Food and Agriculture Organization of the United Nations

FMM/RAS/298: Strengthening capacities, policies and national action plans on prudent and responsible use of antimicrobials in fisheries

MAJOR BACTERIAL DISEASES AFFECTING AQUACULTURE

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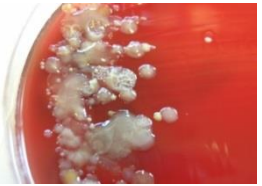
Aquatic AMR Workshop 1: 10-11 April 2017, Mangalore, India

Introduction

FAO organized the workshop ***Food Security for the Future: The Role of Aquatic Health*, Oct 2015, at Mississippi State University,**

and two writeshops (Frascati, Italy, Dec 2016; Mangalore, 7-9 April 2017) for the expert group for the book

"**RESPONSIBLE MANAGEMENT OF BACTERIAL DISEASES IN AQUACULTURE**" for FAO ➡ criteria ➡ Major bacterial diseases affecting aquaculture in view



FAO Expert meeting at Frascati, Italy, Dec 2016

Criteria used for making the draft list of most important bacterial pathogens in aquaculture :

(1) economic importance of affected species
(2) socio-economic impact
(3) zoonotic potential

cold	temperate	tropical
Appr. 0-15°C	5-25°C	20-37°C

Zoonotic means: contact-zoonotic

Most Important Bacterial Diseases in Aquaculture (Dec 2016)

Gram-negative bacteria	Gram-positive bacteria
Vibriosis (*V. anguillarum, V. harveyi* clade, *V. parahaemolyticus, Aliivibrio salmonicida* (*V. salmonicida*), *V. vulnificus* , *Photobacterium damselae*)	Mycobacteriosis (*Mycobacterium fortuitum, M. marinum, Nocardia asteroides, N. crassostreae (ostreae), N. seriolae*)
Aeromonasis (Motile *Aeromonas* spp.:*Aeromonas caviae, A. hydropila, A. sobria, A. veronii, A. jandaei*; *A. salmonicida*)	Streptococcosis (*Streptococcus agalactiae, S. iniae, Lactococcus garvieae, Aerococcus viridans*)
Edwardsiellosis (*Edwardsiella anguillarum, E. ictaluri, E. piscicida, E. tarda, Yersinia ruckeri*)	Renibacteriosis (*Renibacterium salmoninarum*)
Pseudomonasis (*Pseudomonas anguilliseptica, P. fluorescens*)	Infection with Anaerobic Bacteria (*Clostridium botulinum*, *Enterobacterium catenabacterium*)
Flavobacteriosis (*Flavobacterium branchiophilum, F. columnare, F. psychrophilum, Tenacibaculum maritinum*)	
Infection with Intracellular Bacteria (*Piscirickettsia salmonis, Hepatobacter penaei, Francisella noatunensis, Chlamydia* spp.)	

In red: considered important for tropical regions

1. VIBRIOSIS : *Vibrio anguillarum*

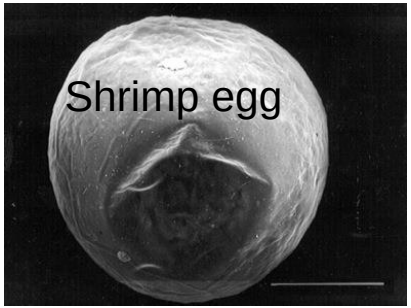
- **Host range**: in **> 50 fish species** of freshwater/marine fish, like eel *(A. anguilla*) and seabass *(Dicentrarchus labrax)*
- **Geographic distribution**: global
- **Diagnostics:** standard, with salt media
- **Management:** vaccines available
- **Zoonotic potential:** no

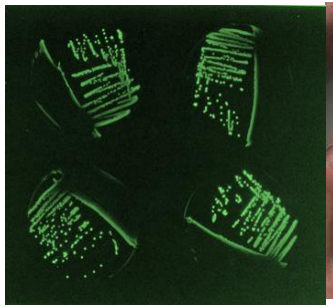
seabass

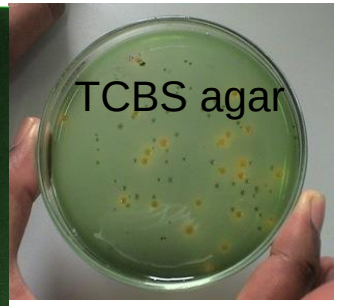
cold | temperate | tropical

1. VIBRIOSIS: *Vibrio harveyi:* Luminescent vibriosis

- **Host range**: in culture of shrimp larvae, grouper, snapper, Asian seabass
- **Geographic distribution**: warm regions, ubiquitous in seawater
- **Diagnostics:** TCBS agar a.o., luminescent; diagnosis is easy
- **Management:** Eggs are colonized by *V. harveyi* before hatch: remove spawners and rinse eggs
- **Zoonotic potential:** no







temperate | tropical

1. VIBRIOSIS: *Vibrio vulnificus*

- **Host range**: eel, *Anguilla* spp. and other marine fish
- **Geographic distribution**: warm regions, ubiquitous in seawater
- **Diagnostics:** standard and TCBS agar a.o.
- **Management:** apply good hygiene, avoid seawater at eel farms
- **Zoonotic potential: yes,** Biotypes 1 and 2

Biotype 1

Biotype 2

temperate | tropical

1. VIBRIOSIS : *Aliivibrio salmonicida* (hitra disease, cold water vibriosis)

- **Host range**: sea-farmed Atlantic salmon, *Salmo salar*, Sea-farmed rainbow trout, *Oncorhynchus mykiss* and Atlantic cod, *Gadus morhua*
- **Geographic distribution**: Since 1977 in Norway, then in Scotland, Iceland and the Faroer Isles, Canada, and the USA
- **Diagnostics:** standard
- **Management:** vaccine since 1987
- **Zoonotic potential:** No

1. VIBRIOSIS :*Photobacterium damselae* “Pasteurellosis”, “pseudotuberculosis”

- **Host range**: various marine fish
  - yellowtail (*Seriola quinqueradiata*) and other : ***Photobact. damselae piscicida***
  - marine fish, like sea bass, tuna: ***Photobact. damselae* subsp. *damselae***
- **Geographic distribution**:
  - *Photobact. dams.pisc.:* Japan, Taiwan, China, Israel, Portugal, Mediterranean
  - *Photobact. damselae. dams.* Extra: Korea and Australia
- **Diagnostics:** standard
- **Management:** lower water temp to <18°C; vaccine for *Photobact. damselae piscicida*
- **Zoonotic potential: yes** (*Photobact. damselae dams.)*

temperate **tropical**

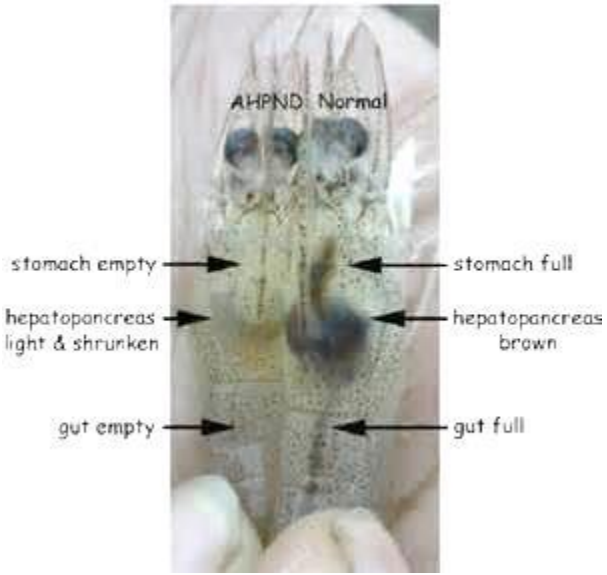
Acute form in sea bass

Chronic form in sea bass

Yellow fin tuna

1. VIBRIOSIS : an AHPND strain of *Vibrio parahaemolyticus* :
Acute Hepatopancreatic Necrosis Disease (AHPND) (OIE listed)

- **Host range**: farmed *Penaeus vannamei, P. monodon, P. chinensis,* possibly other shrimp species
- **Geographic distribution**: since 2009 present: P.R. of China, Vietnam, Malaysia, Thailand, Philippines, and Mexico
- **Diagnostics:** Detection of virulence genes *Pir*A and *Pir*B, expt. field test kits
- **Management:** please see OIE
- **Zoonotic potential:** so far: no



tropical

2. AEROMONIASIS: Motile *Aeromonas* spp.: *A.caviae, A.hydrophila, A.sobria, A.veronii, A. jandaei*

- **Host range**: various fresh- and brackish water fish species, like catfish, tilapia, *Puntius*, rohu, other cyprinids
- **Geographic distribution**: global, opportunistic
- **Diagnostics:** standard
- **Management:** avoid other causes of disease
- **Zoonotic potential:** low

channel catfish *Ictalurus punctatus* in USA

Aer. hydrophila

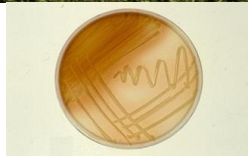
Puntius and rohu in India *(Dr. Sahoo)*

cold | temperate | tropical

2. AEROMONIASIS: *Aeromonas salmonicida subsp. salmonicida*: classical Furunculosis; atypical *Aeromonas salm.*:“Carp erythrodermatitis”

- **Host range**: typical: salmonids, marine fish; atypical: various freshwater and marine fish species
- **Geographic distribution**: Cold to temperate zone
- **Diagnostics:** standard, typical: mostly brown pigment in agar
- **Management:** standard. Vaccines available.
- **Zoonotic potential:** no

typical



atypical

cold | temperate

3. EDWARDSIELLOSIS: *E. tarda*, *E. piscicida*, and *E. anguillarum*

- **Host range**: various freshwater and marine fish, tilapia, *Pangasius hypophthalmus*, eel
- **Geographic distribution**: global
- **Diagnostics:** standard
- **Management:** standard. Vaccines available.
- **Zoonotic potential: yes:** *E.tarda*

cold | temperate | tropical

3. EDWARDSIELLOSIS: *E. ictaluri:* Enteric Septicemia of Catfish (ESC)

- **Host range**: *Pangasius hypophthalmus*, tilapia *(Oreochromis niloticus),* farm-raised catfish (*Ictalurus punctatus)*
- **Geographic distribution:** Mississippi area, Western hemisphere, Florida, Vietnam
- **Diagnostics:** standard
- **Management:** standard. Vaccines available.
- **Zoonotic potential:** no.

temperate | tropical

3. *Yersinia ruckeri*: ENTERIC RED MOUTH (ERM)

- **Host range**: rainbow trout and other salmonids
- **Geographic distribution:** global
- **Diagnostics:** standard, yellow faeces
- **Management:** standard. Vaccines available.
- **Zoonotic potential:** no.

cold | temperate | tropical

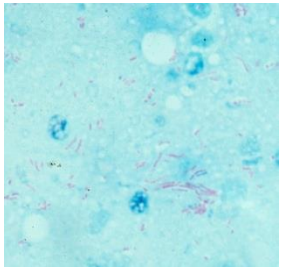
4. PSEUDOMONIASIS: *Pseudomonas anguilliseptica*, ”Sekiten-byo” in Japanese eel, ‘Red spot disease’ in elvers *Anguilla* spp, “winter disease” in sea bream *Sparus aurata;* and *Pseudomonas fluorescens*

- **Host range**: *Pseud. ang*.: Many susceptible fish species, like eel, tilapia (Egypt), cod; *Ps.fluor.:* tilapia, tench, silver carp, bighead carp, rainbow trout
- **Geographic distribution:** *Pseud. ang*.: Japan, since 1981 in Europe, N-Africa, SE-Asia ; *Ps.fluor*.: global
- **Diagnostics:** standard
- **Management:** *Pseud. ang*. can be cured by increasing the water temp to 27°C for 2 weeks, without antibiotics
- **Zoonotic potential:** no.

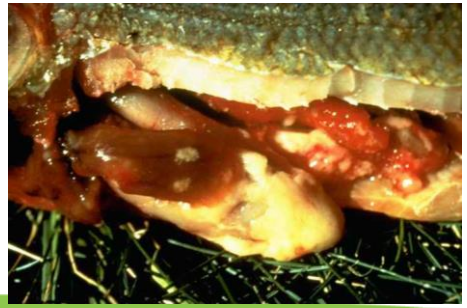
cold | temperate | tropical

5. MYCOBACTERIOSIS: *Mycobacterium marinum* and *M. fortuitum*
Fish tuberculosis

- **Host range**: freshwater, brackish and marine fish species, like tilapia, catfish, cyprinids, snakehead, striped bass
- **Geographic distribution**: global
- **Diagnostics:** special media, slow grower, ZN-stain
- **Management:** Cannot be cured with antibiotics
- **Zoonotic potential: yes**



Ziehl Neelsen +

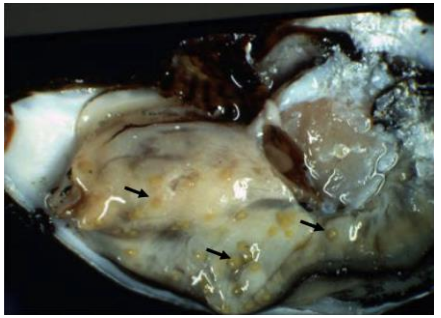


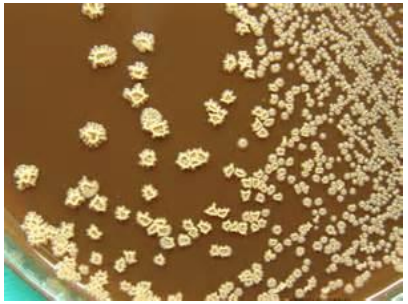
cold | temperate | tropical

5. MYCOBACTERIOSIS: *Nocardia asteroides/seriolae/crassostreae*

- **Host range**:
  - *N. asteroides:* trout, various marine fish, *N. seriolae* in marine fish species, like Jap. flounder, yellowtail, seabass
  - *N. crassostreae* in shellfish (Pacific oyster, mussels)
- **Geographic distribution**: *Nocardia* in fish: global; *N. crass.:* USA and Canada, Japan, the Netherlands
- **Diagnostics:** special media, slow grower, typical colony form
- **Management:** Cannot be cured with antibiotics
- **Zoonotic potential:** no

N.crass. in Pacific oyster





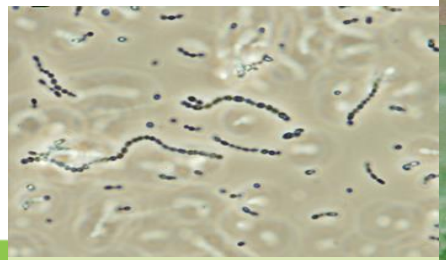
Typical growth

cold | temperate | tropical

6. STREPTOCOCCOSIS

Streptococcus agalactiae/iniae

- **Host range**: various freshwater and marine fish species, **tilapia** (*Oreochromis niloticus*), channel catfish (*Ictalurus punctatus*), rainbow trout (*Oncorhynchus mykiss)*,
- **Geographic distribution**: USA, Australia, Bahrain, Barbados, China, Taiwan, Thailand, Japan, Korea, Israel, S-Europe, Iran, South Africa
- **Diagnostics:** standard
- **Management:** There is a vaccine for *S. iniae*.
- **Zoonotic potential: yes**



Streptococcus iniae

cold | temperate | tropical

6. STREPTOCOCCOSIS: *Lactococcus garvieae*

- **Host range**: rainbow trout, and marine species like Japanese yellowtail, and grey mullet
- **Geographic distribution**: E-Asia, Spain
- **Diagnostics:** standard.
- **Management:** >18°C outbreaks. Vaccine available.
- **Zoonotic potential:** no

6. STREPTOCOCCOSIS: *Aerococcus viridans*: ‘Gaffkemia’

- **Host range**: Crayfish, *Macrobrachium* spp., freshwater lobsters, like *Homarus americanus,*
- **Geographic distribution**: India, N-America, Ecuador, Australia, sometimes Europe with imports
- **Diagnostics:** standard
- **Management:** risk with watering import lobsters
- **Zoonotic potential:** no

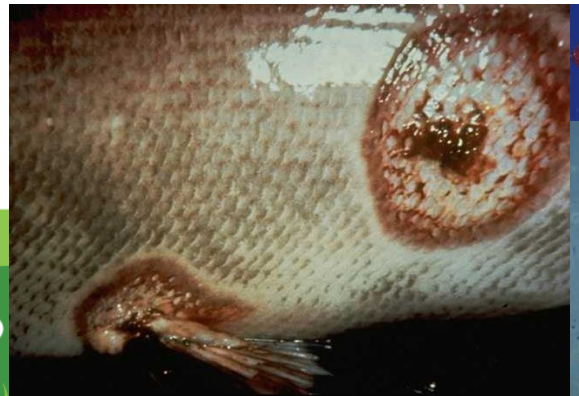
cold | temperate | tropical

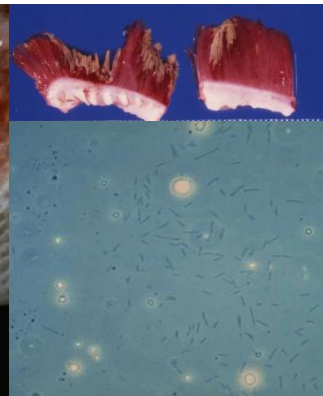
7. FLAVOBACTERIOSIS:

* (***Flavobacterium branchiophilum:*** Bacterial Gill Disease (BGD)(cold))
* ***Flavobacterium columnare:*** Columnaris disease
* (***Flavobacterium psychrophilum:***'bacterial coldwater disease' (BCWD)', 'rainbow trout fry syndrome' (RTFS))
* *(Tenacibaculum maritinum* in marine fish at global level)

Flavobact .columnare:

- **Host range**: various cultured freshwater fish species worldwide, like tilapia, cyprinids
- **Geographic distribution**: global
- **Diagnostics:** special media needed.
- **Management:** standard. Vaccine available
- **Zoonotic potential:** no.

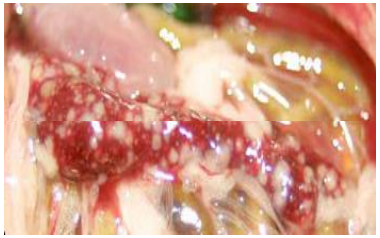




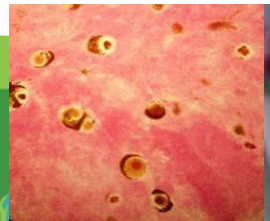
9. INFECTION WITH INTRACELLULAR BACTERIA:

* *Piscirickettsia salmonis* in salmonids (cold)
* Necrotising hepatopancreatitis (NHP) in peneaids (OIE-listed, exotic to Asia)
* ***Francisella noatunensis***
* *Chlamydia* spp.in salmonids

- **Host range**: **tilapia** in the Costa Rica and Asia, hybrid striped bass, threeline grunt, Atlantic salmon, and Atlantic cod
- **Geographic distribution**: Japan, Taiwan, N-Europe, Central- and South America, including Chile
- **Diagnostics:** special media needed
- **Management:** standard.
- **Zoonotic potential:** no.



Lesions in tilapia in Costa Rica



Zoonotical fish pathogenic bacteria from warmwater systems

- *Streptococcus agalactiae* (**tilapia**, a.o.)
- *Streptococcus iniae* (**tilapi**a a.o.)
- *Edwardsiella tarda* (eel, cichlids, ornamental fish)
- *Vibrio vulnificus* (eel)
- *Photobact. damselae damselae* (marine fish)
- *Mycobacterium marinum* (various warmwater fish, incl. **tilapi**a)
- *Mycobacterium fortuitum* (warmwater ornamental fish)

KEEP GOOD HYGIENE!

2 Examples of contact zoonosis from fish

Vibrio vulnificus Biotype 2

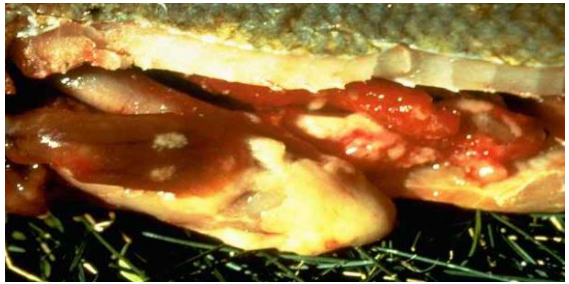
Fasciitis necroticans in **immunocompromised** eel farmer NL

⇩

IC, surgery (4x)

and antibiotics i.v.
amoxicilline, ceftazidim, ciprofloxacine,doxycycline

Mycobacterium marinum



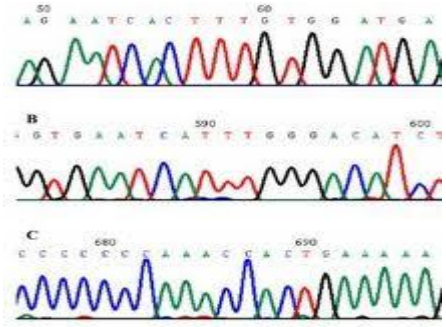
Swimmer granuloma
Take care: may be missed, as cultured at 37°C in hospitals: no growth. 30°C is optimum

Some relevant bacterial problems in cultured warmwater ornamental fish

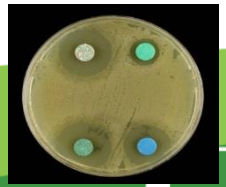
- *Aeromonas* spp. in koi and goldfish
- *Vibrio vulnificus* in *Garra rufa* (spa fish)
- *Edw.ictaluri* in zebrafish *(Danio rerio)*
- *Y. ruckeri* in kissing gourami
- *Pseud. fluorescens* in goldfish
- *Mycobacterium marinum /fortuitum* in goldfish, *Garra rufa,* zoo warmwater fish (old recirculation systems)
- *N. asteroides* in freshwater ornamental fish
- And other...

Diagnosis of fish bacterial diseases

- Always realize: **primary** or **secondary** infection?
- Isolation and identification
  - Biochemistry: slow, not always specific
  - 16S rRNA typing: fast, specific, but expensive
  - Diagnostic PCR (culture needed for ab-test)
  - Serological field tests (ELISA-based)
  - Protein method: MALDI TOF: fast, specific, apparatus expensive



- Antibiogram (pure culture needed)



Prophylaxis: fish vaccines in use

- *Aeromonas salmonicida*
- *Vibrio salmonicida*
- *V. anguillarum*
- *Yersinia ruckeri*
- *Renibacterium salmoninarum*
- *Flavobacterium psychrophilum*
- *F. columnare*
- *Piscirickettsia salmonis*
- *Lactococcus garvieae*
- *Streptococcus iniae*
- *Photobacterium damselae* subsp. *piscicida*
- *Edwardsiella ictaluri* *among others...*

SUMMARY and CONCLUSIONS

- There are many bacterial aquaculture diseases worldwide, of which many relevant for tropical regions
- Some of the pathogens may be contact-zoonotic, good hygiene is crucial for aquafarmers, field technicians, and processors
- Proper diagnosis of bacterial diseases is crucial
- Many of the diseases can be prevented by good management, including use of appropriate vaccines
- In case antibiotic treatment is necessary, we recommend to always make an antibiogram
- Countries: please pay attention to this list of bacterial pathogens
- Please validate during working group discussions: did you miss pathogens?

Thank you for your attention!

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Painting: Anonymus, Utrecht 1640