

V. Subclass Eucestoida (Chapters 20 & 21, BLY 459 2009)

A. Characteristics (Ignore Cestodaria)

1. Differences from trematodes
 - a. No digestive tract
 - (1) No mouth, gut, nor anus
 - (2) All nutrients absorbed through tegument (Essentially tapeworms are a digestive tract turned inside out with reproductive organs on the inside)
 - b. Divided (but not segmented) body
 - (1) Divisions called PROGLOTTIDS
 - (2) Each proglottid contains reproductive organs

Slide 1: Tapeworms on vacation

2. Structural features
 - a. SCOLEX (plural = scolices)
 - (1) Holdfast
 - (2) Located on head
 - (3) Types of scoleces (Fig. 20.5; p. 317)
 - (a) BOTHRIA: Slit-like grooves
 - (b) PHYLLIDIA: Leaf-like with flexible margins (= bothridea)
 - (c) ACETABULA: Suction cups, 4 in a circle
 - b. Zone of proliferation
 - (1) Neck
 - (2) Area where proglottids are forming
 - c. STROBILA
 - (1) Body
 - (2) Reproductive development going on within proglottids

Slide 2: Scolox with Slit-like Bothria

Slide 3: Scolex with Leaf-like Bothria (Textbook: Fig. 20.5i; p. 317)

Slide 4: Scolex with Sucker-like Acetabula

B. Reproduction is monoecious

1. Male and female organs in each proglottid
2. Both do not necessarily mature simultaneously

C. Generalized life cycle

1. OVUM (= egg)
2. ONCOSPHERE [ONCO = hook]
 - a. Larval stage that hatches from ovum
 - b. Because it has 6 hooks, oncosphere is also called a HEXACANTH
 - c. Undergoes metamorphosis
3. METACESTODE
 - a. In body tissues of intermediate hosts
 - (1) Invertebrates
 - (2) Vertebrates
 - b. Some specialized types
 - (1) PLEROCERCID: Compact mass of cells

- (2) CYSTICERCOID: Develops a cavity
- (3) CYSTICERCUS: Large bladder
- c. Effects upon intermediate hosts
 - (1) Can destroy organ functions
 - (2) Increase likelihood of predation
- 4. ADULT
 - a. In intestines of vertebrates
 - b. Most are commensal in this stage

Slide 5: Tapeworm Stomach Insurance

D. Important cestodes of humans

- 1. Order Pseudophyllidea, Family Diphyllbothriidae
 - a. *Diphyllbothrium latum*
 - (1) The “fish tapeworm”
 - (2) Hosts
 - (a) Marine mammals
 - (b) People who eat raw salmon
 - i. Sushi eaters
 - 1) Pacific Coast
 - 2) Japan
 - ii. Chilean & Peruvian coastal communities
 - iii. Scandinavians
 - (3) Characteristics
 - (a) Scolex with 2 deep grooves between dorsal and ventral bothria
 - (b) Strobila may attain a length of 3-10 meters
 - (4) Life cycle (Fig. 21.5; p. 343)
 - (a) Ovum releases a free-swimming oncosphere that is eaten by a copepod (= a crustacean member of the zooplankton)
 - (b) Oncosphere migrates to body cavity of copepod and transforms into the metacestode stage
 - (c) Predatory fish (usually freshwater) eats copepod and metacestode buries itself in fish’s muscle and becomes a PLEROCERCROID
 - (d) Fish-eating mammals (including humans) are definitive hosts

Slide 6: Plerocercoid in Fish Muscle (Textbook Fig. 21.7; p. 344)

- b. SPARGANOSIS
 - (1) Medical condition of mammals that are infected with a plerocercoid of a diphyllbothrid tapeworm
 - (2) Can occur in humans

Slide 7: Sparganosis in Human Eye (Textbook Fig. 21.8; p. 345)

- c. *Diphyllbothrium* (= *Spirometra*) *mansonoides* (pp 345)
 - (1) Adults in cats
 - (2) Infective plerocercoid causes gigantism in mice (pp. 333-334)

Slide 8: Gigantism in infected mice (Textbook Fig. 20.30; p. 335)

- (3) Larva produces a chemical mimic of mammalian growth hormone (= GH)
- (4) Characteristics of GH
 - (a) Peptide hormone released from anterior pituitary gland

Slide #9 Diagram of anterior pituitary gland

- (b) GH induces the synthesis/secretion of other hormones that stimulate muscle and bone growth

Slide #10 & 11 Examples of over and under production of GH

- (5) The GH-mimic is a proteinase located on the surface of the larval tapeworm
- (6) Functions of the proteinase/GH-mimic
 - (a) Facilitates burrowing of larva through host tissue
 - (b) Counteracts host immune system by removing host antibodies that attach to larval tapeworm
 - (c) Larger mice move more slowly and are more likely to be preyed upon by cats than uninfected mice
- (7) Example of CO-APTATION or of how "big jumps" can occur in evolution
 - (a) Parasite proteinase increased likelihood that parasite got to next host by destroying host antibodies (Adaptation #1)
 - (b) By chance, the proteinase molecule bound to GH receptors on host cells (A side- effect)
 - (c) Most side-effects are either detrimental or have no impact upon survival, but this one increased the probability even more that parasites will get to the next stage of the life-cycle. (Adaptation #2 = big, slow intermediate hosts more likely to become prey items)
 - (d) Natural selection now works on two aspects (probably two different regions) of the same molecule

2. Order Cyclophyllidea

a. Background

- (1) Most important human tapeworms are in this order
- (2) Characteristics
 - (a) Scolices with 4 well developed suckers
 - (b) ROSTELLUM (= crown on scolex) commonly has hooks

b. *Taenia saginata* [Note: Older editions of text called this species *Taeniarhynchus saginata*]

- (1) "Beef tapeworm"
- (2) Background
 - (a) More common in humans than *Taenia solium*

- (b) No rostellum
- (c) Size
 - i. 5-10 meters
 - ii. 1,000 - 2,000 proglottids
- (d) Humans are only known definitive host
- (e) Proglottids move like worms until they dry out
- (3) Life cycle
 - (a) Similar to *T. solium*
 - (b) Intermediate hosts are cattle (Cysticerci cause “measly beef”)
- c. *Taenia solium*
 - (1) “Pork tapeworm”
 - (2) Rostellum with hooks
 - (3) Common in Middle East, Europe, & Mexico
 - (4) Life cycle (Fig. 21.15; p. 350)
 - (a) Proglottids containing eggs migrate to rectum
 - (b) Ova (usually still within the proglottid) are eaten by intermediate host
 - i. Dogs and cats, in addition to pigs, serve as intermediate hosts
 - ii. Dangerous, because metacestodes can form in humans (= CYSTICERCOSIS, see below)
 - iii. AUTOINFECTION occurs if ova hatch in small intestine
 - (c) Oncosphere penetrates gut wall entering blood vessels of intermediate host
 - (d) CYSTICERCOSIS
 - i. Cysticerci or “bladder worms” form in muscles and body organs (Does occur in humans)
 - ii. Each cysticercus contains many potential adults
 - iii. When cysticercus is eaten, worms evaginate and attach to wall of small intestine
 - (e) Humans are only known definitive host
 - (5) Symptoms
 - (a) Adult worms: Induce no symptoms
 - (b) Cysticerci can be pathological depending upon location
 - i. Commonly in cerebrum & meninges
 - ii. Paralysis and epilepsy
 - iii. Most common cause of seizures in Mexico

Slide 12: Human Brain Containing Numerous Cysticerci of *Taenia solium* (Textbook Figs. 21.16; 21.17 & 21.18, pp. 350-351)

- d. Cyclophyllidea shed light on human evolution

- (1) Archaeological evidence indicates humans domesticated cattle & pigs about 10,000 years ago
- (2) Prediction
 - (a) If humans acquired tapeworms from ancestors of tapeworms in modern-day cattle & pigs...
 - (b) Then, DNA sequences of human tapeworms would be...
 - i Most similar to tapeworms of cattle & pigs
 - ii Sequence similarity would be extremely close if tapeworms were acquired after domestication of cattle
- (3) Test by Hoberg et al., (2001) who compared DNA sequences of 35 tapeworm species

Slide #13 Phylogenetic tree data from Hoberg *et al.* 2001

- (a) Results
 - i *T. saginata* was most similar to lion tapeworm
 - ii *T. solium* was most similar to hyena tapeworm
 - iii Diverged from common ancestors between 1.7 million to 170,000 years ago
- (b) Conclusions
 - i Reject hypothesis described in “d(2)(b)”
 - ii New Hypothesis: Ancestors of modern humans fed upon the kills of large African predators (= competed with ancestors of modern lions and hyenas.

The most dramatic relationship, however, is between hyenas and Africa's largest predator, the African lion. There seems to be a constant war between these two gregarious species, and it is not always over food, either. Normally, boundaries of another species are disregarded, but not in the case of the hyena and lion. They will put up boundaries against each other...and threaten each other at the borders with snarls, roars, urine, and paste...A pack of hyenas can easily kill a lioness, and are enough to intimidate an entire pride. Hyenas will kill lion cubs, and lions will kill both adult and juvenile hyenas. Lions will steal hyenas' kills just as many times as hyenas steal kills from lions. Sometimes, a neighboring clan and pride will wage a war with each other...Often, prides with more than one male are at the advantage, and are less the target of hyenas as would be prides with one or no males, since male lions are the only thing that truly intimidate a hyena. The lion is the only natural predator of the hyena.

From Lioncrusher's Domain <http://www.lioncrusher.com/animal.asp?animal=75>

Video of Lion/hyena interactions: http://www.metacafe.com/watch/65759/the_lion_king/

- e. *Echinococcus granulosus* (Fig. 21.20; p. 353)
 - (1) HYDATIDOSIS
 - (a) Humans can be intermediate hosts

- (b) Oncosphere becomes bladderworm or “hydatid cyst” in lungs and liver
- (c) Inner lining of cyst produces thousands of potential hosts
- (d) Pathogenicity
 - i. Cyst diameter about 15 cm (= 6 inches)
 - ii. Cause organ damage and death
 - iii. Surgical removal is only treatment
- (2) Common in sheep-raising areas of Australia, South America, & Middle East

Slide 14: Hydatid Cysts of *Echinococcus granulosus* (Textbook: Figs. 21.25 & 21.26; p. 355)

- (3) Normal hosts
 - (a) Definitive hosts are canines: wolves, foxes, & dogs
 - (b) Intermediate hosts
 - i. Rabbits
 - ii. Moose
 - iii. Sheep
 - (c) Important consequences of hunting clubs illegally importing foxes into southern US
- f. *Diphylidium caninum*
 - (1) “Dog tapeworm”
 - (2) Intermediate host is the flea
 - (a) Flea larvae eat tapeworm eggs
 - (b) Dog gets tapeworm when it eats flea
 - (3) Children infected if they eat an infected flea
 - (4) Symptoms mild