New microbial management techniques for improved outputs in fish and crustacean hatcheries

Patrick Sorgeloos, Peter Bossier and **Peter De Schryver**

on behalf of the **Ghent University Aquaculture R&D Consortium**

Coloquio Internacional "Brechas de Investigación en larvicultura de peces"

Sede Puerto Montt

Instituto de Acuicultura

Universidad Austral de Chile
Conocimiento y Naturaleza

INLARVI

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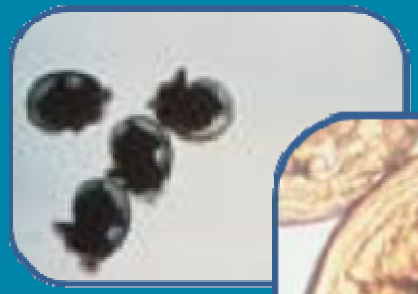
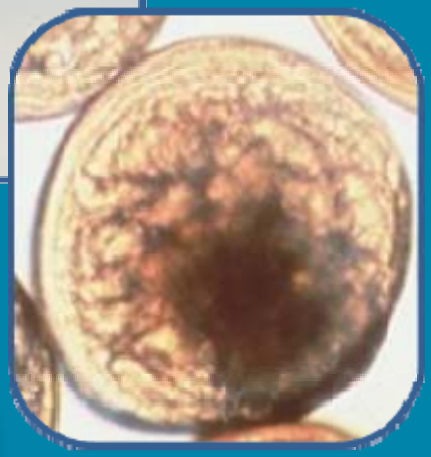
09-PDAC-6912-02

PROGRAMA CORVINA FCH

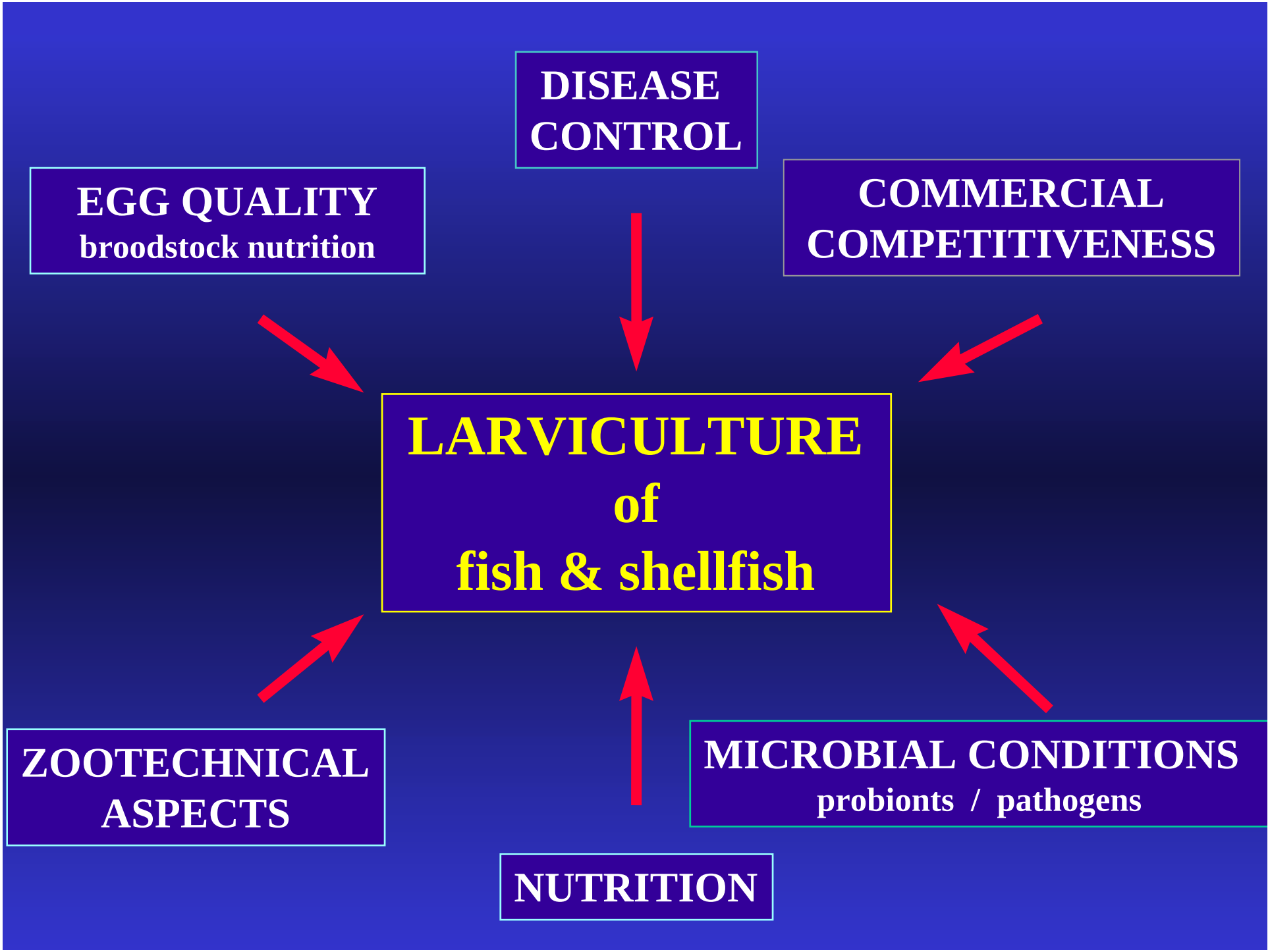
18 enero 2017

Predictable **&** ***cost-effective*** **availability of** ***high-quality*** **fry, fingerlings, postlarvae, seed, spores, ...**





THE key to successfull aquaculture !


DISEASE CONTROL
EGG QUALITY
broodstock nutrition
COMMERCIAL COMPETITIVENESS
LARVICULTURE of fish & shellfish
ZOOTECHNICAL ASPECTS
MICROBIAL CONDITIONS
probionts / pathogens
NUTRITION

Priorities for future aquaculture

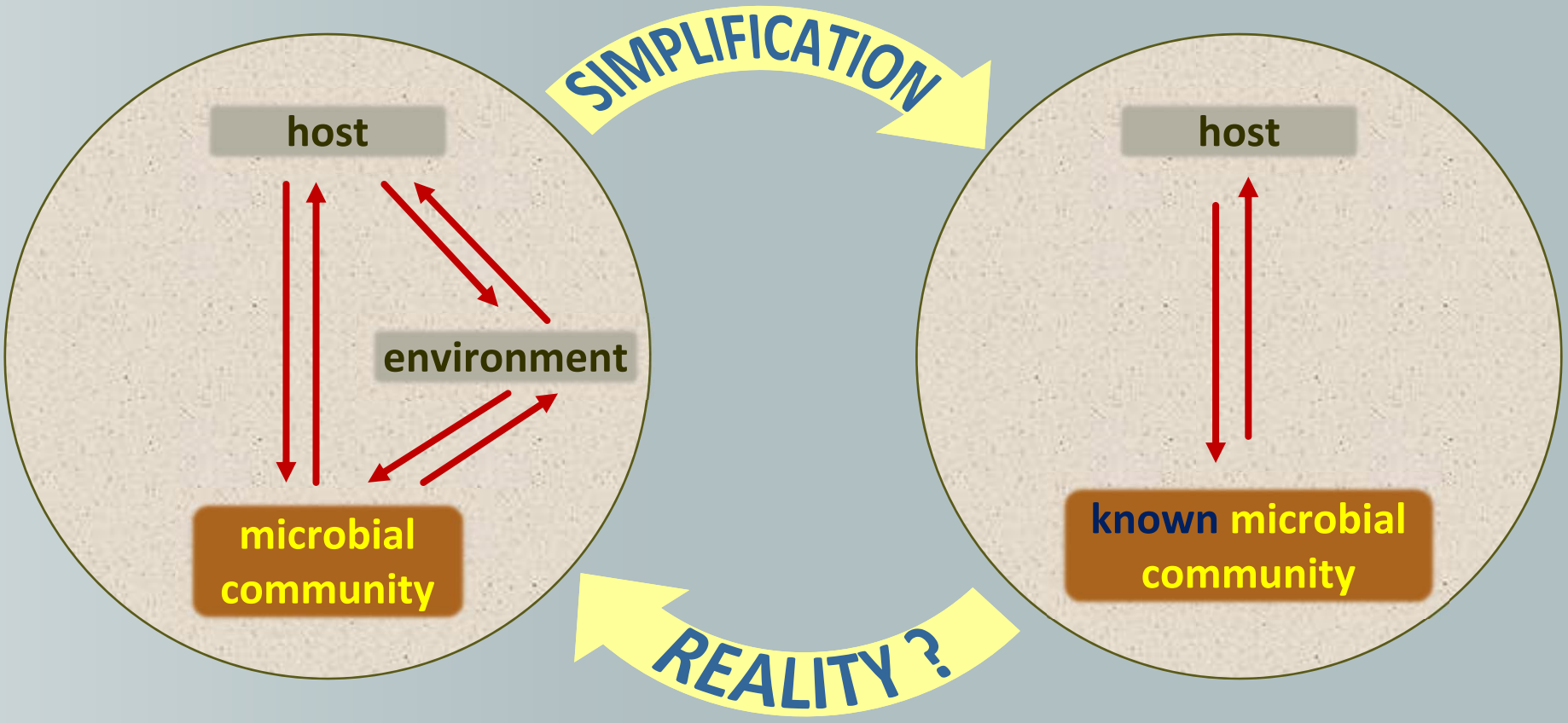
Improved / more cost-effective **SEED PRODUCTION**

example:

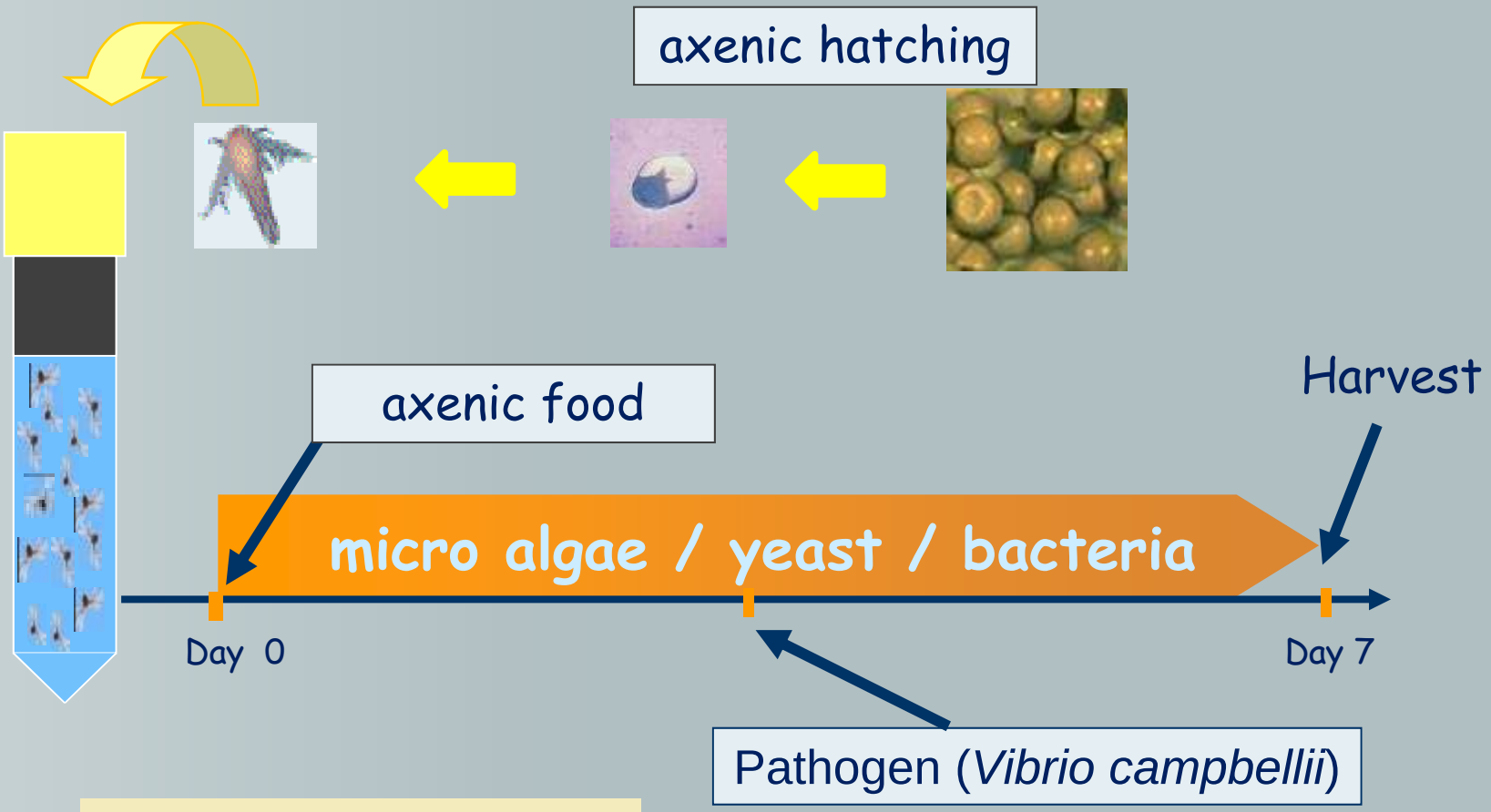
Sea bass/bream larviculture in the Mediterranean

- annual production of 1 billion fry
- market value of 15 Euro cents a piece
- average survival 20 % by day 60
- low survival = critical bottleneck for future cost efficiency and sustainability of the industry
- microbial interference considered to be the main culprit
- no selected breeds available yet

NEW APPROACH IN THE STUDY OF HOST-MICROBE INTERACTIONS



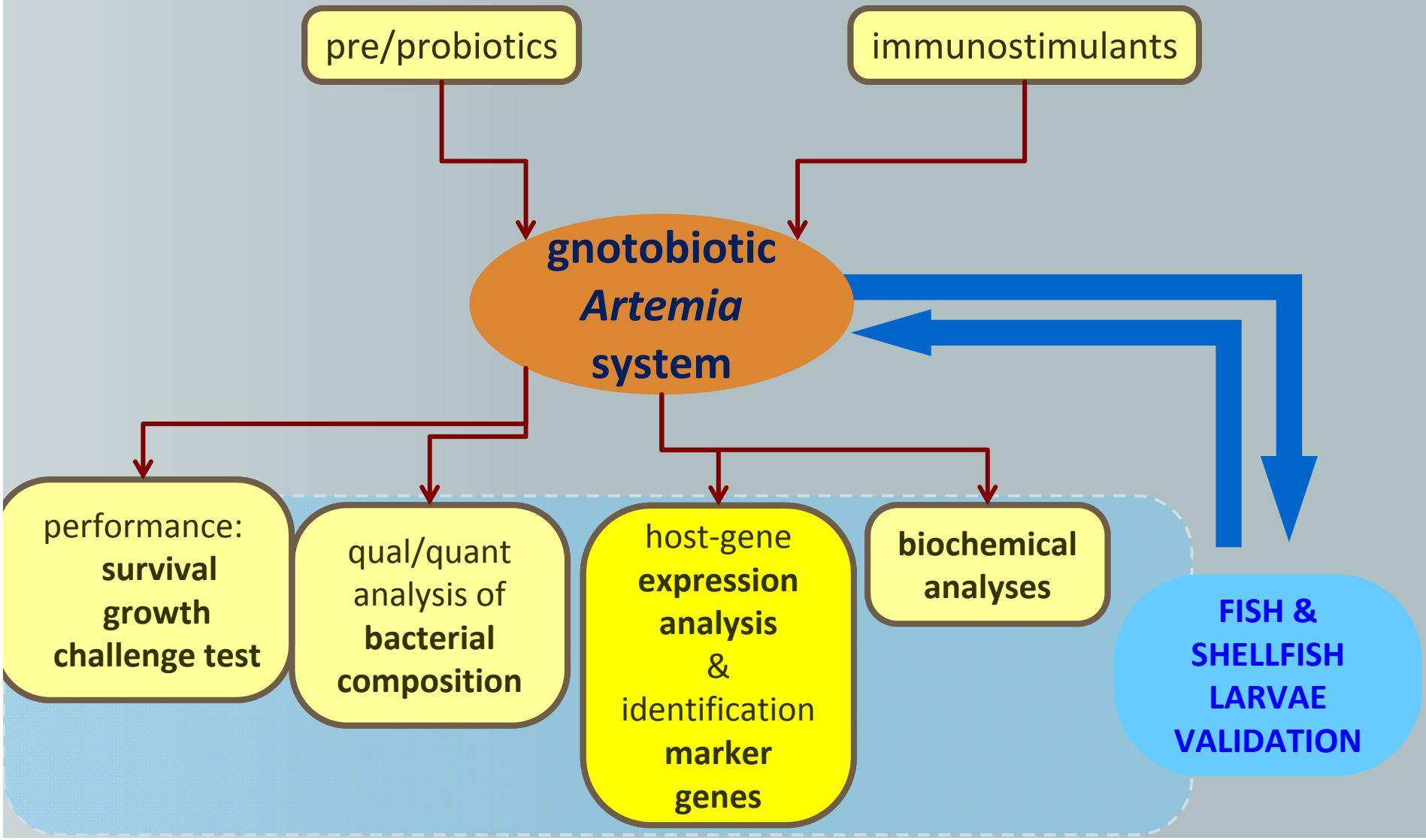
Gnotobiotic culture of *Artemia*



Evaluation criteria

- survival
- length
- total biomass
- immune parameters

Development of innovative microbial management systems



ARTEMIA AS MODEL SYSTEM IN LARVICULTURE RESEARCH

- **host-microbe interactions**

→ ***Influencing microbial numbers or activity***

- ❑ quorum sensing / quorum quenching
- ❑ Poly-β-hydroxybutyrate

→ ***Stimulating the host's immune response***

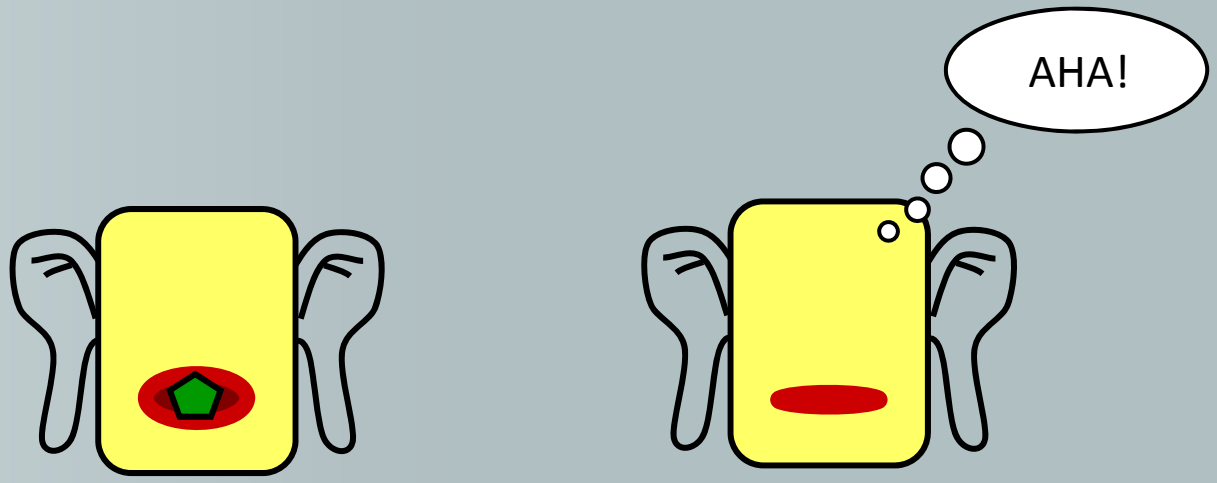
- ❑ heat shock proteins
- ❑ yeast cell wall-bound glucan

Quorum Sensing (QS)

bacteria **sense and respond** to environmental changes

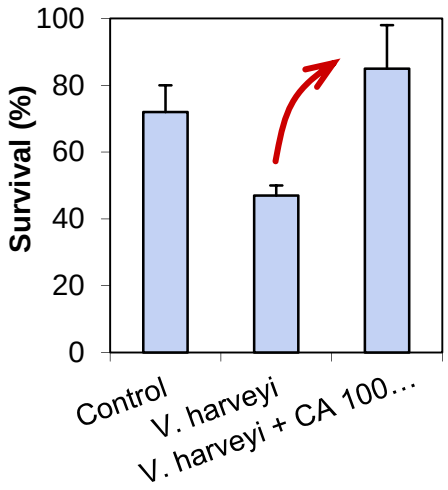
and to each other through **extracellular**

signal molecules ≈ hormones in higher organisms



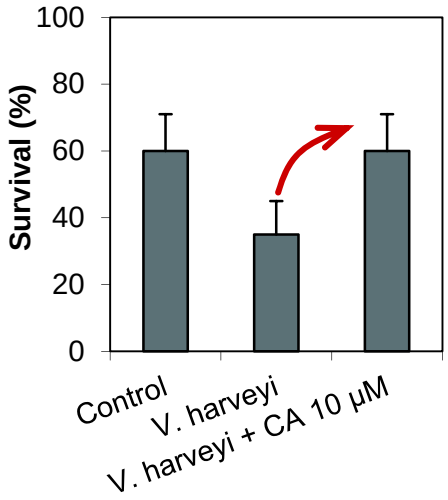
QS-disruption to control bacterial infections

- **use of QS inhibitors** (e.g. plant extracts)
- degradation of QS signals by other bacteria



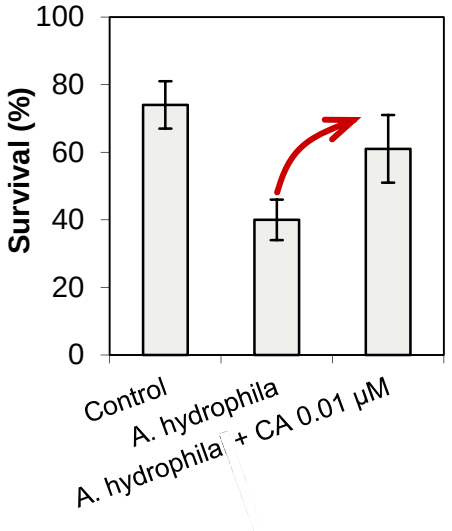
Artemia

Vibrio harveyi



Macrobrachium

Vibrio harveyi



Burbot

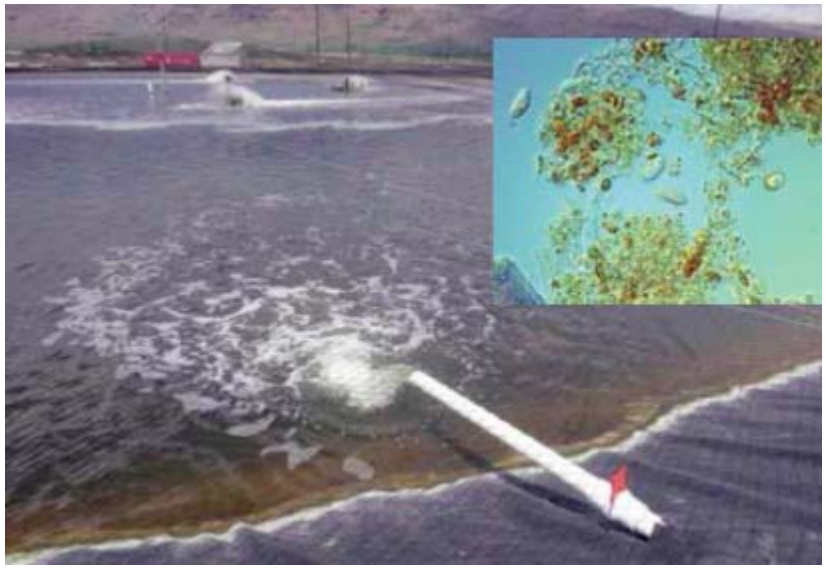
Aeromonas hydrophila

Crustaceans: 10-100 µM

Fish: 0.01 µM

Empirical observations of the strategy of microbial-matured water

- Algae-rich greenwater systems
- Probiotics
- Recirculation systems
- Biofloc systems
- Tilapia co-culture



Production

Do current pond culture practices sustain Early Mortality Syndrome in shrimp farming?

Redrafted after: De Schryver et al. (2014) Early Mortality Syndrome Outbreaks: a Microbial Management Issue in Shrimp Farming? PLOS Pathogens, doi: 10.1371/journal.ppat.1003919

Summary:

The early mortality syndrome (EMS) is without any doubt the most frequently discussed topic in the shrimp culture industry these days. Initiatives such a FAO/MARD Workshop on EM bring together e stakeholders in ar formulate suggest to deal with this problem. But coul the currently strategies a appropriate?

Peter De Schryver
Tom Defoirdt
Patrick Sorgeloos



Laboratory of Aquaculture & *Artemia* Reference Center

Various Critical - Multifactorial Causes?

➡ **microbial diversity & stability compromised?**

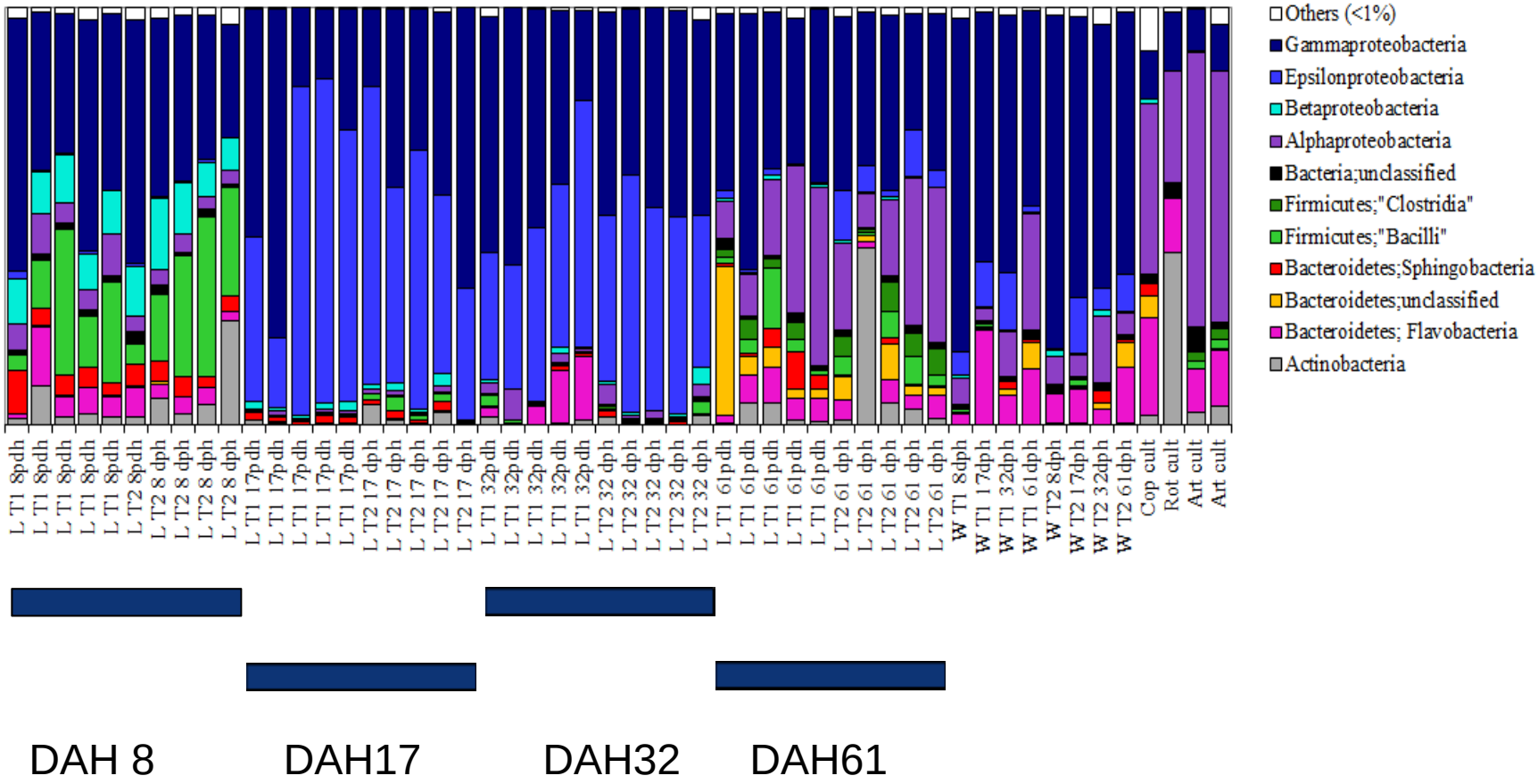
mature/aged water versus facilitating opportunitistic bacteria (*Vibrio spp.*)

➡ **fry/postlarval competence compromised?**

production cost savings (dietary treatments, stocking stage, ...)

Larval microbial community

Large temporal variation

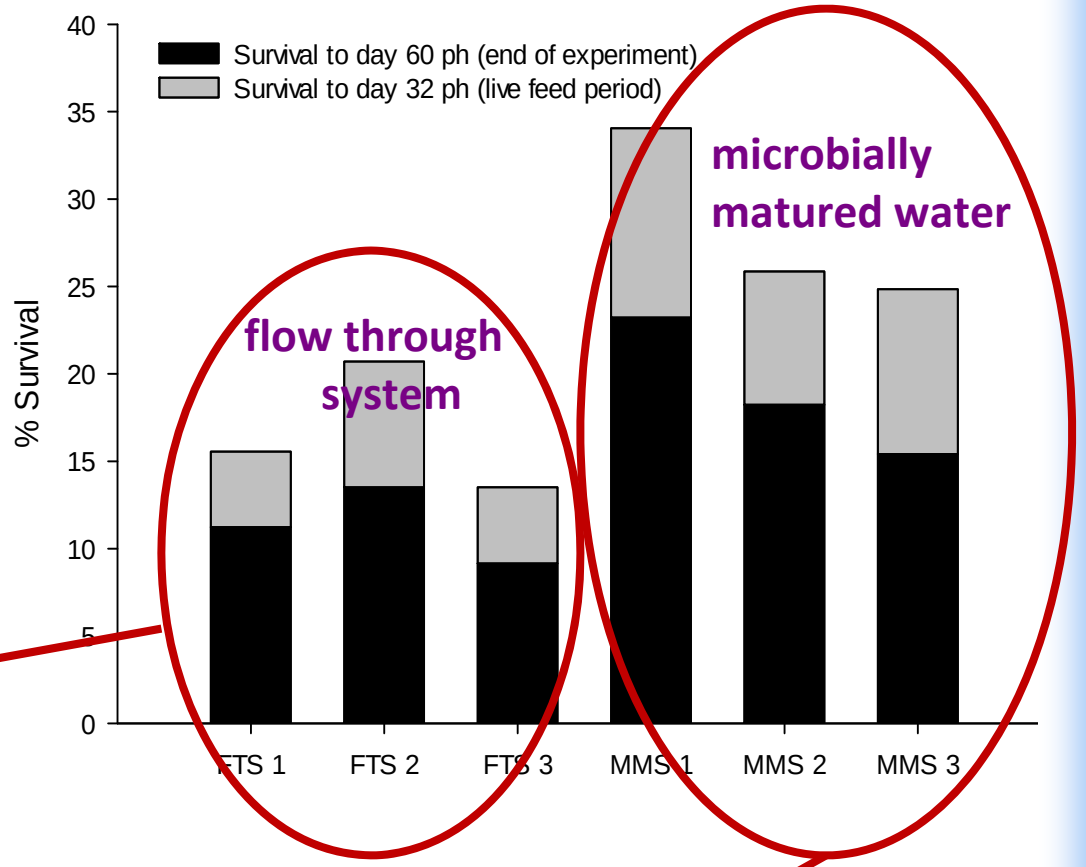


K-selection: Microbial maturation

Effects on the microbial community composition of the incoming water:

A more stable, even and diverse community dominated by slow-growing specialists

Effect on the fish (cod larvae): Significantly higher survival



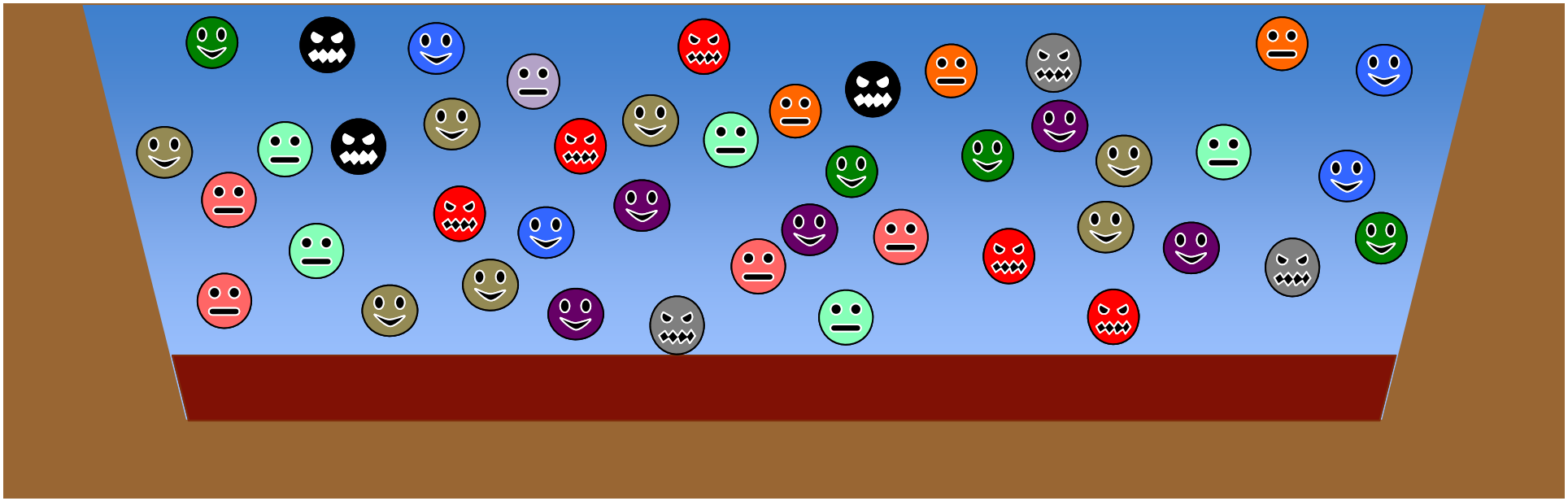
larval microbiota similar to live food microbiota

larval and water microbiota similar

Current aquaculture systems (hatchery tank or pond)

-

random-mixed microbial community

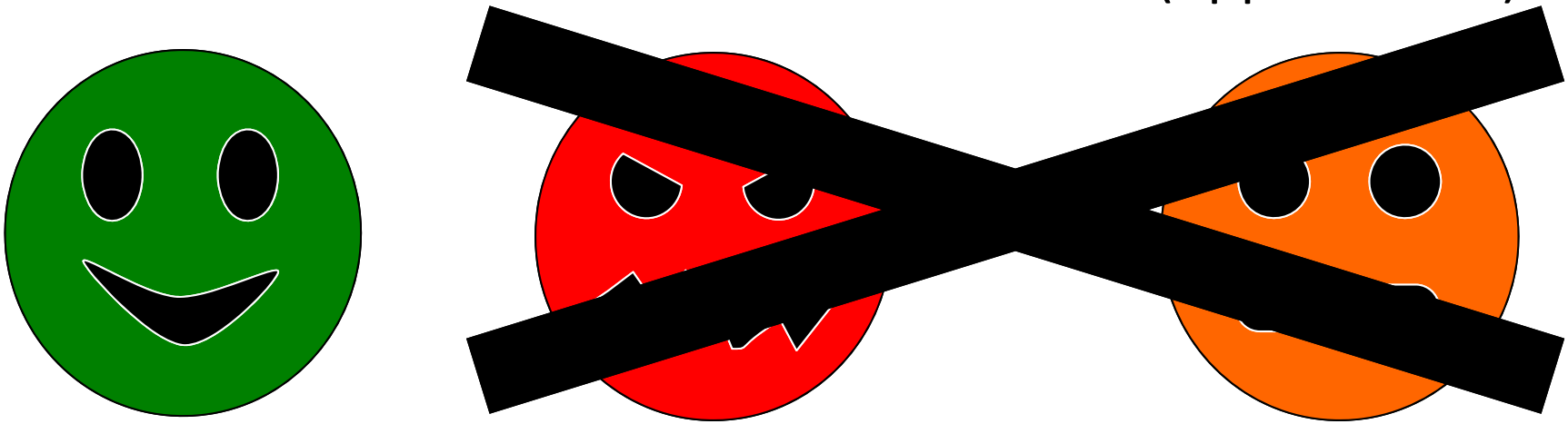


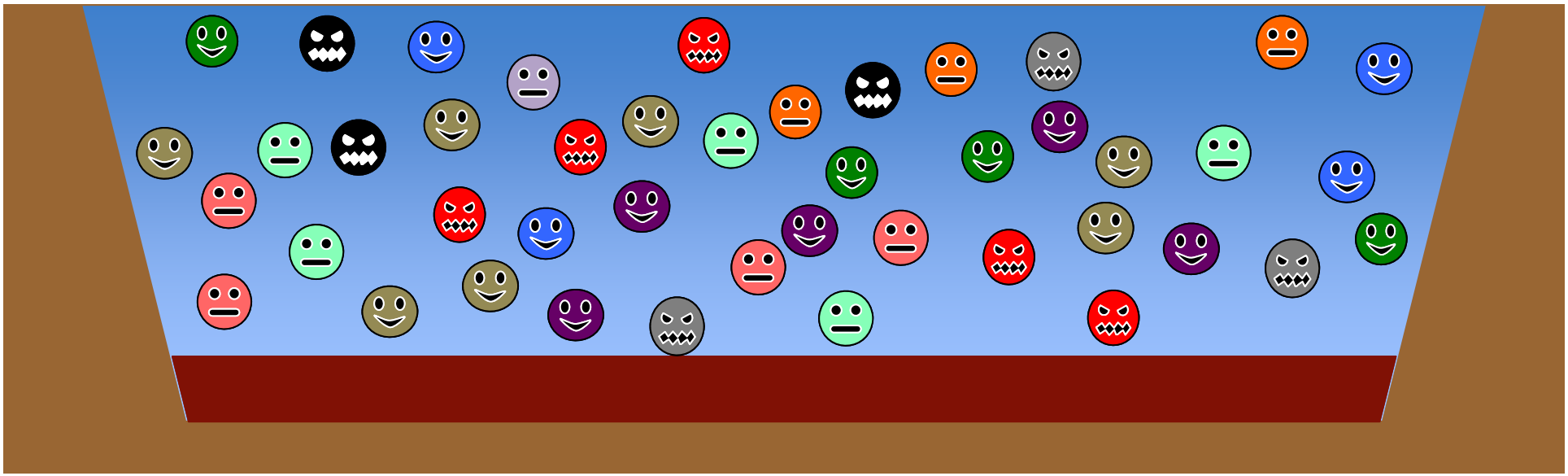
What do we want???

neutral/beneficial bacteria

harmful bacteria (obligate pathogens)

potentially harmful bacteria (opportunists)



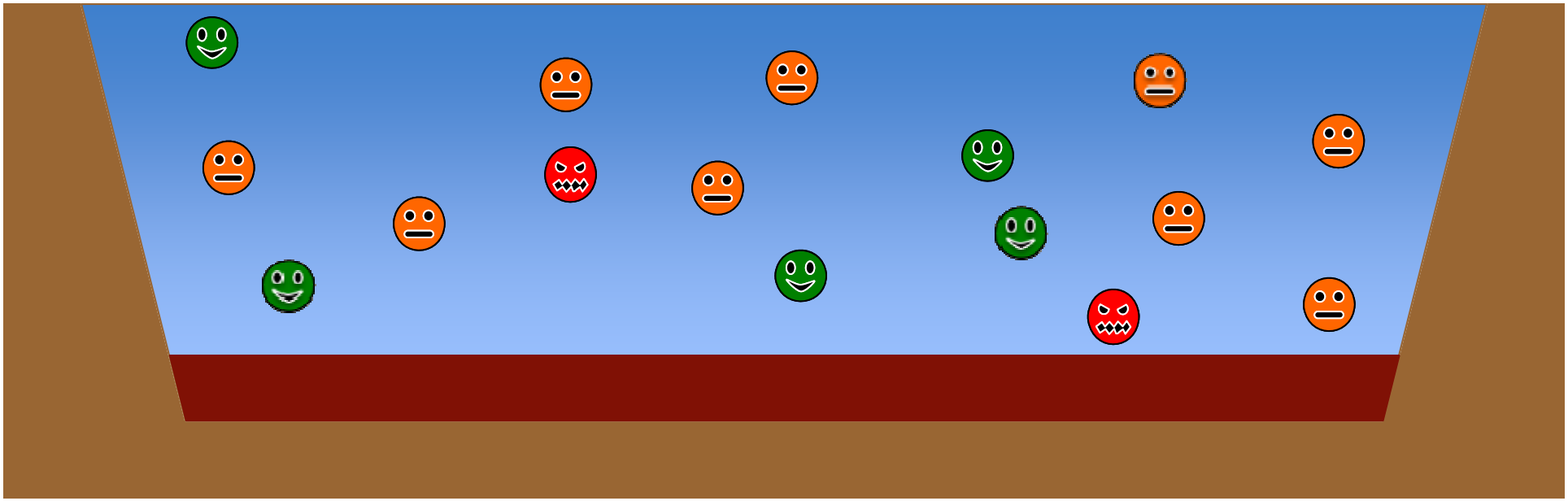


What happens at the microbial level upon disinfection?

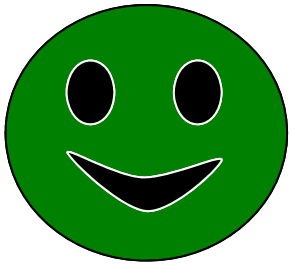
- all bacteria, including obligate pathogens are eliminated

- but, new bacterial colonization starts and fertilization/feeding will stimulate growth of bacteria: :

difference between r-strategists ( ) and K-strategists ( )!!!!



ecological characteristics of



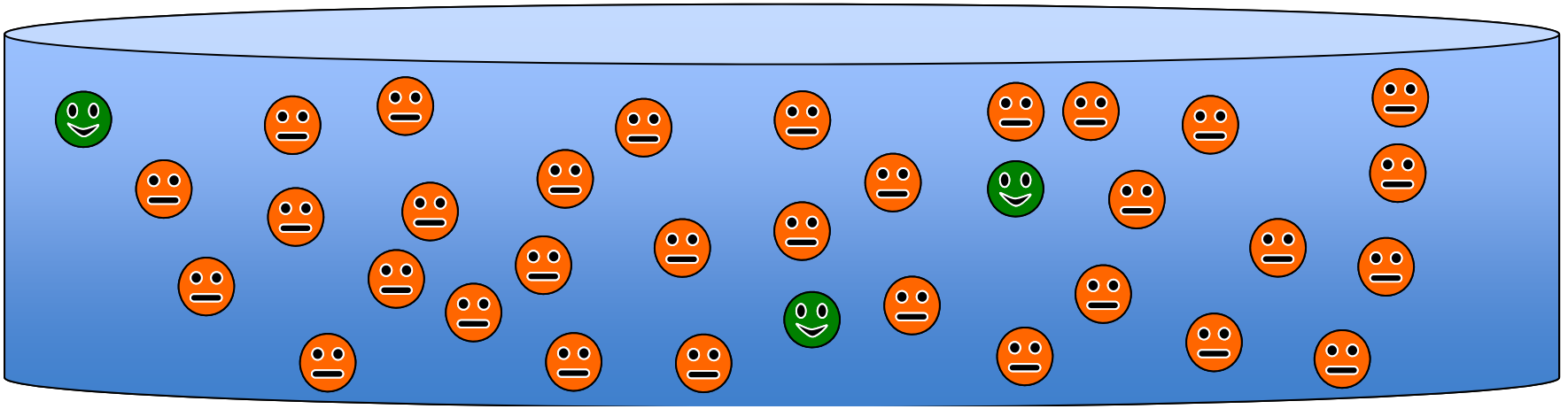
	r-strategist bacteria	**K-strategist bacteria**
Growth rate	HIGH	LOW
Effect of enrichment	RAPID GROWTH	SLOW GROWTH
Competitive ability: High substrate/indiv Low substrate/indiv	 HIGH LOW	 LOW HIGH
Importance for fish/shrimp larvae	Dangerous (opportunistic pathogens)	Generally harmless

What happens in reality at the microbial level in hatchery tanks upon refilling and restocking?

initially: low number of bacteria but lots of nutrients (food/feed)

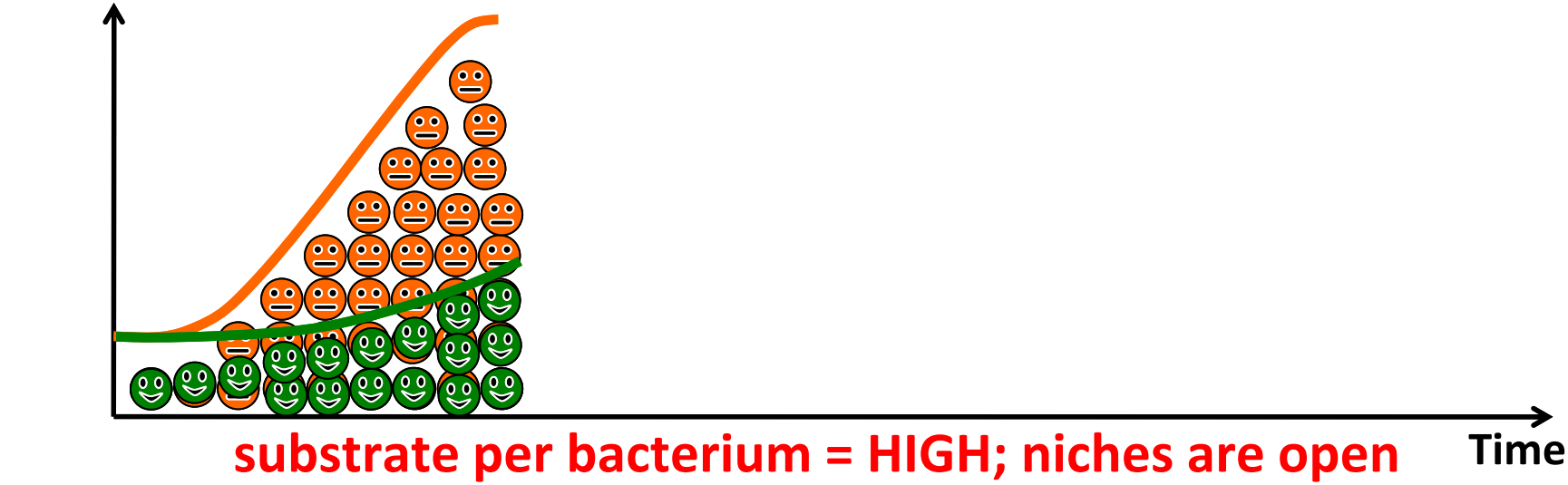
→ stimulates r-strategist bacteria

substrate per bacterium = HIGH; niches are open

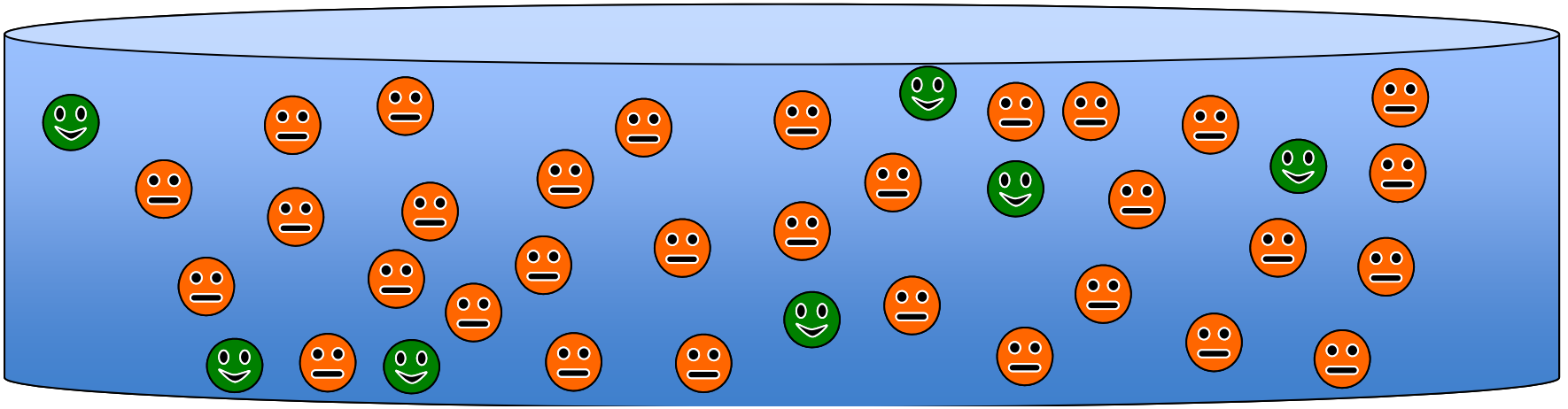


What happens in reality at the microbial level in hatchery tanks upon refilling and restocking?

in the mean time: → K-strategist bacteria grow slowly

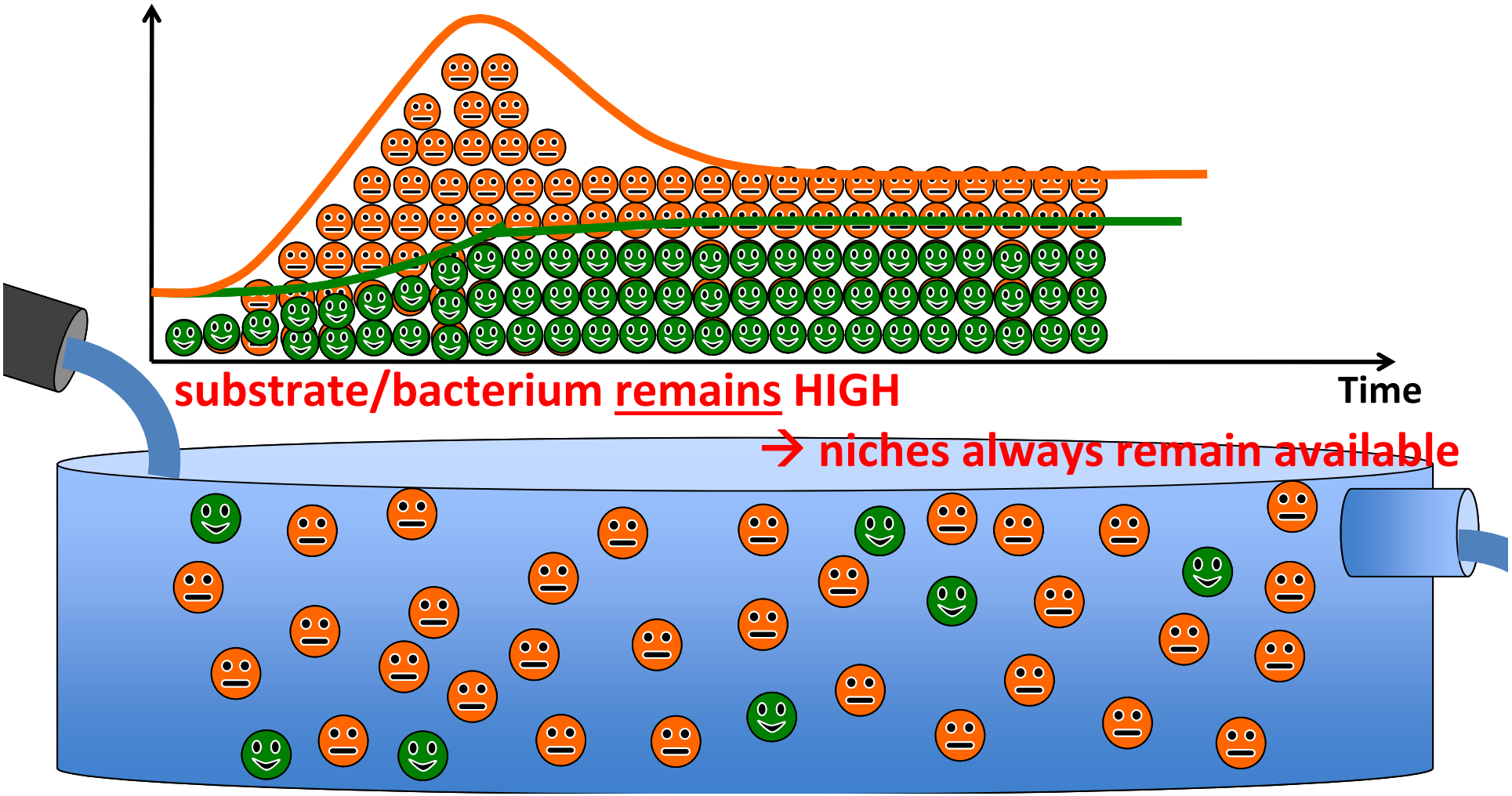


substrate per bacterium = HIGH; niches are open



What happens in reality at the microbial level in hatchery tanks upon refilling and restocking?

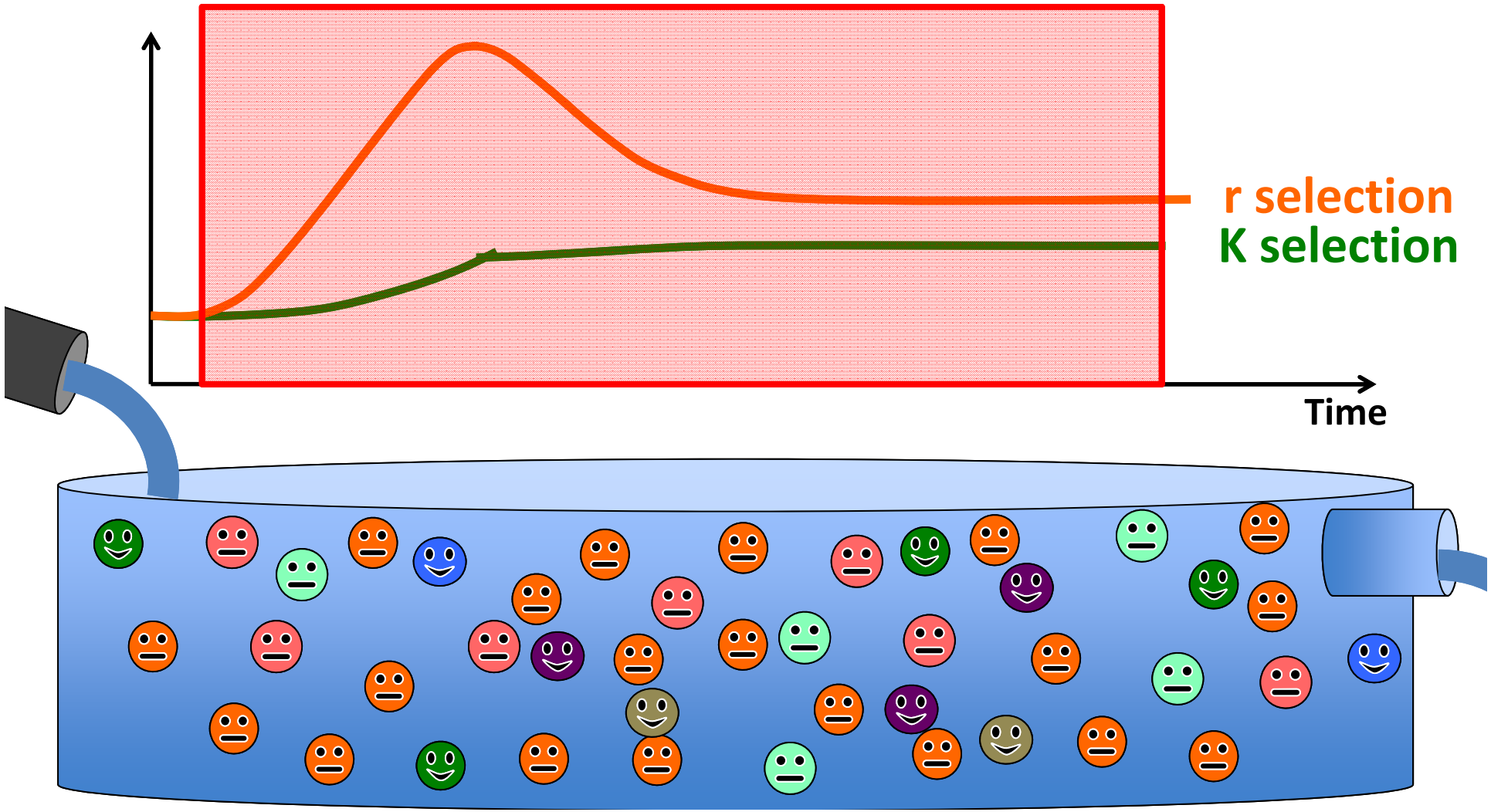
extra dimension: water exchange results in wash-out of bacteria → K-strategists cannot dominate



What happens in reality at the microbial level in hatchery tanks upon refilling and restocking?

introduction of animals:

→ always when r-strategists dominate

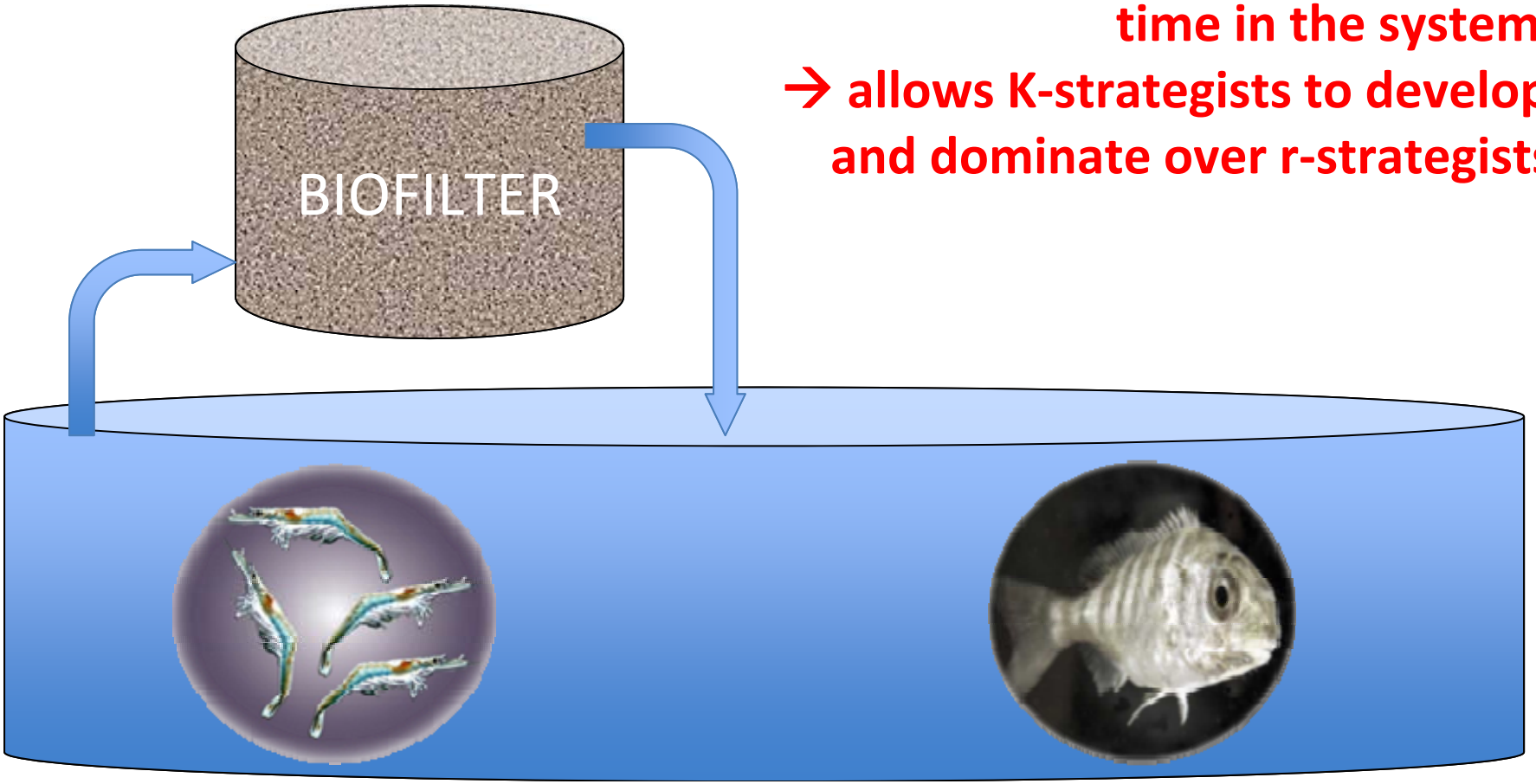


How to control opportunist bacteria in hatchery tanks

application of recirculation technology with biofilter

→ increased water retention time in the system

→ allows K-strategists to develop and dominate over r-strategists

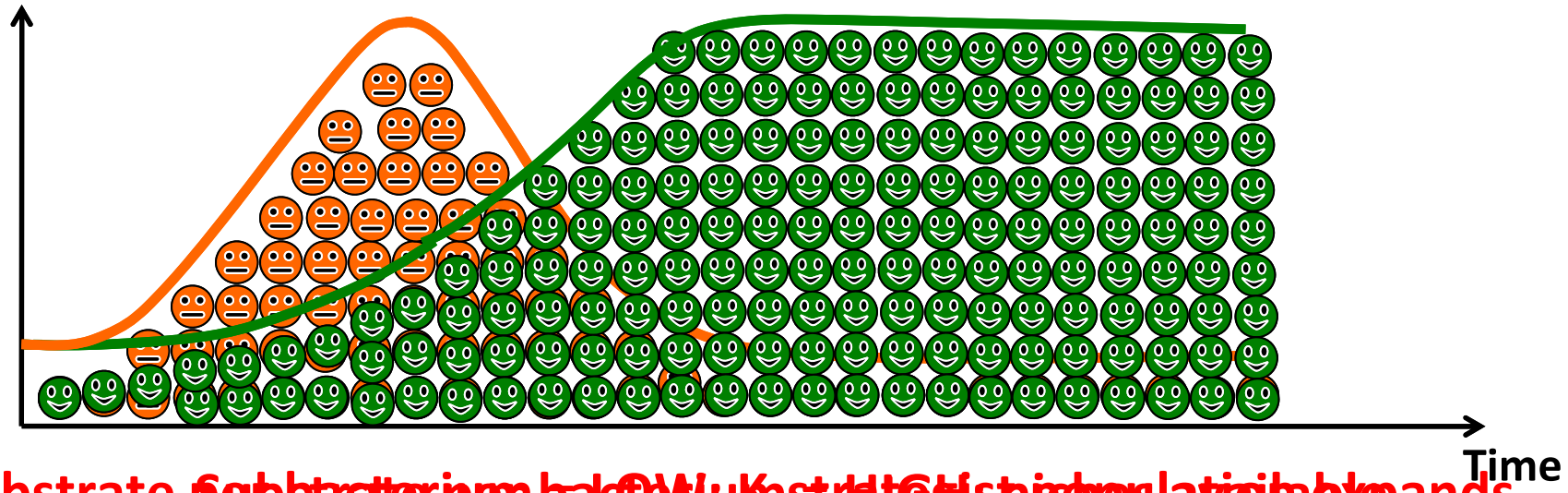


How to control opportunist bacteria in hatchery tank ?

→ application of recirculation technology with biofilter

→ succession of r-strategist and K-strategist populations

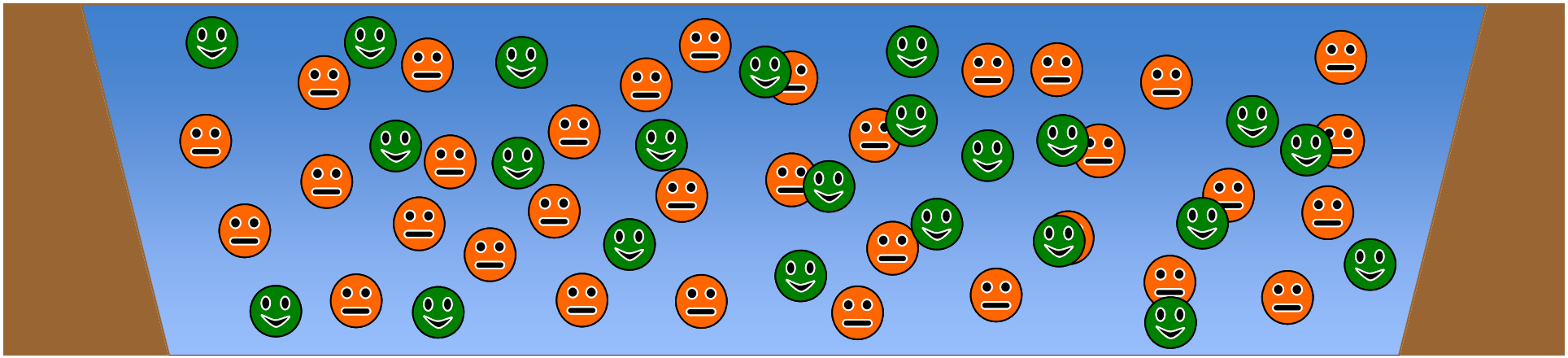
→ finally, all niches taken and no space for new r-strategists



Substrate per bacterium low, r-strategists prevail

Substrate per bacterium high, K-strategists prevail

Substrate per bacterium low, r-strategists prevail

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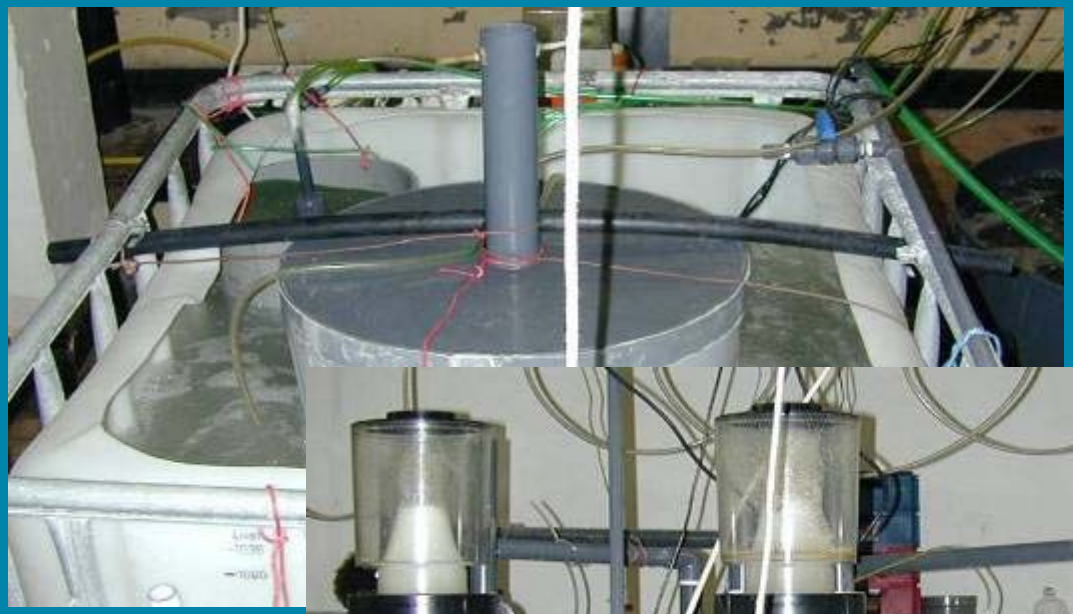
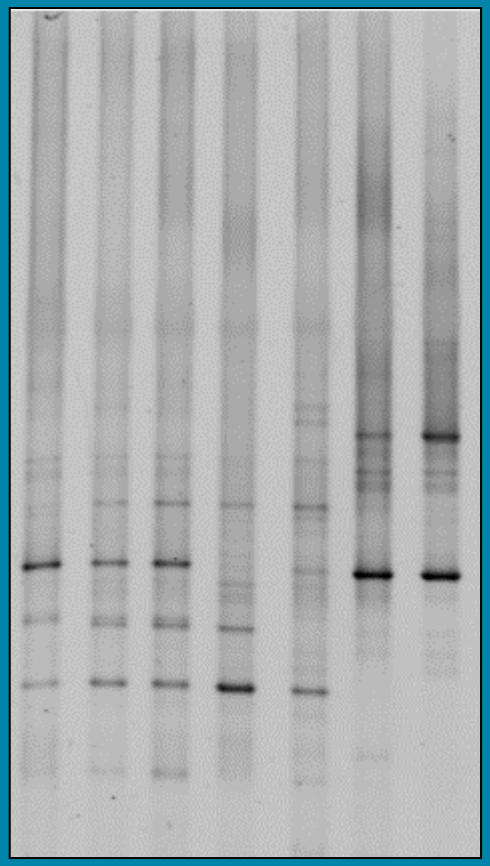
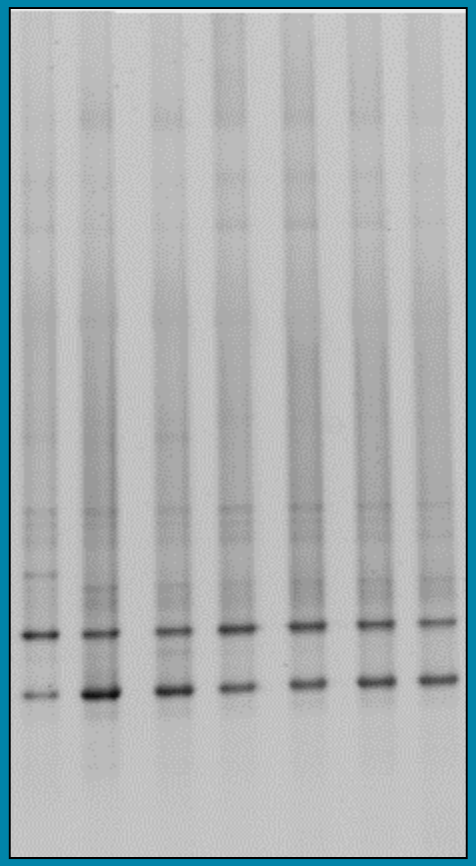


- recirculation system for ultra-high density rotifer culture ~5000 rotifers /ml
- 1 billion rotifers/m3/day

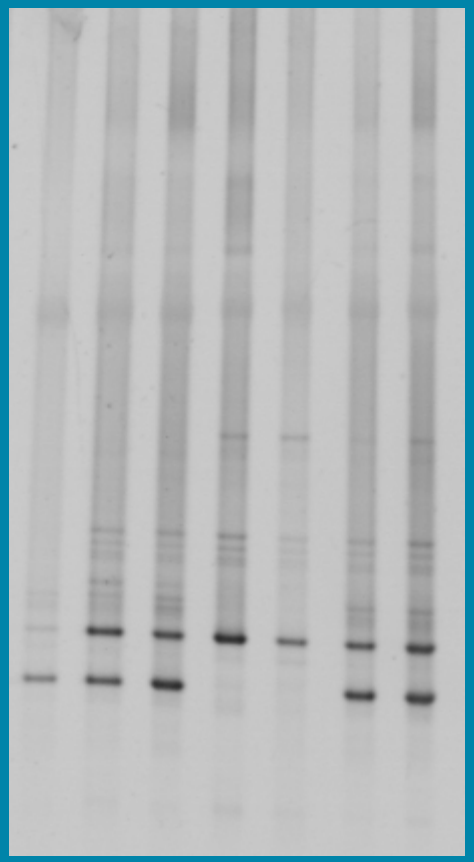
Changes in bacterial communities (DGGE)



week 1

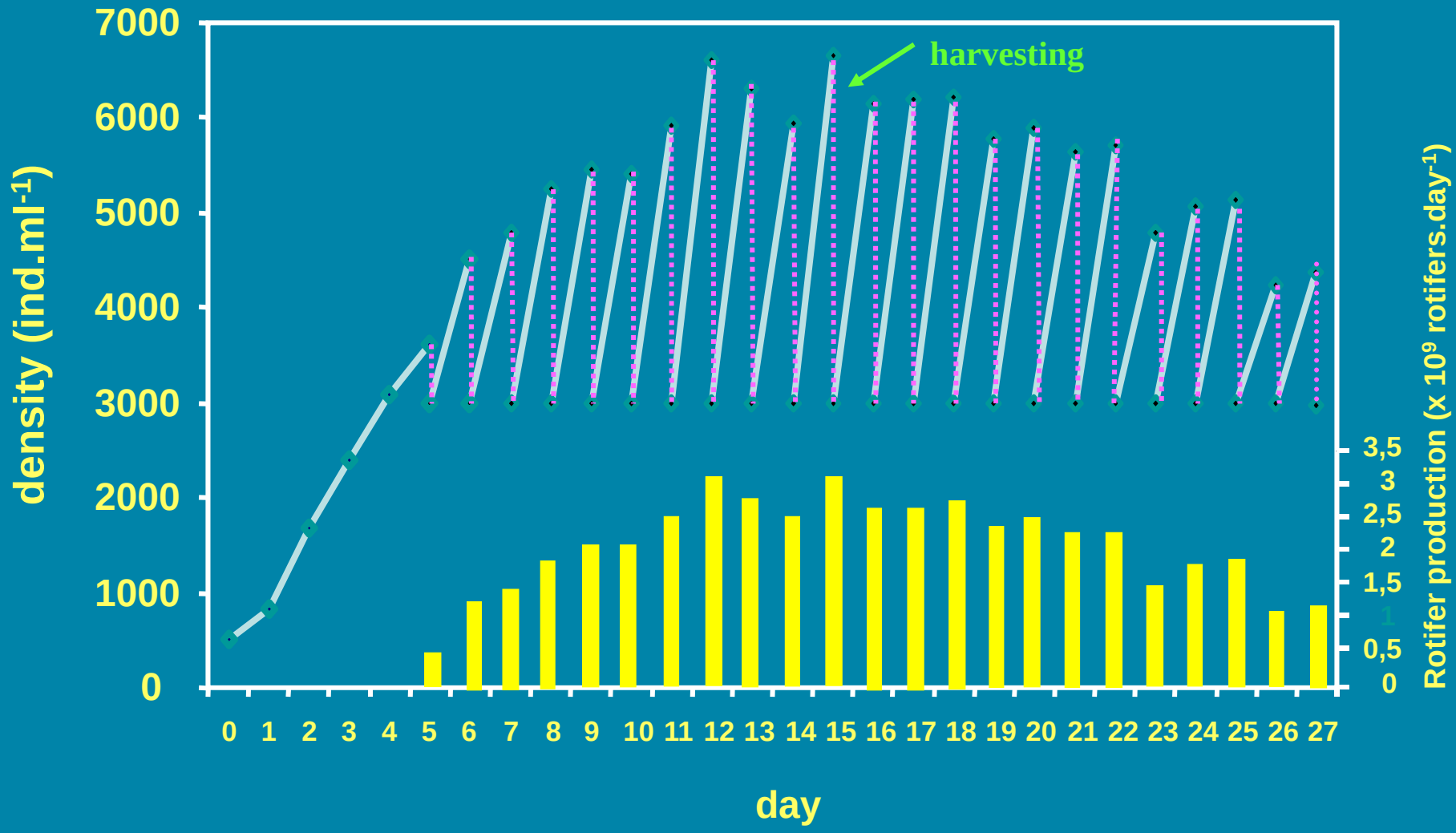


week 2



week 3

Rotifer production at 3000 ind./ml stocking density



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