

GENERAL LIFE CYCLE AND LARVAL FORMS IN CESTODES

Generally, cestode life cycles are not as complicated as those of digeneans because they usually do not involve asexually reproductive larval phases. However, most tapeworms also require at least one or two intermediate hosts.

Life cycle patterns among the eucestoda are of considerable phylogenetic importance, for they often indicate the membership of particular species in specific orders. Unfortunately, the complete representative developmental patterns of all tapeworm orders are as yet not known. The patterns, some yet incomplete, for the Trypanorhyncha, Tetrphyllidea, Proteocephala, Cyclophyllidea, and Pseudophyllidea, however, are known.

Trypanorhynchan life cycle pattern:

No complete life cycle is known among the Trypanorhyncha. However, the following pattern, based on the life cycle of **Lacistorhynchus tenuis** as reported by Riser (1956), gives some indication of how this group develops.

Adult **Lacistorhynchus tenuis** lives in the intestinal spiral valve of sharks. Eggs discharged by the adult tapeworms pass into the sea water and a ciliated larva, the **coracidium**, hatches from each egg. The coracidia are ingested by the splash-pool copepod **Tigriopus fulvus**. The larval stage within the haemocoel of this crustacean is the tailless **procercoid**. When experimentally fed to fish, the procercoid did not undergo further development, and therefore, the complete life cycle is not known.

Tetrphyllidean life cycle pattern:

Very little information is available on the life cycles of Tetrphyllideans. Reichenbach-Klinke (1956), has reported that in case of **Acanthobothrium coronatum**, a parasite of elasmobranchus, developing procercoids occur in small crustaceans, and the next larval stage, plerocercoids occurs in sardines. When the latter are fed to sharks, adult cestodes develop from them. From this information it may be concluded that Tetrphyllids also have two intermediate hosts, the first crustacean and the second a small bony fish.

Protocephalan life cycle pattern:

In the order Protocephala eggs containing larvae known as **onchospheres** leave the host in feces. Generally these eggs are ingested by a copepod, in which the onchospheres (or hexacanth larvae), each bearing three pairs of hooks, escape and actively penetrate the gut wall, reaching the host's haemocoel. In this position, the **onchospheres** develop into proceroid larvae. The proceroids often lack the characteristic **cercomer** – a small caudal appendage commonly found on this type of larva. If a cercomer is present, the characteristic hooks embedded in it are often absent. When the crustacean host is ingested by a definitive host, the proceroids invade such tissues as hepatic, muscular, and intestinal epithelium and develop into plerocercoid larvae with invaginated scolices. These larvae migrate back into the lumen of the gut and metamorphose into strobilate adults.

Cyclophyllidean life cycle pattern:

In the cyclophyllidea, the onchosphere bearing six hooks, also known as the hexacanth larva, remains passive in the egg shell or the unciliated embryophore (a flexible membrane) until the embryo is ingested by a vertebrate or invertebrate intermediate host.

In species that normally utilize an invertebrate intermediate host, usually an arthropod, the onchosphere, upon hatching, penetrates through the host's gut wall into the haemocoel and develops into a solid metacestode (the preadult stage that occurs in an intermediate host) known as a **cysticercoid**. The scolex of the cysticercoid is everted. In those that utilize a vertebrate intermediate host, the onchosphere penetrates the host's intestinal lining and enters a venule. It is then carried in blood to some other area of the body where it develops into a metacestode with a scolex inverted in a vesicle (or bladder) and hence is known as **bladderworm** or **cysticercus**. When several scolices develop a bladderworm, as in *Taenia multiceps*, the metacestode is referred to as a **coenurus**.

Penetration by onchospheres into the intermediate host's intestinal wall is made possible by secretions from glands present in each

onchosphere. Such secretions act on the ground substance of the hosts mucosa and also have a cytolytic effect.

In *Echinococcus granulosus*, the metacestodes display a third variation of scolex formation. In these daughter and grand daughter cysts are formed, the daughters originating as invaginations on the wall of the mother and the grand daughters as invaginations on the walls of the daughters. The walls of the second and third generation cysts, in turn, give rise to a number of protoscolices, which protrude into the cystic spaces referred to as brood capsules. Thus, a large bladder-worm, known as a hydated cyst, is formed enclosing numerous protoscolices, each of which can develop into an adult worm. A hydated cyst commonly measures 10 mm or more in diameter, and may contain thousands of protoscolices. When the intermediate host harboring hydated cyst, *cystercerci*, or *coenuri* is ingested by the definitive host, each scolex develops into an adult.

Evagination of the scolices of certain tapeworm larvae, once they reach the definitive hosts intestine, is sometimes referred to as excystation because these larvae may be enveloped by a protective cyst wall or capsule. Rotham, (1959) has shown larvae of such species as *Hymenolepis diminuta*, *H. citelli*, *Vampirolepis nana* and *Oochoristica symmetrica* require the hosts bile salts for activation and excystation. The influences of bile salts, pepsin, trypsin, and temperature on the excystation of certain cyclophyllidean cestodes.

Pseudophyllidean life cycle Pattern:

In pseudophyllidean, the onchosphere is covered with a ciliated embryophore. The larva hatching from the egg, known as coracidium is free swimming. Coracidia are ingested by the first intermediate host, usually a copepod, and in the intestine of this host the coracidia shed their ciliated coats while penetrating gut wall. In the copepods haemocoel, the larvae develop into elongate oval **procercoids** that retain the six larval hooks. The hooks are situated in a caudal protuberance, the cercomer. When the first intermediate host is ingested by a second intermediate host, procercoids develop into solid, worm like plerocercoids, each with an adult scolex. Finally, when the plerocercoid is

ingested by the definitive host, the strobilate adult form of the parasite develops.

Pseudophyllidean eggs are similar to those of digenetic trematodes in that there is an operculum at one end. For the coracidium to escape, the operculum must be released. Studies have shown that the eggs of a number of pseudophyllideans can hatch in the dark, but light is required in some species. Even in species of the same or closely related genera, the eggs of some require light for hatching, whereas the eggs of others do not.

Lifecycle of the tapeworms/ Cestodes

True tapeworms are exclusively hermaphrodites; they have both male and female reproductive systems in their bodies. The reproductive system includes one or more testes, cirri, vas deferens, and seminal vesicles as male organs, and a single lobed or unlobed ovary with the connecting oviduct and uterus as female organs. The common external

opening for both male and female reproductive systems is known as the genital pore, which is situated at the surface opening of the cup-shaped atrium. Though they are sexually hermaphroditic, self-fertilization is a rare phenomenon. To permit [hybridization](#), [cross-fertilization](#) between two individuals is often practiced for reproduction. During copulation, the cirri of one individual connect with those of the other through the genital pore, and then [spermatozoa](#) are exchanged.

The lifecycle of tapeworms is simple in the sense that no [asexual phases](#) occur as in other [flatworms](#), but complicated in that at least one [intermediate host](#) is required as well as the [definitive host](#). This lifecycle pattern has been a crucial criterion for assessing evolution among Platyhelminthes. Many tapeworms have a two-phase lifecycle with two types of hosts. The adult *Taenia saginata* lives in the gut of a primate such as a human, but more alarming is *Taenia solium*, which can form cysts in the human brain. Proglottids leave the body through the anus and fall onto the ground, where they may be eaten with grass by an animal such as a cow. If the tapeworm is compatible with the eating animal, this animal becomes an intermediate host. The juvenile form of the worm enters through the mouth, but then migrates and establishes as a cyst in the intermediate host's body tissues such as muscles, rather than the gut. This can cause more damage to the intermediate host than it does to its definitive host. The parasite completes its lifecycle when the intermediate host passes on the parasite to the definitive host. This is usually done by the definitive host eating a suitably infected intermediate host, e.g., a human eating raw or undercooked meat.

[Book - DeBarns]

Life cycles

Tapeworms are endoparasites in the guts of vertebrates. Their life cycles require one, two, or sometimes more intermediate hosts, which are arthropods and vertebrates. The basic developmental stages are an onchosphere larva, which hatches from the egg, and a cysticercus or plerocercoid stage, which is terminal and develops into an adult. Although

the following few examples illustrate the basic life cycle patterns of tapeworms, variations exist.

Diphyllobothrium latum, one of the fish tapeworms, is widely distributed and parasitic in the gut of many carnivores, including humans. When the eggs are deposited in with faeces in water, a ciliated, free swimming onchosphere (coracidium) hatches after an approximately 10 days development. The larva is ingested by certain copepod crustaceans. It penetrates the intestinal wall and develops within the haemocoel into a six hooked stage called a proceroid. When the copepod is ingested by a variety of fresh water fish, the proceroid, like the onchosphere, penetrates the fishes gut and eventually reaches the striated muscles of the fish to develop in to a plerocercoid stage. The plerocercoid, which looks like an unsegmented tapeworm, develops into an adult tapeworm when ingested by a definitive host.

Species of the family Taeniidae are among the best known tapeworms. *Taenia saginata*, the beef tapeworm, is one of the most common species in humans, where it lives in the intestine and frequently reaches a length of over 3 meters. Proglottids containing embryonated are eliminated through the anus, usually with faeces. When an infected person defecates in a pasture, the eggs may be eaten by grazing cattle, sheep, or goats. On hatching in the intermediate host, an onchosphere larva, bearing three pairs of hooks, bores into the intestinal wall, where it is picked up by the circulatory system and transported to striated muscle. Here the larva develops into a cysticercus stage. The cysticercus, sometimes called a bladder worm, is an oval worm about 10mm in length, with the scolex invaginated. If raw or insufficiently cooked beef is ingested by humans, the cysticercus is freed, the scolex evaginates, and the larva develops into an adult worm in the gut.

Larval forms of Cestodes

The common forms of metacestodes which occur in the life cycles of cestodes of domestic animals and man can be classified as follows:

Proceroid : This is the first metacestode stage in the life cycle of parasites such as the pseudophyllidea and Diphyllidea. The proceroid is solid bodied and bears hooks on the cercomer in the posterior region.

Plerocercoid : This follows the proceroid and occurs in the second intermediate host. Plerocercoids are elongate, solid bodied metacestodes which bear an adult scolex (e.g., *Diphyllobothrium latum*). Some plerocercoids (e.g., *Schistocephalus*) may show advanced development of the genitalia.

Tetrathyridium : An elongate, solid bodied metacestode with a deeply invaginated acetabular scolex.(e.g.,metacestoides).

Cysticercoid : A metacestode with a single non invaginated scolex withdrawn into a small vesicle with practically no cavity (e.g., *Dipylidium caninum*).It has slightly developed bladder and solid posterior portion.It is present in invertebrates like insects, mite, lice etc in their haemocoel.Cysticercoid in invertebrate host is ingested by the final host for completion of their life cycle.

Cysticercus : A single scolex invaginated into itself in a large fluid containing vesicle or bladder (e.g., *Taenia saginata* T. solium).Cysticercus is a translucent cyst (10\5mm) with an opaque invaginated scolex equipped with suckers and hooks.Cysticercus is present in muscles of tongue,diaphragm,spleen,liver and mesentry.

Strobilocercus : A single scolex which is not invaginated when fully developed, and is attached to the bladder by a long , segmented strobila (e.g., *Taenia taeniaeformis*).

Coenurus : A large fluid containing bladder with a no. of invaginated scolices attached to the wall (*T. multiceps*).

Hydated : A large fluid containing bladder which develops other cysts called brood capsules in which the scolices develop (e.g., *Echinococcus*).

The metacestode is passively transferred to the definitive host when the latter ingests the infected intermediate host. The scolex excysts or evaginates ,and attaches to the mucosa of the intestine.