Metazoa (Helminthes)

The term helminth has been derived from a Greek word meaning worm. It was originally meant to refer to only intestinal worms, but now includes tissue parasites as well as many free living species. These are metazoa.

Classification of helminths

The metazoa are classified into two phyla: Platyhelminthes and Nemathelminthes. Platyhelminthesis divided into two classes: Cestodea (tapeworms) and Trematodea (flukes) while Nemathelminthes has only one class Nematodea (roundworms).

General characteristics of helminthes

1. They do not possess organs of locomotion, so locomotion is by muscular contraction & relaxation.
2. The outer covering, known as cuticle or integument. It is situated on its outer surface & may be armed with spines or hooks. It is resistant to intestinal digestion.
3. Nervous system and excretory system are primitive.
4. Digestive system is complete, partially lost (rudimentary) or absent. The alimentary tract has entirely disappeared from all stages of the tapeworms (cestodes); it is greatly or nearly absent in many of the trematodes, but its present and complete in most nematodes. The digestive system is partially lost (rudimentary) or absent in certain parasitic helminths because of their location in the hosts (intestine or tissue), where predigested nutrient are abundant.
5. Reproductive system is very well developed.
6. They may be monocious or diecious. Both self-fertilization and cross-fertilization may take place.
7. Reproduction to increase the parasite population within the same host (internal autoinfection) does not occur among certain helminths; more over under usual conditions of host & environment, the number of worms that reach maturity in any given host is limited levels that are tolerable to both host & parasite. Thus most of the people who are infected with helminths are asymptomatic carriers, & the diseased individuals among the infected group are those with the heaviest worm burdens. - The terms, light moderate, and heavy as applied to worm burdens are relative and differ for

the various species of helminths & in people of different ages & physical status.

8. When worms are crowded the collective egg output is great, but the output per worm is relatively low, depending on the degree of crowding.

9. The factors that determine helminth population, are those associated with the host-parasite relationship (i.e. the immune factors derived from the host responses & the complex role of co-existing infection).

- Massive infection depends initially on massive inoculation of infective larvae & eggs.

10. The co-existence of several species of helminths in the same individual (poly-helminthism) is widely prevalent.

11. In some helminths, the life cycle is direct & relatively simple; involving only one host species and a brief period of development of an infective stage, an example is the pin worm (*Enterobius vermicularis*).

- In a group referred to as soil transmitted helminths, the life cycle involves only one host (man) but the infective stage (larvae) remaining in the egg, as in *Ascaris lumbricords* & *Trichuris trichiura*;or free in soil as in hookworm species which requires a period of development in soil, i.e. the soil functions as an intermediate host.
- In other, the man-to-man cycle involves essential development in one intermediate host as in the filarial worms & most tapeworms, or two intermediate hosts, as in most trematodes; the first being a snail or other mollusk, the 2nd is an animal or plant that is eaten by people.
- Intermediate hosts provide the parasite with sustenance for essential development, protection & availability to its final host.

12. Worms & larvae that migrate through or reside in tissue generally produce eosinophilia, focally in tissue, in the blood or in both.

- Persistant hyper-eosinophilia is the most recognized general sign of helminthic infection.
- Helminthic infections frequently are occult or cryptic because certain helminths of animal develop in man, but do not produce eggs or larvae & therefore the infection are not patent. Such infections are referred to as nonpatent.
- In addition to eosinophilia, common signals to occult helminthic infections, somewhat in order of their significance or frequency, are hepatomegaly, pneumonitis, bronchial asthma, urticaria, subcutaneous cyst or swelling, neurologic disturbance, and deviations in behavior.

Trematodes

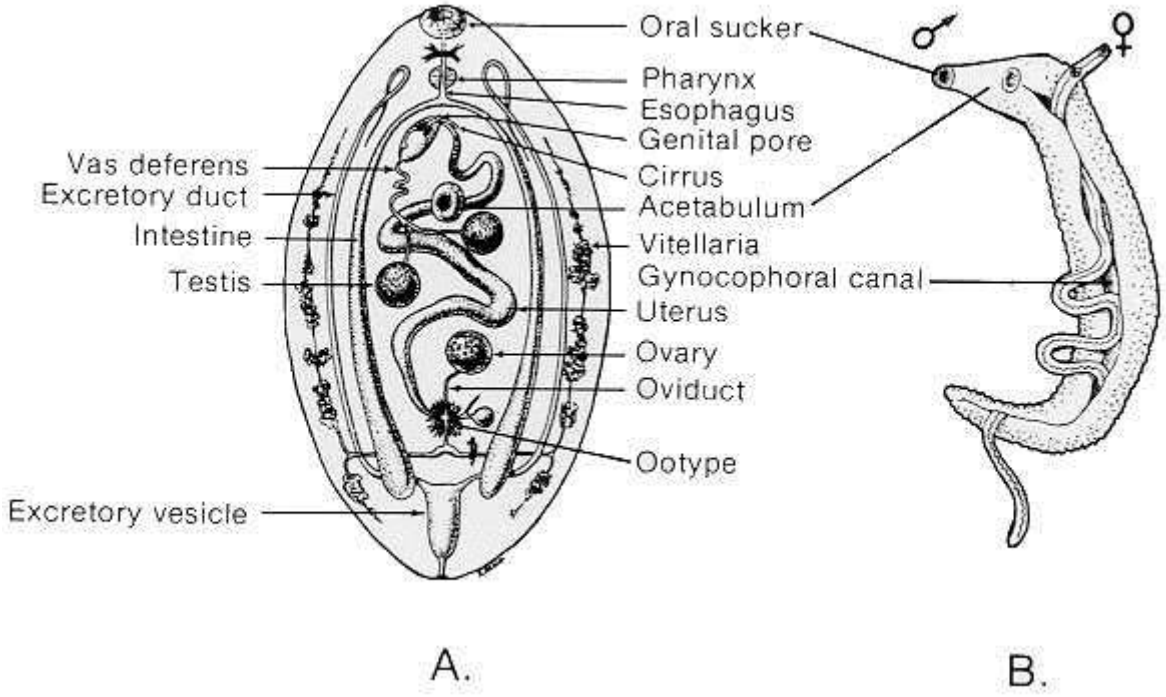
Helminth is a general term meaning worm. The helminths are invertebrates characterized by elongated, flat or round bodies. In medically oriented schemes the flatworms or platyhelminths (platy from the Greek root meaning "flat") include flukes and tapeworms. Roundworms are nematodes (nemato from the Greek root meaning "thread"). These groups are subdivided for convenience according to the host organ in which they reside, e.g., lung flukes, extraintestinal tapeworms, and intestinal roundworms. This chapter deals with the structure and development of the three major groups of helminths.

Helminths develop through egg, larval (juvenile), and adult stages.

General characteristics

1-Trematodes are un-segmented helminthes which are flat and broad resembling the **leaf** of a tree or **flat fish**.
2-They vary in size from the species from just visible to the naked eye [like *Heterophyes*] to the large fleshy fluke [like *Fasciola hepatica*] .
3-Flukes are hermaphroditic [monocious] in which the sexes are not separated, except for Shistosomes in which the sexes are separated .
4- A conspicuous feature is the presence of muscular cup-shaped suckers [the structure by which the worm attached to the host] . **The oral sucker** surrounding the mouth,[the oral or the anterior sucker] at the anterior end. **The ventral sucker** [or Acetabulum] in the middle ventrally .
5- The body is covered by integument which often bears **spines**, **papillae** or **tubercles**.
6- They have no body cavity, circulatory or respiratory organs.
7-The alimentary system consist of: ***Mouth** surrounded by oral sucker.* A muscular **pharynx** and* **esophagus** which bifurcates anterior to the acetabulum to form two **blind caeca** [which reunite in some species], the alimentary canal therefore appears like inverted y, and the anus is absent .
8-The excretory system consist of **flam cells** and **collecting tubules** which lead to median bladder opening posteriorly .
9-There is a rudimentary nervous system consist of two lateral ganglion in the region of pharynx, connecting by dorsal commissures. From each ganglion arise anterior and posterior longitudinal nerve trunks connected by numerous commissures ,[sense organs are almost lacking].

10- The reproductive system is well developed, the hermaphroditic flukes have both male and female structures so that self fertilization takes place [though in many species, cross fertilization also occur] . In the Schistosomes the sexes are separated but male and female live in close apposition [in copula], the female fitting tightly into the folded ventral surface of the male which form the **gynaecophoric canal**.
11-The trematodes are oviparous and lay eggs which are **operculated**, except in the case of Schistosomes .



The eggs hatch in water to form the first stage larvae, the motile ciliated Miracidium [Greck a little boy] .**The miracidium** infects the intermediate host Snail in which further development take place ,the miracidium shed its cilia and becomes sac-like **Sporocyst** [meaning bladder containing seeds].Within the sporocyst, certain cells proliferate to form the Germ balls which are responsible for asexual replication . In Schistosomes the sporocyst develops into second generation sporocyst in which infective larvae **Cercariae** are formed. But in the hermaphroditic trematodes, the sporocyst mature to more complex larval stage named **Redia**, which produce cercariae. Cercariae are tailed larvae.

Classification

Phylum : Platyhelminthes **Class : Trematoda**

. Intestinal species

.Fasciolopsis buski

. Heterophyes heterophyes

. Metagonimus yokogawai

. Liver species

. Fasciola hepatica

. Fasciola gigantic

. Clonorchis sinensis

. Lung species

. Paragonimus wastermani

.**Blood species**

.Schistosoma haematobium

.Schistosoma mansoni

.Shsistosoma japonicum

Liver species

1-Fasciola hepatica [or sheep liver Fluke]

Is the largest and most common liver fluke found in human, but its primary host is the sheep [and to less extent cattle].

DISTRIBUTION;

It is worldwide in distributions, being found mainly in sheep-raising area [it causes the economically important disease "**Liver rot**" in sheep].In addition, the disease, **Fascioliasis**, now recognized as an emerging human disease .

MORPHOLOGY: Adult worm:

1-It is a large leaf-shaped fleshy fluke 300 mm long, 15 mm broad .

2- Grey or brown in color.

3-The anterior end of the parasite forms a conical projection that broadens at the shoulders, then gradually narrows towards the posterior end. At the narrow tip of the conical projection is the ***muscular oral sucker*** , which surrounds the mouth of the parasite. The oral sucker is 1 mm in diameter and the ventral sucker which lies close behind it is about 1.6 mm .

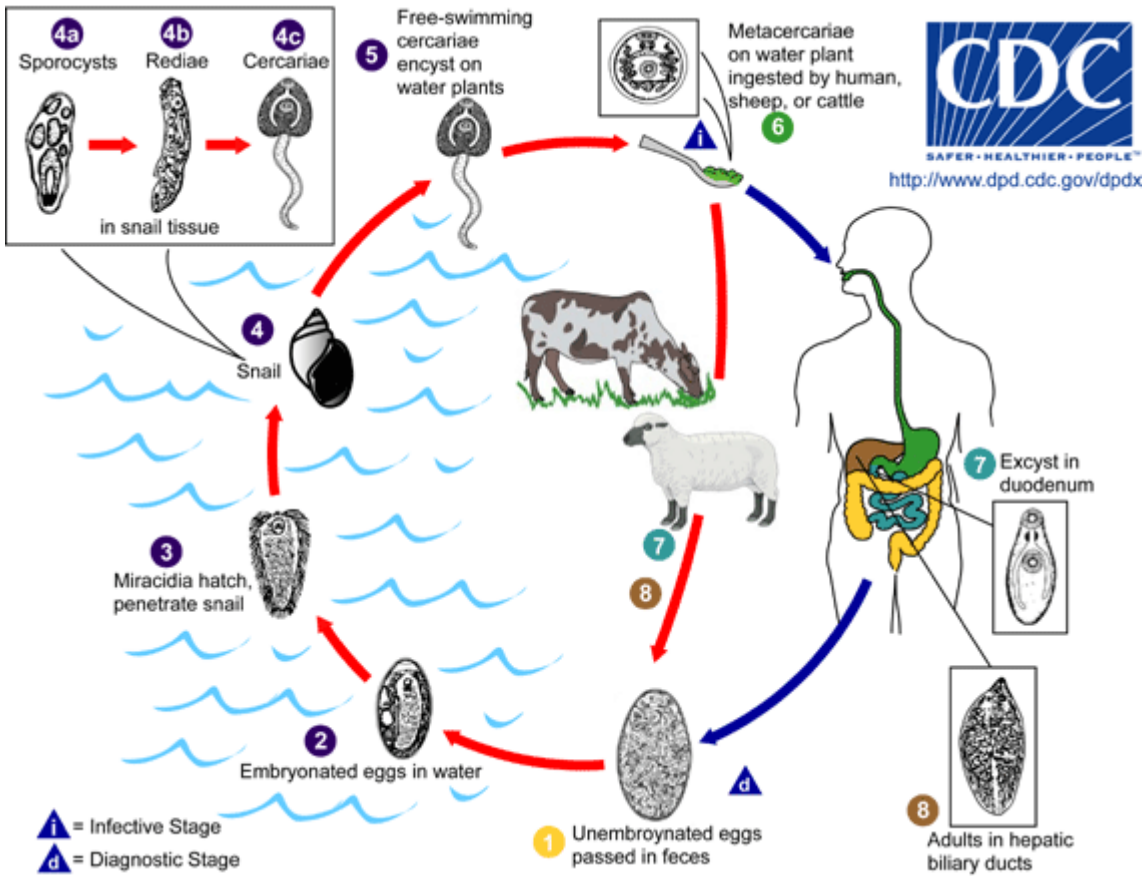
4- lives in the biliary tract of D.H for many years [about 5 years in sheep and to 10 years in human]

The eggs: Large, ovoid, operculated , bile stained and about 140 x 80 micro-meter in size.

Fasciola infections are common in domestic ruminants and wildlife throughout the world and cause massive economic loss in the livestock industry. Humans usually become infected by eating aquatic plants grown in water contaminated with feces from animals harboring fasciola.

Etiology and life cycle

F. hepatica (the sheep liver fluke) cause fascioliasis in humans. The parasites vary in adult and egg size and shape and species of the snail host of the family Lymnaeidae. *F. hepatica* common in temperate and subtropical areas. Especially in sheep – raising areas. The adult worm lives in the bile duct of the final host and eggs are excreted in the feces of the host. The eggs undergo further development upon reaching a water body; miracidium then hatch and penetrate a suitable snail host. After multiplication as sporocysts and rediae, free – swimming mature cercariae exit the snail, attach to aquatic vegetation and become metacercarial cysts. These cysts establish infection upon ingestion by man and other mammals. They excyst in the duodenum, then migrate through the intestinal wall into the body cavity through Glisson's capsule across the liver parenchyma and into the bile duct, where they may live for many years egg are excreted 3-4 months after ingestion. Generally the life cycle is maintained by domestic animals, particularly by sheep for *F. hepatica* and cattle /buffalo for *F. gigantic*; it is completed in 4-6 months.



Pathogenesis

These parasites cause considerable mortality in sheep and cattle, and human morbidity which is dependent on the number of worms and stage of infection. the **acute phase occurs during migration of the immature flukes through the liver. Severe pathology results from:**

1- destruction of parenchymal tissue, haemorrhage, parasite death inflammatory responses largely mediated by eosinophils.

2- 2- Repair mechanisms can lead to extensive fibrosis. Increased pressure atrophy of the liver and periportal fibrosis. **The chronic phase, during which parasites are present in the bile ducts tends to be less severe tissue change, including**,

:

1- bile duct proliferation, dilatation and fibrosis, is largely caused by mechanical obstruction of the ducts inflammatory responses and the activity of proline, which the fluke excretes in large quantity, proline may facilitate movement of the parasite through the narrow ducts.

2- Anemia may result from blood loss through bile duct lesions. Death is uncommon, but is usually caused by haemorrhaging in the bile duct and case reports suggest it occurs more frequently in children.

Flukes that migrate out of the intestine but do not locate in the liver can form ectopic lesions in many tissues. These nodules., granulomas or migration tracts are often misdiagnosed as malignant tumours or gastric ulcers.

Clinical Features

Where cases are symptomatic, diarrhea, upper abdominal pain or pain in the right costal margin, urticaria, malaise, weight loss, coughing, fever and night sweats may begin approximately 2 months following ingestion of metacercaria and 1-2 months prior to the onset of egg excretion. The signs of this acute phase of infection are hepatomegaly, splenomegaly, anaemia, weakness and marked peripheral eosinophilia, up to 80%.

Adult flukes in the bile ducts may be associated with cholangitis and calculous or acalculous cholecystitis. Through their large size and the inflammatory and fibrotic response, the infection may cause obstruction leading to cholestaitc jaundice,nausea, pruritus, abdominal pain, hepatomegaly and fatty food intolerance. In severe cases, ascites with blood and severe anaemia may ensue. Sine these moderate signs and symptoms do not differ from cholangitis and cholecystitis of other causes, the infection often goes unnoticed until worms are observed at surgery or histopathology. Eosinophilia and a history of eating water plants should be considered in the differential diagnosis.

Diagnosis and investigations

1- Fascioliasis has been diagnosed by observation of eggs during fecal examination.

2- by parasite-specific antibody detection in a variety of immunodiagnostic assays.

3- by radiological methods 4- Dietary history is also helpful, particularly in investigating outbreaks.

Examination of faces for eggs is of limited use since:

- eggs are not excreted during the invasive stage of infection, when many patients present with severe symptoms. Often eggs are un-detectable during the chronic phase, but whether the techniques used are insensitive for very low egg outputs in light infections (< 100 eggs per gram) or eggs are not being produced is unclear.

-A further problem with fecal examination is that eggs may be detected after ingestion of liver from infected animals. This does not indicate infection; thus positive cases should be reconfirmed if liver has been eaten recently.

Immunodiagnostic tests using every available technique have been reported in the literature, from skin tests to antibody and antigen detection assays. but cross-reactivity with other trematode infections is problem in areas where they coexist. Fasciola –specific ELISAs using partially purified fluke antigens are available.

The advantage of immunodiagnosis over parasitological techniques is that they can detect early, prepatent infections as well as chronic ones with little or no egg output. In contrast to other infections, levels of antibody in ELIAs appear to drop rapidly after successful treatment, so the assays tend to detect only active infection.

Treatment: Along with pharmaceutical therapy, surgery may be necessary in very extreme cases to clean the biliary tract.

Prophylaxis;

The following consideration can limit the infection:

1-Health education. 2-Preventing pollution of water sources with sheep , cattle and human feces . 3-Proper disinfection of water crass and other water vegetations before consumption.*washing of water grown vegetable with 6./. vinegar or potassium permanganate [5-10 minutes] which kill the encysted cercaria.*Cook water grown vegetables thoroughly before eating .*Use of molluscicide is the most frequent public health intervention ,as it prevent the transmission of many other trematodes

2- *Clonorchis sinensis* ;[chines Liver fluke]

Epidemiology; Clonorchiasis is endemic in far east especially in Korea, Japan , Taiwan and south china .**I t hase been reported in non –endemic areas[including the united states] .in such cases , the infections found in Asian immigrants ,or following ingestion of imported under cooked or pickled fresh water fish containing Metacercaria* .

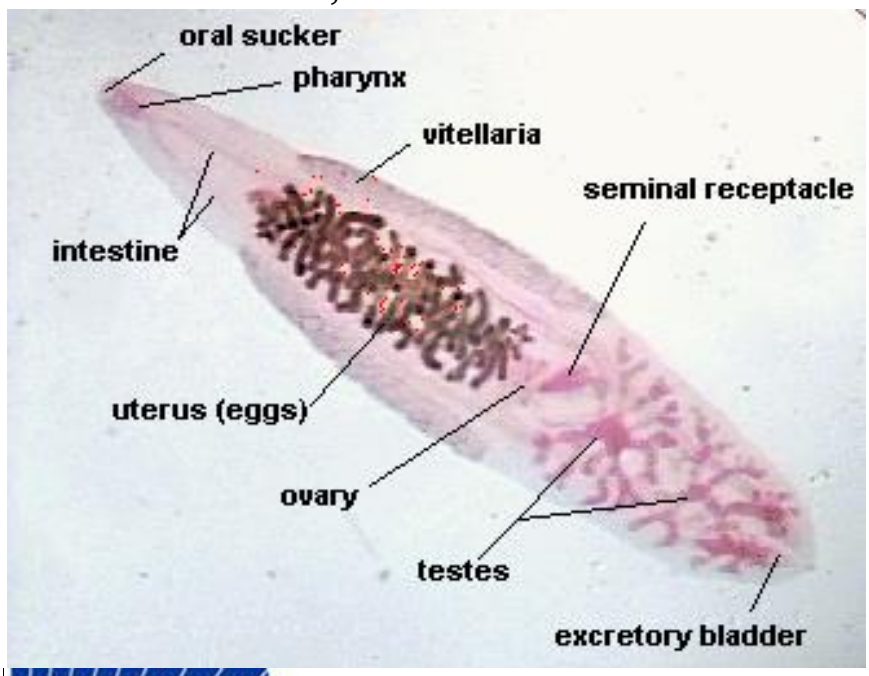
Inhabitancy; the parasite live in the liver of humans and is found in the common bile duct and Gall bladder feeding on bile [Believed to be the third most prevalent worm parasite in the world] .

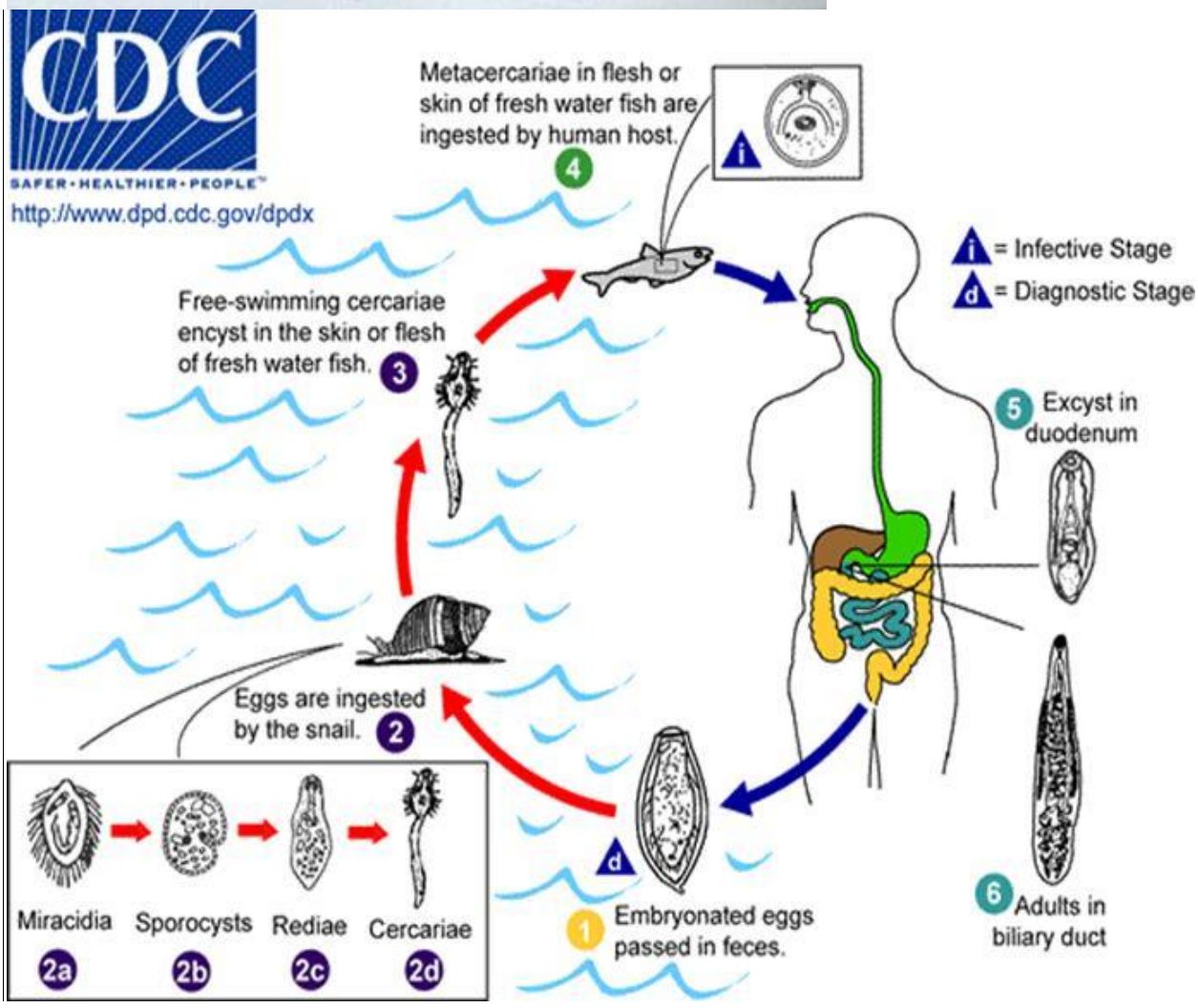
Morphology and life cycle;

The adult worm, live in the human biliary tract [for 15 years or more],it has a flat transparent body , spatulated ,pointed anterioly and rounded posteriorly. *Man is the principal D.H ,but dog and other fish eating canines are reservoir* .

The eggs; are broadly ovoid 30 X 15 micrometers with a yellowish brown shell , it has an operculum at one pole and a small hook like spine at the other . The life cycle of *C. sinensis* involves both a first intermediate snail host and a second intermediate fish host. Embryonated eggs are discharged in the biliary ducts and stool of a human host. An adult fluke lays 2000 to 4000 eggs each day. If these eggs are ingested by a suitable intermediate snail host, the eggs release miracidia, which go through several developmental stages: sporocyst, redia, and cercaria. The cercariae are released from the snail and after a short period of free-swimming time in water, they may come in contact with and penetrate the flesh of a freshwater fish. Here they encyst as metacercariae. Infection of humans occurs by ingestion of undercooked, salted, pickled, or smoked freshwater fish. After ingestion, the metacercariae excyst in the duodenum. Maturation

takes approximately one month. The adult flukes (which measure 10 to 25 mm by 3 to 5 mm) reside in small and medium-sized biliary ducts. In addition to humans, carnivorous animals can serve as reservoir hosts.



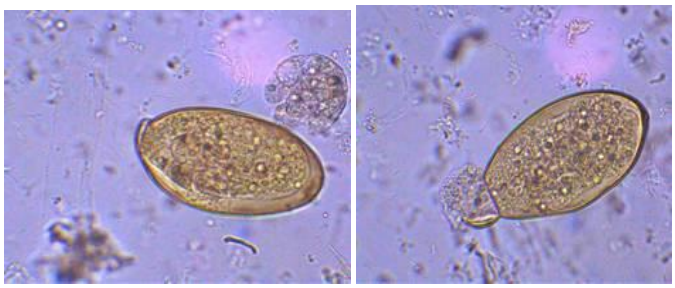


- ***people become infected every year but only a minority suffers from any illness. The pathology is related to the number of parasites present. Light infections of up to 50 eggs or more are usually asymptomatic. A heavy infection of 500 or more eggs may cause serious illness.***
- ***Acute infections may be characterized by fever, diarrhea, epigastric pain, enlargement and tenderness of liver and sometimes jaundice. The invasion by these worms in the gall bladder may cause cholecystitis, due to flukes becoming impacted in the common bile duct***
- ***Humans are infected by eating raw or partially cooked freshwater fish or dried, salted, or pickled fish infected with the metacercariae. In the duodenum, the cyst is digested and an immature larva released. The larva enters the biliary duct, where it develops and matures into an adult worm. The adult worm feeds on the mucosal secretions and begins to lay fully embryonated operculated eggs, which are excreted in the feces.***
- ***Upon reaching fresh water and upon ingestion by a suitable species of operculate snails (first intermediate host), the eggs hatch to produce a miracidium. Inside the snail, the miracidia multiply asexually through a single generation of sporocysts and generations of rediae to fork-tailed cercariae***
- ***Laboratory Diagnosis***

Definitive diagnosis is made by observing the characteristic ova in feces following an iodine stained, formol-ether concentration method of the feces or from duodenal aspirates when there is complete obstructive jaundice or from the Entero-Test.

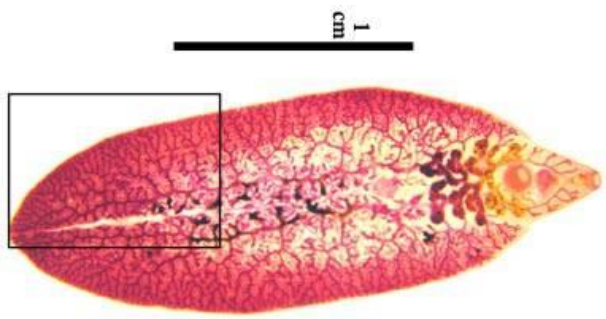
3-Fasciola gigantica (Pathogen – Liver Trematodes)

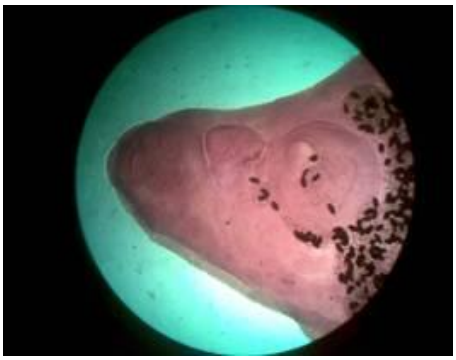
Organism: *Fasciola gigantica* is closely related to *F. hepatica.* It is also a common parasite of cattle, camels, and other herbivores in Africa and of herbivores in some Pacific islands. Human infections have been reported in a number of areas of endemicity. Generally, *F. hepatica* is found in temperate zones and is the predominant species in Europe, the Americas, and Oceania, while *F. gigantica* is better adapted to tropical and aquatic environments and is the predominant species in Africa.



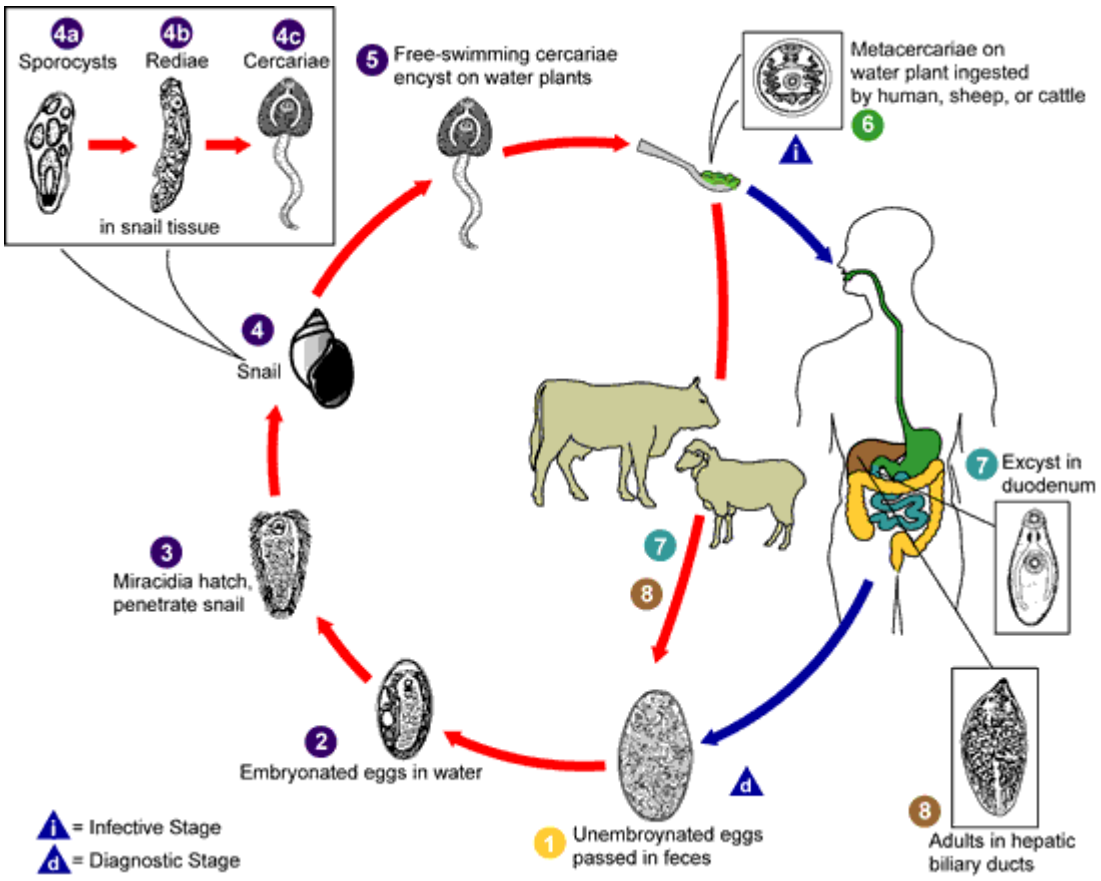
Eggs (operculated)

X-section in liver





Adult worms



LifeCycle:

The life cycle is similar to that of *F. hepatica*; however, the snail hosts of *F. gigantica* are aquatic rather than amphibious like the first intermediate host for*F. hepatica*. Humans become infected through ingestion of water plants which carry the infective metacercariae. Apparently, developmental stages of *F. gigantica* grow at a slower rate, survive longer at high temperatures, and are more susceptible to drying than those of *F. hepatica*. The adult worm resembles *F. hepatica* but is somewhat more lanceolate, with a less distinct cephalic cone. The eggs are very difficult to differentiate from those of *F. hepatica* or *Fasciolopsis buski*; however, they tend to be larger (160 to 190 µm by 70 to 90 µm).

Acquired:
Humans are infected by ingestion of uncooked aquatic vegetation on which metacercariae are encysted.

Epidemiology:
Like *F. hepatica*, infection can occur in a wide range of herbivorous mammals when they ingest infected water plants or drink water contaminated with metacercariae. In some areas, the rate of infection in these animal hosts is quite high: in China, the rates are 50% for cattle, 45% for goats, and 33% for water buffalo; in Iraq, the rates are 71% for water buffalo and 27% for cattle; in northeastern Thailand, the rate is 60% for cattle.

Clinical Features:
The clinical symptoms of *F. gigantica* infection are very similar to those seen with *F. hepatica* and depend on the worm load. The prepatent period between infection and the presence of adult worms in the bile ducts is 9 to 12 weeks. Patients may experience fever, nausea, vomiting, abdominal pain, hepatomegaly, hepatic tenderness, and eosinophilia. As in many light trematode infections, there may be vague symptoms or the patient may remain asymptomatic. Abscess or tumor-like reactions have also been reported to occur in subcutaneous tissues or in the liver.

Clinical Specimen:
Stool: Confirmation of the infection depends on finding the operculated eggs in a routine stool examination; multiple stool examination may be required to find the eggs.

Laboratory Diagnosis:
Stool: The routine sedimentation concentration is recommended. Since the eggs are operculated they cannot be recovered from the zinc sulfate flotation method. The eggs of *F. hepatica*, *Fasciolopsis buski*, *E. ilocanum*, and *G. hominis* are similar in size and shape. Differentiation may be difficult without a patient history. Patients may be symptomatic during the first weeks of infection, but no eggs will be found in the stool until the worms mature, which takes 8 weeks. Multiple stool examinations may be needed to detect light infections.

Organism Description:
Egg: The eggs can be found in the stool; however, they may be absent more often than in infections with *F. hepatica*, so that multiple stool examinations may be required to demonstrate the eggs. Although these eggs are larger than those of *F. hepatica* or *F. buski*, they are very similar in shape. Recovery of adult flukes at surgery would confirm the diagnosis. Other diagnostic options as discussed with *F. hepatica* are also recommended for this infection.

Treatment:
praziquantel is effective at a dose of 25 mg/kg taken after each meal for 2 days, biothionol at 30 to 50 mg/kg on alternate days for 10 to 15 doses is recommended.

Triclabendazole at 10 mg/kg as a single dose is also recommended.

Intestinal flukes

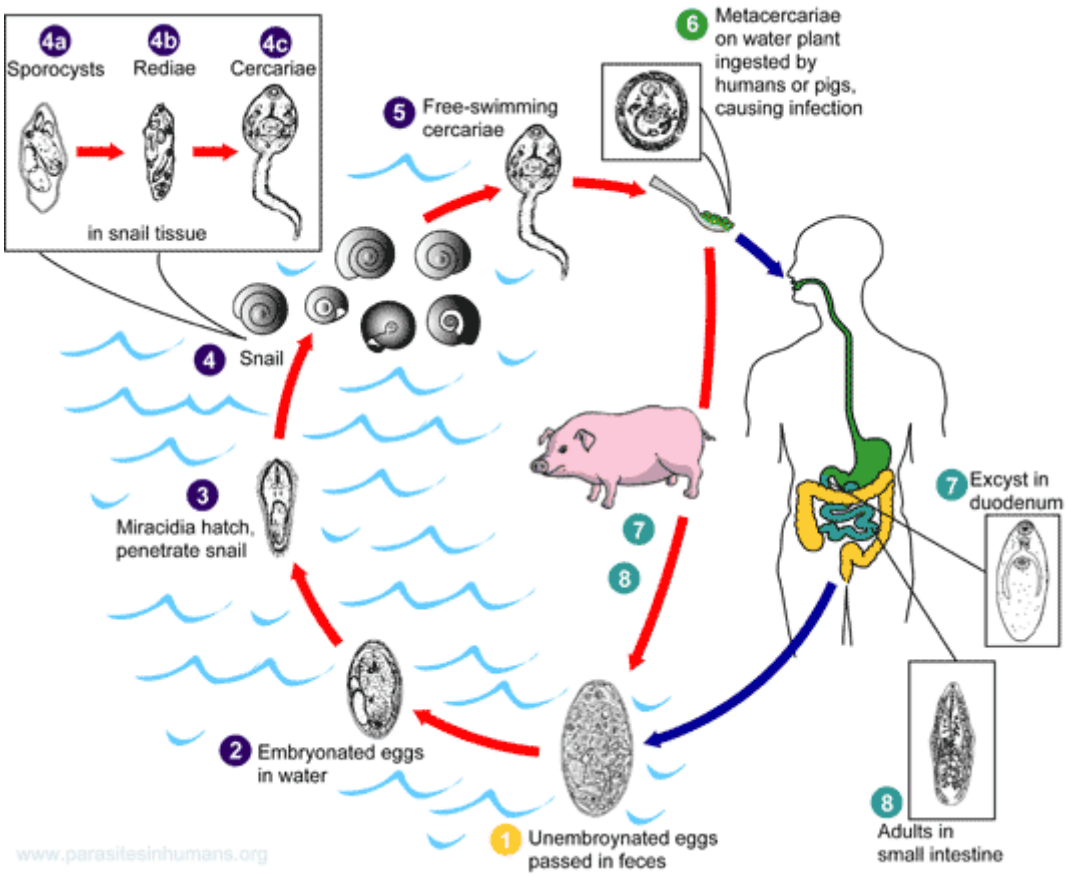
1-Fasciolopsis buski

Fasciolopsiasis is caused by the giant intestinal fluke, *Fasciolopsis buski* it is in the same family as Fasciola, and its life cycle and morphology are similar. However Fasciolopsis infection is largely confined to Asian countries.

Life cycle

In contrast to *Fasciola*, the final host range of *F. buski* is limited and many mammals are refractory. Humans and pigs become infected through the consumption of viable metacercaria attached to the seed pods of plants metacercaria are not present on the edible seed of these plants, ingestion occurs during removal of the pods with the teeth and lips. Metacercaria are also found free on the surface of ponds, and infection may occur from drinking water.

F. buski excysts in the duodenum and the escaping larvae attach to the duodenal and jejunal wall. The larvae become mature adults in 3 months and produce large numbers (an estimated 10000 – 25000 per day per worm) of large, yellow, operculated eggs if these eggs reach water sources, further development and embryonation occurs over 3-7 weeks, then miracidia hatch and enter snail intermediate host (family planorbidae). After multiplication as sporocysts and redia, free- swimming cercaria attach and encyst on seed pods.



Pathogenesis and pathology

Eosinophils accumulate at the site of parasite attachment on the jejunal or duodenal wall where mechanical injury and inflammation. These ulcers sometimes bleed due to capillary damage or become abscesses. Mild infection in healthy people is associated with lower haematocrit and serum levels of vitamin B

but no apparent change in other nutrients. This may result from parasite sequestering of vitamin B or its impaired absorption from the damaged intestinal mucosa. Although a few parasites cause little damage, the presence of many (hundreds to thousands) is associated with severe pathology and sometimes acute intestinal obstruction. Extensive intestinal ulceration may interfere with digestion, and cause malabsorption, leading to sever malnutrition and wasting. Oedema also occurs in severe cases it may result from toxic parasite metabolites. Allergic reaction or from hypoalbuminaemia secondary to electrolyte and protein imbalance from chronic malabsorption.

Clinical Features

Symptoms are generally absent or mild, and may include: diarrhea, hunger pains, flatulence, poor appetite, mild abdominal colic, vomiting, eosinophilia and fever. The abdominal pain may mimic that of peptic or duodenal ulcer. Late, severe cases present with ascites or oedema of the face, abdomen and legs, anemia, anorexia, weakness and vomiting and patients may pass stools containing large amounts of undigested material. Deaths have been reported.

Diagnosis and investigations

Diagnosis by fecal examination is not difficult, given the large quantity and large size of the eggs. Stoll's dilution, formalin ether concentration, direct smears and kato techniques have been used successfully. Differentiation from Fasciola eggs is difficult so that a dietary and clinical history should also be considered.

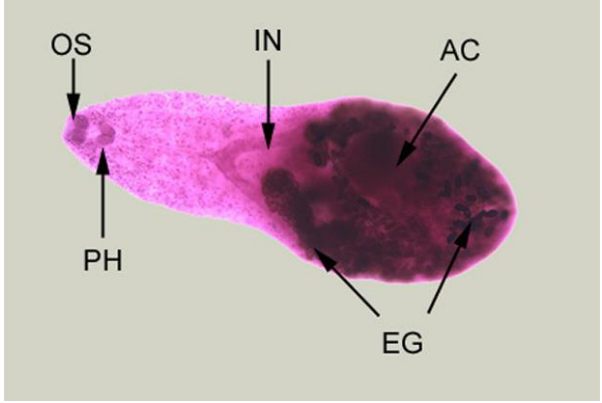
Heterophyes heterophyes :

is a parasitic fluke that can infect humans that is classified within the Trematoda class. Its range is large and includes China, North Africa, Korea, Japan, Asia Minor, the Philippines, and Taiwan.

- Adults reach an average size between 0.3 inches and .06 inches.
- Its body is covered with scales, occurring in higher numbers near the front end, which holds an oral sucker.
- There is an acetabulum located near the middle of its body and two testes on the back end. The female fluke of this species has a different anatomy than males, with an ovary located near the end of the body.
- both sexes' reproductive organs lead away from the back end of the body to the ejaculatory duct. In females, this duct leads to a genital sinus and then to a genital pore, where females can release eggs.

- Adult *heterophyes heterophyes* flukes live in the intestinal villi of its host.
- Eggs are laid underwater and have a miracidium. These eggs will not hatch until they have entered a species of snail, like *Cerithidia cingula* in Japan and *Pirenella conica* in Egypt. Once the eggs are inside of a snail, the miracidium of each egg turns into a sporocyst that is able to produce rediae, which then produce a type of larvae known as cercariae. These larvae swim to the surface of the water and slowly sink back down, eventually landing on a fish. Once the larvae have pushed through the epithelium of the fish, they are able to move into the muscle tissue. In these stages of its life, the larvae are living in intermediate hosts, but once infected raw fish is consumed, they are able to move into definitive hosts like birds and humans.

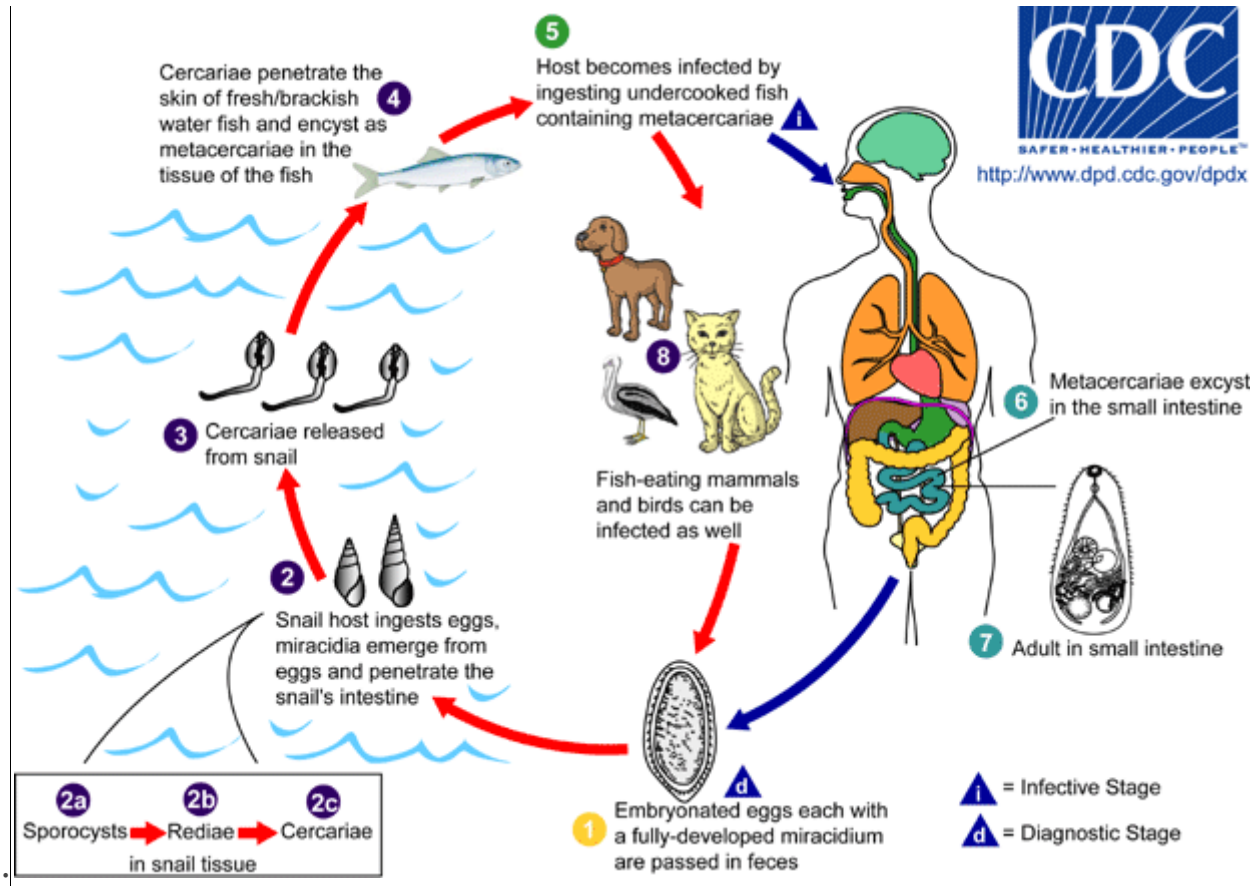
Humans that live near bodies of water within the range of *heterophyes heterophyes* are more likely to contract this species than those who do not, and fisherman are at highest risk. Because raw fish comprises such a large portion of people's diet in the flukes range, people living in areas with higher numbers of the species are especially more at risk.



Symptoms of an infection: include intestinal pain, mucosa diarrhea, and inflammatory reactions in the area where the parasite entered the intestine. Eggs can occasionally leave the intestines and move through the lymph vascular systems and blood of their host. These eggs can enter the heart and brain of the host, causing neurological disorders, heart failure, and death. It can be difficult to diagnose an infection of this species if adult individuals are not present in a stool sample, because the eggs are too similar to *C.sinensis* eggs to distinguish between the two species. Treatments include the medicine Praziquantel, which is a derivative of quinolone.

Heterophyiasis occurs in the Middle East, Far East, and Egypt. The clinical features of the disease include severe and fluctuating abdominal pain and diarrhea. When the eggs of the flukes move into the heart, fatal valvular and myocardial damage may occur. Such a case was recorded in the Philippines. There have also been instances of eggs migrating to various organs such as the brain.

Diagnosis of Heterophyiasis requires microscopy to find eggs in stool samples. Unfortunately, the eggs of the Heterophyes heterophyes are identical to the eggs of the Metagonimus yokogawai and very similar to those of the Opisthorchis and Clonorchis. Fortunately, there is treatment available in the form of a prescription medication called Praziquantel



Pathology

Each worm causes a mild inflammatory reaction at its site of contact with the intestine. In heavy infections which are common cause damage to the mucosa and produce intestinal pain and mucosa diarrhea. Sometimes eggs can enter the blood and lymph vascular systems through mucosa go into the ectopic sites in the body. The heart can be affected with tissue reaction in the valves and myocardium that cause heart failure. Eggs can also get into the brain or spinal cord and cause neurological disorders and sometimes fatalities

Metagonimus yokogawai

is a minute intestinal trematode (fluke). It is the smallest trematode flatworm infecting humans. It is found mainly in the Far East, as well as Siberia, Manchuria, the Balkan states, Israel, and Spain.

Adults release fully embryonated eggs, each with a fully-developed miracidium, and eggs are passed in the host's feces. After ingestion by a suitable snail (first intermediate host), the eggs hatch and release miracidia, which penetrate the snail's intestine. Snails of the genus *Semisulcospira* are the most frequent intermediate host for *M. yokogawai*. The miracidia pass through several developmental stages in the snail: sporocyst, redia, and cercaria. Many cercariae are produced from each redia. The cercariae are released from the snail and encyst as metacercariae in the tissues of a suitable fresh/brackish water fish (second intermediate host). The definitive host becomes infected by ingesting undercooked or salted fish containing metacercariae. After ingestion, the metacercariae excyst, attach to the mucosa of the small intestine, and mature into adults (which measure only 1.0 mm to 2.5 mm by 0.4 mm to 0.75 mm). In addition to humans, fish-eating mammals (e.g., cats and dogs) and birds can also be infected by *M. yokogawai*.