


□ CLASS CESTODA: Tapeworms



CARYOPHYLLAEUS

- Adults of *Caryophyllaeus* live in the digestive tract of Cyprinids and Salmonids, producing different degrees of damage.
- Body is elongate, slender and robust, narrowing towards the posterior end. It is 2-4 cm long, containing only a single set of female and male sexual organs. Cestodes lack a digestive system and semi-digested nutrients from the host are absorbed through the whole body surface.
- Shape of scolex is variable, always wider, usually conspicuously, than the neck and the remaining body.
- Unarmed scolex is dorso-ventrally flattened and like a carnation flower (adhesion organ).
- **Life-cycle:** The eggs are discharged with the feces of fish. They are ingested by an oligochaete belonging to soil-inhabiting annelids, *Tubifex*, *Limnodrilus* worms. Inside these intermediate hosts, a so-called procercoid larva is developed. If fish feed with infected *Tubifex* worms, the procercoid larva develops into the adult stage within 50-70 days.

- ▶ When fish are the final host, adult worms are typically found attached by their scolex to the intestinal mucosa of the pyloric caeca and hind gut.
 - ▶ **Clinical signs:** Worms may introduce **catharrhal-hemorrhagic inflammations**. In heavy infections, parasites may block the intestine, **reduce the food uptake**, and thus lead to such a **loss of weight** that the fish appear with **depressed flanks** or may even die. In addition, **abdominal swelling** due to much parasite in fish.
 - ▶ **Diagnosis:** Adult worms are found in the intestinal tract.
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- A decorative graphic consisting of several parallel white lines of varying lengths and orientations, located in the bottom right corner of the slide.

KHAWIA

- Adults of Khawia live digestive tract of Cyprinids and Salmonids.
- Body is **elongate**, narrowing towards posterior end. It is **2-11 cm** long (longer than Caryophyleus).
- Shape of scolex is variable and flat. Anterior margin of scolex usually **smooth**, in some species resembles **carnation** or has **superficial longitudinal grooves**.
- **Biology** looks like Caryophyleus. Intermediate invertebrate host is aquatic worm (Oligochaete). Fish becomes infected by feeding on infected oligochaetes.
- **Clinical signs:** In heavy intensive infection with 35-50 worms, the parasites completely **obstruct** the intestinal lumen and mortalities occur. Gut includes lesions, **blood loss, inflammation, proliferation** of gut mucosa and increased mucus production.
- **Diagnosis;** Adult worms are found in the intestinal tract.

CYATHOCEPHALUS

- **Adults of** Cyathocephalus live digestive tract and pyloric caeca of especially Salmonid fishes and some lake fishes (0.5-50 cm).
- It has an elongate-fusiform body that lacks a distinct scolex or attachment organs. The attachment organ is **funnel-shaped** and the scolex is separated from strobila by slight constriction.
- **Biology** looks like Caryophyleus. Intermediate invertebrate host is Gammarus (Amphipod crustacea)
- **Clinical signs:** They are able to seriously disrupt the integrity of the mucosal gut layer, inducing lesion of wide degree: from shallow erosions to deep **ulcerations** with **haemorrhages** and **perforation** of the gut wall. These cases usually result in **peritonitis** and **septicaemia** with the lethal outcome, which is rarely noticed in the wild, except in cases of mass mortalities.
- Another important factor in the pathogenesis of gastrointestinal helminths is a **reduction in the host feed intake** that has negative economical repercussions in the farm systems, **constantly weakens** the fish, making the host more susceptible to predation.
- Affects the ovaries during the breeding season, mortality increases
- **Diagnosis:** Adult worms are found in the intestinal tract.

BOTHRIOCEPHALUS

- Bothriocephalus sp. are parasites of freshwater (**cyprinid fish**) and marine fish.
- Elongated body is between **4 and 8 cm length** and up to 4 mm width. It has **heart-shaped scolex**, with a weakly developed **apical disc** and **a pair of deep, slit-like grooves** (bothria) positioned dorsoventrally along the scolex. The scolex is much wider than the first body segments (proglottides). The strobila (body) consists of numerous proglottides.
- **Biology** looks like Cyathocephalus spp. Intermediate host is Copepods (Crustaceans)
- **Clinical signs:** One of the most serious adult cestodes that affect fish is the Asian tapeworm, *B. acheilognathi*. It has been introduced to grass carp and has caused serious problems. Clinical signs associated with bothriocephalus include **sluggish movement**, **emaciation** and **poor body condition**. **Abdomen is enlarged** due to the mass of tapeworms which fill the intestine. The lumen of the intestine is **blocked with worms**, and mechanical injuries appear at the attachment point of scolices. Local inflammation and haemorrhages occur. Heavily infected fish become **exhausted** and **swim close to the water surface**.
- **Diagnosis;** Adult worms are found in the intestinal tract.

TRIAENOPHORUS***

- This worm (15-40 cm) can be easily recognized by the **trident shaped hooks** on its scolex.
- The life-cycle of this parasite occurs in freshwater where eggs are shed from adult worms living in the intestinal tracks of the final host (**pike**, predatory fish). Eggs are eaten by **copepods** (Cyclops) and develop into **procercoids**. The copepods are eaten by the 2nd intermediate **fish (perch, trout, catfish** and other freshwater fish) host where the procercoids migrate from the intestinal tract to the **muscle/other organs** and develop into the **plerocercoid** stage. Larvae of ***T. crassus*** encyst in the **muscle** of a variety of salmonids, while those of ***T. nodulosus*** encyst on the gut of in the **liver** of fish. The life cycle of the worm is completed when the parasitized fish eaten by the final host, commonly pike. Larvae inside the cysts are thin, ribbon-like worms several centimetres (3.5-13 cm) in length. Cysts (**6-25 mm**) in the meat lower the value of the fish. **Adults** of parasites infect the intestine and pylorus of **pike** that have eaten fish infected with plerocercoid.
- In the gut of the pike fish, ***T. nodulosus*** is common. It develops in the liver of perch fish and trout, large nodules of this worm being frequently found in the liver of perch fish and trout.

- **Clinical signs:** *Triaenophorus* occurs yellow to white cysts of host connective tissue that surround the plerocercoids in the muscle. Encysted or unencysted larvae can cause localized **muscle discoloration** and **necrosis**. Liver dysfunction and blood loss can occur from larval migration through the viscera and may be associated with hemorrhaging, necrosis, fibrosis, edema and tissue discoloration. Severe adult tapeworm infestations in the gut can cause **perforations, mechanical blockage** and **swelling**. They cause **emaciation, anemia** and **prevention of food intake**. Infected fish flesh is seen **unsightly**.
- **Diagnosis;** **encysted or unencysted white plerocercoid** in fish. Plerocercoids **scolex** include **dorsal and ventral pairs of trident-shaped hooks** on an apical disc. Adult worms are larger (15-40 cm) and found in the intestinal tract.

PROTEOCEPHALUS***

- These tapeworms are thin compared to *Eubothrium*, this genus has been found in the intestines and pylorus of freshwater fish (especially perch and then catfish, pike).
- Small or medium-sized tapeworms, 1-20 cm long; maximum width 2 mm. Segmentation well pronounced. Scolex with four suckers; apical (fifth) sucker present or absent.
- The growth and maturation of tapeworms in the fish definitive host are controlled mainly by water temperature. So, fish may be both intermediate host and final host.
- **Clinical signs:** Plerocercoids are some of the most damaging parasites to freshwater fish. Plerocercoids decrease carcass value if present in muscle and impair reproduction when they infect gonadal tissue.

EUBOTHRIUM***

- *Eubothrium crassum* and *E. salvelini* are the most abundant species of this genus in salmonids may act as **intermediate** or **final hosts**. *Eubothrium* species can occur in considerable numbers in wild and farmed fish in fresh and sea water (**trout, salmon, perch, pike, bream fish**).
- As adult parasites, the scolex is embedded in the intestine and pyloric caeca. Adult *E. crassum* may reach a length of 1 m, while *E. salvelini* seldom exceeds 30 cm. *Eubothrium* have an **elongate scolex** with a prominent, slightly convex **apical disc**, dorsal-ventral **two elongate bothria**. The apical disc of *Eubothrium* species was variable in shape.
- **FISH** are infected by ingesting infected **copepods** (Cyclops-**procercoid**) or **small fish-plerocercoid**.
- **Clinical signs:** They may **obstruct the gut lumen** and cause **loss of performance, emaciation, production and economic loss**, and **death**. When present in large numbers, the parasites may also **perforate the gut** wall and end up in the peritoneal cavity.

DIPHYLLOBOTHRIUM

- The most common species are *D. dendriticum*, *D. ditremum*, and *D. latum*. Adults are 15-20 m long. Plerocercoids are 1-5 cm long X 4-6 mm width. Scolex has 2 bothria.
- Fish get Diphyllobothrium by eating planktonic copepods that are infected with the parasite larvae (procercoid). In the fish (pike, perch, lake trout, catfish, eel), *D. dendriticum* and *D. ditremum* develop into plerocercoid and migrate into the stomach wall and onto the viscera and walls of the body cavity (usually in viscera, muscle, liver, reproductive organs..) where they become enclosed within pearl-like cysts. The larvae of *D. latum* migrate instead into the muscle tissue and do not encyst.
- When the fish is eaten fish tissue and the cyst walls are digested, releasing the larvae. If the host is a suitable fish the larvae will re-encyst; if it is a suitable bird or mammal host they will mature into adult tapeworms in the host's intestine.
- If the host is not a suitable for the parasite, the larvae are digested or passed

- *Diphyllobothrium* larvae are long-lived in the fish host and accumulate as the fish matures.
- **Clinical signs:** to loss of growth, sterility, decreased market value, and in some instances are a direct cause of death.
- *D. latum* (broad fish tapeworm) is of particular interest because of its zoonotic potential. Diphyllbothriasis in humans who have eaten raw or undercooked fish with infective plerocercoids may develop constipation, fatigue, abdominal pain and severe vitamin 12 deficiency.
- Both *D. dendriticum* and *D. latum* will infect humans and dogs. They can be killed by thorough cooking, or freezing to -21°C. Smoking the fish does not kill the parasite.

LIGULA, DIGRAMMA, SCHISTOCEPHALUS

- Ligulosis is caused by the plerocercoid stages of large tapeworms of water birds belong to the genera Ligula and Digamma.
- *Ligula intestinalis* and *D. interrupta* are known from cyprinid fish (tench, perch etc.). The large plerocercoid developing free in the abdominal cavity of fish can reach 30-60 cm upto 120 cm in length and 0.6-1.2 cm in width. External segmentation is absent in parasite (body segmentation was not obvious), and anterior end of the body is rounded. The scolex has two bothria (grooves). *Ligula intestinalis* and *Schistocephalus* have one set of reproductive organ. *Digamma interrupta* has two sets of reproductive organs
- The final host is fish-eating bird. The worms in the bird's gut produce eggs that are voided into the water with the faeces. Eggs hatch within 5-8 days as a free living larval stage, the coracidium. Coracidia are consumed by copepods, in which the proceroid stage develops. When the infected copepod is eaten by a fish, the parasite burrows through the gut wall and develops into the plerocercoid stage in the abdominal cavity.

- The procercoid develops to plerocercoid in abdominal cavity of fish that bulges out the abdomen; hence, the infested fish is easily preyed.
- The plerocercoid grows considerably, and the weight of one to three worms in the abdominal cavity can reach one third of the fish's weight. Infected fish **lose weight** and have **difficulty in swimming**. They become **emaciated**, but the **belly is swollen** due to the presence of the worms. Fish may survive heavy infections, but they are easily **captured by fish-eating animals**. The flesh of infected fish is of low quality. Diseased fish exhibit **sluggishness, lethargy** and **distention and/or rupture of the abdominal cavity**. A white parasite occupies the peritoneal cavity.
- The infection inhibits the development of host's gonad, **leading to parasitic castration** of the host. These parasites **can affect reproduction**. Plerocercoid inhibits host gonadal development (excretory/secretory product released from the parasite affect brain-pituitary gland-gonadal hormone axis of the fish and thus inhibit gonadal development).

□ CLASS NEMATODA (Round worms)

- Common genera include *Capillaria*, *Camallanus*, *Anisakiosis* (*Hysterothylacium*, *Anisakis*, *Porrocaecum*, *Raphidascaris*, *Contracaecum*), *Philometra* and *Eustrongylides*.
- **CAPILLARIA** is large round worm (1-2 cm) and live in the intestinal tract. Eggs are barrel-shaped and have a polar plug on each end of eggs. **DIRECT LIFE CYCLE**. **Enteritis and rapid weakening are seen.**
- **CAMALLANUS** live in the gastrointestinal tract of fish (**perch, pike**) and is 2-20 cm long. They are easily recognised as a red-small thread-like worm protruding from anus of the fish. **INDIRECT LIFE CYCLE** (Copepod, crustacea is 1st IH, **fish is final host******) **It is not much pathogenic. They suck the blood so, can cause anemia.**