BABASAHEB BHIMRAO AMBEDKAR UNIVERSITY
Department of Zoology
Lecture Outline /Summary Notes

CLASS: **M.Sc. Zoology, 2nd Semester**
PAPER CODE & NAME: **ZL-203-Parasitology -1**
Course Teacher: **Dr. Suman Mishra**

TOPIC- UNIT3: Morphology and Anatomy of Parasites-1
CESTODARIA

TAXONOMIC POSITION

CLASS CESTODA/ CESTOIDEA

Subclass Cestodaria

Order Amphilinidea
e.g. ***Amphilina***

Order Gyrocotylidea
e.g. ***Gyrocotyle***

Subclass Eucestoda

Order Caryophyllidea: in freshwater fish
Order Spathebothriidea: Fresh /marine fish
Order Proteocephalata
Order Tetraphyllidea e.g.*Acanthobothrium*
Order Diphyllobothridea e.g. *Diphyllobothrium*
Order Trypanorhyncha e.g. *Tetrarhynchus*
Order Pseudophyllidea e.g.*Bothriocephalus*
Order Cyclophyllidea e.g. *Taenia*

GENERAL CHARACTERISTICS OF SUBCLASS CESTODARIA

- endoparasites in the intestine and coelomic cavities of various fish and rarely in reptiles, show similarities to both true tapeworms and to trematodes.
- lack a digestive tract and possess fairly well developed parenchymal muscles
- larvae is ciliated, called lycophore, and characteristically bears ten hooks.
  The lycophore of *G. paragonopora* is not ciliated
- some species possess suckers similar to those of digenetic flukes but do not possess scolices
- only one set of hermaphroditic reproductive organs are present.
- unsegmented body i.e. lack strobilation (proglottization).
  Therefore, cestodarians are described as monozoic while Eucestoda are polyzoic .
- tegument is essentially identical to that of the true tapeworms except that electron densetips are absent on the projecting microtrichs
- acoelomate, the spaces between the body wall and the internal organs are filled with a meshlike parenchyma, similar to that found in trematodes and cestodes

ORDER AMPHILINIDEA

None of the members of the Amphilinidea are common, the type genus, *Amphilina*, is probably the most frequently encountered with *Amphilina foliacea*, a parasite in the coelom of European sturgeons, *Acipenser* spp. first described by Rudolphi (1819) who originally thought it was a trematode. Several other species of Amphilina have been recorded in various species of sturgeons. The adults of the members of this order are parasitic in the coelom of sturgeons, other primitive fish, and tortoises. They are ribbon-like monozoic worms up to 37 cm in length. Only 8 amphilinid species are known- *Amphilina foliacea*, *A. japonica, Gigantolina elongata, Gigantolina magna, Schizochoerus (4 species)*. The amphilinids are hermaphroditic, large worms with flattened leaf-like body unsegmented body. They are parasites in the body cavity of freshwater and marine teleost fishes and freshwater turtles and use crustaceans as intermediate hosts. The known life cycles (of three species) include crustaceans (Amphipoda, Decapoda) as intermediate hosts. Final hosts become infected by eating intermediate hosts. Larvae are characterized by anterior penetration glands, two separate posterior nephridiopores (external excretory structure openings), and five pairs of polymorphic posterior hooks, which are retained at the posterior end of the adult. These parasites have little economic significance, although one species was shown to affect sturgeon adversely. Amphilinids are of considerable interest to biologists in reference to study of phylogeny of tapeworms and of related forms. Most studies deal with the taxonomy as well as the light- and electron microscopic structure of a few species. Life cycles are known only for a few species and little is known of their effects on the host.

Taxonomic position

Class –Cestoda
Subclass Cestodaria
Order-Amphilinidea
Family-Single Family Amphilinidae
Genus-*Amphilina*
Type Example*: Amphilina foliacea*

GENERAL MORPHOLOGY

Tegument: It is identical in structure to the tegument of true tapeworms except that it is thinner and the projecting microtriches lack the electron dense tips. Immediately underneath the tegument is a basal lamina of connective tissue fibers followed by poorly developed two-layered tegumental musculature consisting of an outer circular and an inner longitudinally arranged muscle layer. Certain large parenchymal cells are present in the subtegumental, some of these are cytons (or perikaryons), which are connected by cytoplasmic bridges with the surficial, syncytial layer of the tegument.

Proboscis and Related Structures

The proboscis is a powerful, retractable, muscular apparatus located at the anterior end of the body. It is supported by a bundle of well-developed muscle fibers that extend within the body and are attached to certain large cells—called the anchor cells.—located at the posterior end. These muscles help to support the anterior end of the worm during boring process and also to drag the posterior end of the body through the perforation made by the proboscis. True retractor muscles are also present, which are responsible for extension and retraction of the proboscis. In some species clusters of frontal glands are

present that are assumed to play a lytic role during penetration and put out their secretion through minute pores on its surface.

Osmoregulatory System

The osmoregulatory (excretory) system in members of this order is poorly known. In *Amphilina* each flame cell includes a group of 18 to 30 flame bulbs (or cells). Two lateral canals lead into a common excretory vesicle located at the posterior end of the body, which empties to the exterior through a single excretory pore.

Nervous System

It is similar to that of other platyhelminths and consists of a large ganglionic mass (primitive "brain) located immediately behind the proboscis. Two main nerve trunks arising from the brain and are directed anteriorly and two are directed posteriorly. The two posterior nerve trunks are joined by a commissure near the posterior end.

Reproductive Systems

They are monoecious, each worm with a complete set of male and female reproductive organs.

The **Male reproductive organs** include follicular testes scattered throughout the parenchyma, a vas efferens arising from each follicle, a common vas deferens (or sperm duct) directed posteriorly and opening to the exterior through the male genital pore situated at the posterior end of body. Prostate glands are present that p[our their secretion into a muscular zone just before its to opening to the exterior. In some amphilinids, a genital papilla is present at the copulatory terminal.

The **Female reproductive system** consists of a single ovary, located near the posterior of the body, leading into an oviduct which expands into a long uterus, which extends from the ovary to the anterior end, back again to the posterior end, and forward to open at the anterior end at the uterine pore near the proboscis. The vagina branches from the oviduct, extends posteriorly and opens to the outside in one of three ways, depending on the species.

1. The vagina can join the vas deferens and open through a common genital pore, or
2. It opens to the outside of body through a separate female genital pore,
3. It bifurcates and open outside through two separate pores. .

Vitelline glands are follicular and scattered over large parts of the body. The common vitelline duct enters the oviduct near the junction of vagina and oviduct.

During copulation, spermatozoa are introduced into the vagina through the female or common genital pore, depending on which is present. The spermatozoa pass through the vagina and enter the oviduct, where fertilization takes place. Vitelline secretions around the fertilized ovu form part of the egg and provide for nourishment. The eggs pass up the uterus and, in some ovoviviparous species, hatch before their expulsion from the uterine pore. In oviparous species, development of the enclosed embryo is completed outside the host.

The life cycle of *Amphilina foliacea* has been studied by Salensky (1874); Von Janicki (1928).

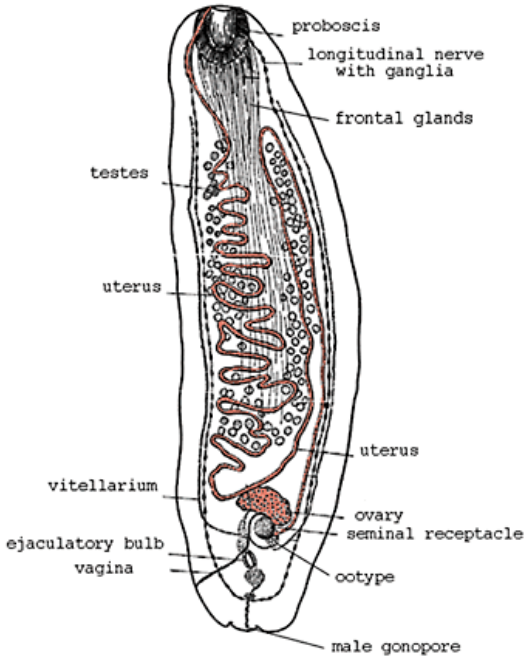
DEVELOPMENT

Zygote, enveloped by a coat of yolk material, is shed as a thin, irregularly ovoid shell. Embryonic development occurs while the egg is *in-utero*. The escaping ciliated larva of *A. foliacea*—known as a

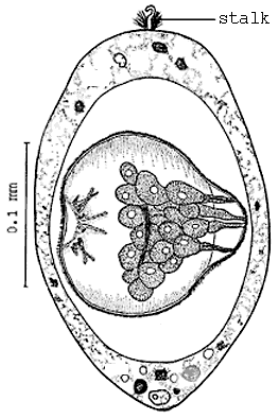
decacanth larva or lycophore —is approximately 100 pm long and has 10 hooks embedded in the posterior end with clusters of large frontal gland cells that open to the outside at anterior end.

Life Cycle of *Amphilina foliacea*.

Adult *Amphilina foliacea* live in the body cavity of European sturgeon, *Acipenser*. Eggs escape through the coelomic pore which connects the body cavity to the outside. Eggs containing infective larvae are ingested by freshwater amphipods. Chewing movements of the mouth parts of the crustaceans break the egg shell and enable the larvae to escape and penetrate into the host. Sturgeon become infected by eating infected amphipods. Von Janicki (1928) has contributed the only completely known amphilinid life history, that of *A. foliacea*. The ciliated lycophore, although fully developed, does not escape from the eggshell until the egg is ingested by the intermediate host—an amphipod crustacean. Within the gut of the amphipod, the lycophore hatches and sheds its ciliated epidermis. The lycophore, by using the secretions of the frontal glands, penetrates the gut wall of the intermediate host (amphipod), and finally inhabits its hemocoel. In the haemocoel, the lycophore undergoes dedifferentiation, i.e. it loses most of its body structures, including the frontal glands, and forms the procercoid larva. The procercoid develops a rounded tail similar to the cercomer of some cestode larvae, bearing 10 larval hooks. The procercoid then undergoes further development : the body elongates, the tail is shed, the adult proboscis is formed along with the frontal glands, and the body muscles begin to take form. This stage is now known as a plerocercoid. When the amphipod host is ingested by a sturgeon, the plerocercoid burrows through the fish's gut wall and enters the coelom, where it attains sexual maturity. In *Amphilina* and related genera (e.g. *Gigantolina)* the 10 embryonic hooks are maintained throughout life in the parenchyma near the posterior end.



Adult *Amphilina foliacea*



Fully developed larva of A. foliacea in egg

ORDER GYROCOTYLIDEA

The most common species in New Zealand is the type species of the genus, *Gyrocotyle rugosa* Diesing, 1850. Two species, *G. fimbriata* Watson, 1911, and *G. urna* (Grube and Wagener, 1852) occur in European and American waters. *G. rugosa* from the elephantfish, *Callorhynchus milii* is found in the Southern Hemisphere**.**

Type example: *Gyrocotyle*

Gyrocotylids are large, dull pink to creamy white monozoic (unsegmented) worms, 32 to 75 millimetres in length, and parasites of marine chimaerid fishes (such as ratfish), primarily inhabiting the host's intestine. These primitive cestoids do not have a typical scolex, but have a spiny acetabulum at the anterior end. The main attachment organ is the highly folded, posterior organ called a rosette with which they attach to the intestinal wall of their host. The very conspicuous 'rosette' is formed by ruffles or undulations of the body wall which helps the parasite to cling to the coelomic wall of the fish host. This rosette forms the border of a funnel-shaped cavity which opens through a smaller dorsal pore. In most species, the thin lateral margins of the body are thrown into folds or undulations but these are absent in *G. rugosa.* In the body wall on each side of an anterior sucker-like organ (the 'acetabulum') are a number of large spines. Other, body spines occur in *G. fimbriata* and *G. urna* but these are reduced in *G. rugosa* to minute points at the tips of small papillæ. A muscular, eversible, cup-shaped proboscis (also known as a sucker or acetabulum) is located at the anterior end with well developed retractor muscles, which control the eversion and retraction of the proboscis. A well developed sphincter is located at the posterior end of the proboscis. Body margins are ruffled and tegument bears spines at the anterior and posterior ends of the body. Spines located at the posterior end are arranged in front of the rosette. There has been much debate as to which end of this worm is the anterior. Lynch (1945), who has recently studied two species of *Gyrocotyle* very thoroughly, concludes that the rosette is posterior and the acetabulum is anterior. This conclusion seems confirmed by his discovery of larval hooks in the wall of the rosette of young adults. The ciliated larva swims with the ten hooks posterior in position.

Nutrition

These parasites lack a digestive system and absorb nutrients from their host via tegumental microvilli.

Nervous System

The nervous system of gyrocotylids is unique as it appears to be better developed posteriorly. The main parts of the nervous system consist of anterior ganglia and larger posterior gangia close to the rosette, connected by large connectives (longitudinal nerve cords). Immediately in front of the rosette are located a commissure, two ganglia, and a nerve ring. Anteriorly, a commissure is located behind the proboscis, and two lateral nerve cords extend posteriorly from it which are joined to the posteriorly situated ganglia. Richly innervated two ridges and pits at the anterior tip of the proboscis of *Gyrocotyle,* are presumed to be tactile.

Osmoregulatory System

The osmoregulatory system of the adult comprises of a protonephridial system consisting of flame bulbs and a network of capillaries and ducts. The flame cells present at the terminals of a network of partially ciliated vessels and minute tubules. The main excretory ducts empty to the outside of the body through two nephridiopores (excretory pores) situated at the anterior end of the body. There is no excretory vesicle.

Reproductive System

The male reproductive system consists of numerous testes scattered anteriorly throughout the parenchyma. The vasa efferentia of testes unite to form a common vas deferens, or sperm duct, which leads to the male genital pore situated on a minute genital papilla located laterally on the ventral body surface near the anterior end. The genital papilla projects from the body surface. The vas deferens forms a spermiducal vesicle followed by a muscular area before it opens on the genital papilla.

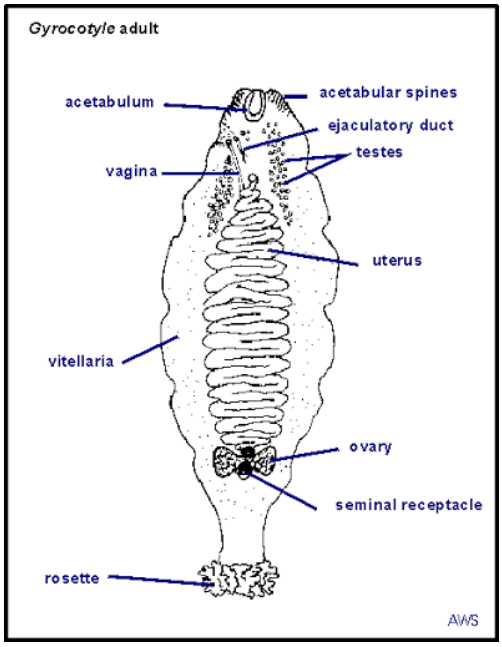
The female reproductive system consists of many ovarian follicles in the posterior region of the body, a single oviductule arising from each follicle, an oviduct formed by union of oviductules, the ootype, and a large coiled uterus which terminates at the female genital pore situated on the middorsal line in the anterior part of the body, posterior to the proboscis. Vitelline glands are scattered throughout the parenchyma, especially in the two lateral regions. The common vitelline duct, Mehlis' gland cells, and duct of the large seminal receptacle, if present, enters into the oviduct. The seminal receptacle is the storage site for sperm. During copulation, the sperms enter the anteroventrally located vaginal pore (female genital pore), swim down from the receptacle and oviduct into ootype, where fertilization occurs with the ova which are released periodically from the ovarian follicles down the oviduct. Mature vitelline cells pass from the vitelline glands to the ootype, where, aided by Mehlis' gland cells, they release globules of shell precursor which coalesce to form a capsule. The operculate capsule, containing the ovum and remains of the vitelline cells or yolk, which serve as nourishment during subsequent development pass into the uterus where it becomes darker and hardens.

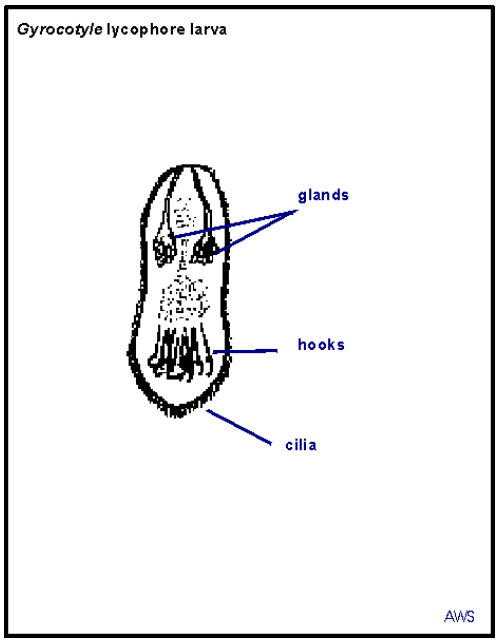
Life Cycle of *Gyrocotyle urna*.

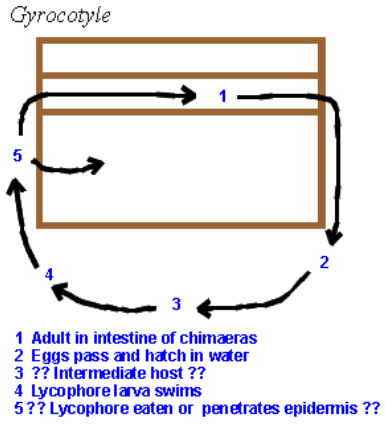
The life cycle of the gyrocotylids is poorly understood. Like many marine parasites they are known mainly from their definitive hosts. If larval forms are found that might belong to that species, it can be difficult to confirm by the traditional route of experimental infection, since many marine hosts are difficult to rear parasite-free and maintain in captivity. *Gyrocotyle* lives in the intestine of deep sea Chimærid (rat) fishes. Eggs are released and hatch to produce a lycophore larva. It is not known whether an intermediate host is required, or whether the lycophore simply penetrates or is eaten by another ratfish.

Although complete life history data on gyrocotylids are wanting, phases of the developmental cycle of *Gyrocotyle* have been reported by workers. In this species, the eggs secrete a gelatinous capsule a few hours after being ejected through the uterine pore. The *in-utero* development of the lycophore is incomplete; hence, further development takes place only after the operculated egg escapes into water. Again, the parent bores through the body wall of the fish host to lay its eggs. Gyrocotylid lycophores generally lack a ciliated epidermis and instead have an embryonic membrane between the larva and the capsule (shell), however lycophore of *Gyrocotyle urna* and

G. rugosa possess a ciliated epidermis. Procercoid larvae, 3-5 mm long, have been reported in fish hosts on which the rosettes had already formed and the ten embryonic hooks grouped together where the rosettes had formed. This finding suggests that no intermediate host is necessary, but many workers believe that larval development in an unknown intermediate host is required. Adults of Gyrocotyle commonly occur in pairs within the fish host, probably to ensure cross-fertilization. How Gyrocotyle is transmitted from one host fish to another is unknown. Almost all intestinal helminths enter their definitive host by way of food. There is at present no evidence regarding what intermediate host, if any, is involved in the life cycle of *Gyrocotyle*.







Gyrocotyle life cycle

LECTURE SOURCES:

- General Parasitology By Thomas C. Cheng, Academic Press College Division, Harcourt Brace Jovanovich, Publishers. (Chapter 11)
- http://tolweb.org/Amphilina_foliacea/20407
- http://www.biology.ualberta.ca/parasites/ParPub/diagram/comp/cesto03a.htm
- http://nzetc.victoria.ac.nz/tm/scholarly/tei-Bio05Tuat02-t1-body-d2.html
- https://krohde.wordpress.com/2011/12/31/the-gyrocotylidea-an-aberrant-group-of-xk923bc3gp4-79/
- Rohde, K. (1994). The minor groups of parasitic Platyhelminthes. Advances in Parasitology 33, 145- 234.

Further Reading (Advanced):

- Xylander, W.E.R. Ultrastructure of the lycophora larva of Gyrocotyle urna (Cestoda, Gyrocotylidea). Zoomorphology 107, 88–95 (1987). https://doi.org/10.1007/BF00312118
- http://aagc.uconn.edu/shared/tapeworm/data/citations/pdf/6763/Williamsetal(1987).pdf
- https://link.springer.com/article/10.1007/BF01632710
- https://www.tandfonline.com/doi/pdf/10.1080/03036758.1973.10421863