BKD – *Renibacterium salmoninarum* infections – what we know and don't know

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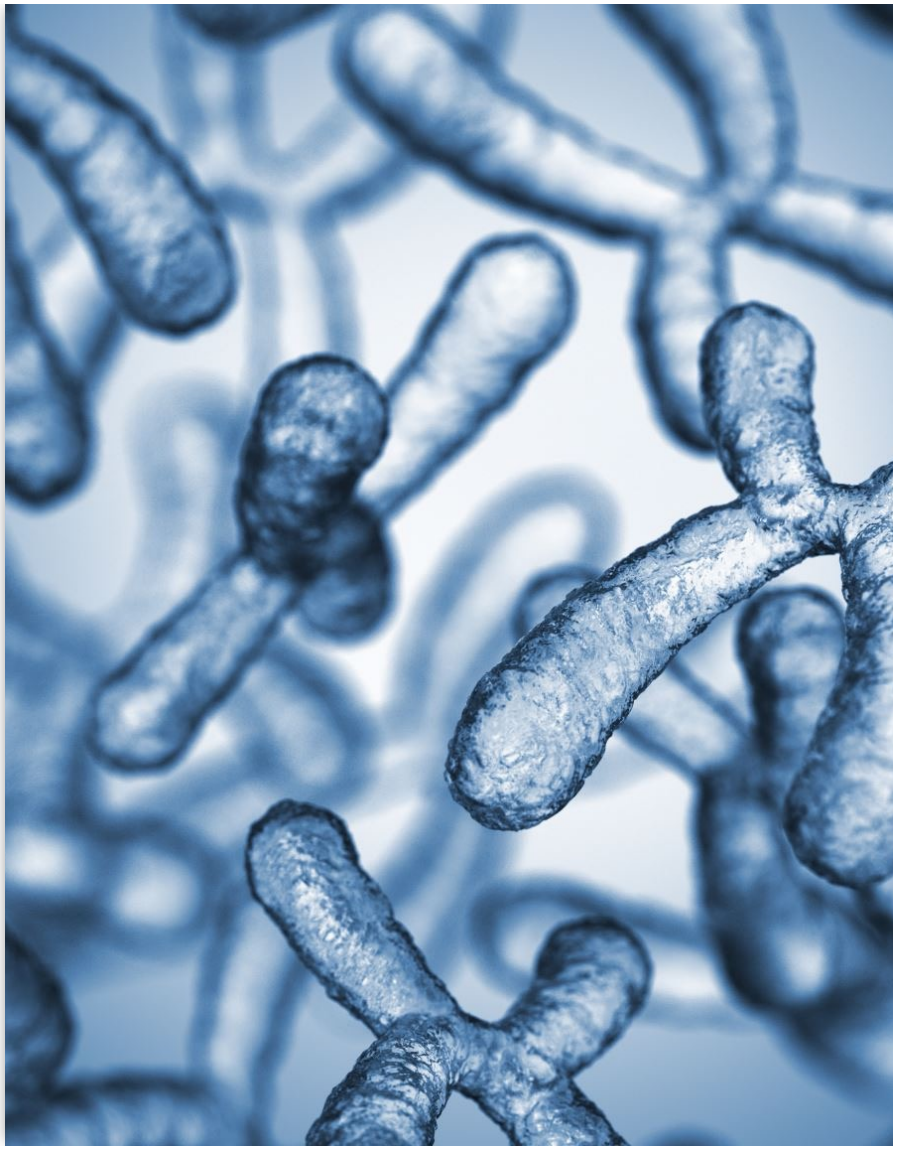
Definitions

- Bacterial kidney disease (BKD) is a chronic bacterial disease
- First reported in wild Atlantic salmon populations in the rivers Dee and Spey in Scotland in 1933
- *Dee - disease*

Some key characteristics (of the bacterium)

- Can be transmitted vertically and horizontally
  - Mother to off-spring and between fish (in water)
- Survives inside macrophages
- *R. salmoninarum* is a highly clonal bacterium with a relatively slow rate of evolution
  - Implications for tracing an infection
- Difficult to prevent



Transmission

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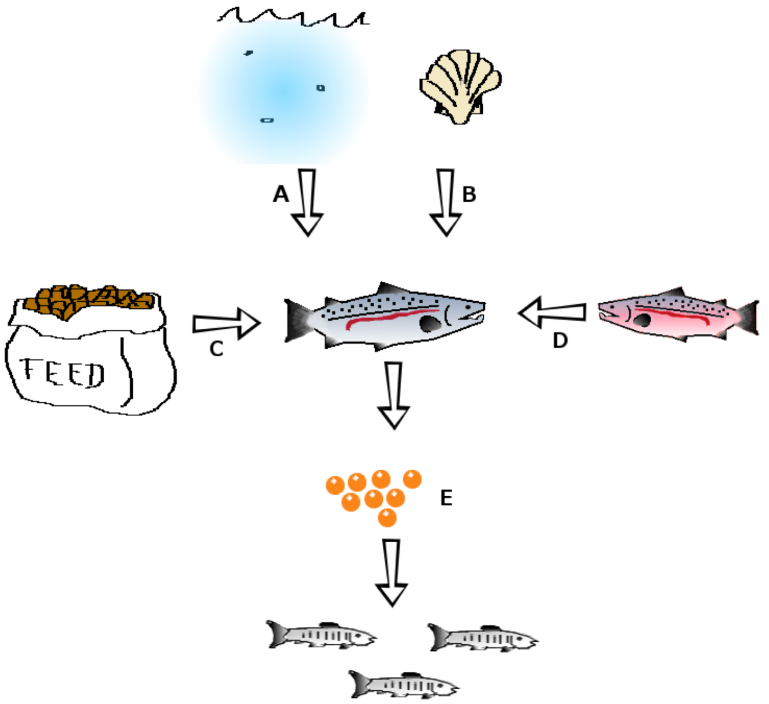
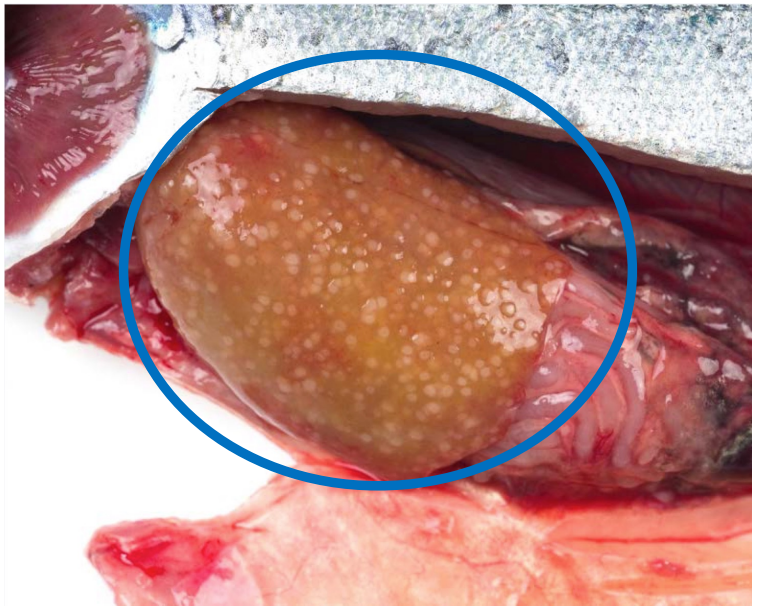


Brynhildsrud 2015

Manifestation of infection in fish

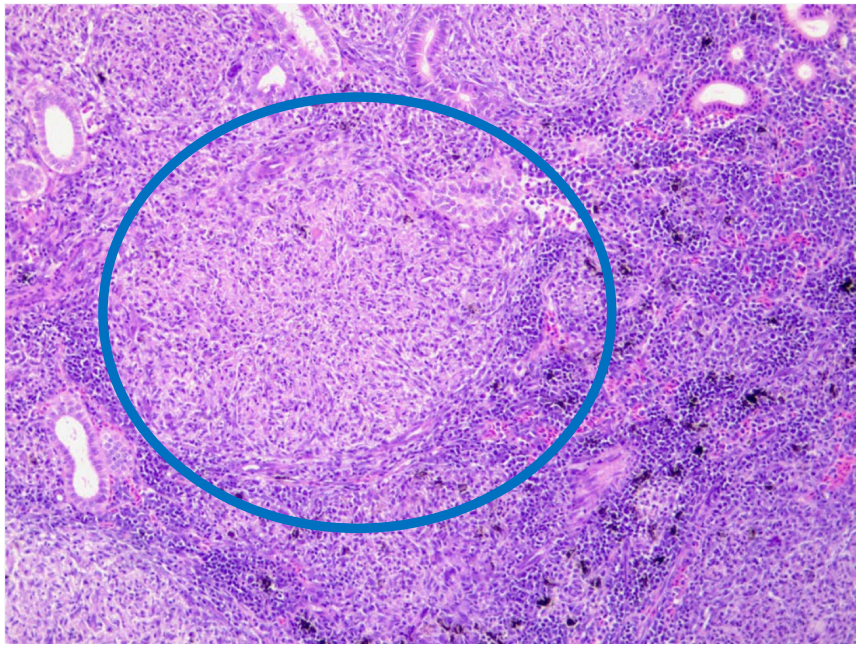
- Granulomas (small white, well circumscribed structures) in internal organs (tuberculosis-like lesions)
- White nodules



Elanco/CAHS/Veterinary Institute (Norway), 2018

Manifestation of infection in fish

- Granulomas in internal organs (tuberculosis-like lesions) – white nodules
- Microscopic manifestation – “organoid structure” (organ-like)



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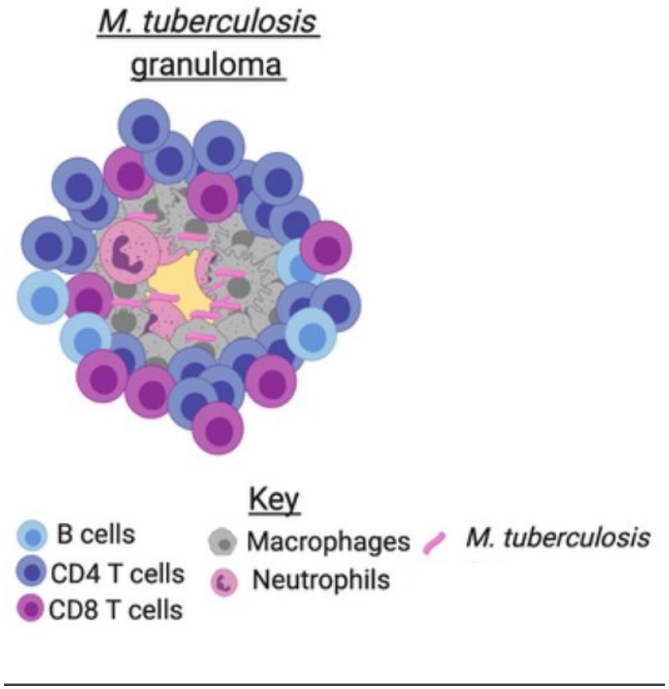
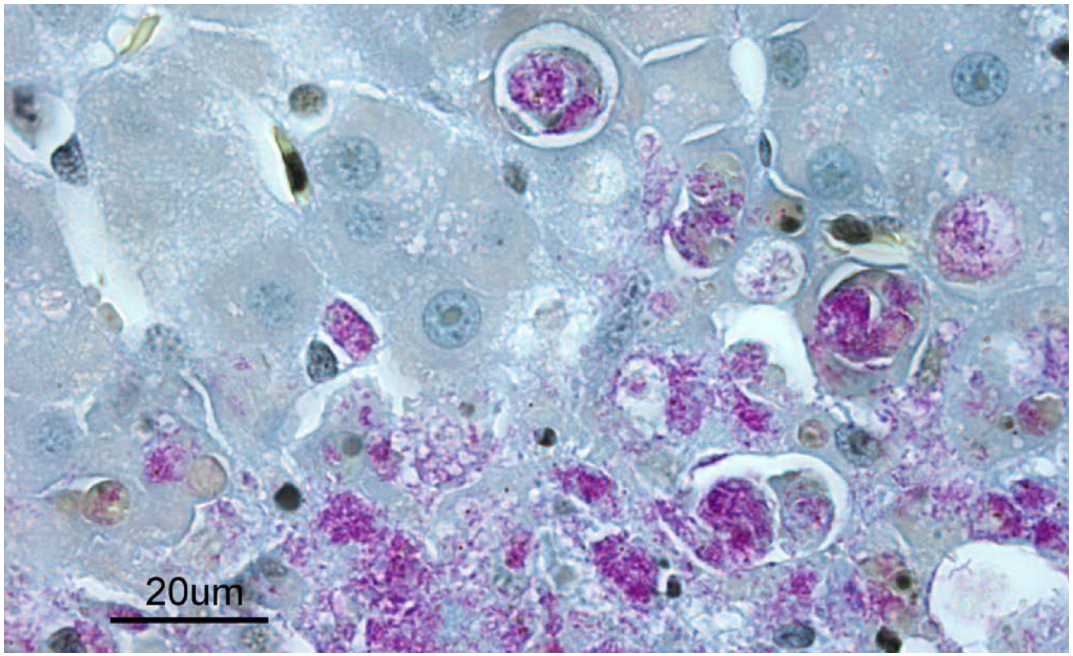
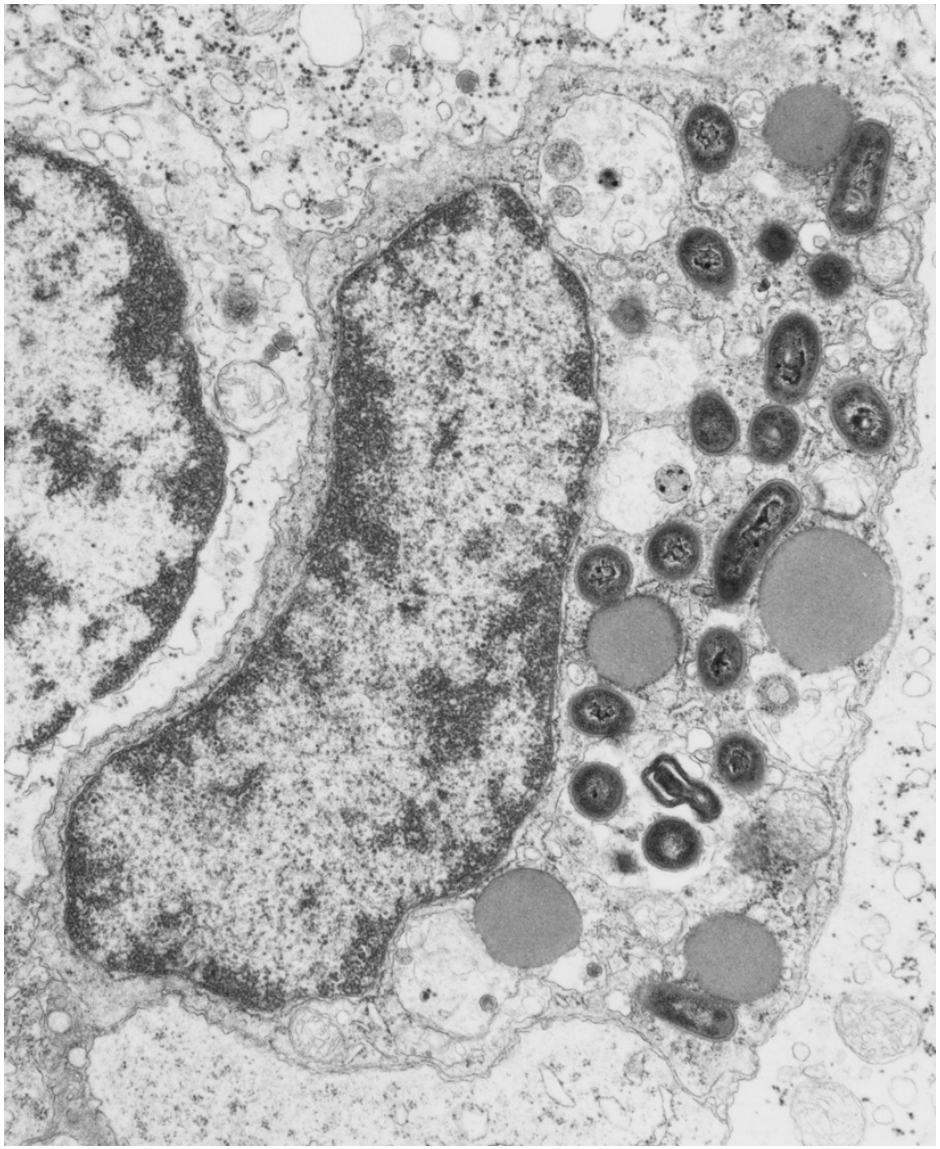


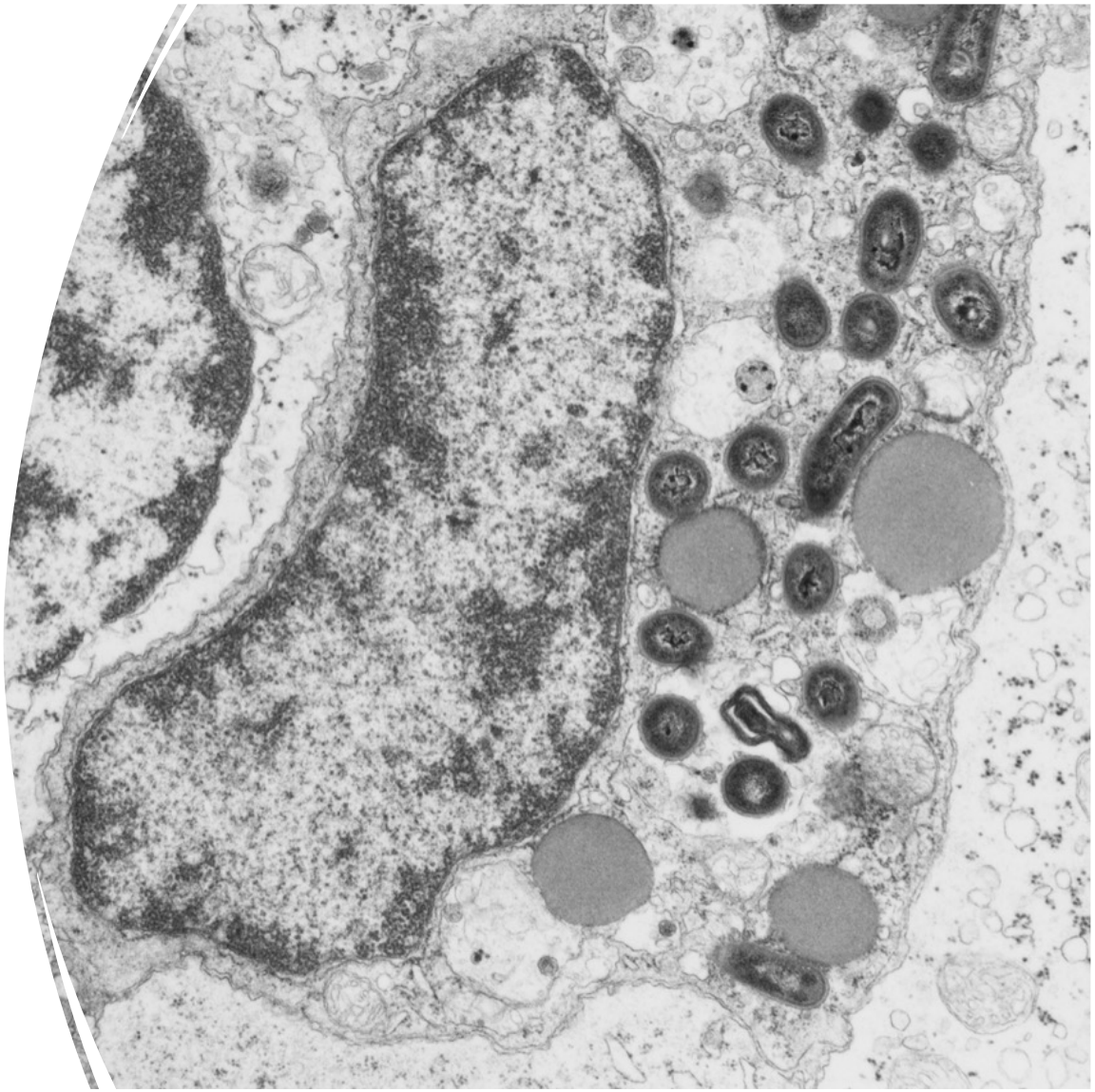
Bacteria locate in granulomas and inside macrophages





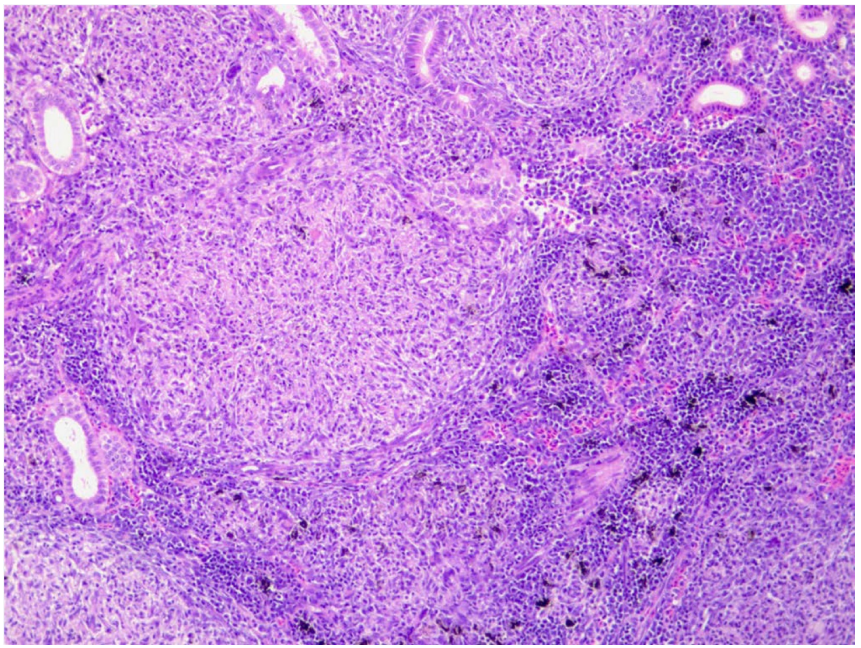
What is the importance of this mechanism?

- A hide-away strategy
- Escapes intracellular killing
- Can move/spread from one cell to another
- Hide from the immune system
- Difficult to mount an immune response against the bacterium



Granulomatous reaction adds to the hide-away

- The bacterium lives inside an organoid structure
- Explains the asymptomatic carriers
- Difficult to treat (antibiotics) – no access to the bacteria

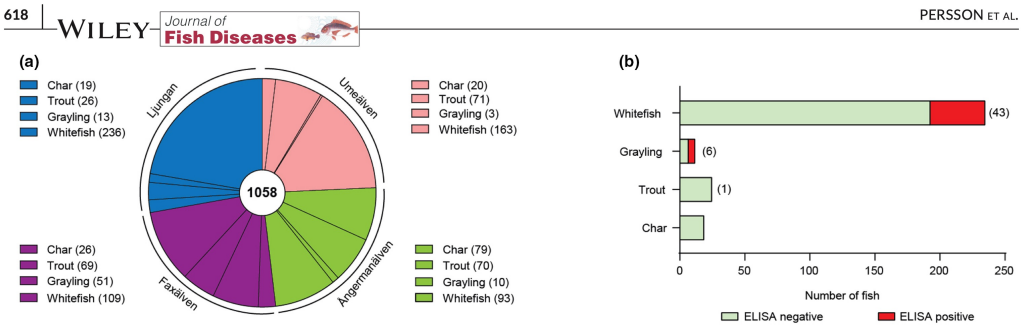


Bacterial traits

- *R. salmoninarum* is a highly clonal bacterium
- All look-alike
- Genetically they are almost identical
- Makes epidemiological tracing difficult/complex

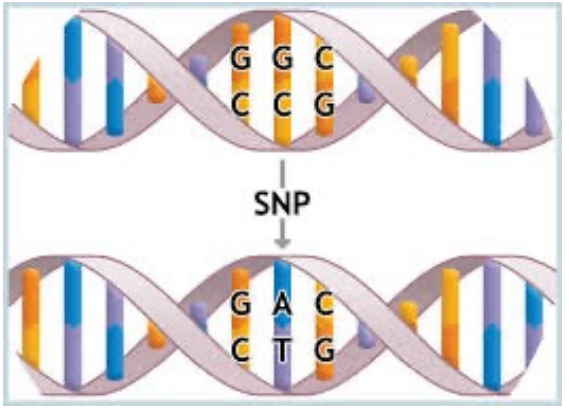
Why is it important?

- Tracing infections
  - From salmon/trout to grayling/whitefish (or vice versa)



Persson et al. 2022

- Deciding on transfer between species would require high resolution sequencing



Farmed-wild interactions

- Interactions between farmed and wild species have been a subject of discussion and concern over many years
- It raises concerns related the **occurrence of disease** under farming conditions which can have severe economic and welfare impacts
- For the wild species it can have **severe ecological impact**
- Disease **transmission goes both ways** and all diseases observed under farming conditions are present in wild species
- To clarify if there are host-restricted lineages of *R. salmoninarum* in rainbow trout and Atlantic salmon in Swedish farms and rivers
- Organisms, rather than the environment (e.g., sediments) are likely to serve as reservoirs for the bacterium, including non-salmonid marine fish such as prey (Rhodes & Mimeault 2019)

SLU

Smitta av BKD hos och mellan odlad och vild fisk

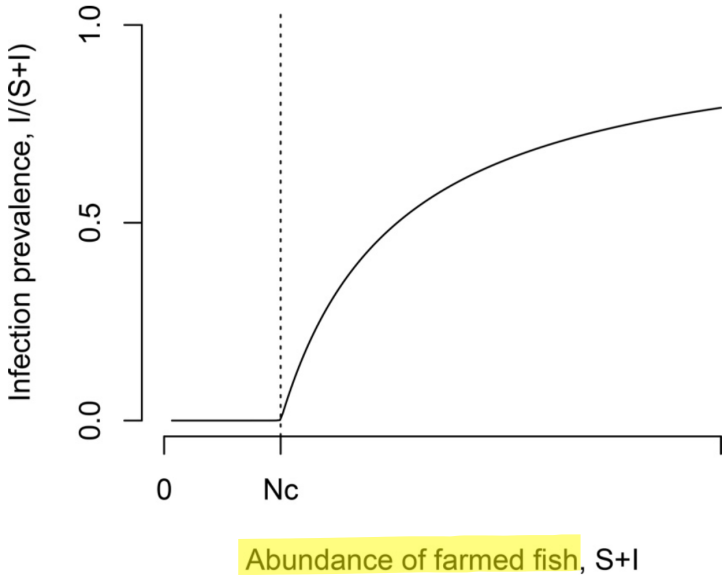
Transmission of BKD between and within farmed and wild fish

Xenia Vincze

Assessing the presence and spread of Renibacterium salmoninarum between farmed and wild fish in Sweden-J Fish Dis 45(4), 2022

Is the farmed fish a source of infection in wild fish ?

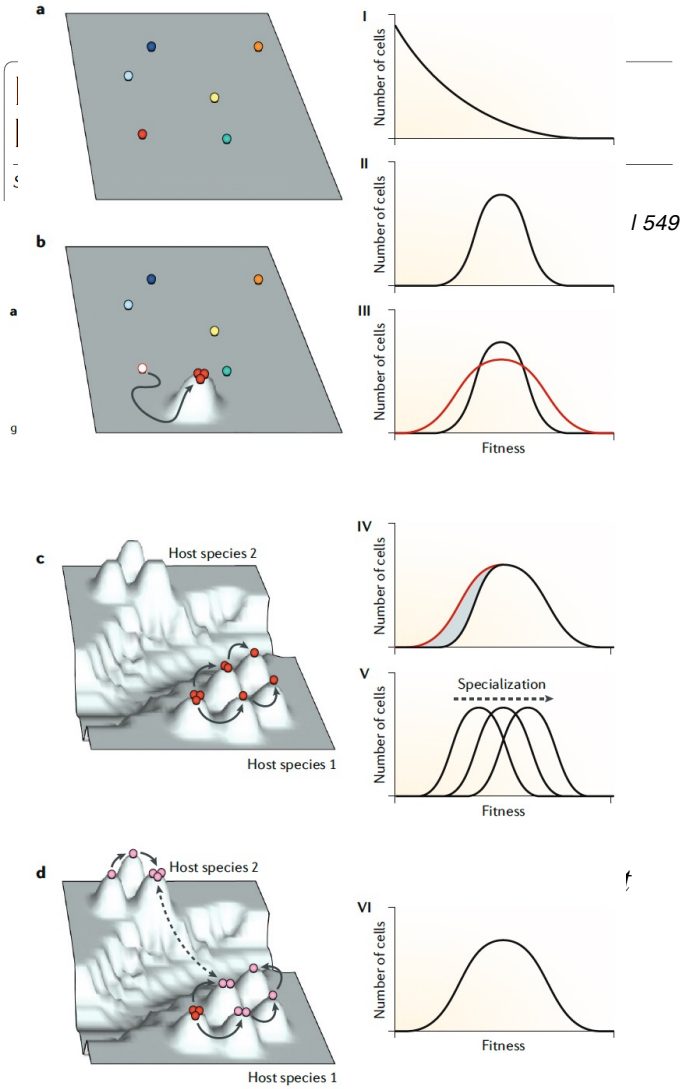
- Yes – it can be
- Dynamics of infection in farmed populations (or any population)
- Tipping point/threshold to be reached before the infection spreads in a population
  - Equilibrium levels of infection prevalence as a function of farmed fish abundance predicted by a susceptible-infected model
  - At abundances below the host density threshold (*Nc*) infection is at a low (nonzero) endemic state
- Will also apply to BKD/*Renibacterium salmoninarum* infection



Krkošek 2016

Transmission - gaps

- Need to know more about “specialization” of strains that “jump” from one fish species to another
  - Mechanisms
  - Tracing becomes easier
- Question: are there any particular signatures of adaptation to a new host?



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Summary

- *R. salmoninarum* is a “smart bug”
- Infect multiple species
- Spreads by means of vertical and horizontal transmission
- Hide in the body (granulomas)
- A genome of little variation (“economize” with genes needed)
- Makes it difficult to trace
  - Where is it coming from and where is it going?
- Prevention is difficult
  - Vaccination attempts have been largely unsuccessful