A mega-analysis using microbial prediction of individual performance across aquaculture species
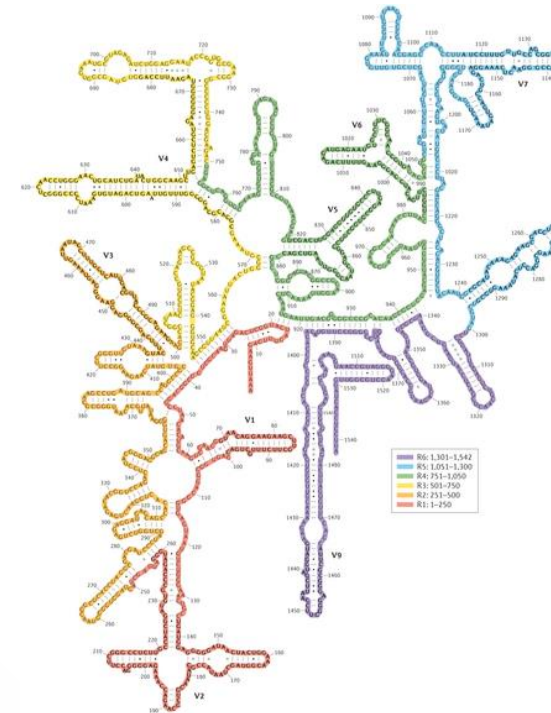
EAAP Gent 2019

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Microbial Revolution

Culturable < Unculturable

Culture Independent methods
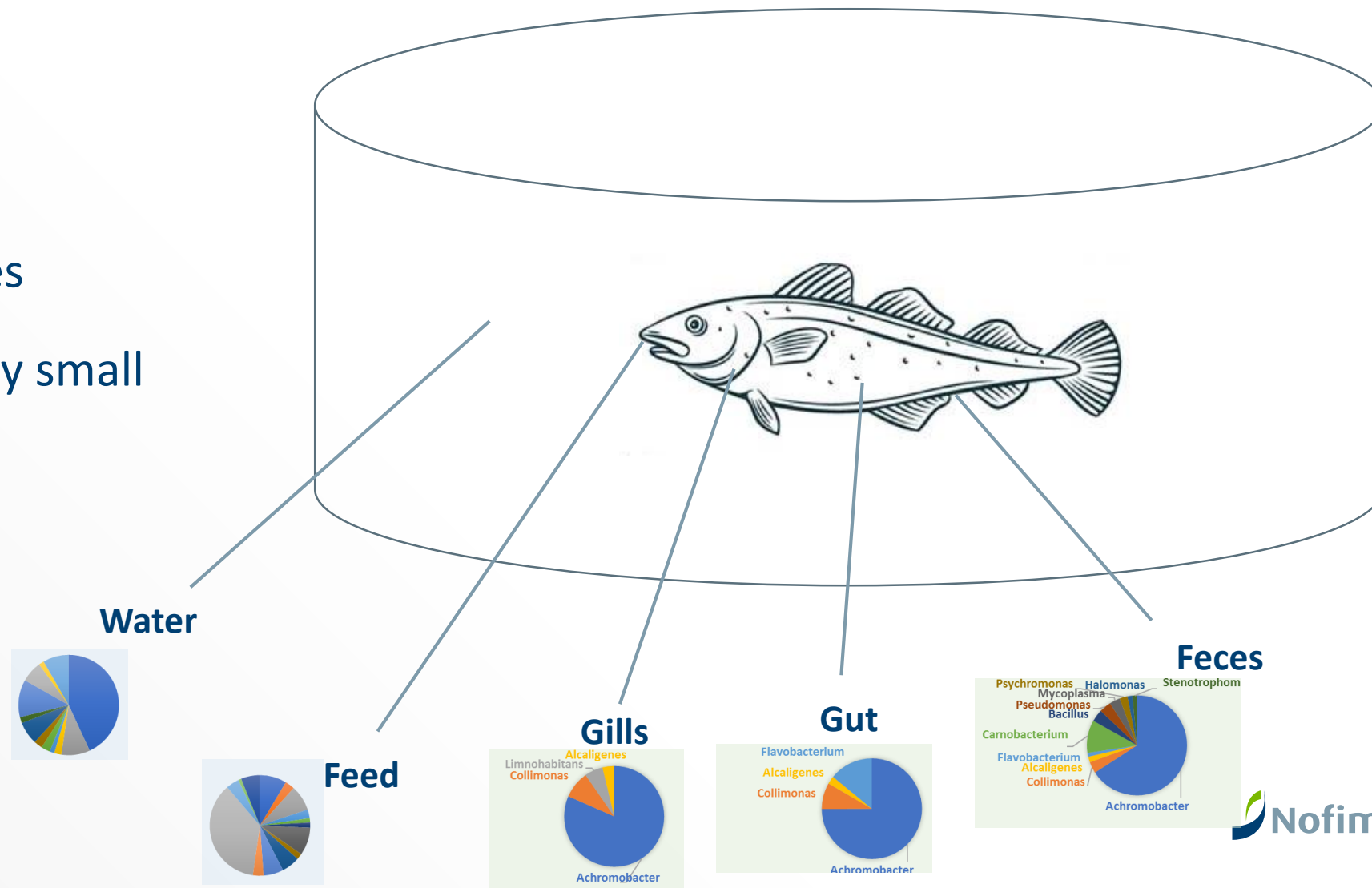
Host x Microbe interaction

**Absence**

Presence

Host x Microbe interaction

Communities

- Microbial communities
- Vital functions
- Many microbes / many small effects?
- + / -

Water

Feed

Gills
- Alcaligenes
- Limnohabitans
- Collimonas
- Achromobacter

Gut
- Flavobacterium
- Alcaligenes
- Collimonas
- Achromobacter

Feces
- Psychromonas
- Mycoplasma
- Pseudomonas
- Bacillus
- Halomonas
- Stenotrophom
- Carnobacterium
- Flavobacterium
- Alcaligenes
- Collimonas
- Achromobacter

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Microbial Communities

- Differ across Hatcheries
- Wild versus Captive
- Body sites

Highly redundant

Webster et al., 2018
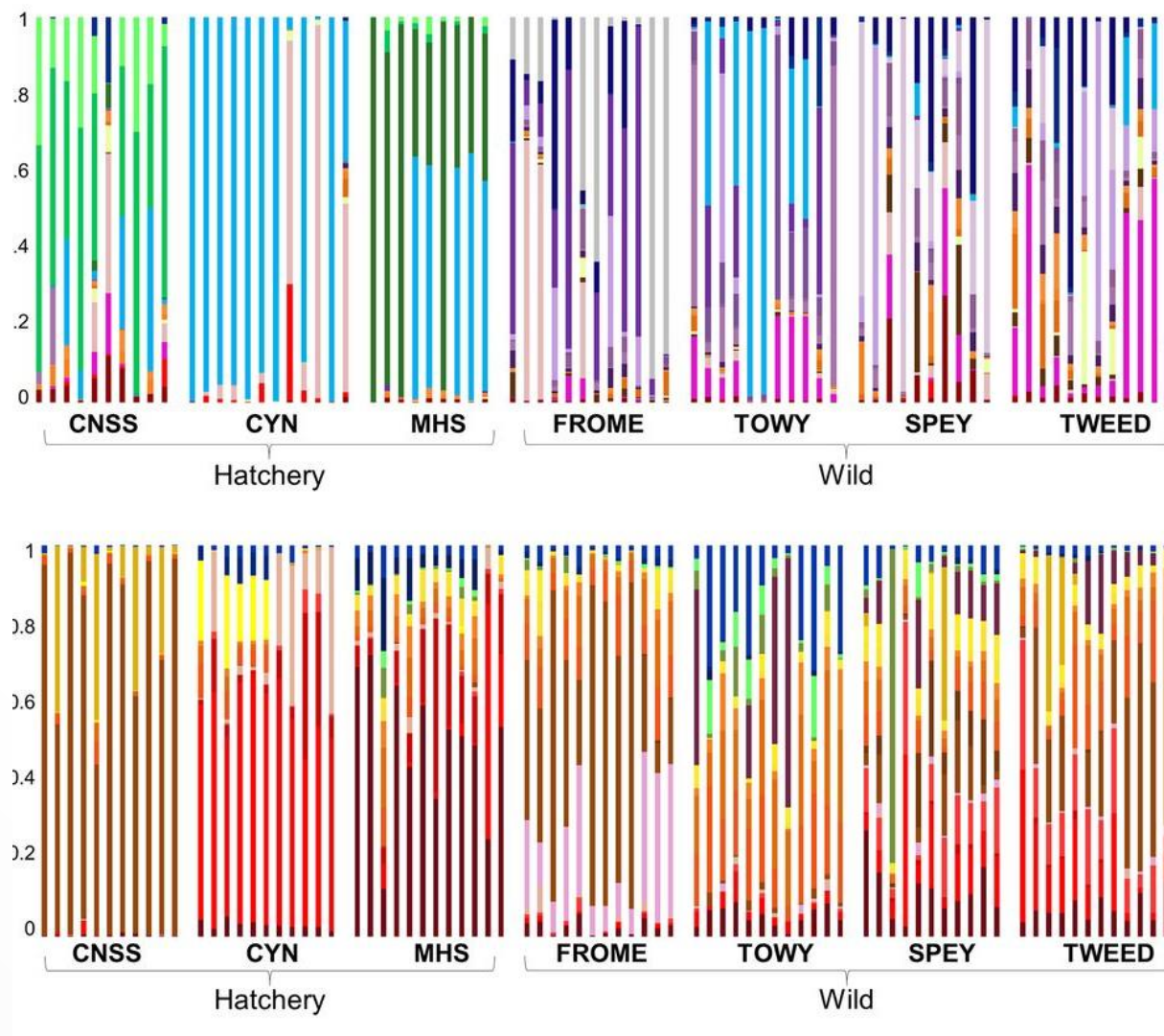
Community Perturbation
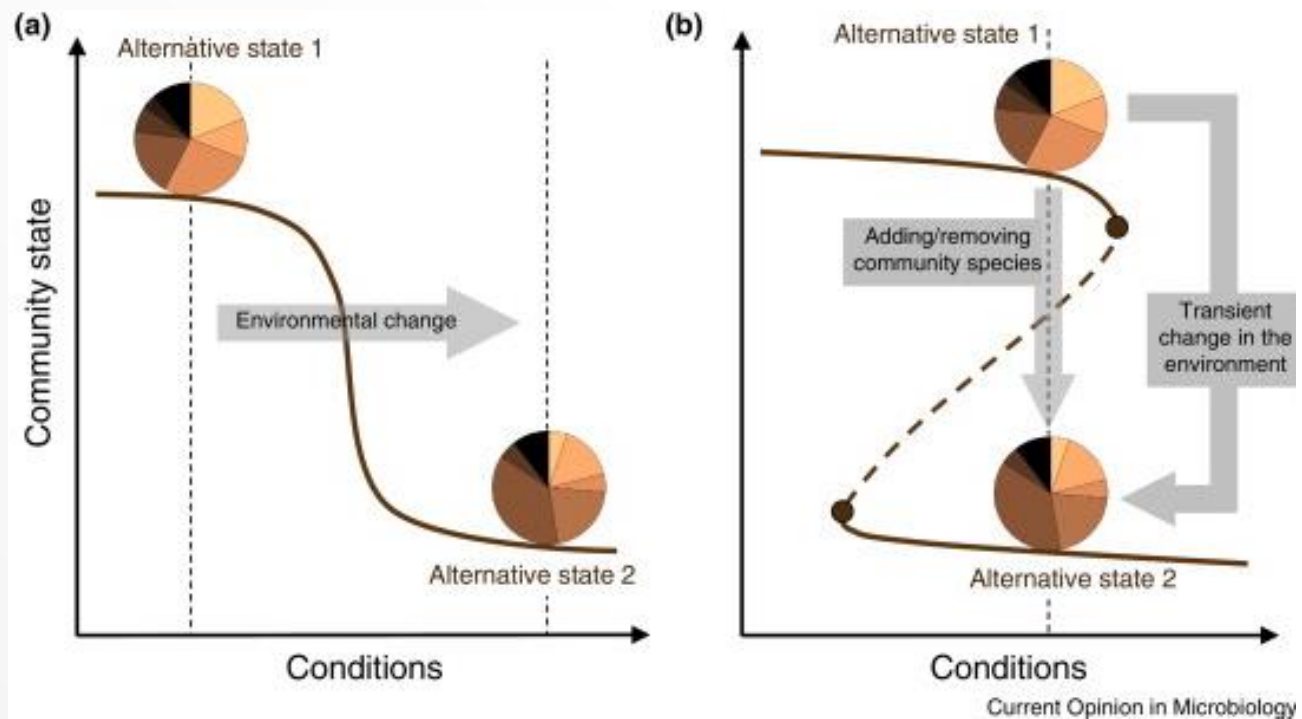
Faust et al., 2015
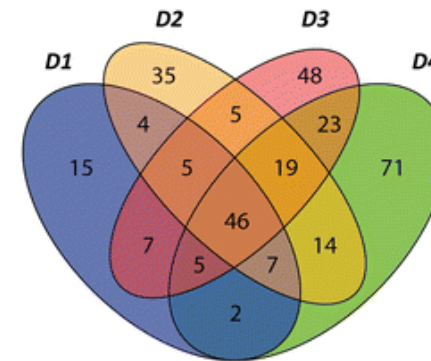
Diets
Piazzon et al. 2017
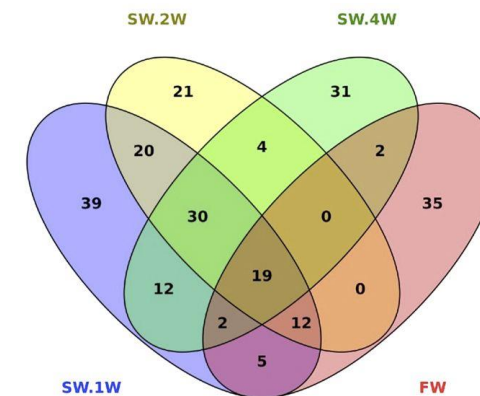
Freshwater – Saltwater
Lokesh & Kiron 2016

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Publicly available Databases

54,992 "studies"
2,744,041
3,306,321 sequencing libraries

Smaller number are aquaculture species
Samples sizes are limited 5 – 300
Salmon dominates

Can we use this for anything?

SRA https://www.ncbi.nlm.nih.gov/sra
ENA https://www.ebi.ac.uk/ena
MGnify https://www.ebi.ac.uk/metagenomics/
MG-RAST https://www.mg-rast.org
IMG https://img.jgi.doe.gov/
iMicrobe https://www.imicrobe.us
National Microbiome Data Collaborative https://microbiomedata.org/
Human Microbiome Project https://portal.hmpdacc.org/
GOLD https://gold.jgi.doe.gov
Microbiome DB https://www.microbiomeDB.org
QIITA https://qiita.ucsd.edu
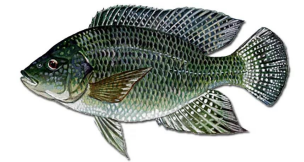GigaDB http://gigadb.org
curatedMicrobiomeData https://waldronlab.io/curatedMetagenomicData
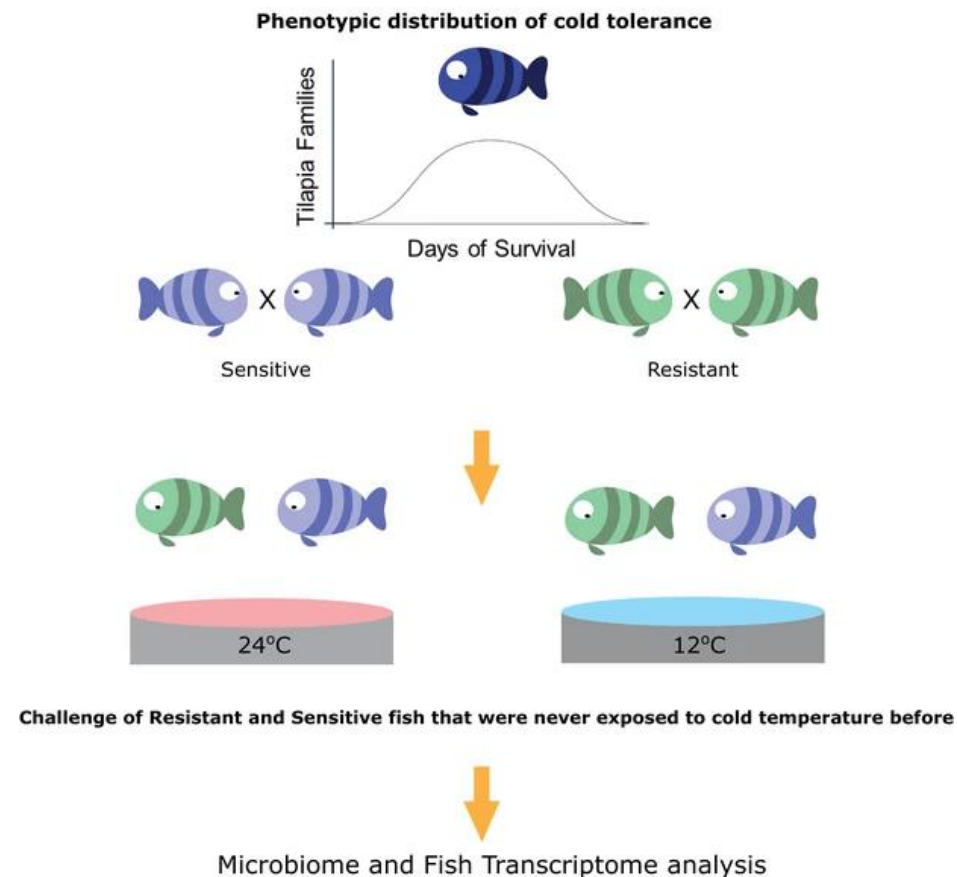
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Aims

- Extract and curate aquaculture microbiome data
- Investigate association microbial communities and host phenotypes

1. Detailed example
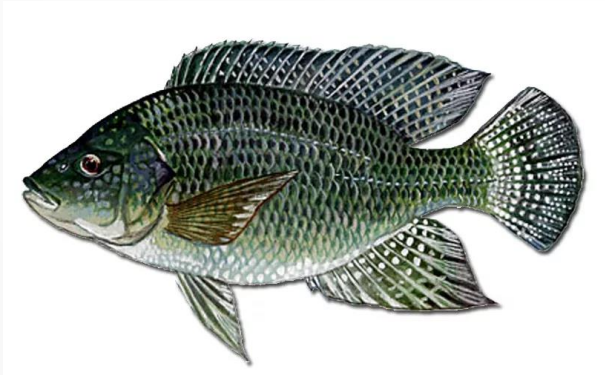2. Overview

Cold tolerance   Isreali Tilapia

- Selected offspring
- 3 cold resistant, 3 cold sensitive families
- N = 168
- 2 tank temperature treatments
- Gut microbiota

Phenotypic distribution of cold tolerance

Tilapia Families

Days of Survival

X   X

Sensitive   Resistant

24°C   12°C

Challenge of Resistant and Sensitive fish that were never exposed to cold temperature before

Microbiome and Fish Transcriptome analysis

Kokou et al., 2018

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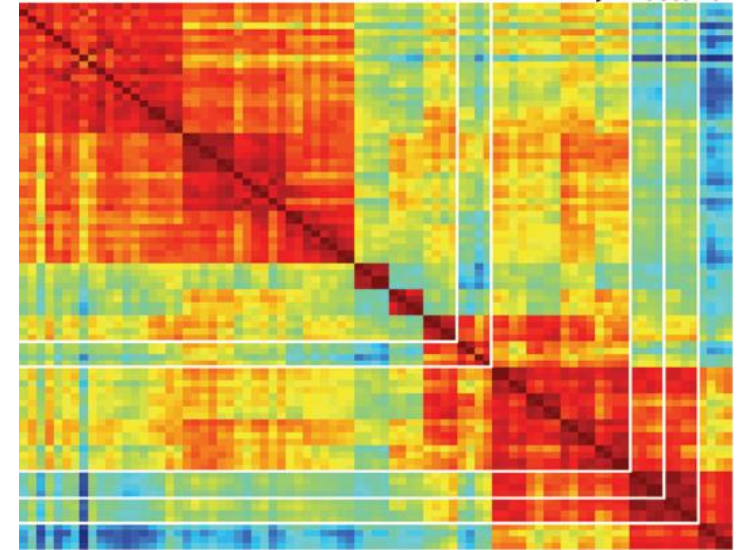
Cold tolerance

Isreali Tilapia

$$Y = U + Xb + {\color{red}M}z + e$$

Training data

Validation data

Prediction Accuracy
R2validation
65%

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Across Species

$$Y = U + Xb + Mz + e$$

Binary traits

Cold adaptation	Gut	R2 = 65%
Fresh vs Salt	Skin	R2 = 77%

Quantiative traits

Length (Wild)	Gut	R2 = 7%
Length (Farmed)	Gut	R2 = 33%

Environmental Trait

Tank	Skin	R2 = 93%

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Conclusion

Freely available microbial data is extremely valuable

Microbiota as predictive tools are very promising

Covariance ≠ Causation

Challenges

Are there microbes common across species?

Can we make an aquaculture host microbe reference database

Thank you!
Any questions?