

BACTERIAL DISEASES

BACTERIAL DISEASES

FURUNCULOSIS

- a disease that produces “furuncles” or necrotizing muscle lesions in the muscle of salmonids and other cold-water species.
 - Atlantic salmon (most susceptible); Rainbow trout (most resistant)
- Other names:
 - Ulcer Disease
 - Goldfish Ulcer Disease
 - Carp Erythrodermatitis

BACTERIAL DISEASES

FURUNCULOSIS

- caused by *Aeromonas salmonicida* subsp. *salmonicida*
 - Gram-negative, diplobacilli
 - 0.3–1.0 μm \times 1.0–3.5 μm
 - appear coccoid; bipolar staining (possible)
 - cytochrome oxidase positive
 - facultative anaerobes
 - glucose fermenters
 - non-motile

BACTERIAL DISEASES

FURUNCULOSIS

- caused by *Aeromonas salmonicida* subsp. *salmonicida*
 - VIRULENCE FACTORS
 - Surface adhesins – A-layer protein, LPS
 - Secreted virulence components – toxins (aerolysin, enterotoxins), enzymes (proteases, lipases)
 - Iron acquisition

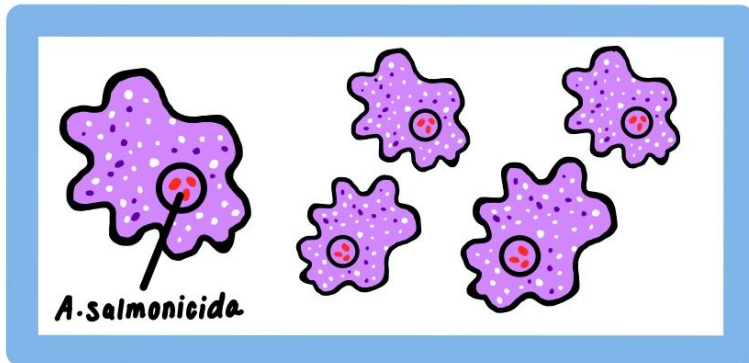
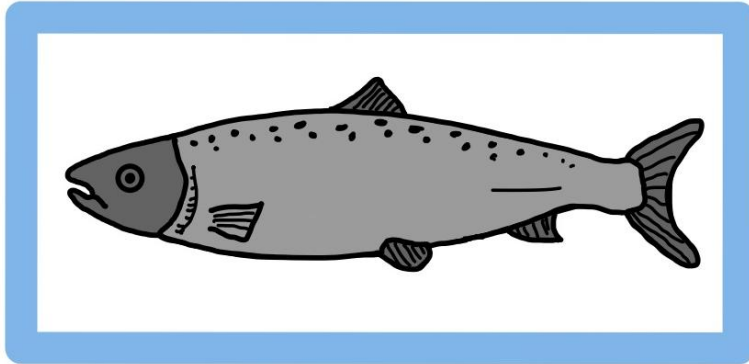


BACTERIAL DISEASES

FURUNCULOSIS

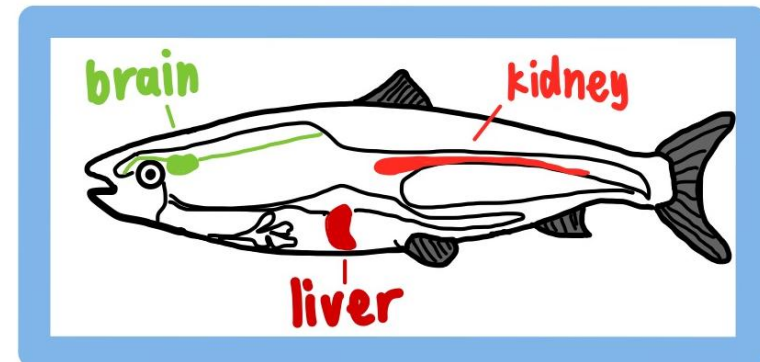
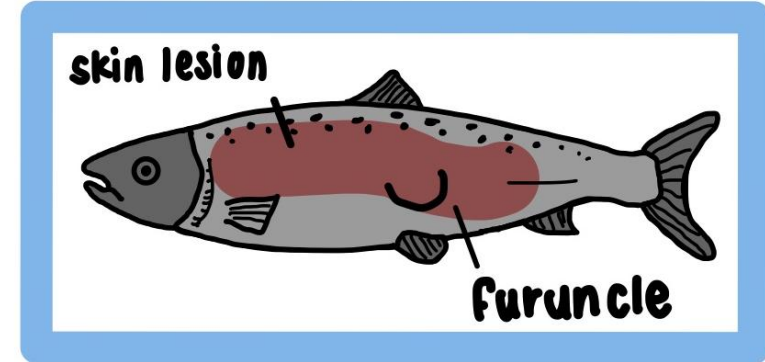
- Transmission
 - Horizontal
 - Ingestion
 - Mechanical vector (experimental) – sea louse (*Lepeophtheirus salmonis*)

① Pathogen enters through skin, gut, or gills



② *Aeromonas salmonicida* replicates within macrophages

④ Physical symptoms such as furuncles and skin lesions



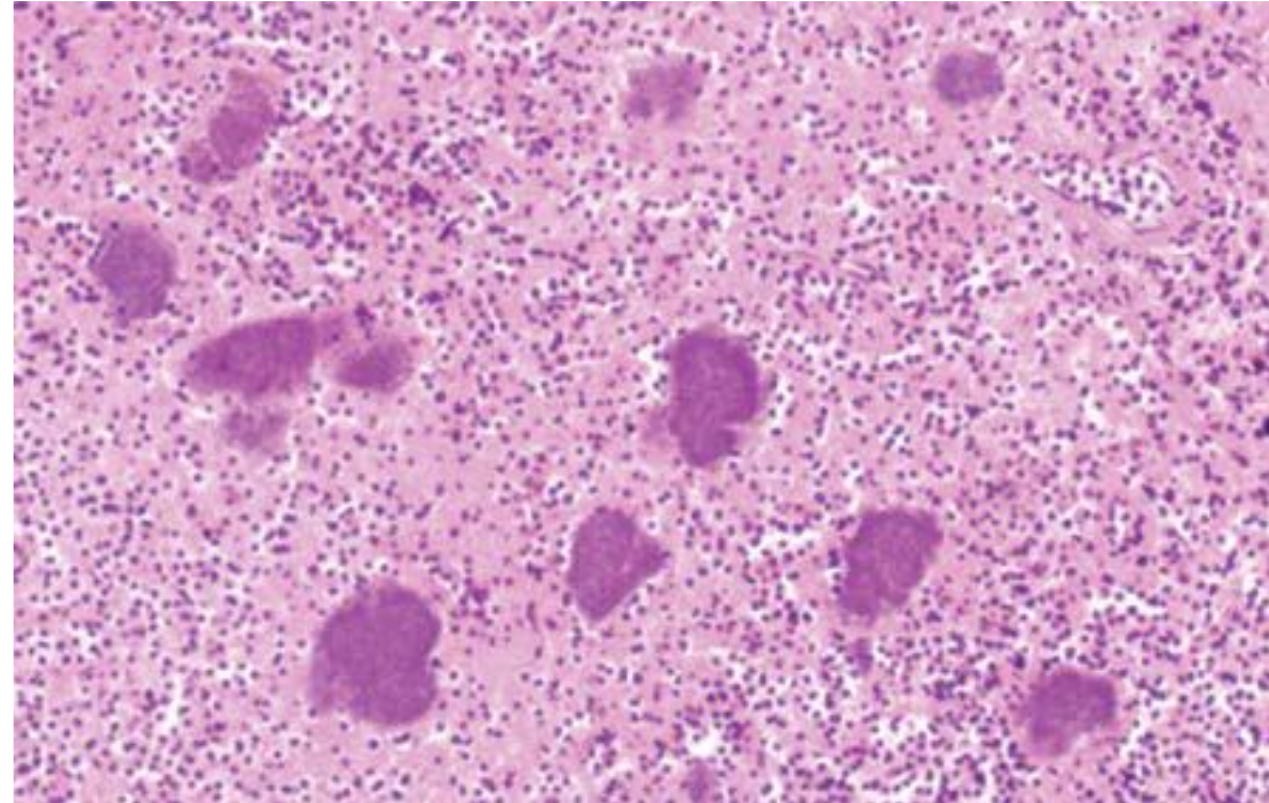
③ Bacteria spreads across the brain, liver, and kidney



BACTERIAL DISEASES

FURUNCULOSIS

- Clinical Signs
 - peracute death in juvenile fish
 - skin darkening
 - lethargy
 - inappetence or reduced appetite
 - erythema, ecchymoses (particularly at the base of fins), hemorrhages, skin ulcers, or fin erosions are common.
 - boils (furuncles) or nodules may be seen prior to skin ulcers
 - exophthalmos
 - coelomic distension/ascites and cloacal/anal distension



BACTERIAL DISEASES

FURUNCULOSIS

- Diagnosis
 - Clinical signs and history
 - Isolation and identification of the bacteria
 - Cytology, histology, culture (TSA, brain heart infusion agar, and blood agar – 15-20°C) and biochemical identification.
 - Necropsy
 - PCRs and ELISA

BACTERIAL DISEASES

FURUNCULOSIS

- Management/Treatment
 - Oxytetracycline dihydrate (Terramycin® 200) at 55–83 mg/kg PO q24 hours for 10 days with a 21day WP
 - Sulfadimethoxine and ormetoprim (Romet® 30) at 50 mg/kg PO q24 hours for 5days, with a 42-day WP
 - Florfenicol (Aquaflor®) at 10–15 mg/kg PO q24 hours for 10 days, with a 15-day WP
 - Other reported treatments: Potassium permanganate immersion

BACTERIAL DISEASES

FURUNCULOSIS

- Prevention
 - Commercial vaccines (IP)
 - Immune stimulants
 - Allicin
 - Glucans
 - Chitosan
 - Probiotics (*actobacillus*, *Lactococcus*, *Carnobacterium* spp.)

BACTERIAL DISEASES

MOTILE AEROMONAD SEPTICEMIA

- an opportunistic bacterial skin and fin disease of all freshwater (wild and cultured) and occasionally marine fishes
 - *Aeromonas hydrophila* (*liquefaciens*)
 - *Aeromonas sobria*
 - *Aeromonas caviae*
 - *Aeromonas veronii*
 - *Aeromonas dhakensis*
- short (1–3 μm), straight, Gram-negative bacilli
- Motile (polar flagellum)
- Grows at 37°C



BACTERIAL DISEASES

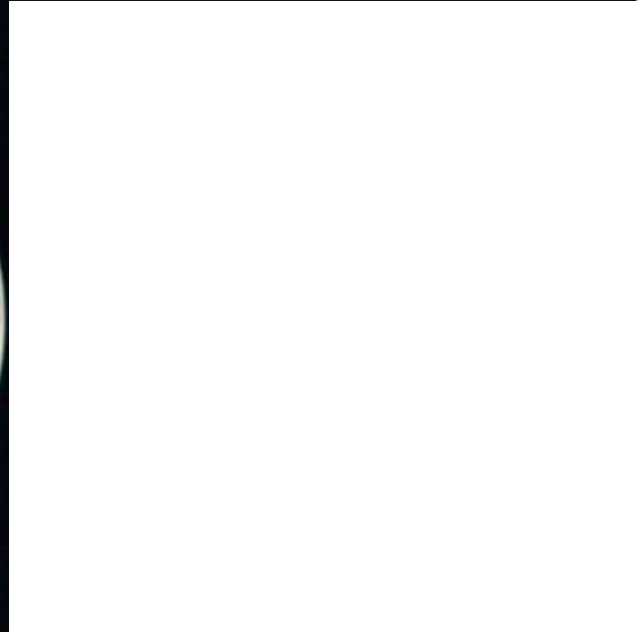
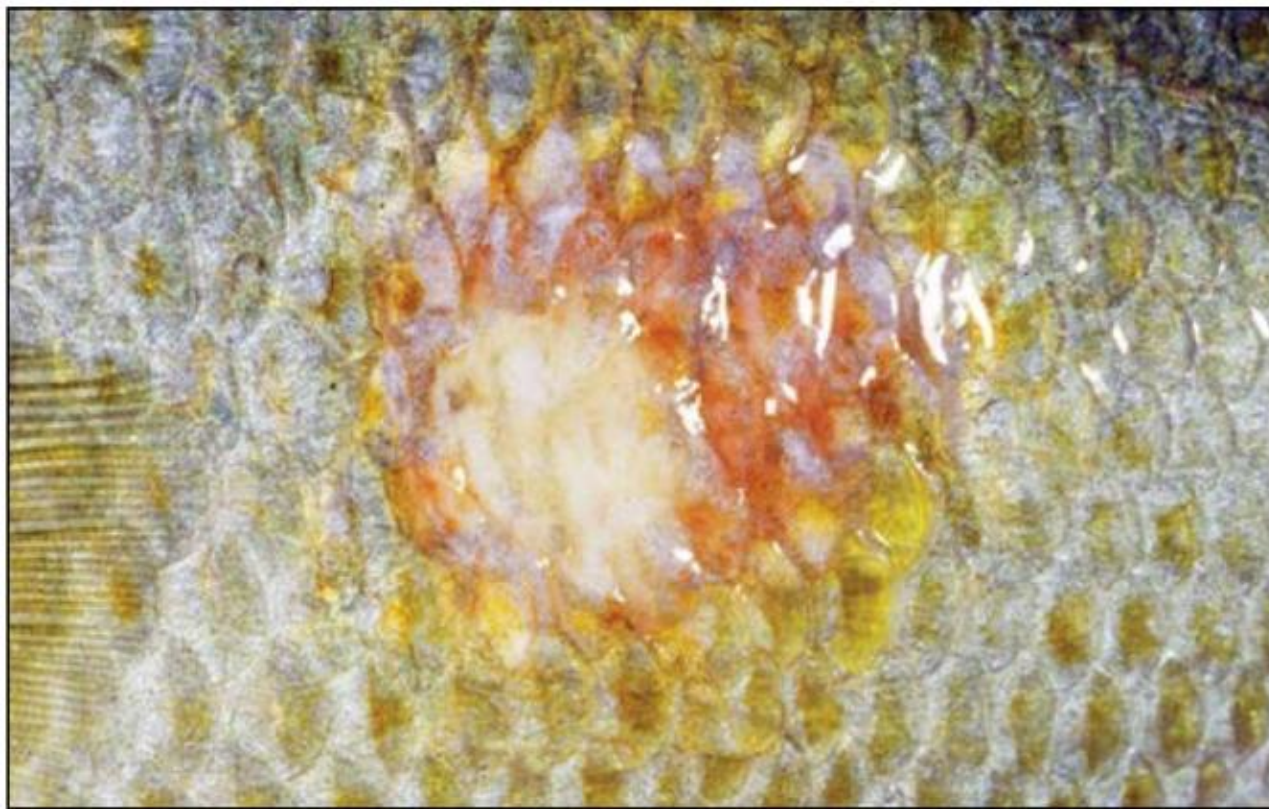
MOTILE AEROMONAD SEPTICEMIA

- Transmission:
 - Horizontal
 - Ingestion
 - Direct contact
 - potential carriers and/or vectors – amphibians and reptiles

BACTERIAL DISEASES

MOTILE AEROMONAD SEPTICEMIA

- Clinical signs
 - inappetence or reduced appetite.
 - lethargy
 - erythema, petechiae, skin ulcers and fin erosions, scale loss, cutaneous edema, or boils (furuncles)
 - exophthalmos
 - coelomic distension
 - gill pallor or edema
 - neurologic signs may be seen.
 - low mortality (except fry and fingerlings – 100%)



BACTERIAL DISEASES

MOTILE AEROMONAD SEPTICEMIA

- Diagnosis
 - clinical signs, cytology, necropsy, histology, and culture)
 - petechiae, congestion, sero-sanguinous coelomic effusion, tissue pallor, organomegaly, or focal necrosis of any tissues with intralesional Gram-negative bacilli.
 - PCR and ELISA tests

BACTERIAL DISEASES

MOTILE AEROMONAD SEPTICEMIA

- Management/Control/Treatment
 - Oxytetracycline dihydrate (Terramycin® 200) at 55–83 mg/kg q24 hrs for 10 days, with a 21-day WP
 - Enrofloxacin, ceftazidime, amikacin, florfenicol, and trimethoprim-sulfamethoxazole (aquarium fish)
 - Low-dose hypersalinity – reduce the osmotic stress in freshwater fish (1–3 g/L)
 - Others:
 - surgical debridement
 - potassium permanganate immersion.

BACTERIAL DISEASES

MOTILE AEROMONAD SEPTICEMIA

- Prevention
 - reduce stressors
 - autogenous vaccines – recurrent outbreaks
 - immune-stimulants
 - beta glucans
 - allicin
 - propolis

BACTERIAL DISEASES

MOTILE AEROMONAD SEPTICEMIA

- Zoonotic Potential
 - may be foodborne, waterborne, or by inoculation.
 - *A. hydrophila*, *A. sobria*, and *A. caviae* – foodborne and waterborne diarrhea from consumption of raw or inadequately cooked or processed fish and shellfish or contaminated food or water.

BACTERIAL DISEASES

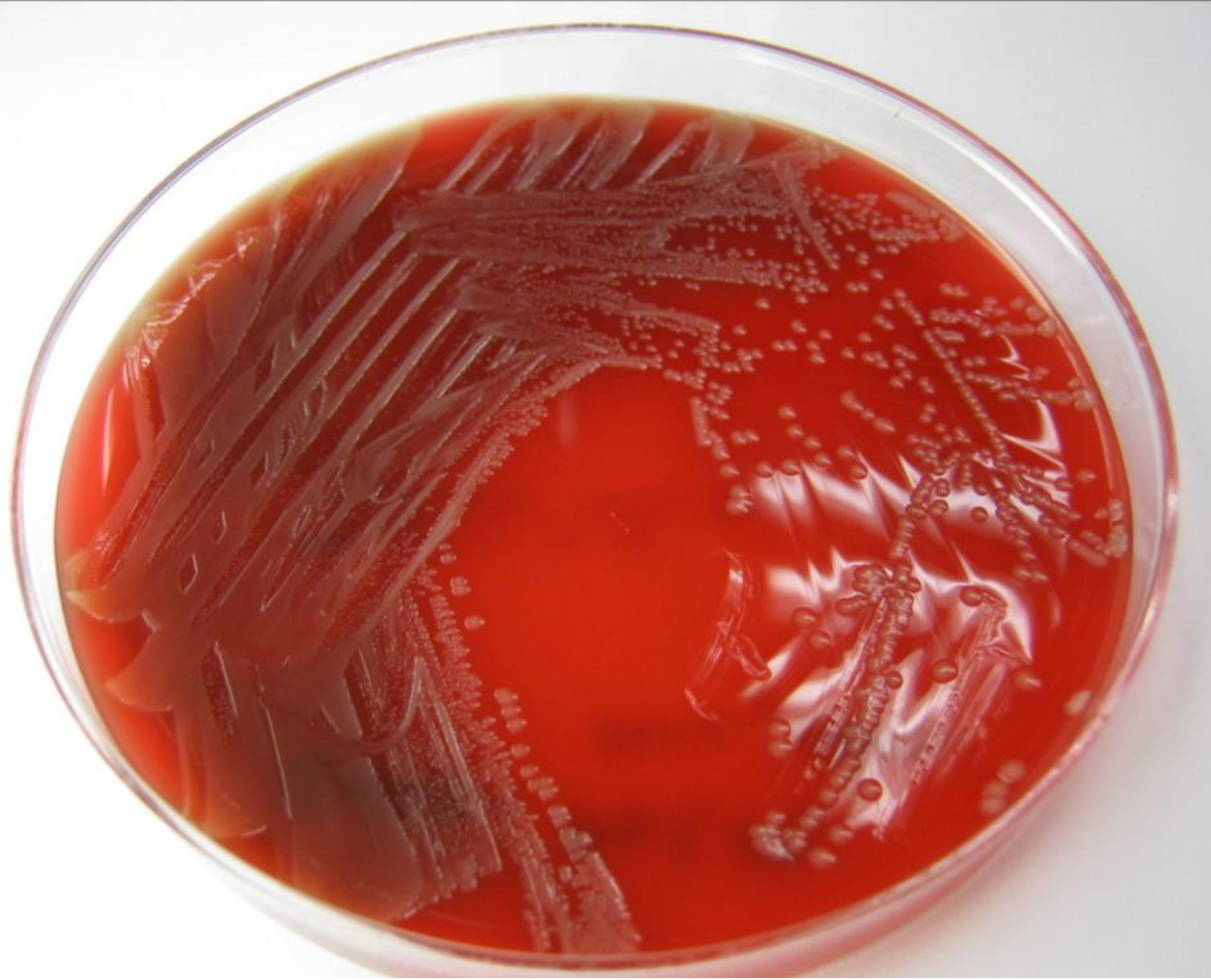
EDWARDSIELLOSIS

- also known as emphysematous putrefactive disease in catfish
 - fish gangrene, and red disease of eels
 - hemorrhagic septicemia
- cause bacterial septicemia by group of enteric bacteria; warm-water and opportunistic
 - *Edwardsiella tarda*, *Edwardsiella piscicida*, and *Edwardsiella anguillarum*

BACTERIAL DISEASES

EDWARDSIELLOSIS

- *Edwardsiella tarda*
 - small, straight, 1 x 2-3 um Gram-negative bacilli, facultative anaerobes, and may be motile (peritrichous flagella)
 - cytochrome oxidase (-)
 - Indole (+)
 - glucose fermenters (acid and gas production)
 - has a triple sugar iron (TSI) reaction of alkaline over acid (K/A) with hydrogen sulfide produced
 - Shotts and Waltman Agar Media – from *E. ictaluria*, *A. hydrophila* and *Yersinia ruckeri*
 - >30°C (summer)



BACTERIAL DISEASES

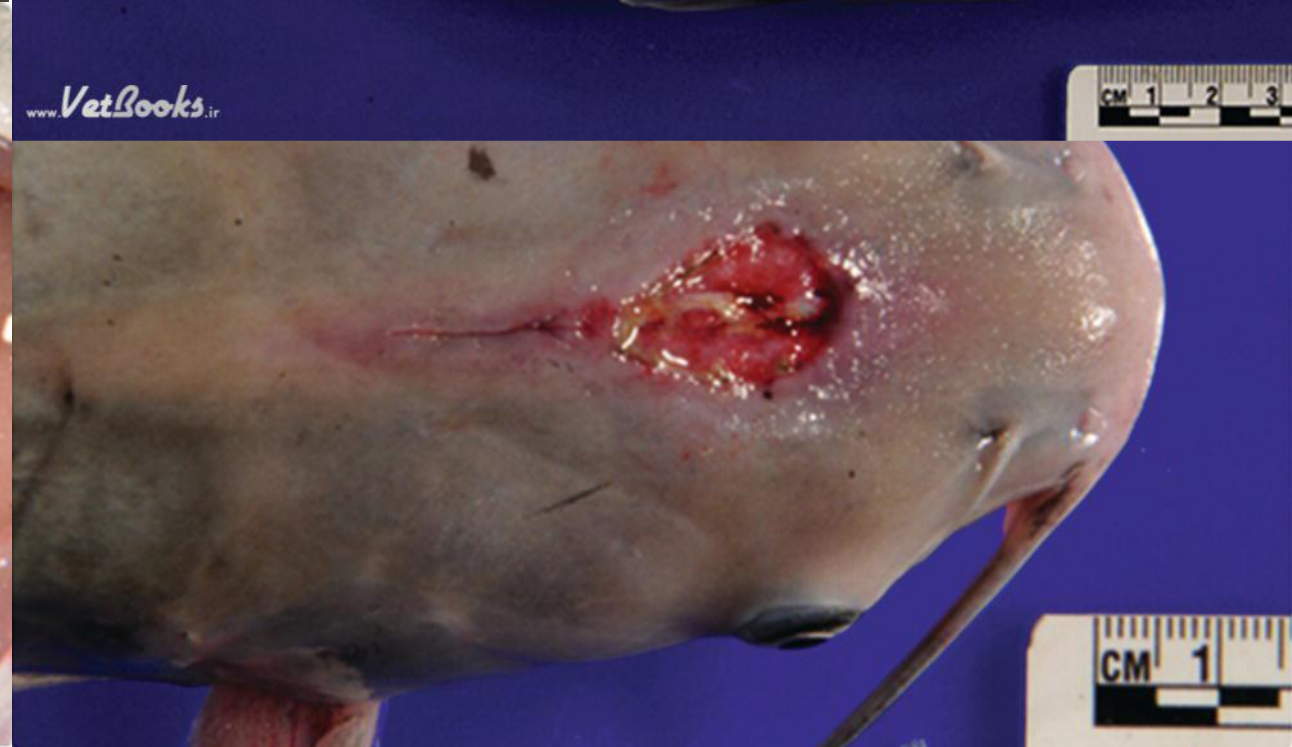
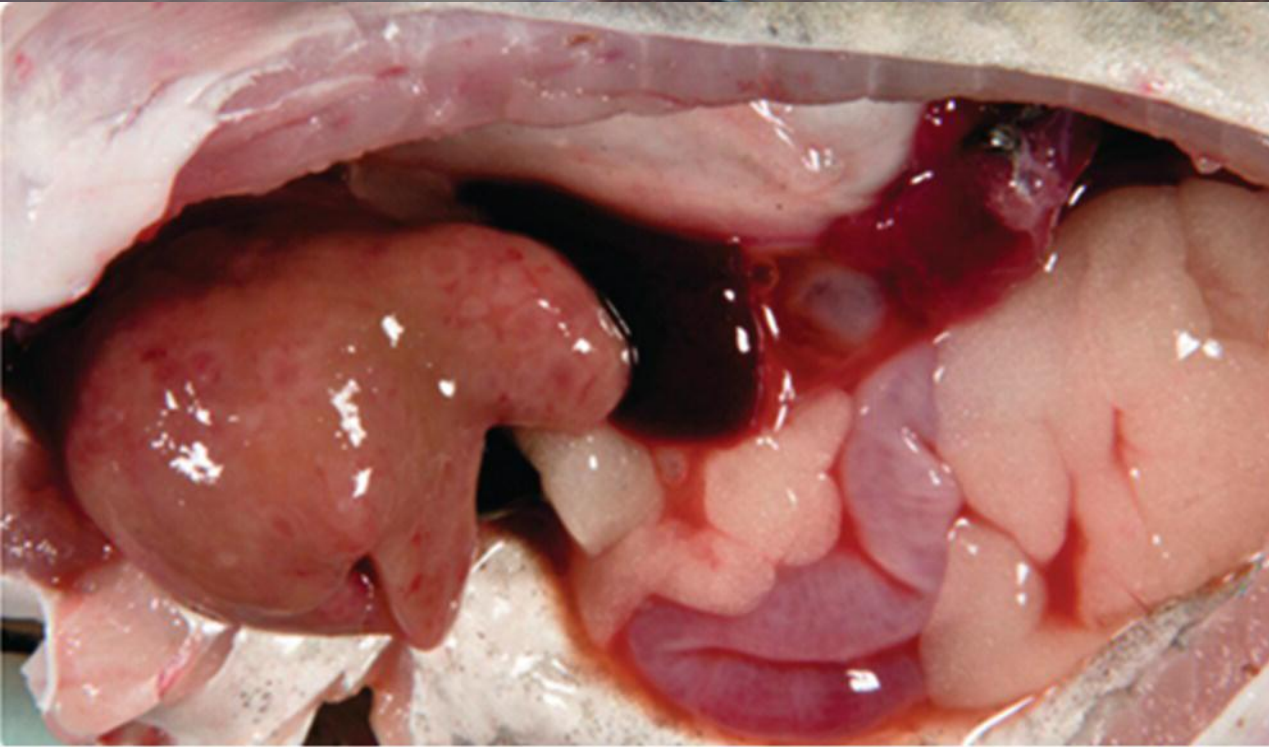
EDWARDSIELLOSIS

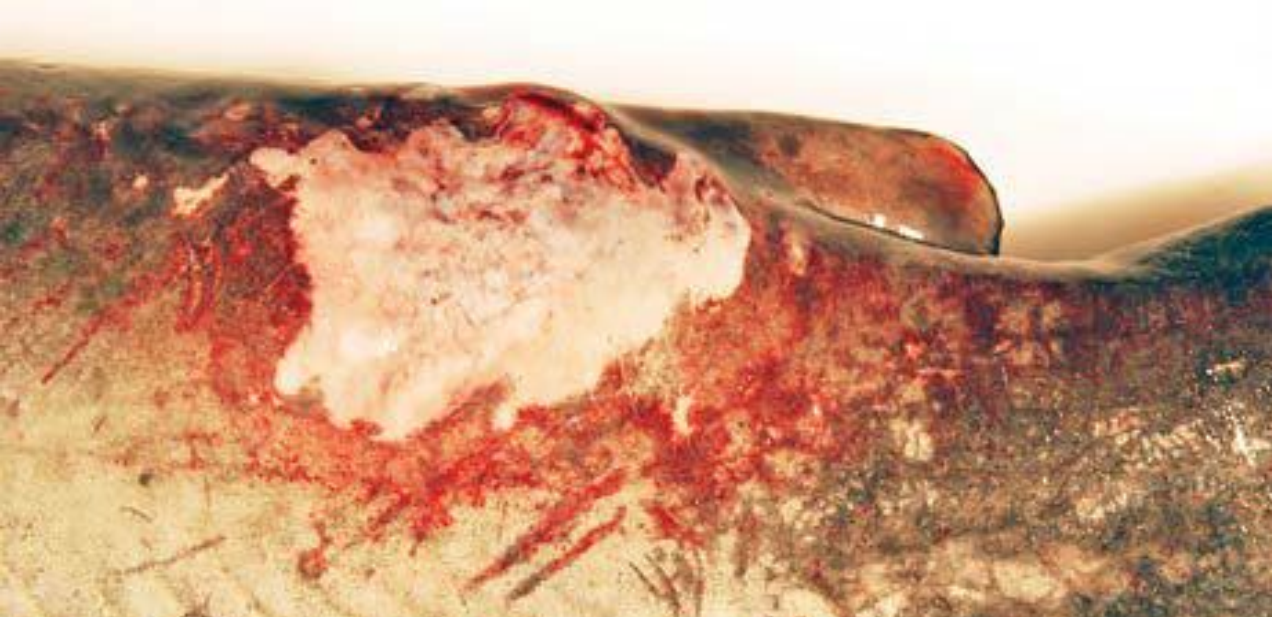
- Transmission
 - feco-oral route
 - Carriers/vectors – invertebrates, amphibians, reptiles, and mammals
 - more enhance at 20-30C

BACTERIAL DISEASES

EDWARDSIELLOSIS

- Clinical Signs:
 - lethargy, spiral swimming, or positive buoyancy
 - inappetence
 - erythema, petechiae, ecchymoses, skin ulcers, fin erosions, or loss of color
 - skin abscesses or fistulas (catfish)
 - malodorous fluctuant subdermal masses
 - gill pallor
 - ascites
 - keratitis, uveitis, hypopyon, or exophthalmos.
 - low and chronic mortality
 - “red-head disease.” – subcutaneous hemorrhages





BACTERIAL DISEASES

EDWARDSIELLOSIS

- Diagnosis
 - Necropsy or coeliotomy – petechiae, congestion, serosanguinous coelomic effusion, tissue pallor, organomegaly, or nodules in any tissues.
 - Malodorous abscesses in the viscera or skeletal muscle (catfish)
 - Histology
 - Suppurative/granulomatous inflammation with intralesional Gram-negative bacilli

BACTERIAL DISEASES

EDWARDSIELLOSIS

- Diagnosis
 - Culture (particularly kidney and spleen) or blood
 - brain-heart infusion agar (BHIA) or tryptic soy agar (TSA) at 26°C–30°C for 24–48 h
 - FA on histology or impression smears.
 - PCR, qPCR, ELISA, LAMP

BACTERIAL DISEASES

EDWARDSIELLOSIS

- Management
 - Antibiotics – culture and sensitivity
 - Tetracyclines
 - Aminoglycosides
 - Fluoroquinolones
 - (-) penicillin G, sulfadiazine, colistin, novobiocin, spectinomycin, ampicillin, tetracycline and chloramphenicol

BACTERIAL DISEASES

EDWARDSIELLOSIS

- Management
 - Disinfectants
 - ethyl alcohol (30, 50 or 70%)
 - benzyl-4-chlorophenol/phenylphenol (1%)
 - sodium hypochlorite (50, 100, 200 or 50,000 mg/l)
 - benzalkonium chloride (1:256)
 - povidone iodine (50 or 100 mg/l)
 - glutaraldehyde (2%)
 - potassium peroxymonosulfate/sodium chloride (1%)
 - (-) chloramine T (15 mg/l) and formalin (250 mg/l)

BACTERIAL DISEASES

EDWARDSIELLOSIS

- Prevention
 - reduce stressors
 - autogenous vaccines – recurrent outbreaks;
 - immune-stimulants
 - beta glucans
 - Allicin
 - propolis

BACTERIAL DISEASES

EDWARDSIELLOSIS

- Zoonotic Potential
 - rare human disease
 - ingestion of raw or inadequately cooked or processed fish.

BACTERIAL DISEASES

ENTERIC SEPTICEMIA OF CATFISH

- A primary pathogen that causes significant economic losses in aquaculture of channel catfish (*Ictalurus punctatus*).
 - *Edwardsiella ictalurid*
 - Primary obligate pathogens
 - not survive long in water but can survive in pond mud for >3 mo at 25°C
 - weakly motile, short (0.75 . 1.25 μm), pleomorphic, Gram-negative bacilli and facultative anaerobes
 - Cytochrome oxidase and indole (-)
 - Glucose fermenters without H₂S production (not fully)

BACTERIAL DISEASES

ENTERIC SEPTICEMIA OF CATFISH

- Transmission
 - ingestion (often feco-oral or through scavenging)
 - Waterborne through the gills and nares.
 - Vectors – piscivorous birds
 - Carriers – fish surviving outbreaks

BACTERIAL DISEASES

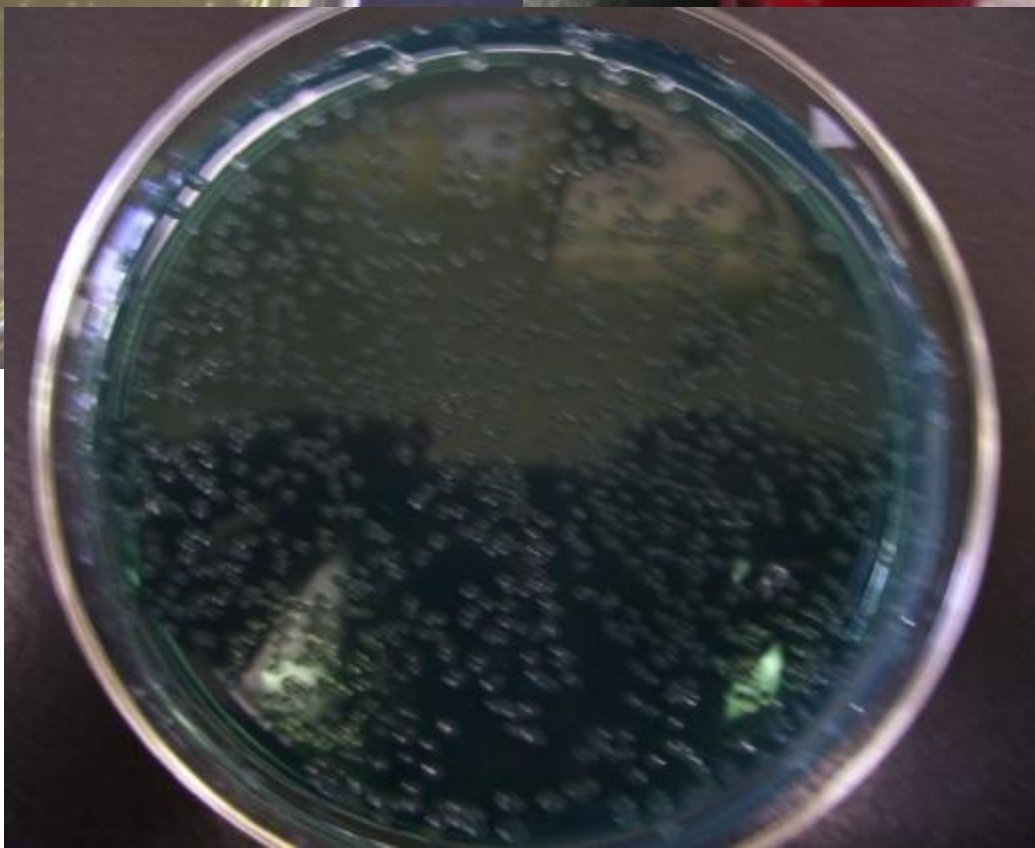
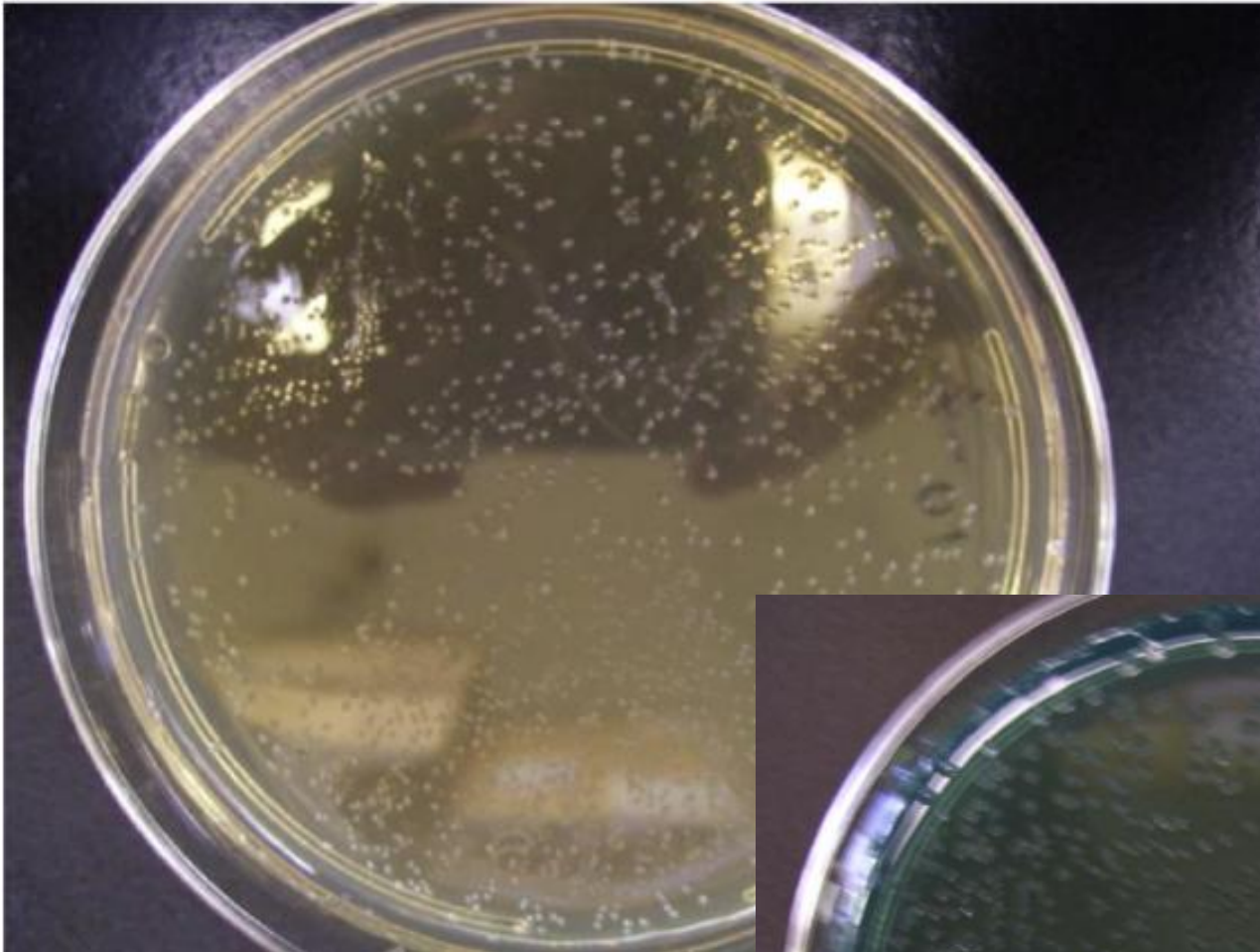
ENTERIC SEPTICEMIA OF CATFISH

- Clinical Signs
 - Neurologic form – more chronic.
 - spiral swimming, circling, and inappetence
 - lethargy or hanging in the water with a low tail position
 - skin ulcers on the head among fingerlings “hole in the head”
 - Enteric/septicemic form – more acute with >50% mortality
 - erythema, petechiae, ecchymoses, hemorrhages, and skin ulcers
 - exophthalmos
 - coelomic distension
 - gill pallor

BACTERIAL DISEASES

ENTERIC SEPTICEMIA OF CATFISH

- Diagnosis
 - Culture (spleen, anterior kidney, liver, and brain) or blood
 - tryptic soy agar, Mueller–Hinton, McConkey agar, or brain heart infusion agar supplemented with 5% sheep blood for 36–48 h at 25–30°C
 - Biochemical tests
 - Necropsy or coeliotomy – petechiae, congestion, serosanguinous coelomic effusion, tissue pallor, splenomegaly and renomegaly with nodules.



BACTERIAL DISEASES

ENTERIC SEPTICEMIA OF CATFISH

- Diagnosis
 - Histology – hemorrhagic enteritis and granulomatous splenitis, nephritis, and encephalitis with intralesional Gram-negative bacilli.
 - Routine media works well, usually at ~25–30°C (77–86°F).
 - Commercial PCR tests – higher sensitivity; sequencing for confirmation.
 - FA and ELISA



BACTERIAL DISEASES

ENTERIC SEPTICEMIA OF CATFISH

- Management
 - take the water temperature out of the permissive range of 22–28°C (72–82°F)
 - reduce or withheld food for 3–28 days in catfish aquaculture
 - antibiotic treatment
 - Sulfadimethoxine and ormetoprim (Romet® TC) at 50 mg/kg PO q24hrs for 5 days, with a 3-day WP
 - Florfenicol (Aquaflor®) at 10–15 mg/kg PO q24 hours for 10 days, with a 15-day WP

BACTERIAL DISEASES

ENTERIC SEPTICEMIA OF CATFISH

- Prevention
 - Disinfectants
 - ethyl alcohol (30, 50 or 70%)
 - benzyl-4-chlorophenol/phenylphenol (1%)
 - sodium hypochlorite (50, 100, 200 or 50,000 mg/l)
 - benzalkonium chloride (1:256)
 - povidone iodine (50 or 100 mg/l)
 - glutaraldehyde (2%)
 - Potassium peroxymonosulfate/sodium chloride (1%)
 - commercial immersion vaccines
 - immune-stimulants – beta glucans

BACTERIAL DISEASES

PISCIRICKETTSIOSIS

- also known as rickettsial septicemia, salmon rickettsia syndrome or coho salmon syndrome
- an acute, subacute or chronic systemic bacterial disease affecting a variety of teleost species farmed in brackish and seawater in different locations of the world

BACTERIAL DISEASES

PISCIRICKETTSIOSIS

- caused by *Piscirickettsia salmonis*
 - Gram-negative, non-motile, pleomorphic coccobacilli, facultative intracellular bacterium
 - Survives in saltwater for 14days
 - Sensitive to freezing temperatures



Piscirickettsia salmonis colonies on modified Thayer–Martin (MTMII) agar (Becton Dickenson BBL, Sparks, Maryland) for 10 days at 20°C.

BACTERIAL DISEASES

PISCIRICKETTSIOSIS

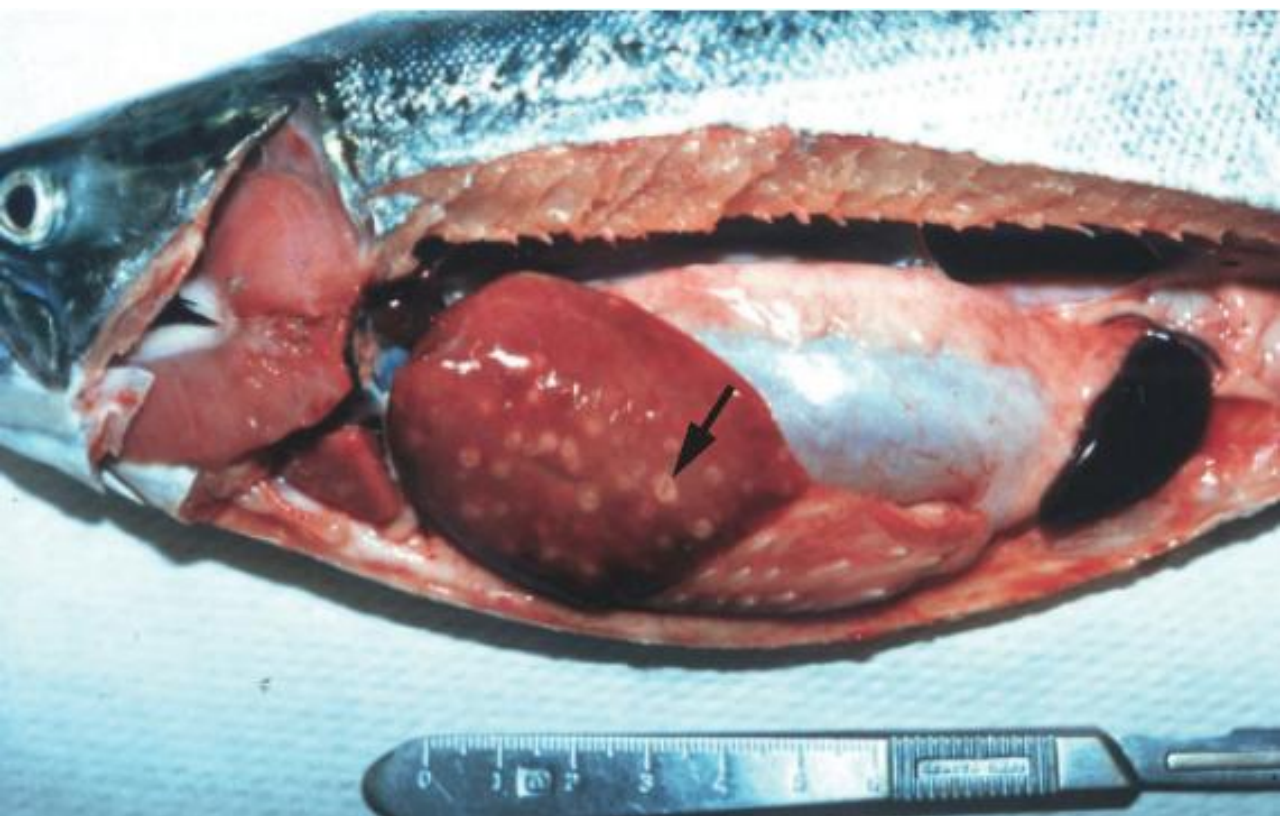
- Transmission
 - Horizontal (contact with fish or water)
 - Ingestion – urine and fecal materials
 - vertical transmission – uncommon
 - crustaceans – vectors
- Cohabitation (consumption of infected prey – white seabass '*Atractoscion nobilis*') to Chinook (*O. tshawytscha*) and coho salmon.

BACTERIAL DISEASES

PISCIRICKETTSIOSIS

- Clinical Signs
 - lethargy, with fish – swimming at the surface or edges of enclosures.
 - inappetence or reduced feeding.
 - dark body discoloration
 - gill pallor
 - whitish-to-reddish skin ulcerations and fin erosions
 - petechial hemorrhages in visceral fat, swim bladder, stomach, and muscle
 - swollen spleen and kidneys
 - yellowish, mucoid material in the intestines
 - nodules
 - coelomic distension / ascites
 - <90% mortality

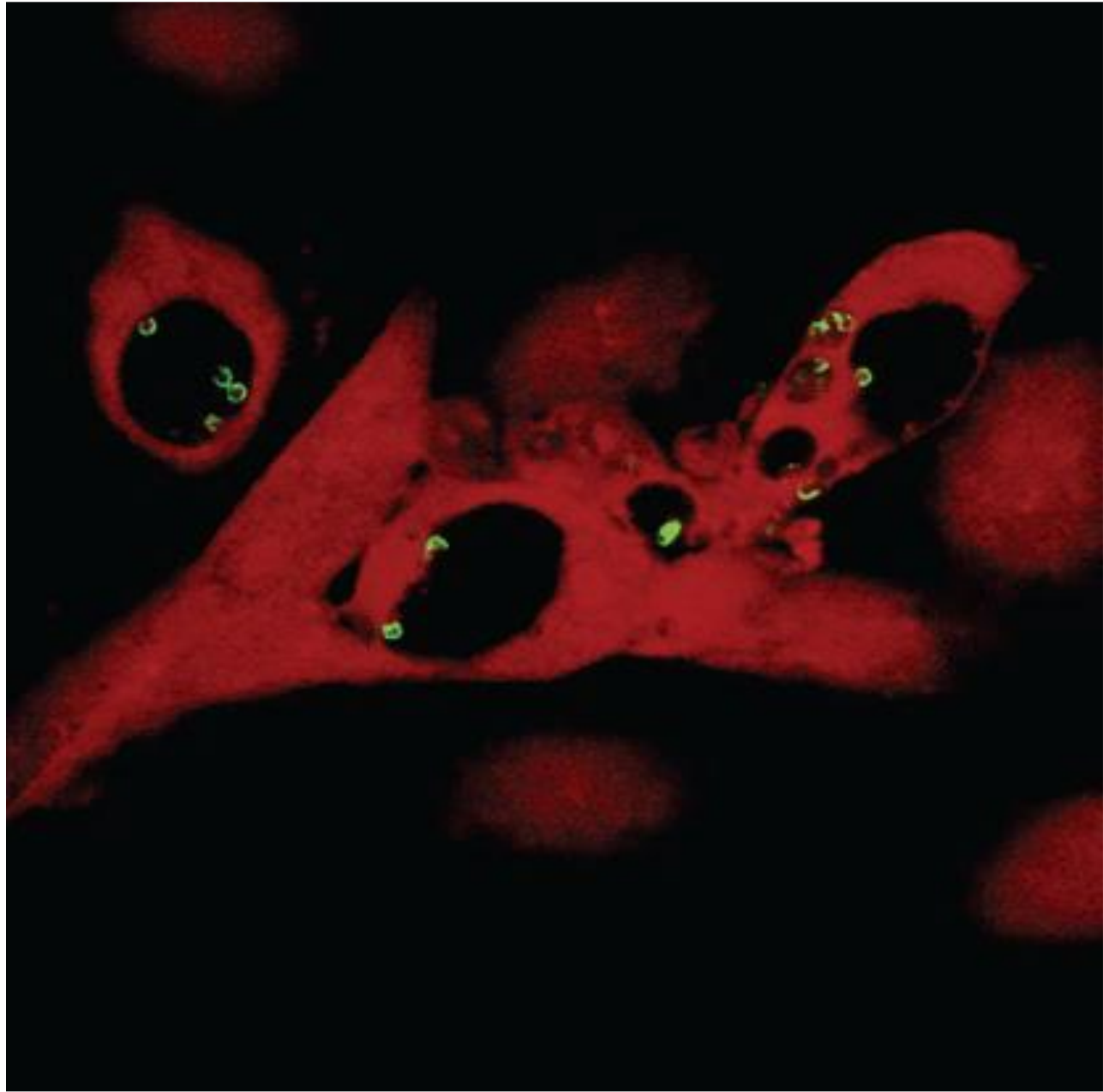




BACTERIAL DISEASES

PISCIRICKETTSIOSIS

- Diagnosis
 - Culture and morphology on blood smears, effusions, tissue cytology, or histology.
 - (+) Giemsa, methylene blue, and acridine orange staining. mounts.
 - Necropsy or coeliotomy
 - Immunofluorescence antibody test – most common
 - ELISA, IHC, or PCR tests



BACTERIAL DISEASES

PISCIRICKETTSIOSIS

- Medical Management
 - aminoglycosides, tetracyclines, gentamicin, streptomycin, erythromycins, macrolides, chloramphenicol and quinolones.
 - (-) penicillins

BACTERIAL DISEASES

PISCIRICKETTSIOSIS

- Prevention
 - commercial vaccines – debated efficacy
 - reduction of risk
 - early harvesting of cultured salmonids (<6mos)
 - after transfer to salt water
 - prior to high water temperatures in summer
 - screening of adult broodstock

BACTERIAL DISEASES

VIBRIOSIS

- also known as
 - salt water furunculosis
 - vibrio infection
 - hitra disease
 - coldwater disease
 - winter ulcer.
- affect a wide range of wild and farmed fish species around the world
 - marine and brackish water environments (occur mostly)

BACTERIAL DISEASES

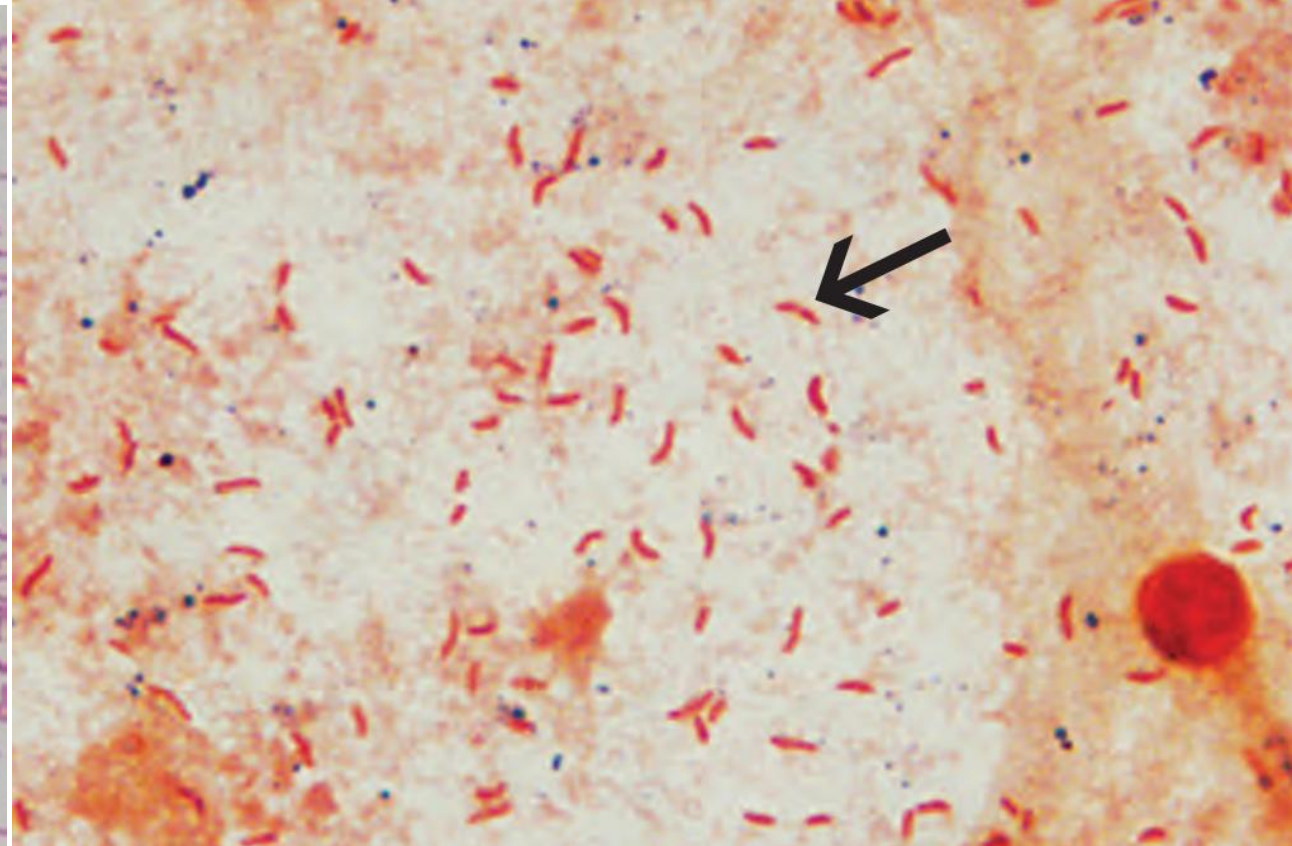
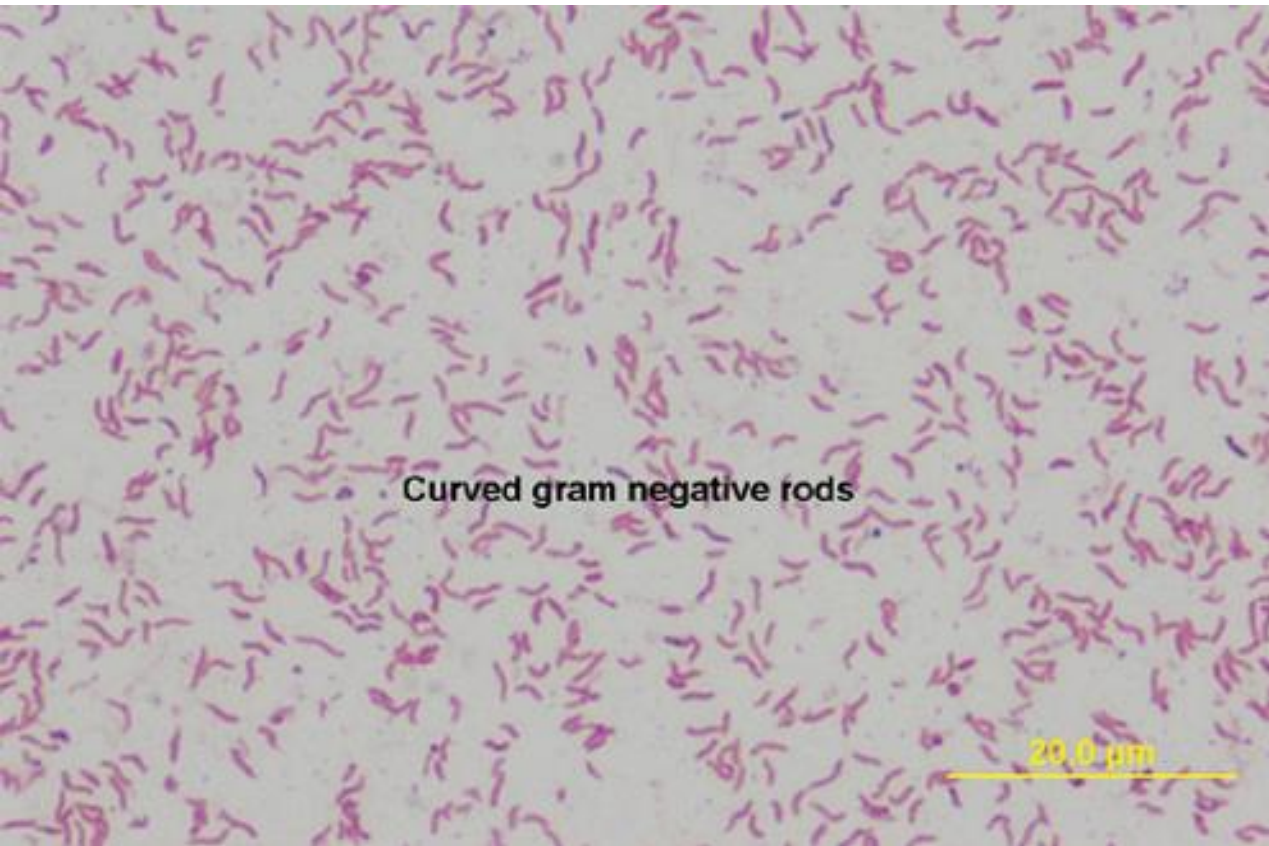
VIBRIOSIS

- caused by *Vibrio* spp. (*Vibrio anguillarum* – saltwater furunculosis, and *Vibrio ordalii*)
 - part of normal fish intestinal flora
 - (+) light-emitting organs of marine fish and cephalopods.
 - common commensals (autochthonous bacteria) in elasmobranch tissues and blood
 - *V. alginolyticus*, *V. harveyi*, and *P. damsela*
 - small (1–3 μm) curved to spiral-shaped, halophilic, Gram-negative bacilli, motile and facultative anaerobes.

BACTERIAL DISEASES

VIBRIOSIS

- Virulence Factors
 - Flagellum
 - Proteolytic enzymes
 - Exotoxins
 - O-antigen
 - Iron-uptake system



BACTERIAL DISEASES

VIBRIOSIS

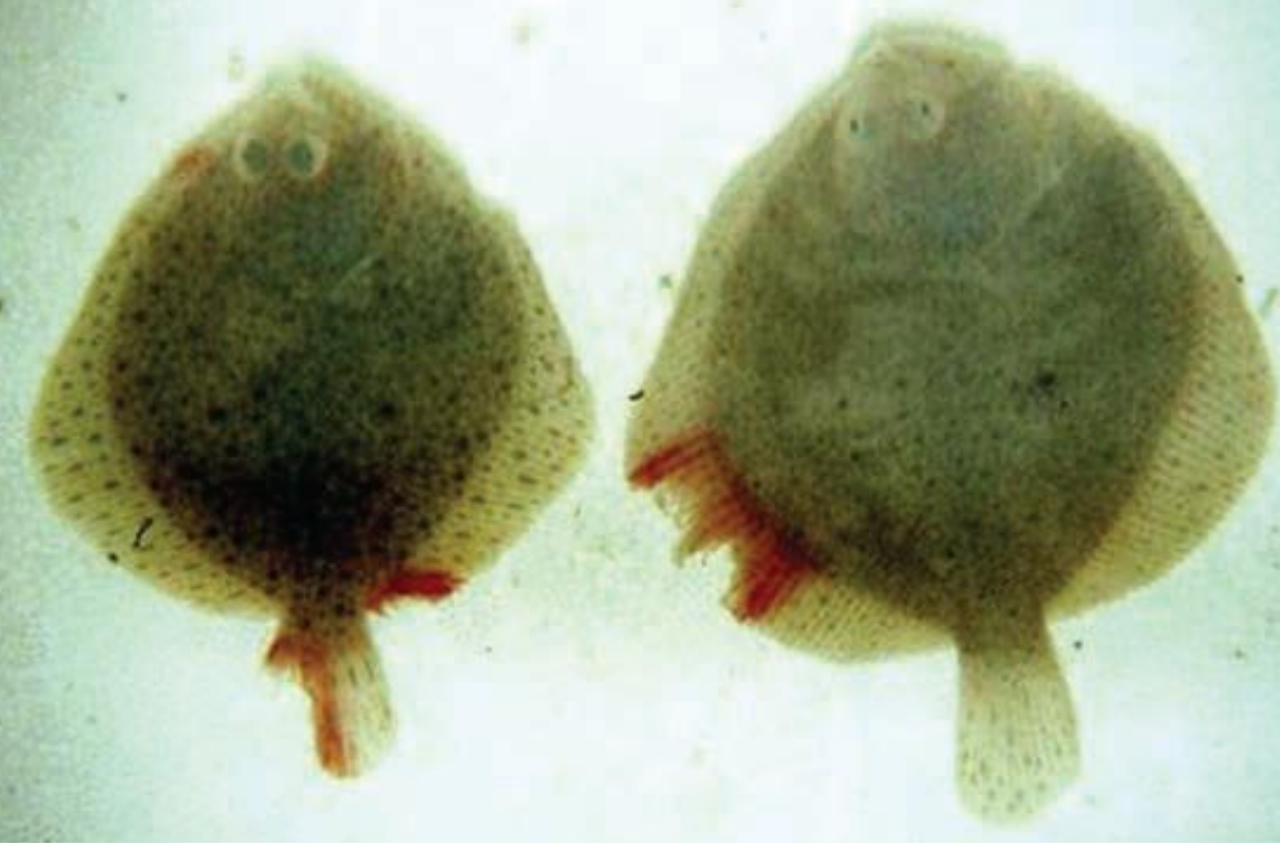
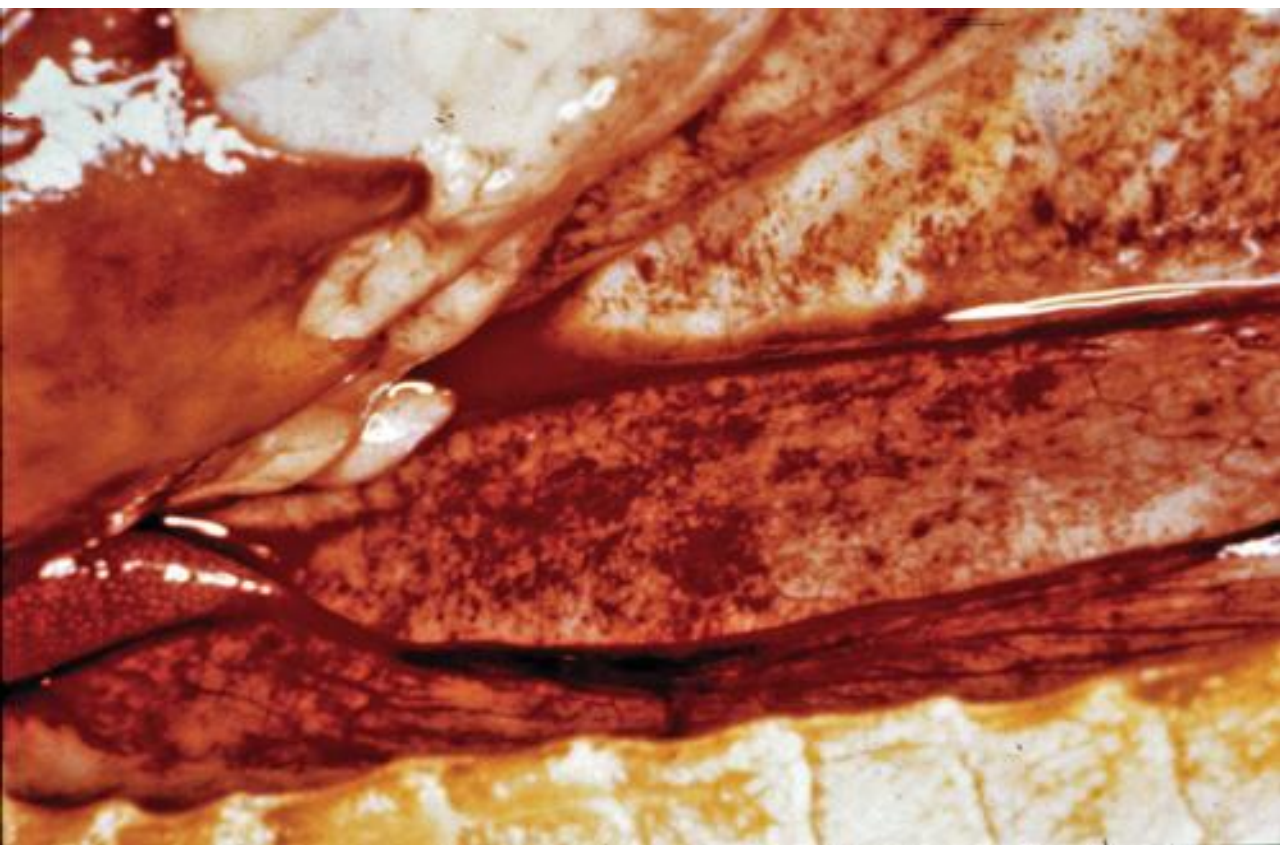
- Transmission
 - horizontal (common)
 - Ingestion of contaminated food or water – mainly larval fish
 - inoculation of wounds
 - vertical (possible)
 - carriers/vectors – aquatic invertebrates (bivalves, penaeid shrimp)

BACTERIAL DISEASES

VIBRIOSIS

- Clinical Signs
 - lethargy
 - inappetence or reduced appetite
 - skin darkening or pallor, erythema, petechiae, ecchymoses, skin ulcers, or fin erosions
 - coelomic distension due to ascites or organomegaly or a pinched coelom
 - corneal edema, keratitis, or exophthalmos.
 - gill pallor
 - neurologic or respiratory signs
 - >50% up to 90% mortality





BACTERIAL DISEASES

VIBRIOSIS

- Diagnosis
 - culture and morphology (kidney, spleen, or blood)
 - 15°C–25°C on standard media (brain-heart infusion agar, tryptic soy agar or thiosulfate-citrate-bile salts-sucrose agar with of 0.5%–3.5% NaCl)
 - Necropsy or coeliotomy and histology
 - PCR or sequencing – identification

Characteristic	<i>V. anguillarum</i>	<i>V. ordalii</i>	<i>A. salmonicida</i>
Acid production from:			
amygdaline	+	-	-
glucose	+	+	+
inositol	-	-	-
maltose	+	-	+
mannitol	+	V	+
mannose	+	-	-
sucrose	+	-	-
trehalose	+	V	+
Arginine dihydrolase	+	-	-
Catalase	+	+	+
Citrate utilization	+	-	-
Cytochrome oxidase	+	+	+
β-Galactosidase	+	-	-
Gelatine hydrolysis	+	V	-
Gram stain	-	-	-
Growth:			
at 25°C	+	+	-
at 37°C	V	-	-
in 0% NaCl	-	-	-
in 3% NaCl	+	+	+
in 5% NaCl	-	-	-
on TCBS	+ (Y)	-	-
Indole production	+	-	-
Lysine decarboxylase	-	-	-
Motility	+	+	+
Nitrate reduction	+	V	-
O/F (oxidative–fermentative) Leifson test	F	F	F
Ornithine decarboxylase	-	-	-
Starch hydrolysis	+	-	-
Voges–Proskauer acetoin test	+	-	-

*Key: F, fermentative; TCBS, thiosulfate-citrate-bile-salts-sucrose medium; V, variable reaction among strains; Y, yellow colonies.

BACTERIAL DISEASES

VIBRIOSIS

- Management
 - reduction of stressors or other disease issues – control signs.
 - movement restrictions, depopulation, and disinfection.
 - Antibiotic therapy – based on culture and sensitivity results.

BACTERIAL DISEASES

VIBRIOSIS

- Prevention
 - probiotics
 - commercial immersion vaccines (or IP injections)
 - autogenous vaccines
 - immune-stimulants
 - beta glucans

BACTERIAL DISEASES

VIBRIOSIS

- Zoonotic Potential
 - predominantly a foodborne zoonosis through ingestion
 - raw or inadequately cooked shellfish (particularly oysters)
 - contaminated food and water

BACTERIAL DISEASES

FLAVOBACTERIOSIS

- Also known as columnaris disease of freshwater fish
 - myxobacterial disease
 - saddleback
 - fin rot
 - cotton wool disease
 - black patch necrosis

BACTERIAL DISEASES

FLAVOBACTERIOSIS

- Etiology
 - *Flavobacterium columnare* – columnaris in freshwater fish.
 - *Tenacibaculum maritimum* – marine flexibacteriosis.
 - thin/slender rod (3–10 μm long by 0.3–0.5 μm wide.), Gram-negative yellow-pigmented bacilli – often grouped together in “haystacks,” motile.
 - $<5^{\circ}\text{C}$ ($<41^{\circ}\text{F}$) reduces survival
 - tolerates $<1\%$ NaCl and survives up to 9mos in sterile stream water
 - *Flavobacterium johnsoniae* (= *Cytophaga johnsonae*) – barramundi and salmonids

BACTERIAL DISEASES

FLAVOBACTERIOSIS

- Risk factors
 - $>15^{\circ}\text{C}$ or 59°F , with morbidity and mortality highest at $24\text{--}32^{\circ}\text{C}$ or $75\text{--}90^{\circ}\text{F}$)
 - high nitrite levels, alkalinity, hardness (70mg/L), and increase calcium.
 - low dissolved oxygen levels, uneaten feed and high arsenic levels

BACTERIAL DISEASES

FLAVOBACTERIOSIS

- Transmission
 - Horizontal
 - Vertical

NOTE: survives >5mos in distilled water and >2yrs in lake water (laboratory conditions)

BACTERIAL DISEASES

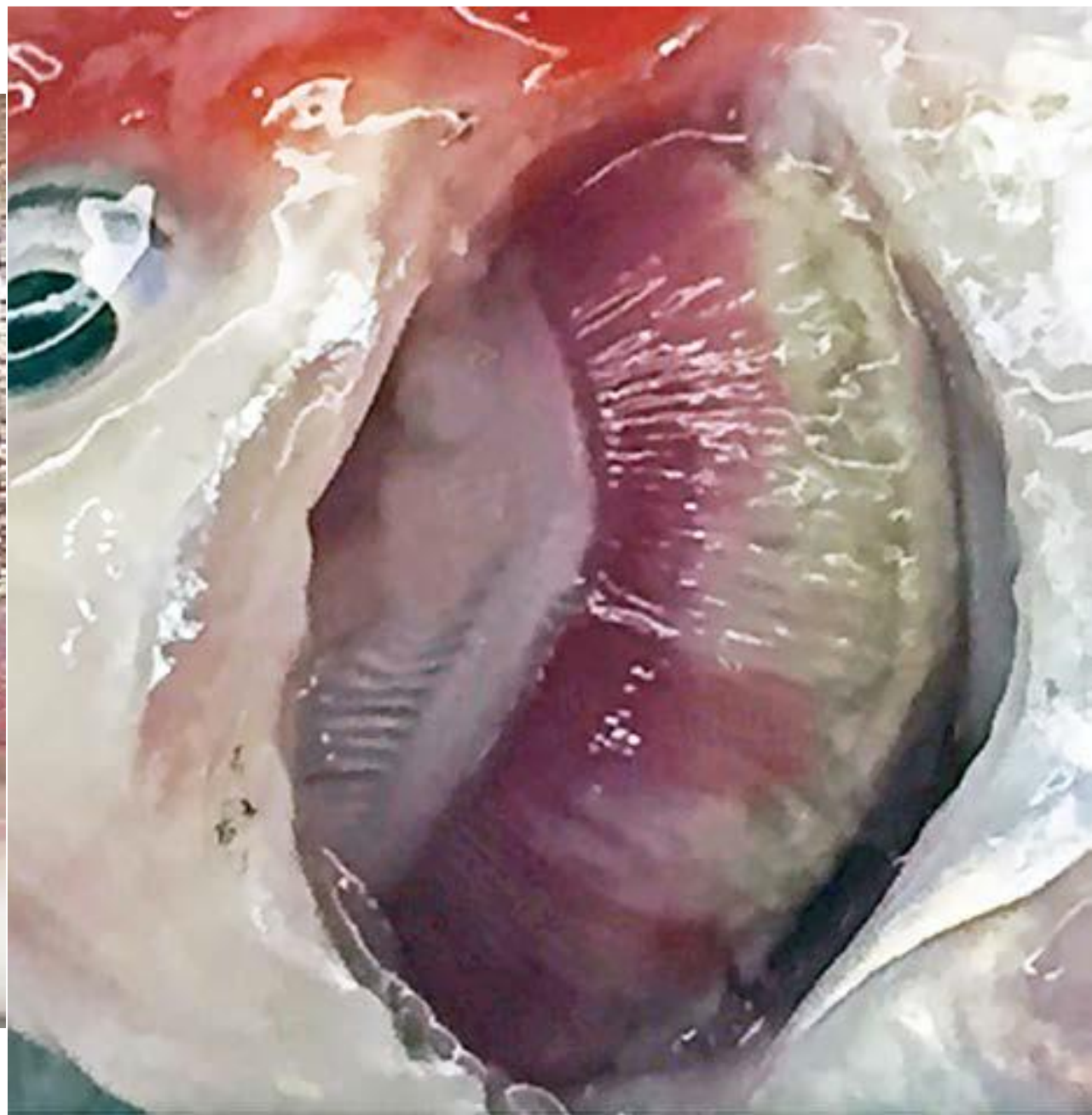
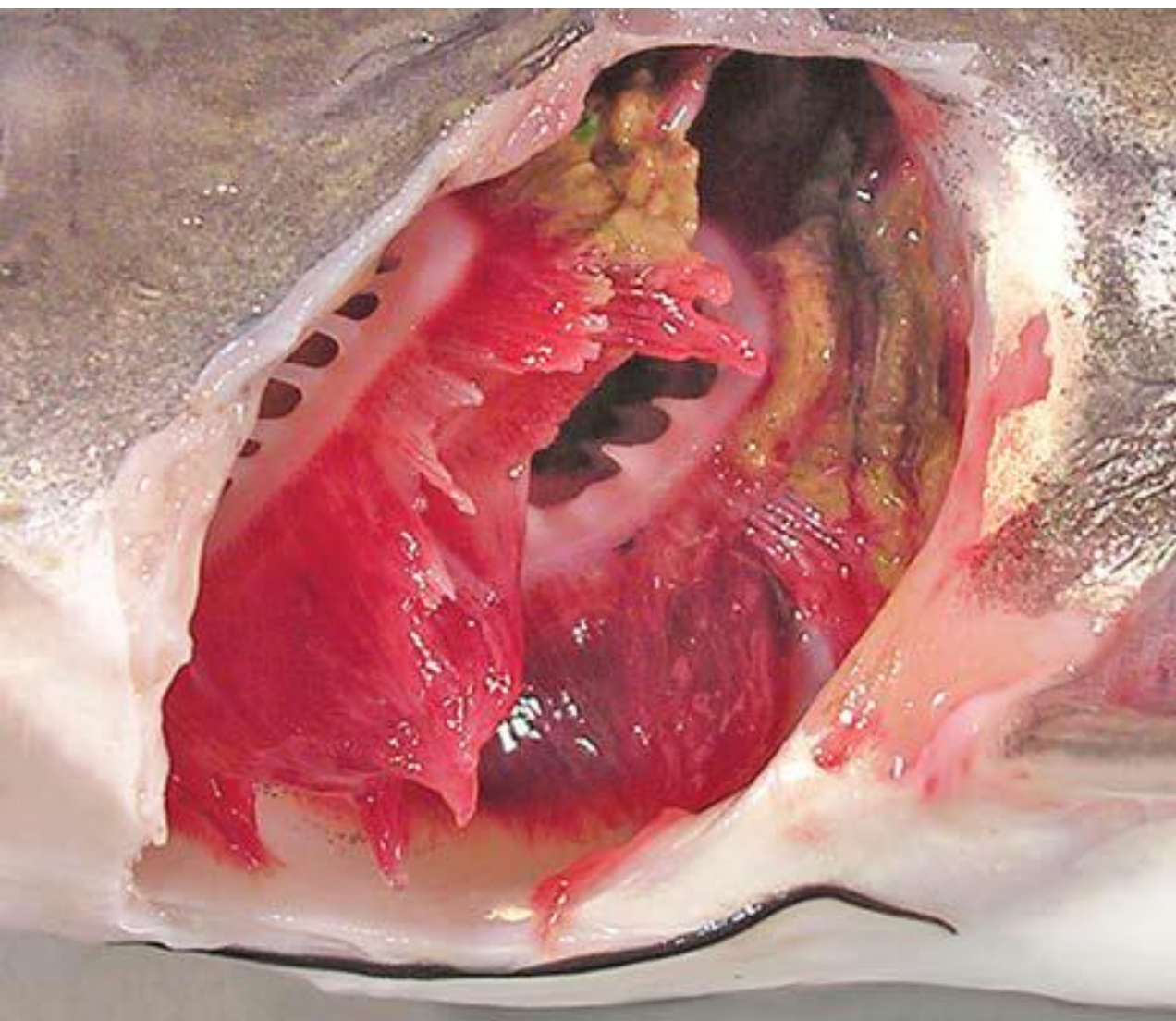
FLAVOBACTERIOSIS

- Clinical Signs
 - mortalities may be seen with no other signs
 - whitish plaques with red margins
 - Head
 - Back
 - Fins
 - pruritus
 - yellow-white or dark brown discoloration of the gills (distal aspect of the primary lamellae)
 - dyspnea and tachypnea

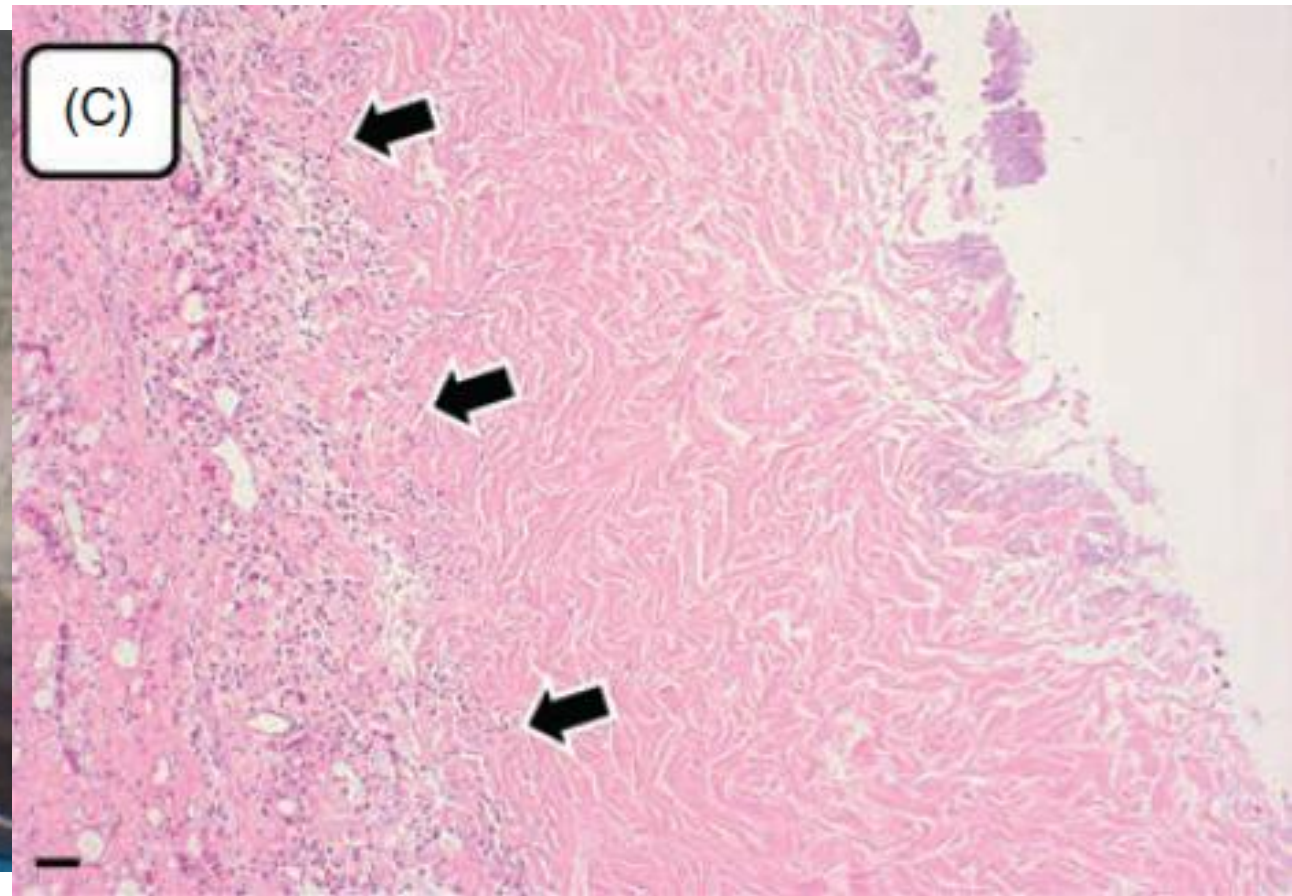
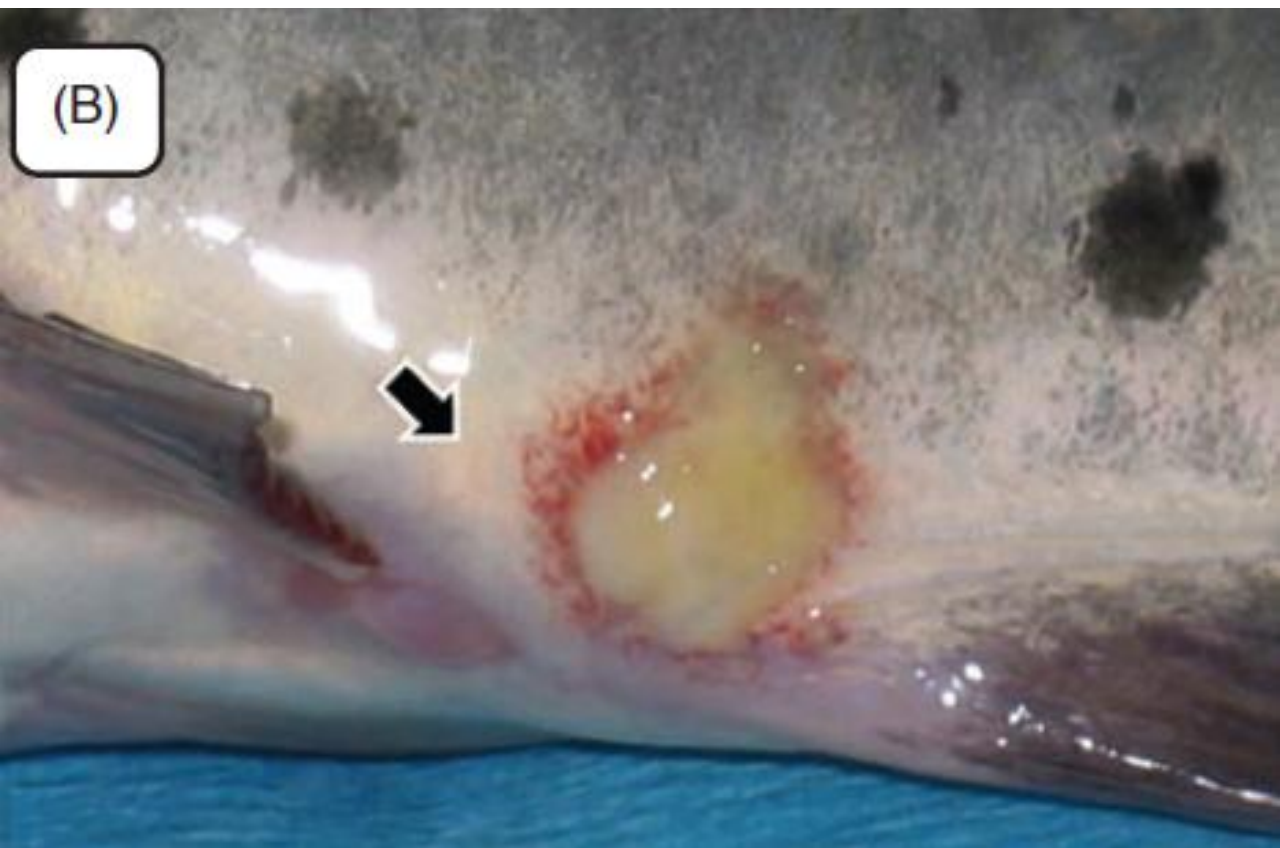
BACTERIAL DISEASES

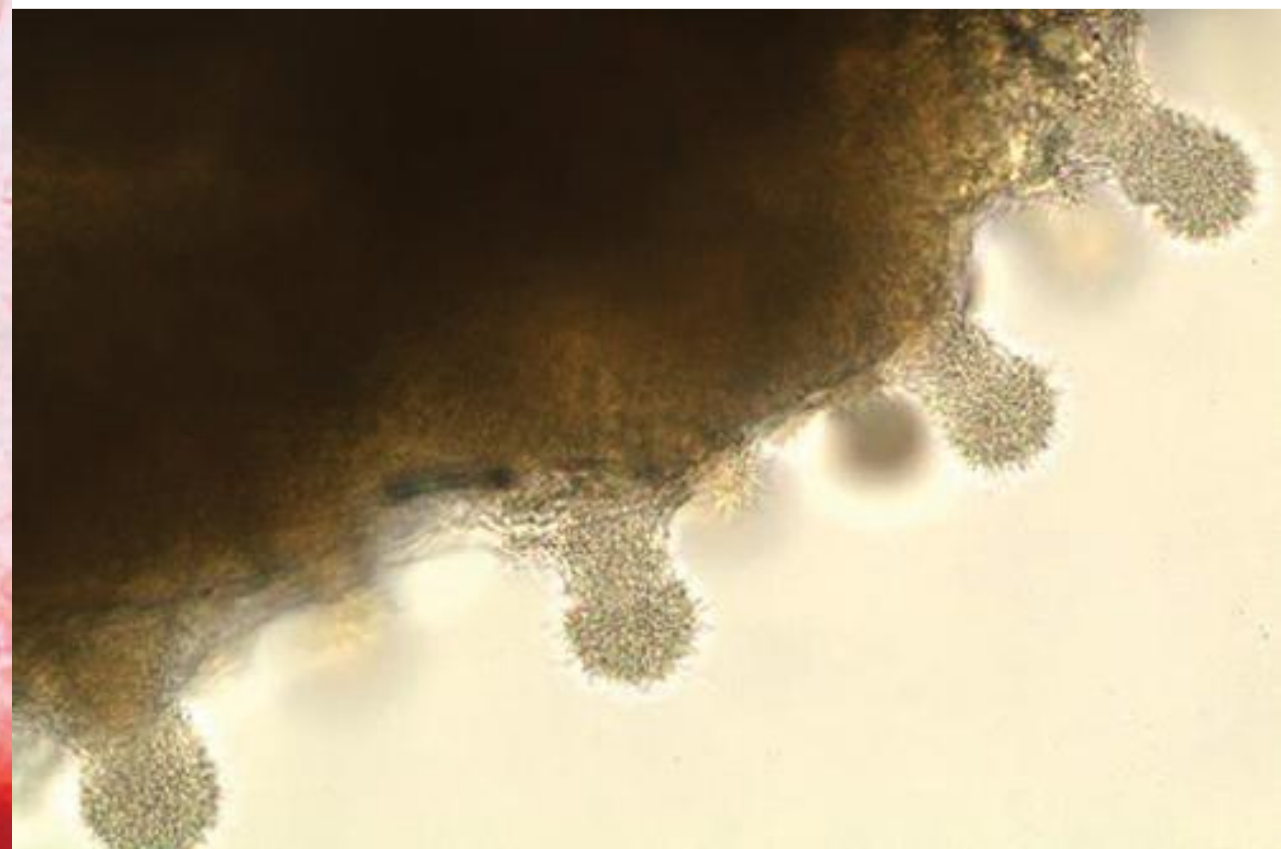
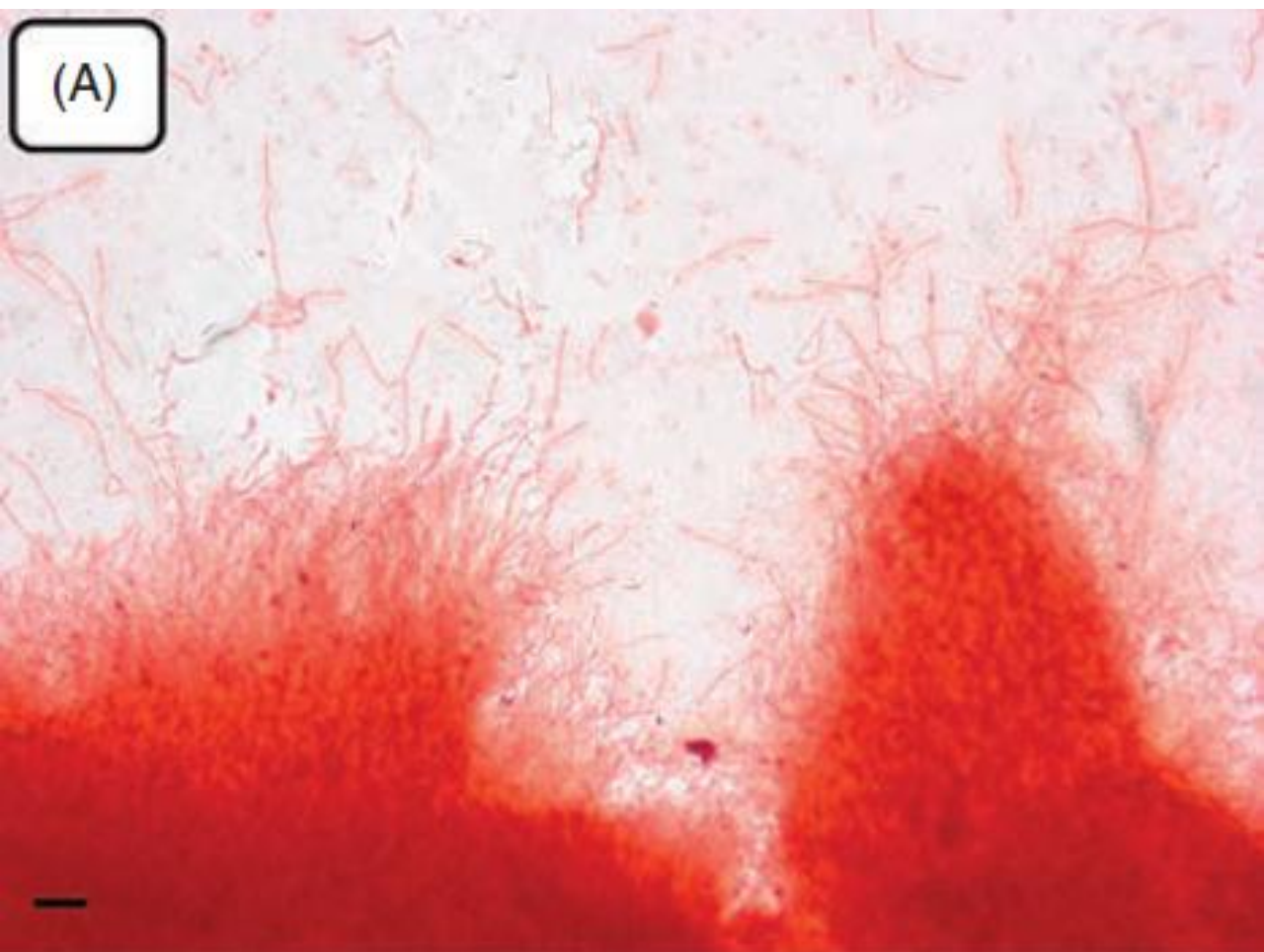
FLAVOBACTERIOSIS

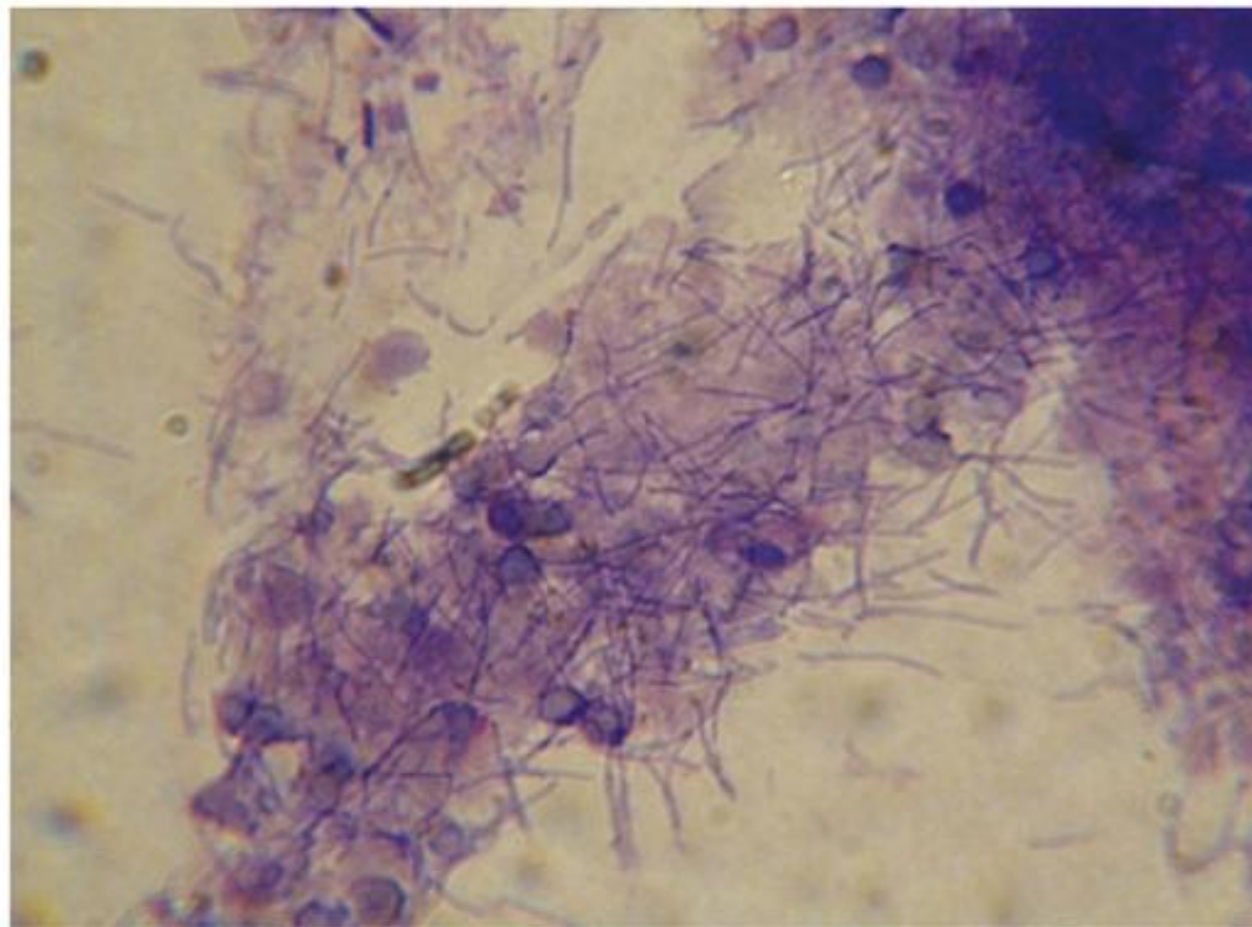
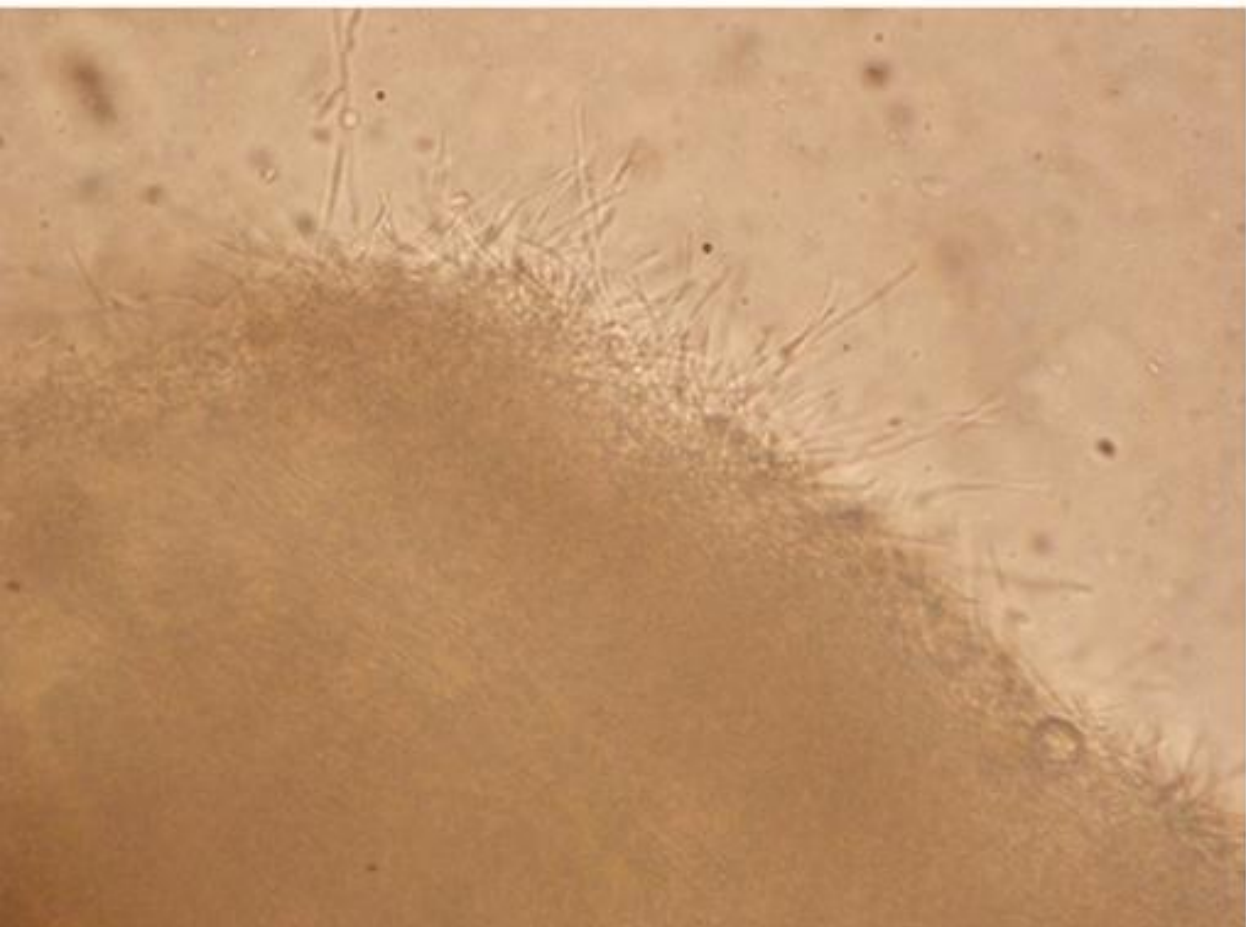
- Clinical Signs
 - Chronic cases
 - inappetence or reduced feeding
 - multifocal skin pallor to ulcers covered with white or yellow cotton-like mucus plaques.
 - hyperemic, yellow, or white rim lesions
 - (+/-) Skeletal muscle
 - fin lesions – start at the base of the fin and progress distally.
 - pruritus, edema, diffuse pallor, or darkening of the gills.











BACTERIAL DISEASES

FLAVOBACTERIOSIS

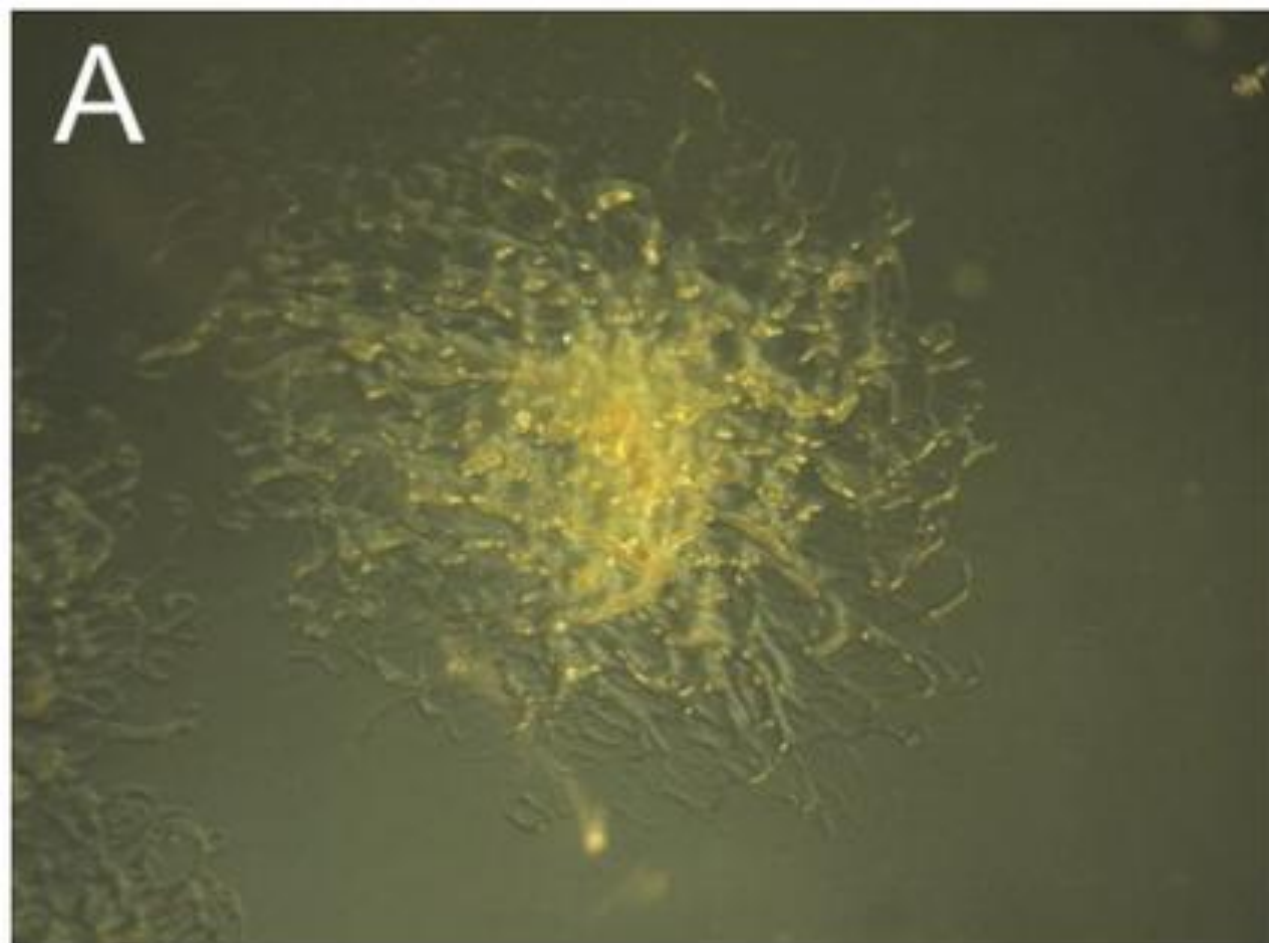
- Diagnosis
 - direct microscopy of skin scrapes or gill biopsies.
 - increased mucus, opportunist pathogens (scuticociliates), gill hyperplasia and fusion of secondary filaments.
 - histology – necrotizing, ulcerative dermatitis or branchitis with intralesional long, thin Gramnegative bacilli.

BACTERIAL DISEASES

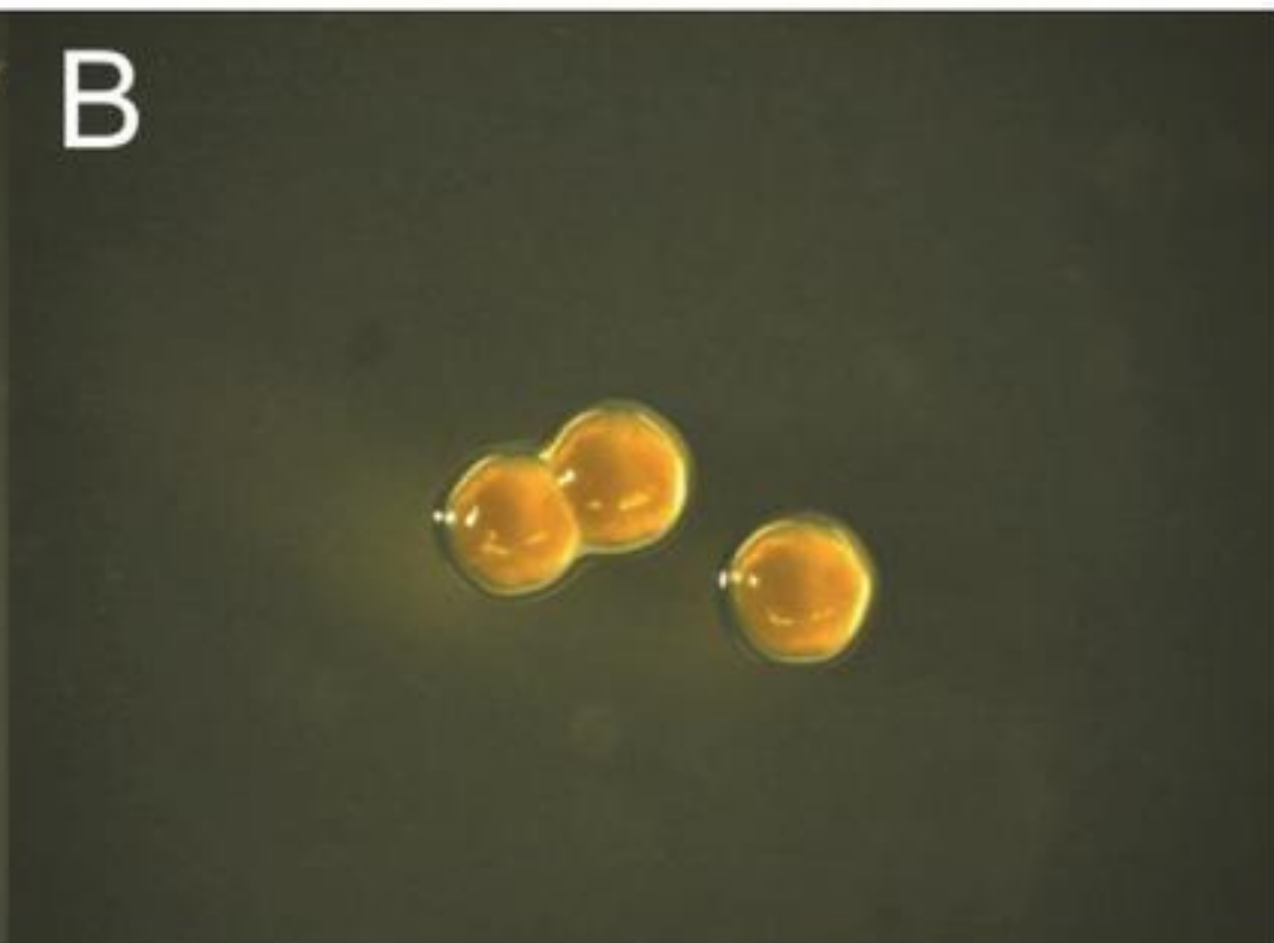
FLAVOBACTERIOSIS

- Diagnosis
 - Culture – edge of active lesions.
 - low-nutrient media (Shieh, Cytophaga, Hsu–Shotts), often at 25–30°C (77– 86°F).
 - Cytophaga medium
 - tryptone-enriched Cytophaga medium
 - tryptone yeast extract salts medium
 - NOTE: Marine flexibacteriosis benefits from additional sodium chloride.
 - PCR and qPCR tests on gill, skin, or cranial kidney
 - LAMP from gills, skin, or cranial kidneys – channel catfish.

A



B



BACTERIAL DISEASES

FLAVOBACTERIOSIS

- Management/Treatment
 - resolving environmental stressors can result in significant improvement.
 - Slowly reduce the water temperature to $<24^{\circ}\text{C}$ ($<75^{\circ}\text{F}$) and ideally $<15^{\circ}\text{C}$ ($<59^{\circ}\text{F}$)
 - Freshwater – low-dose hypersalinity treatment (2–3 g/L).

BACTERIAL DISEASES

FLAVOBACTERIOSIS

- Management/Treatment
 - Florfenicol (Aquaflor®) – 10–15 mg/kg PO q24hrs for 10 days (15-day WP).
 - Oxytetracycline dihydrate (Terramycin® 200) at 83 mg/kg PO q24hrs for 10 days (21-day WP)
 - Other antibiotics used in aquarium fish – enrofloxacin and trimethoprim sulfamethoxazole immersion.

BACTERIAL DISEASES

FLAVOBACTERIOSIS

- Management
 - Chloramine-T (HALAMID Aqua®) immersion is with a 0-day WP
 - Hydrogen peroxide (35% Perox-Aid®) immersion at 50–75 mg/L for one hour every 48 hours for 3 treatments, with a 0-day WP
 - Potassium permanganate (KMnO₄) immersion treatment at 2 mg/L above the permanganate demand
 - Other reported treatments
 - Oxolinic acid immersion.
 - Copper sulfate immersion.

BACTERIAL DISEASES

FLAVOBACTERIOSIS

- Prevention
 - high salinity (>5 g/L) and low hardness (<70 mg/L) – reduce survival.
 - attenuated immersion vaccine – channel catfish

BACTERIAL DISEASES

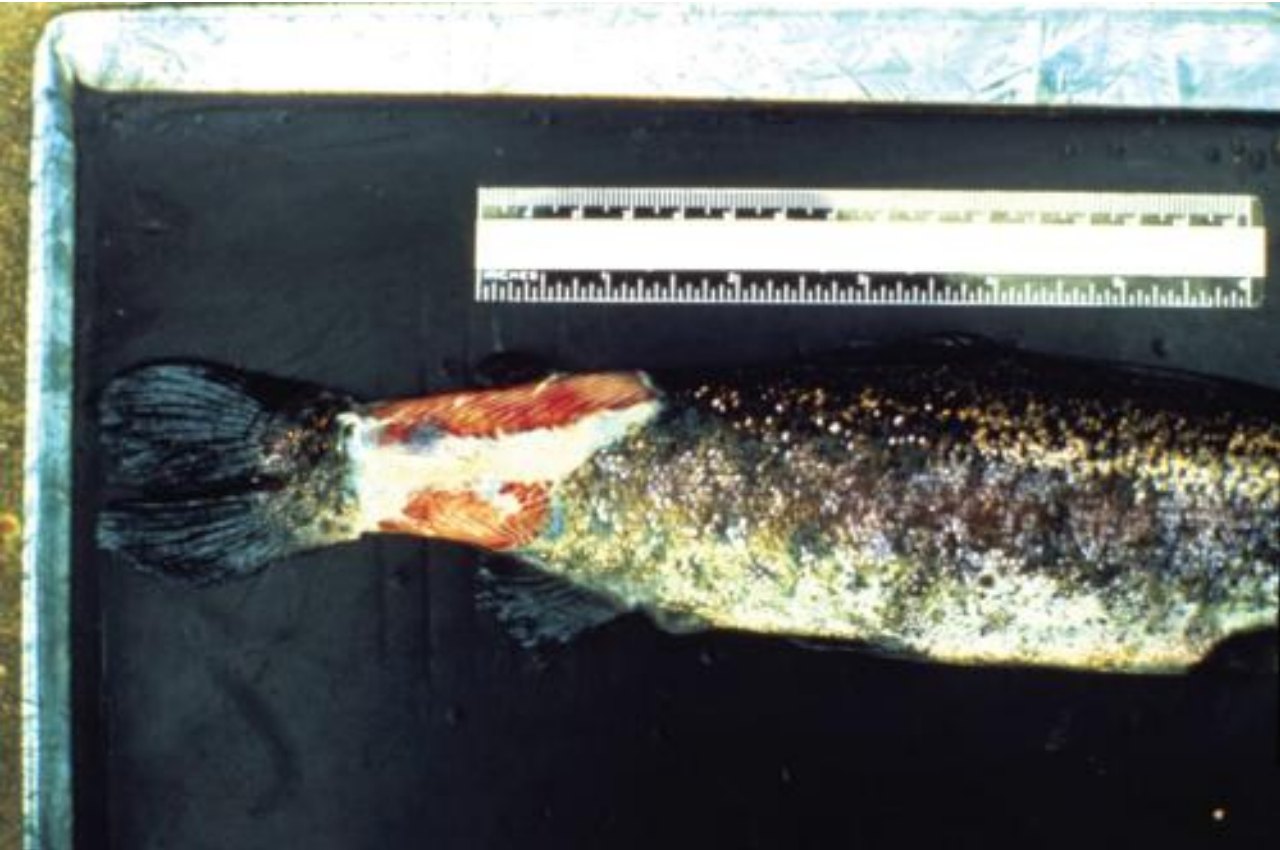
Bacterial cold-water disease and Rainbow trout fry syndrome

- caused by *Flavobacterium psychrophilum*
 - motile, long (~2–6 μm), thin, Gram-negative bacilli, seen in water temperature of <15°C (59°F), and can survive at least 300 days in freshwater.
- also known as **peduncle or saddle-back disease** in salmonid adults and fingerlings (BCWD) and **rainbow trout fry syndrome** (fry anemia syndrome) in fry.
 - horizontally and vertically (water and soil)

BACTERIAL DISEASES

BCWD and RTFS

- Clinical Signs
 - lethargy
 - inappetence
 - reduced feeding or gradual weight loss
 - coelomic distension and cloacal/anal distension
 - bilateral exophthalmos or gill pallor



BACTERIAL DISEASES

- Clinical Signs of *Flavobacterium psychrophilum* infection

Bacterial Cold Water Disease	Rainbow Trout Fry Syndrome
Skin darkening and large cutaneous ulcers and erosions (dorsal fins)	Skin darkening or asymmetrical coloration (right and left side)
Erosions (expose vertebrae)	Neurologic signs (abnormal position in the water and spiral swimming)
70–90% mortality	Low mortality
	Chronic spinal deformities

BACTERIAL DISEASES

Flavobacterium psychrophilum

- DDx (skin ulcers in salmonids)
 - long thin bacterial rods (*Flavobacterium columnare* and *F. psychrophilum*)

BACTERIAL DISEASES

Flavobacterium psychrophilum

- Diagnosis
 - direct microscopy of skin scrapes or gill biopsies.
 - necropsy or coeliotomy – splenomegaly, serosanguinous coelomic effusion, and tissue pallor.
 - Histology – pyogranulomatous inflammation and necrosis (muscle, bone, and cartilage with intralesional Gram-negative bacilli (spleen, heart, gills, muscle, bone, and cartilage)

BACTERIAL DISEASES

Flavobacterium psychrophilum

- Diagnosis
 - PCR – confirmatory
 - Culture from blood or tissues (e.g. spleen, kidney) - requires low-nutrient media (tryptone yeast extract salts), often at ~15–16°C (59–61°F).
 - ELISA and FA tests – screening salmonid broodstock (kidney and ovarian tissues)

BACTERIAL DISEASES

Flavobacterium psychrophilum

- Management
 - Slowly increase the water temperature
 - Transferring fish to systems – cleaned and disinfected with sodium hypochlorite (100 mg/L chlorine for 1hour followed by sodium thiosulfate).
 - Increase cleaning and disinfection
 - Antibiotic Therapy
 - Florfenicol (Aquaflor®) at 10–15 mg/kg PO q24hrs for 10 days with a 15-day WP
 - Oxytetracycline dihydrate (Terramycin® 200) FW at 83 mg/kg PO q24hrs for 10 days, with a 21-day WP

BACTERIAL DISEASES

Flavobacterium psychrophilum

- Management
 - Other treatments
 - Oxytetracycline immersion.
 - Potassium permanganate immersion.
 - Copper sulfate immersion.
 - Chloramine-T immersion.

BACTERIAL DISEASES

Flavobacterium psychrophilum

- Prevention
 - Screen broodstock using diagnostic assays (ELISA)
 - Disinfection of eggs (iodophors) – reduce vertical transmission (high doses)

BACTERIAL DISEASES

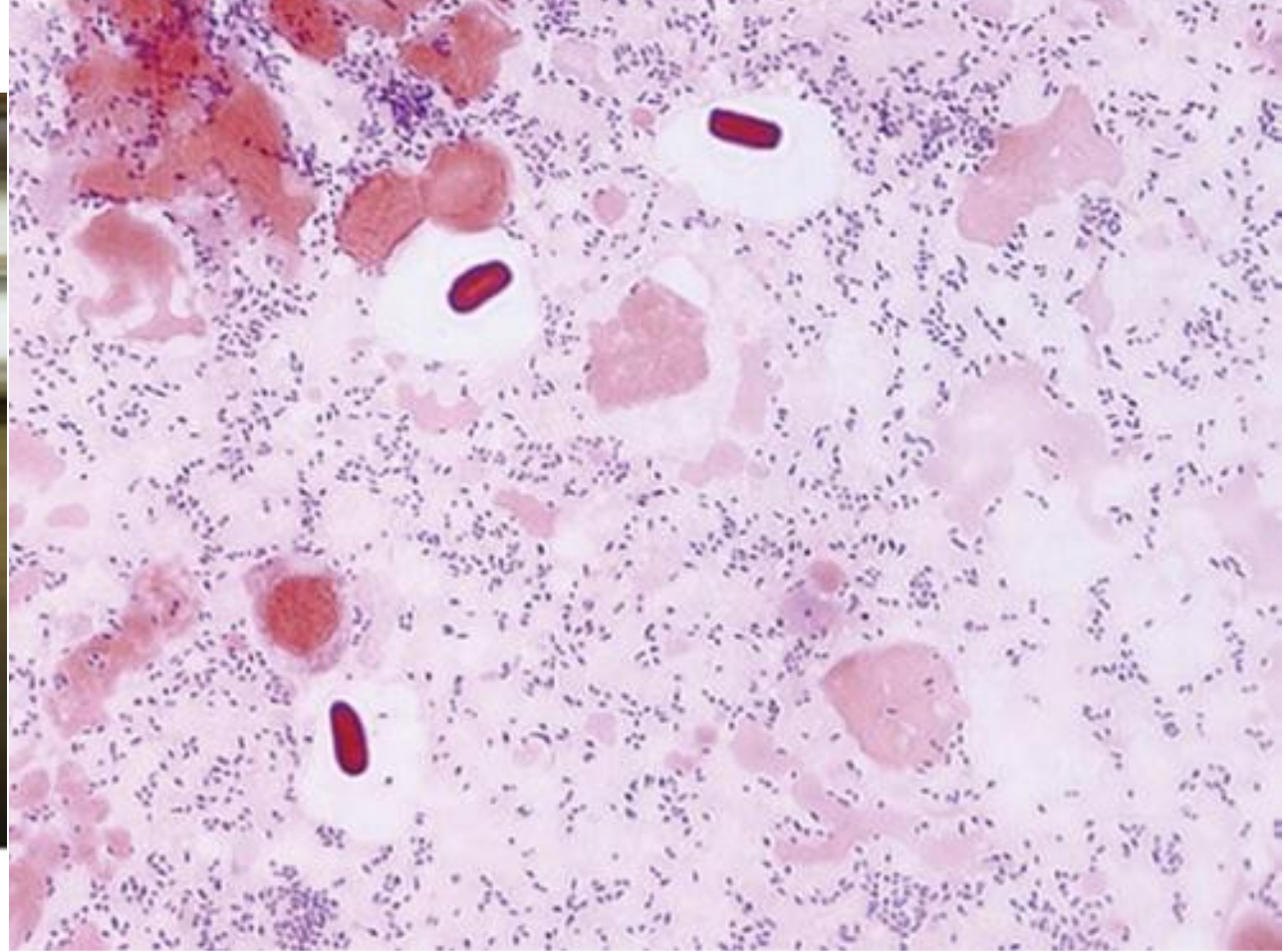
BACTERIAL KIDNEY DISEASE

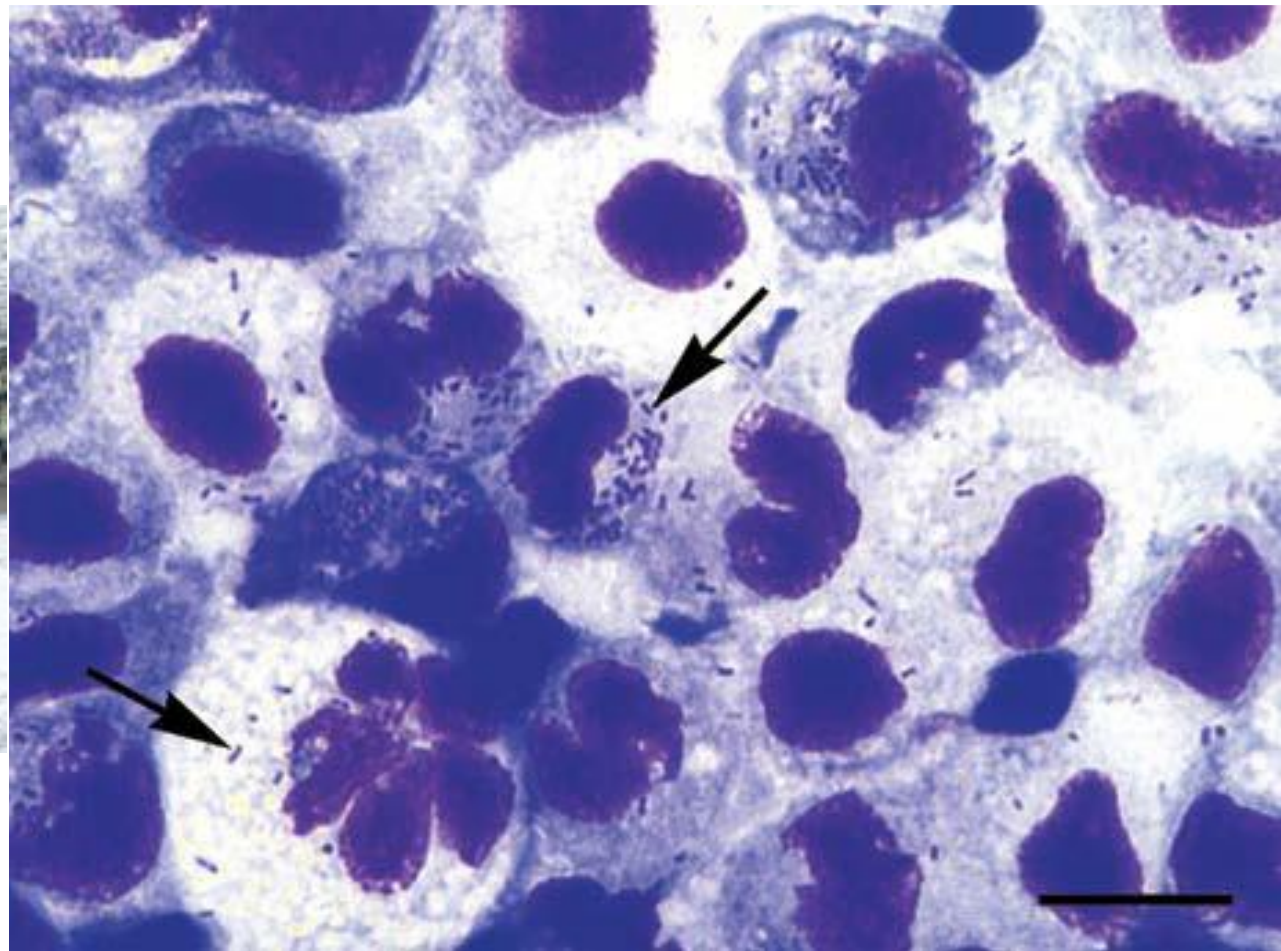
- a slowly progressive, systemic disease that has been reported from wild and cultured (or freshwater and marine) salmonids (6-12mos of age)
- caused by *Renibacterium salmoninarum*
 - obligate pathogen, nonspore-forming, nonmotile, small, Gram-positive diplobacilli, facultatively intracellular, and tend to survive for up to a few weeks in the environment.

BACTERIAL DISEASES

BACTERIAL KIDNEY DISEASE

- Clinical Signs
 - lethargy, poor growth rates, coelomic distension (common)
 - darkening of the skin, petechiae, erythema, ulcers, or pustules along the lateral line (spawning rash)
 - exophthalmos
 - low mortality rate but chronic, sporadic mortalities tend to continue.
 - granulomatous renomegaly with intralesional bacteria





BACTERIAL DISEASES

BACTERIAL KIDNEY DISEASE

- Diagnosis
 - gross necropsy in susceptible species and molecular diagnostics.
 - intralesional bacteria on blood smears, effusions, tissue cytology, or histology
 - Necropsy findings – (spleen, liver, and heart)
 - Serosanguinous ascites and pseudodiphtheritic serosal membranes
 - Cavernous lesions (skeletal muscle adjacent to the kidney)
 - Culture from tissues (particularly kidney)
 - kidney disease media with cysteine and may need antibiotics and antifungals

BACTERIAL DISEASES

BACTERIAL KIDNEY DISEASE

- Diagnosis
 - Nested PCR has a high sensitivity and is a common test outside of hatcheries.
 - Standard ELISAs – screen broodstock in hatcheries
 - Quantitative ELISAs
 - serum, ovarian fluid, or kidney supernatant.
 - FA tests
 - LAMP

BACTERIAL DISEASES

BACTERIAL KIDNEY DISEASE

- Management
 - Culling of fish with clinical signs
 - Macrolide antibiotics (erythromycin).

BACTERIAL DISEASES

BACTERIAL KIDNEY DISEASE

- Prevention
 - Good biosecurity
 - isolation from other farms
 - all-in-all-out management
 - separation of generations.
 - regular examination of broodstock
 - ELISAs (ovarian fluid in broodstock prior to breeding).
 - Erythromycin injection of females pre-spawning and immersion (treat eggs).
 - Experimental live vaccines

BACTERIAL DISEASES

MYCOBACTERIOSIS

- a common chronic disease of teleosts.
- caused by non-tuberculous mycobacteria (NTM)
 - *Mycobacterium fortuitum*
 - *Mycobacterium marinum*
 - *Mycobacterium chelonae*
 - nonmotile, acid-fast positive, non-spore forming, pleomorphic and often variable in length (1–10 μm), beaded bacill; may take up Gram stain
 - aerobic, facultatively intracellular, and slow-growing.

BACTERIAL DISEASES

MYCOBACTERIOSIS

- Risks
 - more common in adult and geriatric fishes
 - 28–30°C (82–86°F) for *M. Marinum*
 - Low pH, high humic and fulvic acids, and contaminants (zinc, iron)

BACTERIAL DISEASES

MYCOBACTERIOSIS

- Transmission
 - Transmission is typically horizontal – ingestion (live prey – rotifers, unpasteurized dead prey, scavenging, picking at the biofilm)
 - Inoculation and immersion.
 - Vertical transmission – uncommon
 - amphibians and reptiles – carriers or vectors.
 - Invertebrates and fomites

BACTERIAL DISEASES

MYCOBACTERIOSIS

- Clinical Signs
 - asymptomatic.
 - Acute(possible); chronic (weeks, months, or years following infection) and progressive
 - Inappetence, reduced appetite, weight loss, or poor growth rates
 - Lethargy, abnormal swimming, or abnormal buoyancy
 - Pigment changes (hyper- and hypopigmentation), petechiae, skin ulcers, scale loss, cutaneous nodules, or firm or soft cutaneous masses with possible exudates

BACTERIAL DISEASES

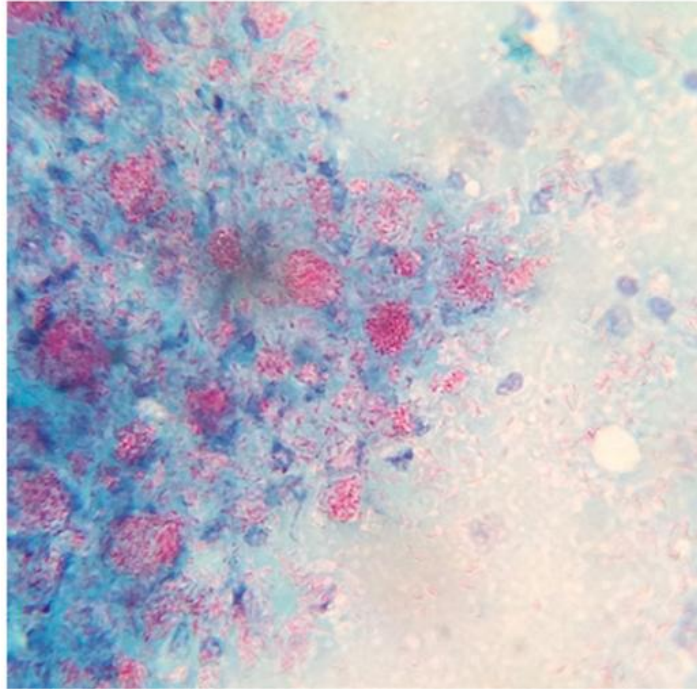
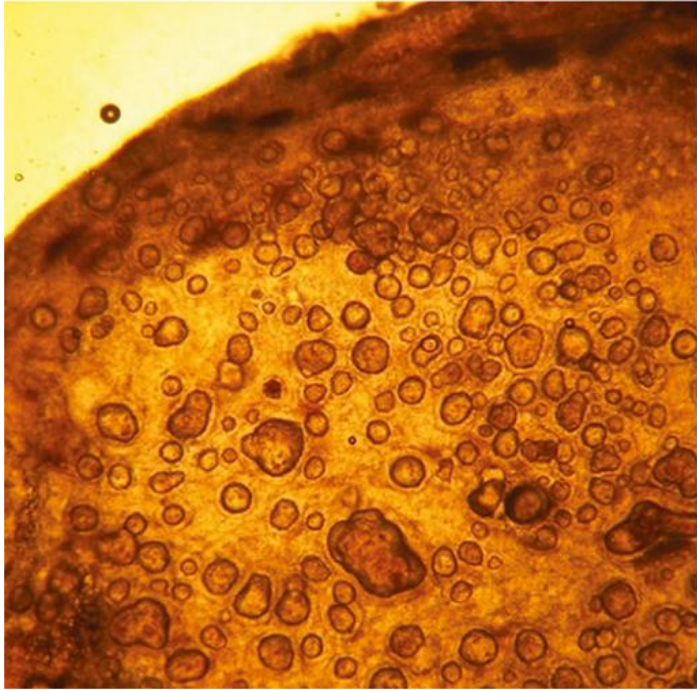
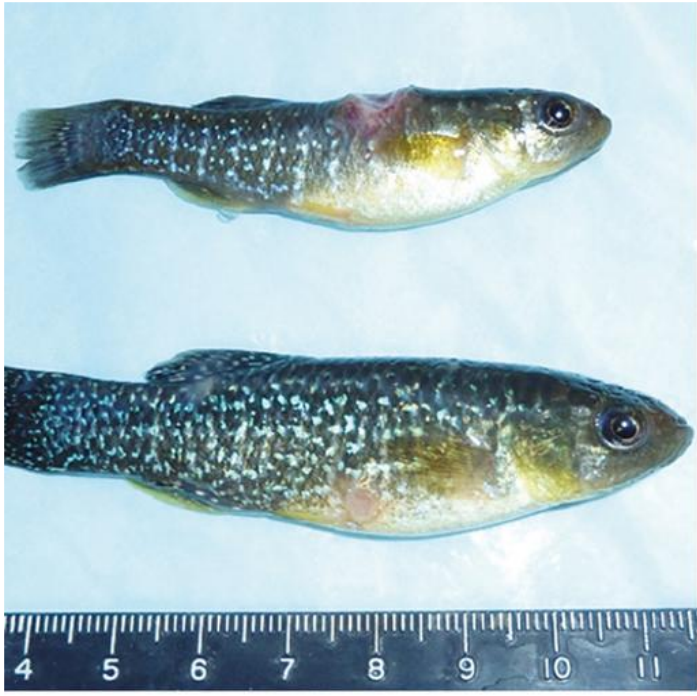
MYCOBACTERIOSIS

- Clinical Signs
 - ascites
 - exophthalmos, or less commonly enophthalmos
 - spinal deformities
 - chronically low fecundity or poor breeding success
 - sporadic mortalities (typical), but epizootics are possible

BACTERIAL DISEASES

MYCOBACTERIOSIS

- Clinical Signs
 - asymptomatic.
 - acute (possible); chronic (weeks, months, or years following infection) and progressive
 - inappetence
 - lethargy, abnormal swimming, or abnormal buoyancy
 - pigment changes (hyper- and hypopigmentation), petechiae, skin ulcers, scale loss, cutaneous nodules, or firm or soft cutaneous masses with possible exudate
 - coelomic distension
 - exophthalmos or enophthalmos (less common)
 - spinal deformities
 - chronically low fecundity or poor breeding success
 - sporadic mortalities but + epizootics



BACTERIAL DISEASES

MYCOBACTERIOSIS

- Differential Diagnoses
 - Granulomatous dermatitis
 - *Mycobacterium* spp., *Nocardia* spp., *Renibacterium salmoninarum*, *Exophiala* spp., and *Mesomycetozoea*.
 - Granulomatous inflammation – acid-fast positive structures
 - *Mycobacterium* spp., *Nocardia* spp., myxozoans, and *Cryptosporidium* spp

BACTERIAL DISEASES

MYCOBACTERIOSIS

- Diagnosis
 - granulomas with acid-fast beaded bacilli on cytology or histology
 - culture and PCR – definitive Dx
 - blood smears, effusions, scrapes from lesions, tissue cytology, or histology
 - On Romanowsky (e.g. Diff-Quik) and Gram stains, they often take up no stain (“ghosting”).
 - Acid-fast stains (Ziehl–Neelsen, Kinyoun, Fite) – pink to red beaded rods.
 - necropsy or coeliotomy and histology – organomegaly, granulomas, congestion, and necrosis (particularly the liver, spleen, kidney, and gonads) with intralesional acid-fast bacilli

BACTERIAL DISEASES

MYCOBACTERIOSIS

- Diagnosis
 - GIT – transient.
 - Diagnostic imaging
 - Culture (selective media – preferred [Lowenstein–Jensen, Middlebrook 7H10, Mitchison 7H11]).
 - Homogenization of tissues facilitates recovery. The growth rate and ease of culture vary significantly by species. Some (e.g. *M. chelonae*, *M. fortuitum*, *M. abscessus*) have a short generation time, while others require months to grow in culture (e.g. *M. marinum*, *M. haemophilum*, *M. pseudoshottsii*).
 - PCR or nested PCR
 - Mycolic acid or fatty acid profiles
 - PCR-RFLP (also known as terminal-RFLP) – more reliable identification.

BACTERIAL DISEASES

MYCOBACTERIOSIS

- Management
 - reduce morbidity and mortality
 - minimize environmental stressors (reducing the water temperature)
 - isolate affected systems
 - culling of fish with clinical signs, cleaning, and disinfection
 - Heat (>60–121°C or 140–250°F)
 - Sunlight
 - Chlorine at >500 mg/L for 30 minutes
 - Phenols (benzyl-4-chlorophenol/phenylphenol (Lysol) 1% for 1min)
 - Ethyl alcohol 70% for 1min
 - UV disinfection with high applied doses (>90 mJ/cm²).
 - ammonium chloride, peroxymonosulfate, or freezing (not effective)
 - dispose all substrate and filter media
 - strict biosecurity measures

BACTERIAL DISEASES

MYCOBACTERIOSIS

- Management
 - Antibiotics – azithromycin, kanamycin, tobramycin, and amikacin.
 - Avoid using human treatment of mycobacterial diseases – isoniazid, rifampin, and clarithromycin.

BACTERIAL DISEASES

MYCOBACTERIOSIS

- Prevention
 - acid-fast staining at necropsy and histology for routine monitoring
 - pasteurization of fish feeds
 - avoid using Elderly fish as broodstock.
 - sentinel programs (zebrafish colonies) and routine disinfection of eggs and larvae
 - experimental live attenuated vaccines (including BCG) and DNA vaccines given by ICe or IM injection – can provide some protection.

