris lumbricoides* (closely related to *Ascaris suum* (in pigs):

- large. Females 8 - 14", 4 - 6 mm in diameter. Males slightly smaller with hooked tail.
- Tropics, but including southeast U.S. Particularly important where sanitation is poor.
- Life cycle:
  - Adults live in small intestine and feed on semidigested food. Occasionally will bite intestinal wall and suck blood/tissue fluids.
  - Each female may have up to 27,000,000 eggs in different stages of development. About 200,000 may be released every day.
  - Need many eggs to insure new host is found
  - Eggs released into ground (w/ feces). Within 10-14 days active embryos develop. These then molt inside egg and become infective (2<sup>nd</sup> stage larva)
  - Oxygen and moisture is also needed. Complete drying is lethal, but, eggs can remain viable in soil for up to 5 years. Live eggs have also survived 10% formalin.
    - German researcher seeded soil in strawberry patch with *Ascaris*. Found that people (volunteers???) got infected for the next 6 years.
  - Eggs swallowed. Hatch in small intestine. Do not stay there.
  - Start tour through body. Burrow through gut wall, carried to liver, heart, eventually lungs.
  - Burrow out into trachea, then go to throat. Here they are swallowed and wind up back in intestine. Grow from .2mm to 2 mm during this "tour".

- During this “tour” phase, people can become quite ill, particularly if infestation is heavy. Lung problems similar to pneumonia may develop
- Prevention - Consistent use of toilets in a particular area would help end disease in that area. Main methods of transmission are: not washing hands, playing in soil, putting fingers in mouth (children).
- Adults are usually not that harmful, though heavy infections can lead to intestinal blockage (see picture of pig intestine in Barnes). An estimated 644,000,000 people are infected, though this information is very dated.

***Enterobius vermicularis:*** [verm = worm, cul = little, ari = veri]

- Common in developed countries, even U.S. More common in temperate zones.
- Infection rate is up to 60% in United States. Especially common among white american children (school age).
- Females 8-13mm long, Males 2-5mm.
- Live in appendix and large intestine
- Female migrates to anus, deposits eggs in perianal region of host (stimulated by contact with air). Worms may occasionally leave host and deposit eggs wherever they crawl.
- Worms can dry out and “explode” in a shower of eggs.
- Eggs are usually everywhere the infected person moves around, but only survive 2-6 days.
- More nuisance than danger (causes itching).

***Necator americanus*** (Necator = a killer) and ***Ancylostoma duodenale*** (Ancyl = hooked)  
(*Necator* in New world, *Ancylostoma* in Old world)

- also known as hookworms
- attach to wall of intestine by biting fast.
- live by sucking out blood and tissue fluids (1000's of worms can drink a lot!)
- adults are about 10mm, males slightly smaller than females.
- each female produces between 5,000 and 20,000 eggs a day.
- Eggs require moisture and warmth for development in soil. Hatch in less than 24 hours

under favorable conditions.

- Larvae are free living, feed on bacteria and other stuff in feces. Grow rapidly
- At end of 5 days, molt for second time, this time retain the shed cuticle for protection until the find a new host.
- Wait for host and live on food reserves (about ½ mm long at this point).
- Live in upper ½ inch of soil. Climb onto highest soil particle and extend themselves. Retreat into soil if sun gets too hot.
- Larvae enter host via bare feet, bore through skin, enter blood vessels. Carried to lungs, then take advantage of ciliary movement to move to throat. If swallowed, wind up in intestine.
- Burrow into villi, begin growing. In humans, begin egg production in about 6 weeks. May live up to 5 years in man, but usually much less.
- Responsible for “lack of ambition” which poor people in tropics and semi-tropics are sometimes accused of. Infection rate in some parts of U.S. were as high as 23% at turn of century (40% in south).
- Most troublesome group of parasites in man and domestic animals
- Large economic burden.

#### Trichuridae, genus *Tricuris*:

- whipworms (Trich = hair, so “hair tail”, but inappropriate since front end is “hair” end.
- thick posterior with reproductive organs.
- live in cecum and large intestine of dogs, rodents, pigs, monkeys, man, etc. Human parasite occurs world-wide and is more common in humid warm regions.
- suck blood. Low level infections usually have mild symptoms, but high infection rates can lead to bleeding of gut, anemia, abdominal pain. Grow to adult in cecum.

#### Trichinellidae, genus *Trichnella*:

- intestinal parasite as adult, but dangerous because juveniles damage other tissues.
- mostly a temperate and arctic parasite. Found in Europe, USA, and arctic regions.
- Eskimos, dogs, polar bears, and (somehow) seals and whales. [One host??]
- Not picked up via eggs.

- Worms enter digestive tract as larvae encysted in meat.
- Freed from cyst in stomach or intestine, and then penetrate all of intestine.
- Mature in about two days, then mate.
- Males are about 1 ½ mm long, Females 3-4 mm.
- Most males pass out of intestine soon after mating. Females live on, but only about 2-3 months after infection.
- Young are born about a week after infection and deposited in gut wall.
- Enter blood vessels, then are distributed over entire body (found in virtually all organs).
- Undergo further development only in voluntary muscles (problem can be bad if it's the respiratory muscles). Here they grow rapidly to about 1mm, then differentiate sexually, roll themselves into a spiral and encyst, eventually becoming a hard calcereous nodule.
- At this point are infective, but will not develop further unless eaten. Will die after several months, but nodules persist.
- Hogs are usually infected by being fed garbage containing pork scraps [Mad cow disease!!].
- About 16% of American population is infected. Most acquire disease by eating undercooked pork. Rats act as a natural reservoir. Most cases are undiagnosed, victims simply are not very healthy.

## **B. Zooparasites with one intermediate host.**

### ***Filaria (or Wucheria) bancrofti***

- Bancroft's filarial worm. Causative agent of Elephantiasis.
- Widespread and important parasite of humans.
- Found mostly in coastal areas and islands with long hot season and high humidity.
- Adult worms live in lymph glands and ducts.
- Female worms give birth to microfilariae, which show up in peripheral blood supply from 10 p.m. to 4 a.m. (ask students why!). Stimulated by sleeping of host.
- Further development requires being sucked up by proper arthropod (in this case up to 41 different species of mosquito will do).

- Embryos penetrate gut wall of mosquito, migrate to thoracic muscles, and develop into infective larvae (about two weeks).
- When mosquito bites warm skin, larva exits and crawls onto skin. Penetrates via mosquito bite or other break. Probably can't break unbroken skin, though wet skin helps (die quickly on dry skin). Adults live 4-5 years.
- In severe cases, lymph passages can be blocked, causing enormous tissue growth (elephantiasis - see pictures in text).

***Dracunculus medinensis*** (Guinea worm):

- Found in northern Africa, Middle East, throughout India.
- Adults live in veins of skin.
- Transmission is NOT through bite of arthropod.
- Instead, female breaks through skin to lay eggs.
- Female forms blister on skin. When exposed to water, blister bursts, and female releases eggs. Very painful.
- larvae infect copepods living in water.
- People get reinfected by drinking water with copepods (usually wells or cisterns).
- Larvae then penetrate through intestinal wall.
- Traditionally, females are removed by grabbing and slowly winding onto a stick (picture in Barnes). This may take several weeks.
- Today drugs are available, but practitioners use a symbol of worm on a stick to advertise. May be origin of medical symbol, or caduceus (many different theories!)

***Onchocerca volvulus*** (River blindness):

- Found in the tropics - South America (uncommon) & Africa.
- Transmitted by bite of the black fly - picks up microfilariae from an infected human.
- These develop over two weeks and then are infectious.
- Black fly will then inject a few larvae when it feeds on another human.

- Larvae then develop into adults which can be found in various tissues (usually in nodules) in humans.
  - Nodules can occur in eye, which leads to blindness (usually only with heavy infections).
- Adults mate and produce microfilariae, and the cycle starts over.
- Until recently this is was the leading cause of preventable blindness in the world.
- Recent efforts have made great progress in eliminating this disease, though it still has a long way to go.

**Note:** there are many more parasites out there, but this is a list of what are probably the most famous (or infamous).