

Disease and parasites in aquaculture

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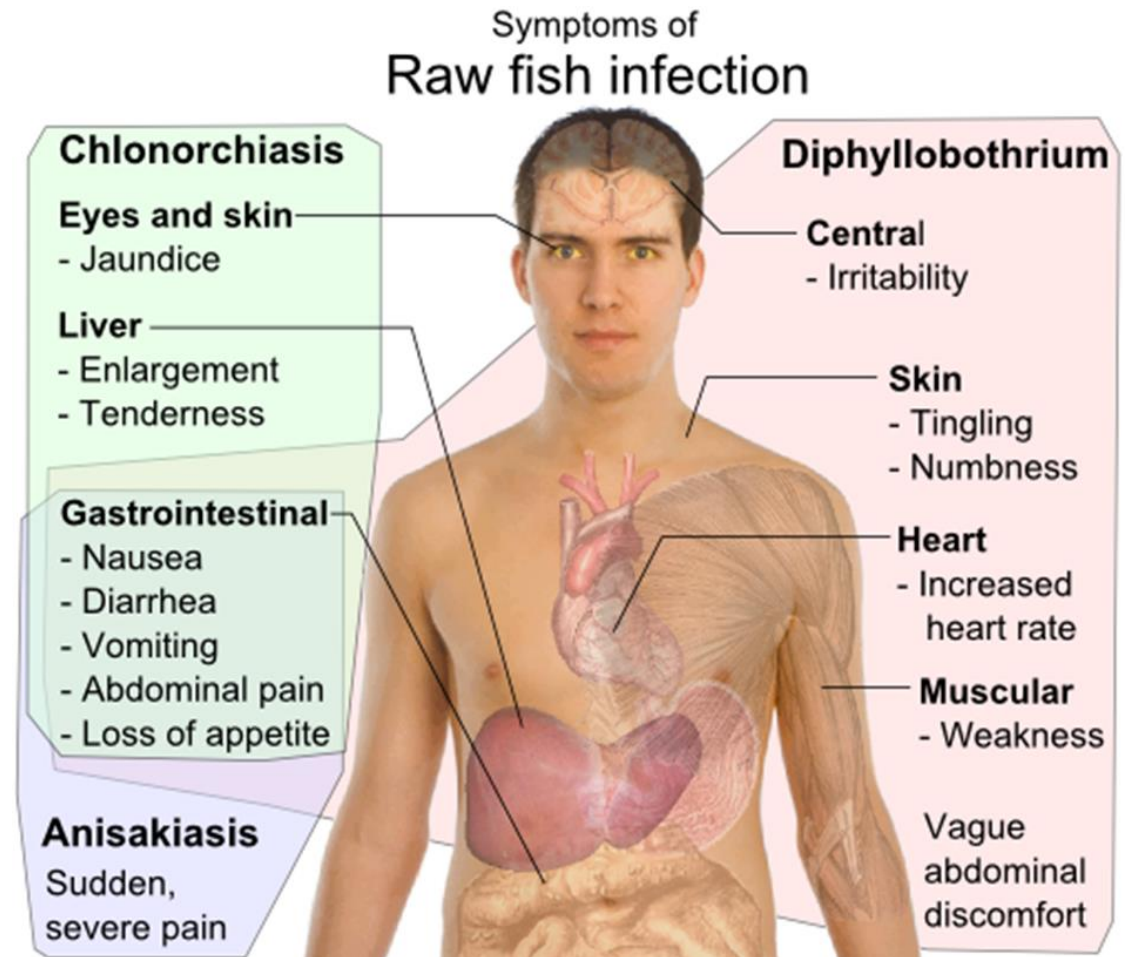
Contents:

- Introduction
- Viral disease
- Bacterial disease
- Fungi
- Parasites
- Diagnostic
- Treatment



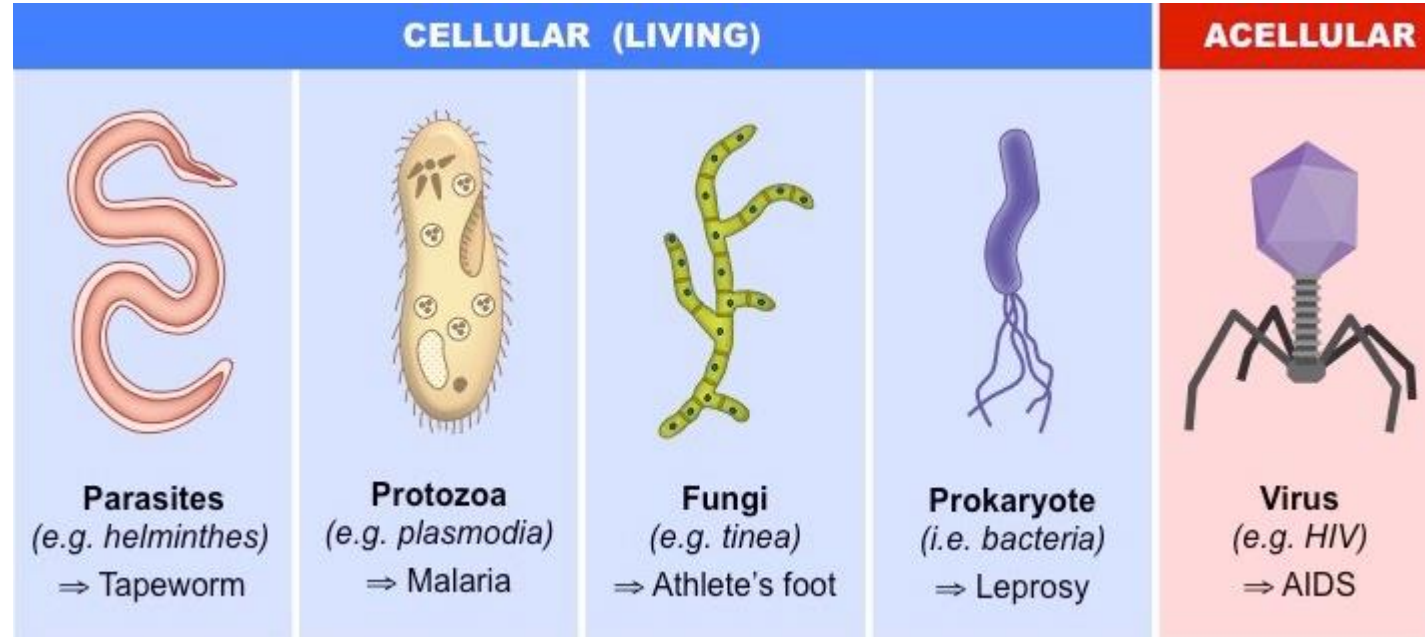
Why should we talk about disease and parasites in aquaculture?

- May cause mass mortalities
- May cause illness in human



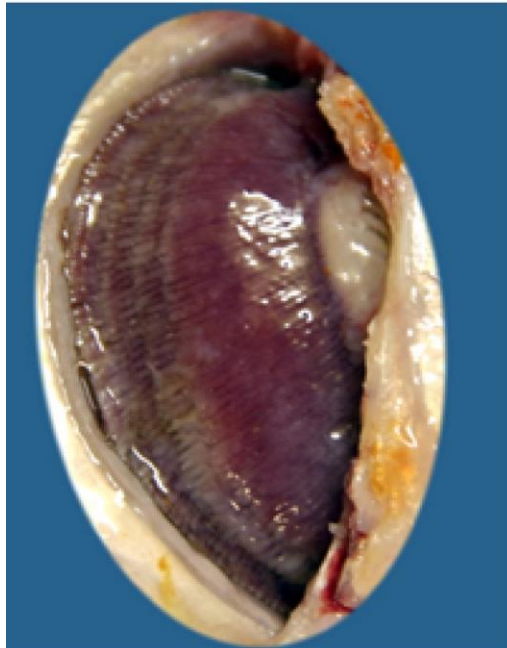
Wich kind of pathogenes are important for aquaculture

- Virus
- Bacteria
- Fungi
- Parasites



Viral diseases

- Koi-Herpesvirus (KHV), *Cyprinid herpesvirus 3*
 - Mortality rates: up to 80 % - 100 %
 - In a period of 24 hours to 14 days



(a)



(b)

Bergmann et al 2020

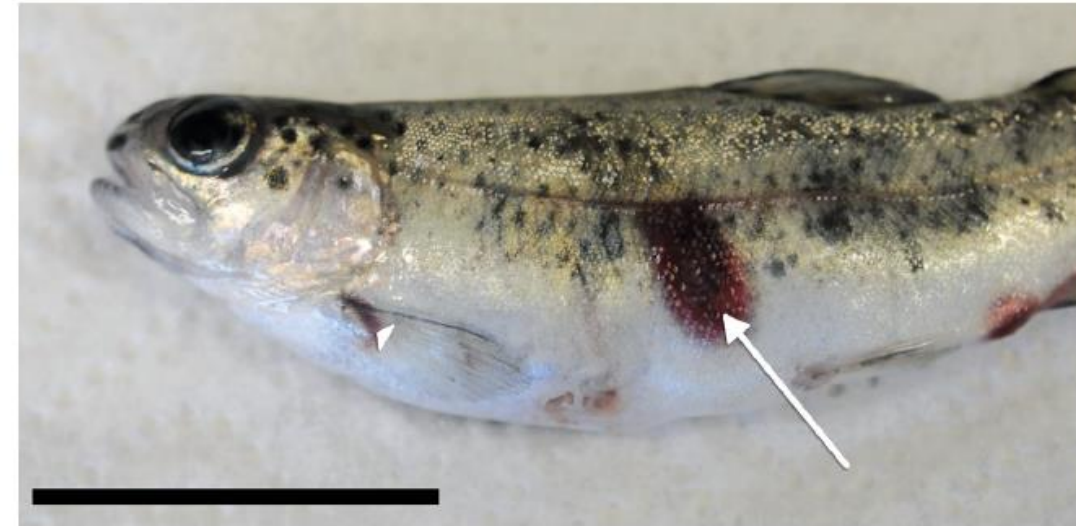
Bacterial diseases

- Omnipresent in the water
- Stress and adverse condition may trigger the outbreak
- Secondary infection caused by bacterial wounds

Phyla	Genus	Characteristics	Diseases
Proteobacteria	<i>Aeromonas</i>	Gram negative, facultative anaerob	Furunculosis, bacterial eye disease
Firmicutes	<i>Enterococcus</i>	Gram positive, facultative anaerob	Urinary tract infections, sepsis
Bacteroidetes	<i>Flavobacterium</i>	Gram negative, obligate anaerob	Cold water disease

Erythrodermatitis of cyprinids: *Aeromonas salmonicida* ssp. nova

- All cyprinids and may others
- Summer disease, water temperature $> 12\text{ }^{\circ}\text{C}$
- Contact infection, transfer via parasites e.g. carp lice, stocking density
- Symptoms: Red ulcerations, low mortality
- Treatment: Wound healing, Antibiotics / Sulfonamids, Furunculoses-vaccination



Menanteau-Ledouble et al. 2016

Furunculoses: *Aeromonas salmonicida*

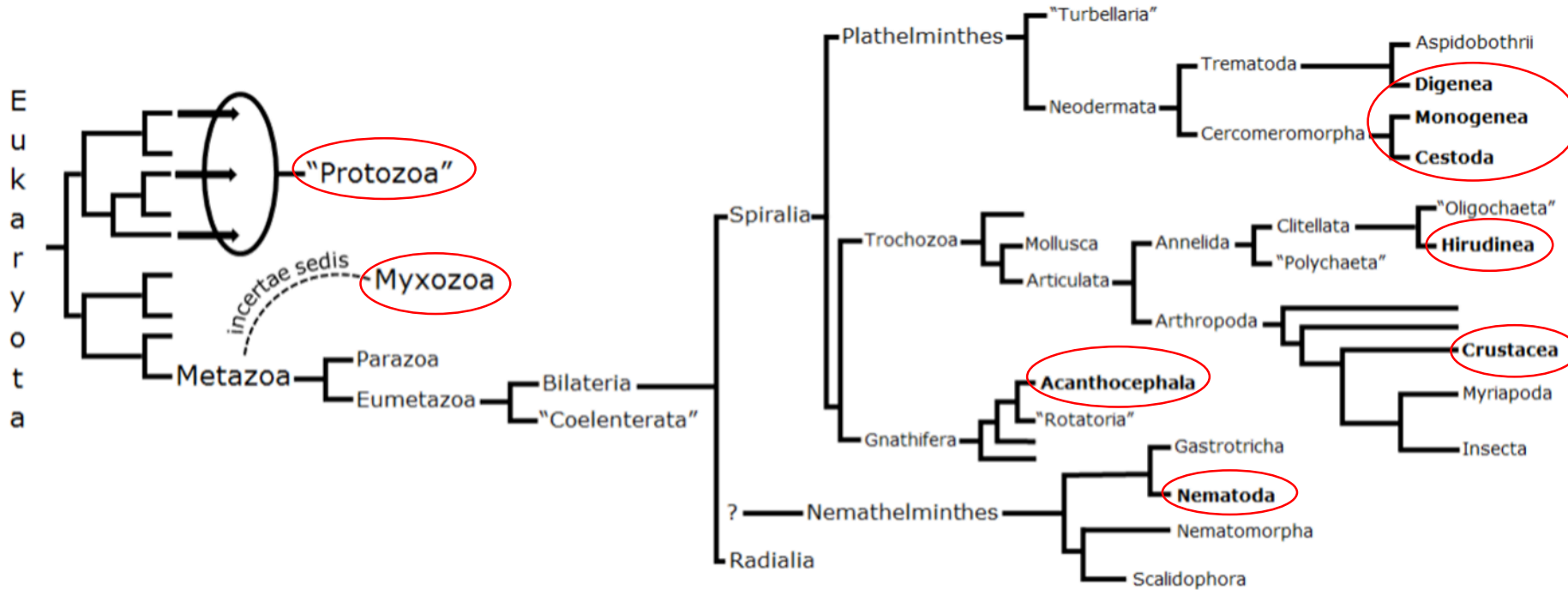
- Salmonids (*Oncorhynchus mykiss*, *Salmo* spp., *Salvelinus* spp.)
- Low O₂-content, Temperature > 14 °C, Stocking density, Stress
- Symptoms: Exophthalmus, No feed uptake, Apathic, Skin lesions and ulcerations
- Treatment: Water treatment, Antibiotics, Reduced feed, O₂-saturation

Fungi

- Water moulds/cotton moulds caused by *Saprolegnia*
- Tolerant to a wide range of temperature, 3–33 °C
- Diploid life-cycle (sexual & asexual reproduction)
- Necrosis of the Skin



Parasites



Hypothetical simplified phylogenetic tree of eukaryotic parasites. Modified after W. Westheide & R. Rieger (2007).

Protozoa

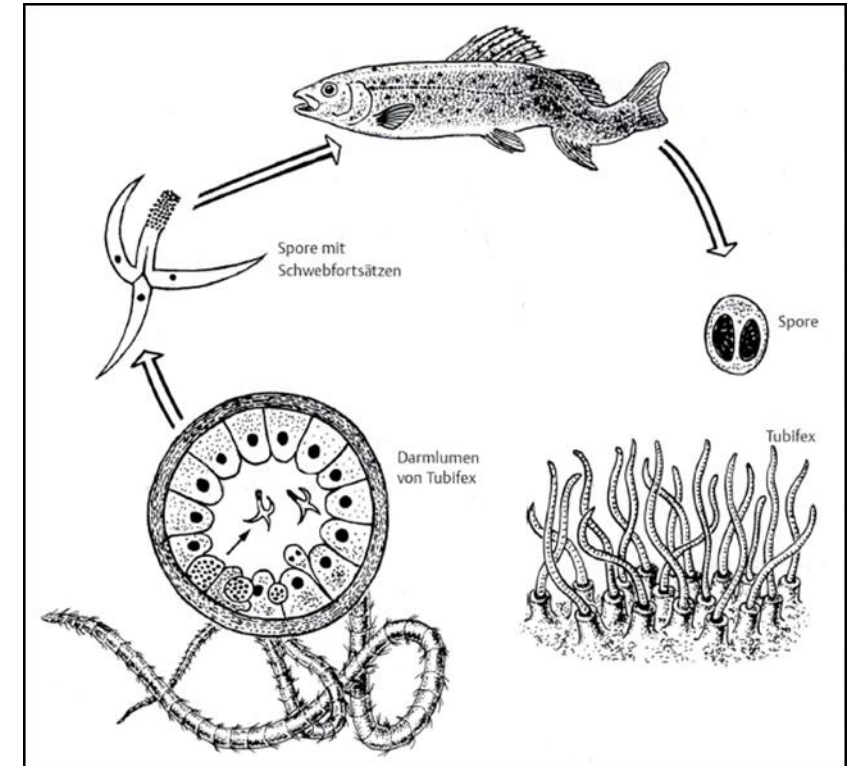
- Trichodina
 - Trichodinids are ciliates
 - Taxonomy difficult
 - Feed from bacteria and from host tissue
 - Only a part of the life cycle is recognizable (e.g. spores)
 - Common fish parasite in aquaculture systems worldwide
 - Regular treatments increase production costs



Unger 2019

Myxzoa

- 1350 species, indirect life cycle
- E.g. *Myxobolus cerebralis*
 - Tubifex – Schizogony, Gamogony, Sporogony (Triactinomyxosporeans)
 - Fish (Schizogony)
 - (Birds)
- Deformation of the vertebrae
- Deformation of the cartilage
- Black tail
- Impact onto the nervous system



Baur et al. 2010

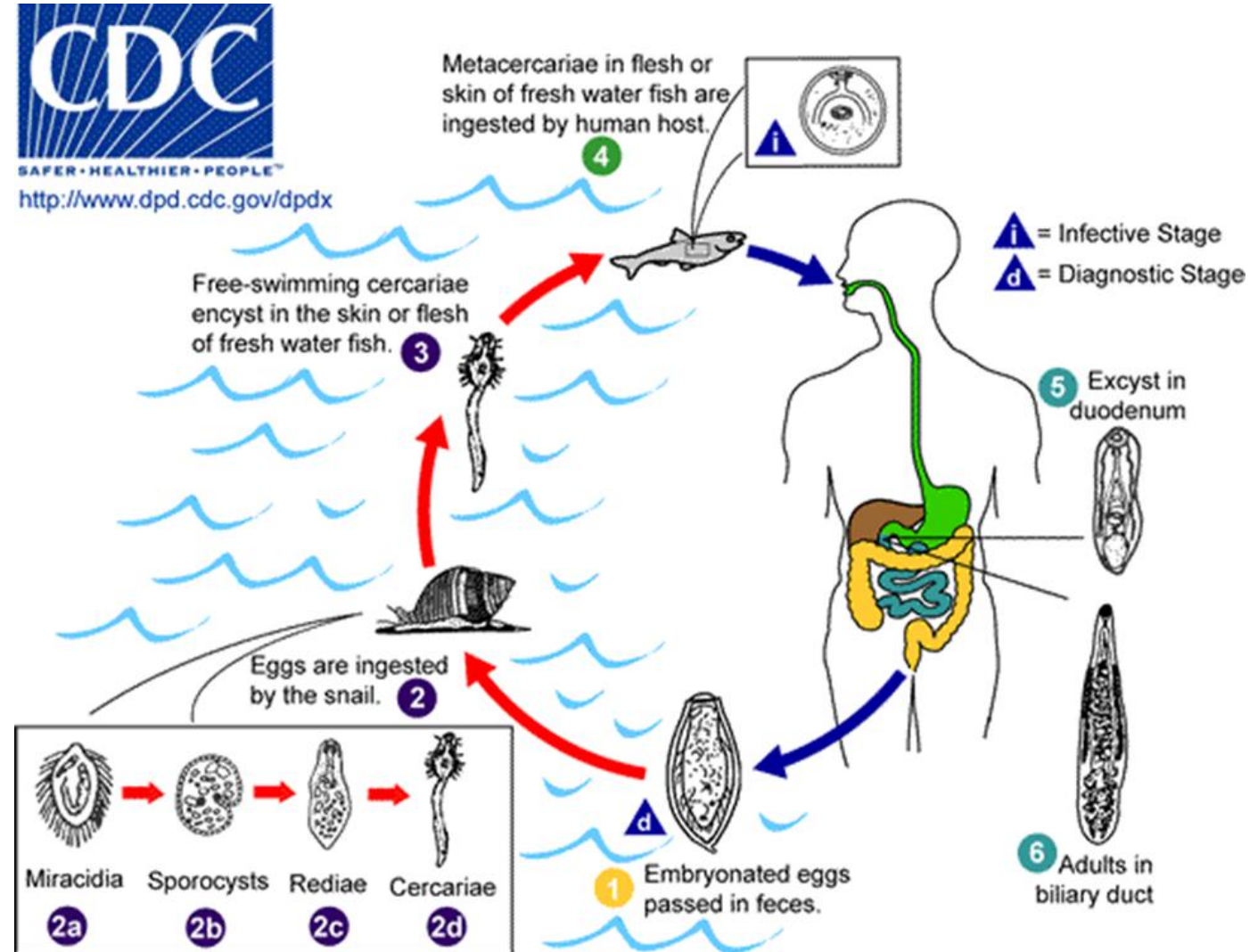
Digenea

- Class of Platyhelminthes – soft-bodied flatworms
- Internal parasites of all classes of vertebrates
- Indirect life-cycles – 2, 3 or 4 hosts
- Fish serve as final or intermediate host
- Always snails as first intermediate hosts



Life-cycle *Clonorchis sinensis*

- Egg
- Miracidium
- Sporocyst
- Radia
- Cercaria
- Adult

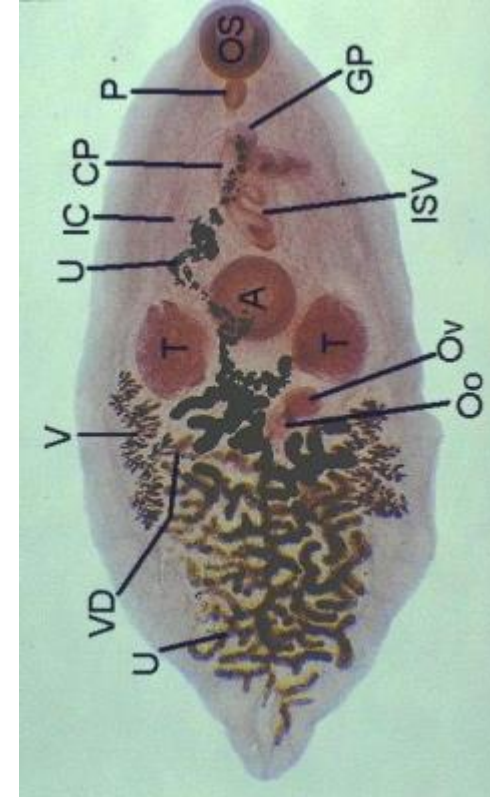


- Abundant in marine and freshwater habitats (hundreds of species)
- Richest group of marine metazoan parasites (so far!)
- Expect that 'your' marine/aquatic animal is infected by a trematode or two



Differential Diagnoses

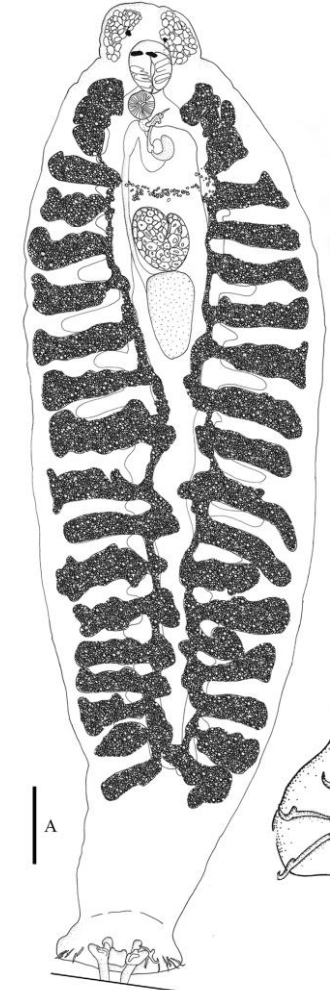
- Flatten habitus
- Oral and ventral suckers are typical but not guaranteed
- Always have a gut (bifurcate) that is closed
- Identifiable by specific reproductive organs



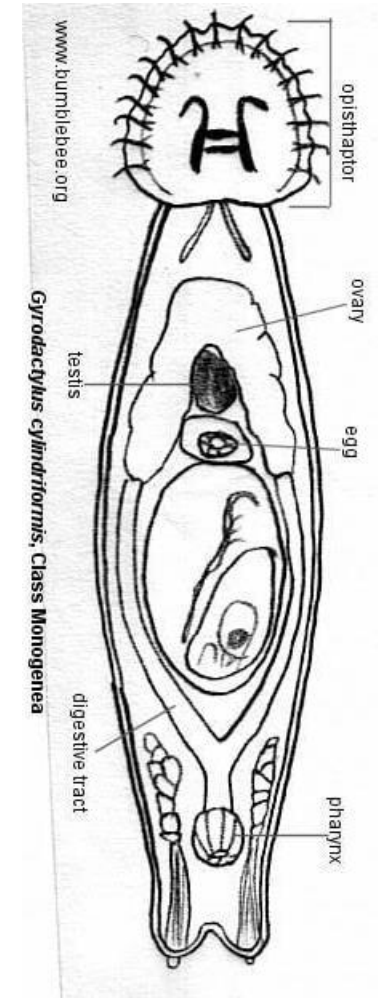
<http://www2.biology.ualberta.ca>

Monogenea

- Class of Platyhelminthes – soft-bodied flatworms
- Ectoparasites
- Life-cycles direct – one host
- Abundant in marine and freshwater habitats (hundreds of species)
- Expect that ‘your’ marine/aquatic animal is infected by a monogenean or two
- On the gills, skin, under the fins, nostrils and rarely inside the body



- Between 0.2 mm - 2 cm long as adults
- Soft-bodied, tegument with/without spines
- Haptor for attachment located posterior
- Haptor uses a combination of marginal and ventral hooks, suckers or cement secretion
- Gut simple with a pharynx, an oesophagus and one or two intestinal caeca
- Two excretory vesicles and systems of ducts and protonephridia (= flame-cells)



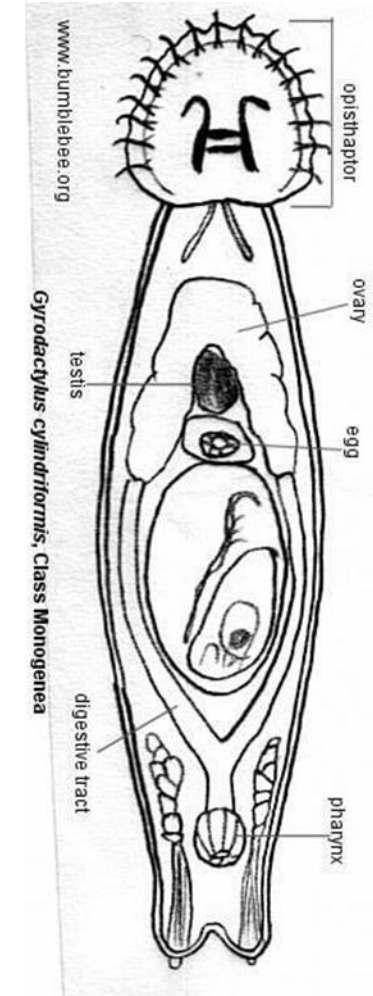
- **Life-cycle strategy** - lack of asexual reproduction (for high reproductive rate) means that monogeneans must be efficient in finding their hosts.
- Eggs operculate - often have complex shapes and filaments
- Main strategies are:
 - Synchronising hatching of eggs with host biology
 - Hatching in the presence of host-derived chemicals (e.g. From skin)
 - Phototaxis
 - Attaching eggs to host or release into the water column

- In large numbers, monogeneans can cause considerable wounds
- Cause secondary infections by viruses, bacteria and fungi
- Those that feed on blood can induce emaciation, lethargy and lethal anaemia



Differential Diagnoses

- Flatten habitus
- Oral suckers in many cases
- Always have a gut (bifurcate) that is closed
- Identifiable by specific reproductive organs
- Opisthaptor with clamps, hooks and suckers for attachment



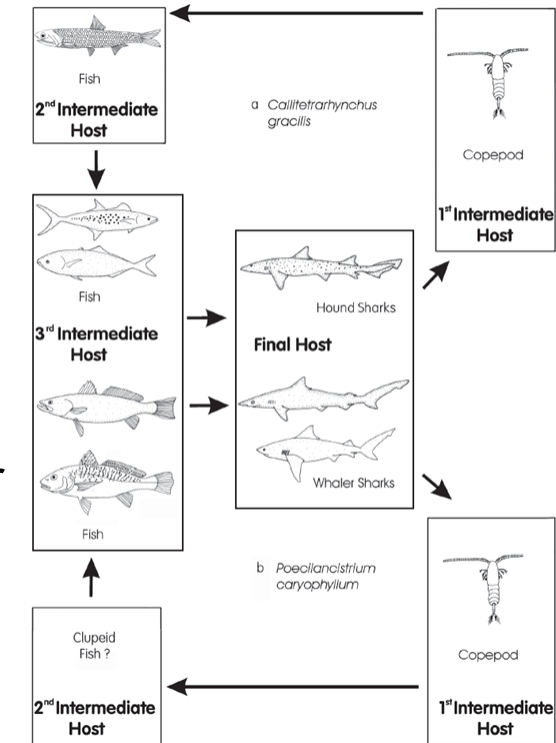
Cestoda

- Class of Platyhelminthes – soft-bodied flatworms
- Neodermis, no digestive tract
- Indirect Life-cycle – 3-4 hosts
 - Copepodes mainly serve as first intermediate hosts
- Abundant in marine and freshwater habitats
- In the marine system, adults as well as larvae are common in fish
- Unsegmented Amphilinidea and Gyrocotylidea
- Segmented Eucestoda with a scolex and proglottids / segments



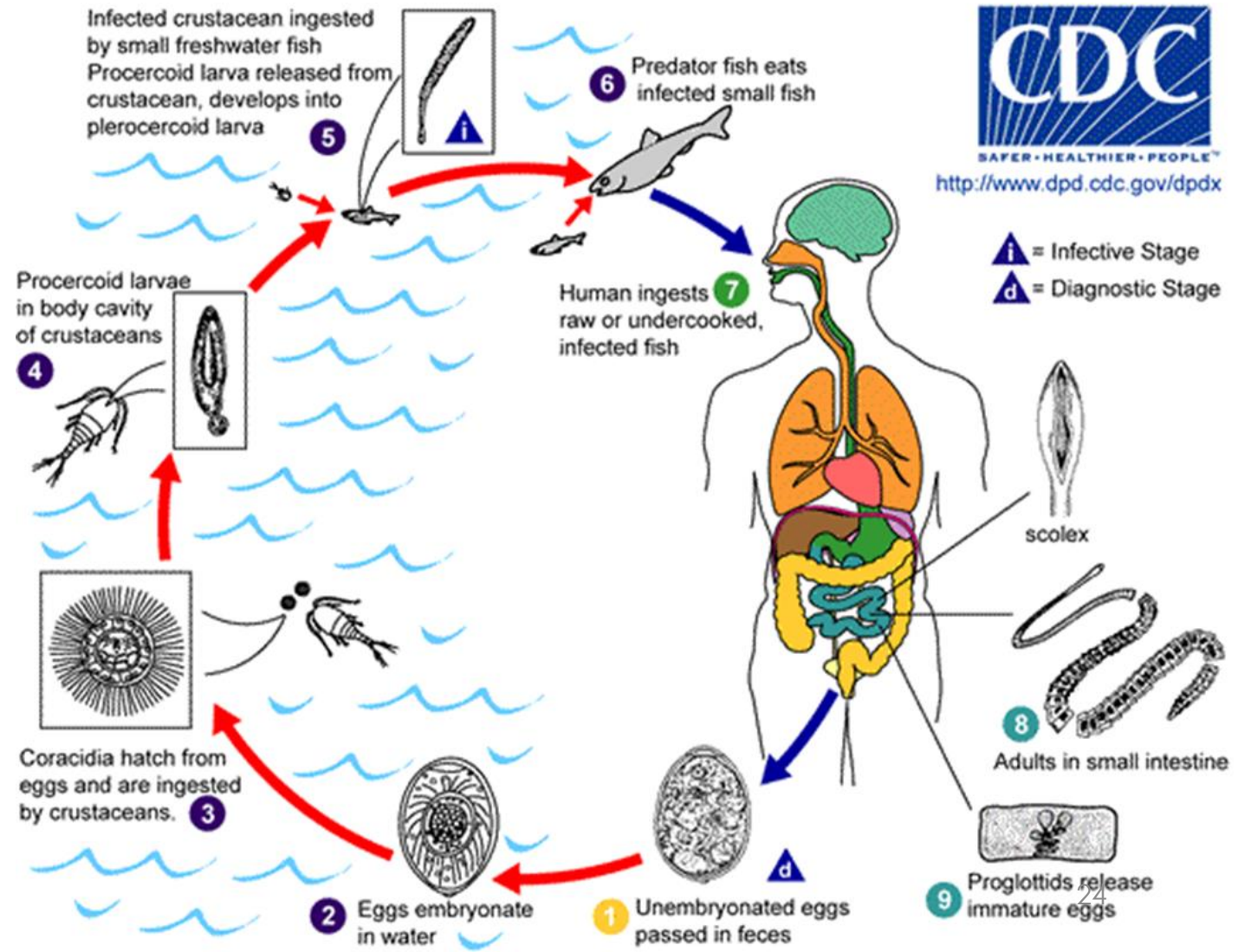
Ligula intestinalis,
(Photo: Pikalov)

- Egg – discharged either in open water or in intestine of definitive host (proglottids, segments)
- Coracidium/Oncosphere – a free-living motile form, it is covered with cilia, ingested by first intermediate host, mainly a copepod
- Proceroid – An elongated sac, often still contains the six hooks, develops inside the first intermediate host
- Plerocercus – A larval form with or without developed anterior scolex end or partial development
- Adult – the fully developed mature stage, it is capable of sexual reproduction



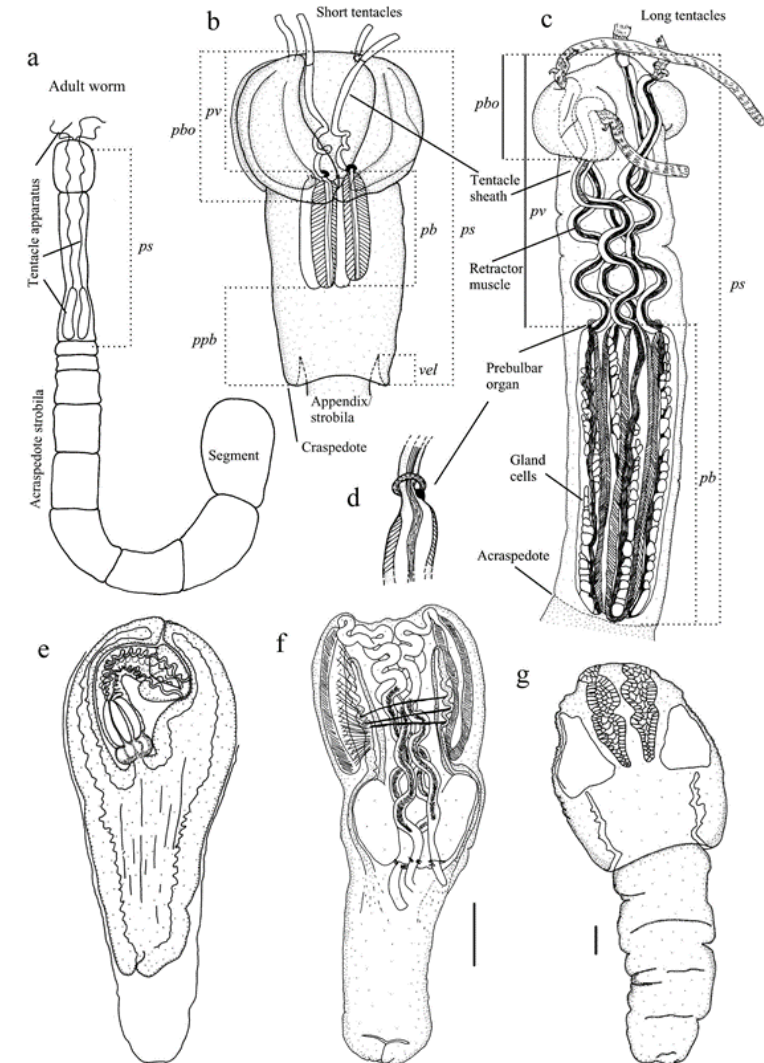
Palm, 2004

Life-cycle *Diphyllobothrium latum*



Differential Diagnoses

- Flat habitus
- Segmented
- Apical suckers
- No intestine
- As larva often in capsules or cysts (blastocyst)
- As adult segmented in scolex and strobila

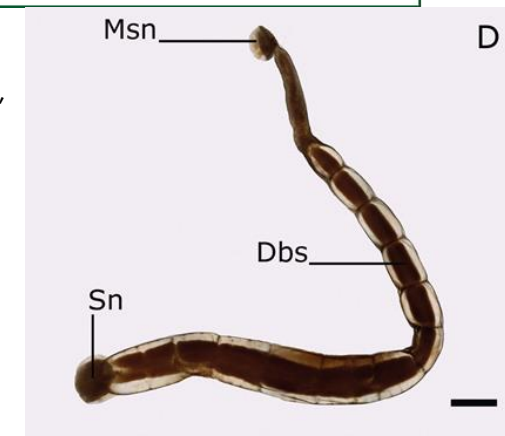


Hirudinea

- Ectoparasites
- Suckers for attachment
- free swimming
- Direct life-cycle
- Sucking blood
- Vectors of kinetoplastid flagellates
- Hermaphrodite
- Secondary infections



Piscicola geometra
www.acsmars.com,
www.i863.photobucket.com,
Pikalov (2017)



Crustacea

- Phylum of Arthropoda
- Ectoparasites, some meso- and some endoparasites
- Life-cycle direct or indirect
- Rich group of marine metazoan parasites
- Expect that 'your' marine/aquatic animal is infected by a crustacean or two
- On the gills, skin, under the fins, nostrils and more rarely inside the body

Lepeophtheirus salmonis - Salmon lice

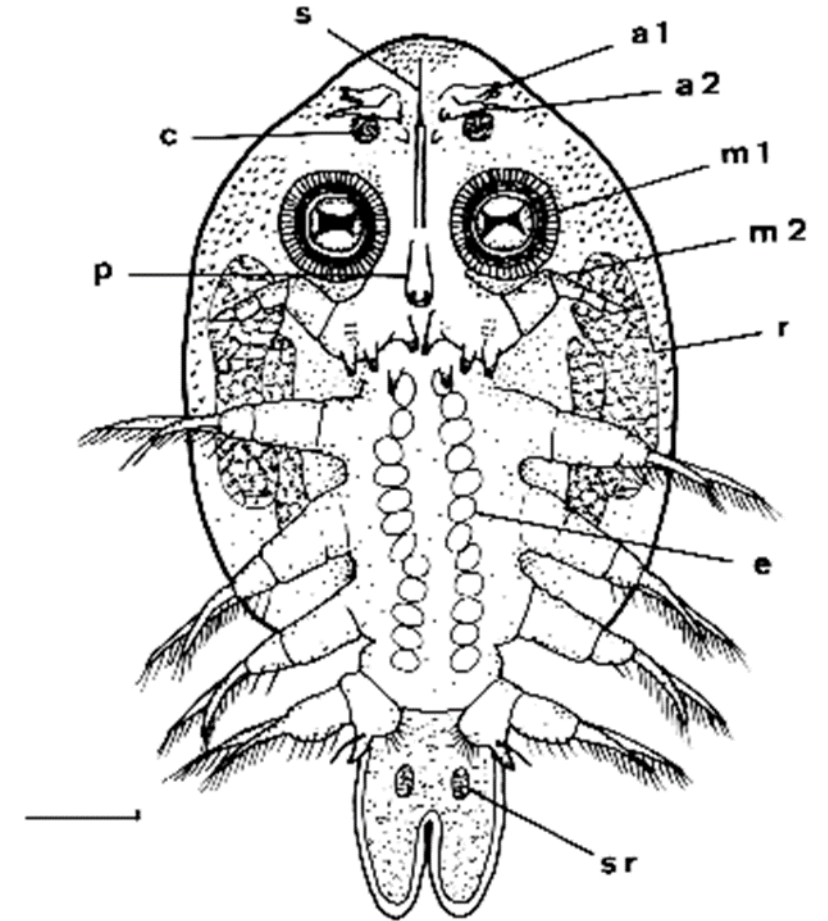
- Tremendous problem in finfish aquaculture in Norway and Chile with millions of US\$ loss per year, biggest obstacle in the further development of Salmon aquaculture !!!



Revie et al. 2009

Differential Diagnoses

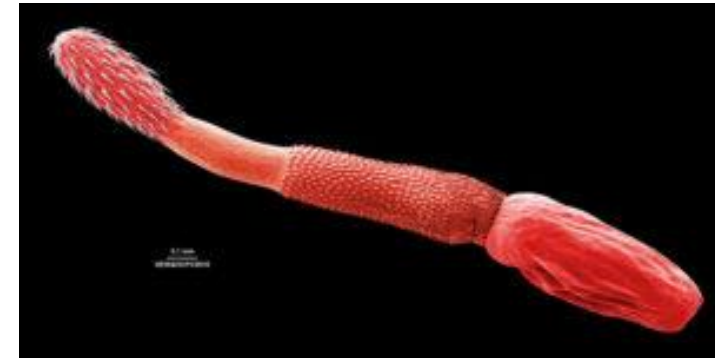
- Segmented, legs and egg sacs
- Nauplii stages
- Direct or indirect life cycle
- Always have complete digestive system



Argulus mondoi after Fryer 1959

Acanthocephala

- Adults only in the intestine of vertebrates and probably squids
- About 1,150 species
 - more than 500 species with fish as final hosts
 - more than 20 species with fish as intermediate hosts
- Adults 2mm up to 70cm (usually a few mm)
- Complex life-cycles
- At least 1 intermediate host (heteroxenous)

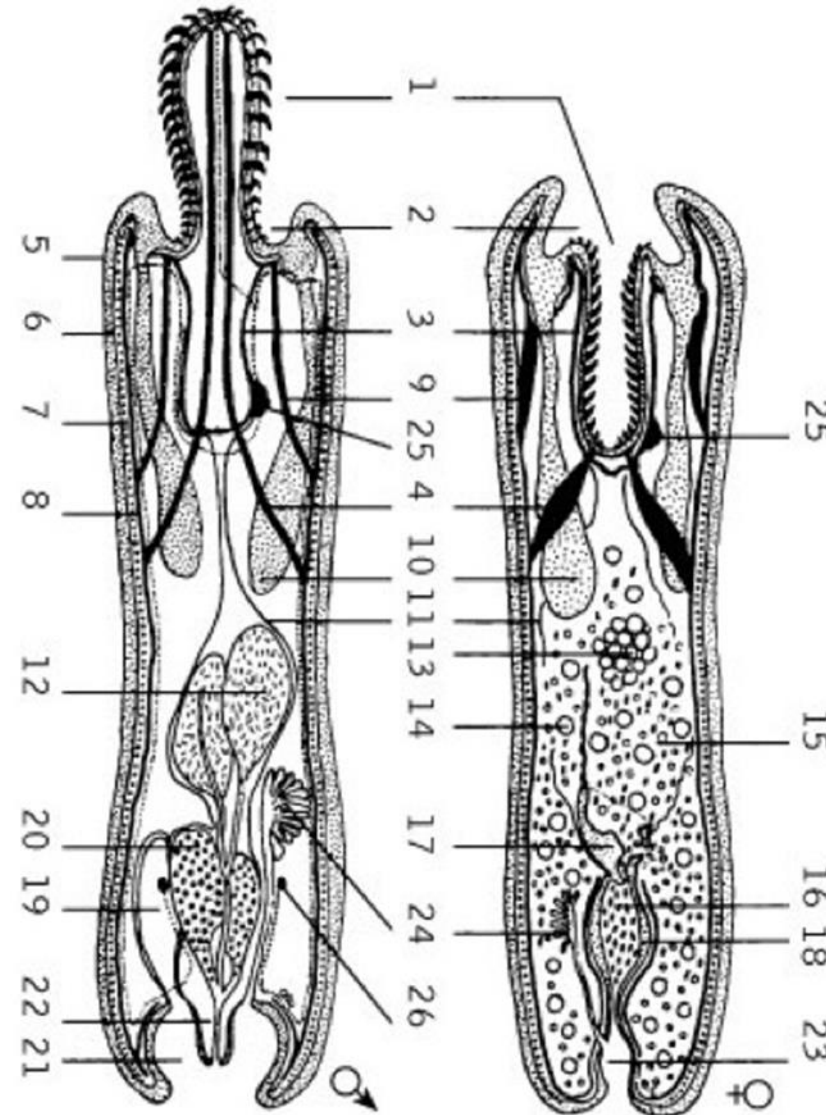


rugusavay.com

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Differential Diagnoses

- Rounded
- Move like a dangling worm
- Proboscis with hooks
- No intestinal tract
- Male and females
- As larva often in capsules
- Pseudosegmented



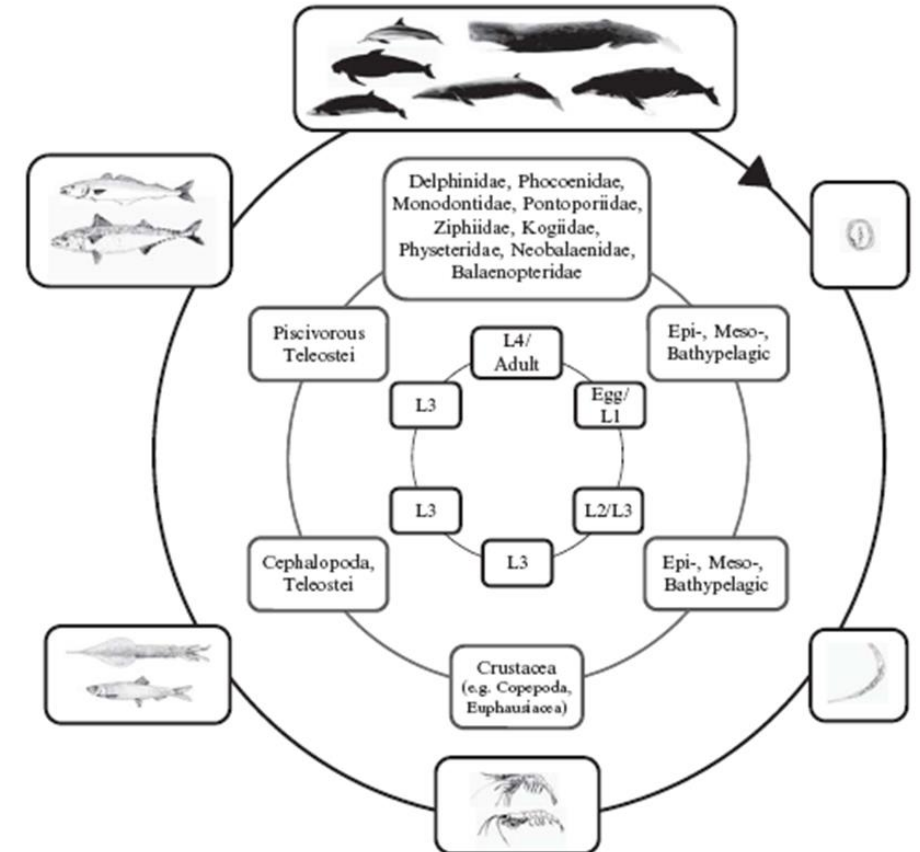
Nematoda

- Two classes: the Enoplea (=Adenophorea; =Aphasmidia) and the Rhabditea
- 40,000 species in 256 families
- 125 families of zoonotic nematodes
- One of the largest and most successful groups in the animal kingdom
- Complex life-cycles



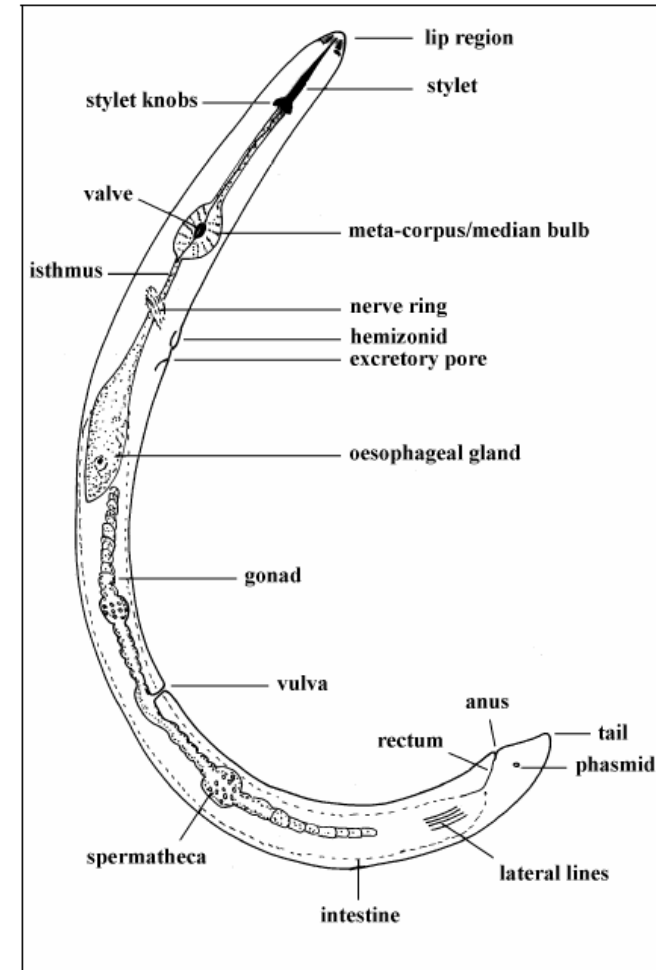
frescoydelmar.com

- Minimum 2 different hosts
- But only 1 generation
 - direct and heteroxenous
(rarely 1 host = monoxenous)
- Females and males: sexual reproduction:
 - adult egg L1 L2 L3 L4 adult
- Typical endoparasites, here *Anisakis* spp.



Klimpel et al. 2010

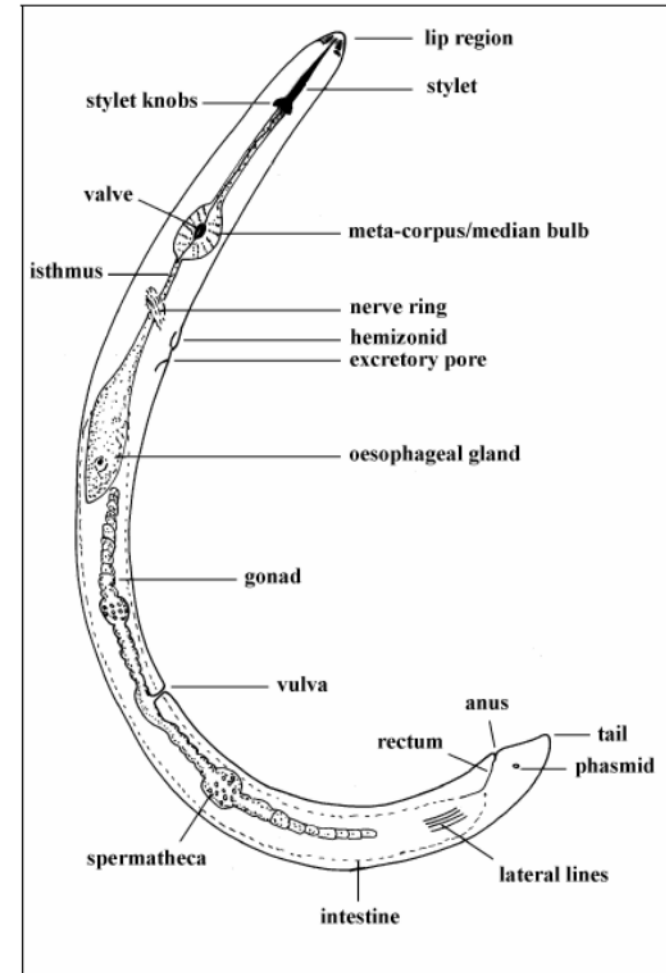
- Longitudinal muscles allow a weaving, snake-like motion
- Epidermis (synticism) produces several layers of a collagenous cuticula
- Cuticle + muscle = hydroskeleton
- Renette: excreting salt for osmoregulation



Stirling et al. 2002

Differential Diagnoses

- Round, move like a snake
- Hydrostatic skeleton
- Entire intestine with mouth and anus
- As larva often in capsules
- Not segmented



Stirling et al. 2002

Clinical picture



Ichthyophthirios- white spot disease
Pathogen: *Ichthyophthirius multifiliis*
Andrews et al. 2005



White/silver bream (*Blicca bjoerkna*)
Digenea cysts in the mesenteries and
black spot disease

Take Home Message: Management

How to reduce endoparasite burden:

- Use pellet Feed; feeding only with cleaned trash-fish (without head and inner organs)
- Use of chemicals and hygenical treatments, with are authorized by the European council (regulation EEC no. 2377/90)

Parasite group	Chemical	Dosage/Treatment
Acanthocephalans	Bithionol	0.2g/kg fish, mixed with feed
Helminths	Ivermectin	2.5mg/100kg fish, twice a week mixed with feed
Cestodes	Niclosamid	100-200mg/kg fish, mixed with feed
<i>Eubothrium</i> <i>Diphyllbothrium</i>	Praziquantel	500mg/100kg fish, mixed with feed

Take Home Message: Management

How to reduce ectoparasite burden

- Way more difficult and demanding
- Millieu switch (fresh water Fish in salt water/ Marine fish in fresh Water)
- Monoxene lifecycles lead to higher infestation rates

Parasite group	Chemical	Dosage/Treatment
Ectoparasites	Formaldehyde	0.25mg/l, bath treatment (1-2h)
Ectoparasites	Copper sulfate	0.5mg/l, bath treatment (1-2h)
Monogenea	Levamisol	50ml/l, bath treatment (2h)
Copepods	Triclorphon	5mg/l, bath treatment (30min)
Ectoparasites	Acetic acid	1-2mg/l, dip treatment (1-10min)

Why further research is important

- New treatment
- Saving medicals and chemicals
- More and more avoidance of antibiotics
- Risk of multi-resistant lines / pathogens



Thanks to the organisers of the summer school and my
colleagues

Thank you for your attention



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