Habitat and Structure of Fasciola Hepatica

BSc. Part I Zoology (Subsidiary)

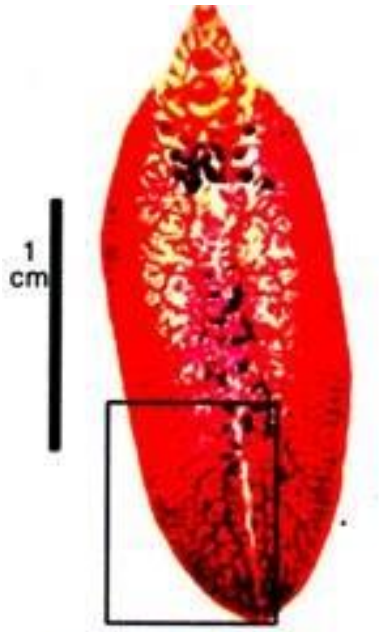
Habit and Habitat of Fasciola Hepatica:

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.

Its other Indian species, F. gigantica (= indica) is found in the bile passages of buffaloes, cow, goats and pigs.



Fasciola gigantica.

Structure of Fasciola Hepatica:

(i) Shape, Size and Color:

F. hepatica has a thin, dorsoventrally flattened, leaf-shaped, elongated and oval body. It measures about 25 to 30 mm in length and 4 to 12 mm in breadth.

The maximum width is at about anterior third of the body from where the body tapers anteriorly as well as posteriorly, however, the anterior end is somewhat rounded, while it is bluntly pointed posteriorly. F. indica has its greatest width at about the middle of the body, and the posterior end is rounded. It is usually pinkish in colour but it appears brownish due to ingested bile of the host.

(ii) External Morphology:

The anterior end of the body is distinguished into a triangular oral cone or head lobe giving it a shouldered appearance. The head lobe, at its tip, bears a somewhat triangular aperture called mouth. There are two muscular suckers an oral sucker at the anterior end encircling the mouth, and a large ventral sucker or acetabulum situated mid-ventrally about 3 to 4 mm behind the oral sucker.

The suckers are cup-like muscular organs meant for attachment to the host by vacuum. In addition to mouth aperture, there are two permanent apertures on the body; one situated mid-ventrally in front of the ventral sucker is the common genital aperture or gonopore, and the other is situated at the posterior end of the body called the excretory pore.

In addition to these apertures, a temporary opening of Laurer's canal appears during the breeding season on the dorsal surface just anterior to the middle of the body. Anus is wanting because alimentary canal is incomplete.

Body Wall of Fasciola Hepatica:

The body wall of F. hepatica lacks a cellular layer of epidermis, unlike those of the turbellarians. However, it consists of a thick layer of cuticle followed by a thin basement membrane and underlying muscle layers surrounding the mesenchyma.

(i) Cuticle:

A tough resistant cuticle, made of a homogeneous layer of scleroprotein, covers the fluke and protects it from the juices of the host. It bears small spines, spinules or scales. The spinules anchor the fluke to the bile duct of the host, provide protection and facilitate locomotion.

The cuticle of F. indica has broad, stout, and blunt scales. The epidermis has been lost during development of the cercaria stage. However, the cuticle is secreted by special mesenchymal cells situated below muscle layers. These cuticle secreting cells were believed to be sunken epidermal cells (Hein, 1904 and Roewer, 1906).

(ii) Basement Membrane:

The lowest layer of the cuticle is a thin, delicate basement membrane. It demarcates the boundary between cuticle and muscle layers.

(iii) Muscle Layer:

The basement membrane is followed by a sub-cuticular musculature. It consists of an outer layer of circular muscle fibres, middle layer of longitudinal muscle fibres and an inner layer of diagonal muscle fibres which are more developed in the anterior half of the body. All muscles are smooth. The muscles form stout bundles of radial fibres in the suckers.

(iv) Mesenchyme:

Below the muscles is parenchyma (mesenchyme) having numerous loosely arranged uninucleate and bi-nucleate cells with syncytial network of fibres having fluid-filled spaces.

Some of these cells are large and provided with large processes extending up to the base of the cuticle to which they are said to secrete. In fact, the mesenchyme forms a packing material between the muscle layer and internal organs. It helps in the transport of nutrients and waste substances.

The body wall plays a significant role in the physiology of fluke. It provides protection, it is the site of gaseous exchange, various nitrogenous wastes are diffused out through it and it also helps in the absorption of amino acids to some extent.

(v) Structure of Body Wall Under Electron Microscope:

The electron microscopic studies of the body wall of F. hepatica by Threadgold (1963), Bils and Martin (1966) have clearly revealed that cuticle is a syncytial layer of protoplasm having mitochondria, endoplasmic canals, vacuoles and pinocytic vesicles. Hence, cuticle is now referred to as the integument because it is metabolically active. The tegument is continuous with tegument secreting cells lying in the mesenchyme.

The outer integumental surface is thrown out into many fine projections which increase its area to facilitate the absorption of host’s fluid. The tegument is also provided with many fine pore canals through which dissolved substances in the form of solution are absorbed into the mesenchyme.

Digestive System of Fasciola Hepatica:

(i) Alimentary Canal:

The oral sucker encloses a ventral mouth which leads into a funnel- shaped mouth cavity, followed by a round muscular pharynx with thick walls, and a small lumen. The pharynx has pharyngeal glands. F. indica has a short muscular pharynx from which arises an oral pouch which is about half the size of the pharynx.

There is a short narrow oesophagus leading into an intestine which divides into two branches or intestinal caeca or crura each running on one side to the posterior end, and ending blindly. The intestinal caeca give out a number of branching diverticula in order to carry food to all parts of the body since there is no circulatory system. The median diverticula are short and lateral ones are long and branching. There is no anus.

The interior part of the alimentary canal up to the oesophagus is lined with cuticle and serves as a suctorial fore gut; the intestine is lined with endodermal columnar epithelial cells. The caceal epithelium has secretory gland cells.

(ii) Food, Feeding and Digestion:

It feeds on bile, blood, lymph and cell debris. The oral sucker and pharynx together constitute an effective suctorial apparatus. Digestion is extracellular, occurs in intestine. The digested food material is distributed by branching diverticula of intestine to all parts of the body as the circulatory system is not found in this animal. Thus, the digestive system functions as a gastro vascular system.

In fact, the digested nutrients are passed into the parenchyma through intestinal diverticula; from parenchyma they are diffused into the various organs of the body.

Reserve food, mostly in the form of glycogen and fats is stored in the parenchyma. However, monosaccharide sugars like glucose, fructose, etc., are directly diffused into the body of the fluke through general body surface from the surrounding fluid of the host. The indigestible remains of the food, if any, are probably said to be ejected through the mouth.

Respiration of Fasciola Hepatica:

Mode of respiration is anaerobic or anoxybiotic. In fact, glycogen is metabolised to carbon dioxide and fatty acids releasing energy in the form of heat.

The process is completed in following steps:

(i) The glycogen undergoes anaerobic glycolysis to form pyruvic acid,

(ii) The pyruvic acid is decarboxylated to form carbon dioxide and an acetyl group,

(iii) The acetyl group then combines with coenzyme A to form acetyl coenzyme A, and

(iv) The acetyl coenzyme A is then finally condensed and reduces to form fatty acids.

The carbon dioxide, thus, produced is diffused out through general body surface and the fatty acids are excreted through the excretory system.

Excretory System of Fasciola Hepatica:

The excretory system of Fasciola hepatica is concerned with excretion as well as osmoregulation. It consists of a large number of flame cells or flame bulbs or protonephridia connected with a system of excretory ducts.

(i) Flame Cells:

The flame cells, supposed to be modified mesenchymal cells, are numerous, irregular in shape bulb-like bodies found distributed in the mesenchyma throughout the body of Fasciola. The distribution pattern of flame cells follows a specific pattern referred to as **'the flame cell pattern'** (Faust, 1919).

The flame cells are characteristic, each has a thin elastic wall with pseudopodia-like processes, a nucleus and an intracellular cavity having many long cilia arising from basal granules. In living condition, the cilia vibrate like a flickering flame, hence, the name flame cell.

(ii) Excretory Ducts:

There is an excretory pore at the posterior end from which arises a longitudinal excretory canal, from this arise four main branches, two dorsal and two ventral, which subdivide into numerous small capillaries which anastomose; the capillaries are continued into the intracellular cavity of flame cells. The longitudinal excretory canal is non-ciliated but the capillaries are lined with cilia.

(iii) Process of Excretion:

The excretory wastes, generally fatty acids and ammonia, are diffused from surrounding mesenchyma into the flame cells and finally collected into their intracellular cavities. The vibrating movement of the cilia causes the flow of wastes from the intracellular cavities of flame cells into the excretory ducts and then into the main excretory canal and finally to the exterior through excretory pore by hydrostatic pressure.

Such an excretory system of flame cells and canals or ducts of various orders with no internal opening and leading to an excretory pore which opens to the exterior is spoken of as a protonephridial system which is excretory but its main function is to regulate the amount of fluid in the animal's body.

Nervous System of Fasciola Hepatica:

A nerve ring surrounds the oesophagus, it has a pair of cerebral ganglia dorsolaterally, and a ventral ganglion below the oesophagus. Small nerves are given out anteriorly from the ganglia. Posteriorly three pairs of longitudinal nerve cords arise from the ganglia, a dorsal, a lateral, and a ventral pair of nerve cords.

The lateral nerve cords are best developed and they run to the posterior end. Nerve cords are connected by transverse commissures and they give out many small branches, some of which form plexuses. The nerve cells are mostly bipolar. Due to parasitic life, sense organs are lost in adult Fasciola.

Reproductive System of Fasciola Hepatica:

Fasciola hepatica is hermaphrodite but usually cross fertilisation takes place. The reproductive organs are well developed and complex.

(i) Male Reproductive System of Fasciola Hepatica:

The male reproductive system consists of testes, vasa deferentia, seminal vesicle, ejaculatory duct, cirrus or penis, prostate glands and genital atrium.

(a) Testes:

These are two in number, much ramified tubular and placed one behind the other (i.e., with tandem arrangement) in the posterior middle part of the body. In fact, they occupy major space from behind the middle part of the body of Fasciola. The cells lining the wall of testes give rise to spermatozoa.

(b) Vasa Deferentia:

A narrow and slender vas deferens or sperm duct arises from each testis and runs forwards.

(c) Seminal Vesicle:

The two vasa deferentia unite together near the acetabulum (ventral sucker) and become dilated to form a muscular, elongated, broad, bag-like seminal vesicle or vesicula seminalis. It serves the purpose of storing sperms.

(d) Ejaculatory Duct:

The seminal vesicle continues anteriorly into a very narrow and coiled duct called ejaculatory duct.

(e) Cirrus:

The cirrus (penis) is a muscular and elongated structure into which ejaculatory duct opens. The cirrus opens by male genital aperture in a common genital atrium. The cirrus of F. indica is covered with small spines.

(f) Prostate Glands:

The ejaculatory duct is surrounded by numerous unicellular prostate glands. These glands open into the ejaculatory duct and their secretion (alkaline) helps in free movement of sperms during copulation.

(g) Genital Atrium:

The genital atrium is a common chamber for male and female genital apertures, it opens externally by a gonopore lying ventrally in front of the acetabulum. The cirrus can be everted through the gonopore during copulation. The cirrus or penis, seminal vesicle and prostatic glands are surrounded in a common cirrus sheath or cirrus sac.

(ii) Female Reproductive System of Fasciola Hepatica:

The female reproductive system consists of ovary, oviduct, uterus, vitelline glands, Mehlis's glands and Laurer's canal.

(a) Ovary:

The ovary is single, tubular, highly branched and situated to the anterior of testes at the right side in anterior one-third of the body.

(b) Oviduct:

All the branches of ovary open into a short and narrow tube called oviduct. The oviduct travels down obliquely and opens into the median vitelline duct.

(c) Uterus:

From the junction of oviduct and median vitelline duct arises a wide convoluted uterus having fertilised shelled eggs or capsules. The uterus opens by female genital aperture into the common

genital atrium on the left side of male genital aperture. The uterus is comparatively small and it lies in front of the gonads.

The terminal part of uterus has muscular walls, referred to as metraterm which ejects the eggs and also sometimes receives the cirrus during copulation.

(d) Vitelline Glands:

On both lateral sides and also behind the testes are numerous follicles constituting the vilellaria, yolk glands or vitelline glands which produce albuminous yolk and shell material for the eggs. The vitelline glands open by means of minute ducts into a longitudinal vitelline duct on each side.

The two longitudinal ducts are connected together by a transverse vitelline duct placed above the middle of the body. The transverse vitelline duct is swollen in the centre to form the yolk reservoir or vitelline reservoir. From the yolk reservoir a median vitelline duct starts and runs forward to join the oviduct.

(e) Mehlis's Glands:

A mass of numerous unicellular Mehlis's glands is found situated around the junction of median vitelline duct, oviduct and uterus. The secretion of Mehlis's glands lubricates the passage of eggs in the uterus and probably hardens the egg shells, it probably also activates spermatozoa.

The junction of oviduct and median vitelline duct is swollen to form ootype in certain flukes like F. indica, in which the parts of an egg are assembled and the eggs are shaped, but an ootype is lacking in F. hepatica (according to some authorities).

(f) Laurer's Canal:

From the oviduct arises a narrow Laurer's canal, it runs vertically upwards. This canal opens on the dorsal side temporarily during breeding season and acts as vestigial vagina to serve as copulation canal.