

FIGURE 51-1 Major morphologic parts of an adult tapeworm.

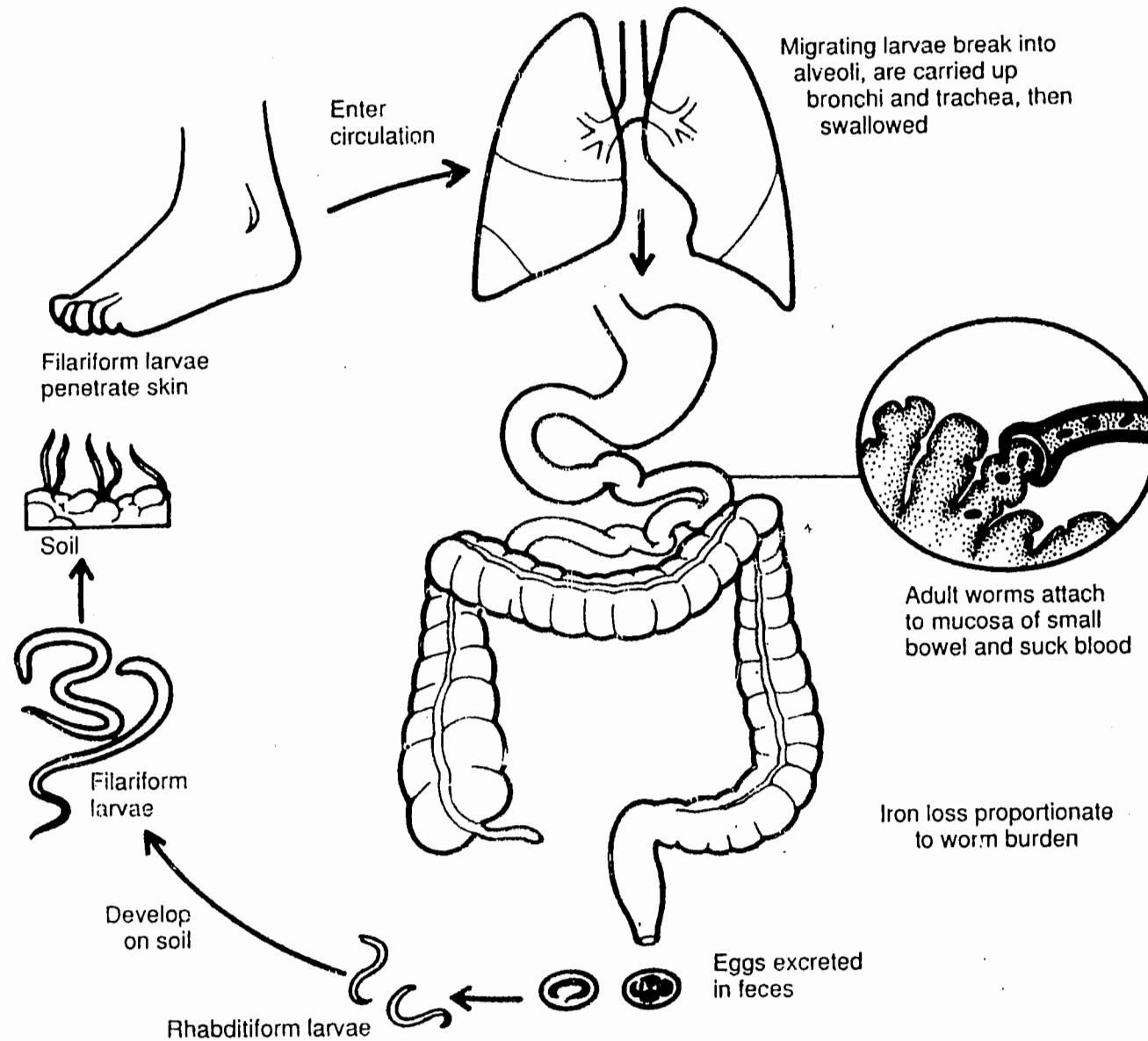


Figure 6-9. Life cycle of human hookworms (*Necator americanus* and *Ancylostoma duodenale*).

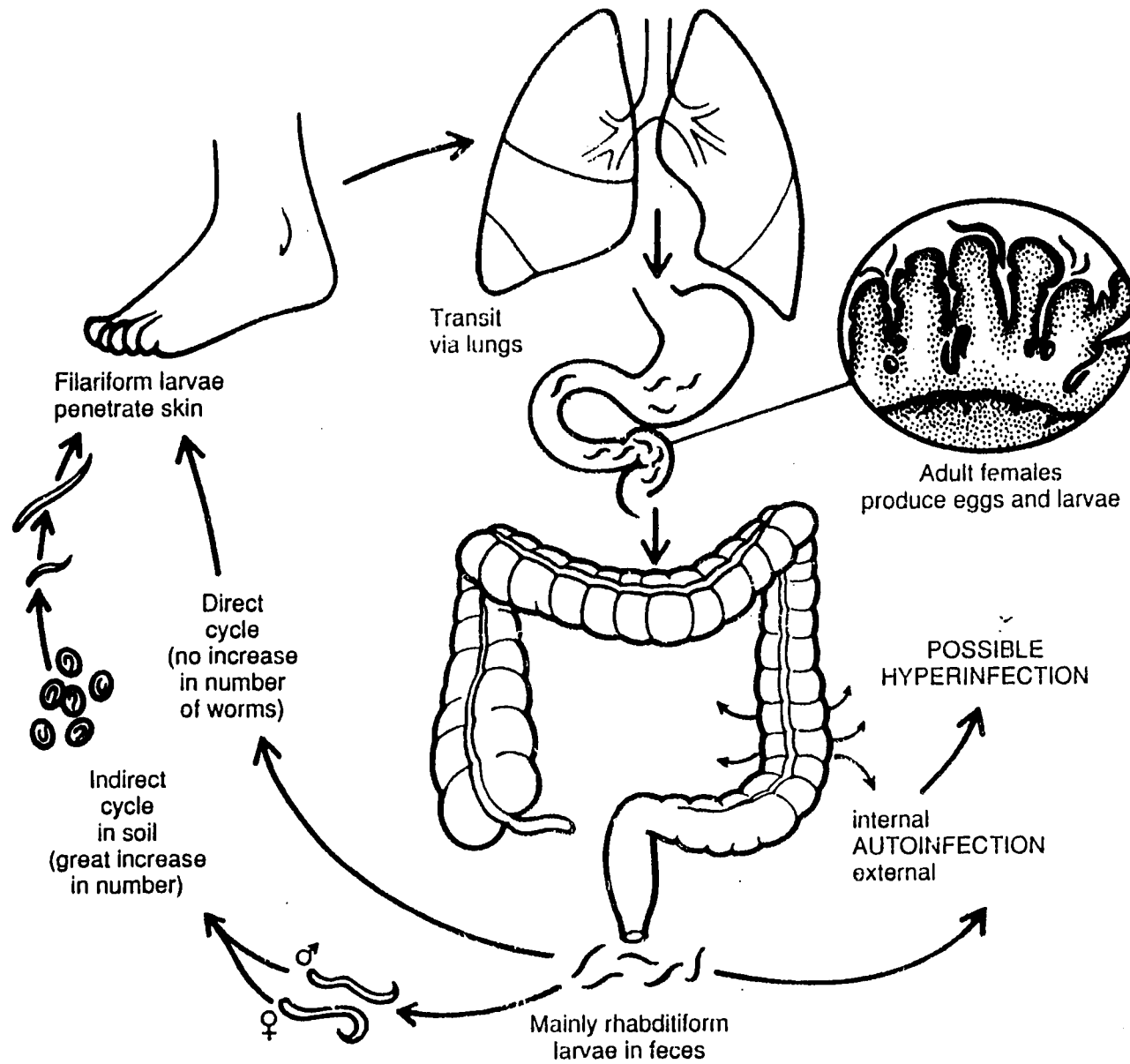


Figure 6-6. Life cycle of *Strongyloides stercoralis*.

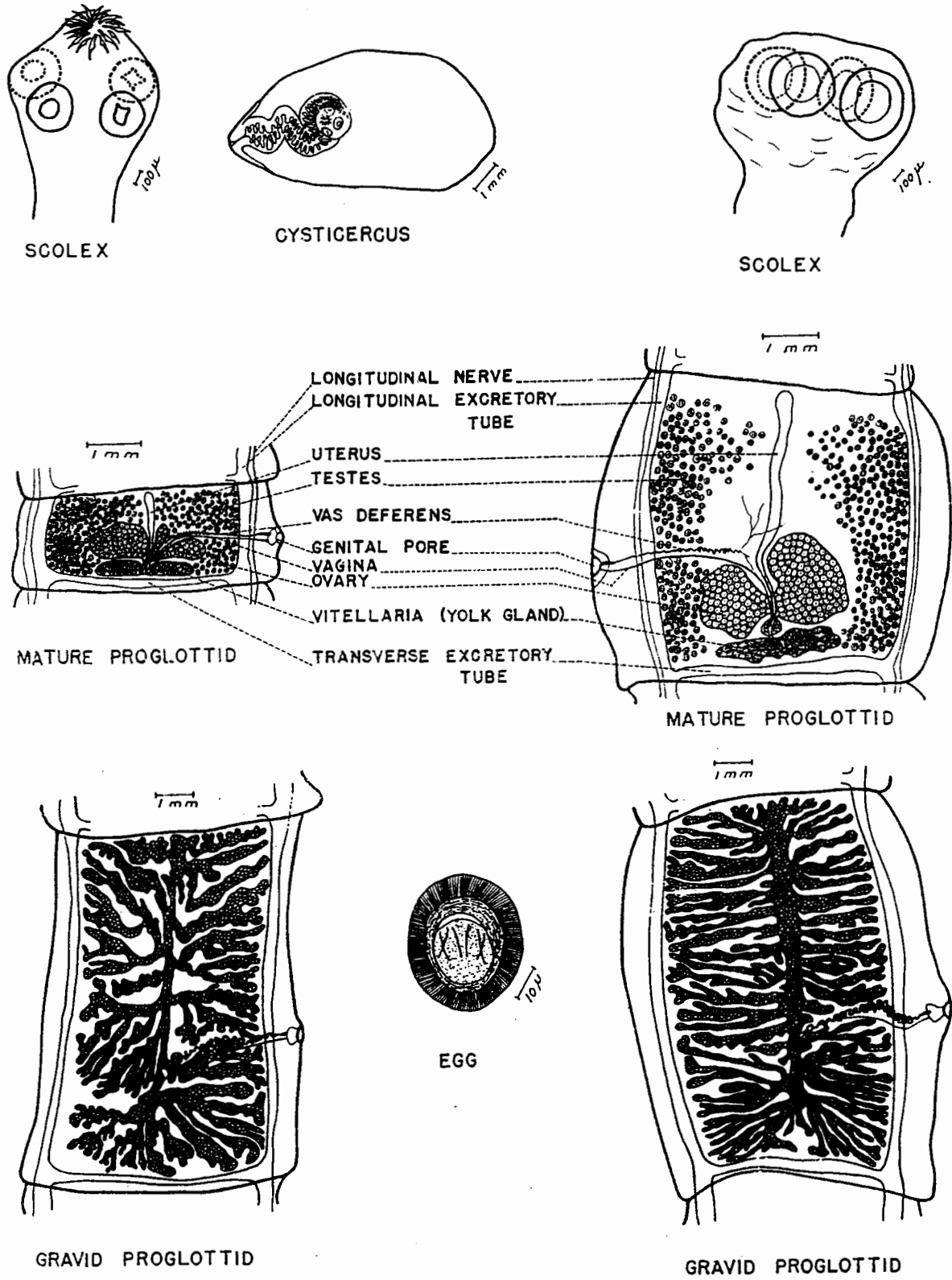


Figure 9-5. *Taenia solium* and *T. saginata*—a diagrammatic comparison.

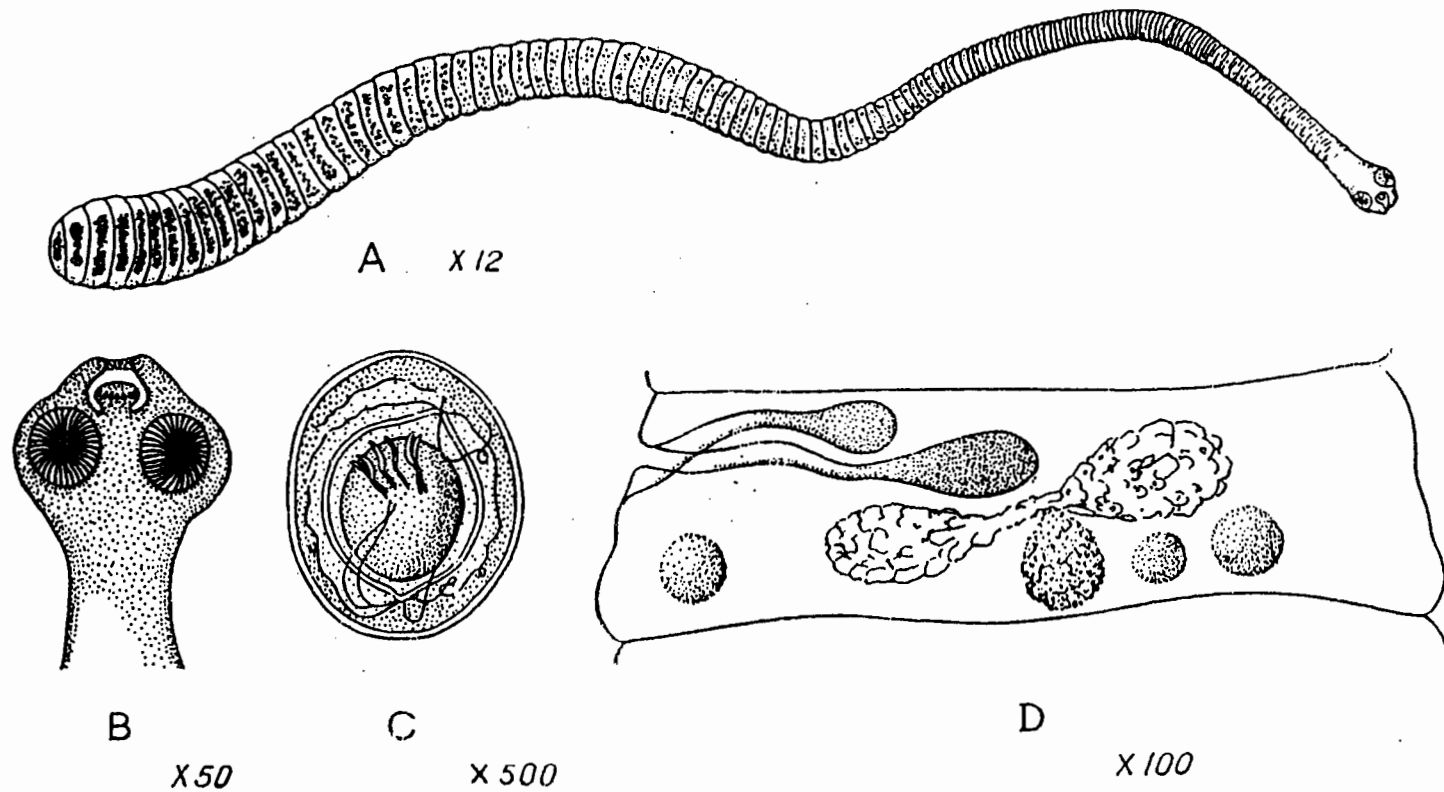


Figure 9-3. *Hymenolepis nana*. **A.** Adult worm. **B.** Scolex. **C.** Egg. **D.** Mature proglottid showing reproductive organs. (A redrawn from Leuckart, 1863. B redrawn from Blanchard, 1886. C redrawn from Stiles, 1903. D redrawn from Leuckart, 1886.)

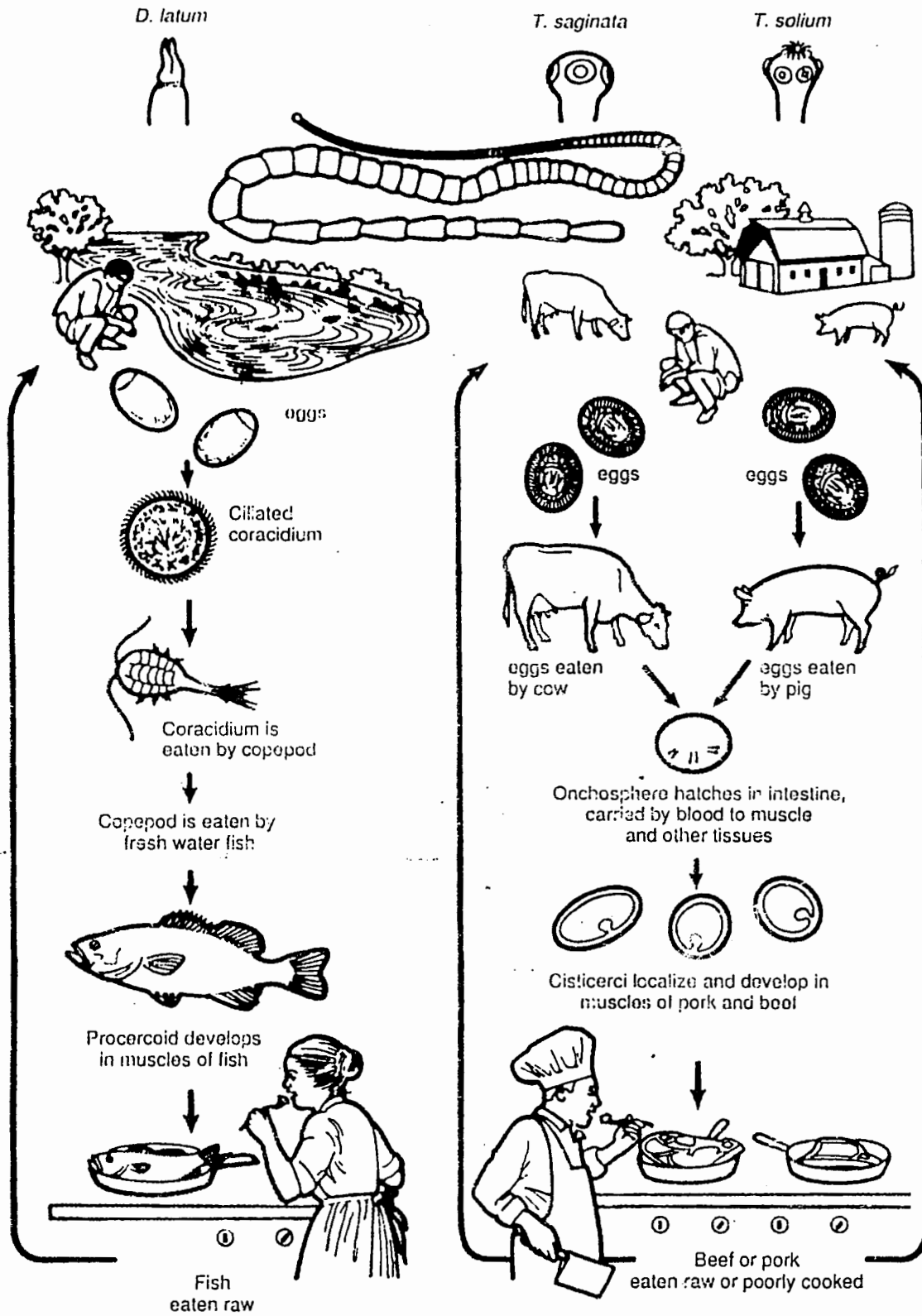


Figure 9-1. Life cycles of the 3 main human intestinal tapeworms.

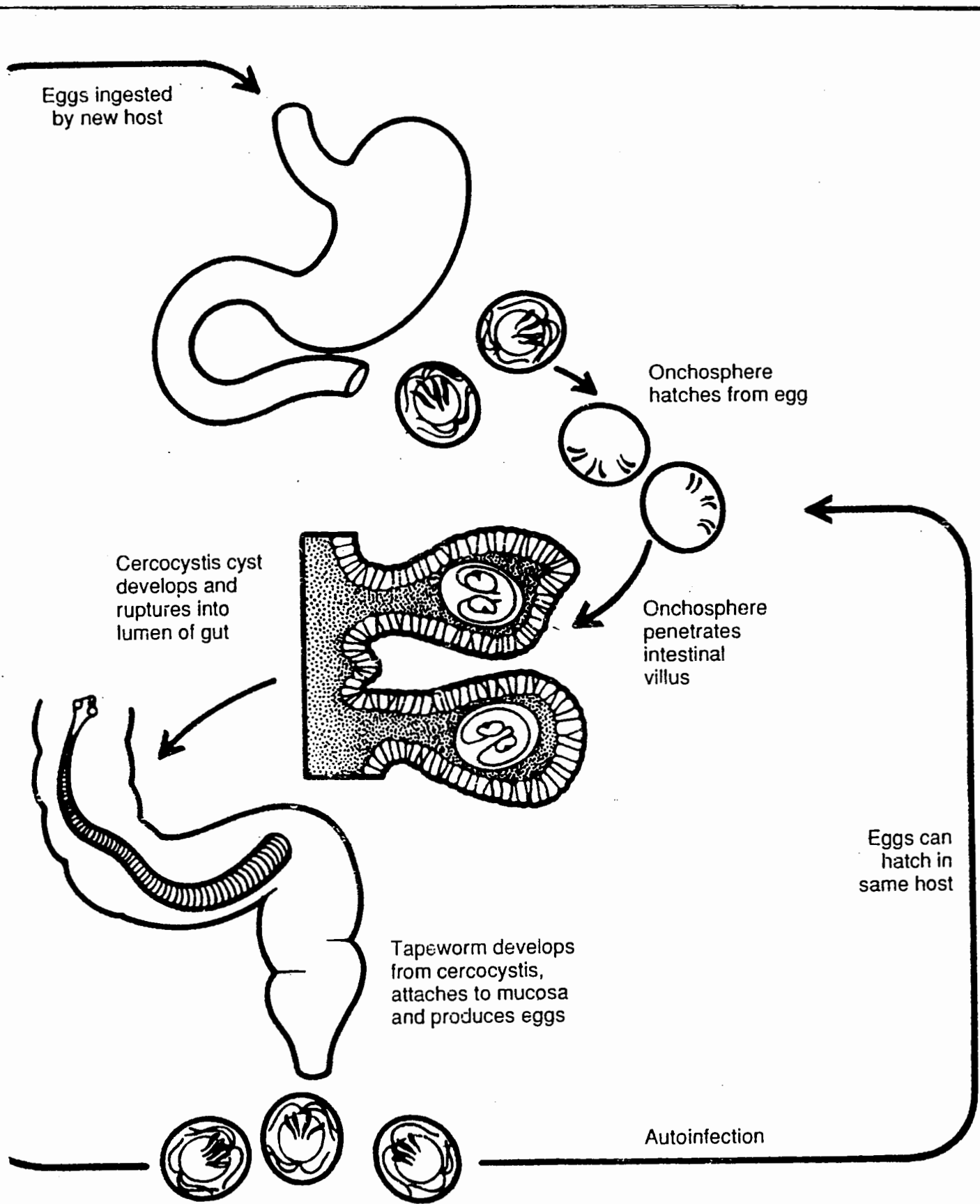


Figure 9-4. Life cycle of *Hymenolepis nana*.

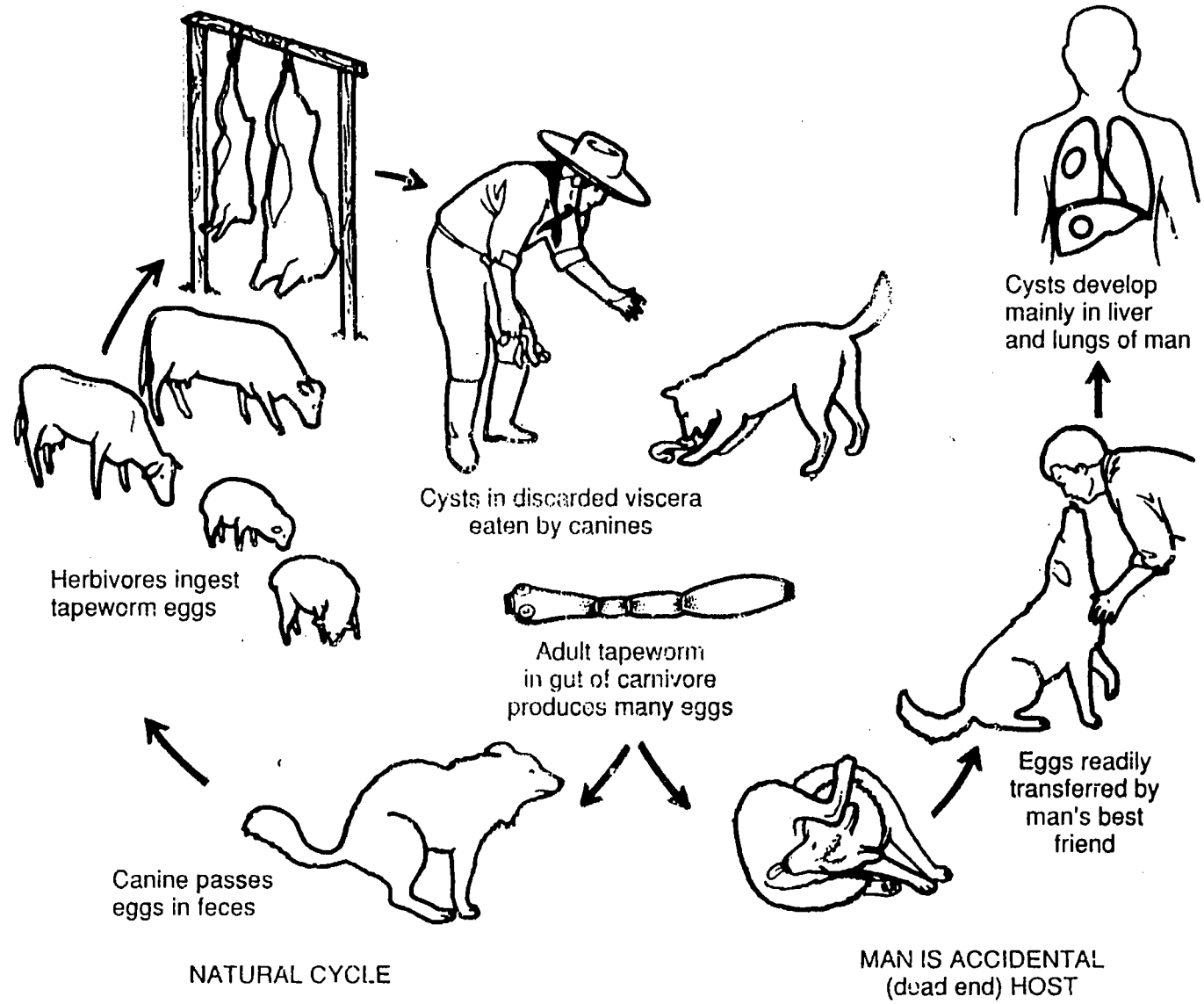


Figure 10-3. Life cycle of *Echinococcus granulosus*.

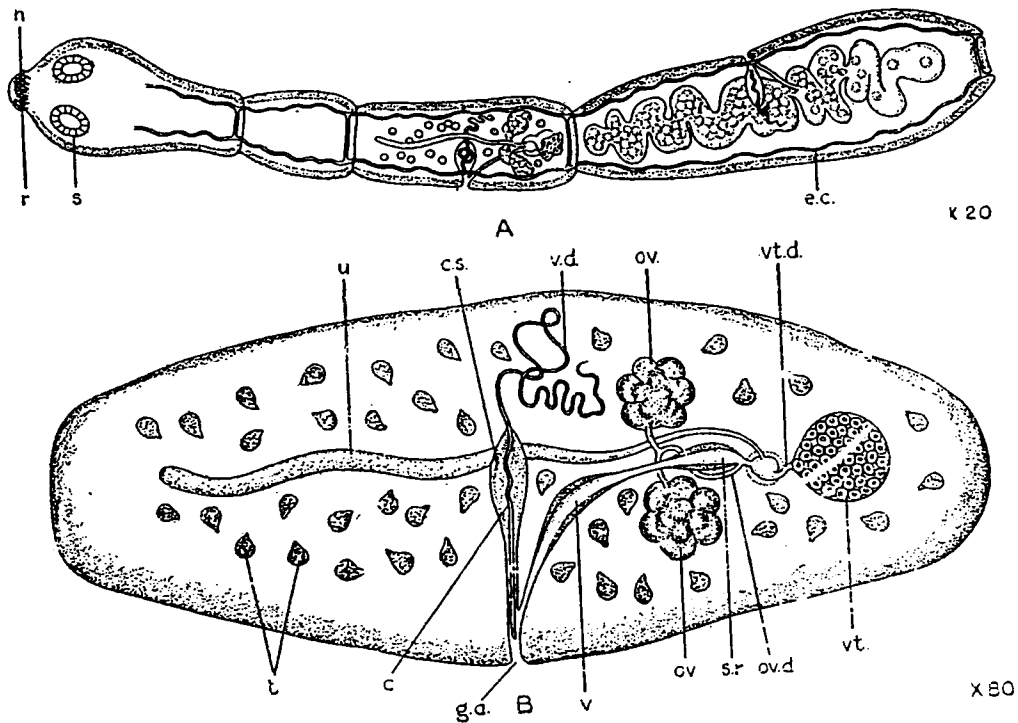
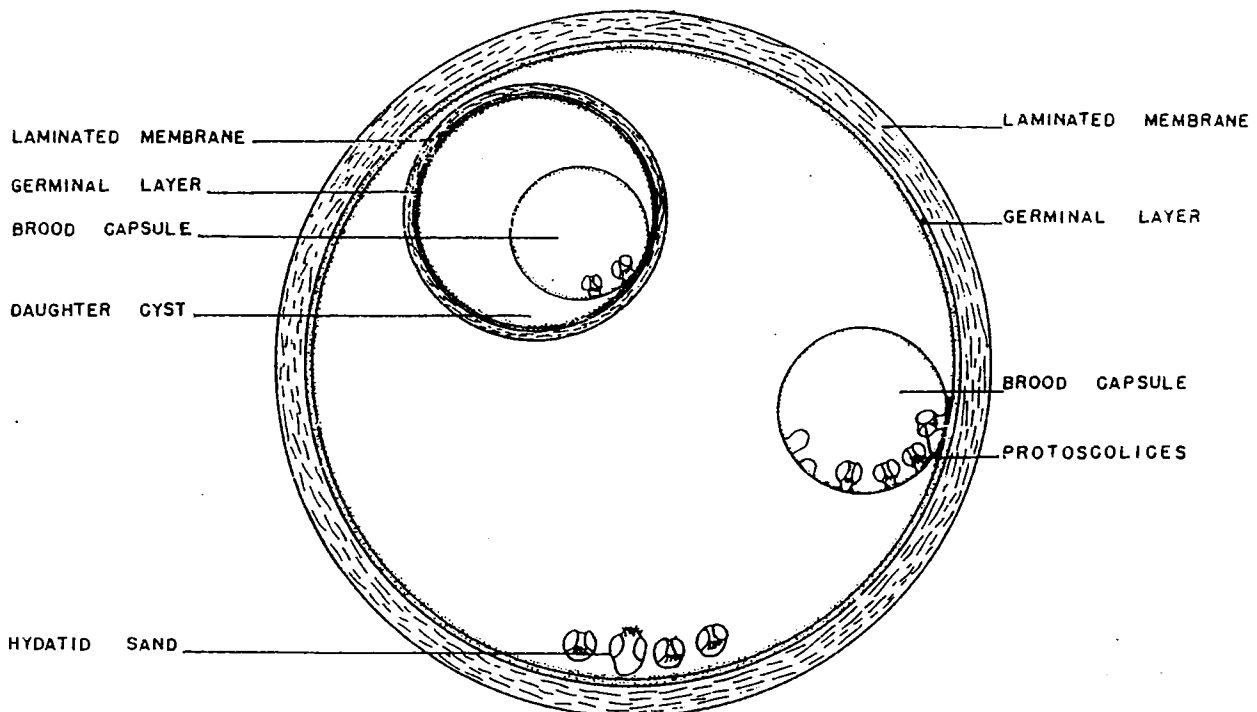


Figure 10-1. *Echinococcus granulosus*. Adult worm. (Top) Longitudinal. (Bottom) Cross section of mature segment. (Composite drawing.) ec.=excretory canal; h=hooklets; r=rostellum; s=sucker; t=testes; u=uterus; ov=ovary; ov. d=oviduct; g.a.=genital pore; v.d.=vas deferens; c.s.=cirral sac; s.r.=seminal receptacle; vt. d.=vitelline duct.



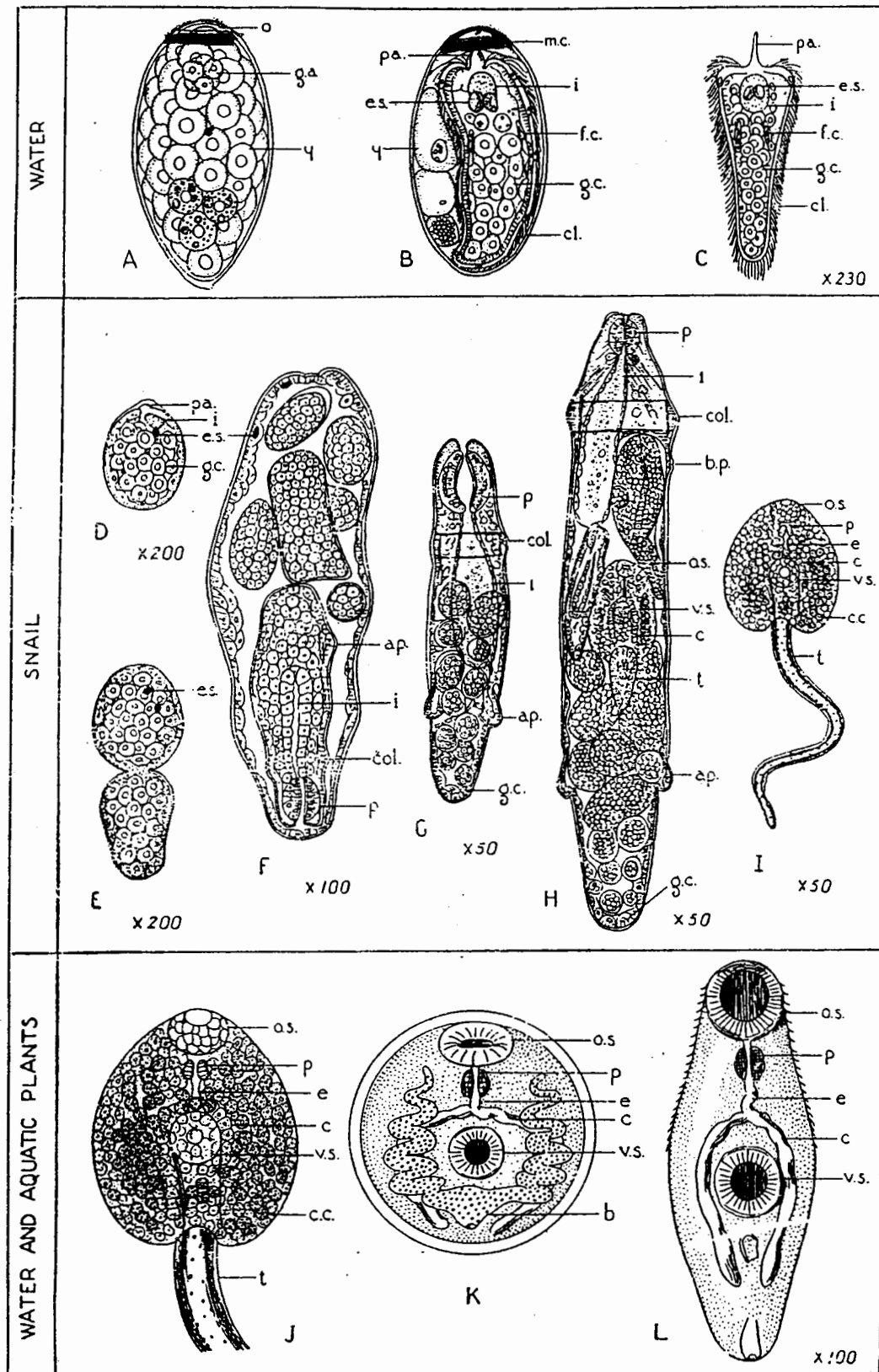


Figure 11-3. Larval forms of *Fasciola hepatica*. A. Immature egg. B. Miracidium in egg shell. C. Miracidium ready to enter snail. D. A very young sporocyst, immediately after completion of metamorphosis. E. Young sporocyst undergoing transverse fission. F. Adult sporocyst with rediae. G. Immature redia. H. Redia with developing cercariae and one daughter redia. I. Cercaria. J. Body of cercaria. K. Encysted metacercaria. L. Excysted metacercaria. ap.=appendages; b=excretory bladder; b.p.=birth pore; c=ceca; c.c.=cystogenous cells; cl.=cilia; col.=collar; e=esophagus; e.s.=eye spots; f.c.=flame cells; g.a.=germinal area; g.c.=germinal cells; i=digestive tract; m.c.=mucoid cap; o=operculum; o.s.=oral sucker; p=pharynx;

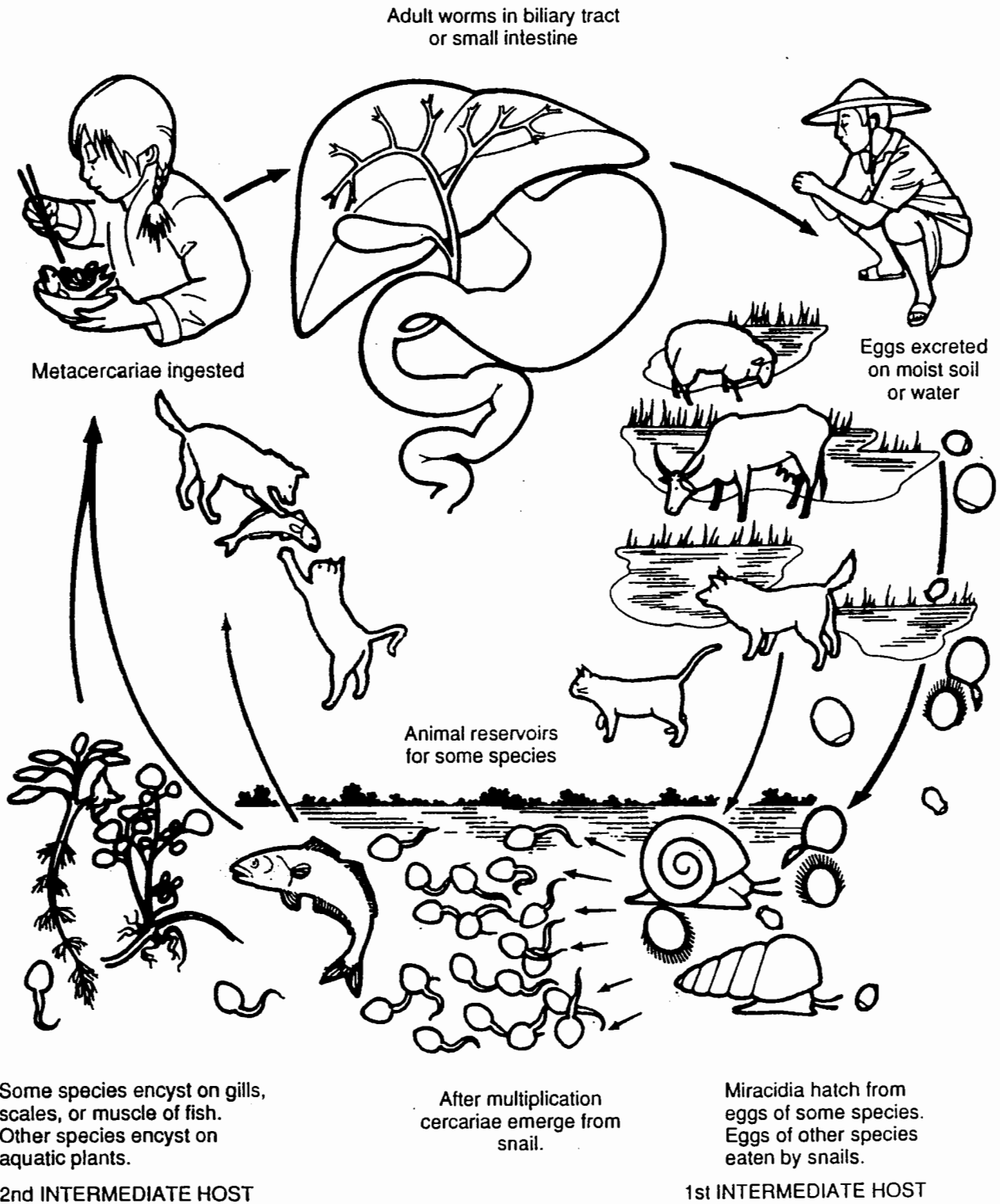
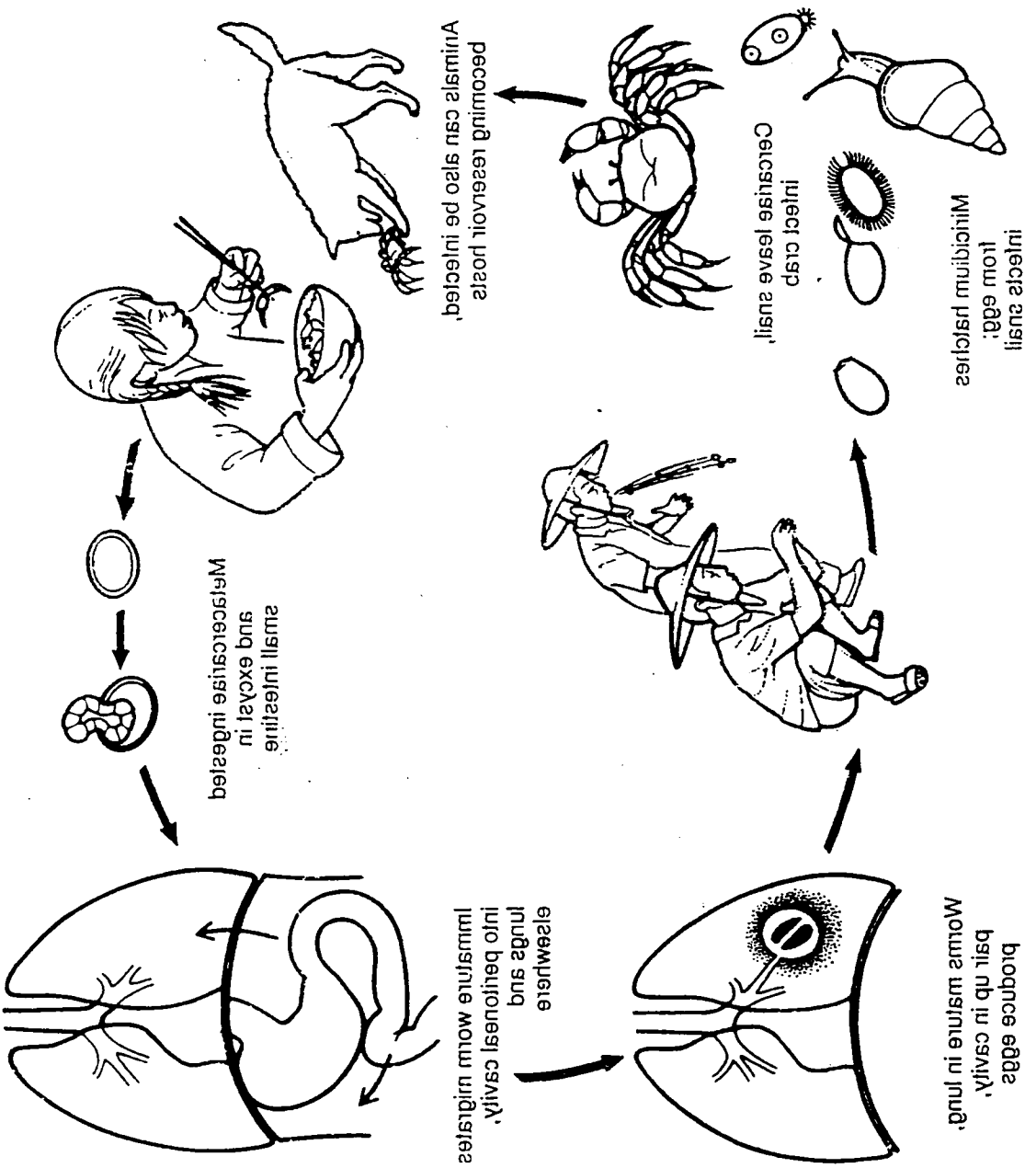


Figure 12-3. General life cycle for human intestinal and liver flukes (*Fasciolopsis buski*, *Heterophyes heterophyes*, *Metagonimus yokogawi*, *Nanophytes salmincola*, *Clonorchis sinensis*, *Opisthorchis felineus*, *O. viverrini*, and *Fasciola hepatica*).

Figure 15-8. Life cycle of *Paragonimus westermani*.



Platyhelminths :

Two classes of the phylum platyhelminths are parasitic to Man :

- 1)- Trematodes (flukes).
- 2)- Cestodes (tapeworms).

Trematodes :

These are flat, leaf shaped ranging from 1 mm to several cms in length. The worm is covered by an integument which may be covered by spines or ridges. There are no pores or microtrichia in the integument as found in the cestodes.

The worms are attached to the host by means of an oral sucker around the mouth and a ventral sucker which is larger and blind located posterior to the oral sucker, there may be hooklets associated with the sucker.

There are three muscle layers under the integument.

There is no body cavity. Loose connective tissue surrounding organs instead.

The digestive system is usually bifurcate ending blindly, indigestible waste is regurgitated through the mouth.

There is an excretory system and a primitive nervous system.

Except for blood flukes (Schistosomes) they are all hermaphrodites.

Eggs are usually operculated except Schistosomes.

Life span up to 30 years. Respiration is anaerobic usually.

Life cycle :

Sexual multiplication in definitive host producing eggs. There is asexual multiplication in the intermediate host a mollusc.

Eggs are passed in faeces, urine or sputum into water, the egg releases a ciliated miracidium which enters the snail, then the ciliae are shed and the miracidium changes into a sporocyst which produces daughter sporocysts or rediae.

Within the rediae cercariae develop and pass out of the snail into the water. Thousands of cercariae may develop from one miracidium. The cercaria may penetrate the skin of the host or encyst on aquatic plants or fish as metacercariae which when ingested by the definitive host can lead to infection.

All trematodes require an intermediate host (mollusc).

Intestinal flukes :

Fasciolopsis buski :

The adult worm is 2-8 cm long, it is the largest fluke of Humans.

It inhabits the small intestine.

Eggs are passed in the faeces, usual life cycle and metacercariae encyst on aquatic plants watercress.

It is prevalent in SE Asia.

Pathology and symptoms :

Inflammation and ulceration at site of attachment of worm, abdominal pain, nausea and vomiting. Int. obstruction.

Diagnosis :

Find eggs in the faeces.

Adult worms are sometimes vomited or passed in the faeces.

Some other flukes encyst on the gills of fish and perpetuate infection when eaten raw or slightly pickled.

Liver flukes :

Fasciola hepatica :

The worm is 2-3 cm long, it is mainly a parasite of herbivores.

It inhabits the biliary passages and gall-bladder.

Life span is about 10 years.

Metacercariae are found on grass, water cress or soil.

When ingested by the definitive host, they hatch in the small intestine, penetrate the wall into the peritoneal cavity, into the liver, parenchyma to biliary passages.

Pathology and symptoms :

Depends on worm load, enlarged tender liver, obstructive jaundice, eosinophilia.

Diagnosis :

Eggs in stools.

Treatment :

Dehydroemetine, dichlorophenol.

Pulmonary flukes :

Paragonimus westermani :

1st intermediate host is a snail. 2nd intermediate host is the fresh water crab, here the cercariae encyst in the gills or leg muscles.

When the crab is eaten, the metacercariae hatch and penetrate the intestinal wall into peritoneal cavity, through the diaphragm into the lungs.

Eggs escape by sputum, or faeces after being swallowed.

Symptoms :

Cough, blood stained sputum, pleurisy may be present. Eosinophilia.

Diagnosis :

Eggs in sputum or faeces.

Handout Micro

Taenia saginatum:

Adult worm is **4-6 metres** long, **1000-2000 proglottids**.

The scolex has 4 suckers but **no rostellum** (hooks).

The **gravid proglottid is distinguished** from that of *T. solium* in that it has more lateral branches of the uterus, 15-30 compared with 7-13 in *T. solium*.

The **yellow-brown eggs** cannot be distinguished from those of *T. solium*. **Radially striated embryophore** surrounds a hexacanth embryo.

The worm lives in the **jejunum**, gravid proglottids are passed in the faeces or may force their way through the anus, they are **motile** due to the muscle in the wall.

The main intermediate host is cattle, but camels and other herbivores may be affected.

The eggs are eaten with the grass, the **embryophore disintegrates** and releases the **hexacanth (oncosphere)** which penetrates the wall and into the blood and lymphatics and carried to various muscles where it becomes a **bladder worm or cysticercus**.

When a live cysticercus is eaten, the scolex of the bladder worm evaginates and attaches itself to the wall of GIT and develops into an adult worm.

Symptoms and pathology :

No significant symptoms, the passage of motile proglottids or parts of strobila is **alarming** and medical advice is sought.

Rarely intestinal obstruction has occurred due to tangled strobila.

Treatment :

Niclosamide (yomesan), it is important to look for the scolex but yomesan macerates the worm making it difficult.

Quinacrine hydrochloride can be used, the worm is passed intact and stained yellow, useful for ascertaining the passing of the scolex. (disadvantages are it may cause nausea and the patient has to be prepared before and after the drug intake.

Praziquantel may be used also.

Prevention by thorough cooking of beef, checking beef for cysticerci, freezing at -15 degrees for 5 days kills the cysticerci, avoid contaminating grass with human faeces, treating patients.

Taenia solium :

Adult worm is **2-4 m long**, about **1000 proglottids**.

The scolex is 1 mm in diameter, **4 suckers with a double crown rostellum**. The mature proglottid has a trilobed ovary.

The gravid proglottid has **7-12 uterine lateral branches**.

The eggs are the same as those of *T. saginatum*.

The worm lives in the upper **jejunum**, life span **25 years**.

The intermediate host is the pig. The ingested egg hatches, the oncosphere penetrates the intestine and settles in muscle mature **cysticercus (thin walled bladder with invaginated scolex)**.

When undercooked pork is ingested, the scolex evaginates and attaches to the wall of intestine and becomes a mature worm in a few months

Symptoms :

Slight intestinal irritation at site of attachment, rarely perforation has occurred.

Humans may become the **intermediate host** by eating the eggs, the cysticerci settle in muscles, and brain, but any organ may be involved e.g. eye, heart and lung. Serious damage can result in **eye and brain**, convulsions also focal motor and sensory deficits.

Diagnosis is made through eggs and proglottid identification in stools.

The onset of **epilepsy** in an adult living in an endemic area should be suspicious of cysticercosis. CT scan and MRI can be helpful.

Treatment :

Is indicated to avoid cysticercosis, **Niclosamide (yomesan)** the worm disintegrate and is partly digested, thus there is a **theoretical risk of eggs** released in gut causing cysticercosis, so some prefer to use **quinacrine HCl** (the worm is passed largely intact), this may cause vomiting thus an anti-emetic should be given before its administration. A purgative is recommended after and fluid diet before treatment.

Hygiene and preventative measures

Praziquantal and albendazole are both effective in cysticercosis, steroids are given at the same time to prevent inflammatory reactions from the dead bladder worms, **anti-convulsant therapy** may have to be continued for some time after drug therapy.

Diphyllobothrium latum :

This is the largest human tapeworm, may reach **3-10 m.** in length with **3000 proglottids**.

It lives in the ileum and sometimes in the jejunum.

It has **two suckorial grooves** anteriorly for attachment, **no hooks and no rostellum**.

Life span up to **20 years**.

Self fertilization is the rule, but cross fertilization between segments may occur.

Proglottids are more wide than long.

Proglottids discharge eggs in the lumen, they disintegrate after laying the eggs.

The **eggs are operculated** on one end and there may be a thickening at the opposite end.

Life cycle :

There are **2 intermediate hosts**. When the egg is passed in the faeces into water they hatch releasing a ciliated embryophore which is ingested by **cyclops** inside which it develops into a larva inside the body cavity.

The cyclops are eaten by **fresh water fish**, and the larva enters the body cavity and into muscles. If this is eaten in raw fish it develops into the adult worm in the intestine of the new host.

Symptoms :

One worm usually does not cause many symptoms, vague abdominal. Several worms may cause intestinal obstruction.

Megaloblastic anaemia may develop.

Diagnosis :

Eggs in faeces. Proglottids in faeces or vomitus.

Treatment :

Niclosamide (macerated worm). Quinacrine HCl (intact worm but disadvantages). Freezing at -10 degrees C for 24 hours, proper pickling, drying or cooking destroys the larvae.

Echinococcus granulosus (hydatid cyst disease) :

Life cycle : The adult worm lives in canine animals e.g. dogs, foxes, wolves. These acquire the worm by eating organs of herbivores (intermediate host) that contain the cystic form of the worm.

It is the **smallest tapeworm 3-9 mm long**. The scolex has a prominent rostellum with a double row of hooks.

The body consists of three proglottids : immature, mature and gravid. The eggs resemble those of other taeniae. The life span of the worm is about **5 months**.

When the egg is ingested by a human being, the liberated embryo penetrates the intestinal wall, and is carried via the blood stream into various organs where it **changes into a cyst 1 cm in diameter**.

This cyst develops slowly over many years reaching **up to 10 cm** in diameter, the cyst has :

- 1)- an external laminated non-nucleated hyaline membrane.
- 2)- an inner nucleated germinal layer.
- 3)- the cyst is distended by a light yellow sterile fluid.
- 4)- brood capsules that have only germinal layer with protoscolices.
- 5)- daughter cysts that are replicas of the mother cyst.
- 6)- protoscolices escape into the fluid of the cyst after rupture of the brood capsules and are known as hydatid sand.
- 7)- a cyst may contain **2 million protoscolices**.

If a cyst is ruptured in the host, the protoscolices develop into daughter cysts and become disseminated..

Endogenous daughter cysts may be derived from germinal layer or protoscolices or brood capsules, they may give rise to grand daughter cysts.

Infection is highest in childhood especially where there is great association with dogs.

Pathology and symptoms :

Frequency : **liver, lung, kidney, bone, brain**.

Space occupying lesion. Prolonged course.

The cyst may metastasize (like a tumour). Rupture of the cyst may give rise to allergic manifestations due to escape of the fluid. If considerable amounts of fluid enter the blood stream **anaphylaxis** may ensue.

Diagnosis :

Differential diagnosis in a slowly growing cystic lesion especially in the liver.

X-rays (may be calcified), **ultrasound** are useful.

Serology is useful, the antigen used is derived from hydatid cyst fluid.

The **Cassoni** hypersensitivity skin test is used but gives up to 20 % false positives. A negative test is proof against the disease.

Treatment :

Surgical removal. **Albendazole** may be used as an option or in conjunction with surgery.

Discharge of the cyst into tissues should be avoided.

Prevention : deworming dogs, not allowing them access to slaughter houses or infected organs.

Hymenolepis nana :

Dwarf tapeworm, **2 cm in length, 200 proglottids.**

Scolex (retractile) has 4 suckers and single row of hooks.

The egg has two membranes enclosing a hexacanth embryo. The inner membrane has two **polar thickenings** from which radiate 4-8 **polar filaments.**

The worm lives in the upper 2/3 of **ileum.**

Life span is **several weeks.**

Life cycle :

No intermediate host. The eggs which are immediately infective are present in the faeces (gravid proglottids rupture in the intestine).

When ingested by a new host, **the oncosphere penetrates a villus and develops into a cysticercus,** this breaks out of the villus into the lumen as the adult worm.

Internal auto-infection may occur, the egg hatches directly in the intestine and repeats the life cycle leading to heavy infection of up to 2000 worms.

The eggs are usually fragile, thus direct contact is necessary for transmission (bad hygiene).

Symptoms :

Usually asymptomatic, vague abdominal complaints, enteritis may occur with heavy infections.

Diagnosis : eggs in faeces.

Treatment : Praziquantal
Niclosamide (Yomesan).