TDC FIRET SEM MAJOR : PAPER -1016

UNIT5: PLATYHELMINTHES
GENERAL CHARACTERS CLASSIFICATION UPTO CLASSES
LIFE CYCLE AND PATHOGENESITY OF FASCIOLA HEPATICA AND TAENIASOLIUM

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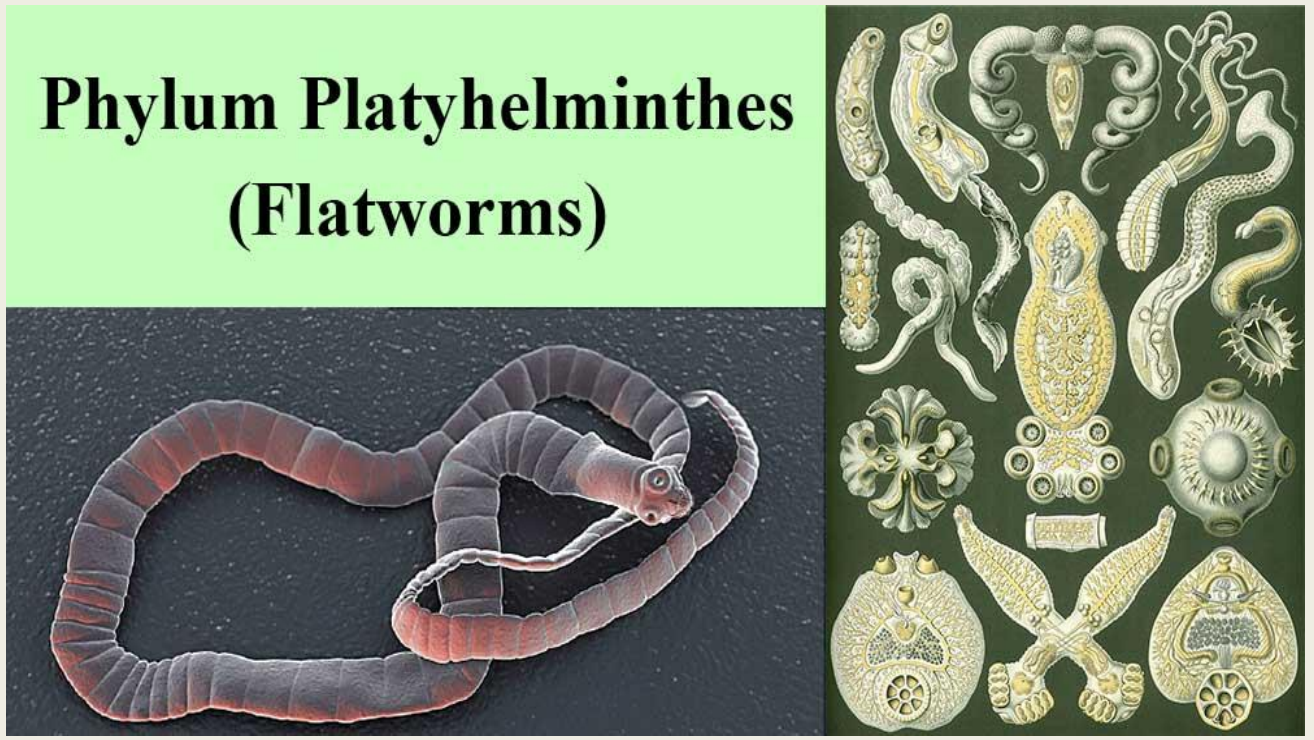
Platyhelminthes are triploblastic, bilaterally symmetrical, dorsoventrally flattened, acoelomate flatworms with organ grade of construction without a definite anus, circulatory, skeletal or respiratory system but with Protonephridial excretory system and mesenchyme filling the space between the various organ of the body.



Phylum Platyhelminthes (flatworms) characteristics

- They are free-living, commensal or parasitic.
- They are bilaterally symmetrical and dorsoventrally flattened, triploblastic worm.
- Bilaterally symmetrical with the definite polarity of head and tail ends.
- Triploblastic i.e. body derived from three embryonic germ layers; ectoderm, mesoderm, and endoderm.
- Dorsoventrally fattened i.e. well-developed ventral surface with mouth and gonopore.

- Their body generally shapes as a worm but varies from moderately elongated flattened to long ribbon-like and leaf-like.
- They are small to moderate in size varying from microscopic to extremely elongated form measuring up to 10-15 meters.
- Their body is unsegmented except in class Cestoda.
- The majority of them are white, colorless and some derive color from ingested food while free-living form are grey, brown-black or brilliantly colored.
- Their anterior end of the body is differentiated into the head.

- Mouth and genital pores on the ventral surface are well marked in turbellarians but less marked in cestodes and trematodes.
- Their parasitic form has adhesive structures like hooks, spines and suckers, and adhesive secretions.
- The body is covered with cellular or syncytial, frequently ciliated epidermis; while trematodes cestodes, lacks epidermis and their body covered with cuticle.
- Exo- and endoskeleton are completely absent, hence the body is generally soft. The hard part consists of cuticle, spines, thorns, hooks, teeth.
- They are acoelomate i.e. without any body cavity.

- Space between various organs filled with special mesodermal tissues, the mesenchyme, and parenchyma.
- Their digestive system is branched and incomplete without an anus and totally absent in acoela and cestode.
- They lack skeletal, respiratory and circulatory systems.
- The excretory system includes a lateral canal and a single or pair of protonephridia with flame cells or bulbs. Absent in some primitive form.
- Their nervous system is primitive, ladder-like. The main nervous system consists of a pair of ganglia or brain and one or three pairs of longitudinal nerve cords connected by transverse nerves.

- Their sense organs are simple. A common occurrence in tubellaria but greatly reduced in parasitic form. Chemo- and tangoreceptors commonly in the form of ciliated pits and grooves.
- They are mostly monoecious (hermaphrodite).
- Their reproductive system is highly evolved or complex in most of the forms.
- Asexual reproduction occurs by fission in many freshwater turbellaria.
- In the majority of form, eggs are devoid of yolk. They are produced separately in the yolk or vitelline glands.

- Fertilization is internal but cross-fertilization in trematodes and self-fertilization in cestodes.
- Their life cycle is complicated involves one or more hosts.
- Parthenogenesis and polyembryony commonly occur trematodes and tapeworms.
- Some tapeworm propagates by endogenous or exogenous budding.
- The flatworm is either free-living or ecto-or endocommensals or parasitic.

Phylum Platyhelminthes (flatworms) Classification

The classification is from Hyman, L.H., (1951) up to suborder only with certain modifications.

Table of Contents [hide]

Class 1- Turbellaria (L., turbella= a little string)

- Mostly free-living but some ectocommensals and endocommensals or parasitic called
- Terrestrial marine or freshwater.
- Body unsegmented and covered with ciliated cellular or syncytial epidermis, containing mucus-secreting cells and rod-shaped body called
- Mouth ventral. intestine preceded by the muscular pharynx.
- Adhesive organs(suckers) abundantly present.
- Sense organ i.e. Tango, chemo, and photoreceptors common in free-living forms.
- The excretory system consists of protonephridia, the flame cells.
- Mostly reproduction sexual, asexual and by regeneration.
- Life cycle simple.

Class 2- Trematoda (Gr., trematodes= having pore)

- Ectoparasitic or endoparasitic commonly called
- Body unsegmented dorsoventrally flattened leaf-like.
- Teguments thick but without cilia and rhabdites.
- Body undivided and covered with cuticle.
- Suckers and sometimes hooks present.
- Digestive tract incomplete consists of the anterior mouth, simple pharynx and two forked or many branches intestine; anus absent.
- 3 pairs of the longitudinal nerve cord.
- Protonephridial excretory system consisting of flame cells.
- Mostly hermaphrodites(monoecious).
- Single ovary, 2 to many testes.
- Development direct (in ectoparasites) or indirect (in endoparasites) with alternation of hosts.

Class 3- Cestoda (Gr., ketos, gridle+ eidos, form)

- Endoparasitic in the intestine of vertebrates.
- Commonly called tapeworm.
- Body divided into many segmented (proglottids) but rarely undivided, elongated, flat, ribbon-like.
- Tegument without microvilli.
- Body without epidermis and cilia but covered with cuticle.
- Anterior end (scolex) is provided with adhesive structures (hooks, suckers) except in cestodaria.
- Mouth and digestive systems totally absent.
- The excretory system consists of protonephridia with typical terminal flame
- The nervous system usually comprises a pair of ganglia and 2 lateral longitudinal nerve cords.
- Each mature segment or proglottids monoecious, with male and female organs.
- Life cycle complicates usually involving 2 or more hosts.
- Embryos with hooks.

LIFE CYCLE AND PATHOGENESITY OF FASCIOLA HEPATICA

Fasciola hepatica (L., fasciola = small bandage; Gr., hepar = liver), the sheep liver fluke, lives as an endoparasite in the bile passages of sheep.

Its life cycle is digenetic, i.e., completed in two hosts (a primary vertebrate host, the sheep and a secondary or intermediate invertebrate host, the gastropod mollusc). The adult parasite is found in the primary host, while a part of its life cycle as larval stages are found in the invertebrate host.

Fasciola hepatica, in addition to sheep, also infects other vertebrates like goat, deer, horse, dog, ass, ox and occasionally man. Its secondary hosts are either Planorbis sps, Bulinus sps., or Limnaea truncatula, all being freshwater gastropod molluscs.

Fasciola hepatica is worldwide in distribution, particularly sheep and cattle raising areas are the primary zones where human beings are also infected

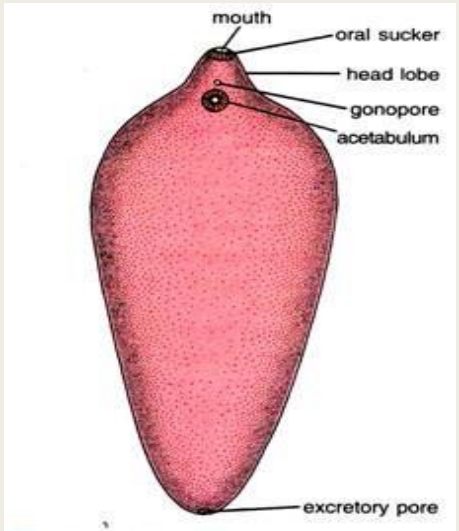


Fig. 41.1. *Fasciola hepatica*. Adult in ventral view.

Life History of Fasciola Hepatica:

(i) Copulation and Fertilization of Fasciola Hepatica:

Though F. hepatica is hermaphrodite even then cross- fertilisation is of common occurrence. Hence, before fertilisation copulation occurs; during copulation, which occurs in the bile duct of the sheep, the Cirrus of one Fasciola is inserted into the Laurer's canal of other Fasciola and the sperms are deposited into the oviduct, so that cross-fertilisation takes place.

During self- fertilisation, which occurs only when cross-fertilisation does not take place, the sperms from the same Fasciola enter the female genital aperture and pass down the uterus to fertilize the eggs in the oviduct.

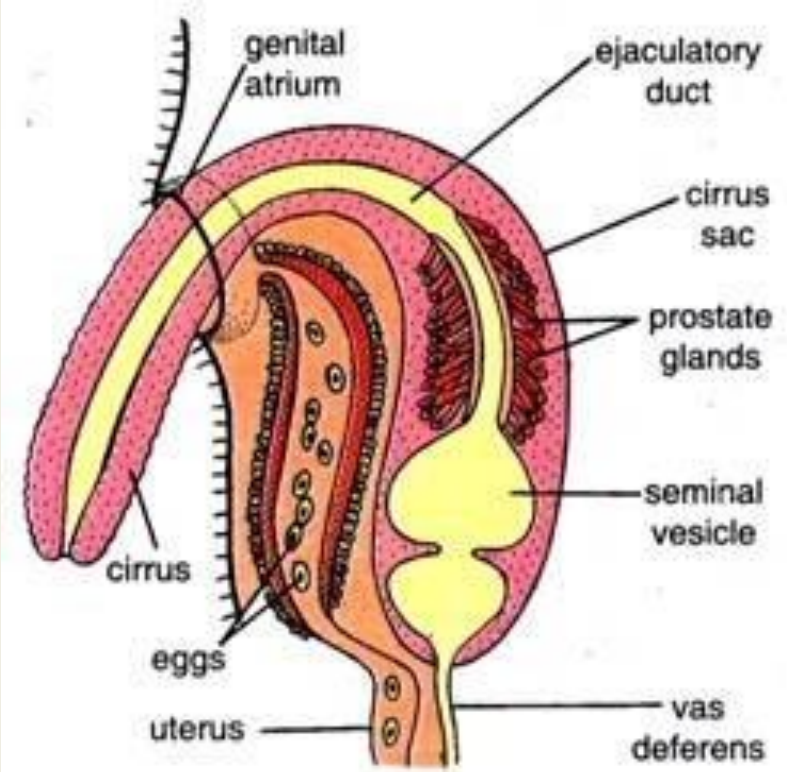


Fig. 41.13. *Fasciola hepatica*. Cirrus protruded through gonopore.

ii) Formation of Egg Capsules in Fasciola Hepatica:

The eggs are brownish in colour, oval in shape and measure about 130 to 150 μ in length and 63 to 90 μ in width.

As referred to, the eggs are fertilised in the oviduct, the fertilised eggs receive yolk cells from vitelline glands and they get enclosed in a chitinous shell formed by granules in the yolk cells giving out droplets, the shell hardens and becomes brownish yellow; the shell has an operculum or lid. Mehlis's glands play no role in the formation of the shell.

The completed ‘eggs’ are called capsules which are large in size and they pass into the uterus where development starts. Capsules come out of the gonopore into the bile duct of the sheep, they reach the intestine and are passed out with the faeces. The capsules which fall in water or damp places will develop at about 75°F. Capsules are produced throughout the year, and one fluke may produce 500,000 capsules.

(iii) Development of Fasciola Hepatica:

Development starts in the uterus and is continued on the ground. The fertilised egg divides into a small propagatory cell and a larger somatic cell. The somatic cell divides and forms the ectoderm of the larva. Later the propagatory cell divides into two cells, one of which forms the endoderm and mesoderm of the larva, and the other forms a mass of germ cells at the posterior end of the larva.

This method of development takes place in the formation of all larval stages during the life history. In two weeks time, a small ciliated

miracidium larva is formed and it comes out of the shell by forcing the operculum. The miracidium produces a proteolytic enzyme which erodes the lower surface of the operculum.

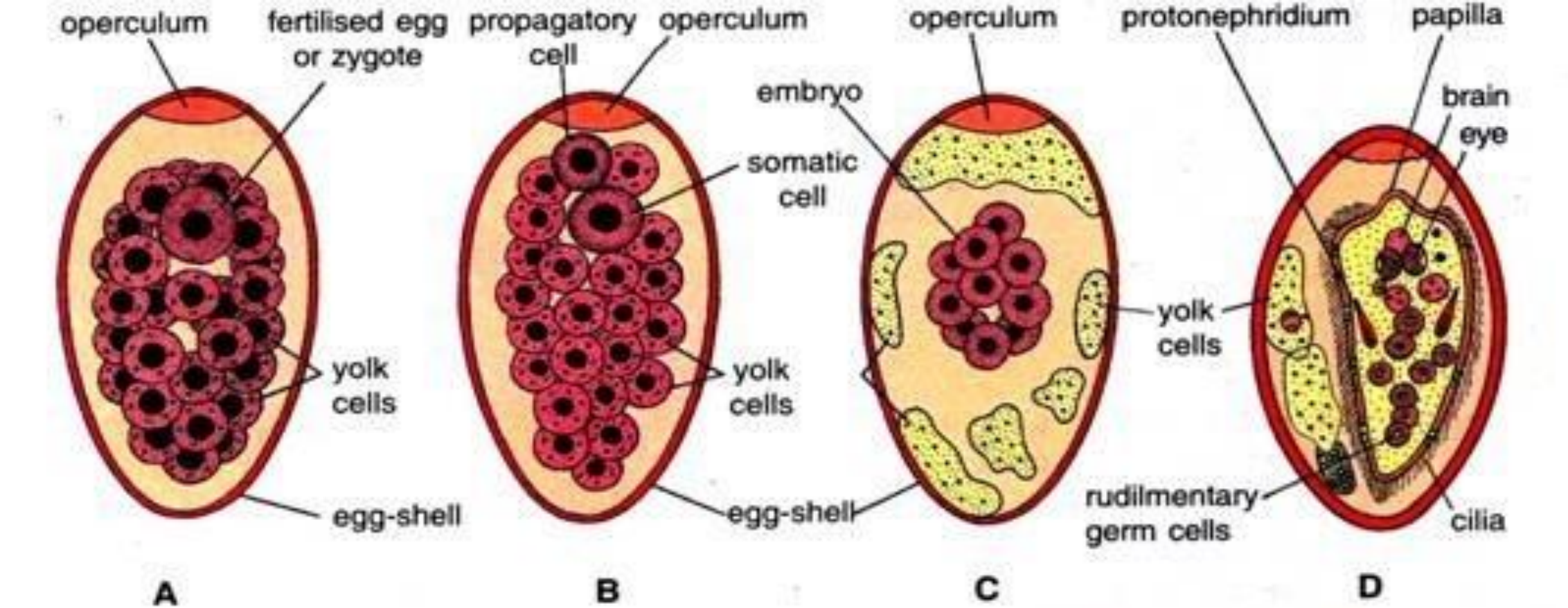


Fig. 41.14. *Fasciola hepatica*. Early stages of development. A—Fertilised egg; B—Two cell stage; C—Many cell stage; D—Miracidium in capsules.

(iv) Miracidium Larva:

Miracidium larva is a minute, oval and elongated, free-swimming stage, it is covered with 18 to 21 flat ciliated epidermal cells lying in five rings.

The first ring is made of six plates (two dorsal, two lateral and two ventral), second ring has again six plates (three dorsal and three ventral), third ring has three plates (one dorsal and two ventrolateral), fourth ring has four plates (two right and two left) and fifth ring has two plates (one left and one right).

A sub-epidermal musculature, consisting of outer circular and inner longitudinal fibres, is situated beneath the epidermal cells.

The sub-epidermal musculature is followed by a layer of cells constituting the sub-epithelium. All these, i.e., epidermal cells, sub-musculature and sub- epithelium, together form the body wall of miracidium.

Anteriorly it has a conical apical papilla, and attached to it is a glandular sac with an opening called apical gland.

On each side of the apical gland is a bag-like penetration gland. There are two pigmented X-shaped eye spots and a nervous system. There is a pair of protonephridia, each with two flame cells. The flame cells

open to the exterior by two separate excretory pores or nephridiopores situated laterally in the posterior half of the body.

Towards the posterior side are some propagatory cells (germ cells), some of which may have divided to form germ balls which are developing embryos. The miracidium does not feed, it swims about in water or moisture film, but it dies in eight hours unless it can reach a suitable intermediate host, which is some species of amphibious snail of genus Limnaea or even Bulinus or Planorbis.

After getting a suitable host the miracidium adheres to it by its apical papilla and enters the pulmonary sac of the snail, from where it penetrates into the body tissues with the aid of penetration glands and finally reaches to snail's digestive gland. In the tissues the miracidium casts off its ciliated epidermis, loses its sense organs and it swells up and changes in shape to form a sporocyst.

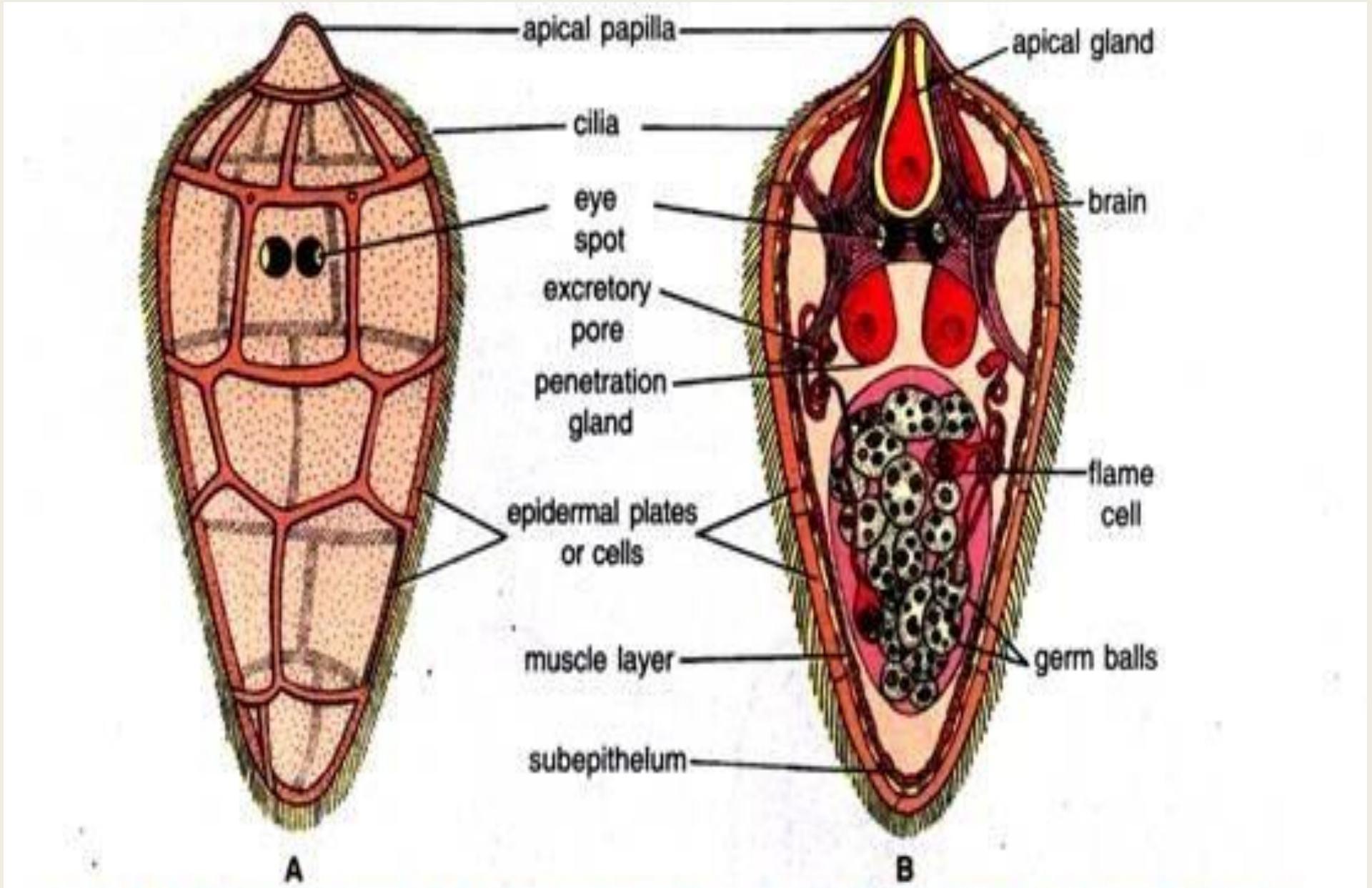


Fig. 41.15. *Fasciola hepatica*. Miracidium larva. A—External structure; B—Internal structure.

(v) Sporocyst:

The sporocyst is an elongated germinal sac about 0.7 mm long and covered with a thin cuticle, below which are mesenchyme cells and some muscles.

The glands, nerve tissue, apical papilla and eye spots of miracidium disappear. The hollow interior of sporocyst has a pair of protonephridia each with two flame cells it has germ cells and germ balls. The germ cells have descended in a direct line from the original ovum from the miracidium developed.

The sporocyst moves about in the host tissues and its germ cells develop into a third type of larva called redia larva. A sporocyst forms 5 to 8 rediae. The rediae larvae pass out of the sporocyst by rupture of its body wall into the snail tissues with the aid of the muscular collar and ventral processes, then the rediae migrate to the liver of the snail

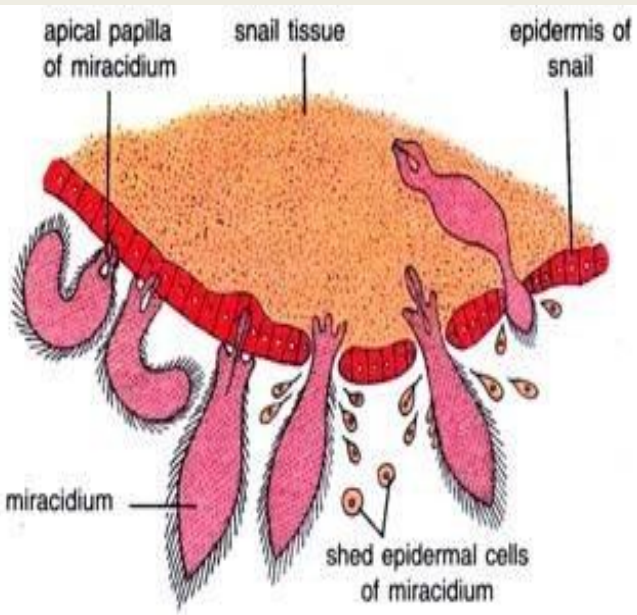


Fig. 41.16. Miracidium of *Fasciolopsis buski*. Stage of penetration through snail epidermis.

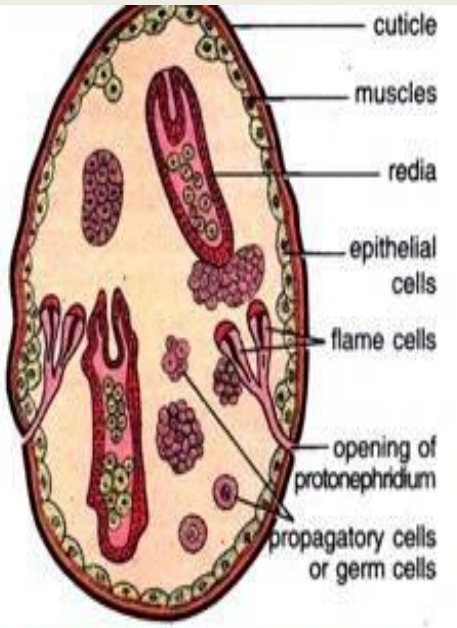


Fig. 41.17. *Fasciola hepatica*. Sporocyst.

(vi) Redia:

The redia is elongated about 1.3 mm to 1.6 mm in length with two ventral processes called lappets or procruscula near the posterior end and a birth pore near the anterior end.

Body wall has cuticle, mesenchyme and muscles, and near the anterior end, just in front of the birth pore, the muscles form a circular ridge, the collar used for locomotion. Redia has an anterior mouth, pharynx in which numerous pharyngeal glands open, sac-like intestine and there is a pair of protonephridia with two pairs of flame cells. Its cavity has germ cells and germ balls.

The germ cells of redia give rise during summer months to a second generation of daughter rediae, but in winter they produce the fourth larval stage, the cercaria larva. Thus, either the primary redia or daughter redia produce cercaria larvae which escape from the birth pore of the redia into the snail tissues. Each redia forms about 14 to 20 cercariae.

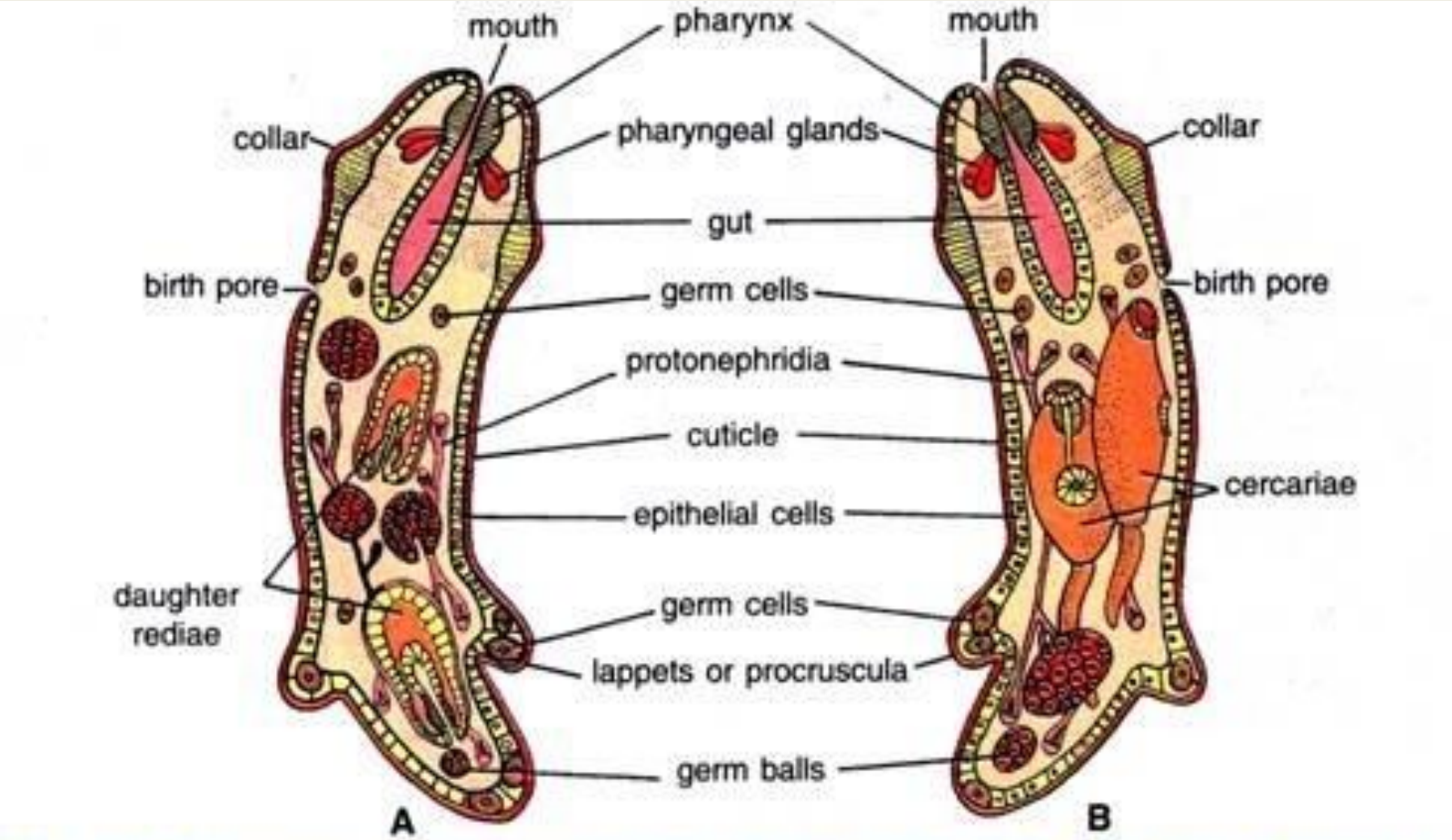


Fig. 41.18. *Fasciola hepatica*. A—Redia with daughter rediae; B—Redia with cercariae.

(vii) Cercaria:

The cercaria has an oval body about 0.25 mm to 0.35 mm long and a simple long tail. Its epidermis is soon shed and replaced by cuticle; below the cuticle are muscles and cystogenous glands. It has rudiments of organs of an adult; there are two suckers (oral sucker and ventral sucker) and an alimentary canal consisting of mouth, buccal cavity, pharynx, oesophagus and a bifurcated intestine.

There is an excretory bladder with a pair of protonephridial canals (excretory tubules) with a number of flame cells. An excretory duct originates from the bladder, travels through the tail and bifurcates to open out through a pair of nephridiopores.

There are two large penetration glands, but they are non-functional in the cercaria of Fasciola.

It also has the rudiments of reproductive organs formed from germ cells. The cercariae escape from the birth pore of the redia, then migrate from the digestive gland of the snail into the pulmonary sac from where they pass out into surrounding water. The time taken in snail from the entry of miracidia to the exit of cercariae is five to six weeks.

(viii) Metacercaria:

The cercariae swim about in water for 2 to 3 days; they then lose their tails and get enclosed in a cyst secreted by cystogenous glands.

The encysted cercaria is called a metacercaria (Fig. 41.20) which is about 0.2 mm in diameter and it is in fact a juvenile fluke. If the metacercariae are formed in water they can live for a year, but if they are formed on grass or vegetation then they survive only for a few weeks, they can withstand short periods of drying.

The various larval stages (the miracidium, sporocyst, redia, and cercaria) are all formed in the same way from germ cells which are set aside at the first division. There is, thus, a distinction between germ cells and somatic cells, and germ cells alone form the various larval stages.

Infection of the primary host (Sheep):

Further development of the metacercaria takes place only if it is swallowed by the final host, the sheep.

Metacercariae can also infect man if they are swallowed by eating water cress on which cercariae encyst, but such cases are rare. But the metacercarie are not infective until 12 hours after encystment. In the alimentary canal of a sheep, the cyst wall is digested and a young fluke emerges and bores through the wall of the intestine to enter the body of the host.

After about two to six days they enter the liver and their movements in the liver may cause serious injuries.

The young flukes stay in the liver for seven or eight weeks feeding mainly on blood and then they enter the bile duct and bile passages. The young flukes have been growing in the liver and after several weeks in the bile duct they become sexually mature adults. The period of incubation in the sheep takes 3 to 4 months.

Life History of Fasciola Hepatica:

Adult flukes in liver → copulation and fertilisation → laying of capsules in the bile ducts → capsules in the intestine (stages in sheep's body) → capsules out in faeces → miracidia escape from capsules (stages in open) → miracidia → sporocysts → rediae → cercariae → (stages in snail's body) → cercariae → metacercariae (stages in open) → metacercariae young flukes → adult flukes (stages in a fresh sheep's body).

Thus, there is a period of asexual multiplication during larval stages, followed by sexual reproduction in the adult fluke. This may be regarded as an alternation of generations, but more probably it is continuous life history in which asexual multiplication occurs in the larval stages due to parasitism.

PATHOGENECITY

FASCIOLA HEPATICA

Fasciola hepatica, also known as **sheep liver fluke**, is a large liver fluke. It causes *fascioliasis* which is a disease of world-wide distribution.

The life cycle of *F.hepatica* is with a **definitive mammalian** (sheep or some cattle) host and an **intermediate snail** host. It is further complicated due to occurrence of a series of different larval stages.

Humans become infected via the consumption of water-cress, water chestnuts, or other aquatic plants that are contaminated with parasitic larva ***adolescariae*** (metacercariae). The larvae excyst in the duodenum, penetrate the intestinal wall and, through the body cavity, reach bile ducts of liver. There they develop and mature into adult worms that can persist 10-15 month in liver before they proceed to the bile ducts to lay their eggs. Each adult, once securely lodged in the liver, can produce up to 25,000 unembryonated eggs per a day. Further development takes place in fresh water. If landed in water, the egg become embryonated and develops a *miracidium* larva. The miracidium invades an aquatic snail *Lymnaea*. Inside the snail, miracidium divides asexually through a single generation of *sporocyst* and two generations of *rediae*, finally to develop into *cercaria*, a

Cercariae leave the snails and swim until they find aquatic vegetation or other grass to which they can adhere. There they form cysts called **adolescariae** (metacercariae), which is invasive stage of liver fluke to human. When human and sheep eat these plants, they become infected and life cycle is repeated.

Pathogenecity and symptoms. The adult worms cause *inflammation, tissue destruction,* and *obstruction of the biliary fluid.* Clinical manifestations include *headaches, rashes, muscle pain, jaundice, abdominal pain, loss of appetite, anemia, nausea,* and *vomiting*.

A single mammal host may harbour as many as 200 flukes. Extensive damage of host's liver, causing **"liver rot"** is the common consequence of such heavy infection.

Laboratory diagnosis Adult *F. hepatica* is identified from eggs in a stool sample by microscopy.

Prophylaxis (preventive measures): liver flukes are killed in the cooking process; humans can avoid fascioliasis by not consuming raw plants containing adolescariae, eating raw shellfish or raw liver. Control measures for *F.hepatica* ideally should also involve removal of flukes in affected livestock, reduction of the intermediate host snail population, and prevention of livestock access to snail-infested pasture.

THANK YOU