

**FAO/ASTF Project: GCP/RAF/510/MUL:**

**Enhancing capacity/risk reduction of emerging Tilapia Lake Virus (TiLV) to  
African tilapia aquaculture: Intensive Training Course on TiLV**

4-13 December 2018. Kisumu, Kenya

in cooperation with Kenya Marine Fisheries Research Institute (KMFRI) and Kenya Fisheries Service (KeFS)

**Session: 2**  
**Parasites of Tilapia in Africa**

[pakoll@cns.mak.ac.ug](mailto:pakoll@cns.mak.ac.ug) or [akollp@gmail.com](mailto:akollp@gmail.com)



**Food and Agriculture  
Organization of the  
United Nations**



# WHAT CAUSES DISEASE

## ○ Infectious (mainly biological)

- Bacteria
- Fungi
- Parasites
- Viruses

## ○ Non-infectious

- dietary
- hereditary
- All forms of Stress
- Tumors
- Environmental conditions



# PARASITES

## ○ Ectoparasites

- Protozoa
- Monogeneans
- Crustaceans

## ○ Endoparasites

- Protozoa
- Cnidaria
- Monogeneans
- Digeneans
- Cestodes
- Nematodes
- Acanthocephalans



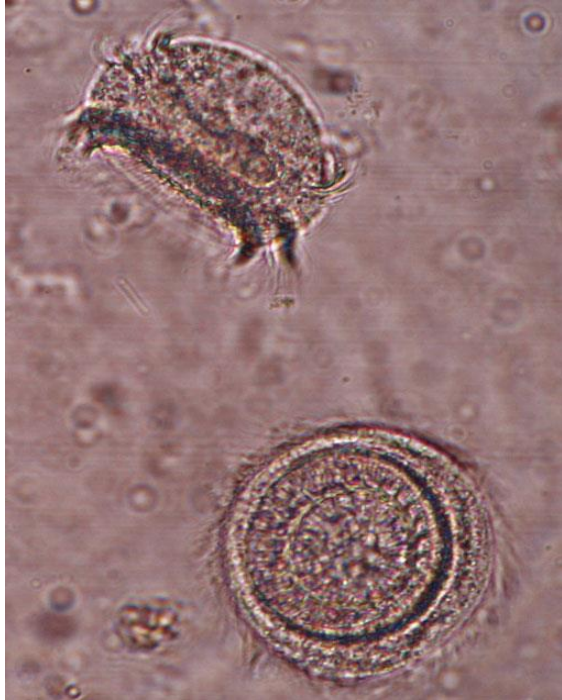
# PROTOZOA

- Single celled organisms -range from 1 $\mu$ m to 150 $\mu$ m
- Ciliophora (Ciliates: Ecto- & Endoparasites)
- Apicomplexa – Endoparasites
- Microsporidia – Endoparasites
- Sarcomastigophora (flagellates– Endoparasites
  - Phylum Dinozoa (Dinoflagellata)
  - Phylum Retortamonada
  - Phylum Parabasalia (Diplomonadida)
  - Phylum Euglenozoa (Kinetoplastea)
  - Phylum Axostylata
- Amoebozoa – Endoparasites



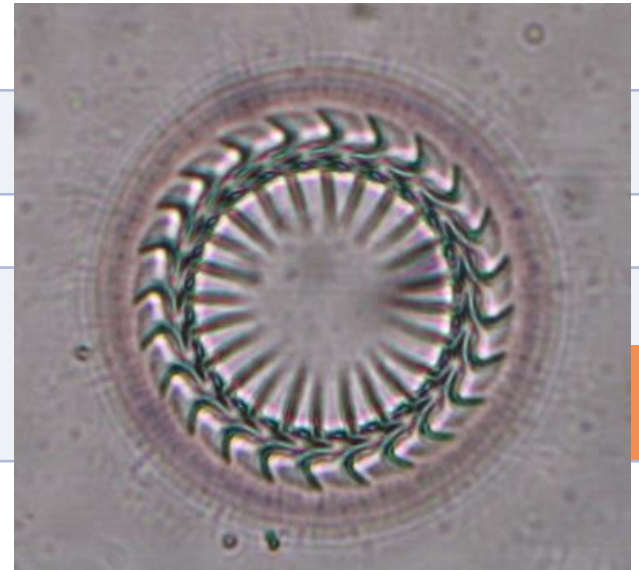
# PROTOZOA - TRICHODINIDS

- Belong to 5 genera: *Trichodina*, *Tripartiella*, *Paratrachodina*, *Vauchomia* and *Trichodonella*
- Over 15 sp. recorded in *O niloticus*— mainly as ectoparasites



# PROTOZOA – TRICHODINIDS

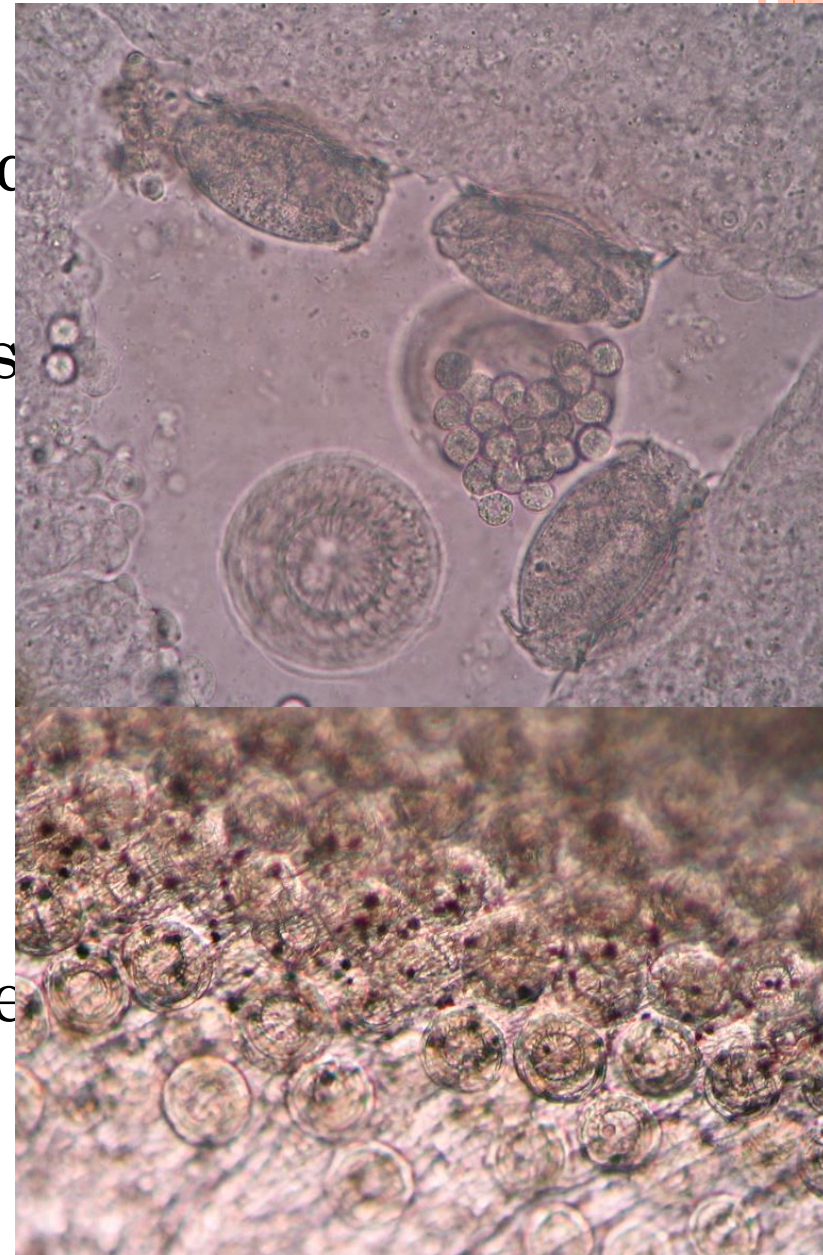
<i>Trichodina migala</i>	<i>T. mutabilis</i>
<i>T. centrostrigata</i>	<i>T. tilapiae</i>
<i>T. heterodentata</i>	<i>Tripartiella cichlidarum</i>
<i>T. cichlidarum</i>	<i>Tripartiella orthodens</i>
<i>T. compacta</i>	<i>Paratrichodina africana</i>
<i>T. nigra</i>	<i>Trichodinella epizootica</i>
<i>T. Magna (sy pediculus)</i>	
<i>T. acuta</i>	
Noor El-Din & Naeim 1998, Basson & Van As 2006	





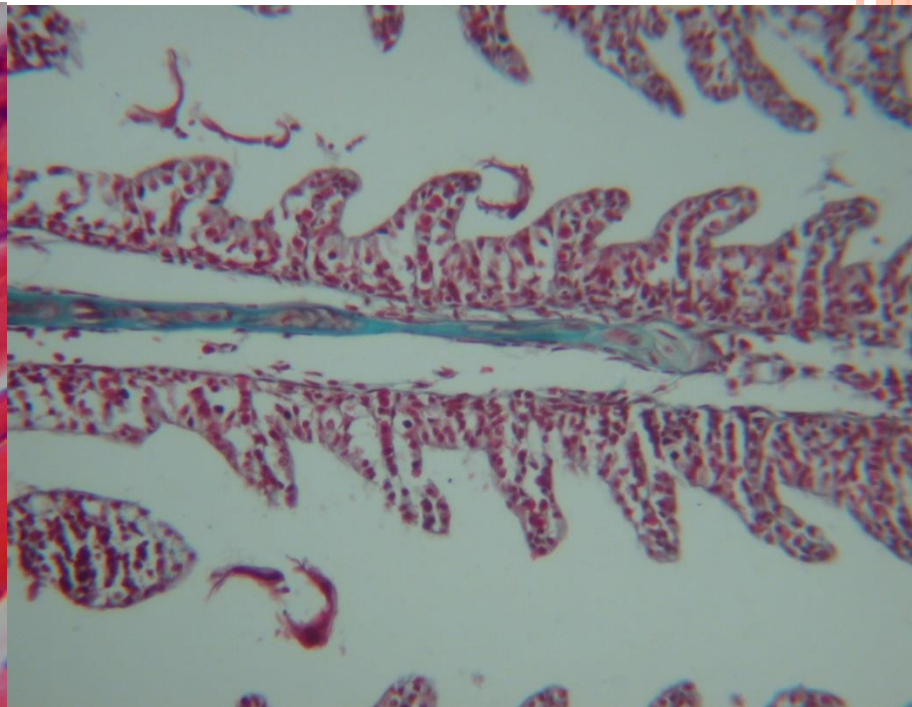
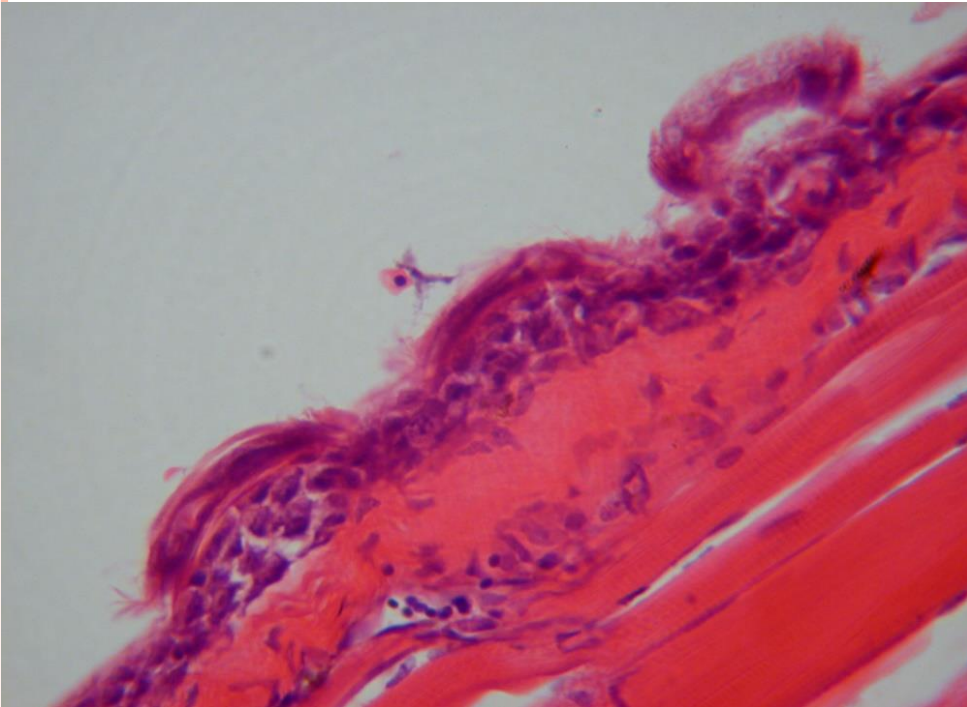
# PROTOZOA – TRICHODINIDS

- **Occurrence:** Prevalent in farmed esp. hatcheries & wild
- **Intensity** higher in farms esp. fry & juveniles decreases with age
- **Life cycle attributes:** binary fission/ conjugation & transmitted by contact – *rapid proliferation & persistent infection*
- **Host versatility** – hitch-hiker on other aquatic organisms



# PROTOZOA – TRICHODINIDS

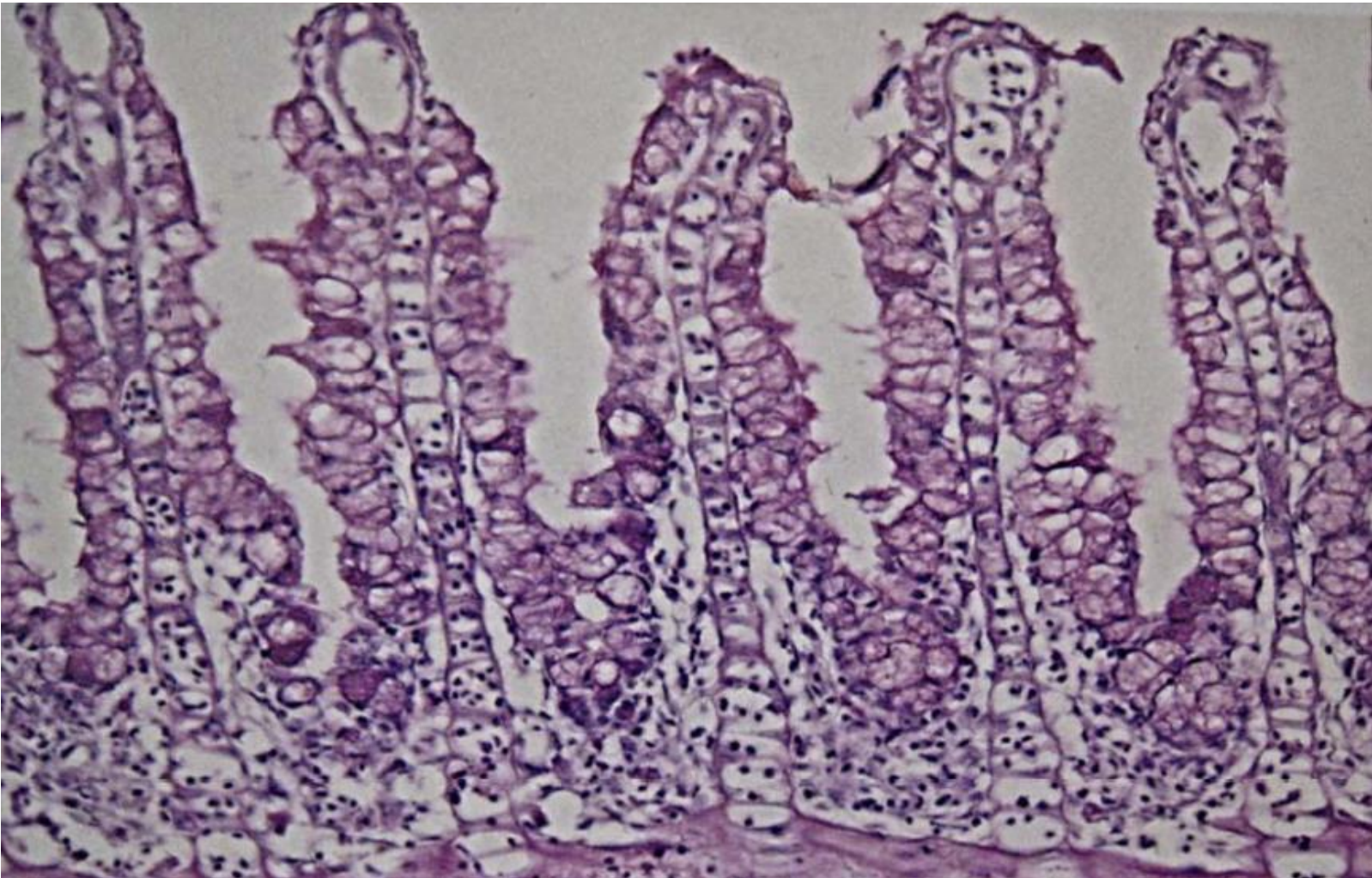
- **Pathology:** sloughing of skin epithelial cells – lead to skin lesions
- Edemas in gills larvae and fry under heavy infestation – leading to mortality





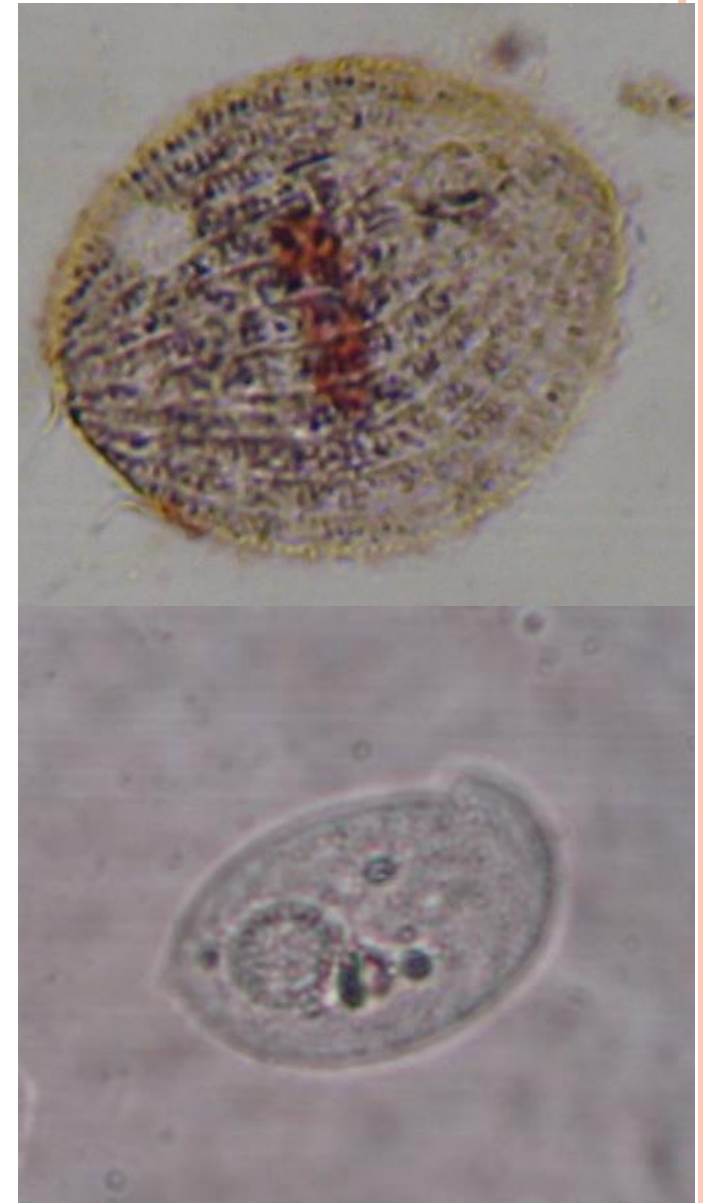
# PROTOZOA – TRICHODINIDS

- **Pathology:** Hyperplastic /hypertrophic reaction leading to lamellar fusion in gills



# PROTOZOA – CHILODONELLA

- Small oval shaped ciliated protozoa but appear rounded under microscope
- Species recorded on gills and skin of tilapia:
  - *Chilodonella piscicola* (4 – 20°C)
  - *C. hexasticha* (26 to 31°C)
- Feed on living cells of the host



# PROTOZOA – CHILODONELLA

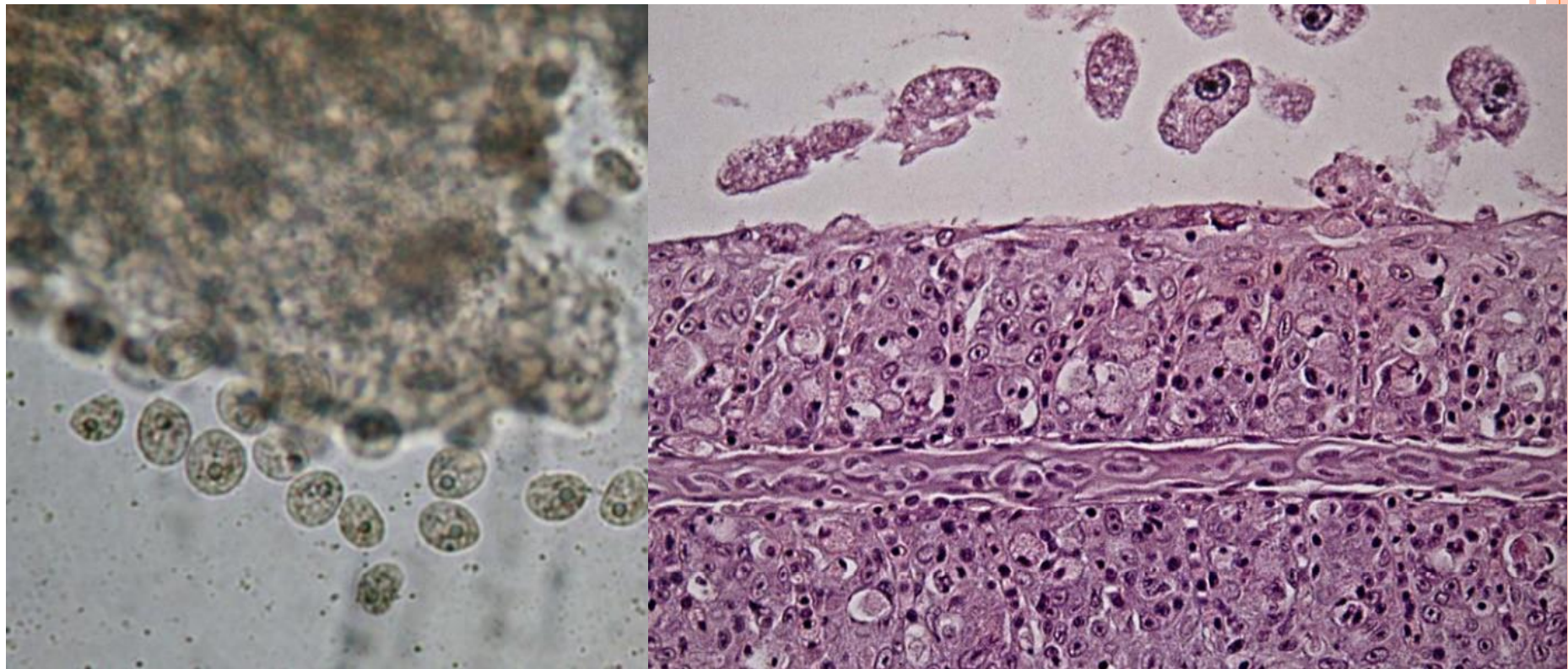
- **Occurrence:** high prevalence in farmed fish esp. hatcheries & low in wild hosts
- **Intensity:** high in farms esp. fry & juveniles decreases with age (in most cases) and in high stocking density & poor environmental conditions
- **Life cycle attributes:**  
transverse binary fission/  
conjugation, & transmitted by  
contact – *rapid  
proliferation & maintain  
infestation in the  
population*





# PROTOZOA – CHILODONELLA

- **Pathology:** hyperplasia of gill epithelium leading to lamellar fusion and necrosis of branchial epithelium in heavy infestation



# ICHTHYOPHTHIRIUS MULTIFILIIS

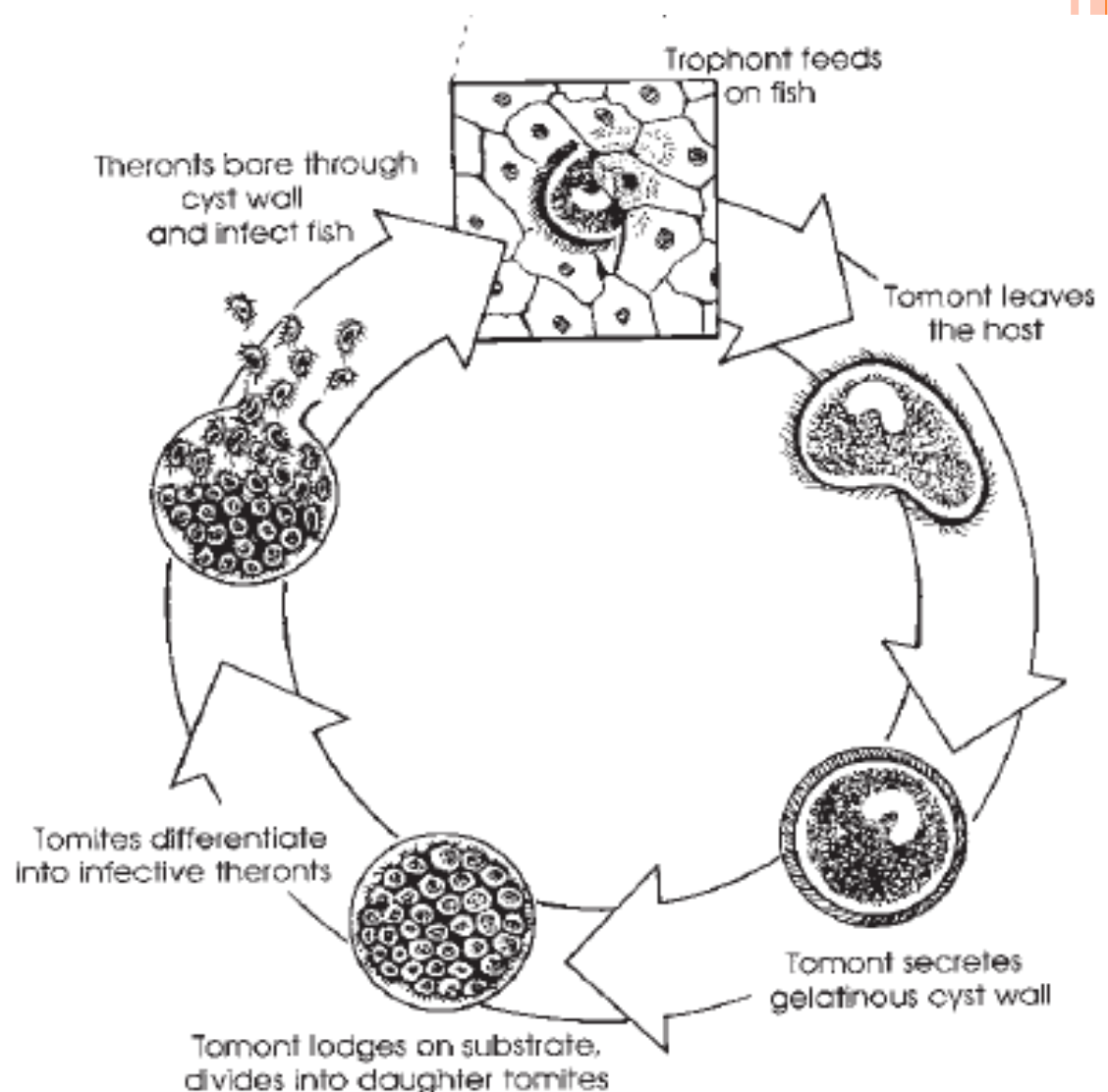
- Round ciliated – Ich (white spot disease)
- pathogenic parasite of fish
- Have characteristic horseshoe shaped macronucleus
- Infect fish from 7°C to 28°C
- Stress conditions: crowding/ environment





# ICHTHYOPHTHIRIUS MULTIFILIIS

- **Life cycle attributes—**
  - reproduce by multiple binary divisions off the host
  - Transmitted by contact – rapid proliferation in the population



# ICHTHYOPHTHIRIUS MULTIFILIIS

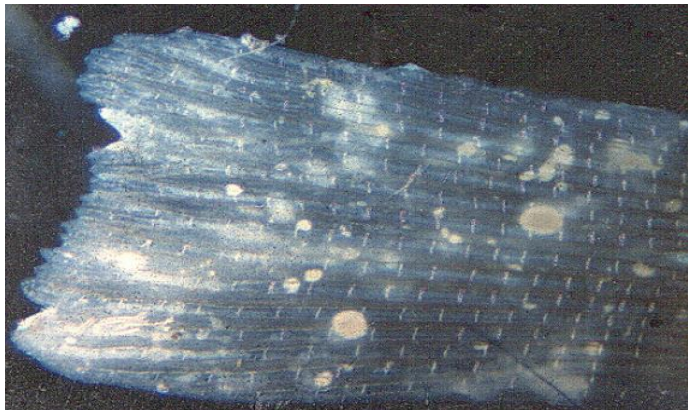
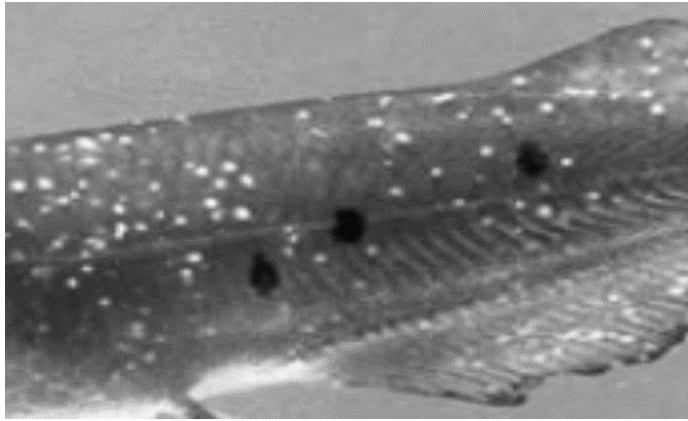
- **Pathology:**
  - In mild infections – few white spots on the fish surface
  - Localized hypertrophy/hyperplasia





# ICHTHYOPHTHIRIUS MULTIFILIIS

- **Pathology:** Heavy infections – generalized hyperplasia e.g. gill epithelium to fusion
- Skin and fin erosion– extensive cell necrosis



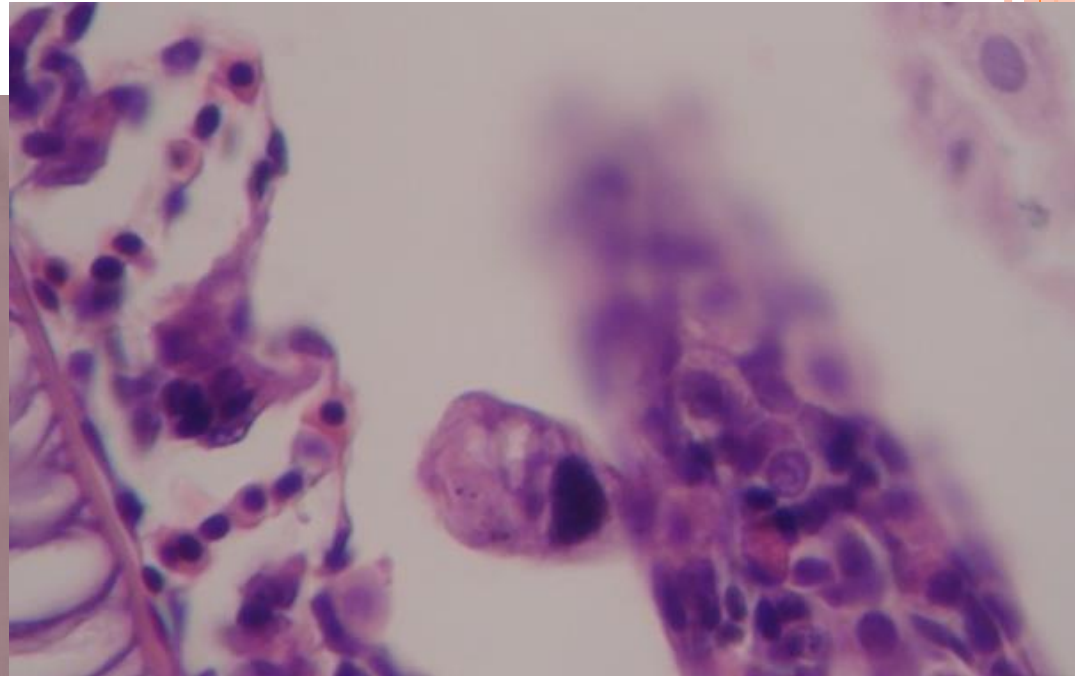
# PROTOZOA - SESSILINES

- Attached commensal protozoa – use various substrate including fish
- Occur in large numbers on weakened fish
  - Heavy growth indicates the fish has been exposed to debilitating conditions
- Attachment on to the host causes
  - Focal impairment of skin functioning
  - Irritate & destruct the surface epithelial cells



# PROTOZOA - SESSILINES

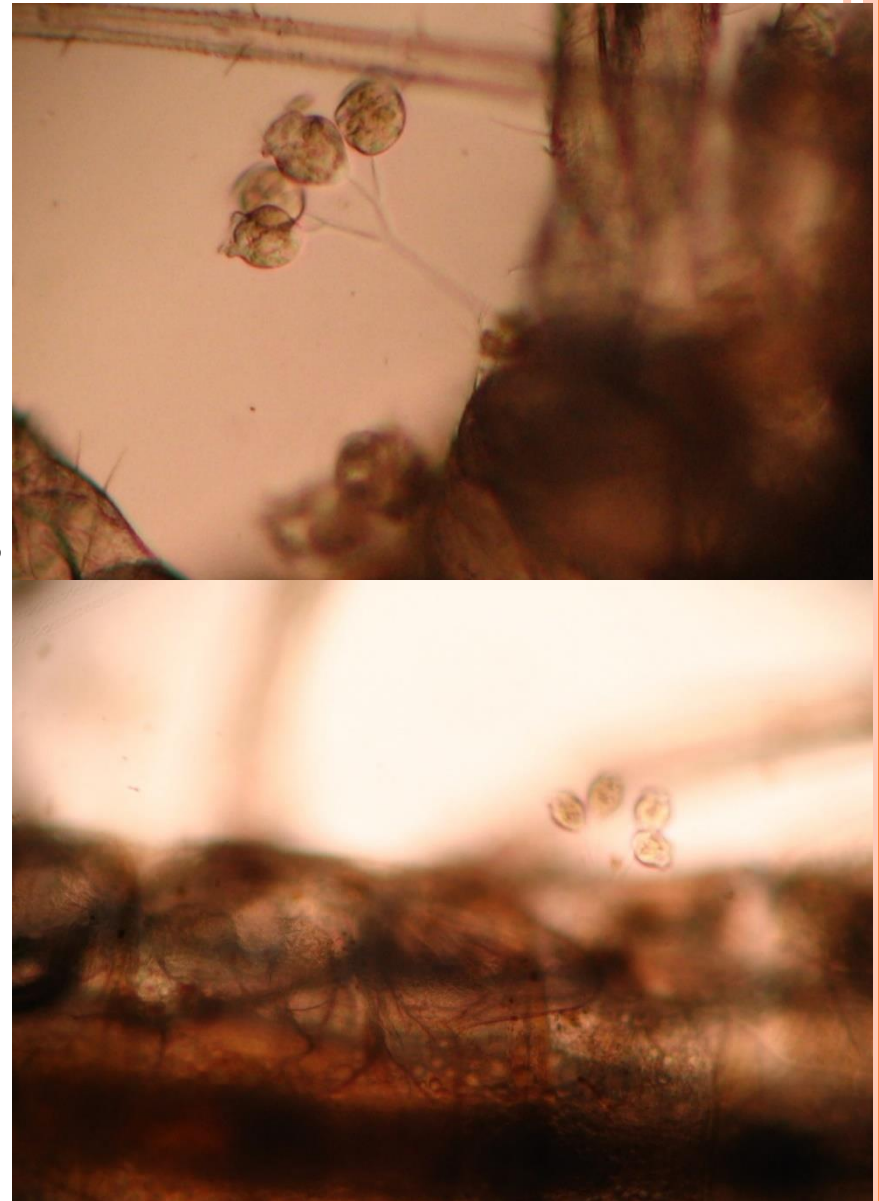
- ***Apiosoma***– Solitary ciliates exclusively associated with fish
- Two species: ***A. piscicolum***-*Tilapia zillii* gills; ***A. conica*** – skin of *T. zillii*
- **Pathology:** Hyperplasia, Oedema & necrosis epithelium





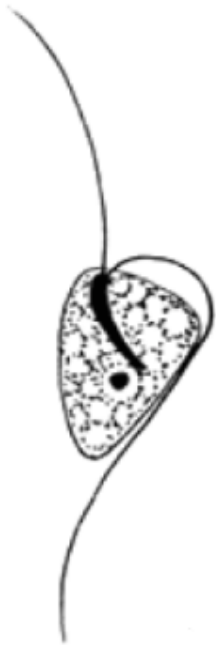
# PROTOZOA - SESSILINES

- **Epistylis** –colonial ciliates with bell-shaped or conical bodies
  - Non-contraction stalk
- **Pathology:**
  - Focal hyperplasia (points of attachment)
  - Necrosis & hemorrhagic ulcer in advanced stages (red sore)
  - Exacerbates secondary infections



# PROTOZOA - CRYPTOBIA

- *Cryptobia* spp. are two flagellated protozoa.
- Have free shorter anterior flagellum,
- Attached recurrent flagellum but with free ends



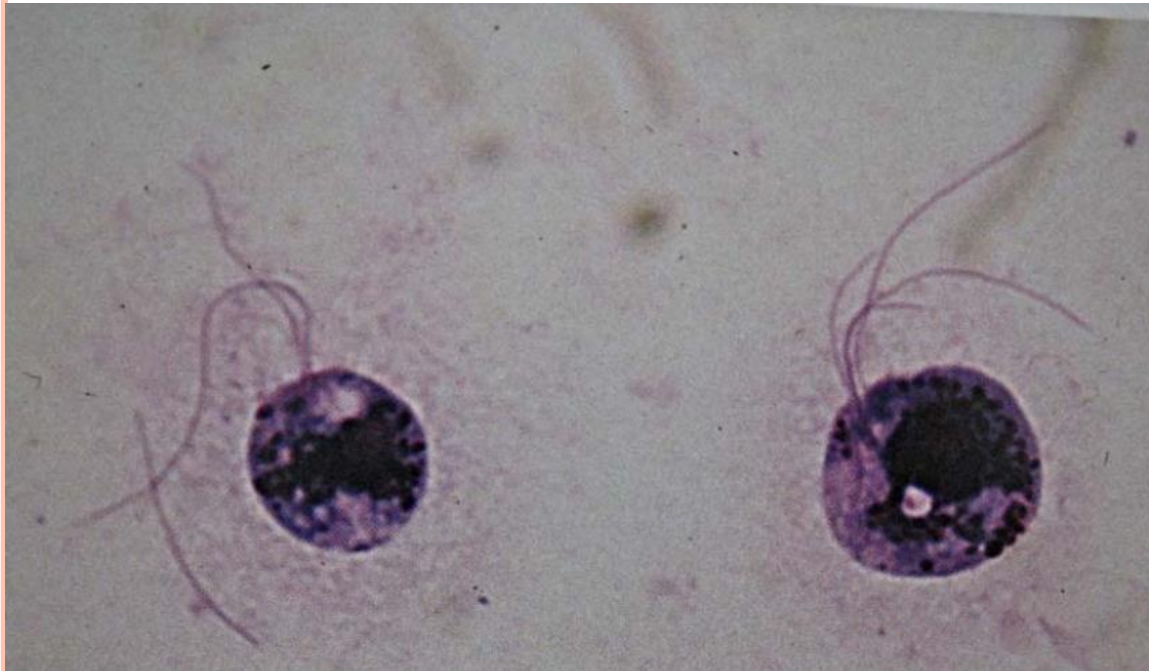
# PROTOZOA - CRYPTOBIA

- Ecto-species (skin and/or gills) – *Cryptobia branchialis*
- Endo-species – (the digestive tract) *C. iubilans* in the blood – *C. salmositica* & *C. borreli*)
- **Species record:** *Cryptobia* sp. Florio *et al.* (2009); Ojwala 2018
- **Life cycle attributes:** binary fission
- **Transmission:** fish-to-fish transmission



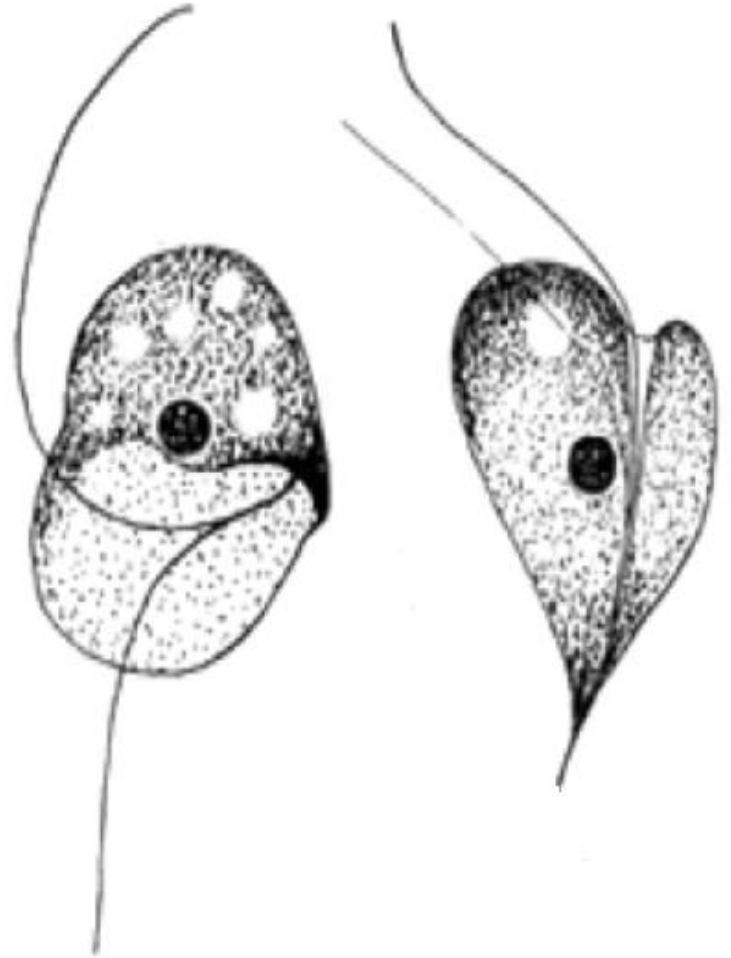
# PROTOZOA - ICHTHYOBODO

- Obligate biflagellate ectoparasites (gills, skin)
- Parasitic form (trophozoite) are attached & elongated
- Feeds mainly on detached cells of the host



# PROTOZOA - ICHTHYOBODO

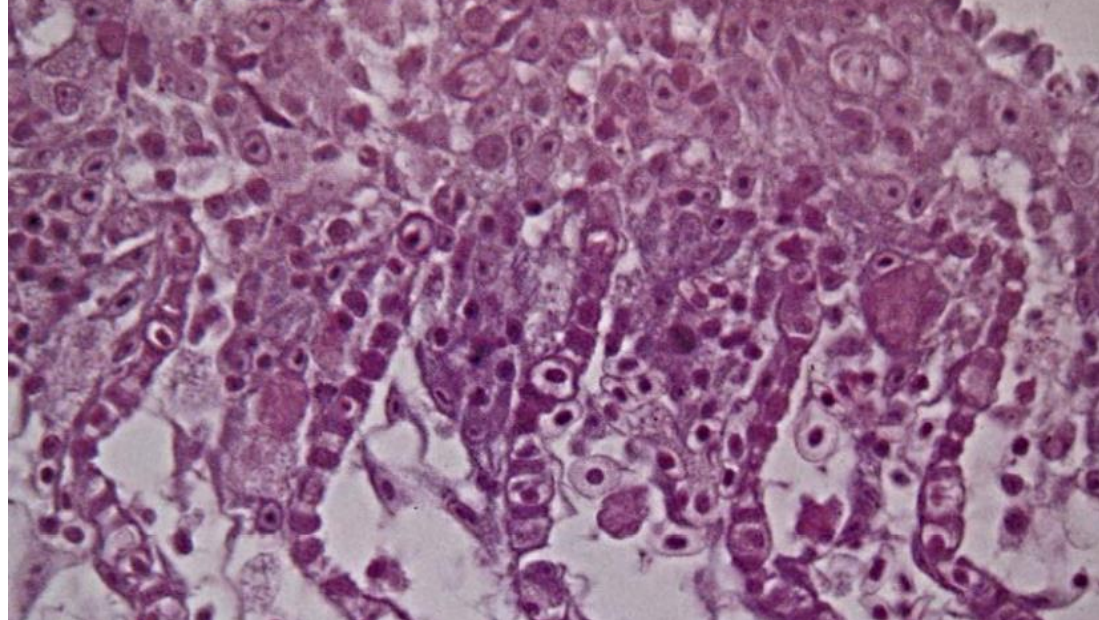
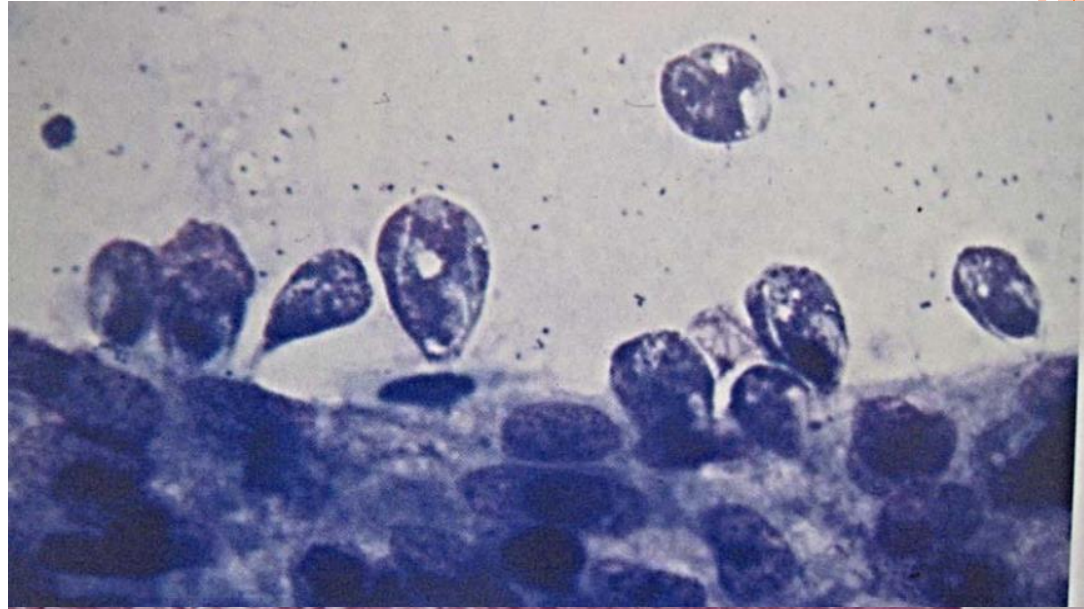
- **Species record:**  
*Ichthyobodo* sp. (Florio et al. 2009)
- **Life cycle attributes:** free-living stage divides by binary fission
  - Multiplies rapidly between 10 and 25°C & encysts at about 8°C
- **Transmission:** free-living infective stage – important for spread & colonization of new hosts





# PROTOZOA - ICHTHYOBODO

- **Pathology:**
  - Oedema followed by degeneration and sloughing of the epidermis
  - Hyperplasia/hypertrophy of epithelial cells – in gills lead to lamella fusion



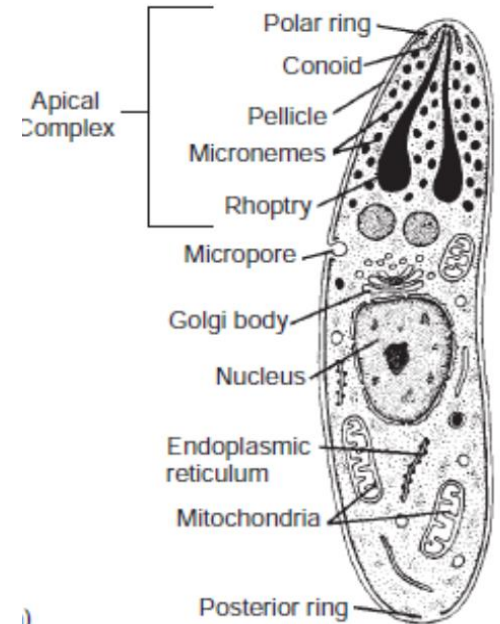
# PROTOZOA - TRYPANOSOMA

- Single flagellum and a single disc shaped kinetoplast,
- Transmitted by vector e.g. leeches
- Species record:  
*Trypanasoma mukasai* (Baker 1960)



# PROTOZOA – APICOMPLEXAN

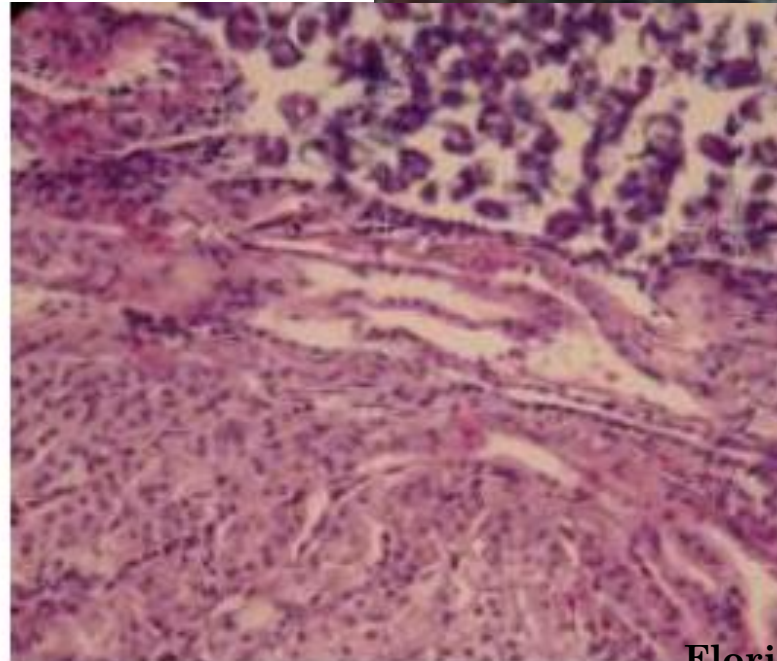
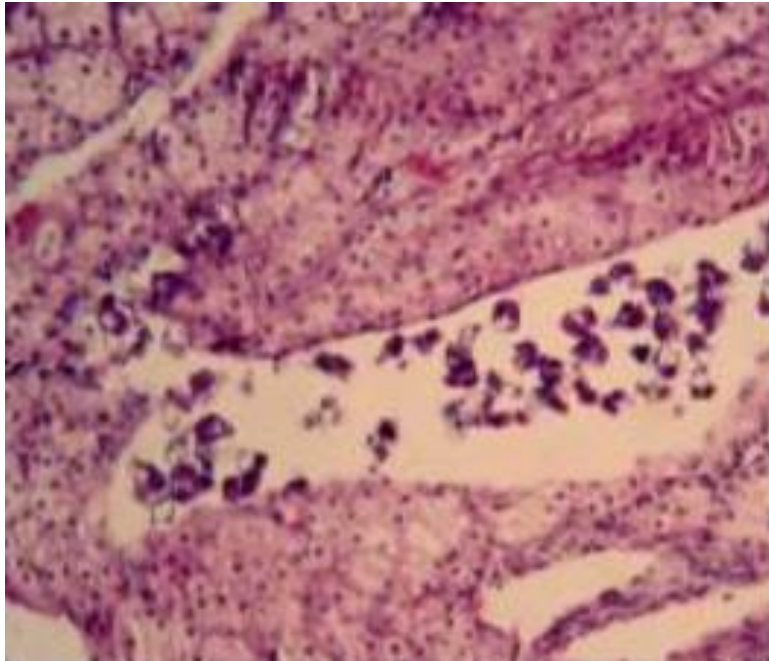
- have **apical complex** – invasion of the host cell
- Form resistant spores or oocysts
- Intestinal / histozoic = *Goussia*, *Eimeria*, *Cryptosporidium*,
- Blood = *Dactylosoma*, *Babesiosoma*
- **Tilapia associated species:**
  - *Eimeria* sp. (Swimbladder) Landsberg & Paperna, 1985
  - *Goussia cichlidarum* intestines and swim bladder
  - *Goussia vanasi* (Syn. *Eimeria vansi*) intestines Landsberg & Paperna, 1987
  - *Dactylosoma mariae* (Blood) Baker 1960





# PROTOZOA – APICOMPLEXAN

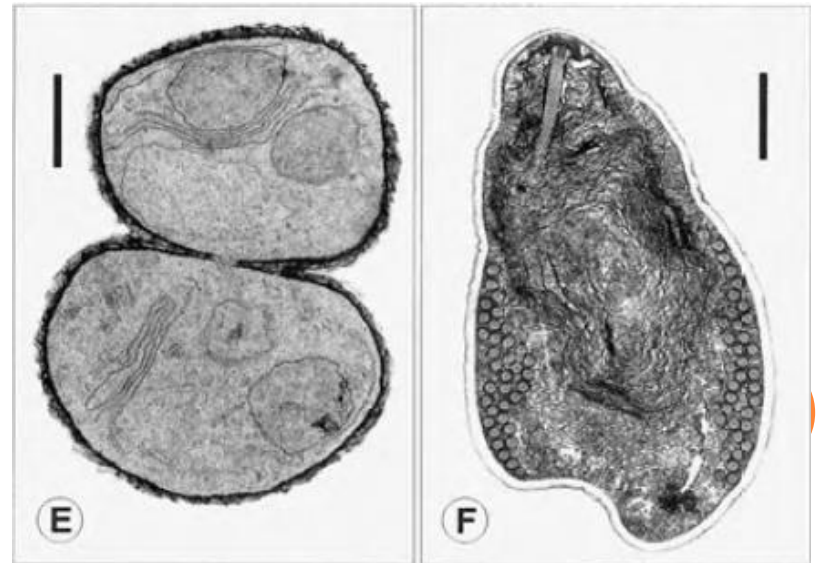
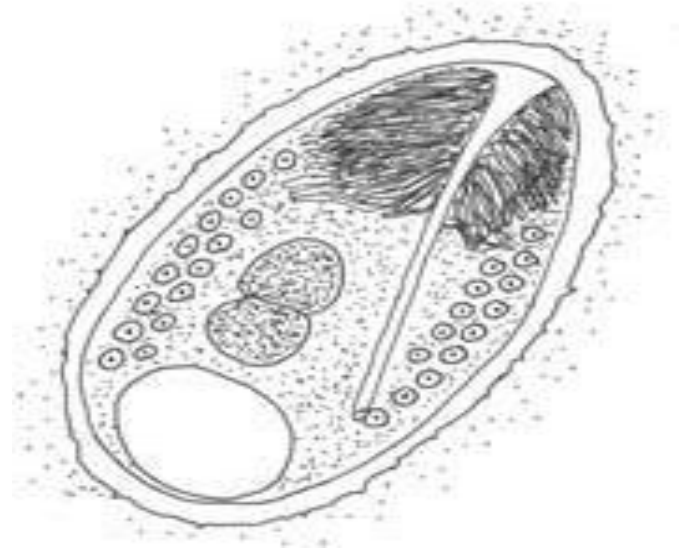
- **Pathology:-** chronic low pathogenicity –
- Oocysts nodules cause atrophy tissues cells; necrosis





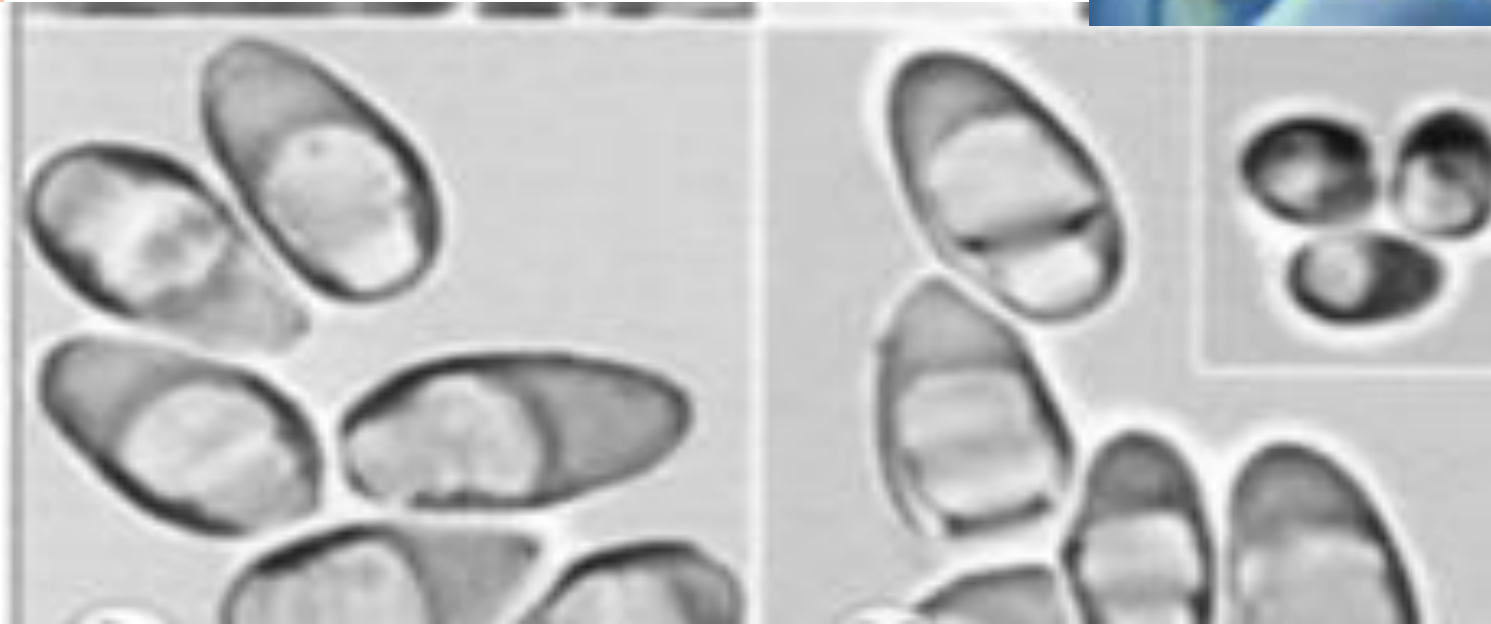
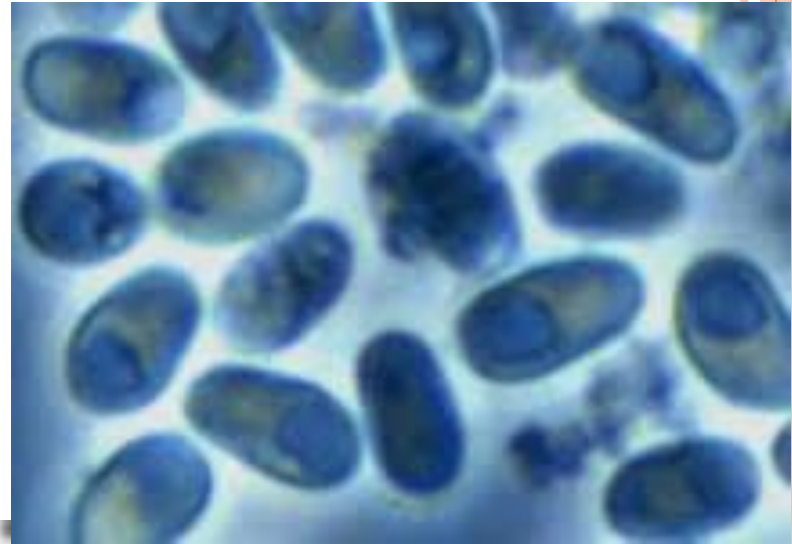
# PROTOZOA – MICROSPRIDIA

- Unicellular with one uninucleate or dinucleate sporoplasm
- Have a specialized polar filament to injected sporoplasm into host cells
- Ovoid, spheroid, or cylindroid in shape.
- Produce spores



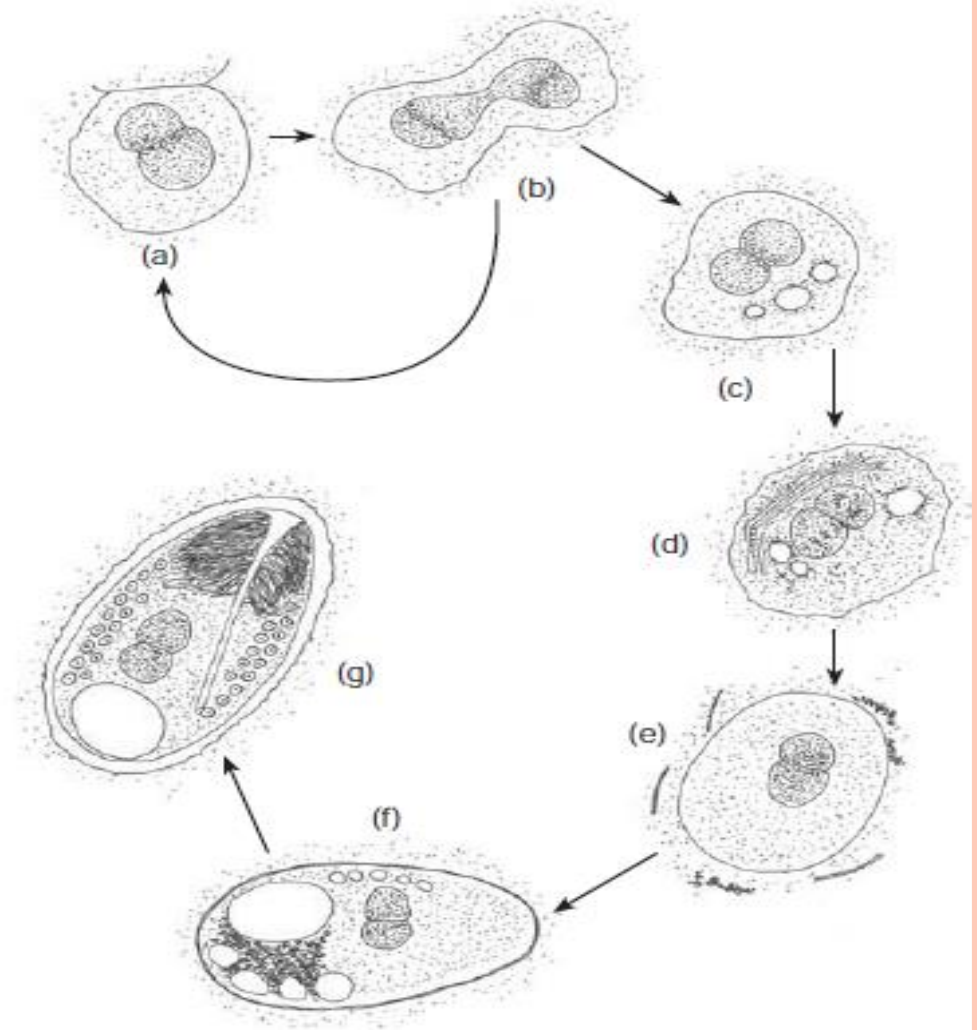
# PROTOZOA - MICROSPORIDIA

- Species record:  
*Neonosemoides tilapiae* in  
tilapia Zillii



# PROTOZOA – MICROSPORIDIA

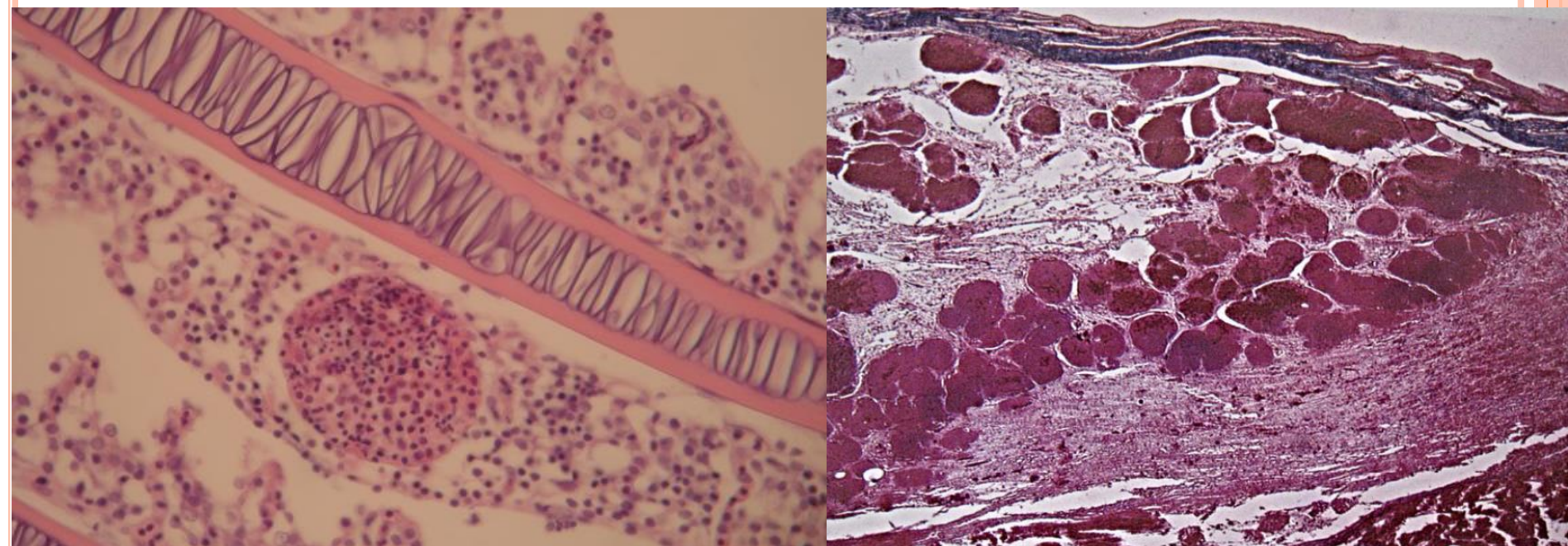
- **Life cycle attributes:-** can produce 12,000 to 88,000 spores
- Asexually by binary or multiple fission (merogony)
- Sexually produce spores (sporogony)
- Transmitted through contact





# PROTOZOA – MICROSPORIDIA

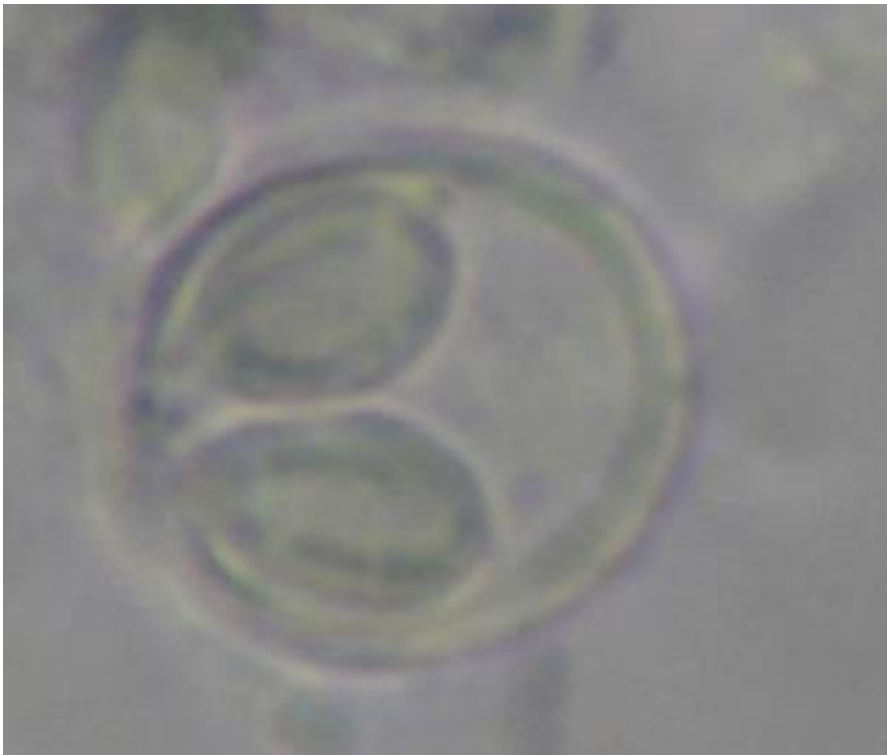
- **Pathology:-** Generally cause chronic disease – characterized with emaciation
- Xenomas cause hyperplasia; atrophy tissues cells; necrosis





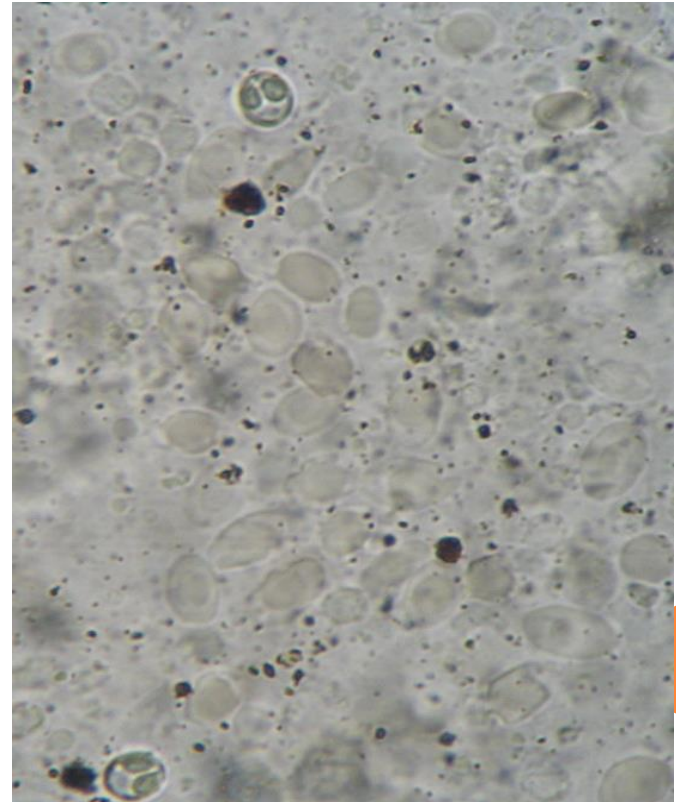
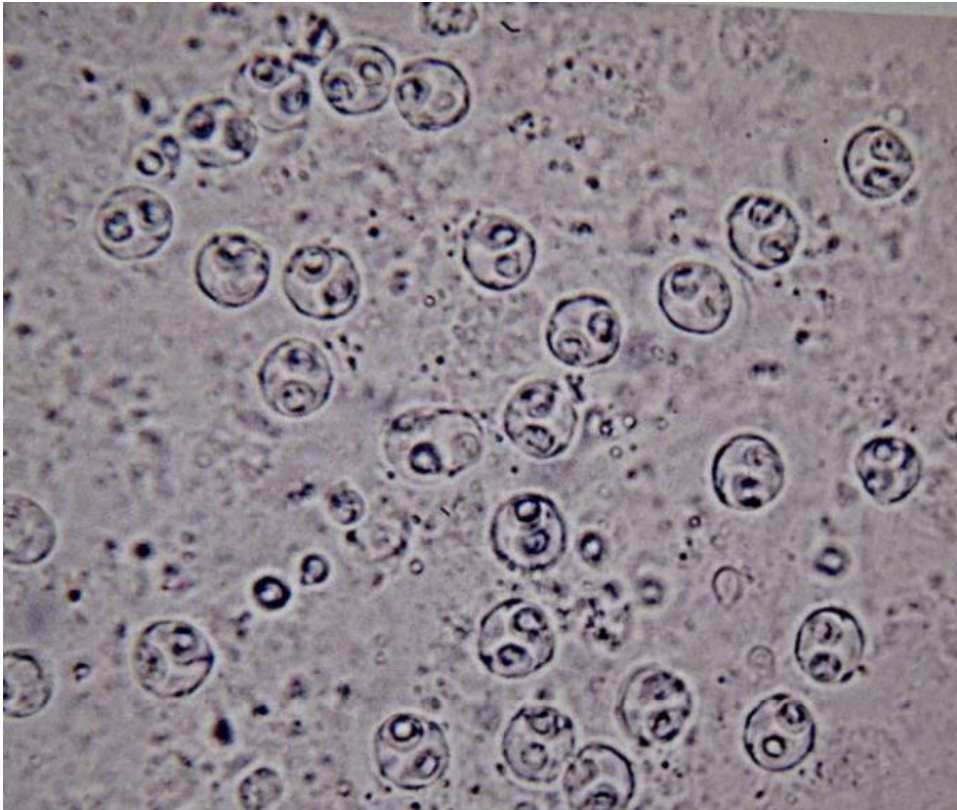
# CNIDARIA

- Cnidarian parasites comprising two classes – the Myxosporea & Malacosporea
- Myxosporea – composed of fish parasites
  - Characterized by presence of spores



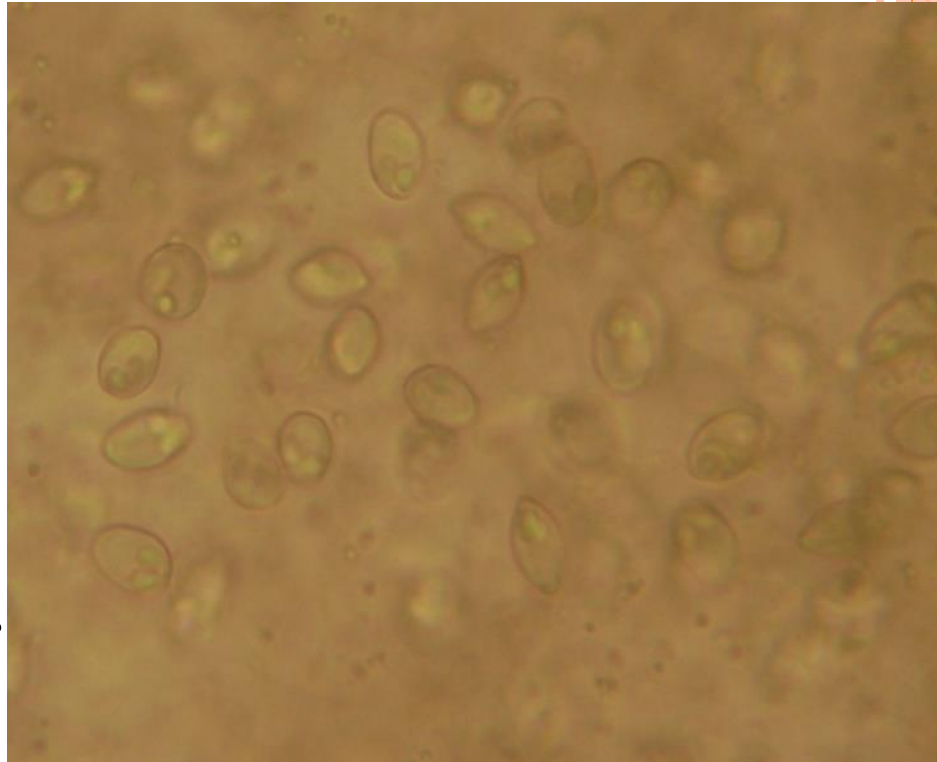
# MYXOZOA

- Genus *Myxobolus*: Spores have 2 polar capsules
- Form plasmodia – cyst-like swellings in infected tissues



# MYXOZOA

- **Species record in tilapia: over 21**
- *Myxobolus agolus* (Kidneys & spleen)
- *Myxobolus camerounensis* (Gills, eyes & muscles)
- *Myxobolus galilaeus* (Eyes, kidneys and spleen)
- *Myxobolus fotoi* (gills)
- *Myxobolus brachyspora* (Kidneys & spleen)
- *Myxobolus nilei* (Gills, skin, eyes, kidneys & pancreas)
- *Myxobolus dahomeyensis* (Ovaries)



# MYXOZOA

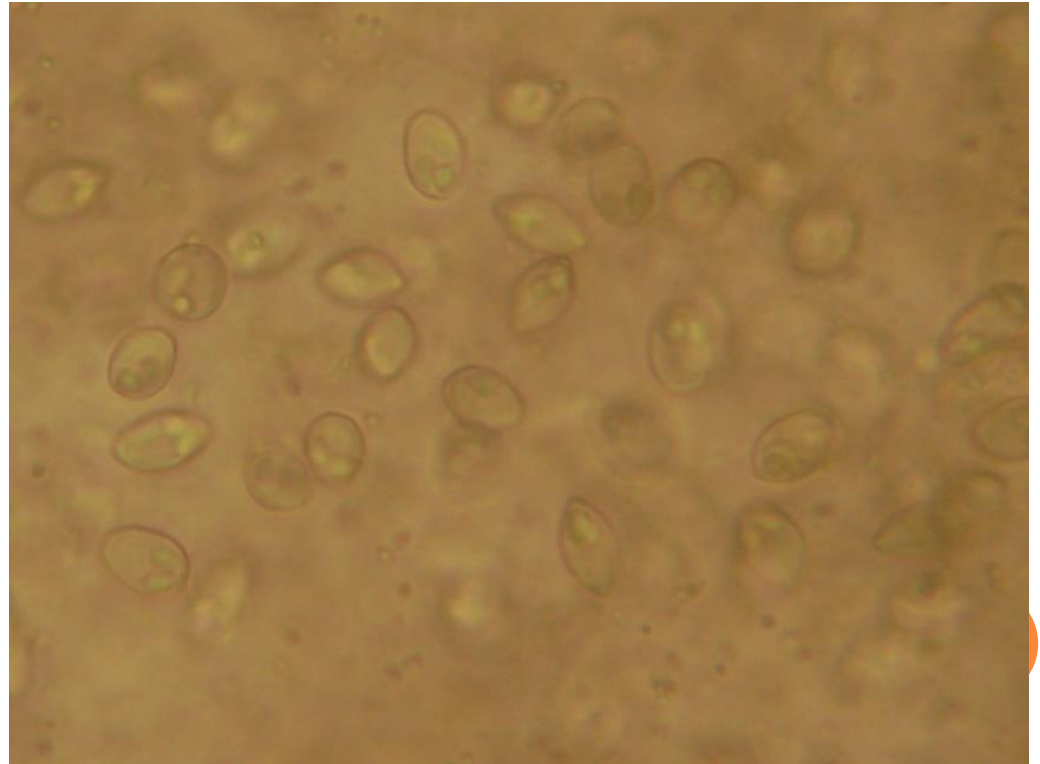
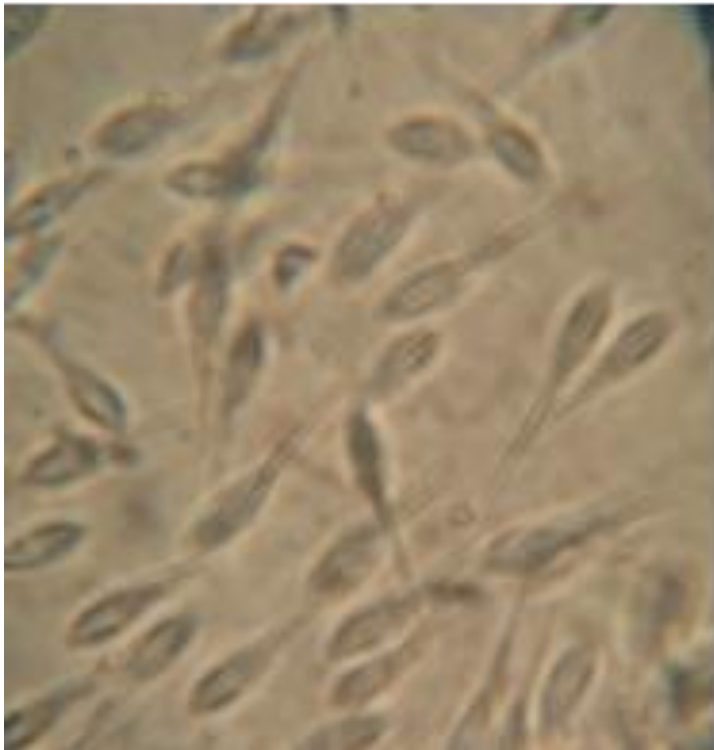
- *Myxobolus heterosporus* (sym heterospora; Liver, kidneys and spleen)
- *Myxobolus equatorialis* (Kidneys and spleen)
- *Myxobolus dossoui* (Gills)
- *Myxobolus microcapsularis* (Gills)
- *Myxobolus homeosporus* (Cornea)
- *Myxobolus kainjiae* (Ovaries)
- *Myxobolus saintlouisensis* (Gills)
- *Myxobolus israelensis*; (Gills, kidneys and spleen)
- *Myxobolus sarigi*; (Kidneys and spleen)
- *Myxobolus ocularis* (Eyes)





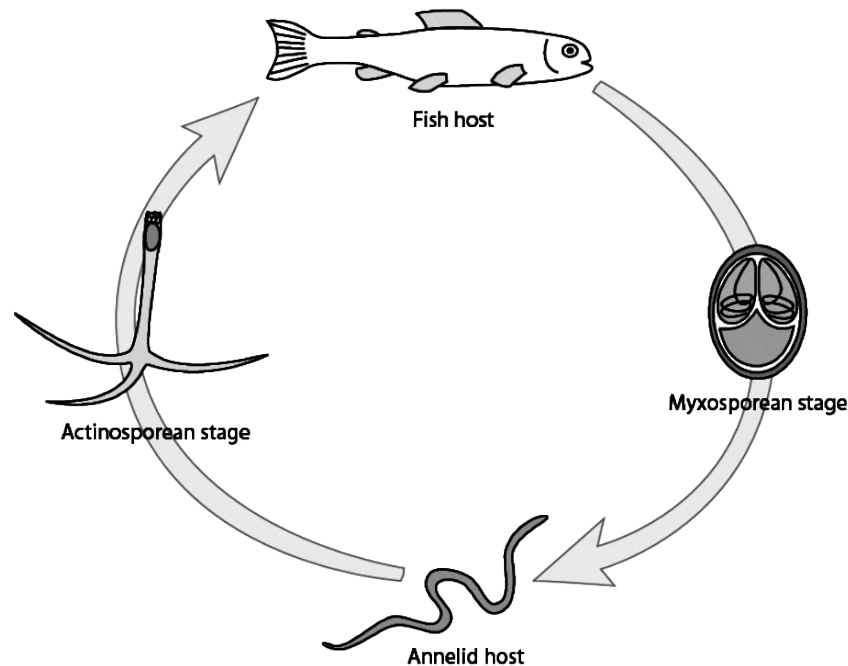
# MYXOZOA

- *Myxobolus tilapiae* (Gills, fins, kidneys & spleen)
- *Sphaerospora melenensis* (Kidneys)
- *Sphaerospora tilapiae*; (Kidneys and spleen)
- *Henneguya suprabranchiae* (Gills)



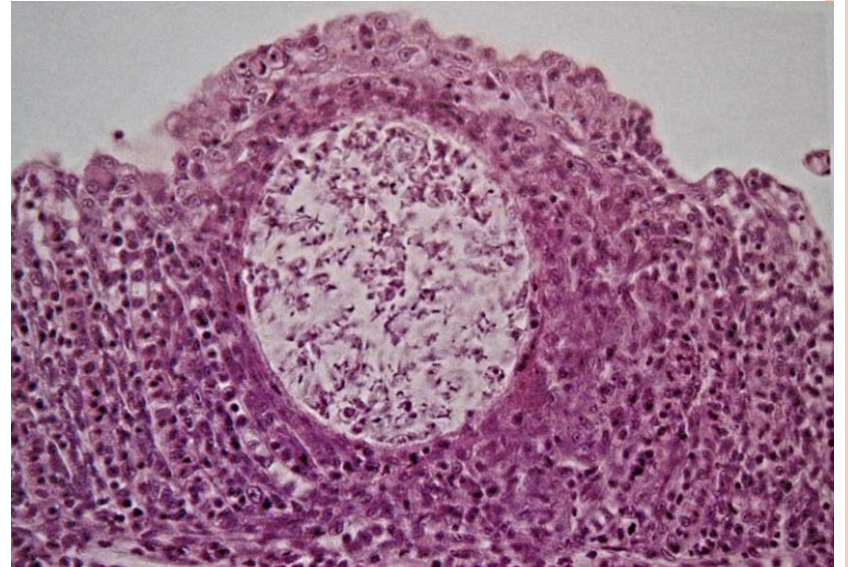
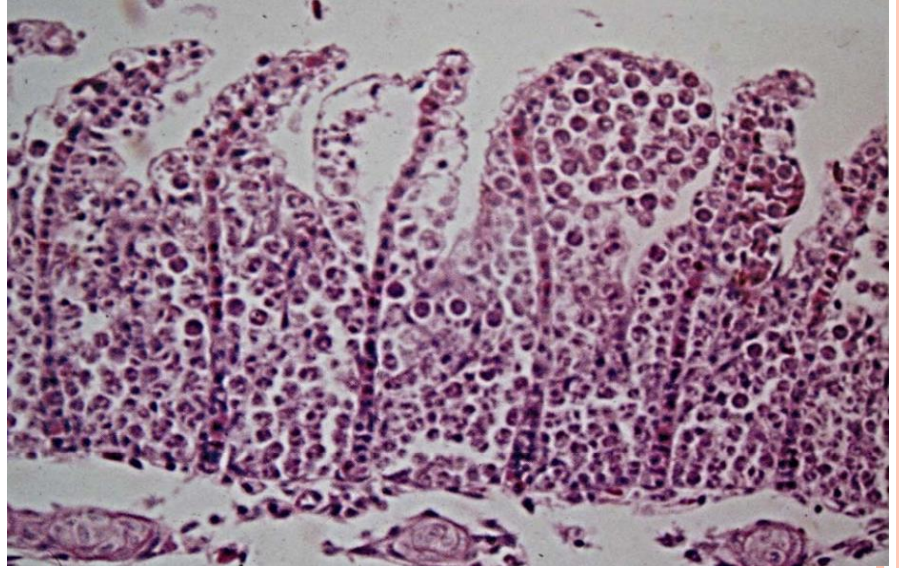
# MYXOZOA

- **Life cycle:** two host life strategy
  - Actinospore sexual phase occurs in oligochaete & are transmitted to fish by contact
  - Myxospore asexual phase occurs in fish
- **Transmission:** direct contact of myxospore onto the host



# MYXOZOA

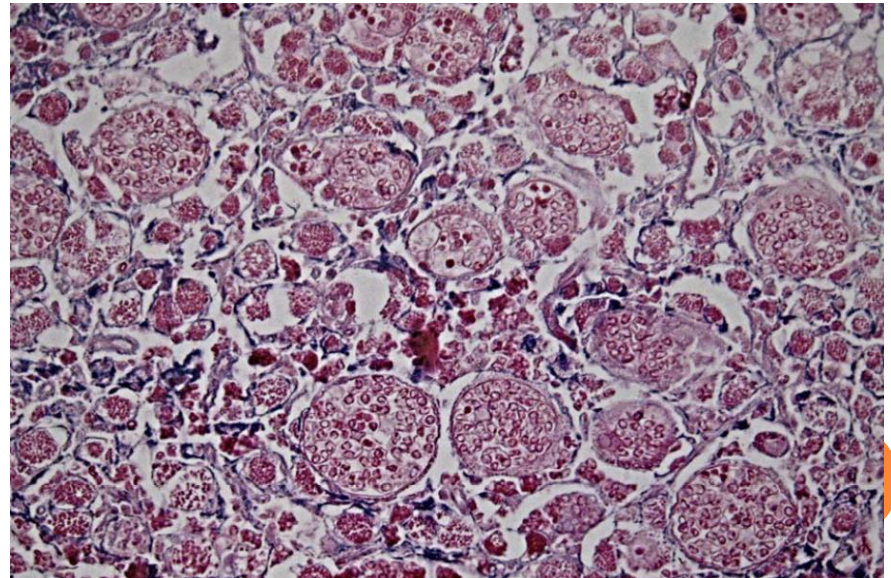
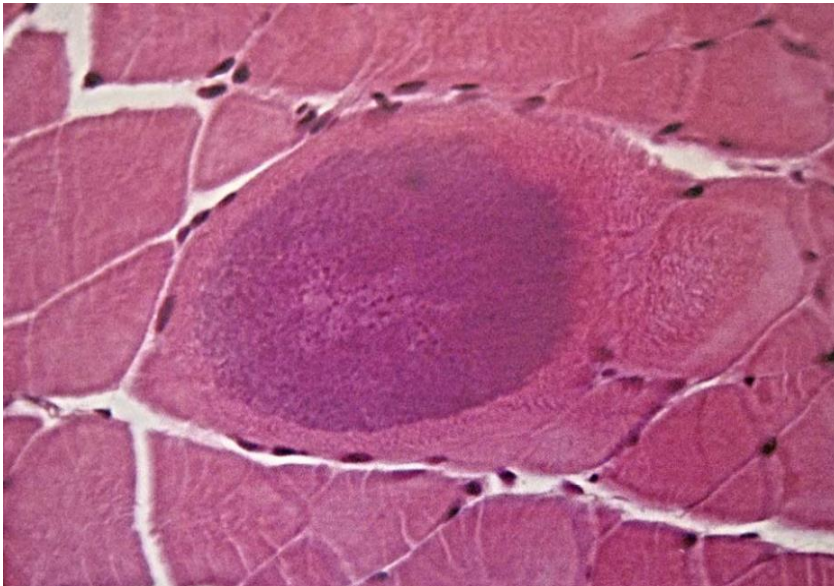
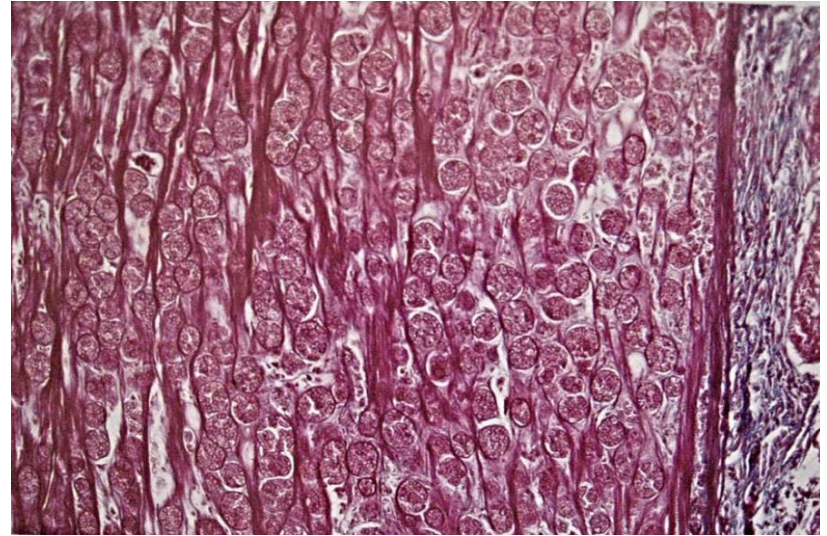
- **Pathology:**  
Plasmodium in gills cause hyperplasia in epithelia cells are compress tissues resulting in gill fusion





# MYXOZOA

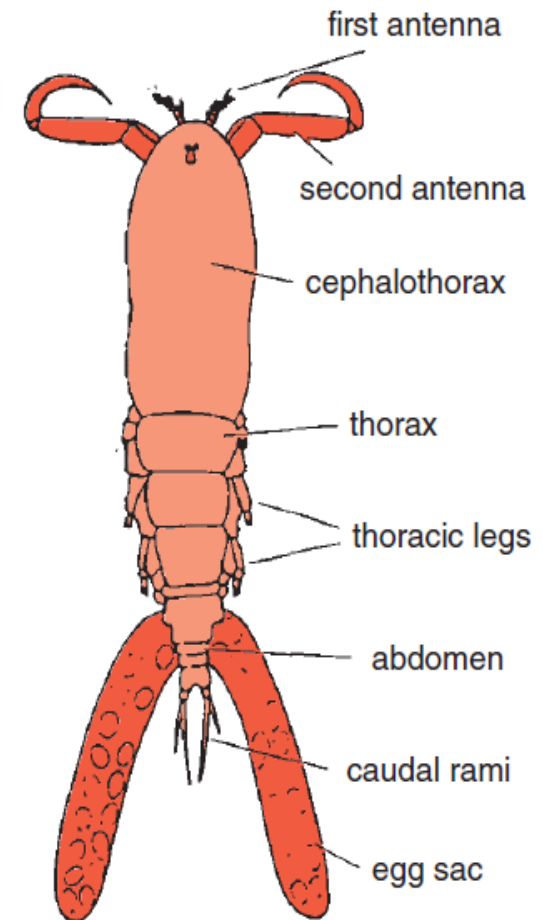
- **Pathology:**  
Plasmodium in muscles cause necrosis, atrophy of myomeres & fibrosis





# CRUSTACEAN - ERGASILIDS

- Sub-adult and adult females are parasitic copepods to fish
- Have characteristic two egg sacs on the genital segment
- Second antenna are modified into a hooks for attachment
- Cephalothorax is half or more of body length

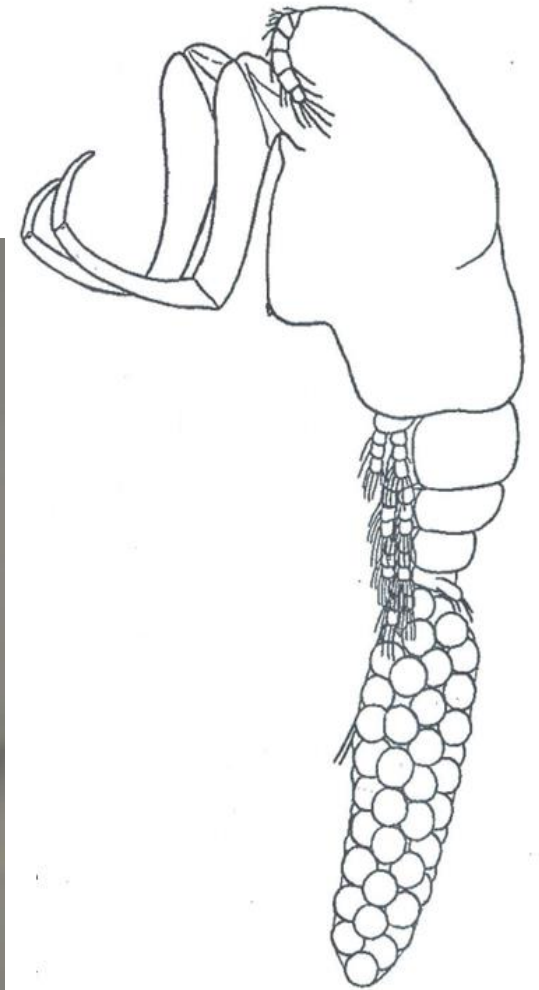


Roberts 2012



# CRUSTACEAN - ERGASILIDS

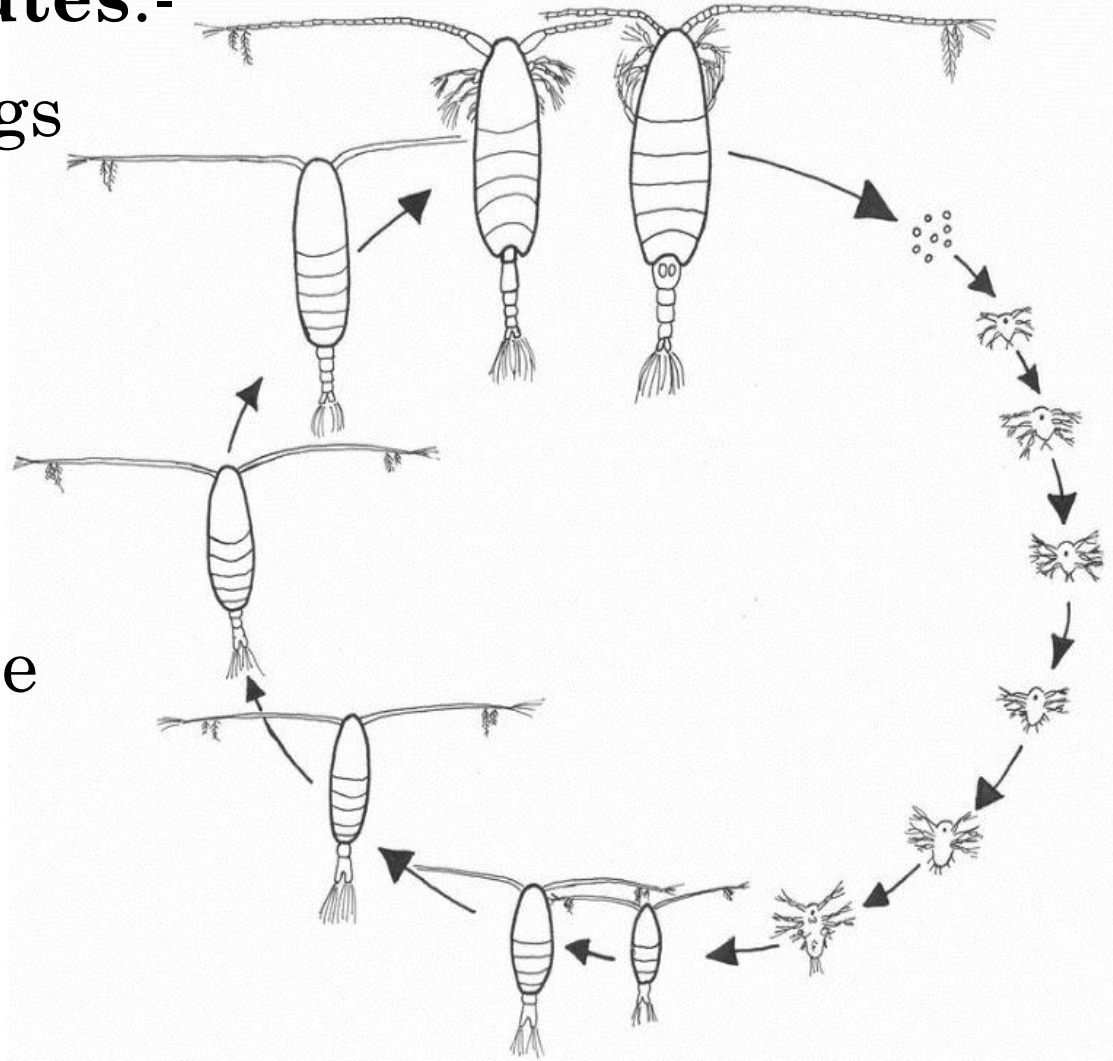
- **Species record:**
- *Ergasilus latus*
- *E. canningtoni*
- *E. macrodactylus*



Fryer 1960

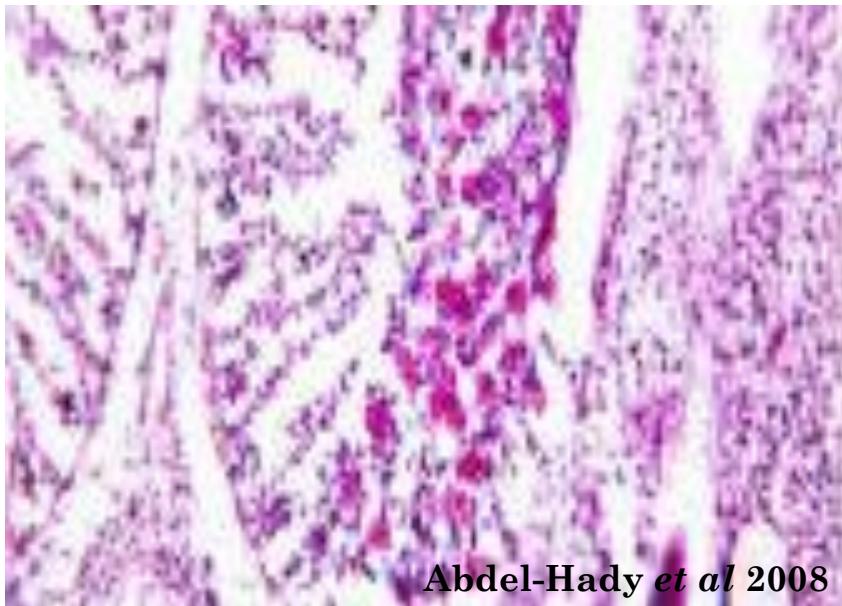
# CRUSTACEAN – ERGASILIDS

- **Life cycle attributes:-**
- produce several eggs up to 100 eggs/sac
- Several free-living stages (nauplii & copepodites) – sustain prolonged infection & enhance wide spread/transmission



# CRUSTACEAN – ERGASILIDS

- **Pathology:-** Ergasilids feed on gill tissue and mucus causing focal epithelial erosion
- Epithelium hyperplasia – causing fusion of lamellae in gills
- Mechanical damage cause hemorrhage – anemia & exacerbating secondary infection





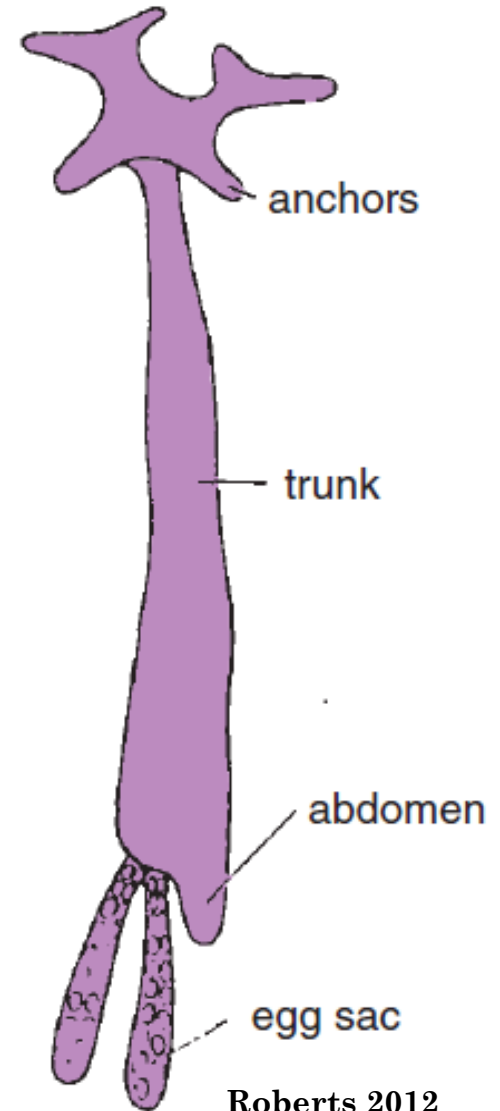
# CRUSTACEAN – LERNAEID

- Females are parasitic with characterized two egg sacs
- Adult female are unsegmented/ partly segmented rod shaped individuals
- Cephalothorax is less than half of body length
- Head have specialized holdfast organ – the cephalic horns (anchors)
- Three main genera recorded in tilapia:
  - Lernaea
  - Opistholernaea
  - Lamproglena



# CRUSTACEAN – LERNAEID

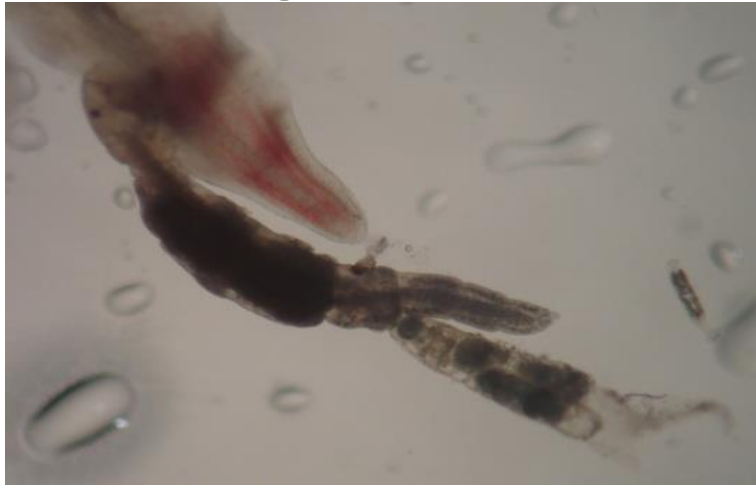
- **Species record:** seven
- *Lernaea barnimiana*
- *L. cyprinacea*
- *L. hardingi*
- *L. tilapiae*
- *L. palati*
- *Opistholernaea laterobranchialis niloticus*



Roberts 2012

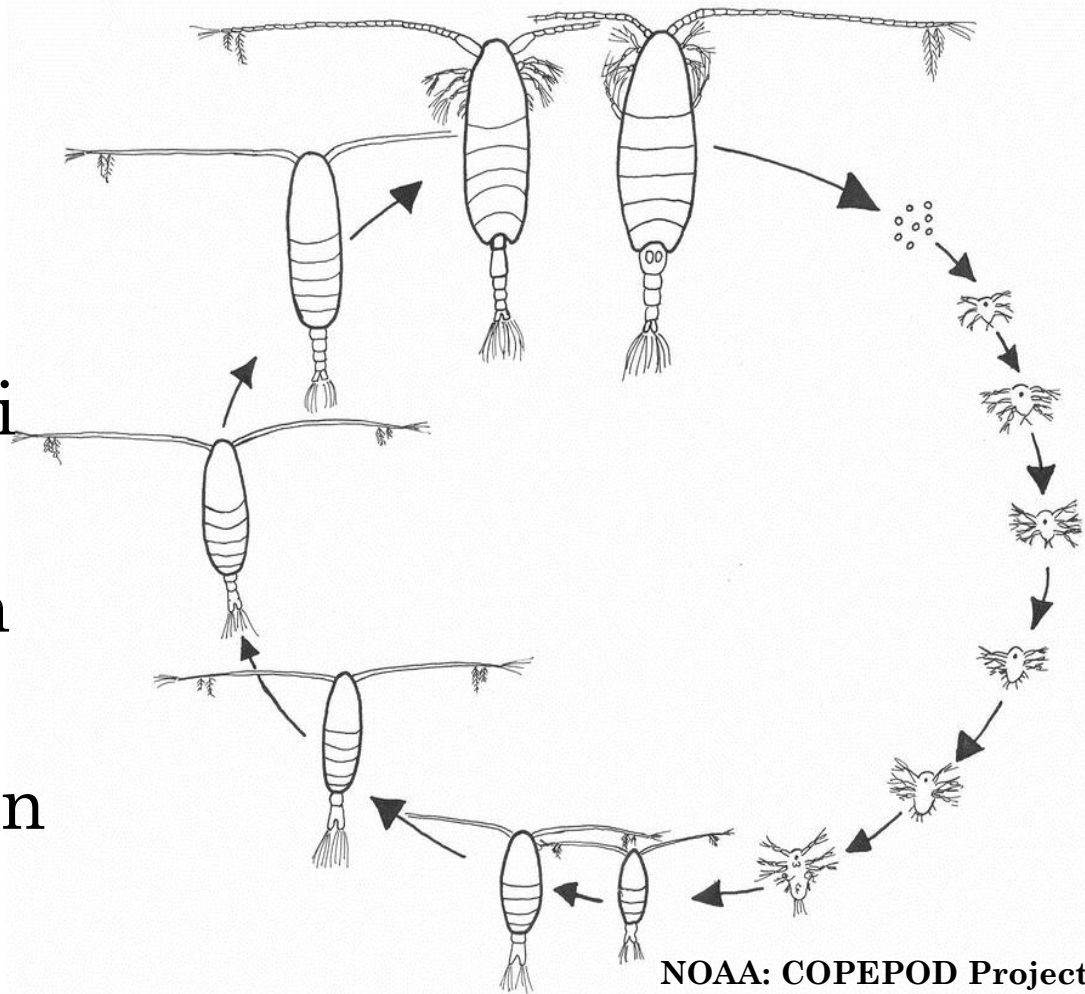
# CRUSTACEAN - LERNAEID

- Lamproglena
- *Lamproglena monodi*



# CRUSTACEAN - LERNAEID

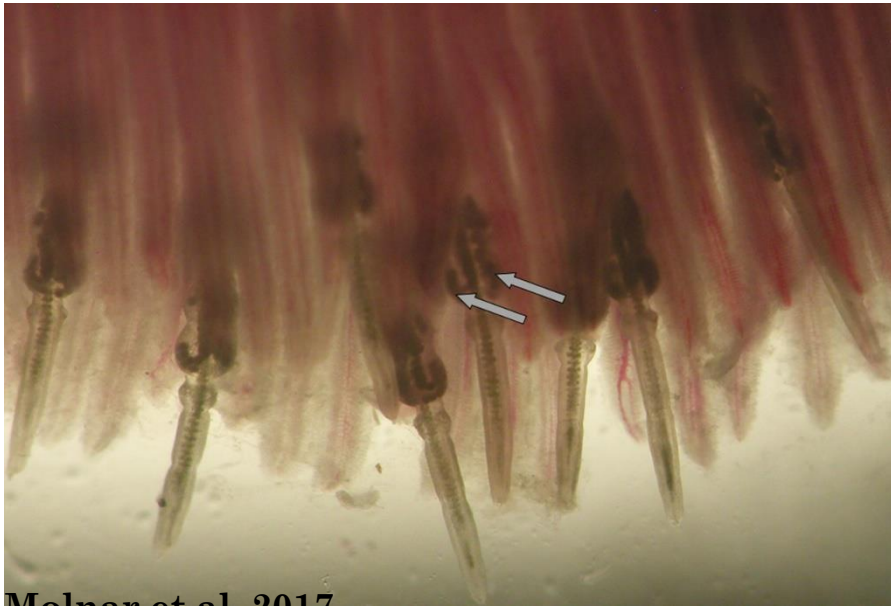
- **Life cycle attributes:** produce over 200 eggs/sac
- have several free-living stages (nauplii & copepodites) –
  - sustain an infection
  - Support wide spread/ transmission





# CRUSTACEAN - LERNAEID

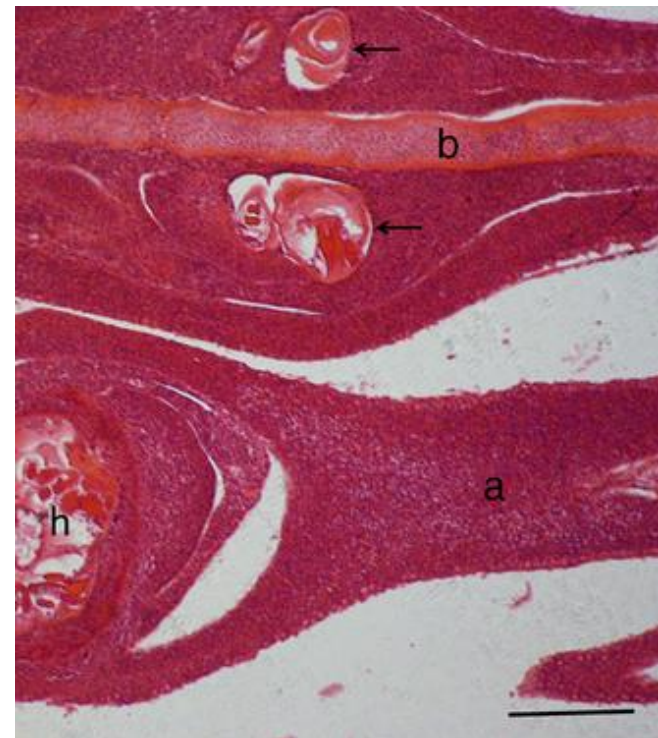
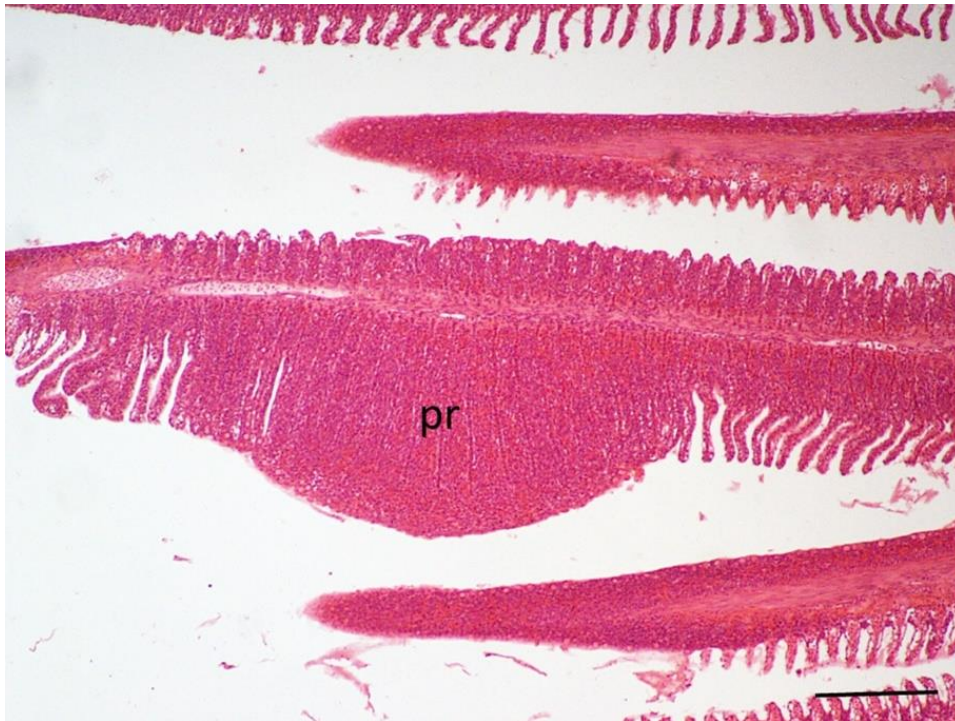
- **Pathology:**
- The anchors penetrates the host skin causing **mechanical damage**
- The anchors can penetrates the internal organs



Molnar et al. 2017

# CRUSTACEAN - LERNAEID

- **Pathology:** At sites of attachment:-
  - Hypertrophy of the lamellar epithelial cells
  - Hyperplasia of goblet leading to fusion of gill lamellae



# CRUSTACEAN - BRANCHIURA

- Two genera recorded in tilapia
- **Argulus and Dolops**
- *Argulus africanus*
- *Argulus rhipidiophorus*
- *Dolops ranarum*





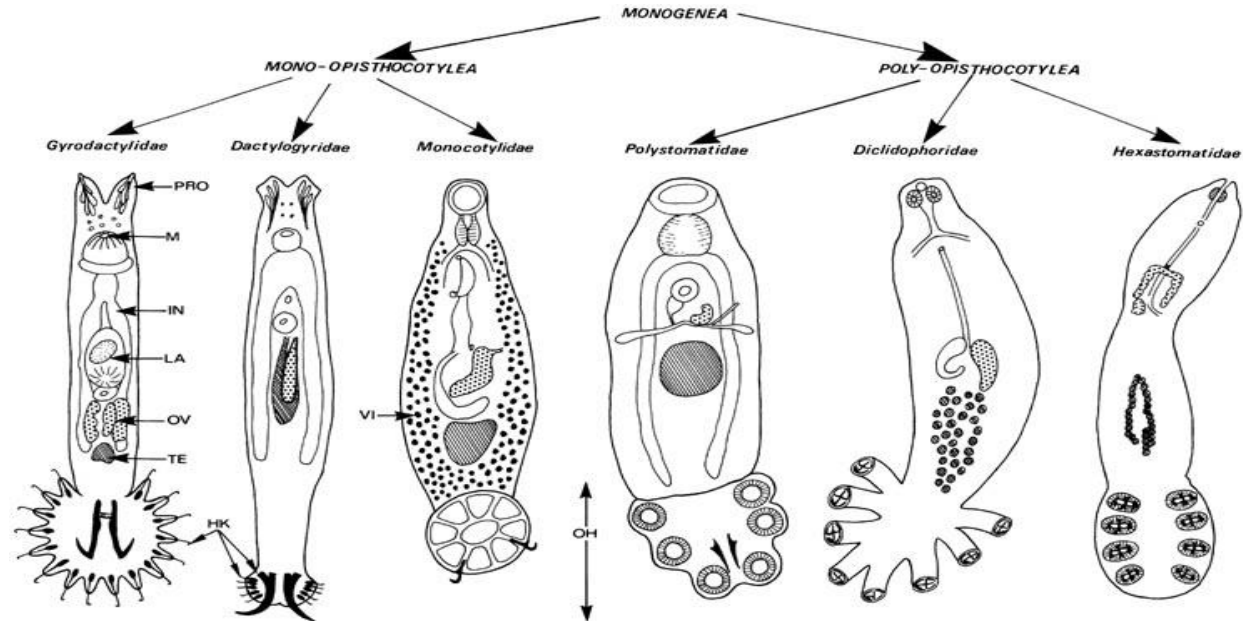
# CRUSTACEAN - BRANCHIURA

- **Life cycle attributes:** produce over 600 eggs hatch within 25–35 days at 24°C in batches – sustain the infection
- **Pathology: mechanical damage** resulting into **hemorrhage;**
- **hyperplasia** of epithelial cells;  
Necrosis of tissues



# MONOGENEA

- Two lineages: monopisthocotyleans – muscular disc or sucker and pair or 2 of anchors
- Polyopisthocotyleans – one or more pairs of muscular suckers or clumps with or without anchors



# MONOGENEA

## ○ Genus: *Cichlidogyrus* with over 17 species

➤ *C. halli*

➤ *C. sclerosus*

➤ *C. thurstonae*

➤ *C. tiberianus*

➤ *C. tilapiae*

➤ *C. aegypticus*

➤ *C. arthracanthus*

➤ *C. rognoni*

➤ *C. digitatus*

*C. dossoui*

*C. Ergensi*

*C. haplochromii*

*C. longicirrus*

*C. nematocirrus*

*C. tubicirrus magnum*

*C. zambezensis*

*C. cirratus*

*C. cubitus*

*Scutogyrus longicornis*

*Enterogyrus cichlidarum*

*Gyrodactylus cichlidarum*



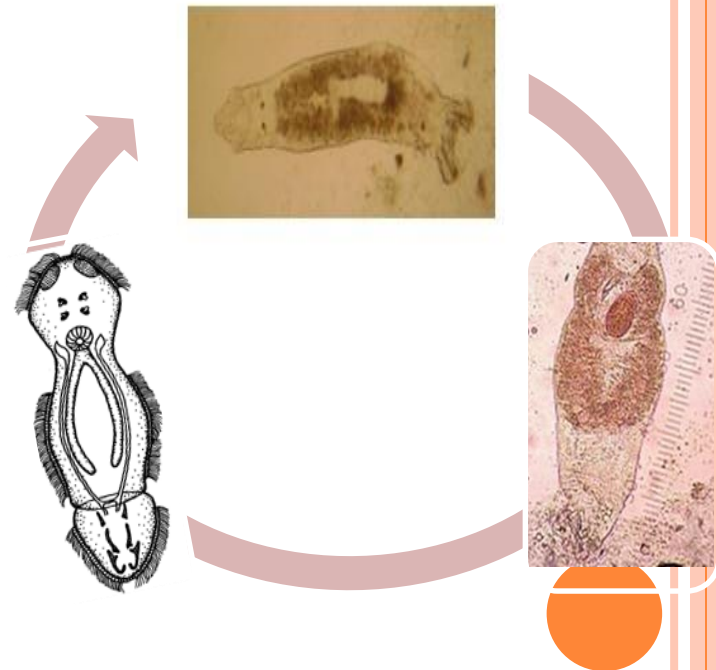


# MONOGENEA

## Life cycle attributes

- Simple life-cycles, reproducing by binary fission => rapid proliferation

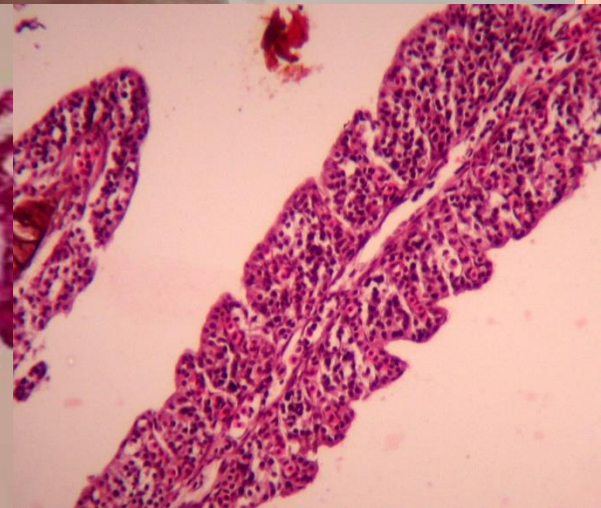
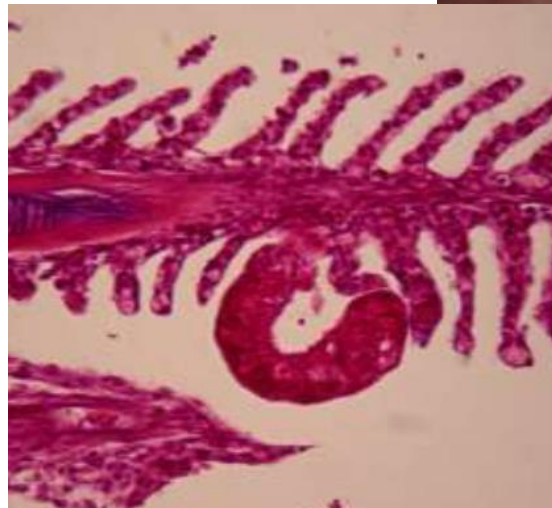
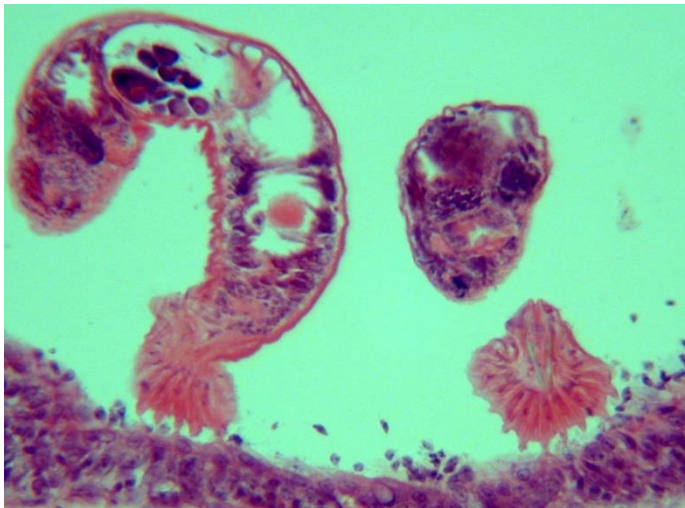
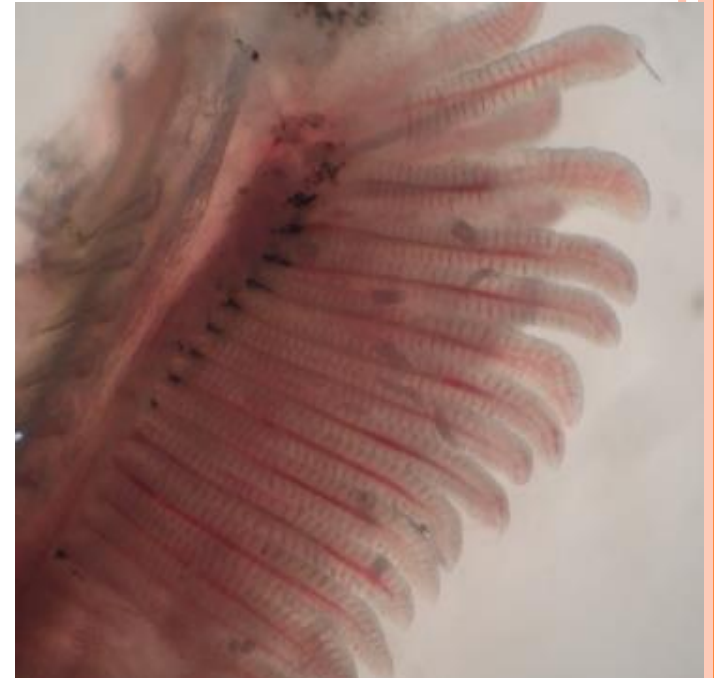
**Transmission:** between and within hosts through host contact or swimming through water => parasite build-up in the same host/fish



# MONOGENEA

**Infestation levels:** Prevalent in both wild and cultured fish

**Pathology:** Epithelial sloughing, hemorrhage & hyperplasia – gill fusion



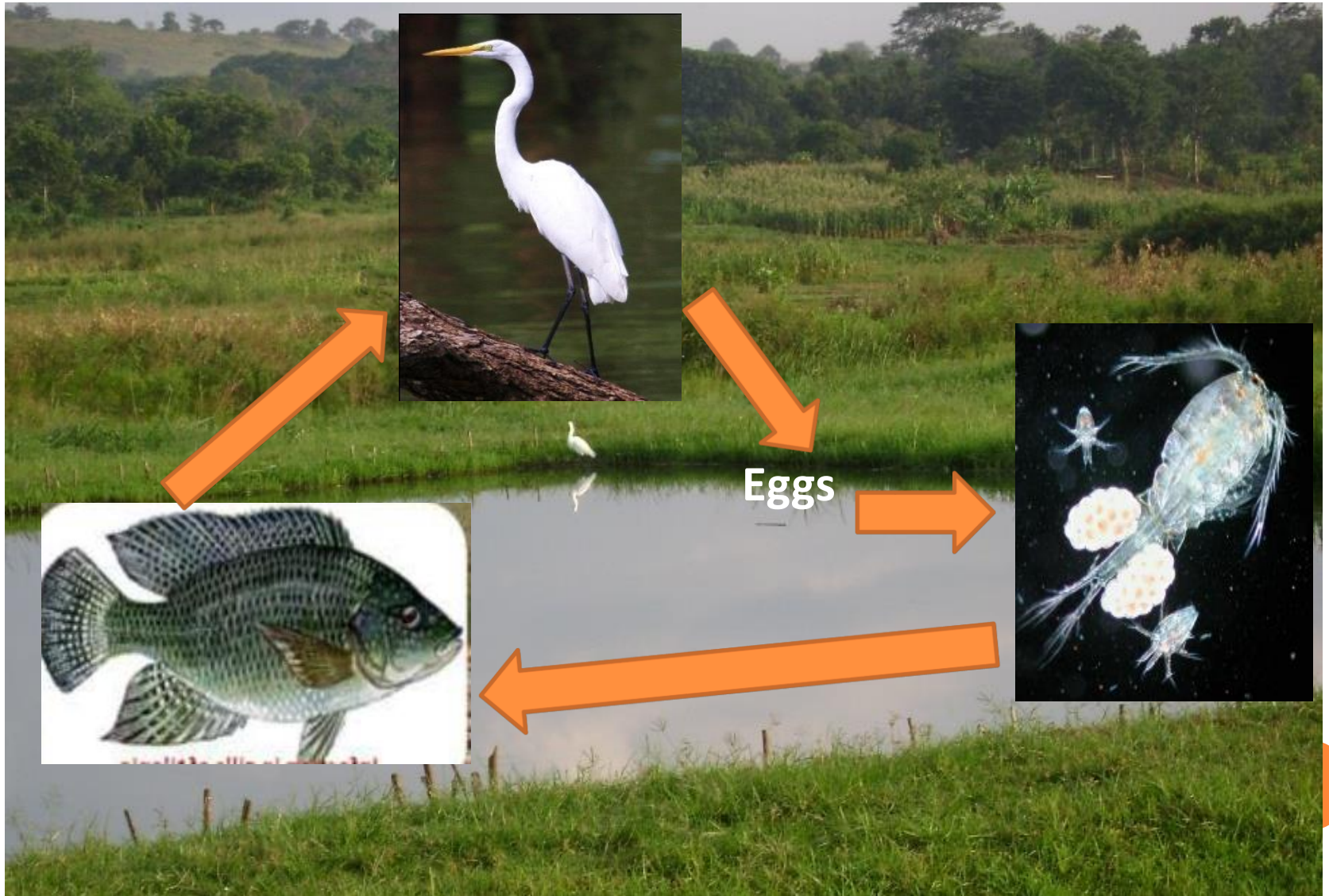
# CESTODES

- Dorsal-ventral flattened and elongate bodies
  - Segmented – polyzoic proglottids (eucestoda except Caryophyllidea & Spathebothriidea)
  - Unsegmented (cestodaria)
- Parasites of fish as adults (definitive host) and larvae – plerocercoid (2<sup>nd</sup> intermediate host)



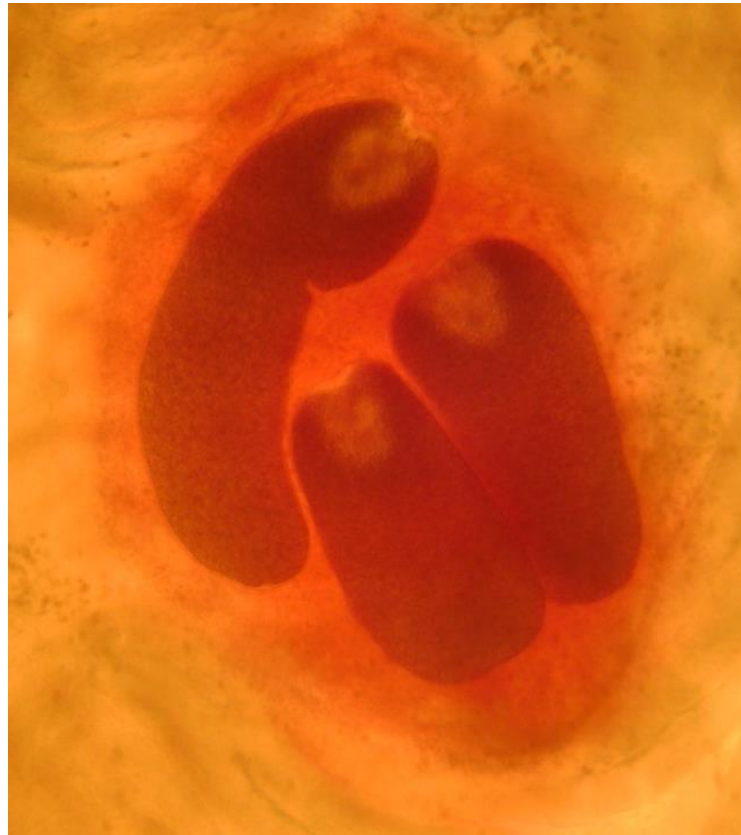
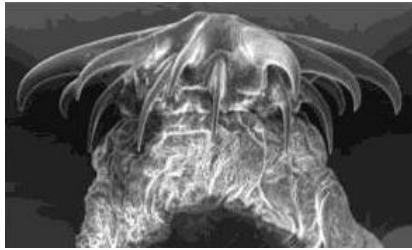


# CESTODES



# CESTODES

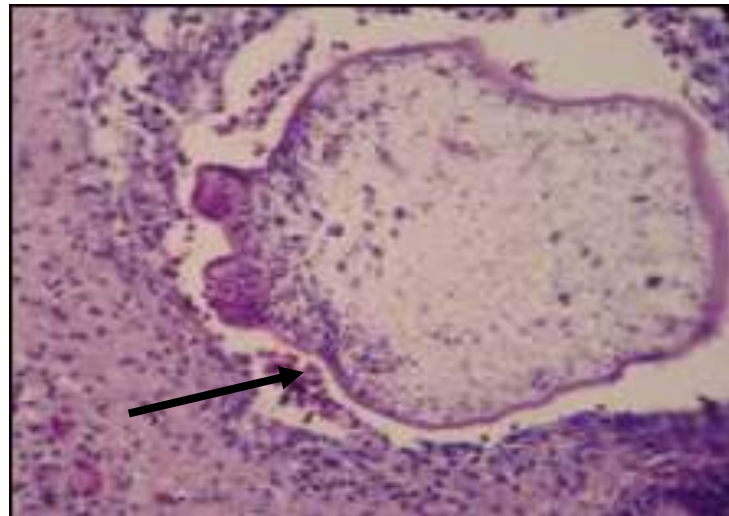
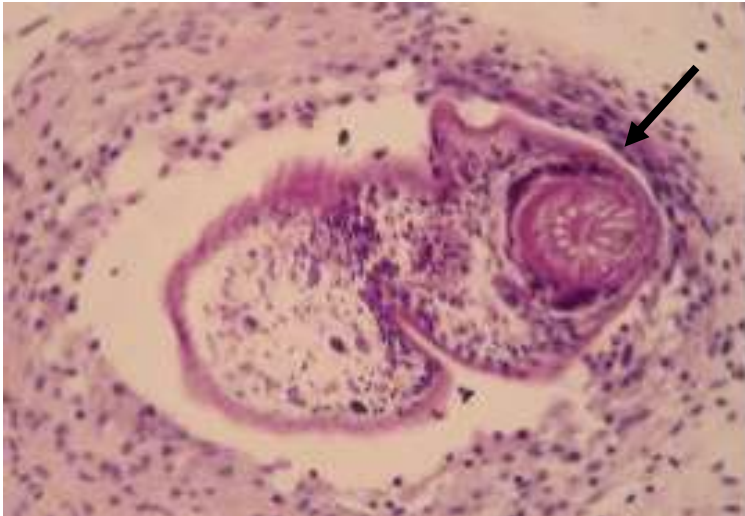
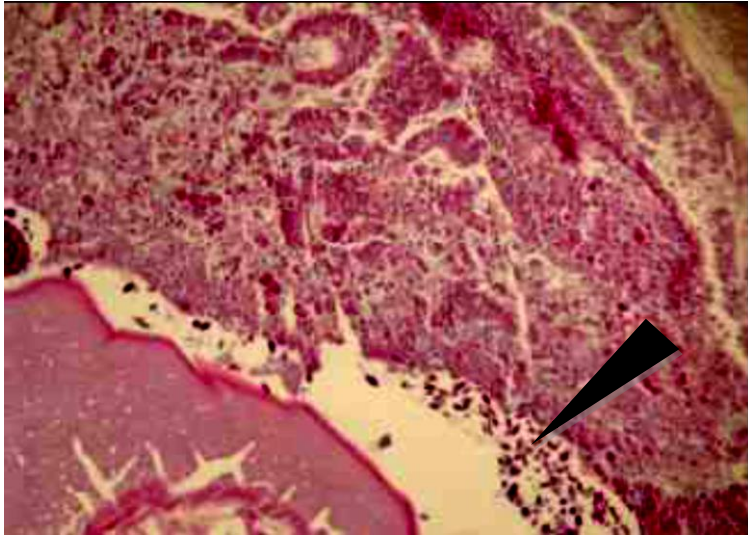
- Species record: *Amirthalingamia macracantha*





# CESTODES

## PATHOLOGY



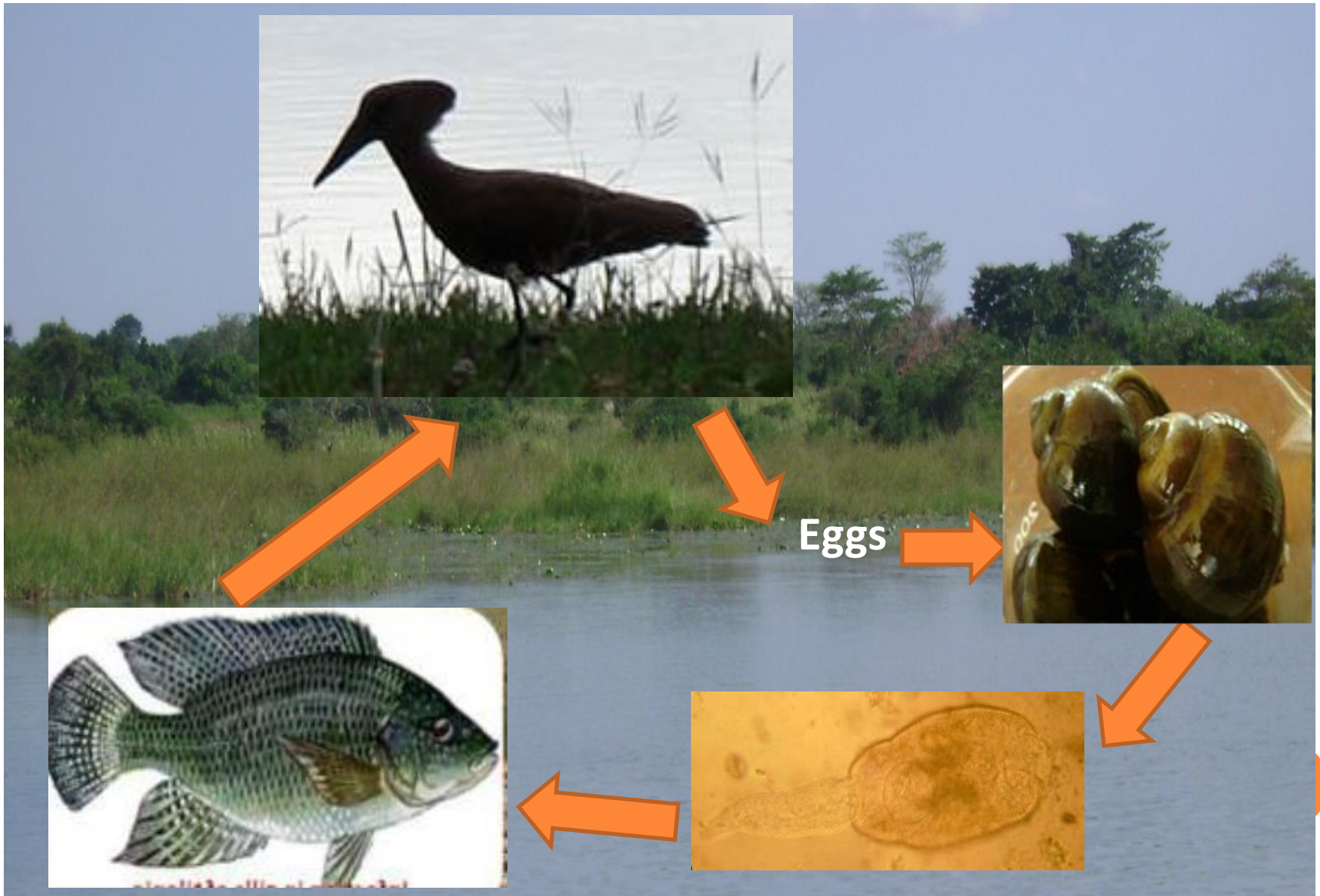
# TREMATODES

- Dorsoventrally flattened, oval or filiform (threadlike) or rounded bodies – flukes
- Occur in fish either as **adult** or **juvenile**.
- Have characteristic muscular suckers: Oral (anterior) & Ventral (acetabulum)
- Hermaphroditic (monoecious) except Schistosomes – dioecious





# TREMATODES



# TREMATODES

- *Centrocestus* spp. in gills



# TREMATODES

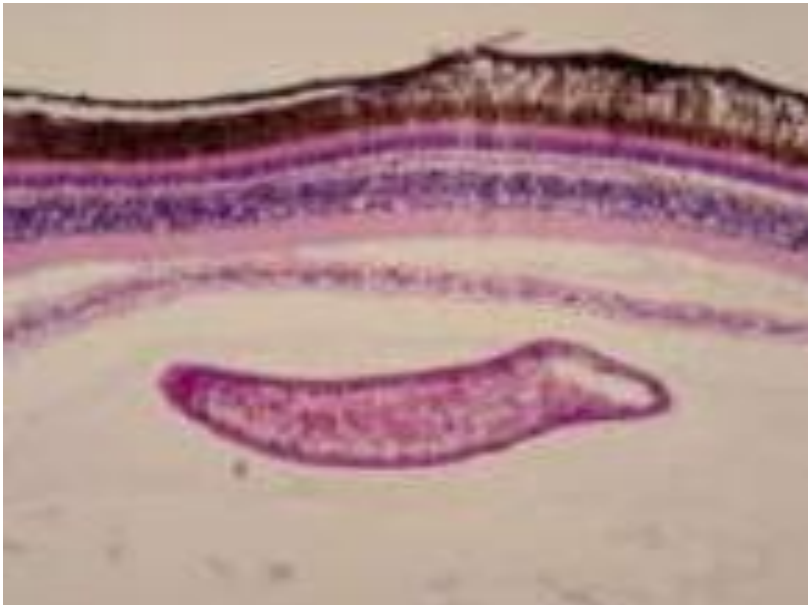
- **Pathology:-** Atrophy of the cartilage
- Hyperplasia of the gill epithelial cells
- General distortion of the gills





# TREMATODES

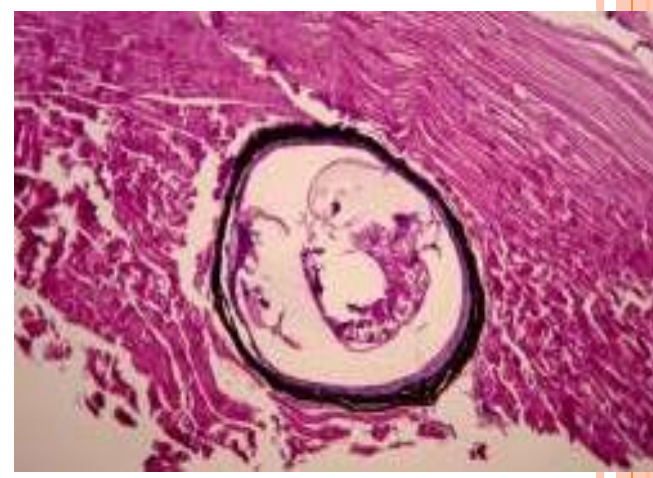
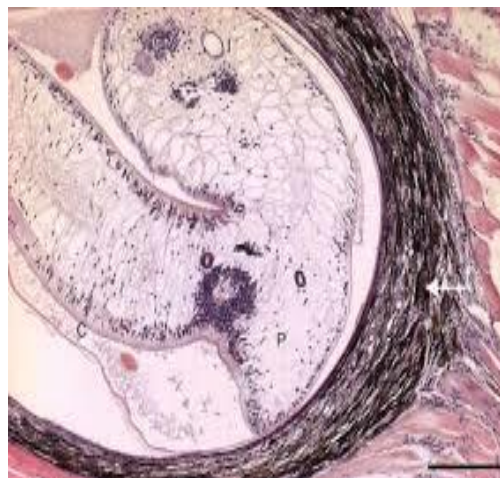
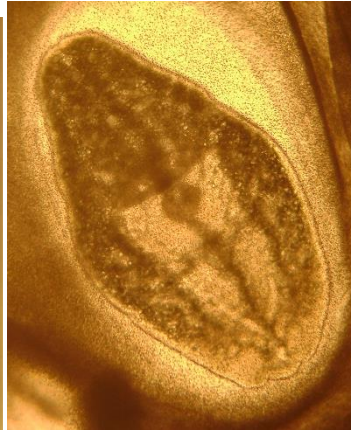
*Tylodelphys* spp. & *Apharyngostrigea* spp. in vitreous eyes





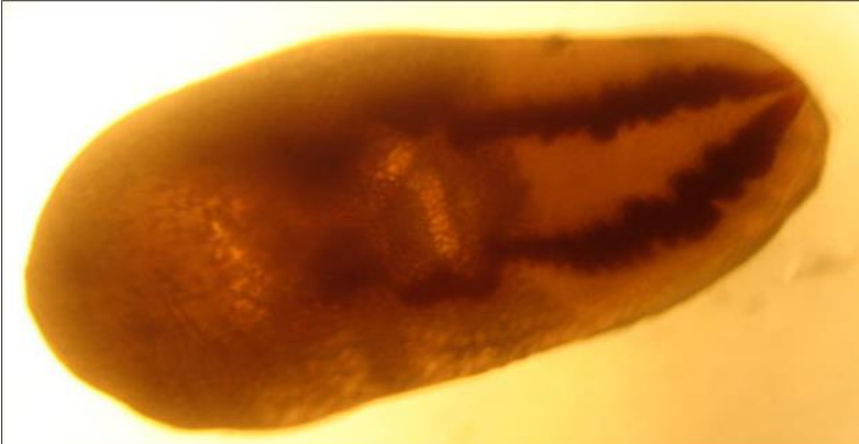
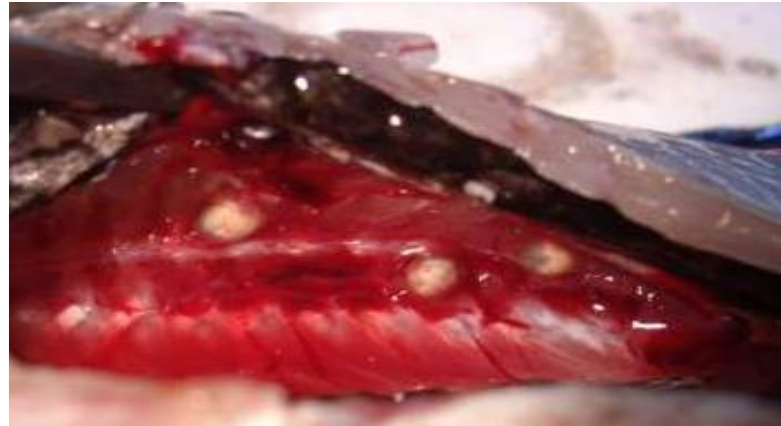
# TREMATODES

*Bolbophorus levantinus* in muscles & *Neascus* sp. under the skin



# TREMATODES

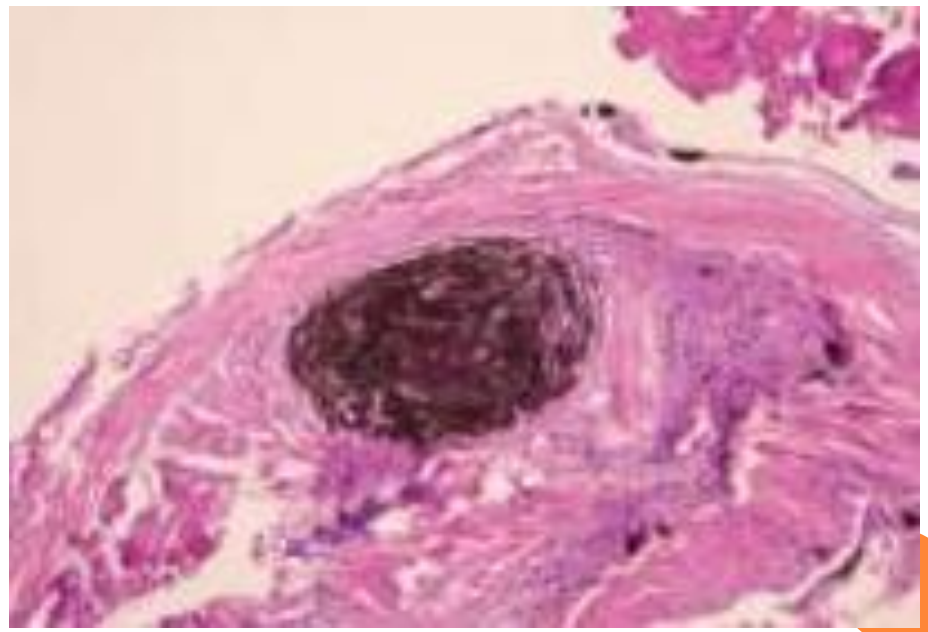
- *Clinostomum cutaneum*, *C. phalacrocoracis*; *C. tilapiae*; *C. macrosomum* under the skin  
*Euclinostomum heterostomum* (kidney, viscera)





# TREMATODES

- **Pathology:** Atrophy in muscular tissue around the parasite cyst
- Focal haemorrhages
- Of concern: *appearance and public health*



# NEMATODES

- Five species
- *Contraecaecum* sp., *C. multipapillatum*; *Eustrongylides*; *Procamallanus* sp., *Paracamallanus* sp.





# ACATHOCEPHALA

- *Acanthogyrus Acanthosentis tilapiae* & *Polyacanthorhynchus kenyensis*







[pakoll@cns.mak.ac.ug](mailto:pakoll@cns.mak.ac.ug) or [akollp@gmail.com](mailto:akollp@gmail.com)



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