

Phylum PLATYHELMINTHES Continued.

Class Cestoda 2 Subclasses

→ I follow Schmidt's classification system, there are several others, based on different methods for arriving at classifications.

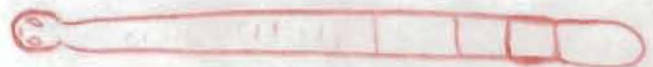
① Subclass Eucestoda

-12 orders in the group. We will talk about the most important, medical and veterinary.

② Sich. cestodaria - monozoic w/ 10 hooks

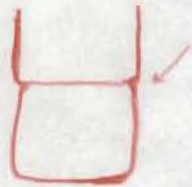
Morphological Characteristics of Tapeworms.

Terms + Definitions



Proglottids - Reproductive organs in a chain.

Many proglottids - Polyzoic, Body = Strobila.



One proglottid are Monozoic. e.g. *O. Caryophyllidea* [parasite of catostomid fish]

Usually strobila is segmented, zone of muscular weakness at the anterior and posterior ends of each proglottid.

-Some polyzoic, but lack segmentation.

-Others may have more than one proglottid per segment.



\* Each Proglottid contains 1 or more sets of reproductive organs. Depending on the genus.

Proglottids or segments are produced near the anterior end of the animal by asexual budding = Strobilization. Body called Strobila

Each bud moves toward the posterior end as a new one takes its place.



craspedote vs. Acraspedote - Velum not present.



Gonad maturation.

As the proglottid moves down the body or the Strobila, they become sexually mature, in many cestodes, the testes mature first

\* = Protandrous, or Andogenous.

\* If female system matures first = Protogynous or Gynandrous.

### Types of egg shedding:

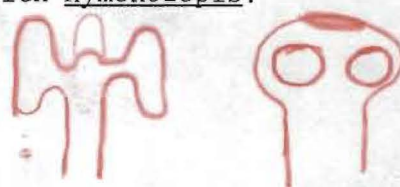
Gravid proglottids (ones filled with eggs) break off the posterior end of the worm and either disintegrate or pass out with the feces.

- 1) -Apolytic - segments detach and leave with feces and disintegrate.
- 2) -Anapolytic - segments stay attached and shed eggs into GI tract.
- 3) -Hyperapolytic - segments detach before becoming gravid.

The SCOLEX is the holdfast organ of the tapeworm, and this may be equipped with many different structures, usually thought to aid in attachment.

### Types of Accessories on scolex:

- rostellum, hooks, suckers, Grooves, Glandular areas.
- the scolex is highly moveable. We will see this in the lab when we necropsy a rat that is infected with Hymenolepis.



### ORGAN SYSTEMS OF CESTODES

\* Tegument. [~~SEE HANDOUT~~] drawing on board.

-Cestodes lack a digestive system, and thus absorb all nutrients through the body covering.

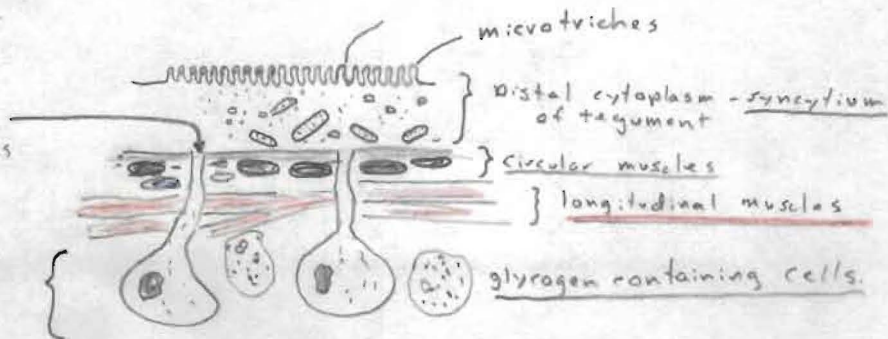
-surface cestode called the Tegument is covered with tiny fingerlike microtriches, analagous to the microvilli of the vertebrate intestinal epithelium (increase in surface area).

-the tegument is a syncytium, with the cell nuclei or perikarya communicating with the distal cytoplasm via trabeculae extending through the superficial muscle layers and connective tissue.

longitudinal section of cortical tegument

Trabeculae or Intervenuial processes

Perikarya



microtriches

distal cytoplasm - syncytium of tegument

Circular muscles

longitudinal muscles

glycogen containing cells.

Muscle system [see handout of tegument section]

Well developed, with circular, longitudinal, and transverse muscles.  
No evidence of striations.

Excretion [See handout or Drawing] →  
See plates



Protonephridia. Flame cells with cilia. Ductules feed to the main excretory ducts. Most cestodes have dorsal and ventral systems. Dorsal usually reduced in size relative to Ventral system.

This is one easy way to orient dorsal and ventral in a cestode, ovary is also always ventrally oriented.

Fluid movement in dorsal duct moves toward scolex, in ventral duct, toward posterior end.

Nervous System

*-nerves are unmyelinated.*

Primitive Ladder type through the body.

The scolex has cerebral ganglia, and some motor nerve endings.

Physiological Systems.

-One mole of Glucose produces from 4 to 6 moles of ATP in the cestode metabolic pathways.

-Glycolysis is most important. The TCA cycle is non-existent as a major source of energy production.

-There is an interesting Alternate pathway of use of PEPyruvate, one that can either degrade PEP to Pyruvate and then to Lactate, or to Acetate, or Succinate via Malate. (See handout).

p 360 Schmidt + Roberts.

-Glucose is the primary source of energy, lipids have not been shown to be used by the cestode.

cestodes migrate up and down the intestine, dependent on the feeding cycles of the rats, or host.

Storage of glucose is in form of glycogen.

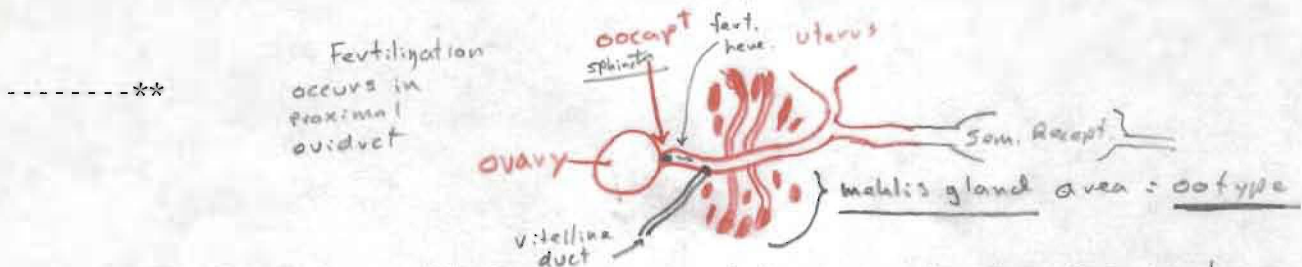
Reproductive systems: [see handout] - Boerd

Like that of a trematode, with minor modifications.

[Go over the handout]

(male system) - testes, vasa efferentia, vas deferens,  
\*external Seminal Vesicle.  
Cirrus pouch, internal seminal vesicle, cirrus.

(Female system) - Ovary, vitellaria either diffuse or compact.  
*called* → [oogenotop] Seminal receptacle, vagina, Uterus.



Egg formation: [1] Ova pass out of Ovary. = Ectolecithal (dont prod. own yolk) Fert. occurs here.

[2] -Combine with vitelline cells [<sup>prod.</sup> yolk and shell]

[3] -Pass down oviduct through [ootype] mehlis gland produces membrane around the zygote.

[4] Shell is formed from vitelline cells.

[5] -Into Uterus, embryonation

Life cycles and General Biology.

[1] -Indirect cycles Most have this type. (\*draw example)

[2] -Direct Cycles, Few have this type.

General pattern that is found in most cestodes:

Reproductive systems: [see handout]

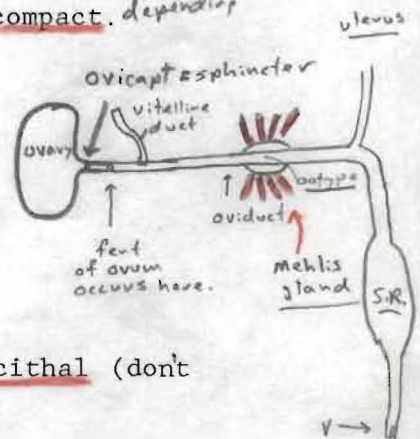
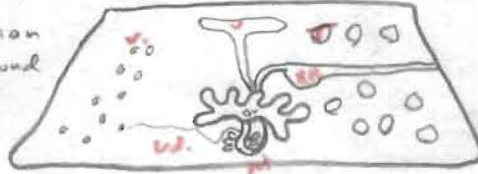
Like that of a trematode, with minor modifications.

[Go over the handout]

- \* (male system) - testes, vasa efferentia, vas deferens,
  - \* external Seminal Vesicle.
  - Cirrus pouch, internal seminal vesicle, cirrus.

whole System called → \* (Female system) - Ovary, vitellaria either diffuse or compact, depending on oogenotop. Seminal receptacle, vagina, Uterus.

Vit. → yolk + shell formation  
 \*\* Mehlis → prod. Membrane around zygote + ASS. cells.  
 Egg shell form. completed from within by vitt. cells.



Egg formation: [1] Ova pass out of Ovary. = Ectolecithal (don't prod. own yolk) Fert. occurs here.

zygote [2] -Combine with vitelline cells [yolk and shell]

[3] -Pass down oviduct through ootype, mehlis gland produces membrane around the zygote.

[4] Shell is formed from vitelline cells. within.

[5] -Into Uterus, embryonation

Life cycles and General Biology.


Two general types of life cycles of cestodes.

[1] -Indirect cycles Most have this type. (\*draw example) eg. Nyamenolopis

[2] -Direct Cycles, Few have this type. eg. Vampirolopis nana.

General pattern that is found in most cestodes:

↳ of life history

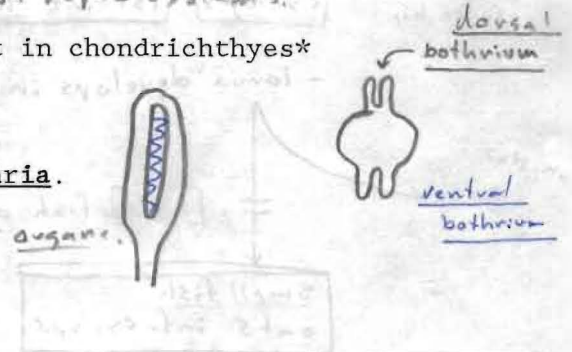
- [1] Embryogenesis results in an onchosphere larva.  also called a hexicauth.
- [2] Hatching after or before being eaten by next host. (depending on species).
- [3] Penetration to parenteral (extraintestinal) site.
- [4] Metamorphosis into a juvenile Metacestode. (changing stage) (int. host is eaten)
- [5] Development of adult from metacestode in intestine of definitive host.

\*\*Several morphological types of larval tapeworms, we will discuss them when we get to the various orders in which they exist\*\*

Order Pseudophyllidea : from 1-20 sets of repro systems.

\*parasites of all vertebrate classes, not in chondrichthyes\*

Morphological Characteristics:

- Scolex with grooves called Bothria.  
serve as hold fast + locomotor organs.
  - Proglottids have separate uterine pores.
  - Proglottid like a fluke.
  - Female and Male genital pores open in a common Genital Atrium. - some sup. middle of proglottid. - some on margin.
- 

Family Diphyllbothriidae

- Diphyllbothrium latum "The broad fish tapeworm"

Distribution: Northern Hemisphere.

Definitive host: Carnivorous (piscivorous) mammals, Man too.

In some areas of the world prevalence may reach 100% in the human population.

- May reach 30 to feet long. 40 50

Life Cycle:

Egg shed into water, Operculum opens and out comes a Ciliated Coracidium.

Copepod ingests, larva penetrates into hemocoel (parenteral site).

Infective to Next Intermediate Host.

[in fresh water = Cyclops = genus of copepod]---Human Ingests Water.

Sparganosis - Development of larva in parenteral site.

Cyclops is eaten by a small fish, pleurocercoid develops in muscle.

Small fish is eaten by large fish, Pleurocercoid migrates to muscle here.  
=(paratenic host) not required by parasite, but will do well until transfer to the definitive host occurs.

Carnivore eats large fish, Cestode develops in the Intestine.

Epidemiology:

see life cycle drawing.

Humans become infected with either larval or adult stages depending on which stage they ate or were exposed to.

Other species cause infections in man besides Diphyllobothrium however, the larval stages are difficult to identify.

Three main modes of infection:

- [1] Ingestion of 2nd int. host and aquisition of adult cestode in gut.
- [2] Ingestion of 1st int. host (copepod) - Pleurocercoids develop in body.
- [3] Infection may occur via transfer of pleurocercoid from a split frog applied to eye, inflamed vagina, or wound. {{Old Chinese remedy}}

Other species cause different types of sparganosis.

Diphyllobothrium <sup>later</sup> is usually associated with Northern hemisphere cases of infection.

Pathogenesis:

(1) [Adult worms in intestines]

-Verminous Intoxication

-Pernicious Anemia, Worm absorbs vit B12, and outcompetes host for this vitamin, the host becomes anemic because of the lack of vit b12..

(2) [Sparganosis] *Spargana* in tissues (= larval stages).

-Inflammation of organs caused by spargana in them.

-Lumps in connective tissue, or in eye, etc..,

Diagnosis and Treatment:

Eggs or proglottids passed in feces.

Drug of choice Cucuberin, developed from cucumber seeds.

For Spargana-Surgical excision.

O. Cyclophyllidea

Morphological characteristics:

-Single compact vitelline gland.

-Scolex with four suckers.

-Genital pores all lateral in proglottids. But for one family, Mesocestoididae

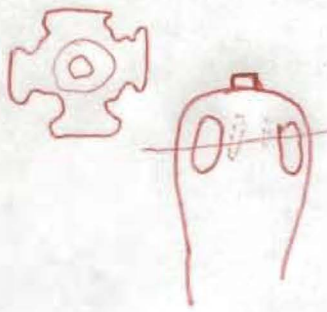
Most cestodes of birds and mammals are in this order  
Some species are large >>30 feet, most are small.

-No species with adults in fish.



O. Cyclophyllidea

Morphological characteristics:



- Single compact vitelline gland.
- Scolex with four suckers.
- Most with 1 set of reproductive organs/segment.
- Genital pores all lateral in proglottids. But one family, Mesocestoididae

~~for more~~

Most cestodes of birds and mammals are in this order  
Some species are large >>30 feet, most are small.

- No species with adults in fish.

Family Taeniidae ← The medically important cyclophyllideans.

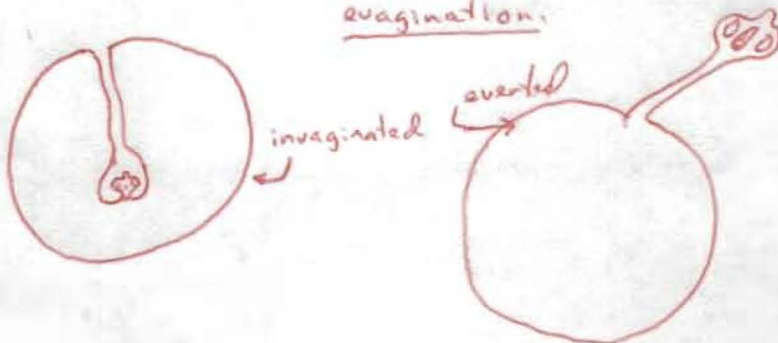
Taenia = Ribbon.

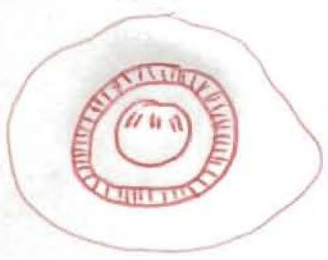
Contains most of the medically important cestodes.

- Most with armed rostellum.
- Testes few to Numerous.
- Mammals are intermediate hosts.
- Largest of the cyclophyllideans.
- Larval forms are bladderworms of various types. = cysticercus.

Drawing of a cysticercus. A fluid filled bag with the scolex inverted into it. If a carnivore eats this, the bladder is evaginated, digested away and strobilization begins.

Bile salts stimulate evagination.

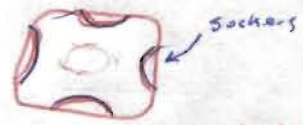




Drawing of egg. Taeniid eggs have a characteristic striated appearance, surrounded by a thin outer membrane. The outer membrane is usually lost in the feces.

[1] Taenia saginata also called Taeniarhynchus saginatus

-the beef tapeworm.



Morphological characteristics.

-lacks rostellum or hooks on the scolex. Scolex is box-like w/o Rostellum.

Hooks & Rostellum - these are present in the larval form of this species, evident through study of ontogeny. Thus the genus Taenia!!

-Mature proglottids are wider than long, with 300 - 400 testes.

-Gravid proglottids are longer than wide with a uterus that is characterized by having a medial stem with lateral branches.



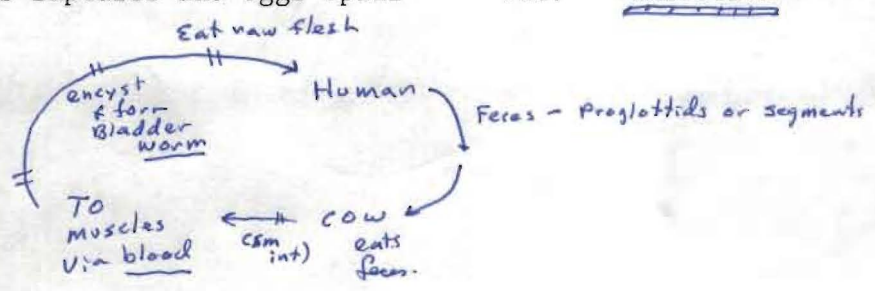
-Eggs are typical taeniid eggs with a striated appearance.

Life Cycle:

-human in the natural definitive host!!

-this worm can grow to be 20 - 30 feet long.

[1] Apolytic- Segments detach when gravid and migrate out of the anus or are deposited with feces. -Highly mobile- crawl about on the ground, like independent organisms. Uterus ruptures and eggs spill out. -Infective -



[2] Cattle are intermediate hosts --Measly Beef- a cow that is infected.

-egg hatches and typically penetrates the small intestine of the

cow and emerges into the blood system. Any muscle of the body of the cow can be infected.

[3] Humans are infected when they eat raw beef with the cysticercoids.

-bladderworm evaginates in small intestine of human and develops to maturity.

Distribution: cosmopolitan where people eat cattle - Raw.

Most prevalent in Africa and South America where beef is eaten commonly.

-Associated with low levels of sanitation and poor sewage disposal.

Epidemiology:

one person defecating in a cattle feed-lot can infect almost all the cattle.

In India moslems may have high prevalence of infection. *Some places, cows will eat dung.*

*worm may live several years.*

Control:

→ Proper disposal of sewage and cooking meat before eating.

→ Freezing beef in deep freezer kills the larvae.

Pathogenesis:

Eggs not infective to humans.

Verminous intoxication with symptoms of abdominal pain, headache, Delirium is possible, loss of appetite, opposite of folioma.

Psychological trauma observing large motile proglottids moving around

a fresh stool, or crawling out of the anus at a dinner party.

Diagnosis:

4  
\* -Gravid proglottid with 15 - 20 lateral branches on each side of main stem of uterus. Scolex

#### Treatment

Niclosamide.

\* Taenia solium \*The pork tapeworm\* - A fairly rare species.

#### \* Morphological characteristics:

Armed → Scolex with two circles of non-retractible hooks.

- About 1 mm in diameter.

Strobila 6 - 10 feet long. *may be longer.*

Mature proglottids wider than long with 150 - 200 testes.

\* Gravid proglottid like T. saginata but with only 7 - 13 lateral branches per side.

#### o Life cycle:

*(about the same as T. saginata but pig is int. host)*

Human is definitive host.

[1] Proglottids pass with feces, infective when passed, and before!!

→ Pigs (swine) eat them and become the intermediate host.

[in swine it is called Cysticercus cellulosae]

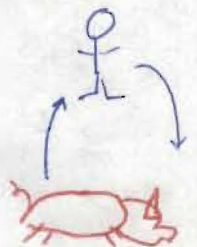
→ this stage was described before the life cycle was known. ...

[2] Cysticerci develop in muscles of pig and are transferred to humans when raw pork is eaten.

[3] cysticercus evaginates in small intestine and develops to adult in about 6 weeks.

#### Epidemiology:

The cycle is prevalent where unsanitary conditions exist and pork is commonly eaten, undercooked.



\* Control:

Cook or freeze pork before eating, dispose of wastes properly.

\* Pathogenesis:

~~most frequent agent + cause of disease in humans called~~

~~caused by taeniid larvae.~~

This species causes

Cysticercosis: disease caused by larval taeniid cestodes in humans.

Fecal contamination of food stuffs <sup>by infected humans</sup> is dangerous because the cysticerci can develop in the human and cause severe damage to organ systems of the body.

\* Infection: Eggs hatch in the sm. int. intestine of int. hosts.

-Route of infection: ① Proglottid may migrate up <sup>to duodenum</sup> or the eggs may be carried there due to reverse peristalsis, or ② the fecal-oral route may occur.

\* hexacanth embryos penetrate the small intestine and then migrate via blood to all organs of the body where they encyst, ~~via the blood stream.~~

encyst in these organs

↳ most commonly [1] connective tissue

[2] eye

[3] brain

\* 1% of removals of eyes in US caused by T. solium mistaken for melanoma. ~~some people have etc etc~~

-symptoms: vague paralysis, blindness, hydrocephalus, epilepsy.

-usually, diagnosis is made at autopsy when the CNS is involved.

-May become metastatic <sup>usually</sup> cause massive organ damage.

-long term cases may calcify, resulting in blindness, etc..

Other taeniids that may be encountered, see Schmidt & Roberts for more.

T. serialis-canid parasite, sheep may be int. host.

\* Taenia serialis -causes gid or staggers in sheep, when sheep ~~become~~ <sup>are</sup> infected with the larval cestode in the CNS.

-larval stage is called a coenurus, with many protoscolices developing inside the bladder.



germinal zone gives rise to protoscolices each is infective to def. host.

drawing:



② Taenia pisiformis [coyote parasite] [int. host is rabbit]

③ T. taeniaformis in cats, with voles the intermediate host.

The next important genus is Echinococcus spp. still F. Taeniidae some authorities place these forms in a separate family.

\* Smallest cyclophyllidean, looks like a miniature Taenia. Adults have about 3 segments besides scolex and neck.

\* Causes a disease called Hydatidosis. Larval stages are large, called Hydatids.

give table

| Four species known.         | Def. host    | Int. Host  | Distribution   |
|-----------------------------|--------------|--|--|
| 1) <u>E. granulosus</u>     | Wolf/Dog     | Moose/Reindeer/Cattle/Llamas<br>(other herbivorous mammals)<br>Goats, etc... | Cosmopolitan <del>orig. Holarctic</del> where cows + dogs live |
| 2) <u>E. multilocularis</u> | Wolf/Dog     | Voles=Field mice   | Holarctic  |
| 3) <u>E. vogeli</u>         | Bush dog/Dog | Agouti: <u>Dasyprocta</u> (lg. rodents)                                      | S. america   |
| 4) <u>E. oligarthrus</u>    | Felids       | <u>Agouti</u> <u>Dasyprocta</u>  | S. america   |

E. granulosus -the bladder worm of this species causes CYSTIC HYDATID DISEASE.

-usual intermediate host is sheep or moose.

Sylvatic cycle is wolf - moose, or caribou.

Domestic cycle is dog - sheep, or other herbivore.

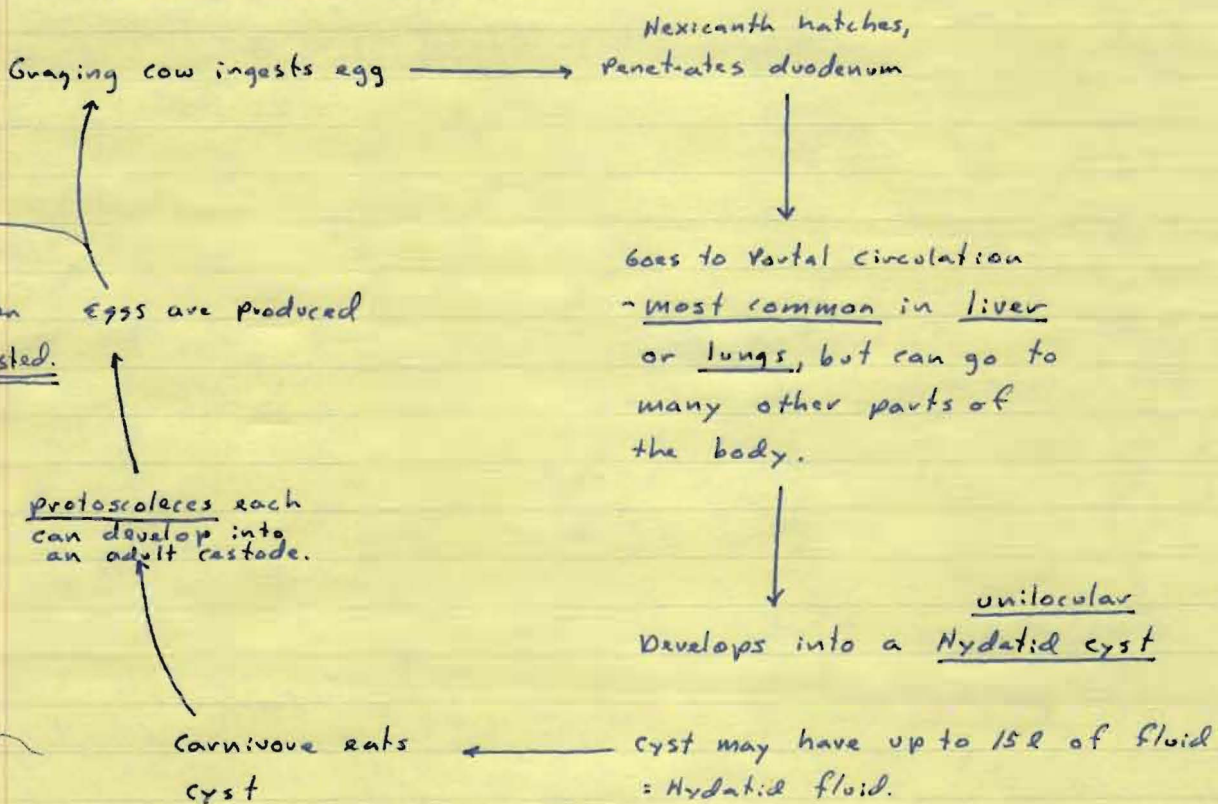
General biology:

Egg is ingested, hatches and penetrates to the portal-circulatory system. Liver and lungs are the most common sources for infection.

Forms a cyst with up to 15 liters of fluid in the cyst, in the large herbivore int. host.

cyst is called unilocular hydatid cyst

Good example of life cycle.

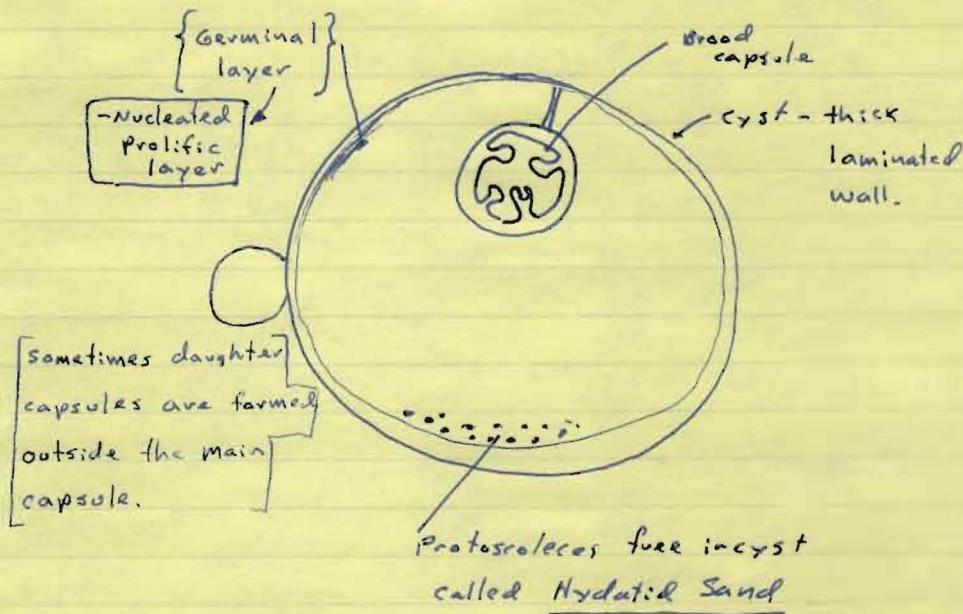


protoscolices each can develop into an adult cestode.

cyst contains

- 1) Brood capsules with
- 2) Protoscolices within.
- 3) Protoscolices also are produced
  - Brood capsule usually is attached to germinal layer of cyst

directly from the germinal layer.



Pathogenesis:

Humans.  
 Causes a large blockage in liver, liver malfunction.  
 many

Epidemiology:

Humans are infected when they ingest dog feces.

- Africa - some tribes relish roast-raw dog intestine.  
 with so many adults it looks like villi: ~~on the~~ coating the small intestine.
- close association with dogs that are infected causes human infection.

Pathogenesis:

- Liver obstruction + malfunction.
- often takes  $\approx 20$  years for symptoms to show up, especially if it is in liver.
- can localize in lungs, Brain, etc... with obvious side effects.

ELISA

- Surgery ~~very~~  $\rightarrow$  many people die when the doctor cuts into a supposed carcinoma  $\rightarrow$  the fluid drains out + causes Anaphylaxis.

Diagnosis: Immunologic techniques.

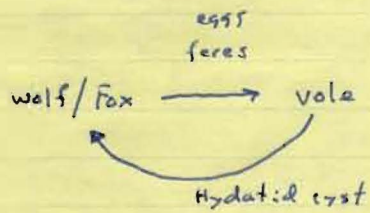
Enzyme linked Immuno sorbent Assay  $\rightarrow$  ELISA  
 in conjunction with CAT Scan.

Treatment: - Formalin injection into cyst unoperable cases

- mebendazole injection into cyst.
- Draining cyst.
- Surgical excision.
- many cases are beyond surgical treatment.



## Echinococcus multilocularis



morphology: Similar characteristics.

- smaller size
- ~~fewer~~ testes

cyst: Thin outer wall that proliferates by budding & infiltrates into surrounding tissue.

cyst in E. multilocularis is called Alveolar hydatid or multilocular hydatid.

- pieces ~~and~~ break off cyst & travel to other parts of the body & there proliferate. i.e. Liver

↓ Brain  
lungs etc..

Epidemiology: - fox trappers  
- Eskimos with dogs that eat voles.