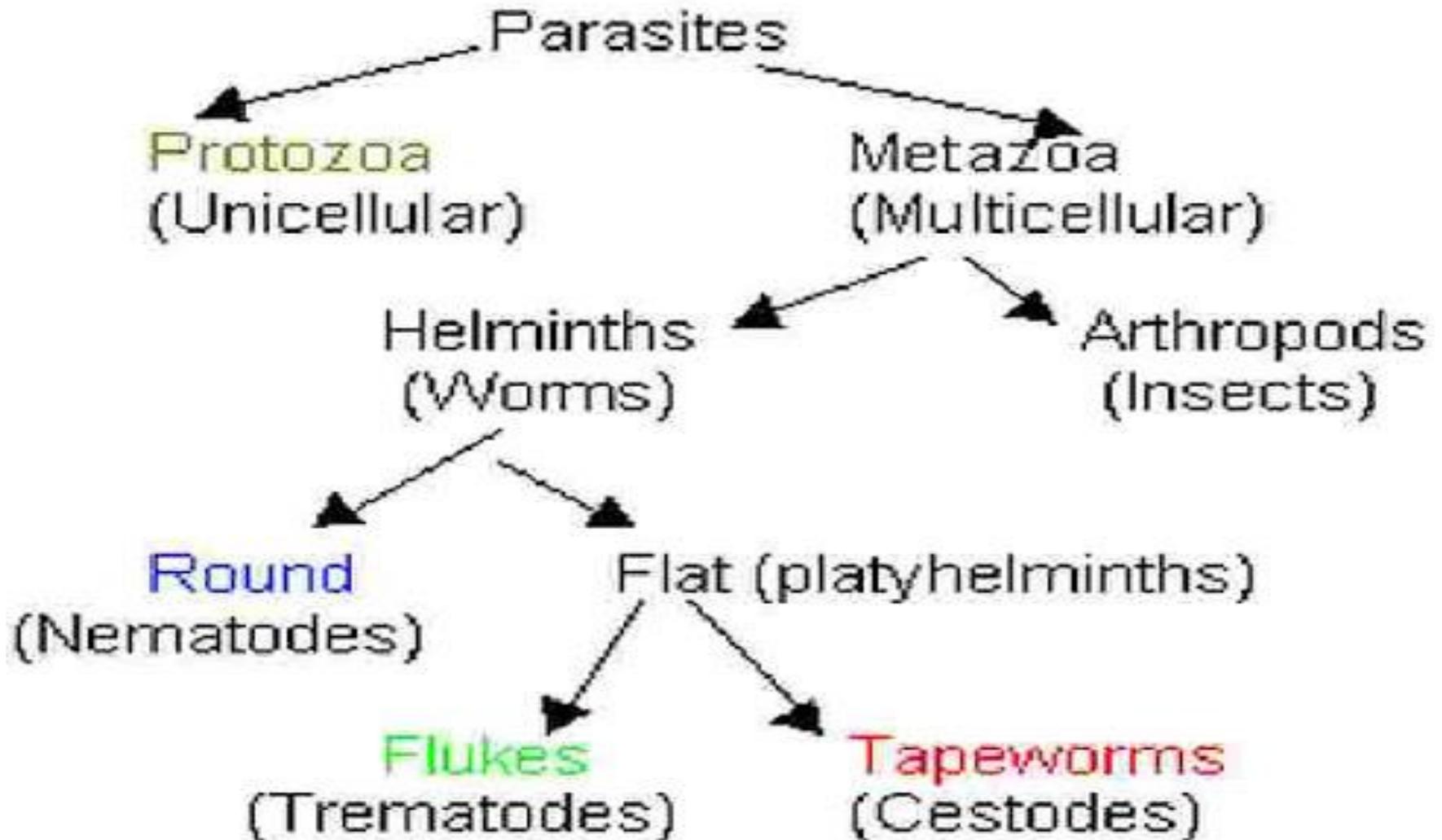


Pathogenicity mechanism of fish parasites

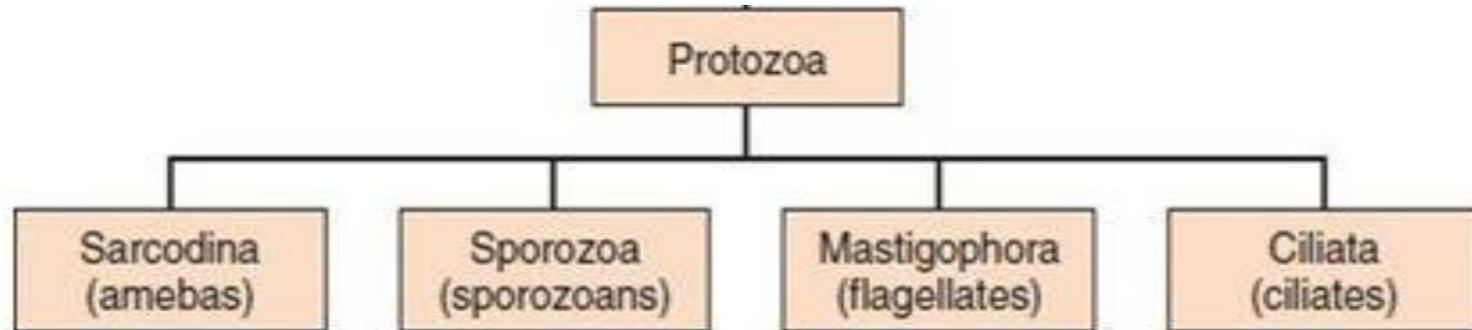
Introduction

- **Pathogenicity:** It refers to the ability of an organism to cause disease.
- Pathogenesis of a disease is the biological mechanism that leads to the diseased state/ condition.
- **Parasite:** A parasite is an organism that lives on or in another organism called host, and often harms it.
- Parasite depends on its host for survival –live, grow and multiply.
- Parasite cannot live independently.

Classification of parasites



Protozoa parasites



1. **Ciliates**- Ichthyophthirius and Trichodina
2. **Flagellates**- Ichthyobodo and Trypanosoma
3. **Sporozoan**- Apicomplexa

Pathogenesis of external protozoa

Protozoan invasion

Skin cellular irritation

Skin cellular destruction

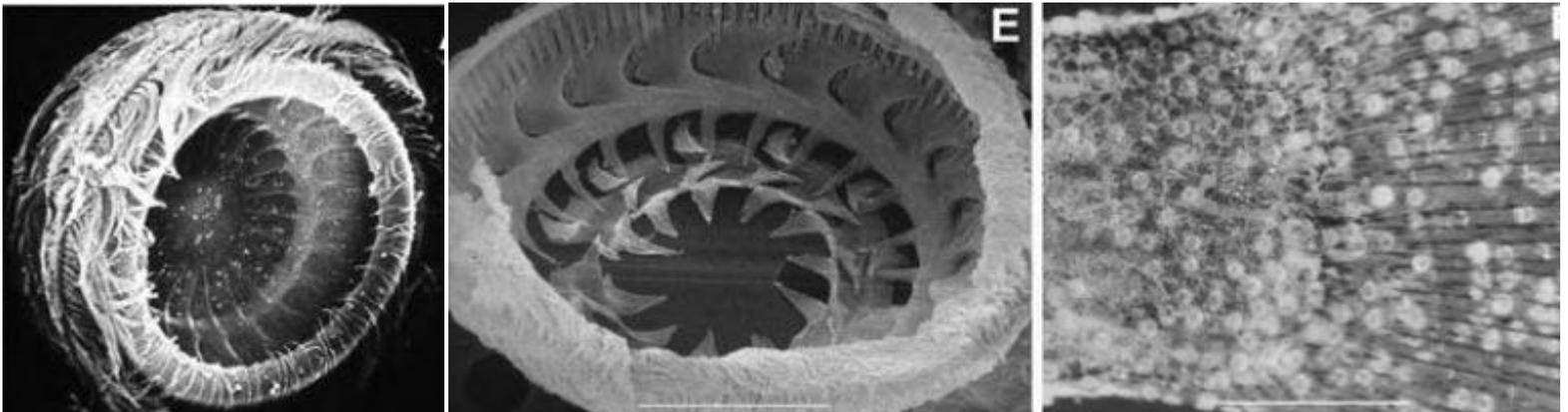
1. Abnormal swimming
2. Excessive mucus

1. Hemorrhages
2. Erosions and ulcers

Ciliates

- **Trichodinids:**

- Comprises mobile ciliated organisms with conical, cylinder-shaped bodies, of which the dominant feature is an aboral adhesive disc.
- The cup- to cylinder-shaped body of a trichodinid is covered by a thin membranelle, the pellicle.



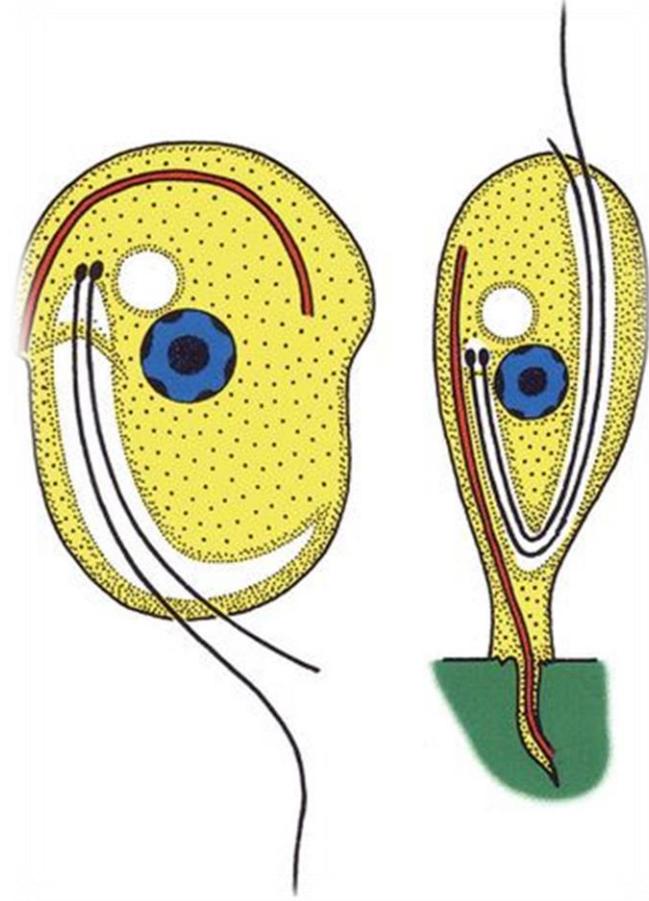
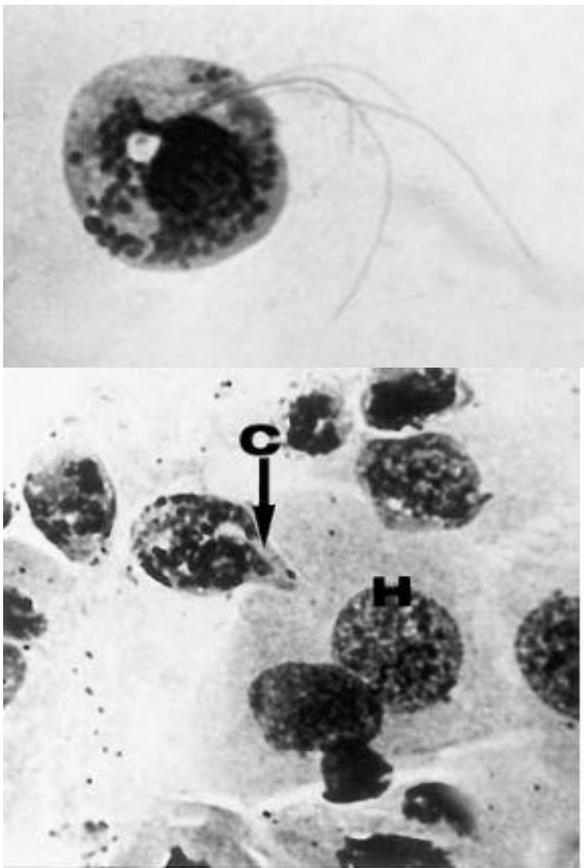
Pathology and clinical sign

- Trichodinids attach firmly to their host, epithelial cells are drawn into the adhesive disc.
- They feed on waterborne particles and bacteria, as well as detritus particles from the fish surface.
- In a firmly attached *Trichodina*, the rim of the border membrane 'bites' into the surfaces of epithelial cells, and the surface it encircles is forcibly vaulted as by a sucker; these activities probably cause irritation to the fish.
- A massive number of trichodinids can, by their constant attachment and rotating movements, seriously damage the epithelial or epidermal cells.

- Heavily infested fish may exhibit a greyish-blue colour, formed by excessive mucus secretion and peeled epithelia, and frayed fins.
- Debilitated fish are sluggish, swimming just beneath the water surface or near the water edge, and they cease feeding.
- **Endozoic trichodinids**, with the exception of two species ***Trichodina fariai*** and ***Trichodina luba***, live in the urinary tract, where they are found rolled up to fit into the narrow lumen of the urinary bladder to the collecting ducts in the kidney.
- ***Trichodina oviduct*** (endozoic) is the largest trichodinid.
- ***Trichodina polycirra***- Freshwater endozoic species.

Flagellates- Ichthyobodosis

- **Ichthyobodosis** in freshwater fishes is caused by the ectoparasite *Ichthyobodo necator*.
- The disease was known as **costiasis** after the previous name of the parasite, **Costia necatrix**, which was originally described from brown trout (*Salmo trutta*) alevins in France.
- The organism has a free-living stage in water and a parasitic stage which is usually attached to dorsal fins and the tips of secondary gill lamellae of fish.
- The free-living stage has a long and a short flagellum, however, these flagella are not seen when the organism attaches to epithelial cells.



- ❖ The free-swimming form of *I. necator* is ovoid to spherical and measures 5–18 μm by 3–8 μm with two flagella – one measures 9 μm , the other is 18 μm long.
- ❖ It attaches to the skin and gills of sweet water fish and introduces severe slimy covers often leading to death.

Clinical signs and pathology

- ❖ Fish with light infections on the body may roll in the water (flashing) and rub against immersed objects or sides of the tank.
- ❖ Fish with heavy infections are often listless and anorexic.
- ❖ Spots appear on the body surface and these fuse to form greyish films on fins and body surface.
- ❖ Gills are usually swollen and increased mucus secretions and frayed or destroyed fins.
- ❖ Some infected fish may not be able to maintain an upright position or swim to the water surface.
- ❖ Fish with only gill infections are listless and anorexic but do not flash or have excessive body mucus.

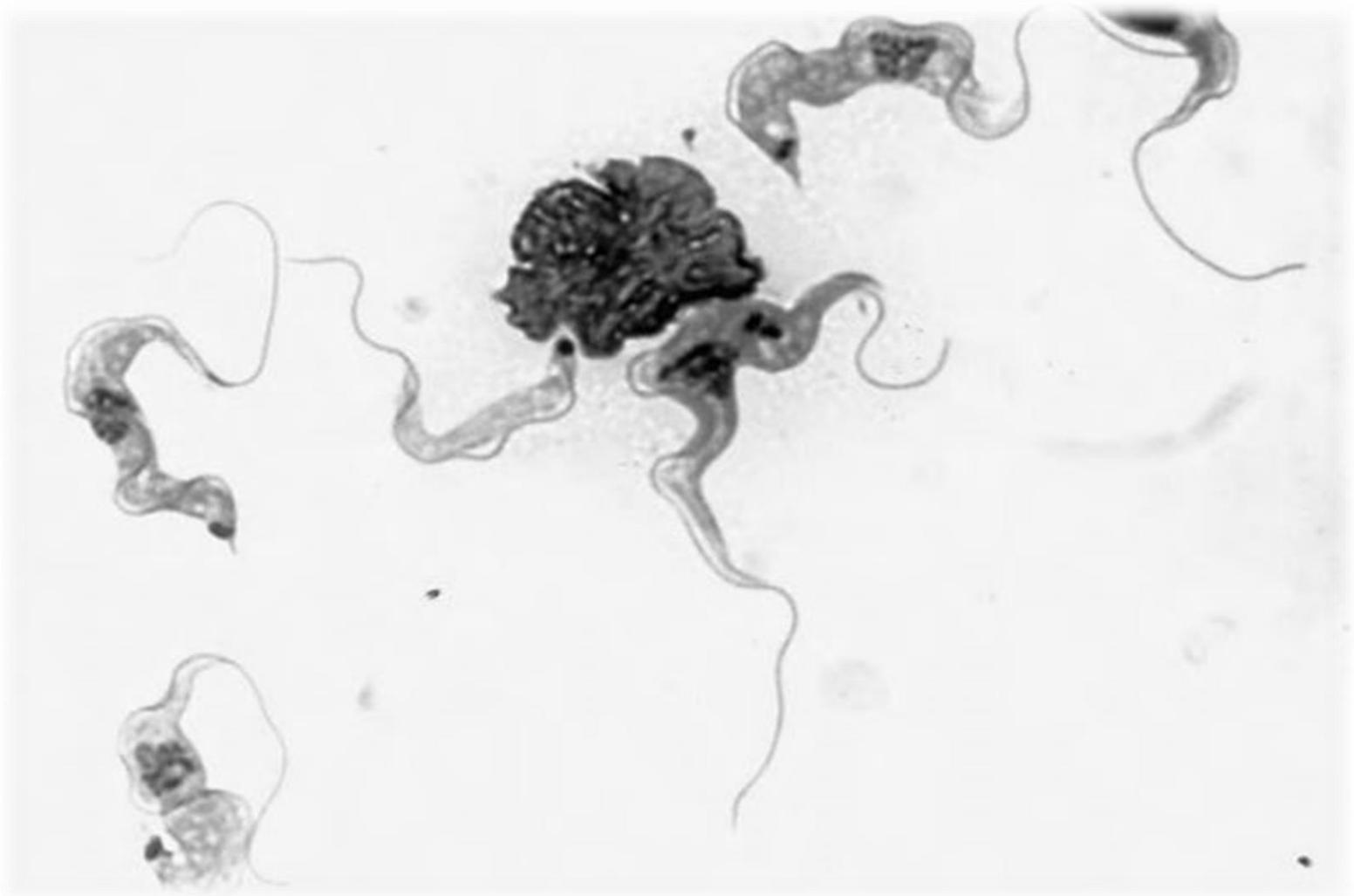
Control

1. Flush treatment with formalin (166 ppm) for 1 h or a formalin bath (1 : 4000) for 15–30 min is well tolerated by salmon fry.
2. Formalin treatment is not recommended if the young fish have bacterial gill disease.
3. The treatment is with copper at 0.2 mg per liter (0.2 ppm) to be repeated once in a few days if necessary.
4. Acriflavine may be used instead at 0.2% solution (1 ml per liter).
5. As acriflavine can possibly sterilize fish and copper can lead to poisoning, the water should be gradually changed after a cure has been effected.
6. Salt bath 3% solution.

Trypanosomiasis in freshwater fish

Trypanosomiasis

- *Trypanosoma danilewskyi* was first described from the blood of the common carp (*C. carpio*) in Europe.
- The parasite has been found in carp, goldfish (*C. auratus*), tench (*Tinca tinca*) and eel (*Anguilla sp.*) in Europe and in *Saccobranchus fossilis* (*Heteropneustes fossilis*) in India.
- Trypanosomes usually have a free flagellum at the anterior end.
- About 190 species of piscine trypanosomes have been reported.
- Piscine trypanosomes are always transmitted by leeches



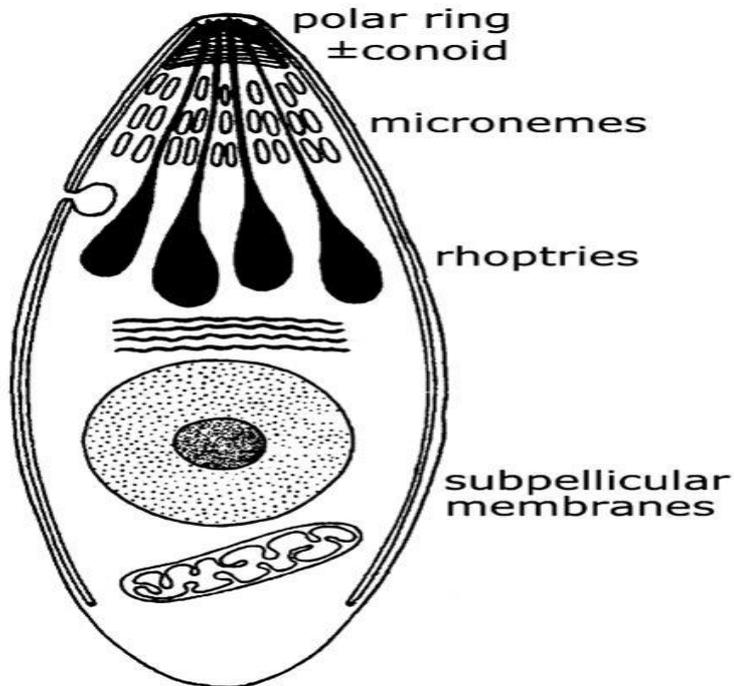
***Trypanosoma danilewskyi* in the blood of an experimentally infected goldfish**

Pathology and mortality

- *T. danilewskyi* causes anaemia in fish.
- severity of the anaemia in trypanosomiasis is directly related to the number of parasites in the blood, and it is also partly caused by a lytic factor and haemodilution.
- The lytic factor(s) is secreted by living parasites and it lyses red cells .
- Mechanism of the anaemia in trypanosomiasis is released of the virulent factor such as protease.

Sporozoan

- A phylum of mainly parasitic **spore-forming protozoans** that have a complex life cycle with sexual and asexual generations.
- Members of the phylum Apicomplexa Levine, have a special cell organelle, called the apical complex, which facilitates invasion of the host cell.



Apicomplexa

- **originally called sporozoa**
- **no free-living forms**
- **complex life cycles**
 - spore-like forms
 - intracellular stages
- **defined by apical organelles**
 - invasive stages
 - rhoptries
 - micronemes
- **gliding motility**

Infection of fish

- Fish-parasitic coccidia *sensu lato* have heteroxenous life cycles, which involve two hosts, one being the fish and the other a parasitic leech or insect.
- The development of coccidia *sensu lato* is divided into merogony, gamogony and sporogony.

Development types:

Cyrrilia *Desseria* *Haemogregarina* *Babesiosoma* *Dactylosoma*

Merogony



e

io

e

e

e

Gamogony



e

e

e

e

e

Gamonts



f

f

f

f

f

Transmitted stages

gamonts

gamonts

gamonts

gamonts

gamonts

Syzygy



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Sporogony



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Sporozoites



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Merogony



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Merozoites



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Transmitted stages

sporozoites

merozoites

merozoites

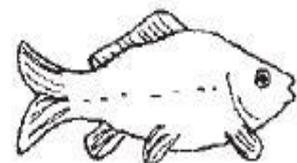
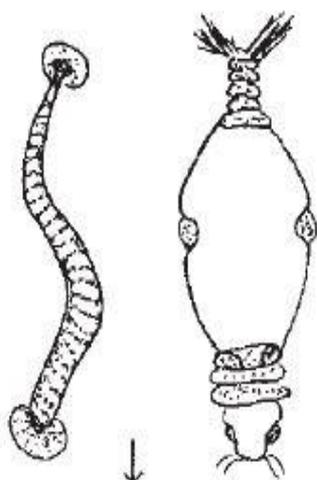
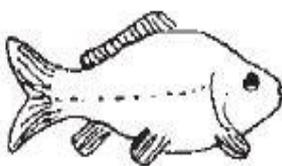
merozoites

merozoites

Merogony

io = development in cells of internal organs
f = free in blood/intestine

e = intraerythrocytic
ie = intraepithelial



Monogenea (Phylum Platyhelminthes)

- Monogeneans are flatworms (Platyhelminthes) with representatives in freshwater, brackish and marine habitats.
- The vast majority of species are ectoparasitic and they all have a direct life cycle, i.e. without intermediate hosts.
- There are about 20,000 species in the genus *Gyrodactylus* alone.



Gyrodactylus

- The majority of the monogeneans are on external surfaces of fish (skin, fins, gills, mouth cavity, nostrils) but a few species have adopted an endoparasitic life.
- Monogenean found in the bladder and urinary ducts of fish (labrids) - ***Acolpenteron ureteroecetes***.
- In foregut and stomach of *Pomacanthus paru*- ***Enterogyrus sp.***
- In cloaca of skates and rays - ***Calicotyle kroyeri***.
- The main character of the group is the **opisthaptor** (main adhesive apparatus in the hind part of the worm).
- . This organ of attachment is normally equipped with sclerotized structures (hooks, clamps and suckers).
- Also the fore part of the worm has attaching capacities (adhesive pads, cephalic openings) and is referred to as the prohaptor.

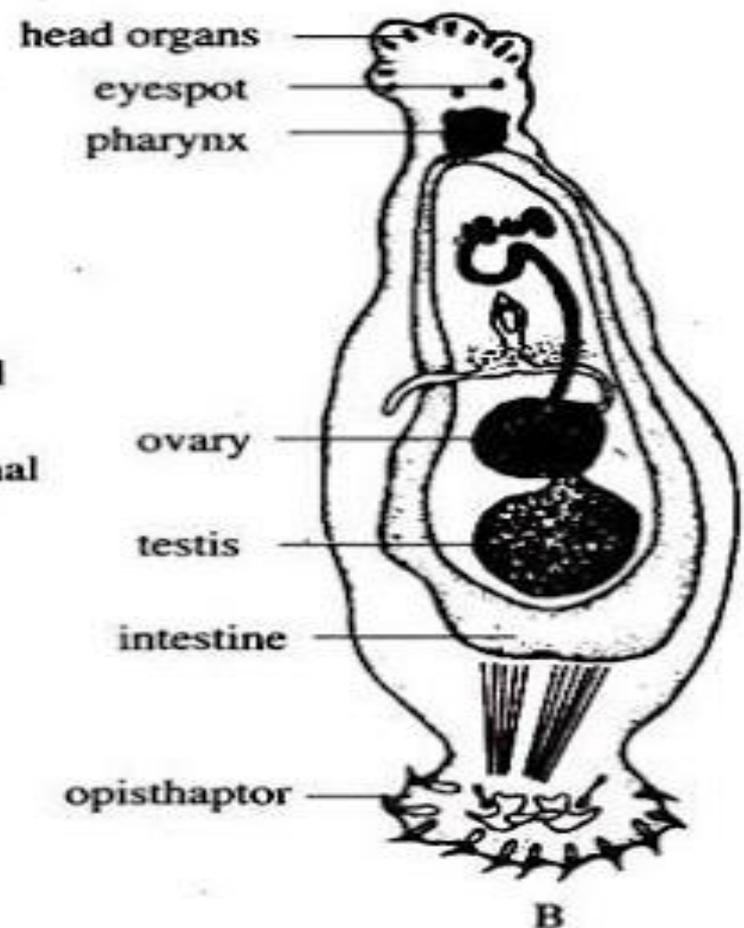
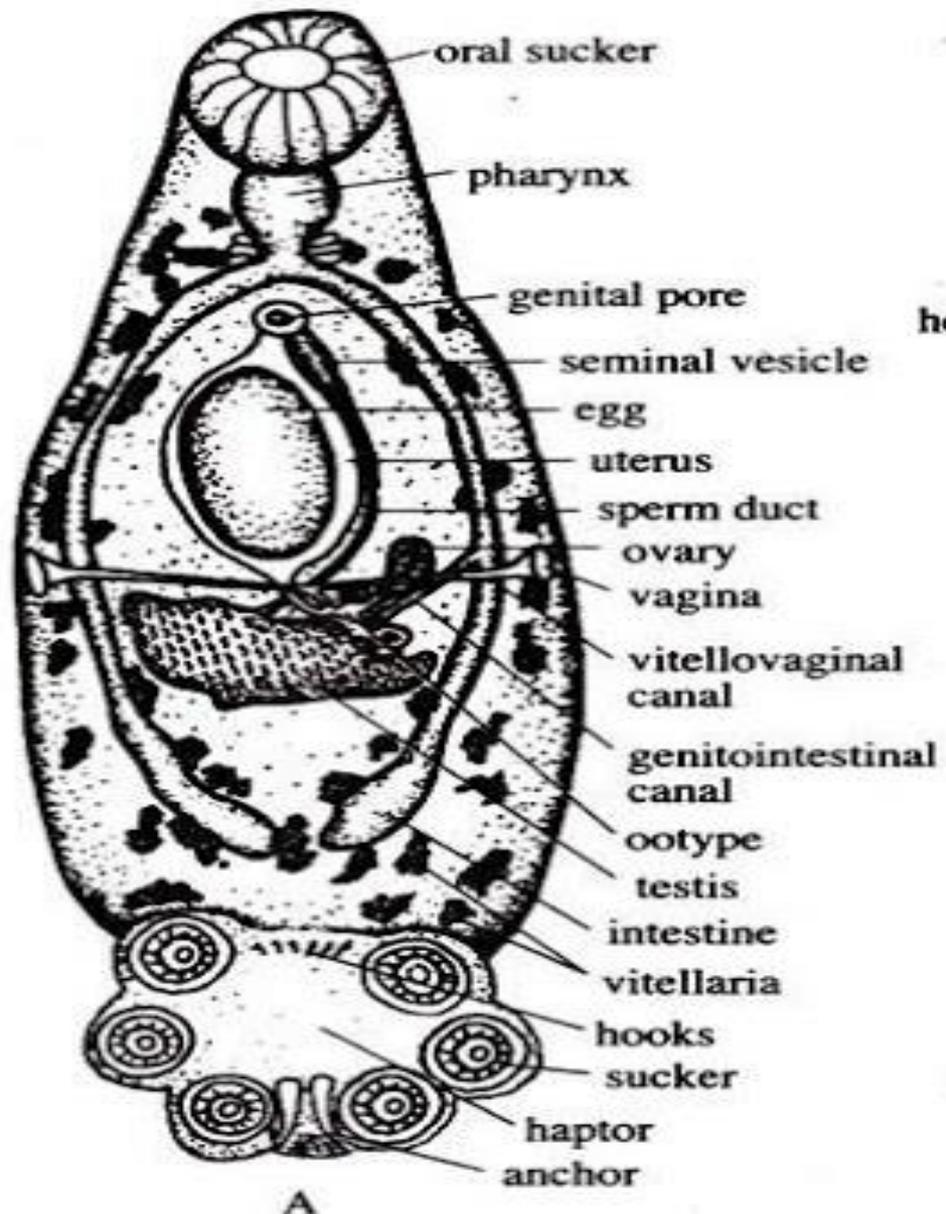


Fig. 1.48 : A. *Polystomoidella*, B. *Dactylogyryus vastator*.

- Molecular and ultrastructural studies have even suggested that Monogenean comprising two groups i.e. **Polyopisthocotyleans** and **monopisthocotyleans**.
- Polyopisthocotyleans are blood feeders, whereas monopisthocotyleans are epithelial feeders browsing the host surface and ingesting epithelial cells, mucus and only occasionally a limited amount of blood leaking from hemorrhages.
- **Sanguinivorous**-Subsisting on a diet of blood.
- ***Discocotyle sagittate***- Polyopisthocotyleans
- ***Tetraonchus sp.***- monopisthocotyleans

Pathogenicity

- Direct blood feeding by polyopisthocotyleans can result in anaemia in the host.
- Pathological condition associated with lethargy, anorexia, dark skin colour and paleness of the muscle, gills, kidney and liver of the infected fish.
- The proteins in the serum lowered.
- Enzyme activities of lactate dehydrogenase (LDH), alkaline phosphatase (AIP) and glutamic pyruvic transaminase were also low.
- The hamuli, marginal hooklets, suckers and clamps of monogeneans all have direct contact with host tissue caused mechanical damage directly.

Digenea (Phylum Platyhelminthes)

- Digean are flatworm parasites
- Digeneans are heteroxenous (i.e. they require more than one host to complete their life cycle), and their adult stage is parasitic in vertebrates.

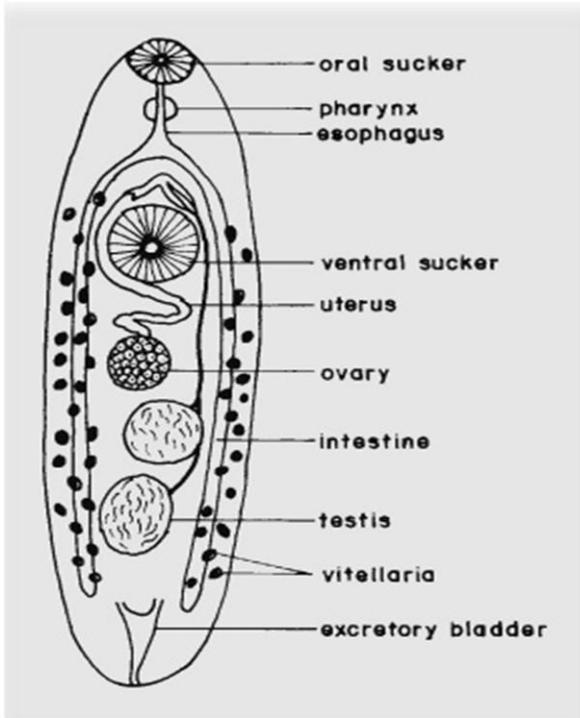
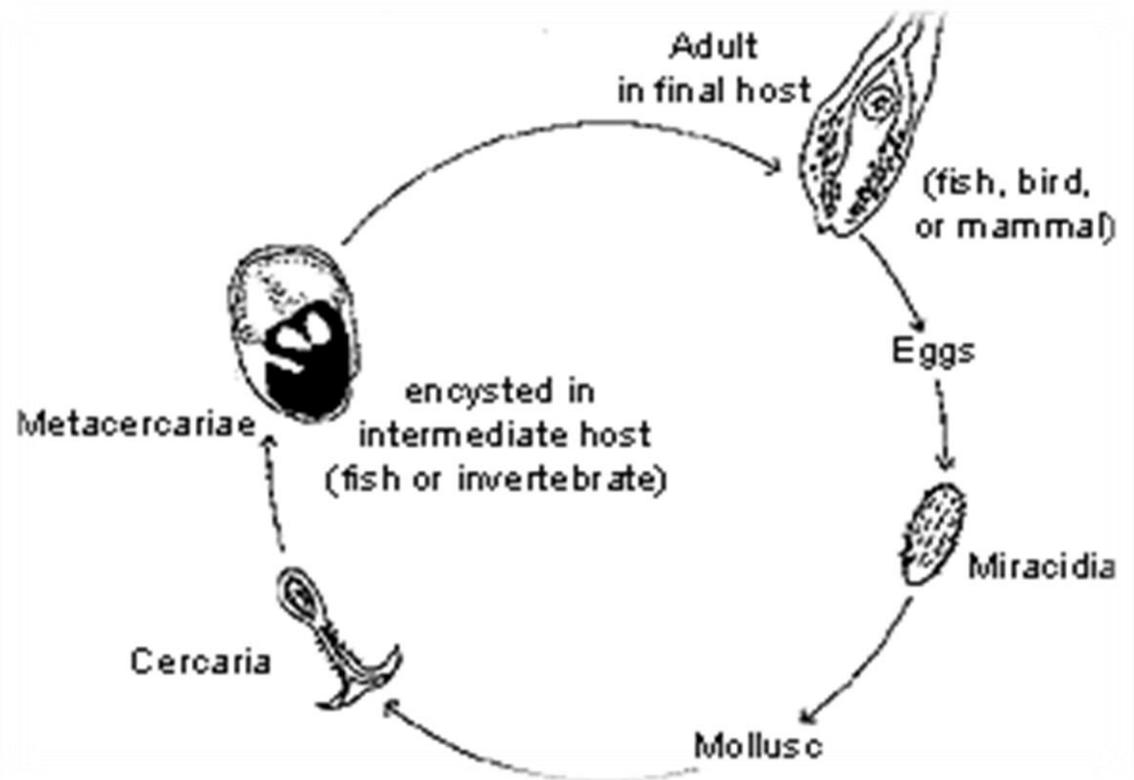


Figure 5-7. Generalized structure of an adult digenean



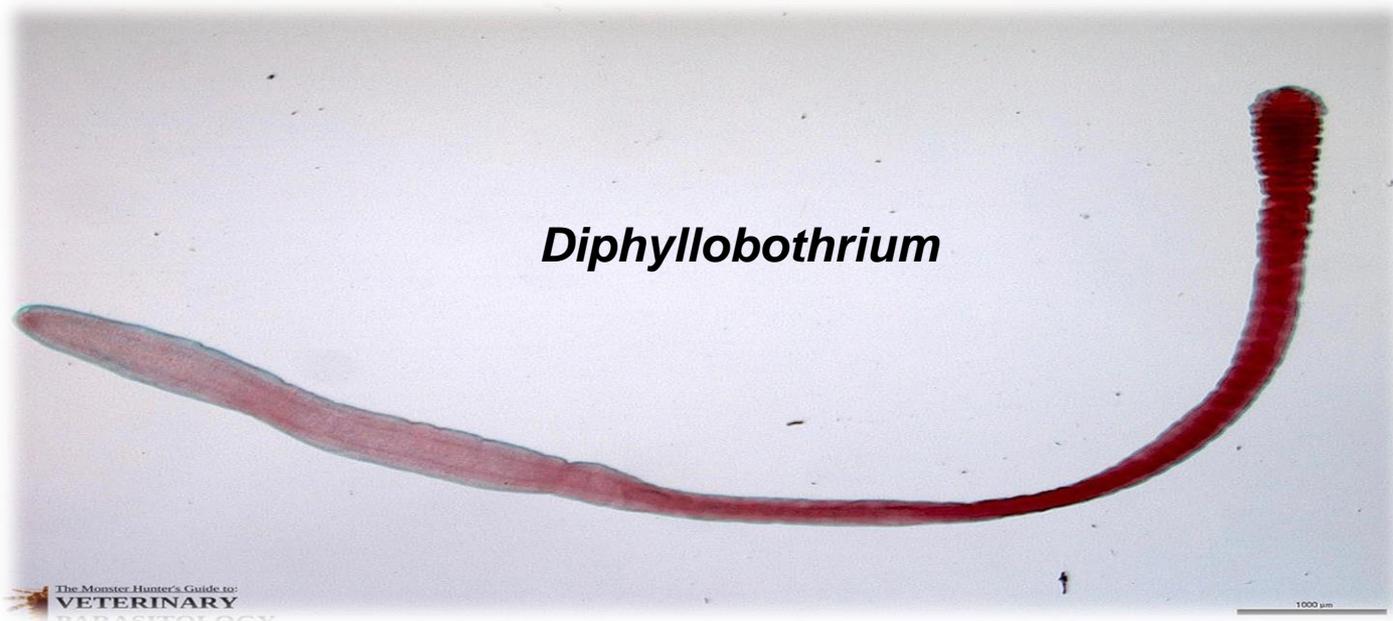
- The majority of digeneans reach their definitive piscine host via planktonic or benthic organisms.
- **Pathology:**
- Blood flukes - **sanguinicolids and aporocotyles**, cause considerable damage to the gills and impair respiration.
- Adult worms and eggs can physically obstruct the passage of blood and cause thrombosis and subsequent tissue necrosis.
- Extensive rupture of the gill lining by emerging miracidia and tissue response around trapped eggs in capillaries and internal organs appeared to be the direct cause of mortality of blood fluke-infected fish.
- The metacercariae enter the aqueous and vitreous humours of the eye, causing corneal oedema.

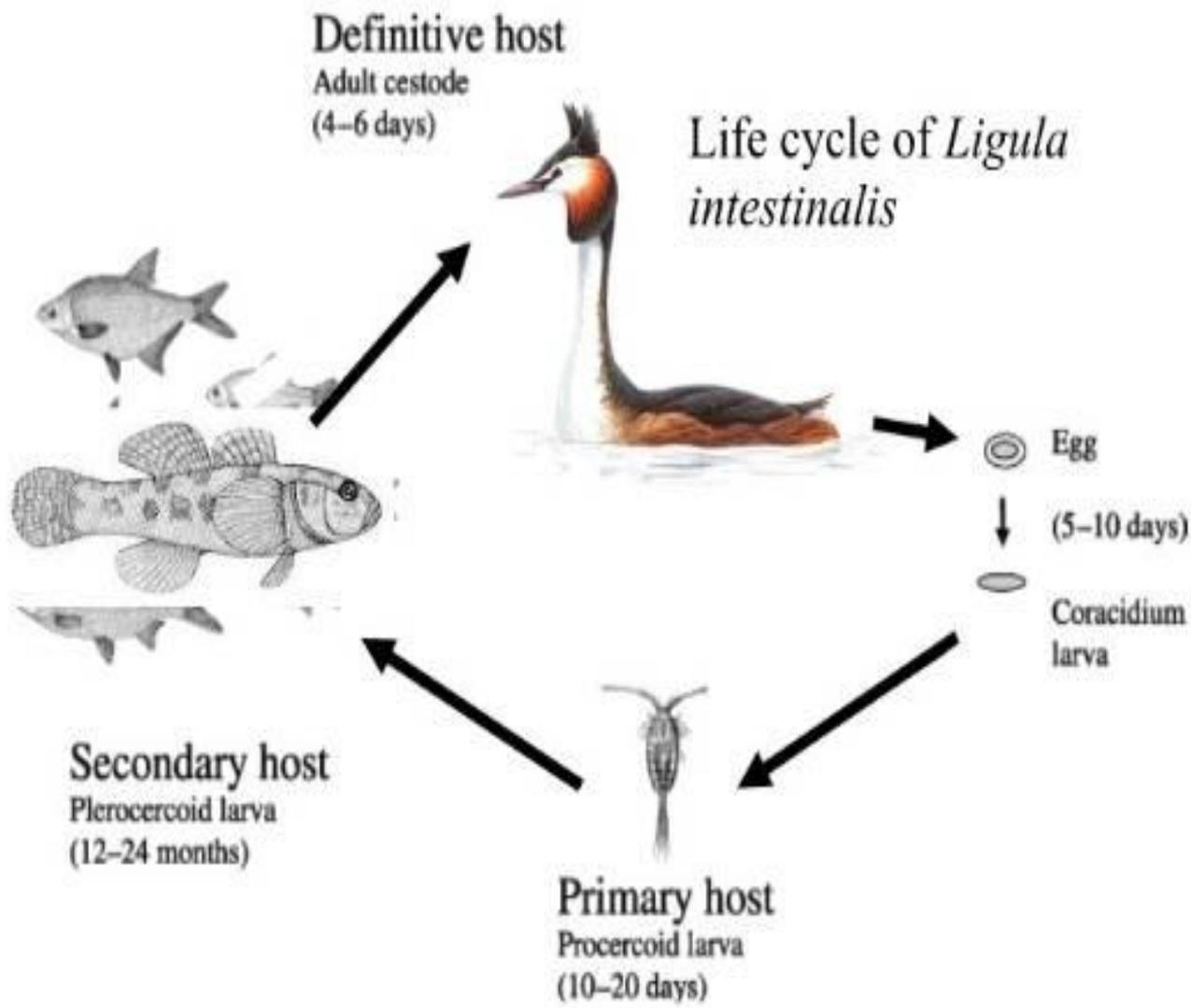
Prevention and Control

- There is no practical way to prevent contamination of pond waters by droppings of presumably infected piscivorous birds, the definitive hosts of most metacercariae infecting fish.
- The best preventive strategy for controlling digenean infections in farmed fish is the elimination of the intermediate host snail.
- This includes the use of chemical molluscicides, environmental manipulation and the use of molluscophagous fish.
- **Praziquantel** is safe and effective against digeneans and cestodes of man and animals.
- Drug dose @ 300 mg/kg body weight.

Cestoidea (Phylum Platyhelminthes)

- Cestoidean is a **Tapeworms**.
- Most of the economically important fish tapeworms are in temperate, north temperate and Arctic regions of the world, with some species - ***Diphyllobothrium*, *Triaenophorus* and *Ligula***.





Pathology

- ✓ The pathophysiology caused by the plerocercoids of *Ligula* and *Schistocephalus* includes
 - ✓ Growth retardation
 - ✓ Abdominal distension
 - ✓ Morphological/physiological alteration of internal organs.
 - ✓ Inhibition of gametogenesis
 - ✓ Reduced liver glycogen, muscle carbohydrates, proteins, blood amino acids and lipids.
- Mortality is often attributable to liver dysfunction and blood loss in salmonids infected with *D. ditremum*.

Table 11.2. Chemotherapy in the control of fish tapeworms.

Parasite	Target host (location)	Chemical	Result
<i>Bothriocephalus acheilognathi</i>	Carp (China)	Cucurbita, areca ¹ (ground up in feed)	Effective
	Carp (E. Europe)	Taenifugin carp ² (minimum 2% of fish wt)	Successful in feed, two times over 3 weeks
	Carp (Europe)	Zestocarp ²	80–100% reduction
<i>Bothriocephalus gowkongensis</i>	Carp	Mansonil, Yomesan ²	1 g/kg fish, 100% effective
	Carp	Taenifugin carp ²	100% effective
	Carp, grass carp	Niclosamide	Successful, incorporated into fish pellets
<i>Bothriocephalus opsariichthydis</i>	Carp	Phenasal	100% effective
<i>Bothriocephalus</i> sp.	Carp (S. Africa)	Lintex ³ (50 mg/kg fish wt)	100% eradication
<i>Caryophyllaeus</i> sp.	Carp	Kamala ¹	Infection reduced
	Carp	Rottlera ¹	Infection reduced
<i>Caryophyllaeus</i> and <i>Khawia</i>	Carp	Zetocarp ² (Cestocarp)	(> 12°C, day 1: 20 g/kg fish, day 2: 10 g/kg fish) 93–100% effective
<i>Proteocephalus ambloplitis</i>	Bass (N. America)	Mebendazole (100 mg/kg fish wt per day in feed)	90% reduction

¹Herbal extracts.

²Active ingredient niclosamide.

³Active ingredient 2', 5-dichloro-4'-nitrosalicylanilide. See Schaperclaus (1992) for details.

Phylum Nematoda

- Nematode is a **roundworm**.
- Most nematodes infect fish as adults, but a large proportion of them occur as larval stages.
- These are usually parasites of piscivorous birds, mammals or reptiles, or less frequently of predatory fishes.
- Phylum Nematoda is divided by molecular methods into two major classes, **Adenophorea** and **Secernentea**.
- Adenophorea consist mostly of free-living marine and freshwater species, as well as terrestrial soil nematodes.
- Adenophorea has three families: **Diectophymatidae**, **Capillariidae** and **Cystiopsidae**.

- Most nematodes have a yellow or whitish color but those that live in the blood vessels (*Philometra obturans*, *Philometroides sanguinea*) or feed on blood may be a red or dark brown colour.

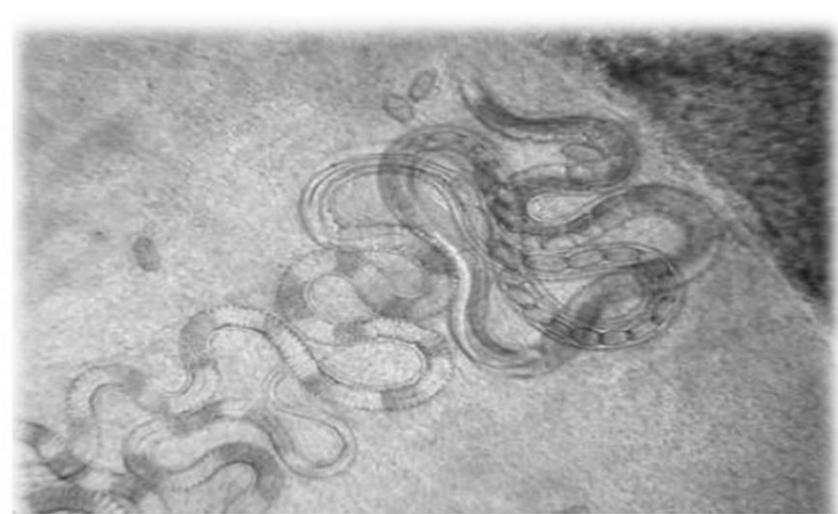


Fig. 12.5. Female specimen of *Capillaria pterophylli* in the gut of a discus fish (*Symphysodon discus*). (× 66) Photo by Ferenc Baska.



Fig. 12.4. *Philometroides cyprini* female freed from the scale pocket of common carp (*Cyprinus carpio*) (× 0.3).

THE LIFE CYCLE OF THE ANISAKIDAE

Females produce eggs, eggs passed in host's feces.

Eggs hatch and juveniles eaten by marine crustacean.

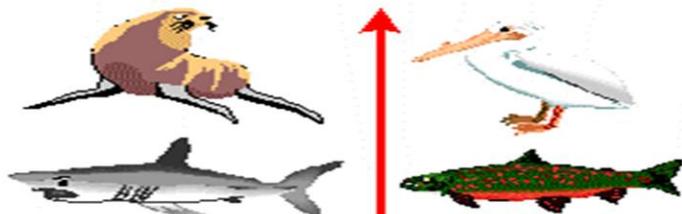


Juveniles mature to the infective third stage.

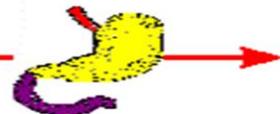
Crustacean eaten by a fish or squid. Infective juveniles migrate into tissues of this host.



Adult males and females in the intestine of marine mammals.



Definitive host (marine mammals and birds, reptiles and fishes), infected when it eats an infected fish or squid containing juveniles.



Humans are infected with "stomach worms" when they ingest raw or undercooked fish.

Pathological effect

- Nematodes damage the hosts by depriving the fish of digested food; by feeding on host tissues, sera or blood; and by direct mechanical damage to host tissues or migrating in them.
- Nematodes generally possess a range of enzymes, such as proteases, which may have tissue-degrading functions.
- Large-sized parasites compress organs deform the shape of the body, reduce the size of organs and cause hemorrhages, inflammation, granulomas and ascites.

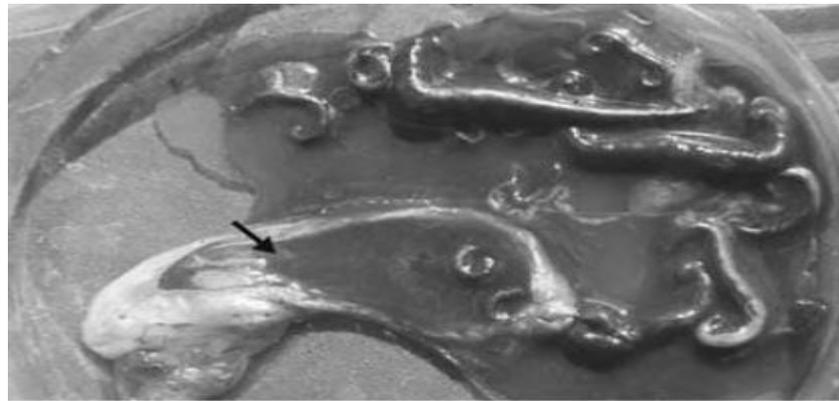
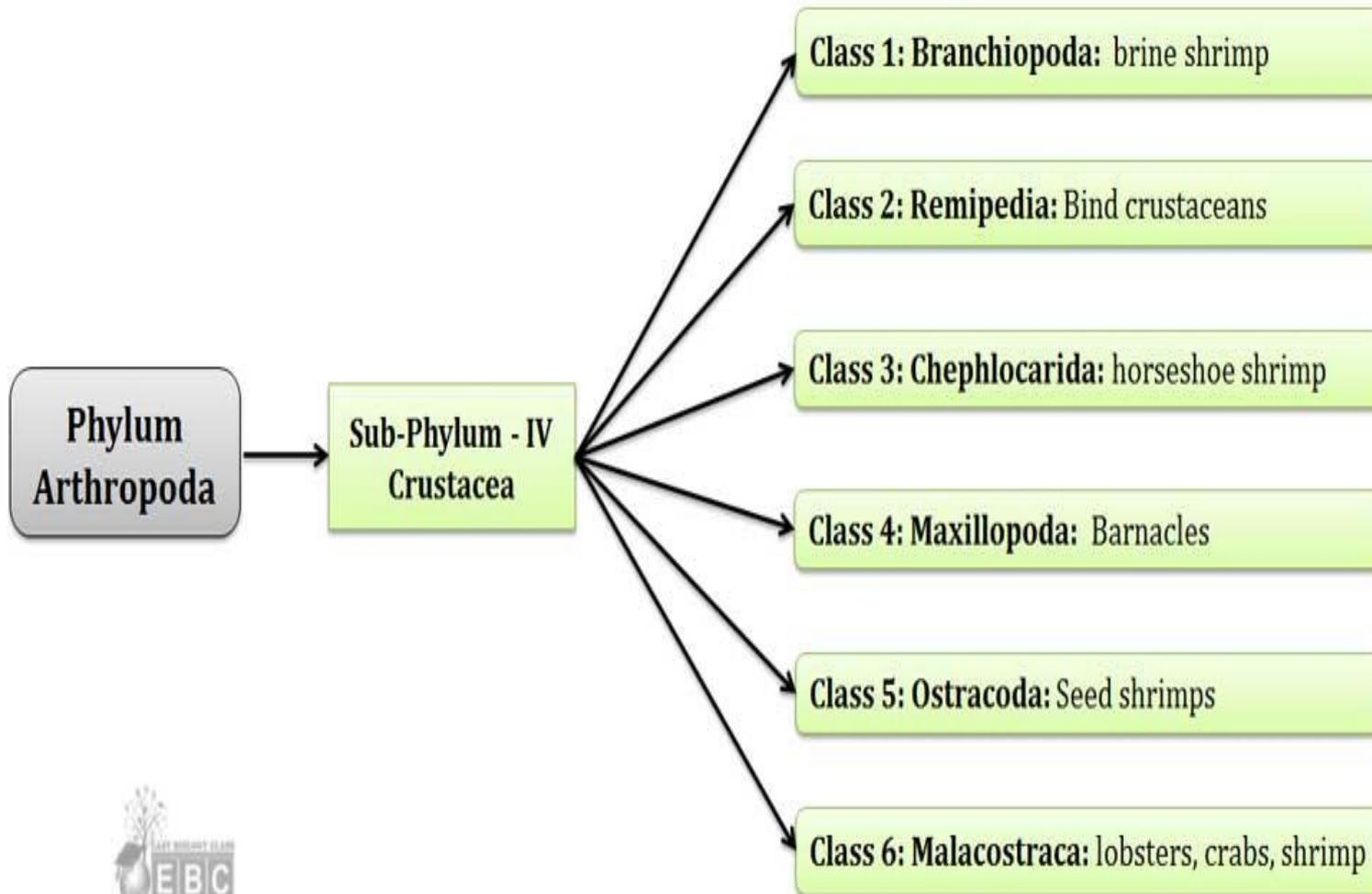


Fig. 12.16. With heavy infections with *A. crassus*, the worms die and decay in the lumen of the thickened swim bladder (arrow) ($\times 0.7$).

Prevention and Control

- Anthelmintics, such as **garlic oil**, **piperazine**, **trichlorphon** and **levamisole**, have varying effectiveness when administered in food.
- **Trichlorphon** in a bath (concentration of 4 ppm or 7 ppm), but several side effects were recorded.
- **Fresh minced garlic** (200 mg/l water) and its hexane extract were 100% effective in treating *Capillaria* in carp.
- **Ammonium potassium tartrate** (1.5 mg/l, twice daily) 86% effective.
- Heat inactivation (60°C) or freezing (-20°C for 24 h) will kill infective third-stage larvae of *Anisakis* spp.
- Likewise, *Pseudoterranova* larvae are killed in fish products by storage at -30°C for a minimum of 15 h or at -20°C for at least 7 days.

Phylum Arthropoda



Crustaceans

Branchiopoda

Maxillopoda

Ostracoda

Malacostraca



Brine shrimp



Barnacles



Copepod



Ostracod



Sand hopper



Crayfish



Crab



Prawn



Mantis Shrimp

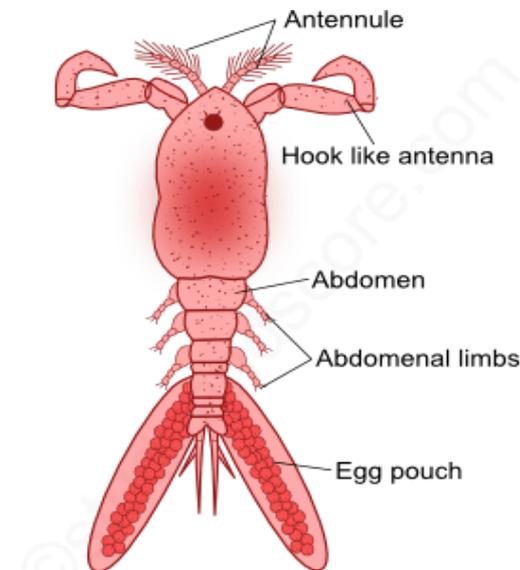


Krill

- About 2000 species of parasitic arthropods have been described, the majority of which belong to the class Copepoda..

Copepoda: Ergasilidae

- Ergasilid copepods damage the gills and cause commercially significant epizootics in cultured and wild populations of fishes.
- Most species in the family Ergasilidae belong to the genus *Ergasilus*, of which 65 species are parasitic on freshwater fishes and 33 species on marine teleosts.



CRUSTACEAN PARASITE - ERGASILUS
©studyandscore.com

Clinical signs and histopathology

- Extensive gill damage and severe hemorrhage, with inflammation and exsanguination associated with the attachment and feeding of the parasite.
- Blood vessels in the gill filaments are blocked and this leads to atrophy of gill tips.
- In adjacent tissue, there are increased numbers of mucus cells, eosinophilic cells, and neutrophils.
- Epithelial hyperplasia and infiltration of macrophages, lymphocytes and eosinophils in gill filaments.
- Gill damage results in loss of gill surface area for respiration and leads to suffocation, particularly at high water temperatures.

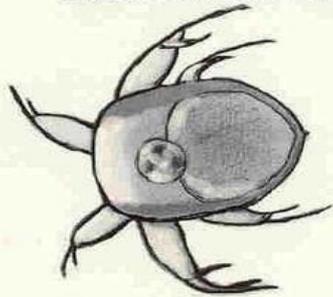
Prevention and control

1. treat with 3–5 ppm **Potassium permanganate**.
2. or 3–5 ppm **3,4-Dichloropropioanilide**.
3. or 5 ppm **Gammexane** .
4. or 0.1–5.0 ppm **Fenitrothione**.
5. or 2 mg/l **Dipterex** for 24 h to control *E. intermedius*.

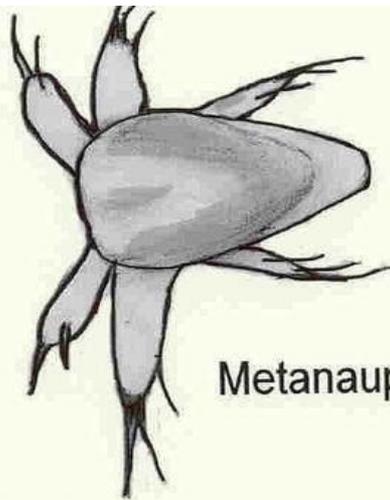
Copepoda: *Lernaea*

- Lernaeids or **anchor worms** are common pests in freshwater aquaculture of cyprinids and, to a lesser extent, of salmonids and other fish.
- They are particularly pathogenic to small fish because of their relatively large size.
- In the genus *Lernaea*, there are over 40 species.
- Its optimum temperature is 26–28°C.
- Thus, in temperate climates the parasite is most common in late summer.
- It is more prevalent in still or slowly flowing water than in fast-flowing streams and less common during floods than in droughts.
- There are at least 110 species of lernaeids, all in fresh water.

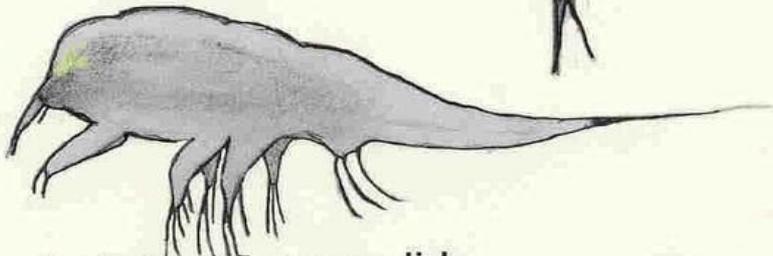
Lernaea life stages



Nauplius

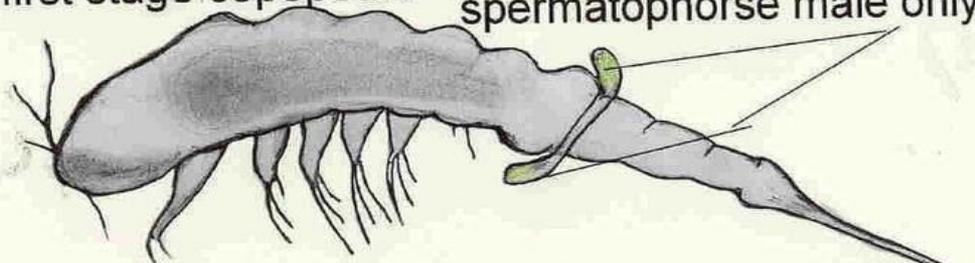


Metanauplius

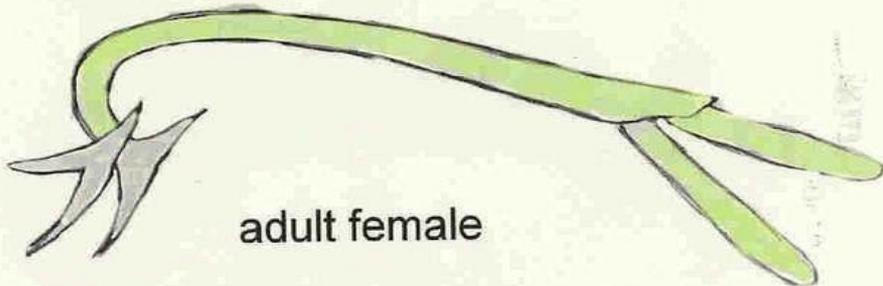


first stage copepodid

spermatophorse male only



sixth stage copepodid



adult female



Clinical signs and histopathology

- ❖ Copepodids of *L. cyprinacea* on small cyprinids cause disruption and necrosis of the gill epithelium.
- ❖ Grazing of large numbers of copepodids on the surface of each gill filament caused epithelial hyperplasia, haemorrhage and death.
- ❖ Oedema and infiltration of neutrophils around the anchor.
- ❖ This was followed by macrophage infiltration and phagocytosis of dead neutrophils and other cell debris.

Prevention and control

1. Organophosphate insecticides, particularly trichlorphon (**Dipterex, Neguvon, Masoten**), are commonly employed.
2. As copepodids take 8–9 days to develop (at 27°C), treatment is carried out every 7 days to prevent reinfection until all the adult females have died (within 30 days at 27°C).
3. **Bromex** (dimethyl-1,2-bromo-2,2-dichlorethylphosphate) at 0.12–0.15 ppm kills both nauplii and copepodids.
4. 0.01–0.02% **malathion** in three applications at 10-day intervals.