Magic solutions to bacterial problems in early life stages: Do they exist?

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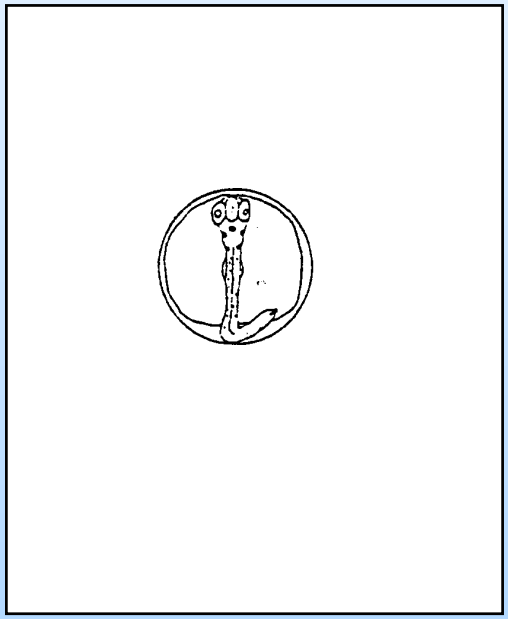
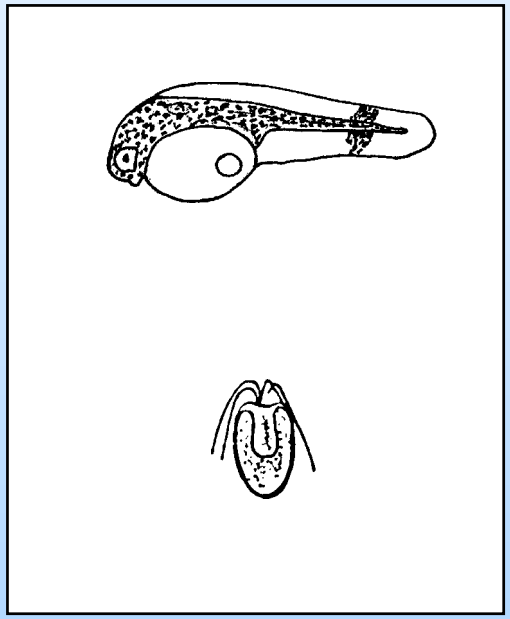
MICROBIAL CONDITIONS

EGG

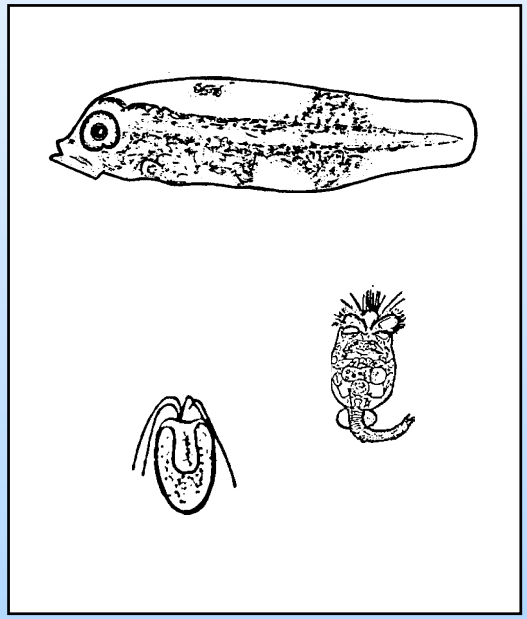


YOLK SAC



two-step

FIRST FEEDING



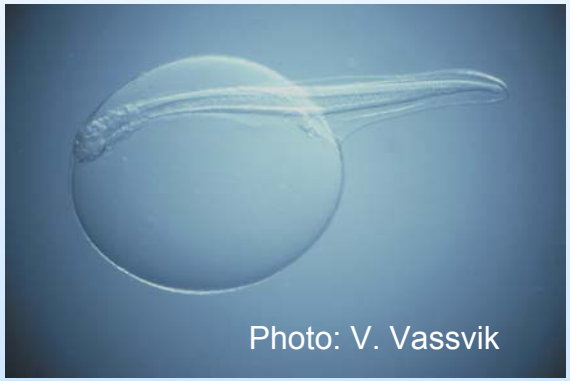
three-step

Physical, chemical factors: temp., exchange rates, water quality...

MICROBIAL CONTROL??

- It is a dynamic system!
- High reproductive rates and metabolic versality - high speed of adaptive changes
- Short generation times - large population fluctuations
- Capacity for dormancy
- Beneficial mutations can be rapidly established by natural selection
- Various strategies for survival:
  - Not resource limited - high growth rates
  - Resource limited - many competitive adaptations

MICROBIAL CONDITIONS



Early life stages

- Sterile at hatching - the importance of the bacterial load and the composition of the ambient water for the establishment of a primary protective microflora
- Bacteria and microalgae ingested at the yolk sac stage
- Differences between marine fish species (short vs long yolk sac period, clear vs green water)
- Exposure to stressors in early life stages - adverse effects later in development

HATCHING

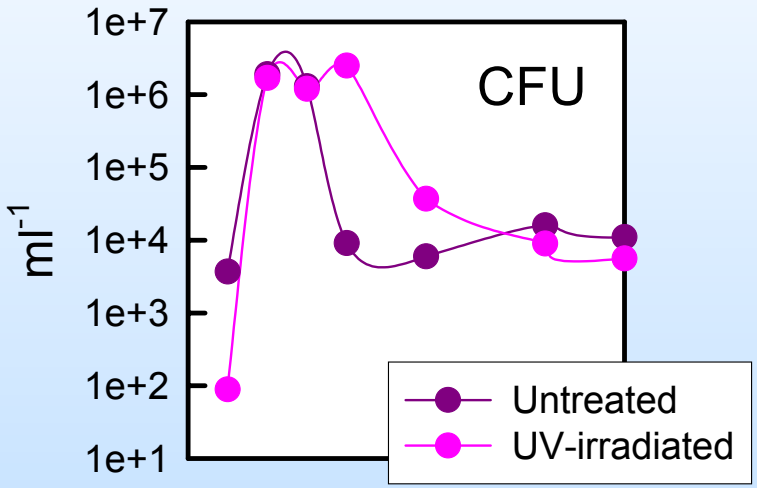
Enhanced organic loading

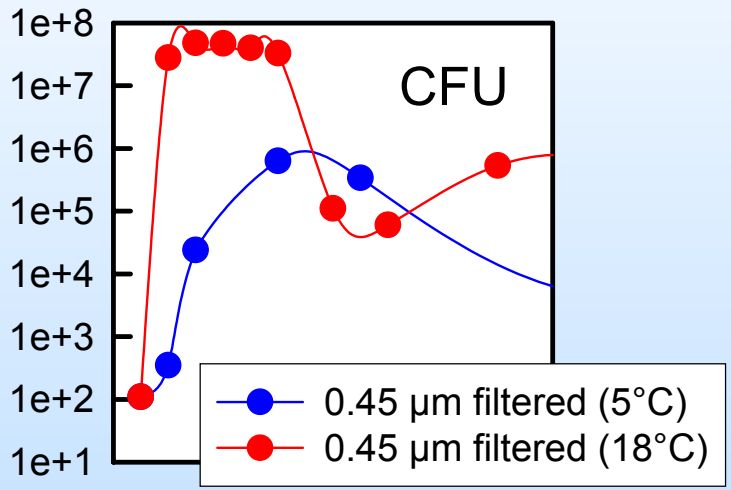
CARBON BUDGET

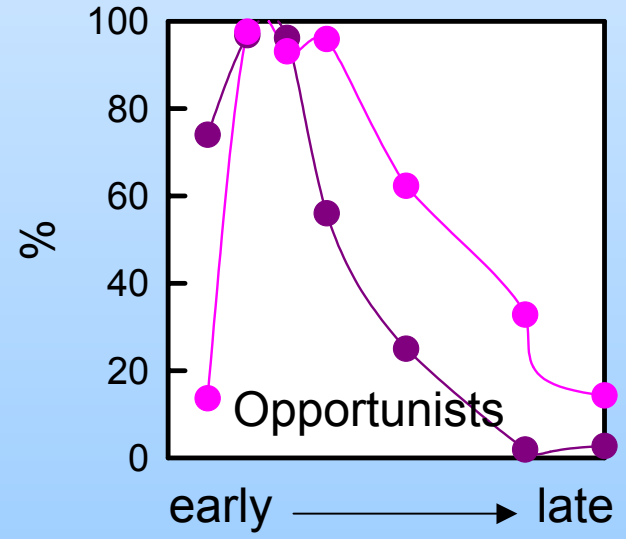
	$\mu g\ C\ egg^{-1}$	%
Larvae	552	65.0
Chorion	12	1.4
Estimated DOC loss	286	33.7

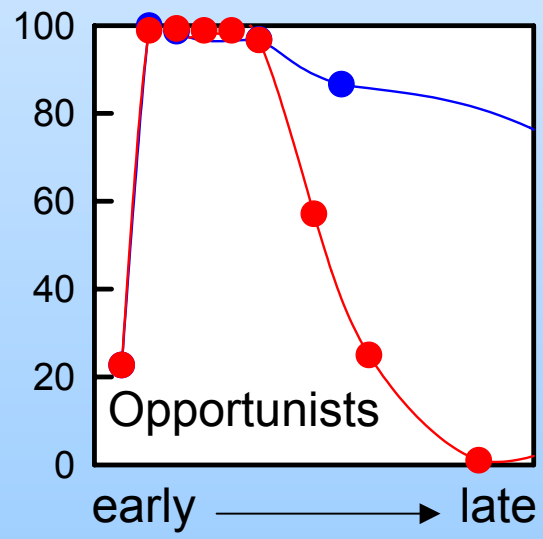
Dahlø et al., unpublished results

No bacteria introduced, only substrate...









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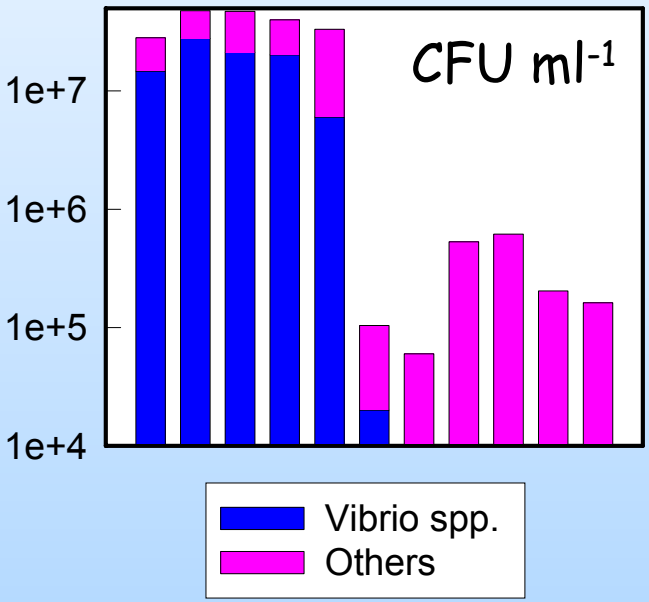
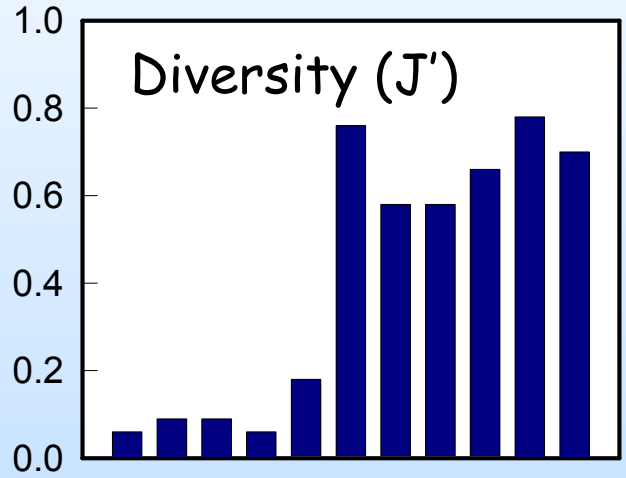
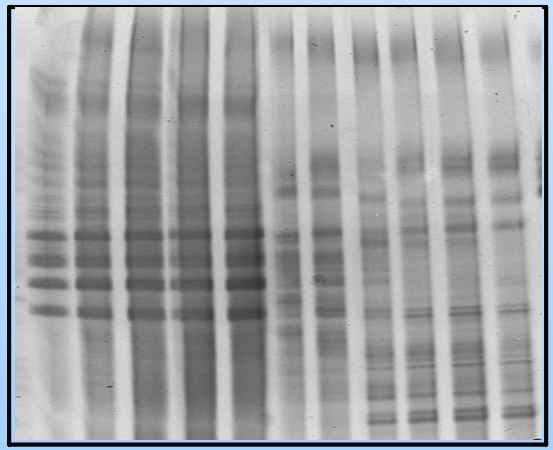






DGGE

early → late in succession

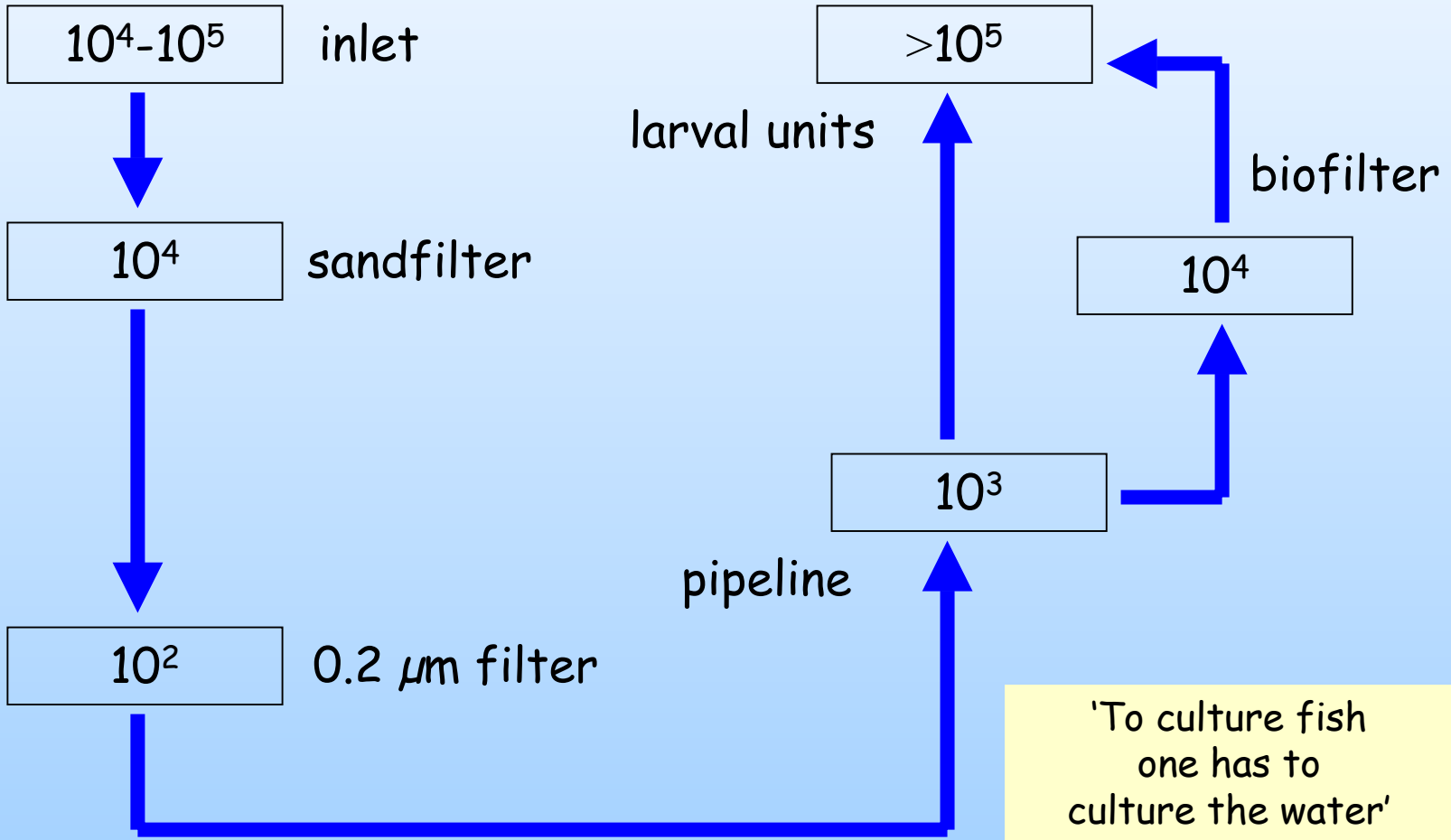
Beat them
or
join them?

The Unknown Enemy

Fig. 2. Protective clothing of the kind worn by plague doctors during the seventeenth century.

REDUCTION

RECOLONIZATION



'To culture fish
one has to
culture the water'

Chinese saying

RECOLONIZATION

A probiotic approach?

MICROALGAE - green water technique

ALGAE
Interactions with bacteria

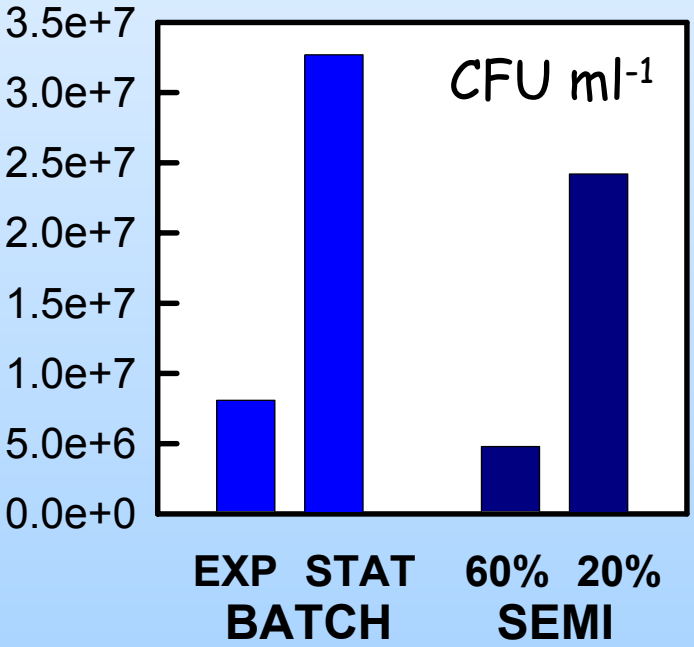
- stimulate growth by release of dissolved organic carbon
- inhibit growth through production of toxic metabolites
- interfer with the expression of traits important for virulence, colonization

A wide range of mechanisms by which algae may regulate bacterial communities

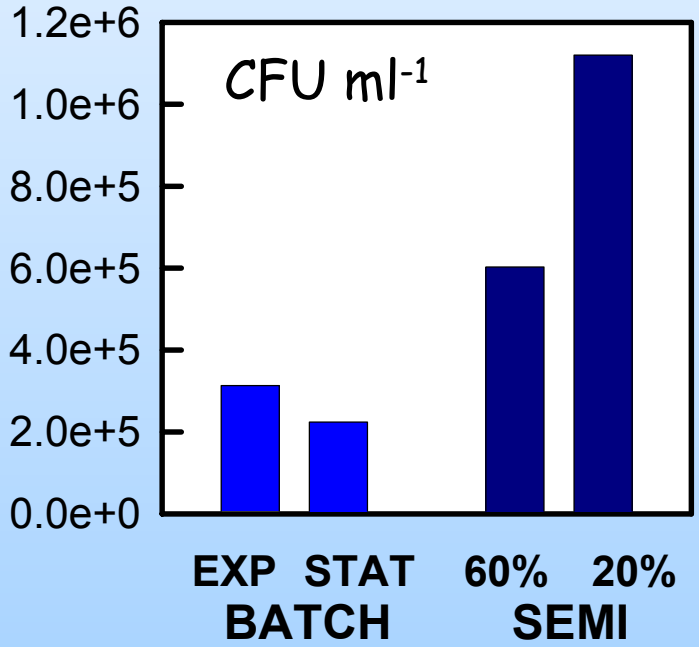
BACTERIAL LOAD

Isochrysis galbana

Associated with algal culture



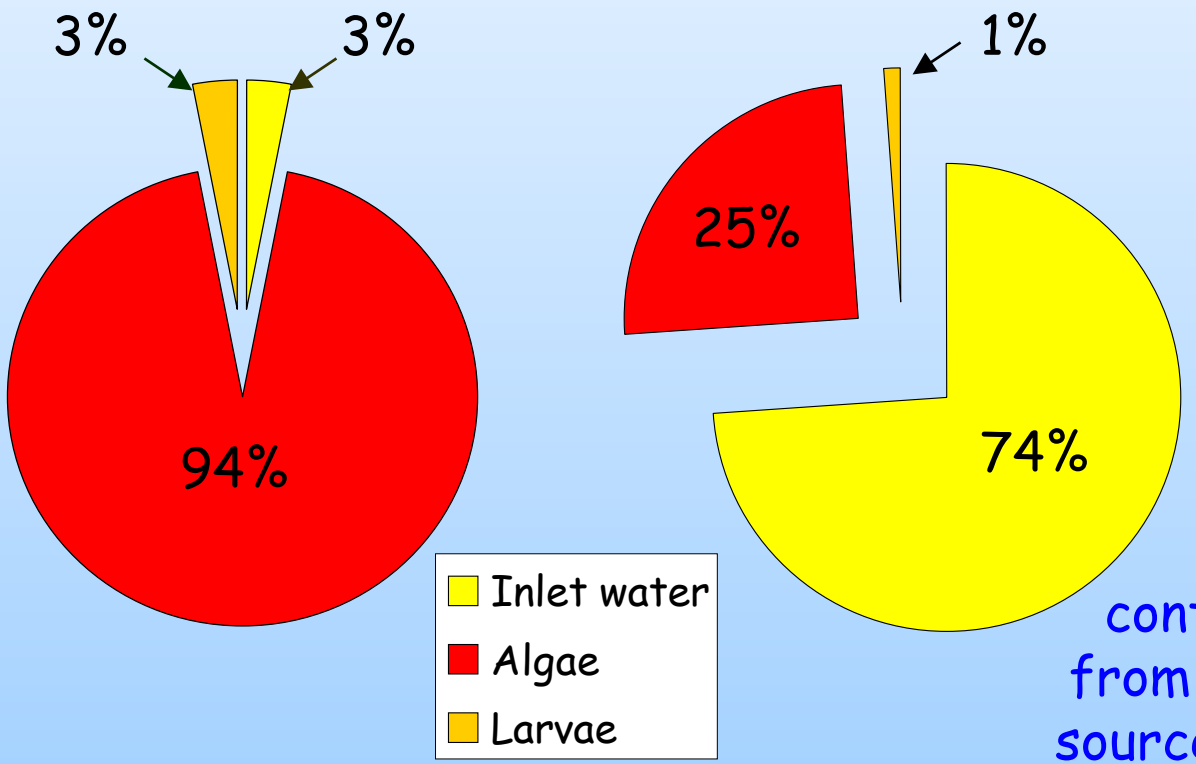
Added to obtain a algal density of 100 cells μl^{-1} in larval culture



No (batch) or very low levels (< 0.01%, semi-continous) of Vibrio spp.

Contribution of bacteria

bacterial level
in inlet water: 1×10^3 1×10^5



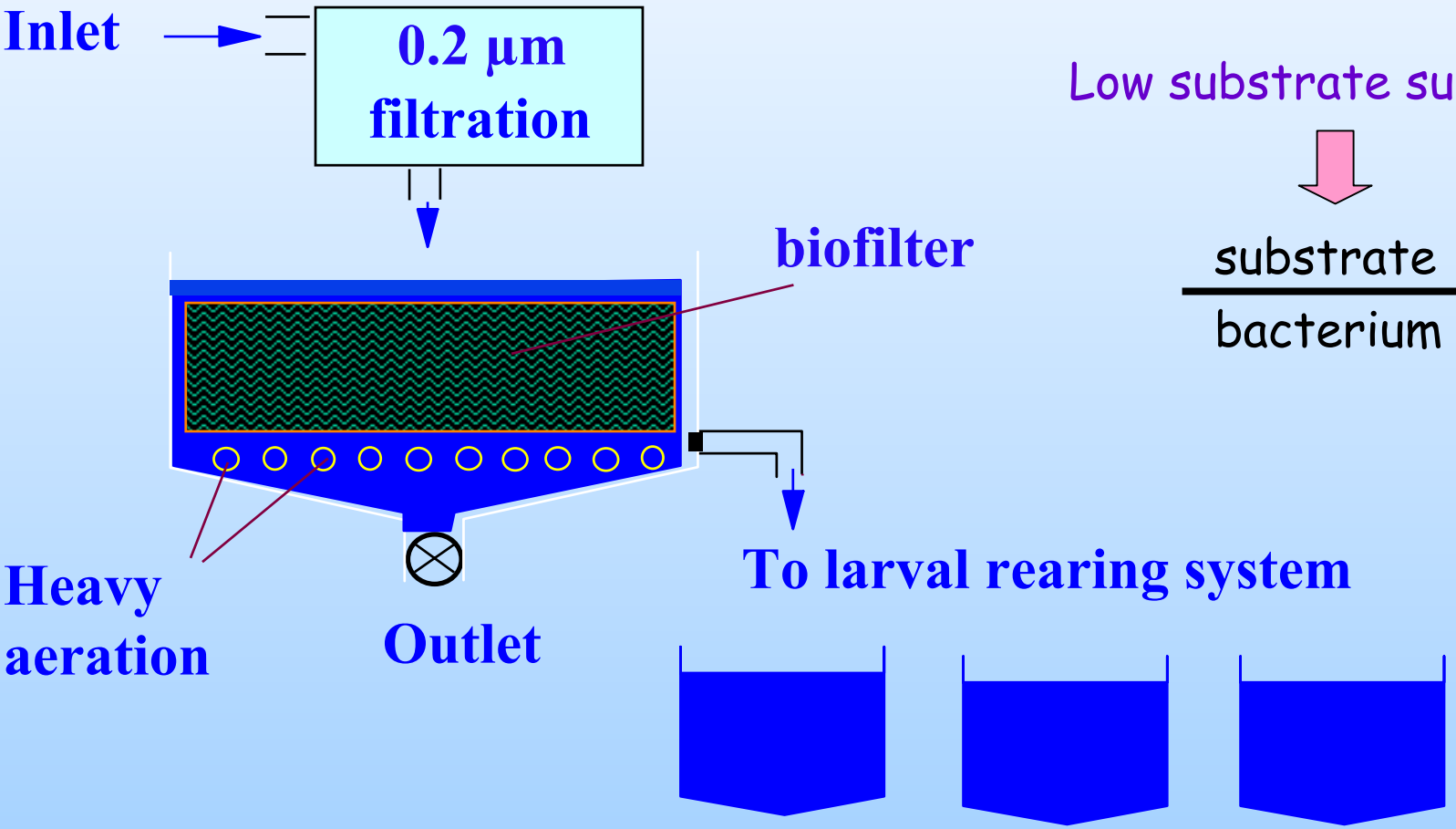
contribution from different sources into the system

RECOLONIZATION

A probiotic approach

WATER TREATMENT - biofilter technology

BIOFILTER (flow-through)

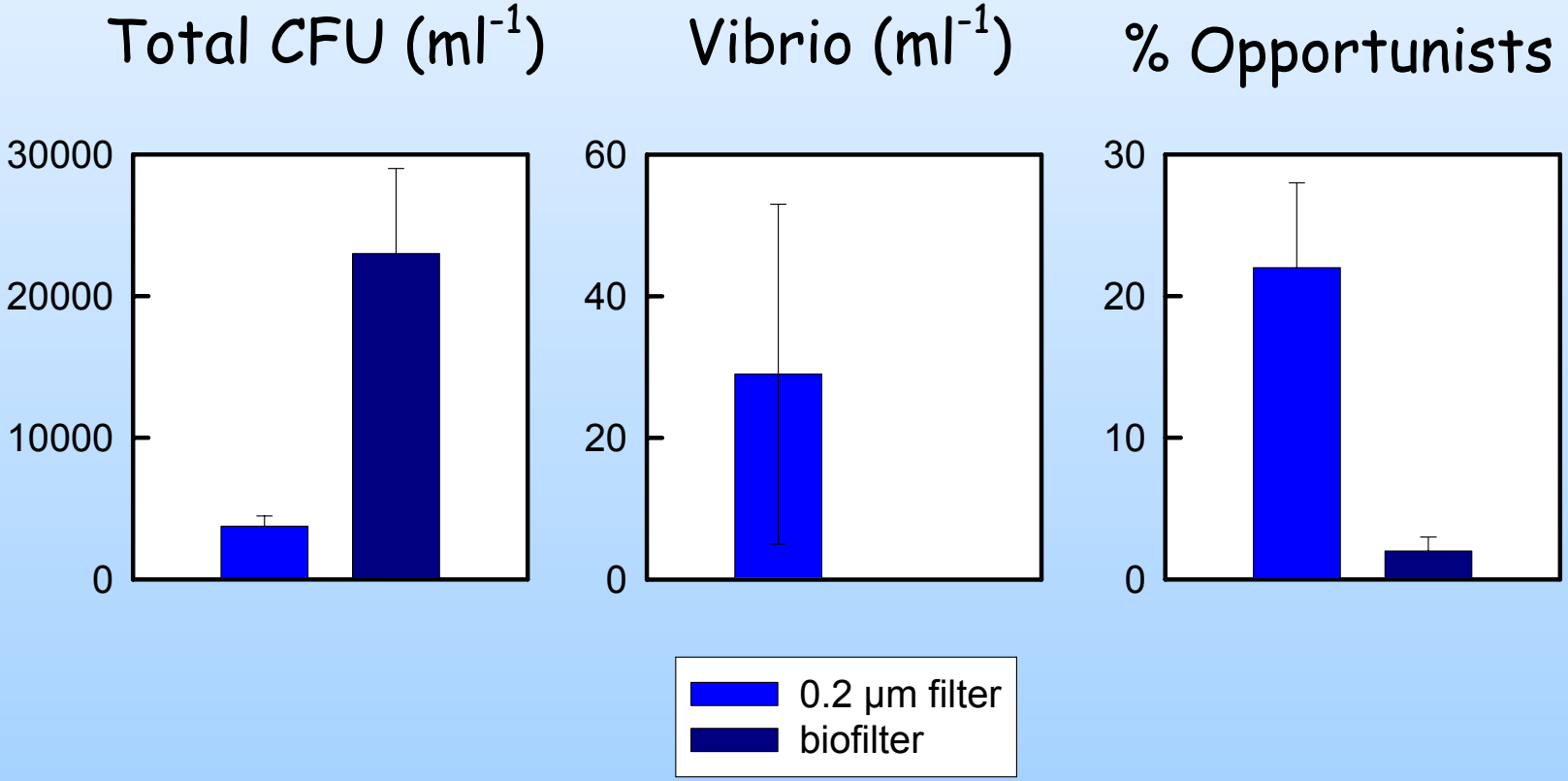


Low substrate supply

substrate / bacterium

Skjermo et al., 1997

RECOLONIZATION IN BIOFILTER
A magic solution?



TWO WATER QUALITIES

0.2 μm filter and biofilter

How is the bacterial community of the water affected by enhanced organic loading in combination with microalgal addition?

ORGANIC LOADING

	Total CFU		Vibrio		% Opport.	
	0.2 µm	biofilter	0.2 µm	biofilter	0.2 µm	biofilter
Clear water	$2.1 \cdot 10^7$	$1.3 \cdot 10^6$	$4.0 \cdot 10^6$	$9.5 \cdot 10^3$	100	99

Low levels of opportunistic bacteria (0.3-7%) and no Vibrio spp. observed in both water qualities before organic loading

Everything is everywhere,
the environment selects

M.W. Beijerinck

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Clear water	$2.1 \cdot 10^7$	$1.3 \cdot 10^6$	$4.0 \cdot 10^6$	$9.5 \cdot 10^3$	100	99
Green water						
Isochrysis	$2.5 \cdot 10^7$	$9.8 \cdot 10^5$	$5.4 \cdot 10^4$	$1.2 \cdot 10^3$	98	69
Pavlova	$2.0 \cdot 10^7$	$5.4 \cdot 10^6$	$2.0 \cdot 10^6$	$3.0 \cdot 10^2$	88	8

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Chaetoceros	$1.5 \cdot 10^7$	$2.4 \cdot 10^7$	$1.3 \cdot 10^6$	$1.9 \cdot 10^5$	60	19
Mix (1:1:1)	$1.4 \cdot 10^7$	$1.3 \cdot 10^7$	$8.2 \cdot 10^5$	$5.9 \cdot 10^5$	83	44

Relatively high bacterial densities and large proportions of opportunistic bacteria are associated with cultures of Bacillariophyceae (e.g. Chaetoceros sp.)

CONCLUSIONS

- The significance of microbial conditions in early life stages
  - exploit growth potential
- Important differences in response to enhanced organic loading
- No magic solutions, but large potentials for microbial management
  - What is removed, will be replaced……