

Helminthology

Trematodes (flukes)

Trematodes are unsegmented helminths which are flat and broad, resembling the leaf of a tree or a flatfish (hence the name Fluke, from the Anglo-Saxon word *floc* meaning flatfish).

The name Trematode comes from their having large prominent suckers with a hole in the middle (Greek *trema*—hole, *eidos*—appearance).

They vary in size from the species just visible to the naked eye, like *Heterophyes* to the large fleshy flukes, like *Fasciola* and *Fasciolopsis*. Medically important members of the class Trematoda belong to the subclass Digenea, as they are digenetic, i.e. require two hosts. The definitive hosts in which they pass the sexual or adult stage are mammals, humans or animals, and the intermediate hosts in which they pass their asexual or larval stages are freshwater molluscs or snails.

FLUKES: GENERAL CHARACTERS

- Flukes are hermaphroditic (monoecious) except for schistosomes in which the sexes are separate .
- presence of two muscular cup-shaped suckers (hence called Distomata)—the oral sucker surrounding the mouth at the anterior end and the ventral sucker or acetabulum in the middle, ventrally.
- The body is covered by an integument which often bears spines, papillae or tubercles.
- They have no body cavity, circulatory or respiratory organs.
- The alimentary system consists of the mouth surrounded by the oral sucker, a muscular pharynx and the oesophagus which bifurcates anterior to the acetabulum to form two blind caeca, which reunite in some species.
- The alimentary canal therefore appears like an inverted Y.
- The anus is absent, the excretory system consists of flame cells and collecting tubules which lead to a median bladder opening posteriorly.
- There is a rudimentary nervous system consisting of paired ganglion cells.
- 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 occurs. In the schistosomes the sexes are separate, but the male and female live in close apposition (in copula), the

female fitting snugly into the folded ventral surface of the male, which forms the gynaecophoric canal.

- 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 larva, the motile ciliated miracidium (Greek miracidium—a ‘little boy’).
- The miracidium infects the intermediate host snail in which further development takes place. The miracidium sheds its cilia and becomes the sac-like sporocyst (meaning a ‘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 the second generation sporocyst in which the infective larvae cercariae are formed by sexual multiplication. But in the hermaphroditic trematodes, the sporocyst matures into a more complex larval stage name redia, which produce cercariae. Cercariae are tailed larvae and hence their name (Greek kerkos—tail). In schistosomes, cercariae have a forked tail and infect the definitive host by direct skin penetration. In the hermaphroditic flukes, the cercariae have an unsplit tail, and they encyst on vegetables or within a second intermediate host, fish, or crab, to form the metacercariae, which are the infective forms, infection is acquired by ingesting metacercariae encysted on vegetables (*F. hepatica*, *F. buski*, *W. watsoni*), in fish (*C. sinensis*, *H. heterophyes*) or crabs (*P. westermani*).
- The asexual multiplication during larval development is of great magnitude, and in some species, a single miracidium may give rise to over half a million cercariae.

Classification of trematodes :

A. Dieocious blood flukes or Schistosomes which live inside veins in various locations:

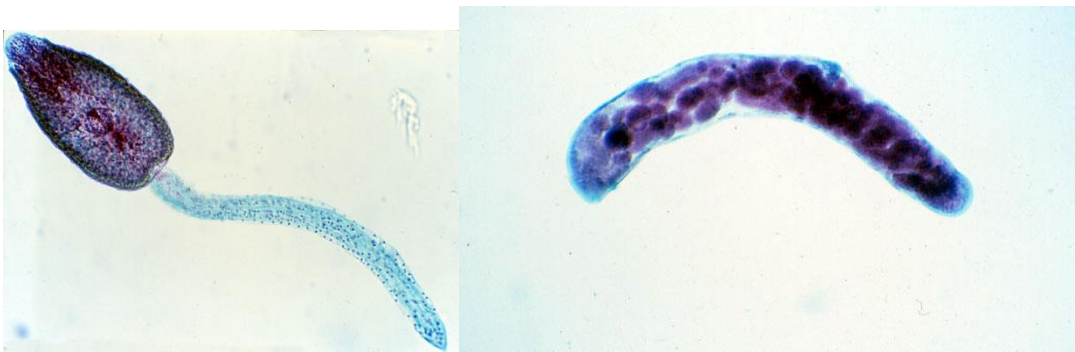
1. In the vesical and pelvic venous plexuses—*Schistosoma haematobium*.
2. In the inferior mesenteric vein—*S. mansoni*
3. In the superior mesenteric vein—*S. japonicum*

B. Hermaphroditic flukes (monocious trematodes) which live in the lumen of various tracts:

1. Biliary tract (liver flukes); *Clonorchis sinensis*. *Fasciola hepatica*. *Opisthorchis* sp.
2. Gastrointestinal tract (Intestinal flukes): . a. Small intestine—*Fasciolopsis buski*, *Heterophyes heterophyes*, *Metagonimus yokogawai*, *Watsonius watsoni* b. Large intestine—*Gastrodiscoides hominis*
3. Respiratory tract (Lung fluke)—*Paragonimus westermani*.

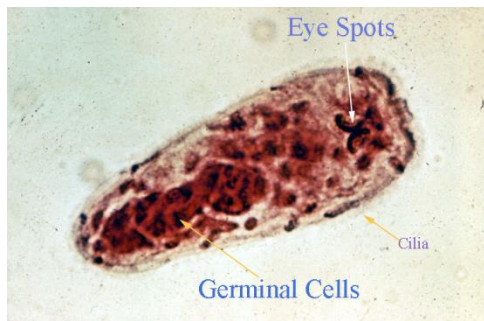
Larval stages of Trematodes

- Miracidium - This larval stage is ciliated and slightly oval in shape. It has 2 simple eyespots and lateral papillae which protrude outwards and serve as sensory organs.
- Redia - At this larval stage, it retains a very simple worm structure. In some ways, it still resembles a sac. It has a pharynx but no esophagus or intestine. Developing cercariae are visible in the rest of its body .
- Cercaria - this stage, resembles a small adult with a tail, which it loses upon penetration of the second intermediate host. The tail has dorsal and ventral fins on it to aid in locomotion. It is brownish in color. Unlike an adult, it has two eyespots, penetration glands and a stylet at its anterior end, and a cuticle with small spines.
- Metacercaria - this form, is encysted and does not look like a fluke. It has lost larval organs such as the eyespots, the stylet, and the tail. The round cyst has very thick walls and within it, the maturing fluke is visible as are its suckers.



Cercaria

Redia

**Miracidium**

HERMAPHRODITIC FLUKES: LIVER FLUKES

The adult forms of all hermaphroditic flukes infecting humans live in the lumen of the biliary, intestinal or respiratory tracts. This location affords the parasites considerable protection from host defense mechanisms and also facilitates dispersal of eggs to the environment. Flukes inhabiting the human biliary tract are *Clonorchis sinensis*, *Fasciola hepatica*, less often *Opisthorchis* species, and rarely *Dicrocoelium dendriticum*.

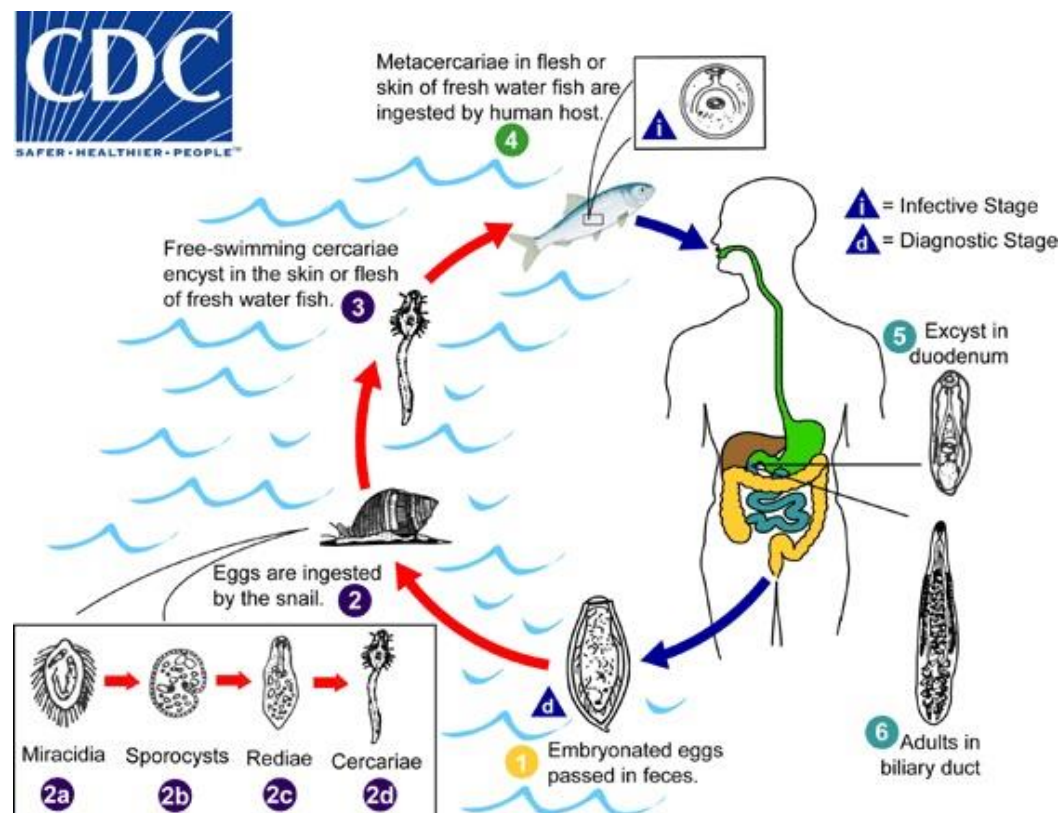
CLONORCHIS SINENSIS

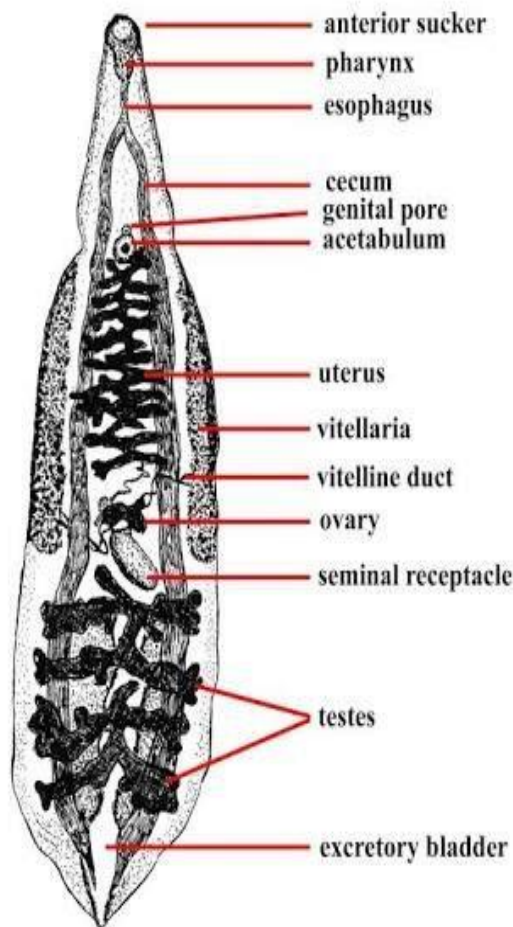
Morphology and Life Cycle

- Humans are the principal definitive host, but dogs and other fish-eating canines act as reservoir hosts.
- Two intermediate hosts are required to complete its life cycle, the first being snail and the second fish.
- The adult worm lives in the human biliary tract for 15 years or more. It has a flat, transparent, spatulate body; pointed anteriorly and rounded posteriorly, 10 to 25 mm long and 3 to 5 mm broad.
- *C. sinensis* is a very narrow fluke, flattened dorsal-ventrally, with Trematode characteristics.
- A thick and elastic cuticle lacks any kind of spines or scales and can either be a translucent gray color or yellow color (due to absorption of bile). When stained on a slide, its branched testes, lobed ovary, and follicular vitellaria are apparent as is the long and convoluted uterus
- It discharges eggs into the bile duct. The eggs are broadly ovoid, 30 μm by 15 μm with a yellowish brown shell. It has an operculum at one pole and a small hook-like spine at the other. The eggs passed in feces contain the ciliated miracida. They do not hatch in water, but only when ingested by suitable

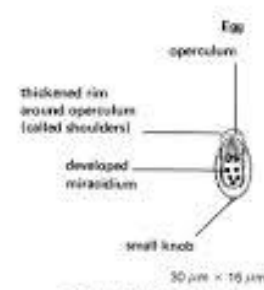
species of operculate snails, such as *Parafossarulus*, *Bulinus* or *Alocinma* species.

- The miracidium develops through the sporocyst and redia stages to become the lophocercus cercaria with a large fluted tail in about 3 weeks. The cercariae escape from the snail and swim about in water, waiting to get attached to the second intermediate host, suitable fresh-water fish of the carp family.
- The cercariae shed their tails and encyst under the scales or in the flesh of the fish to become, in about 3 weeks the metacercariae which are the infective stage for humans.
- Infection occurs when such fish are eaten raw or inadequately processed by human or other definitive hosts. Frozen, dried or pickled fish may act as source of infection. Infection may also occur through fingers or cooking utensils contaminated with the metacercariae during preparation of the fish for cooking.
- The metacercariae excyst in the duodenum of the definitive host. The adolescaria that come out enter the common bile duct through the ampulla of Vater and proceed to the distal bile capillaries where they mature in about a month and assume the adult form.





Clonorchis sinensis egg



Pathogenicity

The migration of the larva up the bile duct induces desquamation, followed by hyperplasia and sometimes adenomatous changes. The smaller bile ducts undergo cystic dilatation. The adult worm may cause obstruction and blockage of the common bile duct leading to cholangitis. Chronic infection may result in calculus formation. A few cases go on to biliary cirrhosis and portal hypertension. Some patients with chronic clonorchiasis tend to become biliary carriers of typhoid bacilli. Chronic infection has also been linked with cholangiocarcinoma. Patients in the early stage have fever, epigastric pain, diarrhoea and tender hepatomegaly. This is followed by biliary colic, jaundice and progressive liver enlargement. Many infections are asymptomatic.

Diagnosis

The eggs may be demonstrated in feces or aspirated bile. They do not float in concentrated saline. Several serological tests including complement fixation and gel

precipitation but extensive cross-reactions limit their utility. Indirect haemagglutination with a saline extract of etherised worms has been reported to be sensitive and specific.

Treatment: Chemotherapy has not been very successful. Chloroquine and praziquantel have been reported to be useful. Surgical intervention may become necessary in cases with obstructive jaundice

FASCIOLA HEPATICA

Fasciola hepatica or the sheep liver fluke. It is the largest and most common liver fluke found in humans, but its primary host is the sheep, and to a less extent cattle. It is worldwide in distribution, being found mainly in sheep-rearing areas. It causes the economically important disease 'liver rot' in sheep.

Morphology and Life Cycle

- The adult worm lives in the biliary tract of the definitive host for many years— about 5 years in sheep and 10 years in humans.
- It is a large leaf-shaped fleshy fluke, 30 mm long and 15 mm broad, grey or brown in colour.
- The outer tegument is covered in tiny spines which face backwards enabling them to attach themselves along with their suckers to the tissues.
- It is possessing both ovaries and testes, which are highly branched and occupy a large part of the body. The adult is grayish brown in colour when fresh, with a flattened body that usually shows the dark outline of the blood filled caeca.
- The anterior end of the parasite forms a conical projection that broadens at the shoulders, then gradually narrows towards the posterior end.
- The alimentary canal consists of two main branches of the caeca with an elaborate system of secondary and tertiary lateral branches.
- The male and female reproductive systems are both very dendritic.
- The testes lie one behind the other in the middle portion of the body. The small, highly branched ovary is in front of anterior testis
- It has a conical projection anteriorly and is rounded posteriorly.
- The eggs are large, ovoid, operculated, bile stained and about 140 µm by 80 µm in size.
- They are laid in the biliary passages and shed in feces. The embryo matures in water in about 10 days and the miracidium escapes. It penetrates the tissues of intermediate host, snails of the genus *Lymnaea*.

- In snail, the miracidium progresses through the sporocyst, the first and second generation reidia stages to become the cercariae in about 1 to 2 months.
- The cercariae escape into the water and encyst on aquatic vegetation or blades of grass to become metacercariae which can survive for long periods.
- Sheep, cattle or humans eating watercress or other water vegetation containing the metacercariae become infected. The metacercariae excyst in the duodenum and pierce the gut wall to enter the peritoneal cavity.
- They penetrate the Glisson's capsule, traverse the liver parenchyma and reach the biliary passages, where they mature into the adult worms in about 3-4 months.

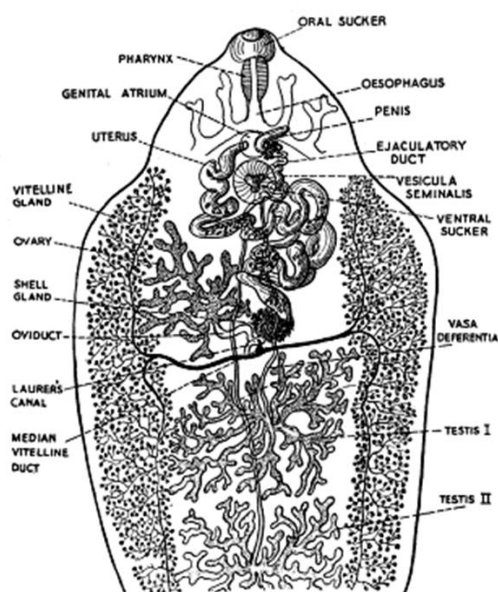


Fig. 65. *Fasciola hepatica*.—Diagram of the reproductive system.

Adult of *Fasciola hepatica*

Pathogenicity

Fascioliasis differs from clonorchiasis in that *F. hepatica* is larger and so causes more mechanical damage. In traversing the liver tissue it causes parenchymal injury. As humans are not its primary host, it causes more severe inflammatory response. Some larvae penetrate right through the liver and diaphragm ending up in the lung. Patients present initially with fever, eosinophilia and tender hepatomegaly. Later they develop acute epigastric pain, obstructive jaundice and anaemia. Cholelithiasis is a common late complication.

Occasionally, ingestion of raw liver of infected sheep results in a condition called halzoun (meaning suffocation). The adult worms in the liver attach to the pharyngeal

mucosa causing oedematous congestion of the pharynx and surrounding areas, leading to dyspnoea, dysphagia, deafness and rarely asphyxiation.

Diagnosis

Demonstration of eggs in feces or aspirated bile is the best method of diagnosis. Eosinophilia is constantly present. Serological tests such as immunofluorescence, immunoelectrophoresis and complement fixation may be helpful

Treatment :Oral bithionol is the treatment of choice. Intramuscular emetine has been used successfully.

Control and prevention

Health education, preventing pollution of water courses with sheep, cattle and human feces, and proper disinfection of watercresses and other water vegetations before consumption can limit the infection. *F. gigantica*, a related species is a common parasite of herbivores in Africa and has caused occasional human infection. It is also prevalent in Indian herbivores.

DICROCOELIUM DENDRITICUM

Known also as the 'lancet fluke' because of its shape, *D. dendriticum* is a very common biliary parasite of sheep and other herbivores in Europe, North Africa, Northern Asia and parts of the Far East.

Eggs passed in feces are ingested by land snails. Cercariae appear in slime balls secreted by the snails and are eaten by ants of the genus *Formica*, in which metacercariae develop. Herbivores get infected when they accidentally eat the ants while grazing.

Fasciola gigantica

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. 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 unclear 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.