Diseases of freshwater fish in aquaculture

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Workup when disease occurs

1) **Check environment! (waterquality!!)**
2) **Take samples from live fish**
   - **Lesions**
   - **Skin**
   - **Gills**
   - **Others if necessary (faeces, blood, …)**
3) **Perform necropsy**
4) **Have additional lab tests performed**
   - **Costly and time consuming**

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!!!!!!!!!!!!!

Diseases: often multifactorial !

no black/white situation

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Layout of the presentation

1. **Diseases due to environmental factors**
2. **Parasitic diseases**
3. **Bacterial diseases**
4. **Viral diseases**
5. **Fungi**
6. **Brief overview on treatment**

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1. Diseases due to environmental factors

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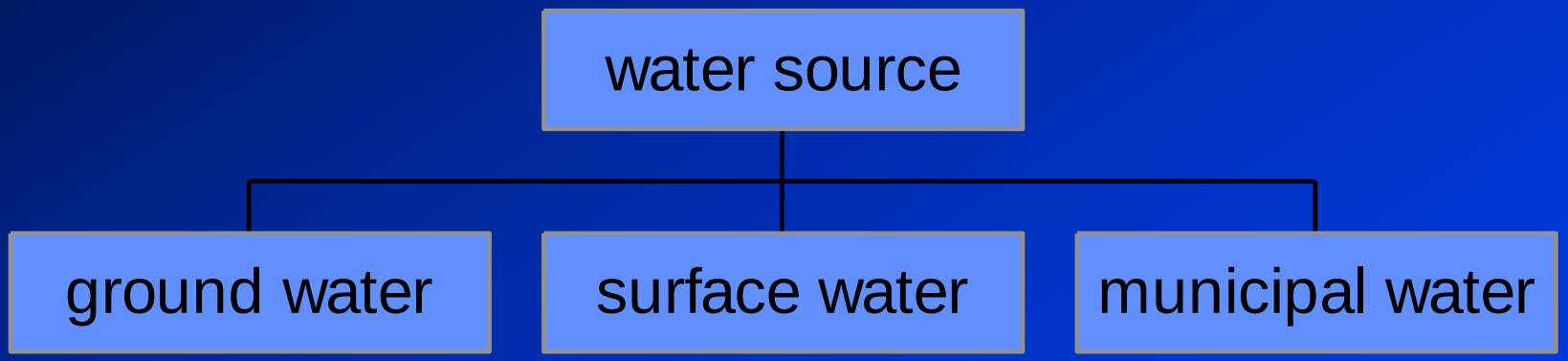
Water supply

intrinsic nature of the water supply: very impt



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* <u>Ground water</u>: **best** source of water for fish housing

free of suspended matter, path. agents

less easily polluted

constant composition and t°

→ check 1x/year

dependable supply

may need to be **treated** (aeration,...)

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* <u>Surface water</u>: streams, rivers, ponds,...

subject to **contamination/pollution**

(industry, farming, ...)

quality **varies** with time

→ check regularly

possible contamination with **wild fish, disease agents**

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* <u>Public supply</u>: quality depends
  - on original source
  - treatment protocol

chlorine often has been added !!

→ dechlorination necessary
  - aeration
  - filtration through carbon
  - sodium thiosulfate

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All water should be analyzed before use !!!

* classical water quality parameters
* extraneous toxins
* pathogenic infective agents

It may be necessary to "treat" the incoming water (organic/inorganic characteristics, thermal profile dissolved gas composition)

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Fish rearing systems

open (flow-through)	closed (recirculating)	static aquaria/tanks
ideal for salmonids	more practical	
may be expensive	easy to construct	
quite difficult to set up	requires good management	

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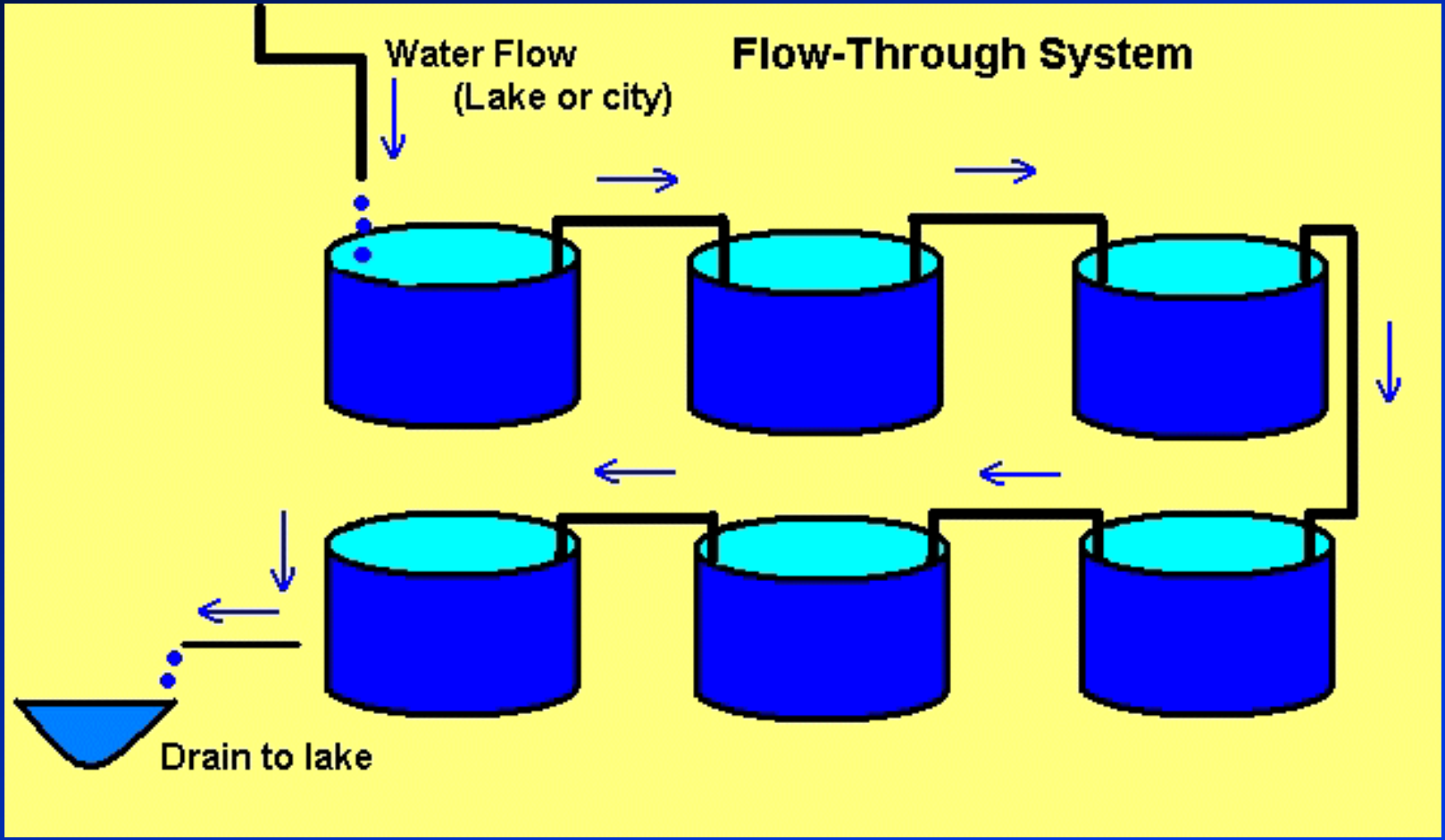

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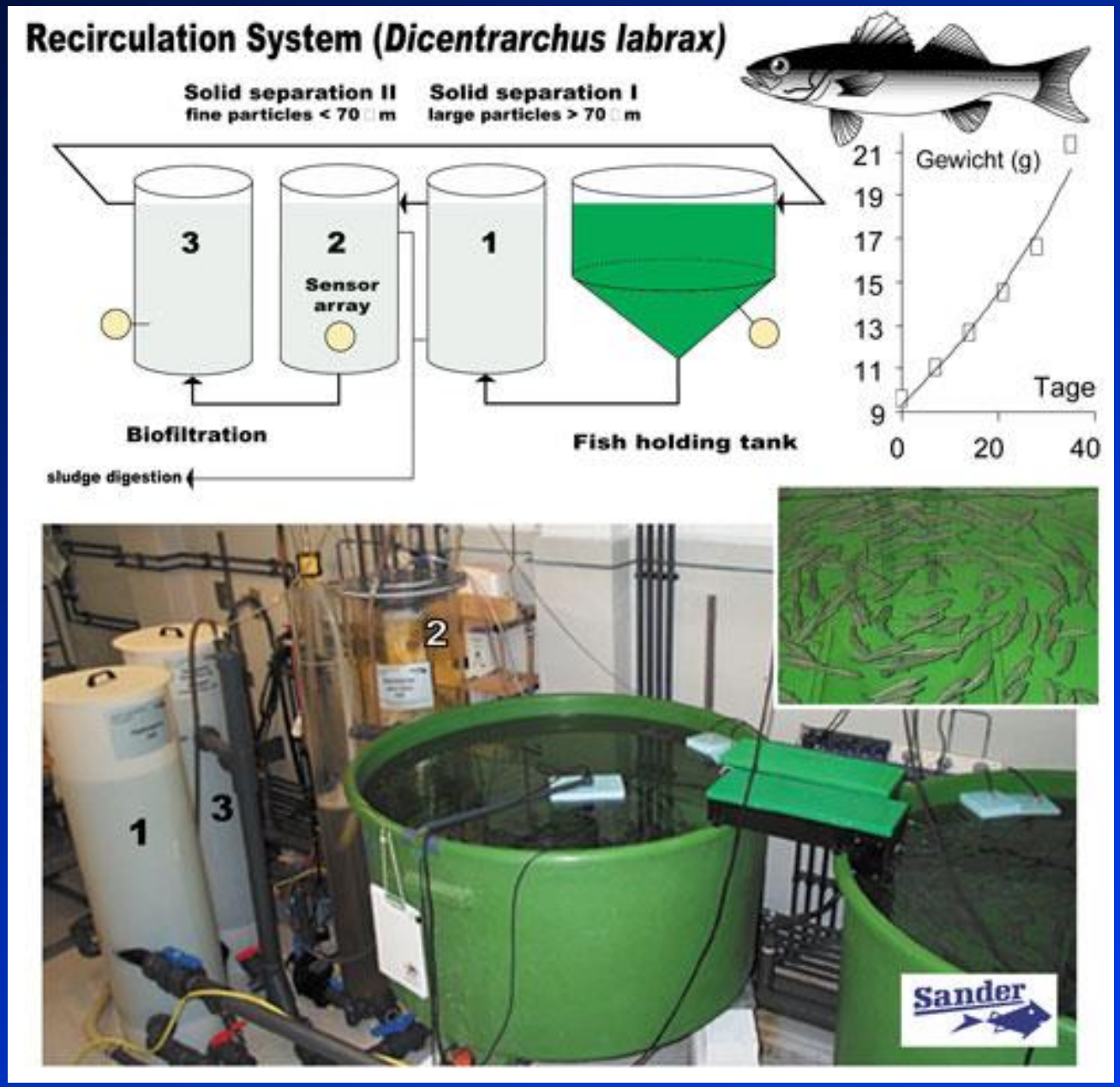

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Environmental (water quality) management

Filtration: EXTREMELY IMPORTANT !!!!!

especially in the case of a <u>closed</u> system

↓

The removal of unwanted materials from the water

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Three types of filtration

- mechanical filtration
- chemical filtration
- biological filtration

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- **<u>Mechanical filtration</u>:**
  * **principle: water passes through a fine medium, which obstructs the particles**
  * **e.g. floss, gravel, bristles**

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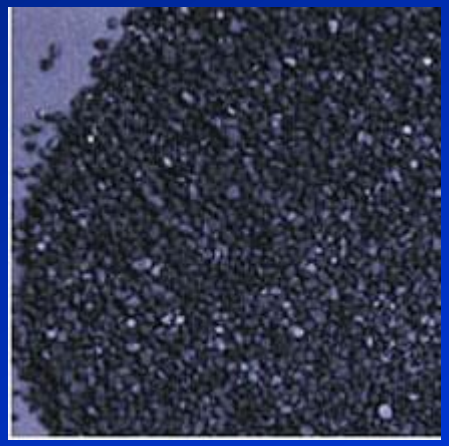
- **Chemical filtration:**

  * removes **molecular** contaminants from water

  * **e.g.** ion exchange (resins, activated carbon)
    oxidative systems (ozone)
    zeolite, UV, foam fractionation



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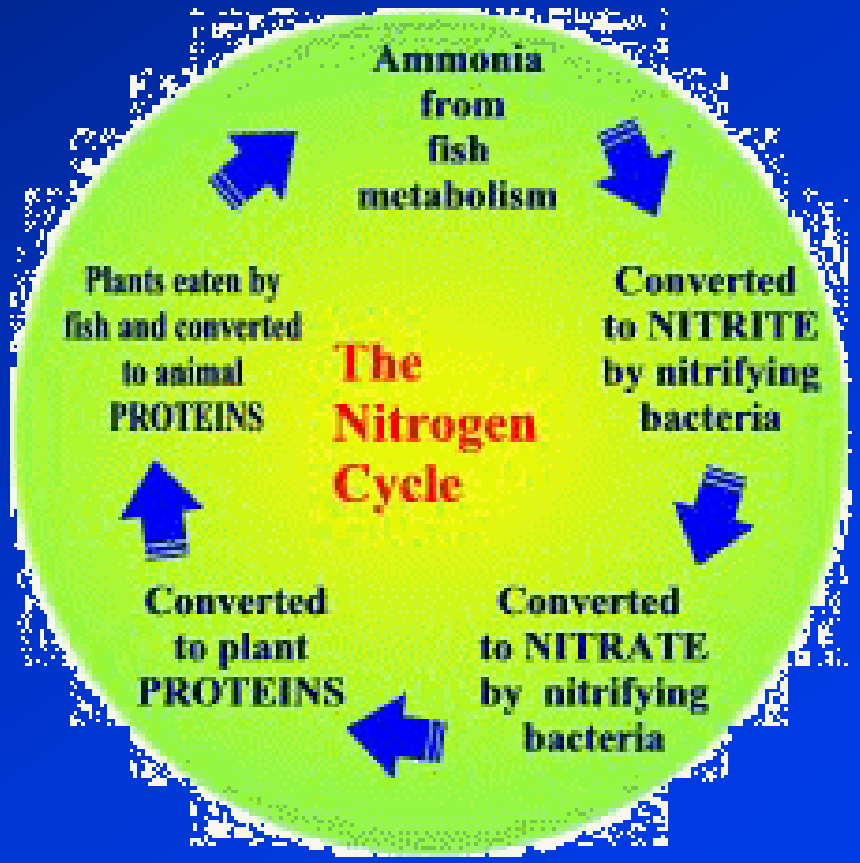
- **<u>Biological filtration:</u>**

  *** biological fixation of nitrogenous wastes into less toxic compounds by bacteria**



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- **Biological filtration:**

  * **critical factors:**
    - surface area
    - water contact
    - pH, t°, O_2

* **take care when setting up a new system !!!!!!**

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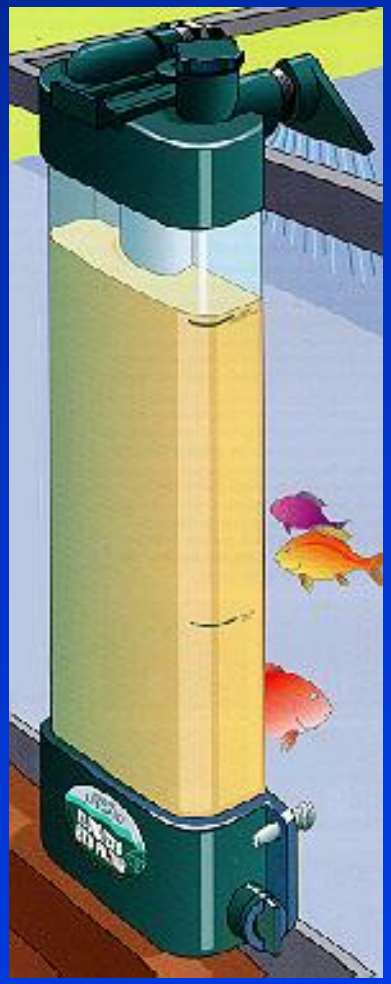

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Disinfection/sterilization

- **Implements:** * each tank should have its own disinfection in between use
  - rinsing
  - disinfecting (chlorine, formalin)
  - rinsing
- **Tanks/aquaria: see above**

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Pumps

Rule of thumb: water turnover: twice per hour

- **<u>Airlift pumps</u>:** *** water circulation in fixed positions**

  *** cheap, quiet in operation**

  *** suited for in-tank under-gravel**

  f

  *** extra aeration**

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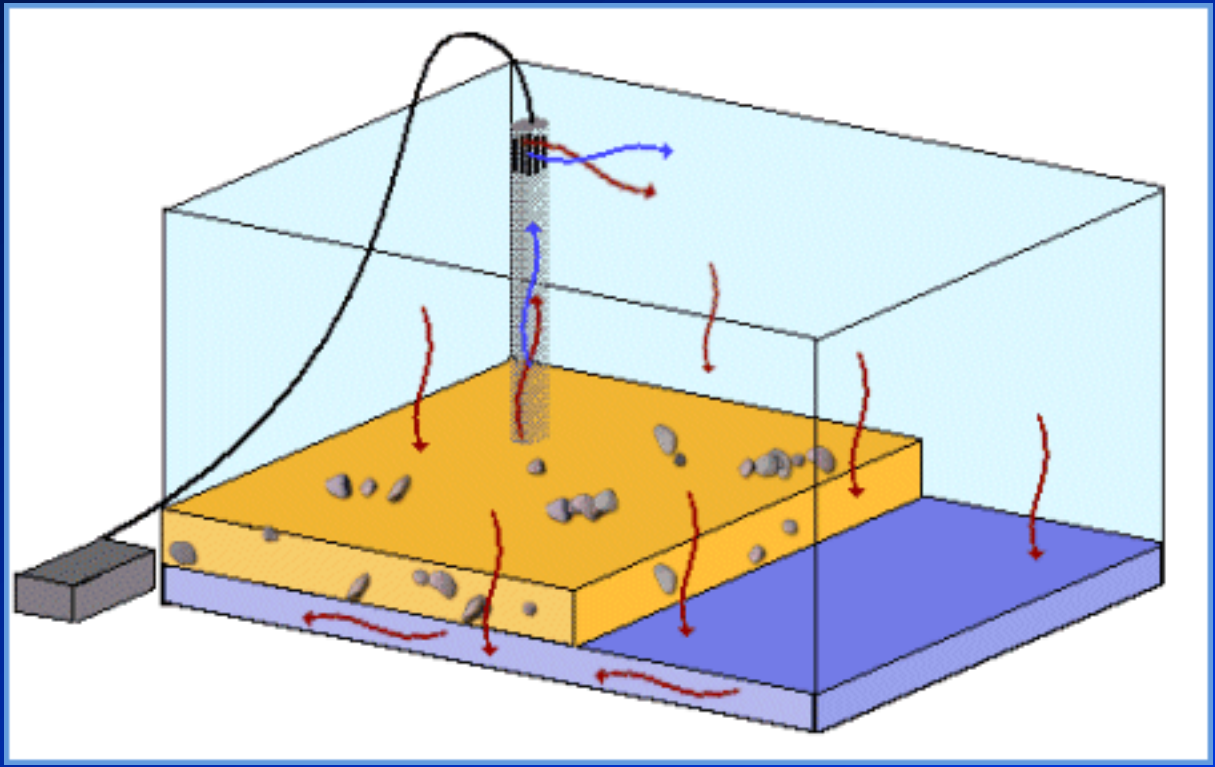

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Pumps

Rule of thumb: water turnover: twice per hour

- **<u>Airlift pumps</u>:** * water circulation in fixed positions
  * cheap, quiet in operation
  * suited for in-tank under-gravel f

  * extra aeration

- **<u>Centrifugal pump</u>:** * can deliver large water vol
  * should never run dry !

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Pipes

- avoid copper pipes

Air systems

- should be connected to emergency power generator
- location of air intake !!!

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Temperature control: heaters/coolers

- energy !!

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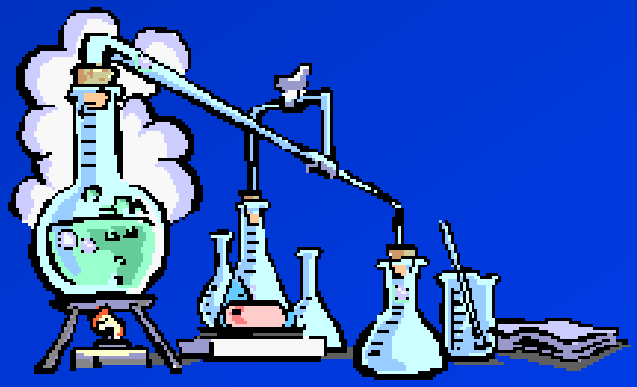
Monitoring and managing water quality

- fish are very <u>sensitive</u> to water quality changes
- <u>more “common” water quality parameters</u>
  - chlorine and derivatives
  - temperature, pH, salinity
  - dissolved oxygen, total gas pressure
  - ammonia, nitrite
  - hardness



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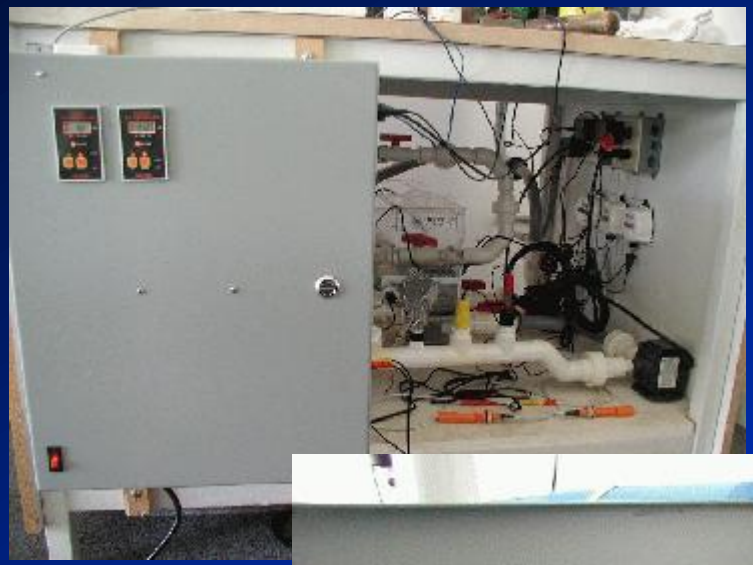

AquaController Pro
Up
Select
Down
Neptune Systems
Power
X-10
Serial
I/O
Conductivity
Dissolved O
Temperature
ORP
pH

TEMPERATURE

- <u>influences</u> health, feeding , performance, survival, reproduction, gas saturation ...
- temperature requirement ↷ fish species
- <u>very gradual</u> water t° equilibration is crucial (1°C/h)

- <u>change</u>: room temperature ↗↙ heaters or coolers

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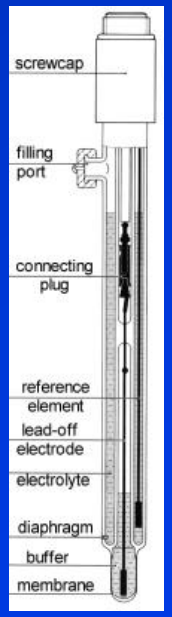
PH

- levels 6.5 - 9.0 are desirable; species dependence
- influences dissolved gas level, dissolvability of metals in the water, oxygen uptake by the fish, organic acids, phosphates, ratio un-ionized to ionized ammonia
- measurement: pH electrode, indicators



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PH (contd.)

- <u>change</u>: should be carried out very gradually
  to raise: sodium bicarbonate, dolomite
  to lower: acids, peat moss

DISSOLVED OXYGEN

- should be <u>near saturation</u> otherwise “stress”
  - » Mg/l or ppm: min 4-6 mg/l
- limit <u>depends</u> on life stage, species, size, feeding
- <u>measurement</u>: | chemically (Winkler method)
  electrochemically (electrode)

- <u>improvement</u> by means of aeration (agitation, liquid oxygen, air diffuser, air stone)

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AMMONIA

- source: principal excretory product of fish
  degradation of protein sources
- equilibrium between
  toxic non-ionized form ⟵ less toxic ionized form

  pH, t° ↗

  ⟶

  pH, t° ↘
- decrease: see infra

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NITRITE & NITRATE

- source: oxidation of ammonia (see nitrogen cycle)
- especially nitrite is critical !!!! ⟷ nitrate
- nitrite is taken up by the gills

  ⟶ reacts with Hb

  ⟶ methaemoglobinaemia
- nitrite tolerance ↷ fish species

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AMMONIA, NITRITE, NITRATE

- **measurement**: colorimetric analysis

- **remediation**:
  - rigorous water changes
  - improve filtration efficiency
  - reduce stocking density and pH
  - provide adequate aeration
  - stop feeding
  - NO_2 : add salt !!!!!

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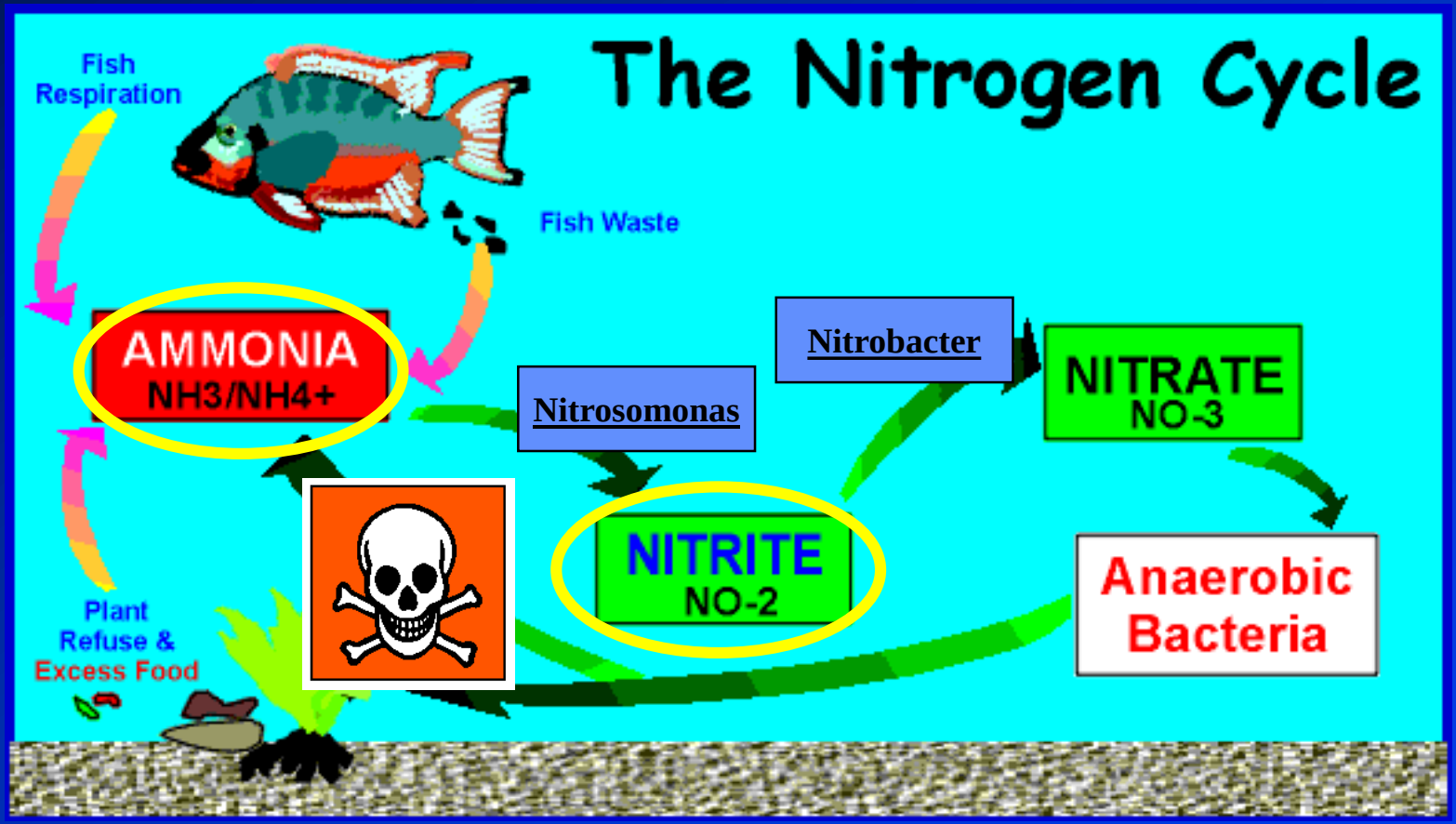

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SALINITY

- salt content of the water = grams/kg or ppt
- salinity tolerance ↷ fish species → marine (30-40)
  → brackish
  → freshwater (<0.5)
- measurement: related quantity: chlorinity
  conductivity
  portable conductivity meters

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HARDNESS: confusing !!!

- total hardness: cationic calcium and magnesium

calcium bicarbonate (temporary)

calcium sulphate (permanent)

1 dH=10 mg Ca/Mg oxide/l water (10ppm)

- carbonate hardness: Na+, K+, Ca++, Mg++ ... (dKH)
- optimal level of hardness ↷ fish species
- change: reduce: addition of distilled/de-ionised H2O

  increase: coral sand, Ca+, Ca/Mg sulphate

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addendum: WQ IN TERMS OF FISH SPECIES

- **carp:**

  temperature between 0 and 30°C

  pH between 7.0 and 8.5

  DO: 4-10 ppm

  hardy fish !!!

  ammonia, nitrite: sensitive !!!

  chlorine: very susceptible !!!

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- **catfish:**

t°: eurythermic

optimal: 28-30°C

pH: 4 - 10

best: 6.5 - 9

DO: very hardy fish

nitrite, ammonia: hardy fish

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- **salmonids:**

relatively difficult to keep

good water quality

strong current

relatively low temperatures

DO: very good aeration !!!

pH: between 6.0 and 8.0

ideally: 7

nitrite, ammonia: sensitive

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2. Parasitic diseases

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Parasites

External parasites

MICROSCOPICALLY

*clinical signs: flashing, rubbing, pressing fins, greyish discoloration, mucus at the operculum, slowing down, anorexia, hyperpnoea

*sometimes secondary bacterial or fungal infections

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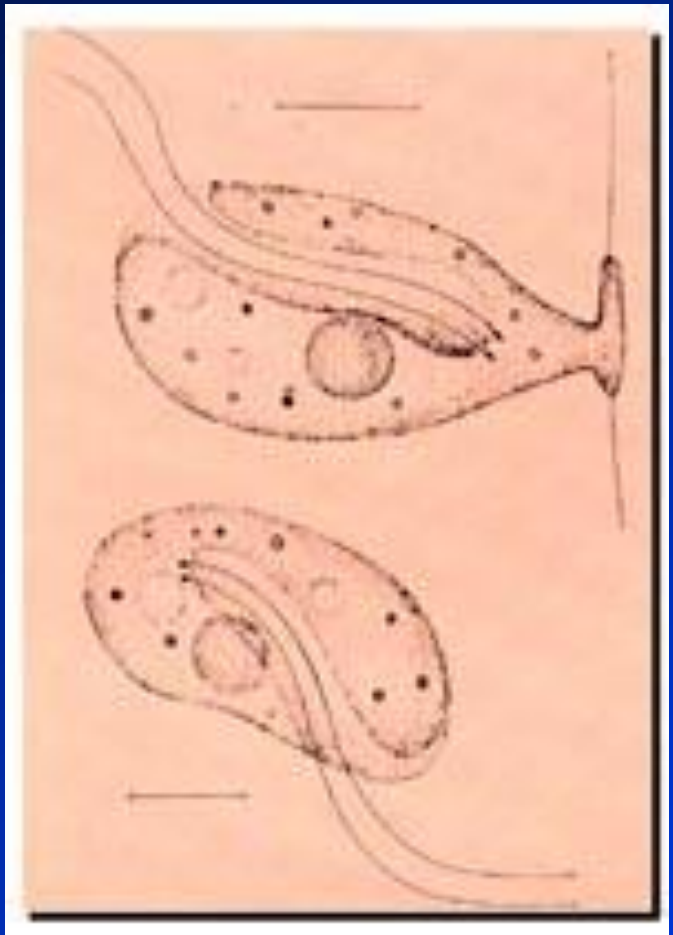
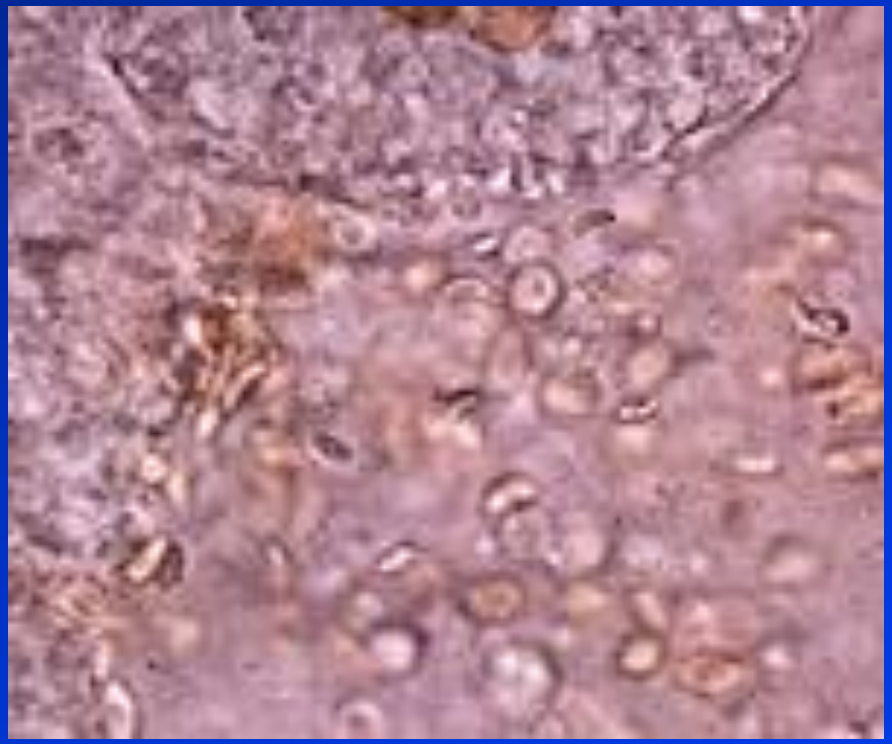
Costia (Ichtyobodo necator)





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Costia

* Flagellate, protozoon

* **Prevalence**: cold-/warm water fish
  skin/gills
* **Significance**: frequently occuring problem !
* **Clinically**: mucus on skin, respiratory problems, acute death without external symptoms

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Ichthyophthirius multifiliis (freshwater white spot disease, ich infection)

***ciliate/protozoon**

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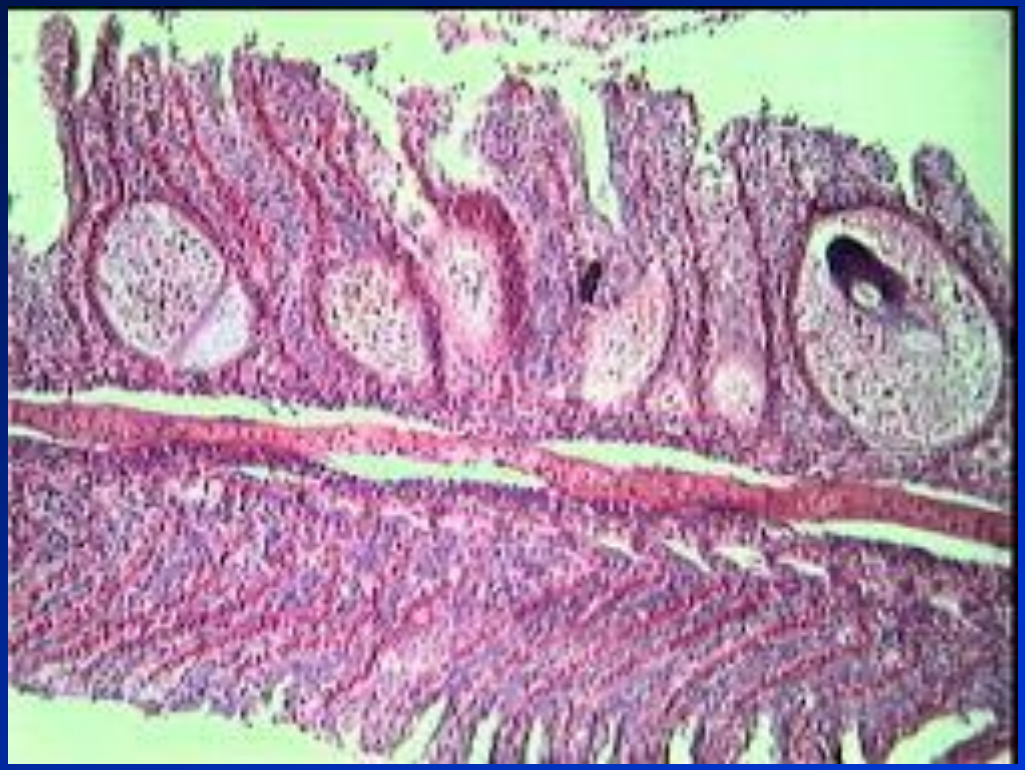
Ich infection

***<u>Prevalence</u>: universal, on skin and gills**



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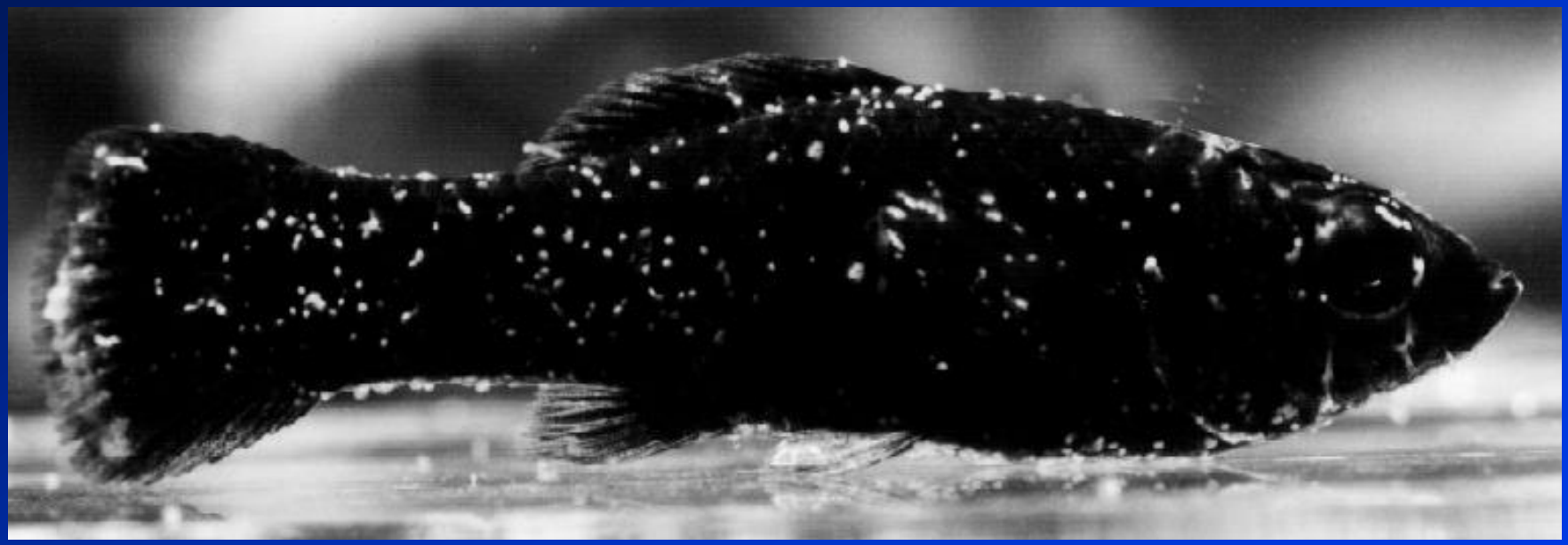
Ich infection

***<u>Significance</u>: can be very pathogenic, massive d**

***<u>Clinically</u>:**



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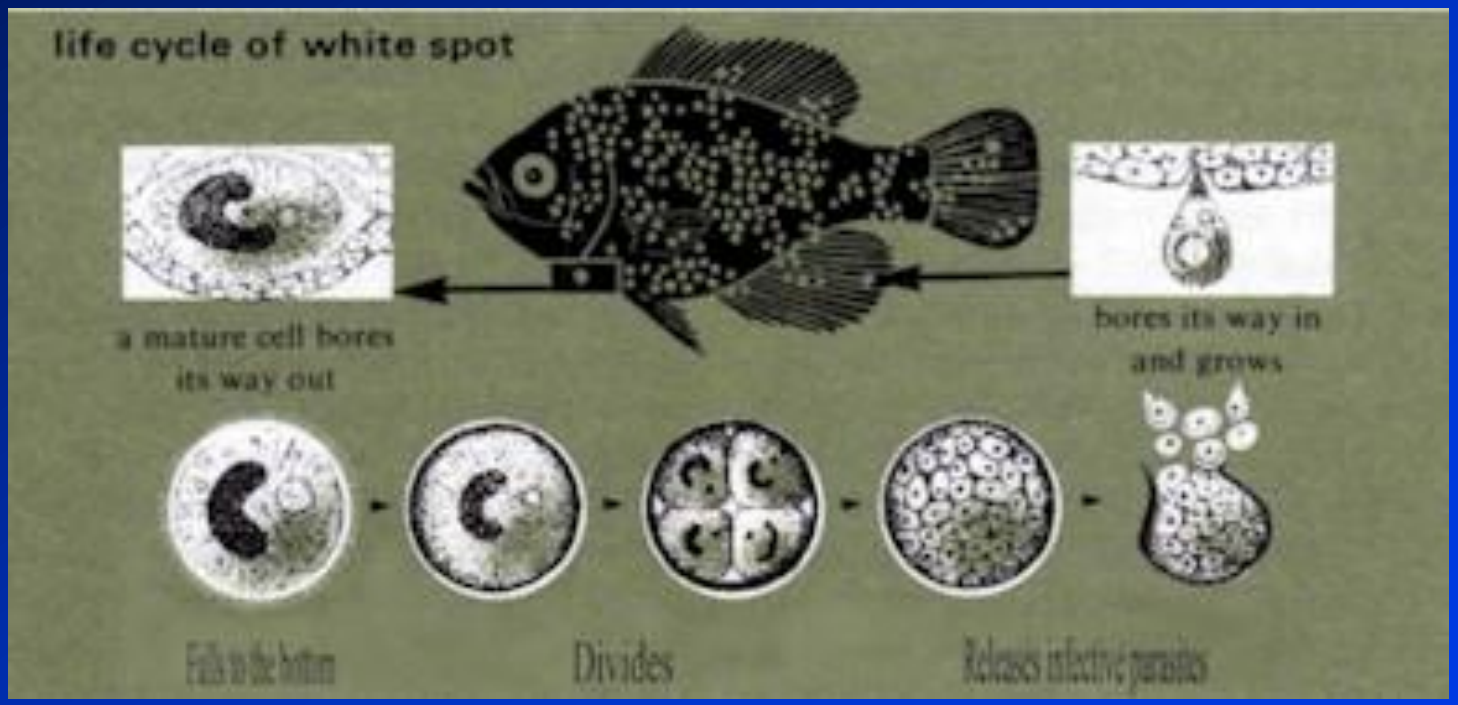
Ich infection

***<u>Treatment</u>: take into account life cycle and water temperature**



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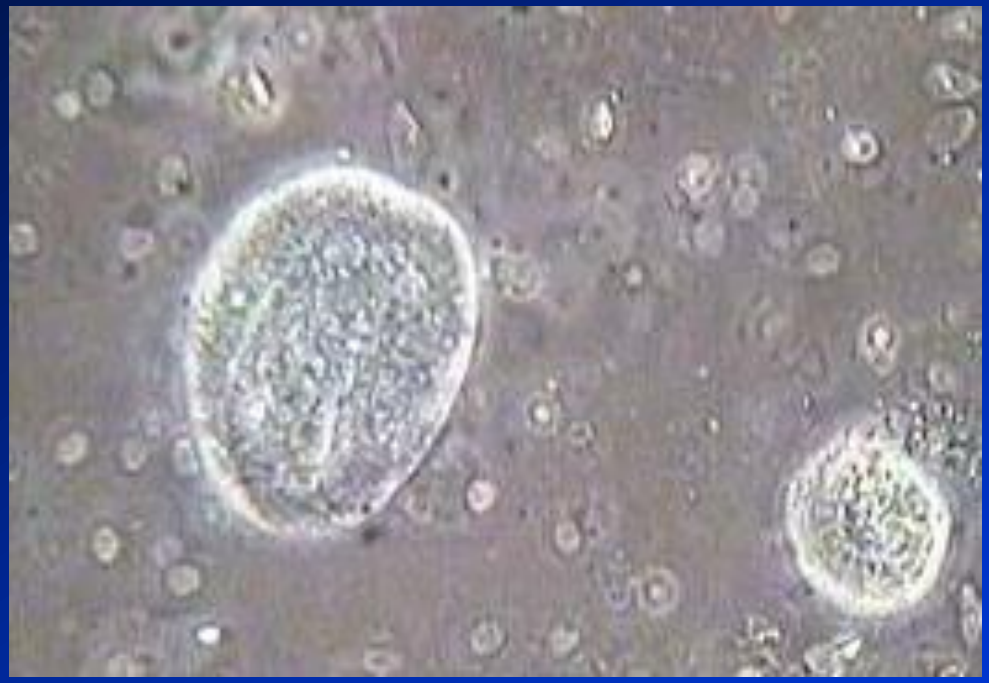
Chilodonella

***ciliate/protozoon**



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Chilodonella

*<u>Prevalence</u>: universal; skin and gills

*<u>Significance</u>: weakly pathogenic; only secondary

*<u>Treatment</u>: search for primary problem

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Trichodina

*ciliate/protozoon; “most beautiful fish parasite”

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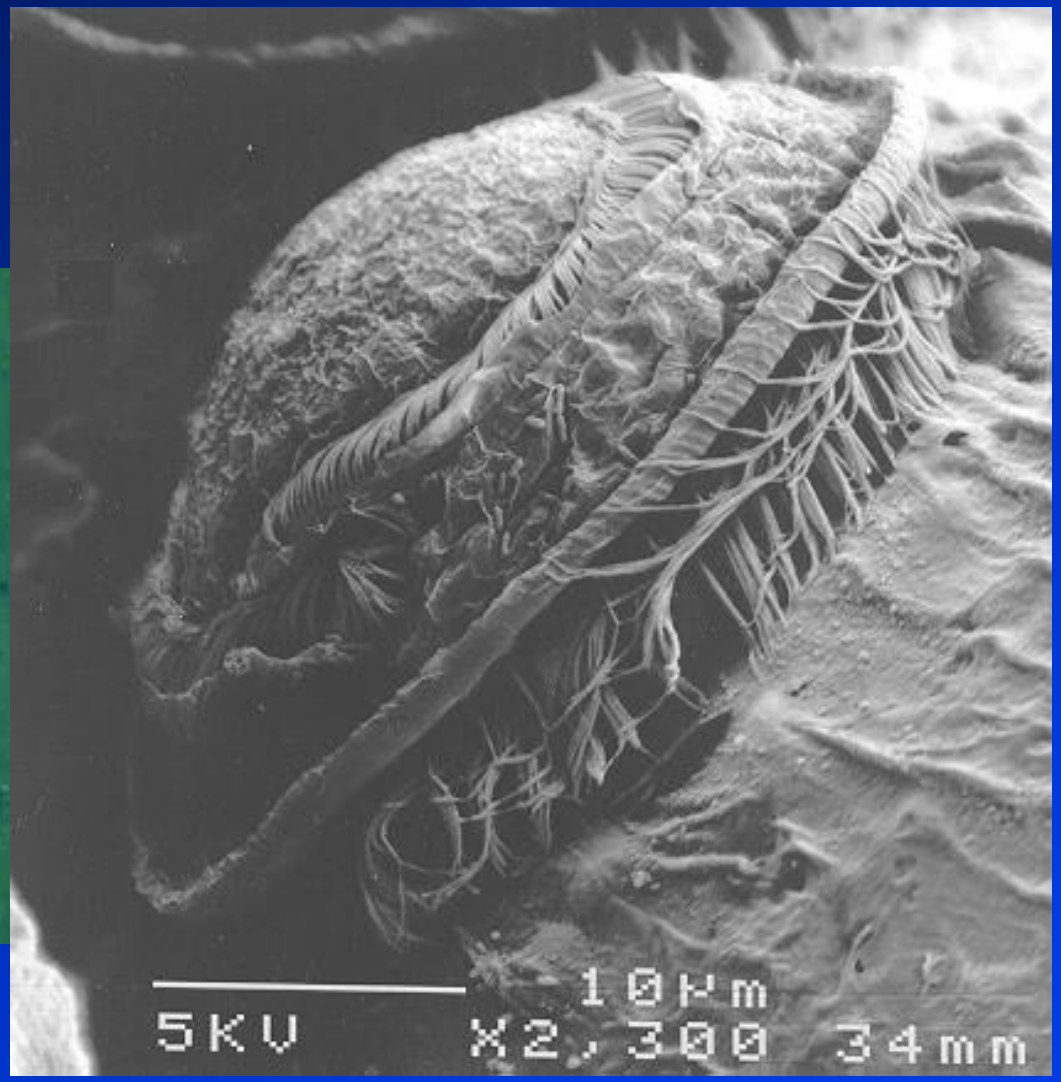

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Trichodina

*<u>Prevalence</u>: universal; skin and gills

*<u>Significance</u>: especially after “stress periods”

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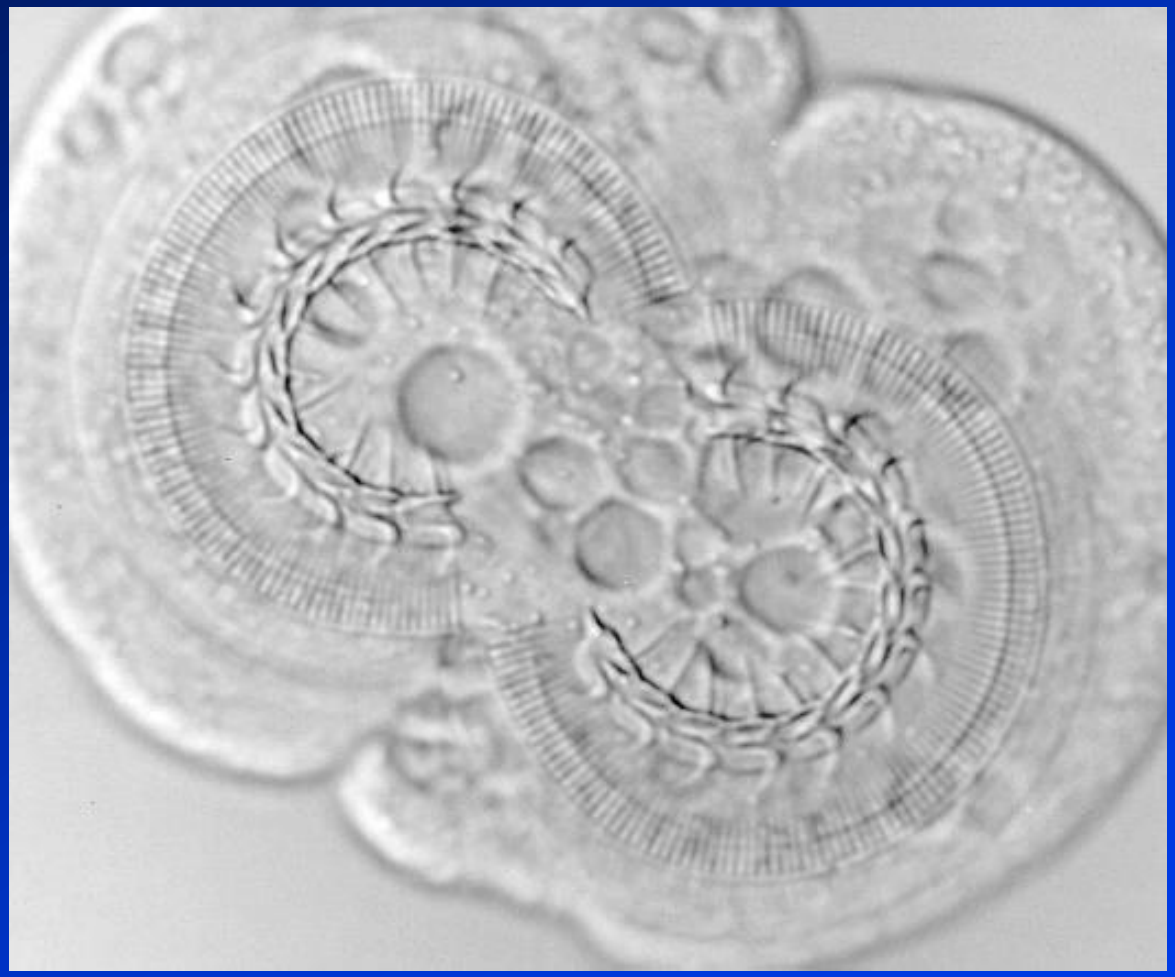
Trichodina



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Monogeneans

*Metazoa

*Prevalence: universal/skin and gills

*Significance: often cause problems

*Differ between: *skin worm (Gyrodactylus)*

gill worm (Dactylogyrus)

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Dactylogyrus

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Gyrodactylus

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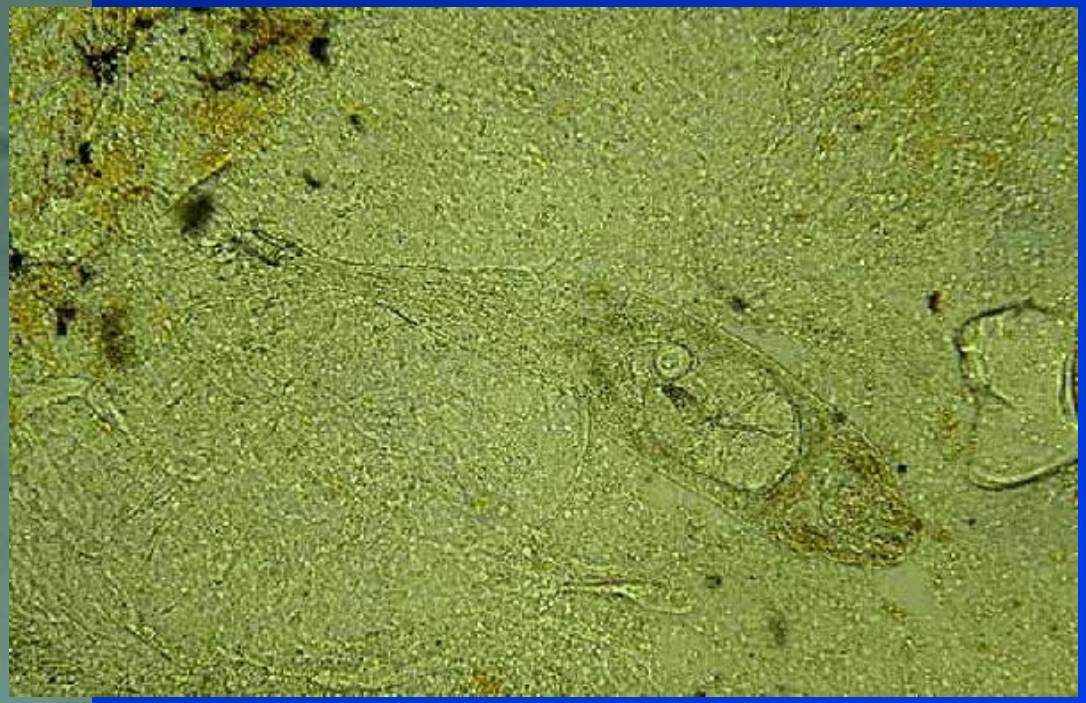

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Monogeneans

***<u>Treatment</u>: single or repeated, depending on life cycle (*Gyrodactylus* ↔ *Dactylogyrus*)**

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Movie links:

http://www.youtube.com/watch?v=lo0DXqeEMXM

http://www.youtube.com/watch?v=gZFQyTM-NzU

http://www.youtube.com/watch?v=CRnA37tZ7uI

http://www.youtube.com/watch?v=qKwsg2mzqYs

http://www.youtube.com/watch?v=_IC9hLsjafw

http://www.youtube.com/watch?v=vuhtfPSAmLE

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Parasites

External parasites

MACROSCOPICALLY

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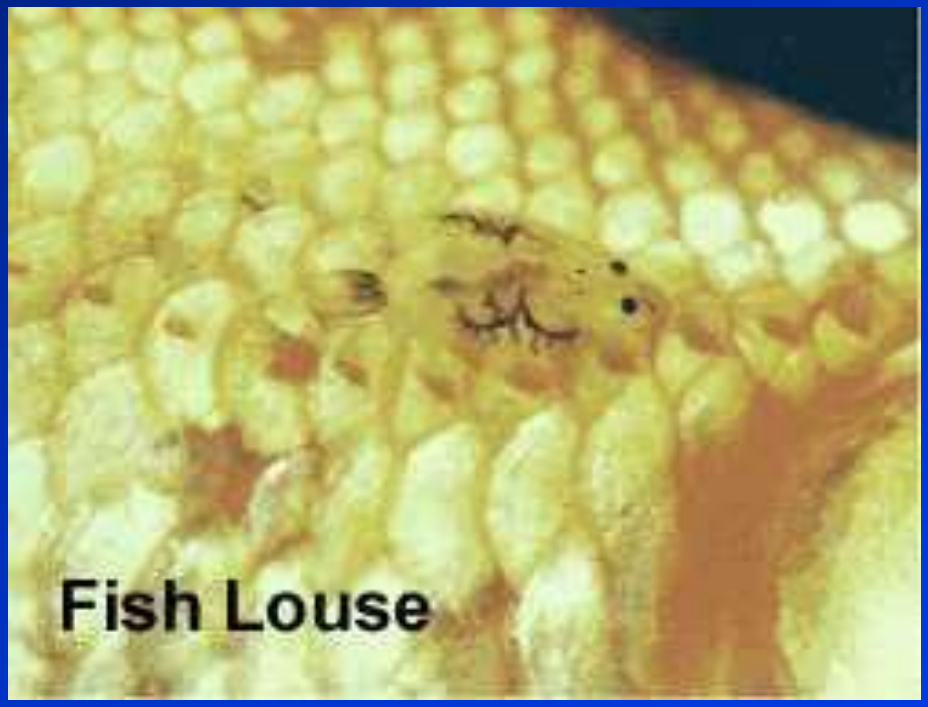
Argulus (Fish louse)



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Argulus

*<u>Prevalence</u>: less common

*<u>Significance</u>: problems only if present abundantly

*<u>Clinically</u>: moving slowly, anorexia, often secondary infections

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Lernea cyprinacea (anchor worm)

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Anchor worm

*<u>Prevalence</u>: less common

*<u>Clinically</u>:

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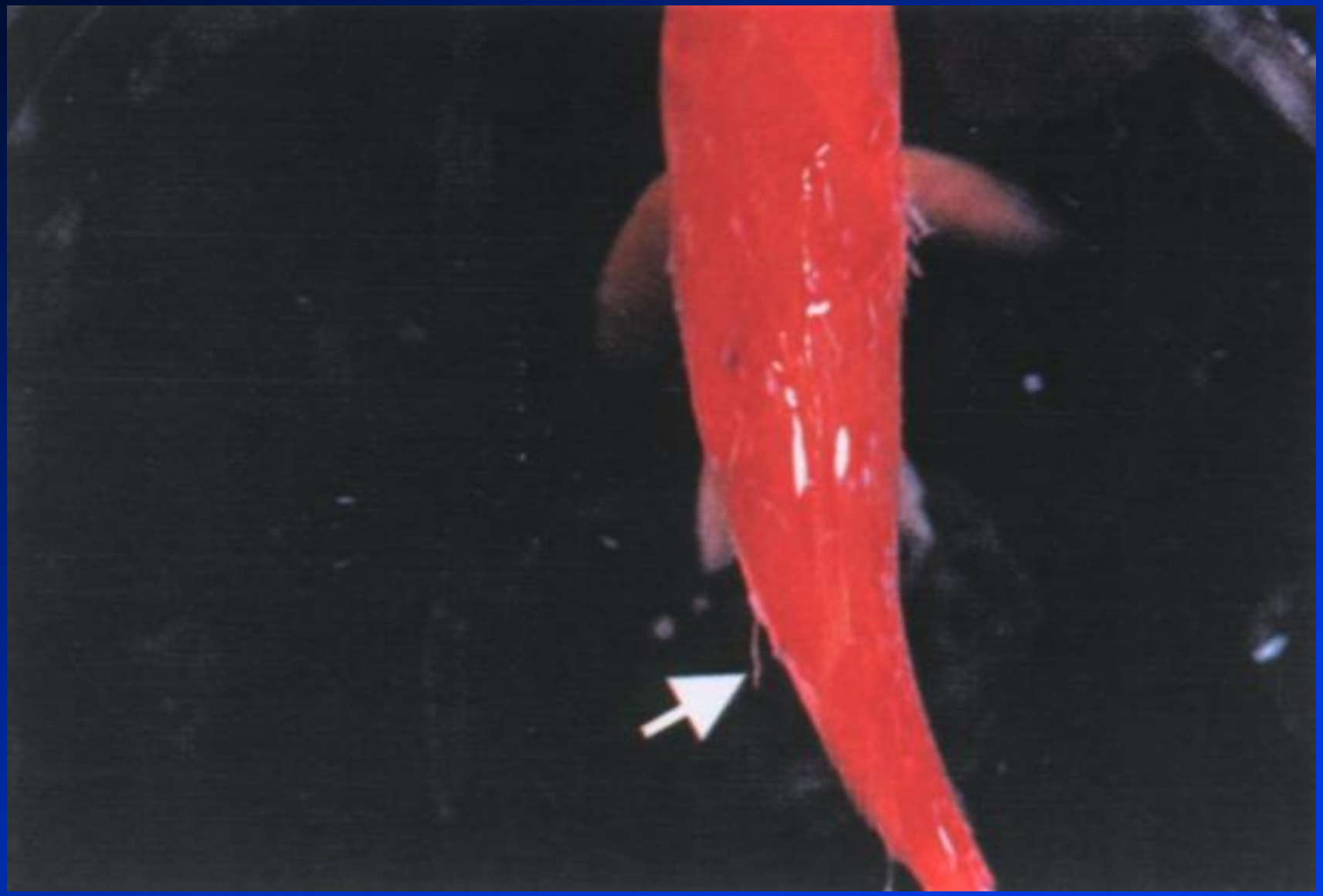

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Parasites

Internal parasites

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Roundworms

*<u>gut parasites</u>; microscopically identifiable

*<u>Prevalence and significance</u>:

less common (spread through live feed)

*<u>Clinically</u>: varying depending on infestation: reproductive and growth decrease, weight loss, listlessness, slimy faeces

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Roundworms

*<u>Diagnosis</u>:

post mortem: microscopy gut content

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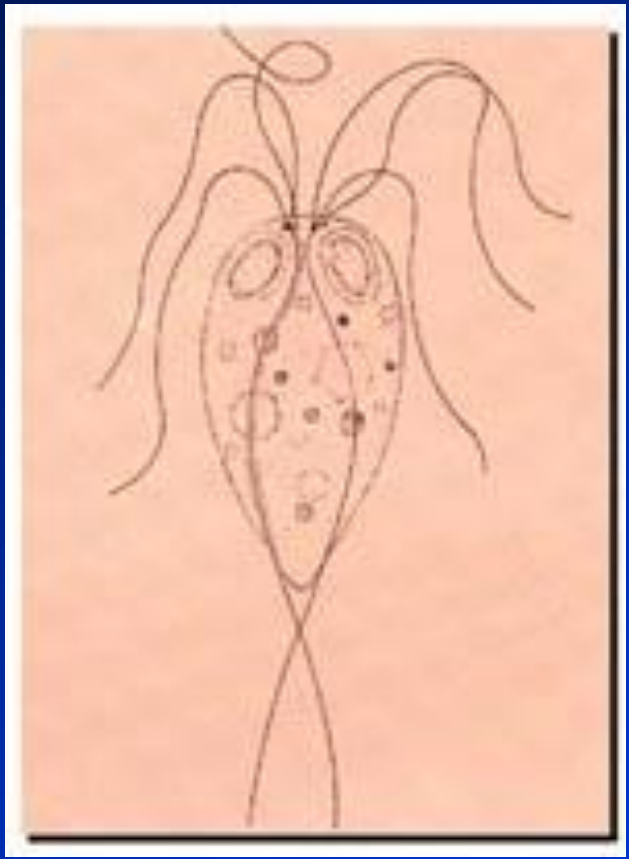
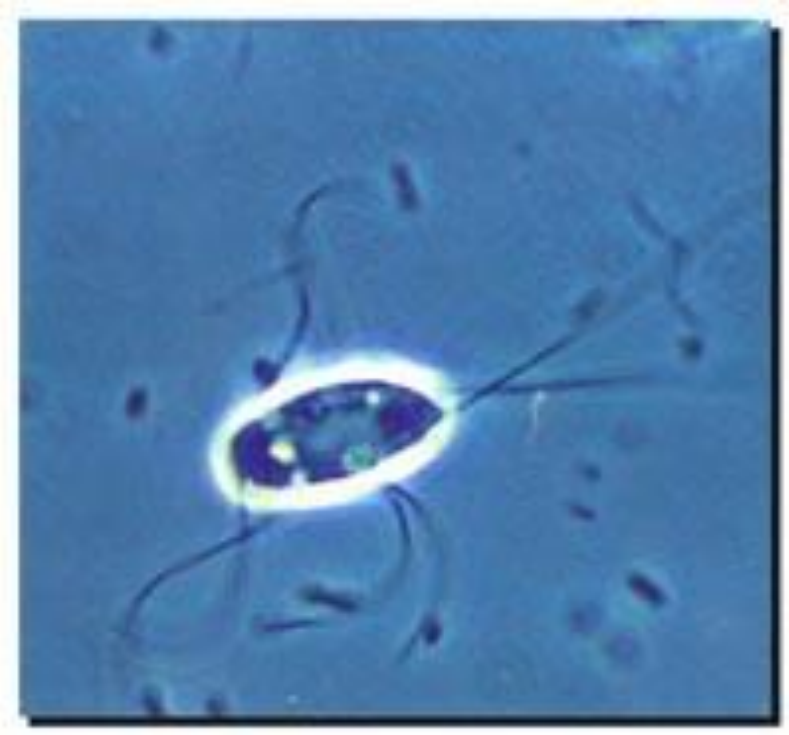
Spironucleus salmonis (flagellates)

*<u>gut parasite</u>; microscopically





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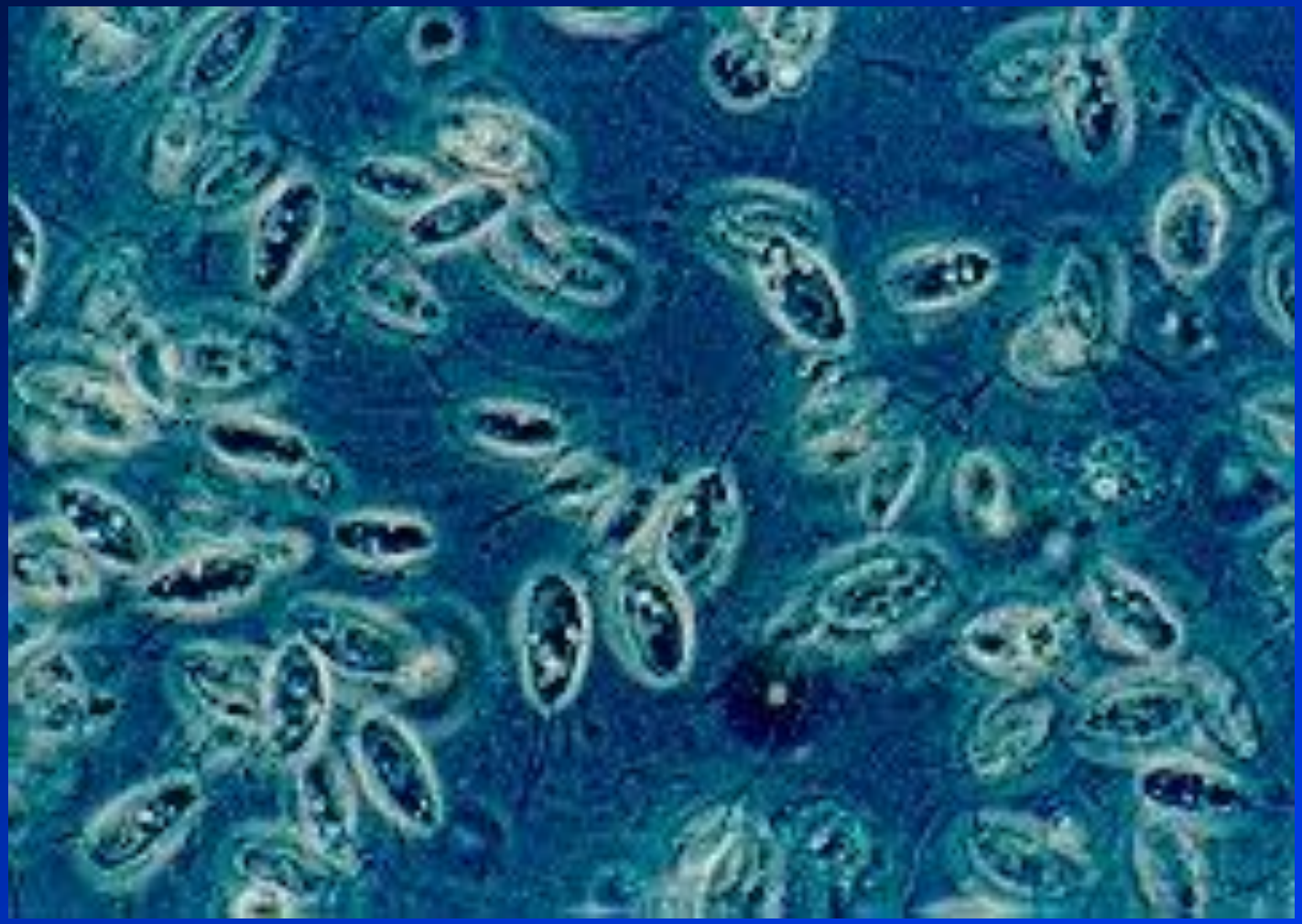
Flagellates

*<u>Prevalence and significance</u>:

in aquaculture mainly in salmonids (debilitated and stressed fish are prone to developing the disease)

*<u>Clinically</u>: emaciation, abdominal distension, exophtalmus, high mortality



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2. Bacterial diseases

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Bacteria

*mostly secondary pathogens

*mainly gram-negatives

*!!Always look for primary cause!

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*High antimicrobial resistance rate !

→ sensitivity testing !!!!

Superficial bacterial diseases

*ulceration:

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***possibly leading to septicemia !**

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DIERGENEESKUNDE

*superficial BUT:

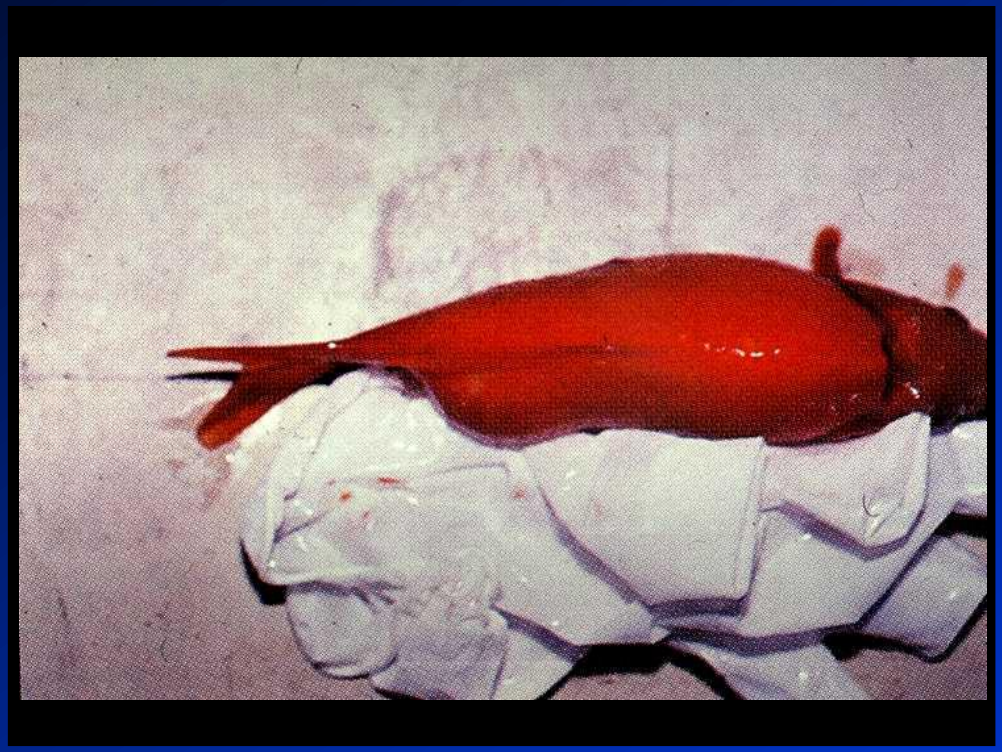
-portal of entry for other agents

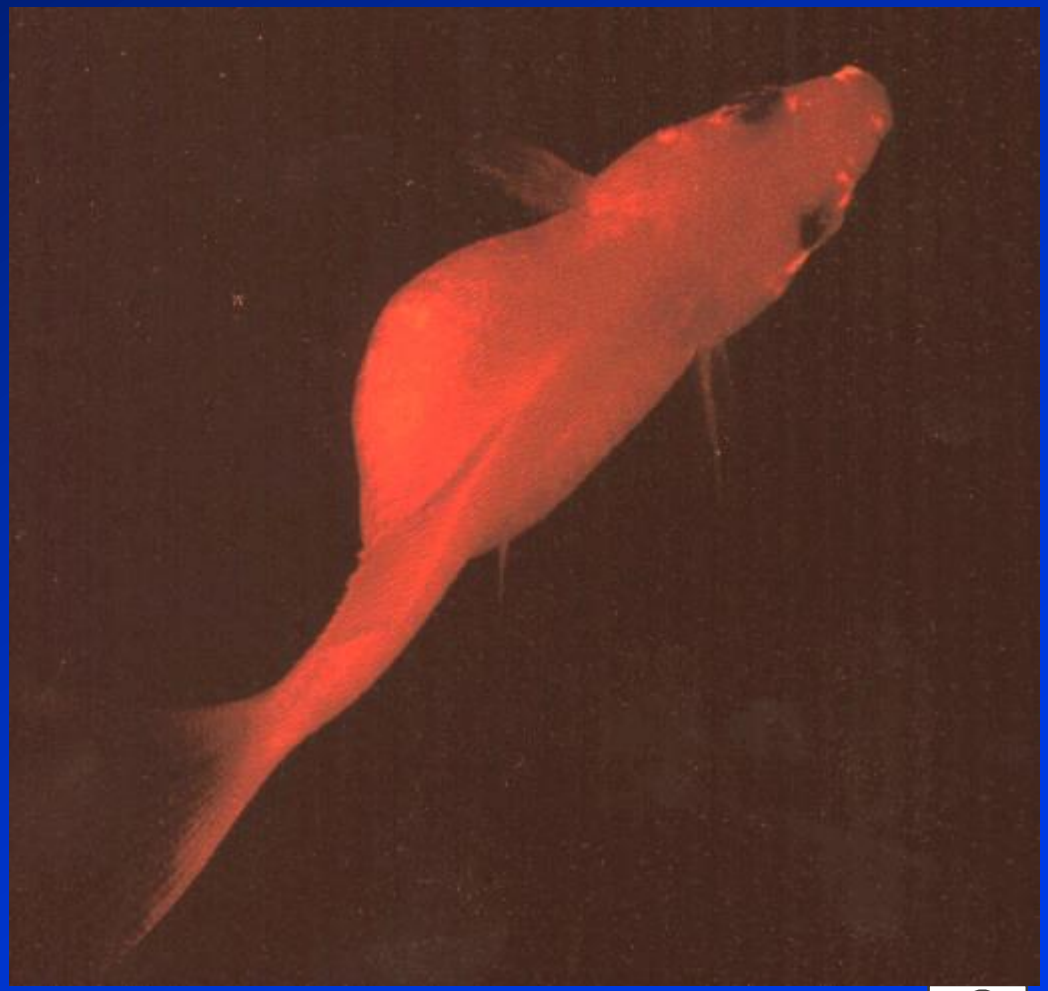
-osmoregulatory problems

-fungal growth

FACULTEIT DIERGENEESKUNDE

FACULTEIT
DIERGENEESKUNDE





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Primary bacterial infection:

***Flavobacterium* (columnaris disease)**

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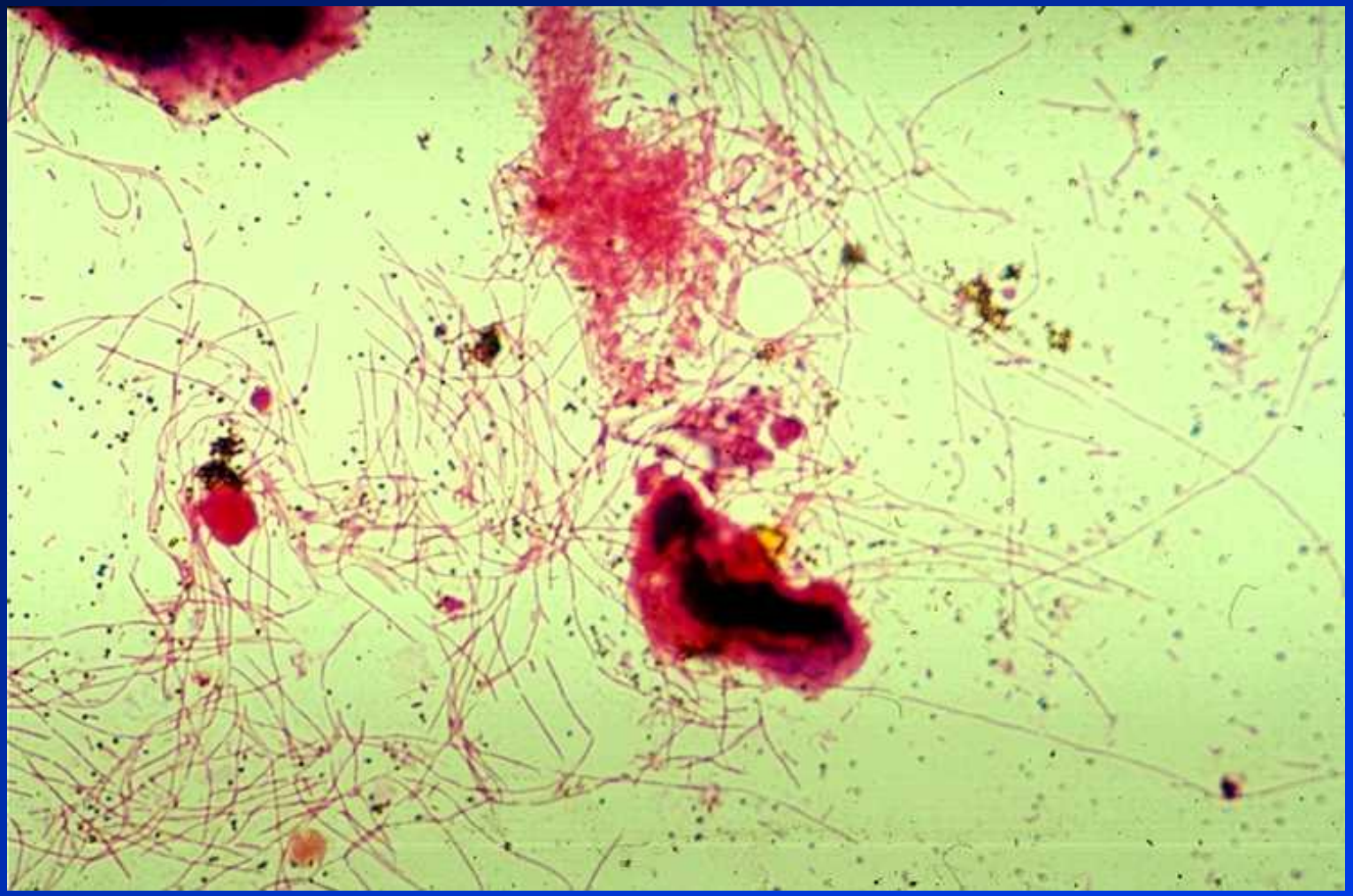

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Acuut systemic bacterial infections

- externally: bleedings, swollen abdomen, exophtalmia, hyperemia
- Internally: hemorrhages, lesions in spleen and kidney

FACULTEIT
DIERGENEESKUNDE

FACULTEIT
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*<u>diagnosis</u>:

- live fish with ascites: punction of fluid
- dead fish: isolation from spleen/kidney

FACULTEIT DIERGENEESKUNDE

Chronic granulomatous disease

Mycobacterium spp.

*fish tuberculosis

*prevalence: may affect all fish species

*incubation period: 6w - 1 year !!!

FACULTEIT DIERGENEESKUNDE

Mycobacterium spp.

FACULTEIT
DIERGENEESKUNDE

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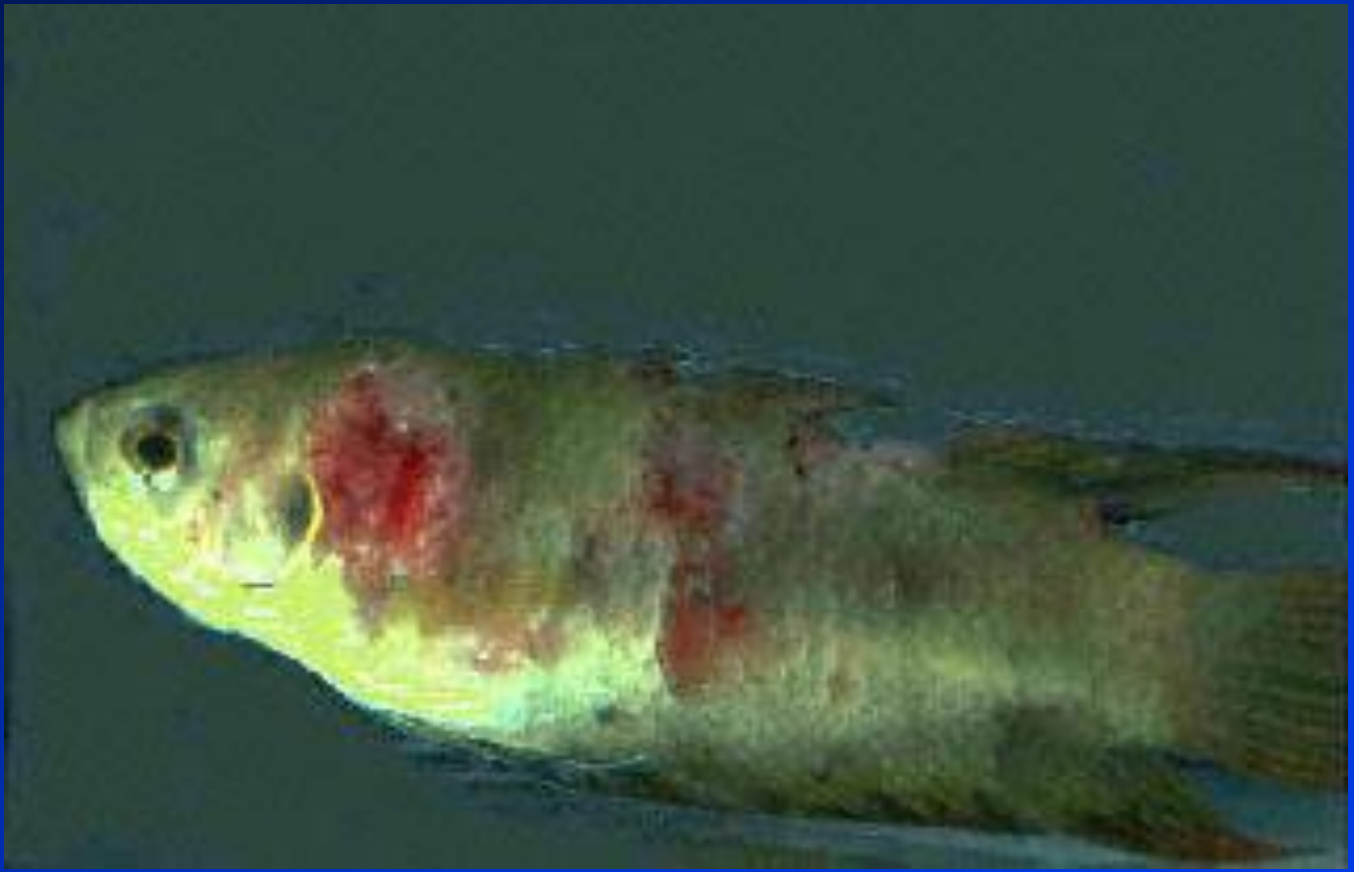
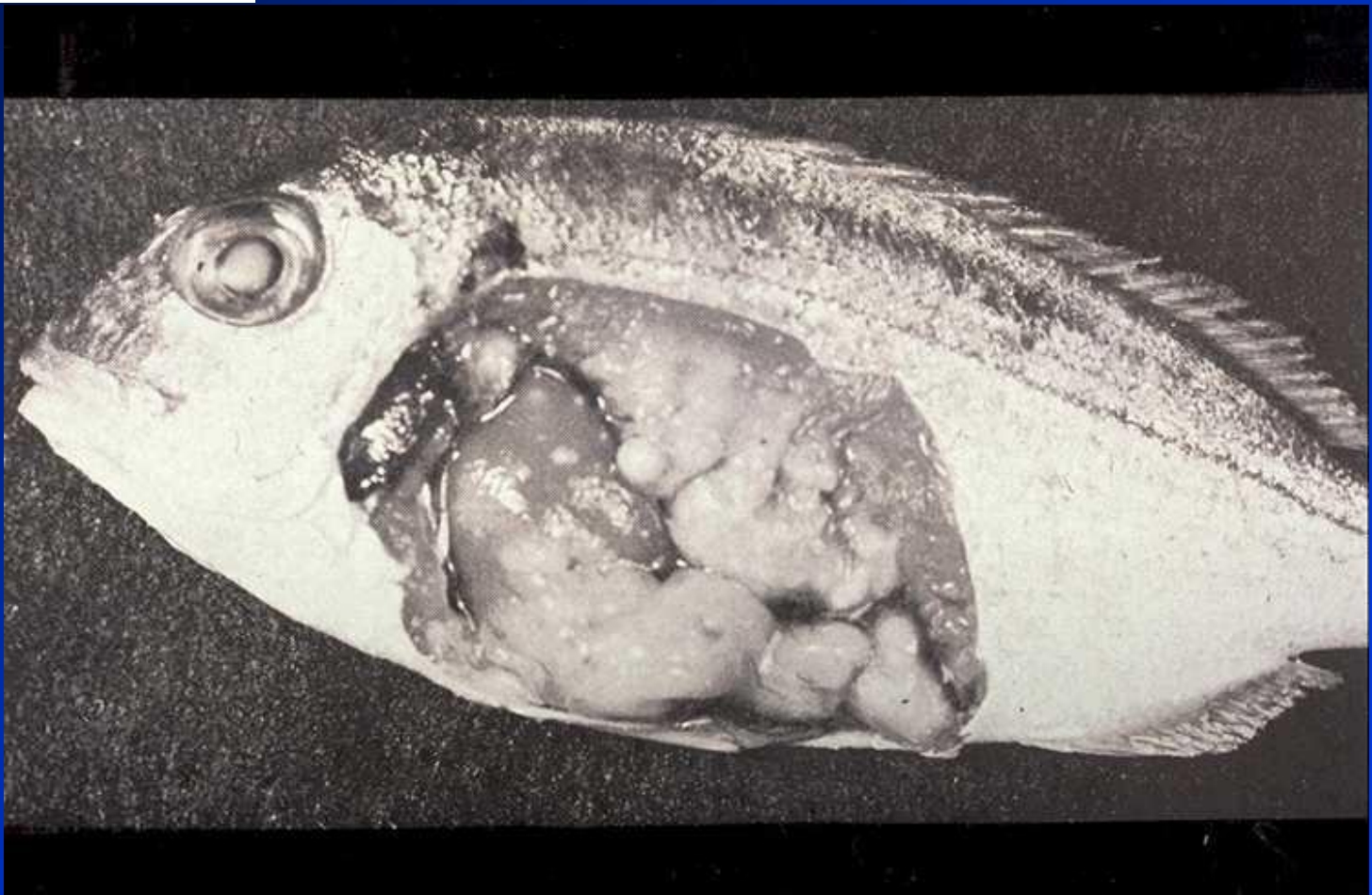
DIERGENEESKUNDE



FACULTEIT
DIERGENEESKUNDE

Mycobacterium spp.

***post mortem**



FACULTEIT DIERGENEESKUNDE

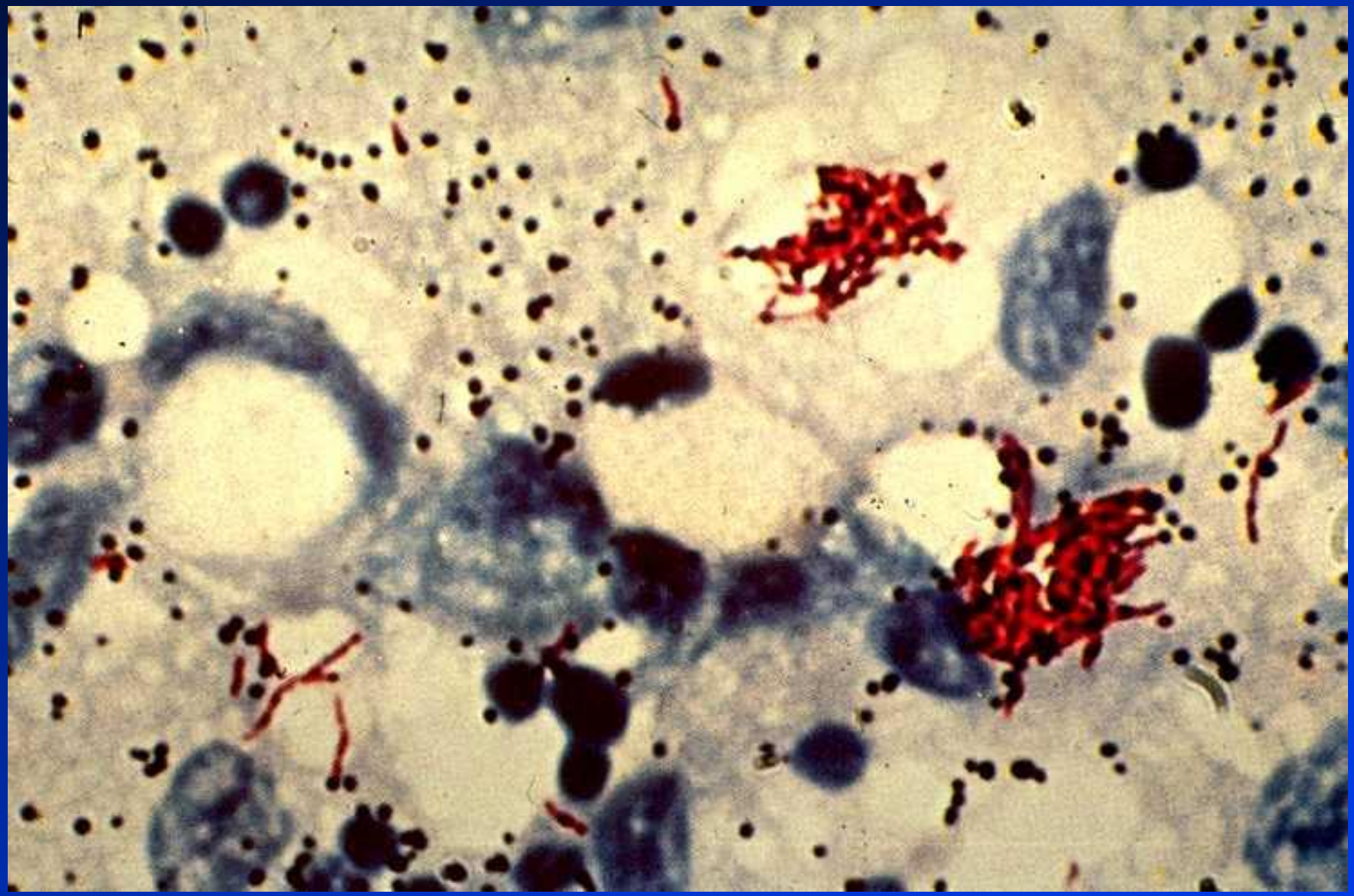
Mycobacterium spp.

*<u>diagnosis</u>: clinical signs

necropsy findings

histology: Ziehl Nielsen: acid-fast stain

FACULTEIT DIERGENEESKUNDE



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DIERGENEESKUNDE

Mycobacterium spp.

*<u>zoonosis</u> !!

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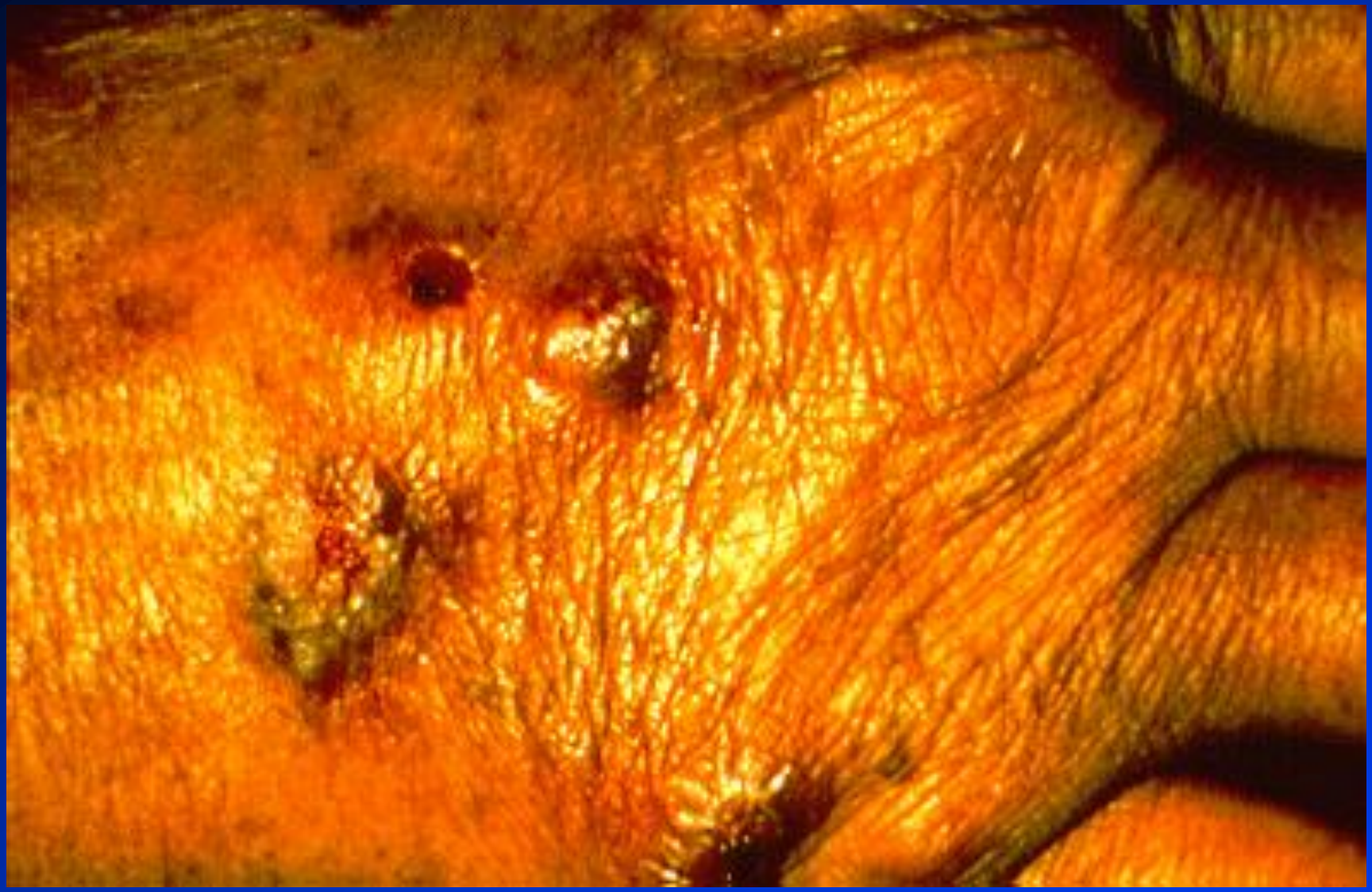

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2. Viral diseases

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DIERGENEESKUNDE

Viruses

FACULTEIT
DIERGENEESKUNDE

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DIERGENEESKUNDE

Some examples of generalized viral infections:

- **Channel catfish virus disease**
- **Viral hemorrhagic septicemia**
- **Infectious salmon anemia**
- **Spring viremia of carp**
- **Koi herpesvirus disease**

4. Fungi

FACULTEIT
DIERGENEESKUNDE

Fungi

Saprolegnia

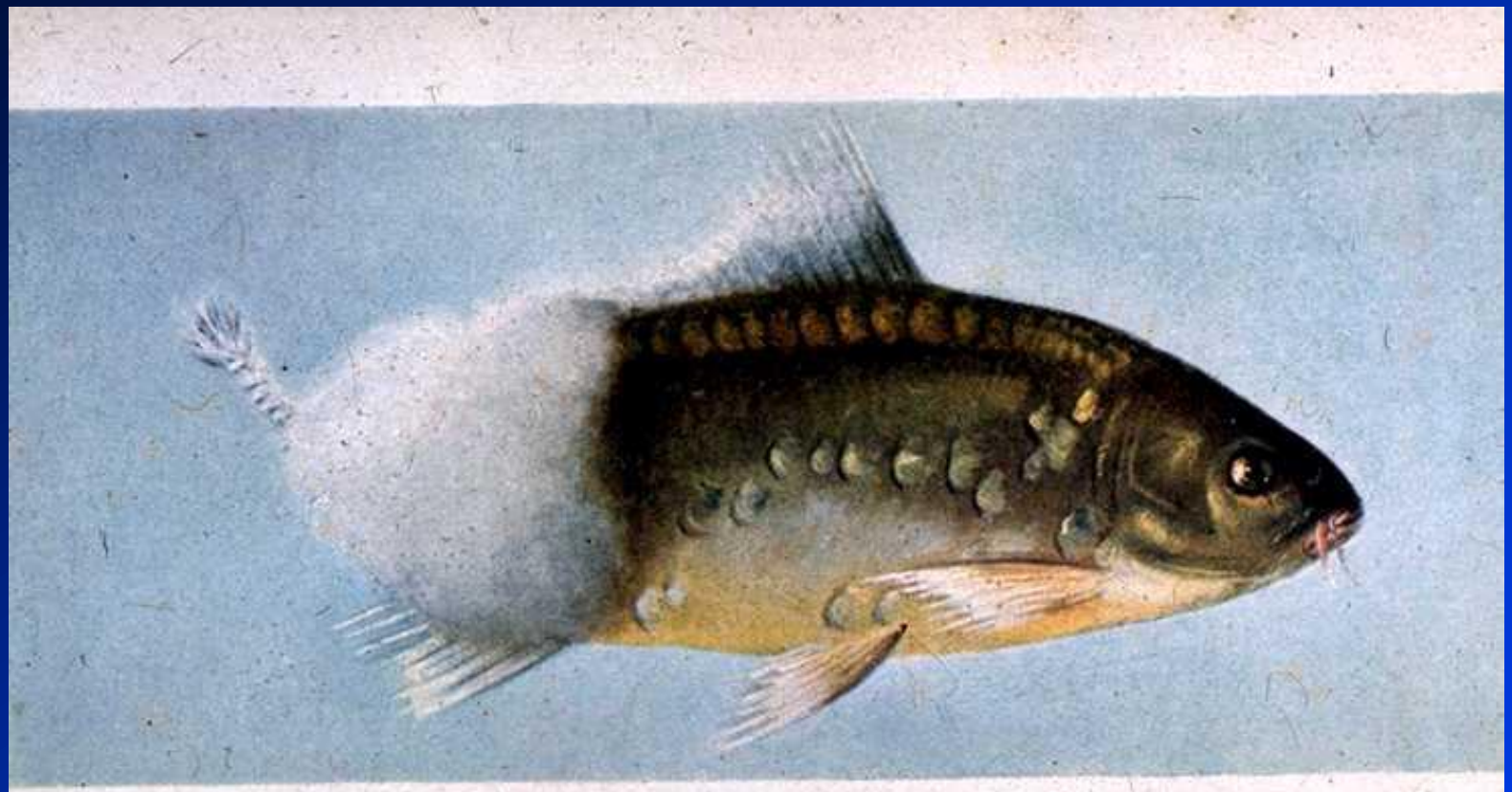
*Prevalence: very often (fish, eggs)

often secondary, tertiary!

FACULTEIT DIERGENEESKUNDE

*Clinically

FACULTEIT
DIERGENEESKUNDE



Karpfen. Zerstörung von Haut und Muskulatur durch Schimmelpilze.
Aus Hofer, Handbuch der Fischkrankheiten.

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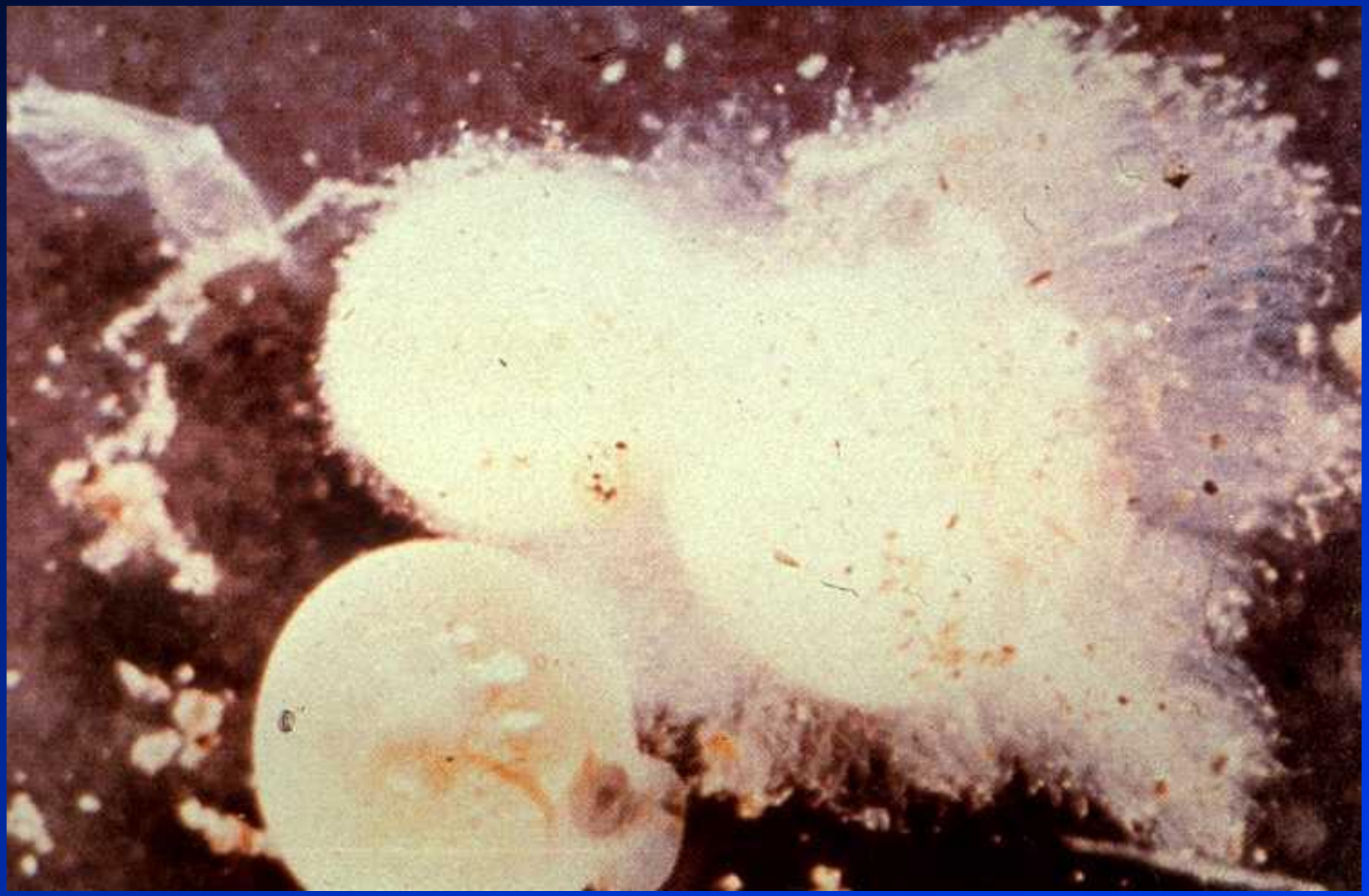

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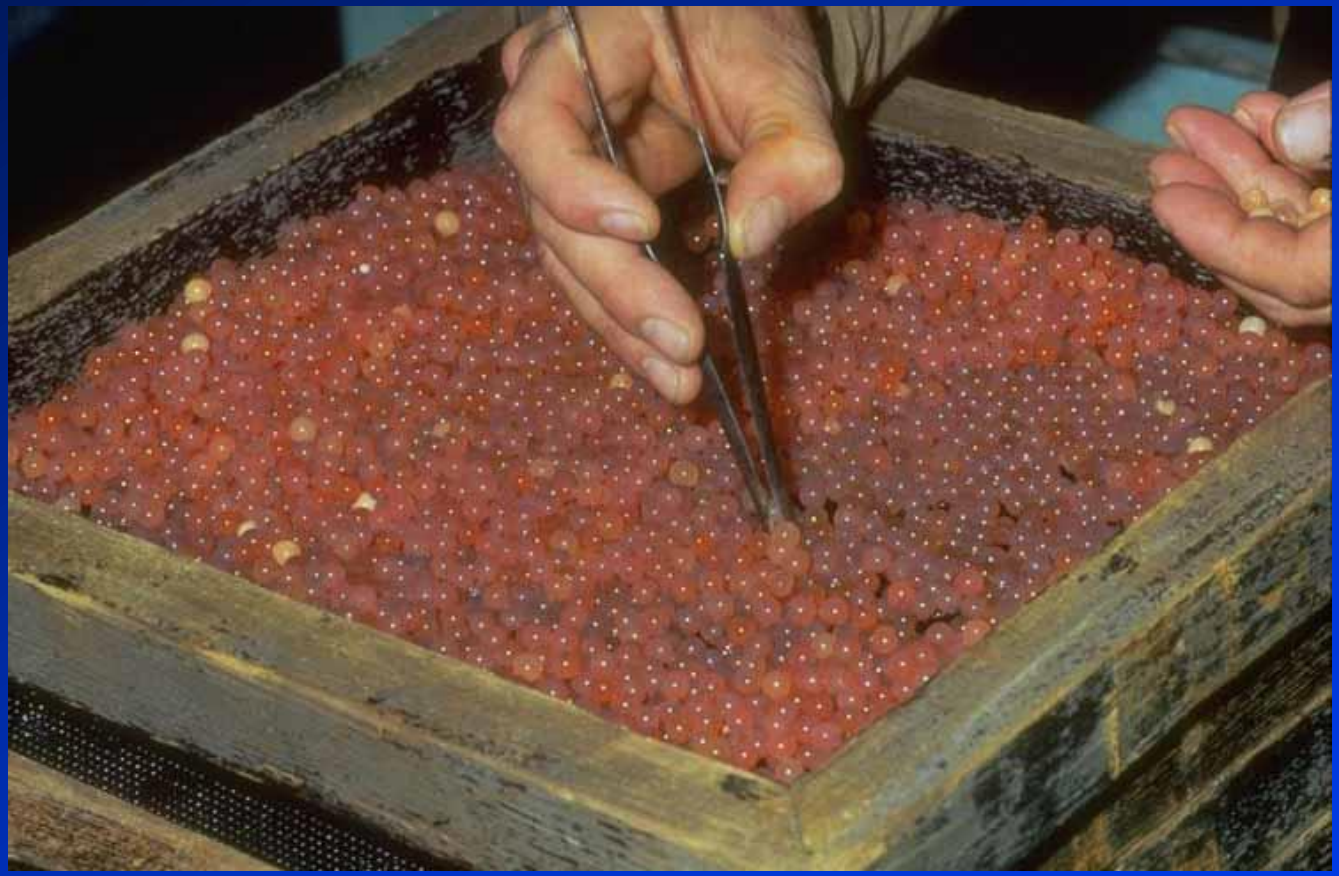

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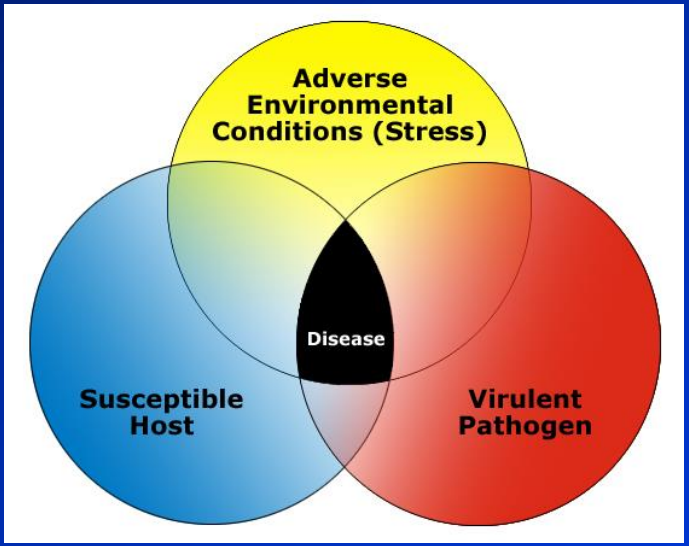
2. Brief overview on treatment

FACULTEIT
DIERGENEESKUNDE

Treatment of fish diseases



Proper diagnosis !

Consult veterinarian !

Responsible use of chemotherapeutics ! Legislation !!

- **fish !**
- **public health !**
- **environment !**

FACULTEIT DIERGENEESKUNDE

Treatment of fish diseases

Treatment options in various holding systems

***aquaria**: <u>most highly controllable</u>

- supplementary methods
- water borne treatments

***ponds / cages**

FACULTEIT DIERGENEESKUNDE

Treatment of fish diseases

Treatment options in various holding systems

***aquaria**: <u>most highly controllable</u>

- supplementary methods
- water borne treatments

***ponds / cages**

***flow-through systems**: <u>least controllable</u>

- high and constant water-turnover
- water borne treatments ???

FACULTEIT DIERGENEESKUNDE

Treatment of marine versus freshwater fish

→ ≠ chemistry between fresh- and saltwater

* is the agent effective in saltwater ?

* different pharmacokinetics (drug metabolism)

FACULTEIT DIERGENEESKUNDE

Drug metabolism in fish

*skin: not keratinized / gill: highly vascularized

*liver: main organ involved

*similar to mammals ?!

*BUT: one tenth of the rate of mammals

*excretion is esp. influenced by temperature

DEGREE DAYS: withdrawal time !

Fish pharmacology

“responsible use of therapeutants”

* knowledge of the disease
* properties of pharmacological agent
* fish species
* environmental conditions
* human safety

FACULTEIT DIERGENEESKUNDE

Routes of drug administration

Water-borne administration

*most common

*advantage: easy, non stressful

*disadvantage: costly, damage to biological filter

*esp. for external infections, less for systemic ones

FACULTEIT DIERGENEESKUNDE

Take into account:

*epidermis: not keratinized

*gills: highly vascularized

*gastro-intestinal system: ???!!! FW ⟷ SW

*consequences on environmental quality

FACULTEIT DIERGENEESKUNDE

Routes of drug administration

Water-borne administration

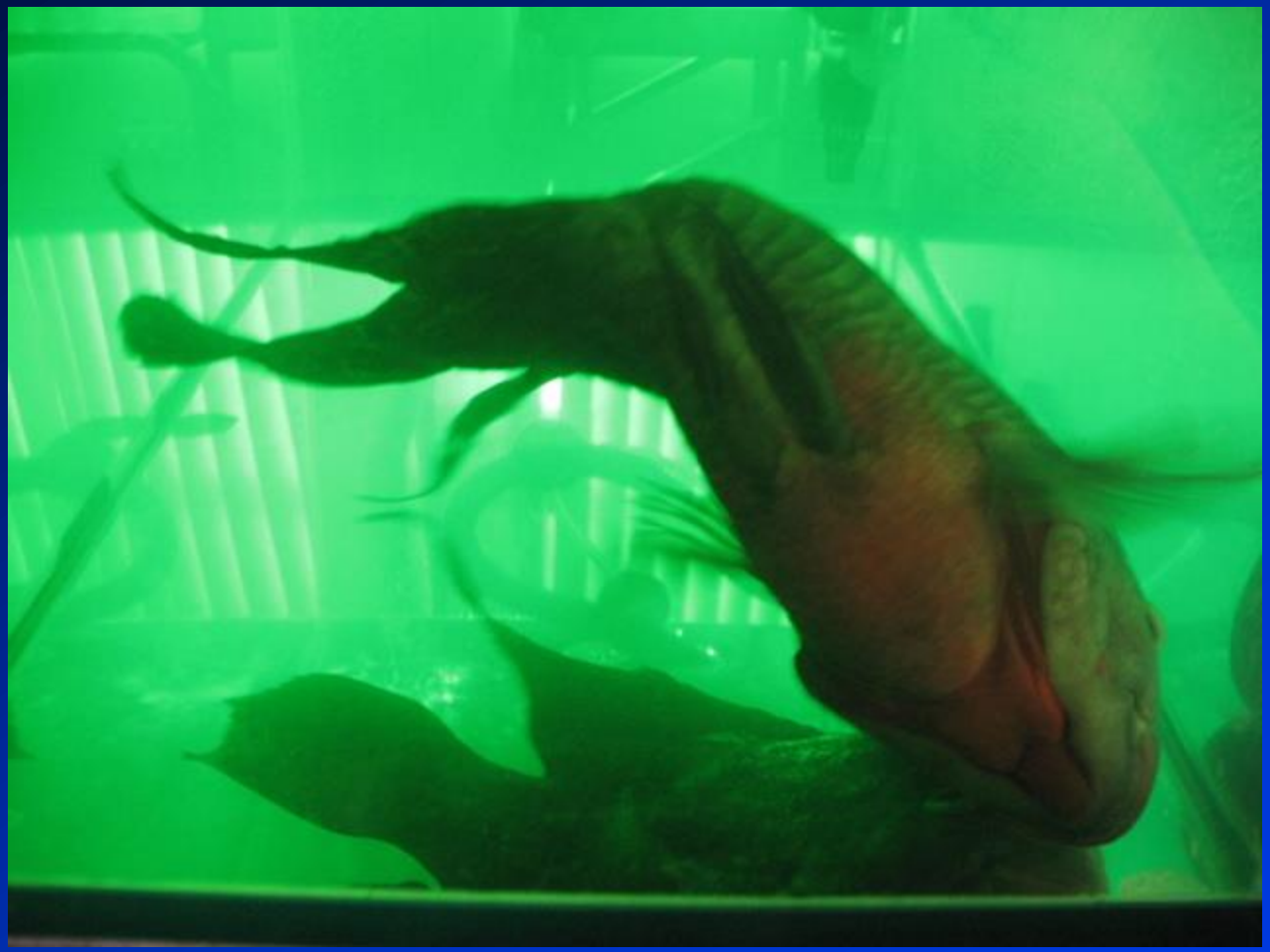
*most common

*advantage: easy, non stressful

*disadvantage: costly, damage to biological filter

*esp. for external infections, less for systemic ones

*types: dip/bath, flush, prolonged immersion



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DIERGENEESKUNDE

Water-borne administration (contd.)

*do not feed the fish

*responsible disposal of water

*check calculations

*mixing !

*airstone

*monitoring !

FACULTEIT
DIERGENEESKUNDE

Oral medication

*<u>advantage</u>: may be effective, not stressful, cheap

*<u>disadvantage</u>: sick fish often loose appetite

gastro-intestinal resorption ?

Injection of therapeutants

*for treatment of systemic diseases

*intraperitoneally (intramuscularly)

*toxicity !

Treatment of fish diseases

Various drawbacks …

Resistance

Residues … public health …

Environment

« Chemical use in salmon aquaculture: a review of current practices and possible environmental effects »

(Burridge et al., 2010 (Aquaculture 306, 7-23))

FACULTEIT DIERGENEESKUNDE

Treatment of fish diseases

Various drawbacks …

E.g. antimicrobial agents …

Leakage of antibiotic into … water / pond

- leakage directly from pellets
- non-eaten pellets …
- excretion through feces …

FACULTEIT DIERGENEESKUNDE

Treatment of fish diseases

Various drawbacks …

E.g. antimicrobial agents …

Leakage of antibiotic into … water / pond

- Influence on algae / invertebrates
- Influence on bacterial population

FACULTEIT DIERGENEESKUNDE

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DIERGENEESKUNDE

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“… indicating a substantial impact of fish farming on several groups of bacteria associated with aquacultural environments” (Schmidt et al., 2000; freshwater fish, Denmark)

“… use of OA can affect the levels of antimicrobial resistance and diversity in the microflora of natural aquatic habitats downstream” (Guardabassi, 2000: freshwater trout, Denmark)

FACULTEIT DIERGENEESKUNDE

Petersen et al. (2002; Applied and Environmental Microbiology)

“Integrated fish farming seems to favor antimicrobial-resistant bacteria in the pond environment”

Petersen en Dalsgaard (2003, Aquaculture) “The practice of integrated fish farming may lead to higher levels of antimicrobial-resistant bacteria in the intestine of the fish” ...

FACULTEIT DIERGENEESKUNDE

“… a major change occurring in the structure of the benthic bacterial community most probably due to fish farming and its close association with antibiotic resistance patterns” (Chelossi et al., 2003; sea bream, Mediterranean)

“ … a high frequency of drug resistant microorganisms occurring in the freshwater eel environment” (Alcaide et al., 2004; European Eel, Spain)

FACULTEIT DIERGENEESKUNDE

“… these findings suggest that both OTC treatment in aquaculture facilities and the farms themselves may be sources of tetR gene introduction to the environment” (Seyfried et al., 2010)

“… these results support the possibility of the hatchery as a source of tetracycline-resistant microorganisms” (Stachowiak et al., 2010; trout and related species)

FACULTEIT DIERGENEESKUNDE

“… Considering the rapid growth and importance of aquaculture industry in many regions of the world and the widespread, intensive and often unregulated use of antimicrobial agents in this area of animal production, efforts are needed to prevent development and spread of antimicrobial resistance to reduce the risk to human health” (Heuer et al., 2010)

FACULTEIT DIERGENEESKUNDE

Treatment of fish diseases

Various drawbacks …

E.g. antimicrobial agents …

Further research !

- Effluent treatment
- Vaccine development
- Management (prevention !)
- Alternative treatments

FACULTEIT DIERGENEESKUNDE