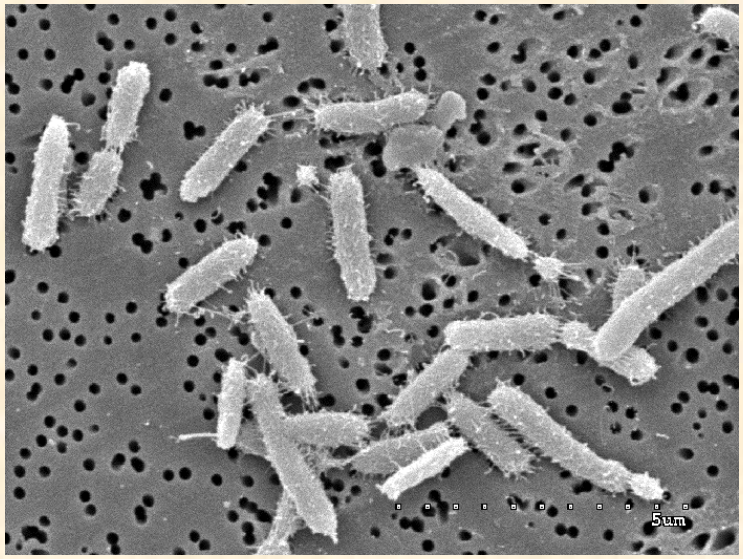
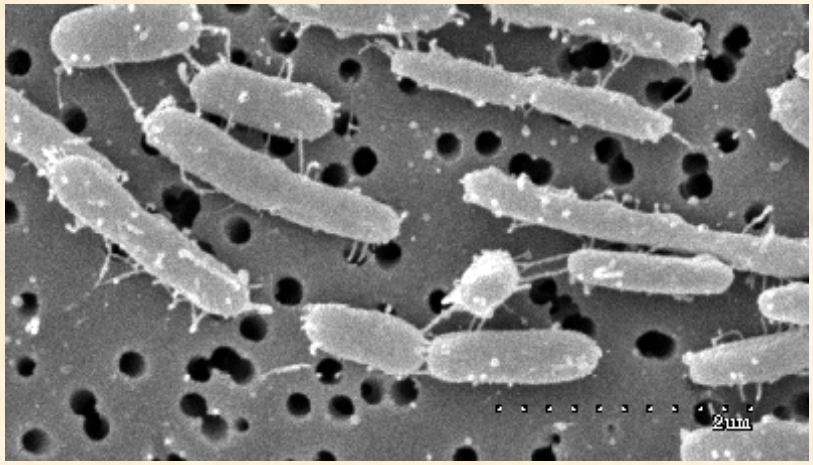
Mikrobiell oceanografi – eller, varför i all världen ska jag bry mig om celler och deras biologi?

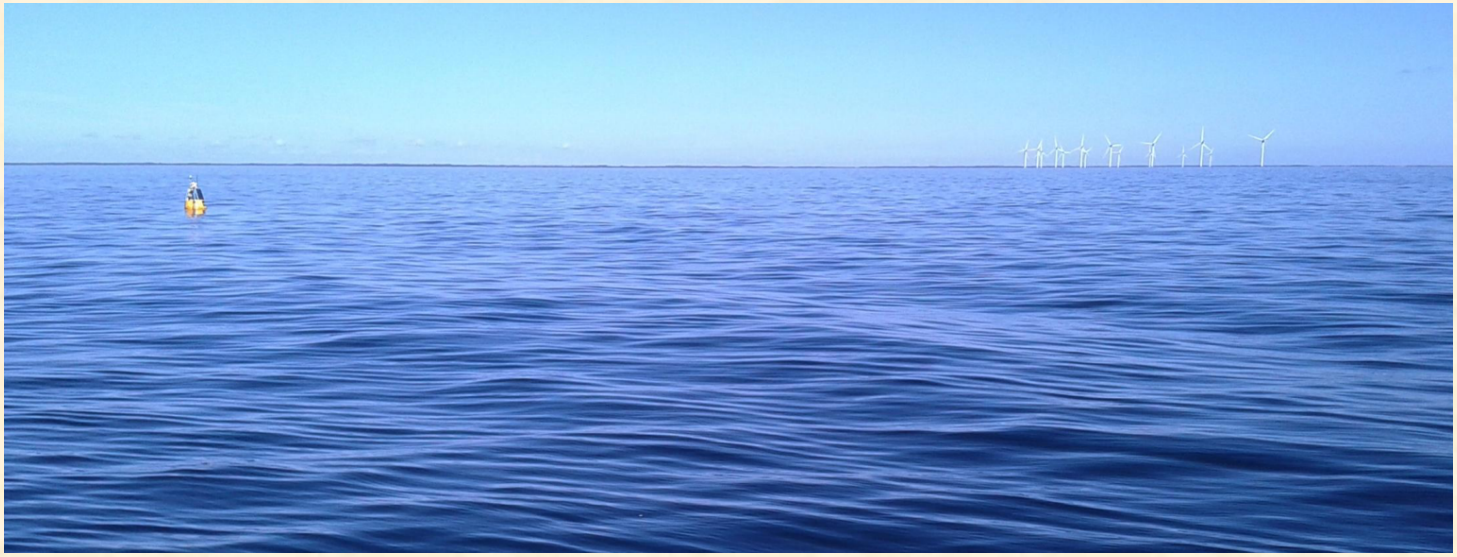


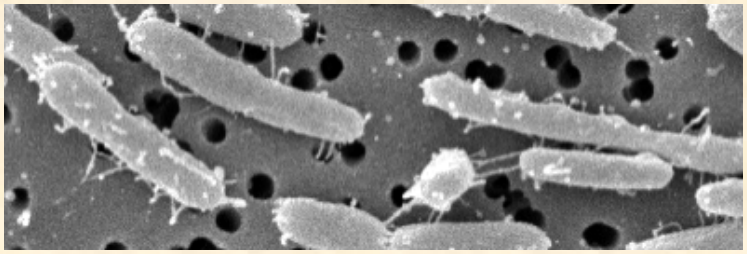


Linnæus University | Centre
Ecology and Evolution in Microbial model Systems

Jarone Pinhassi

Cultivating marine model bacteria to gain insights into bacterioplankton

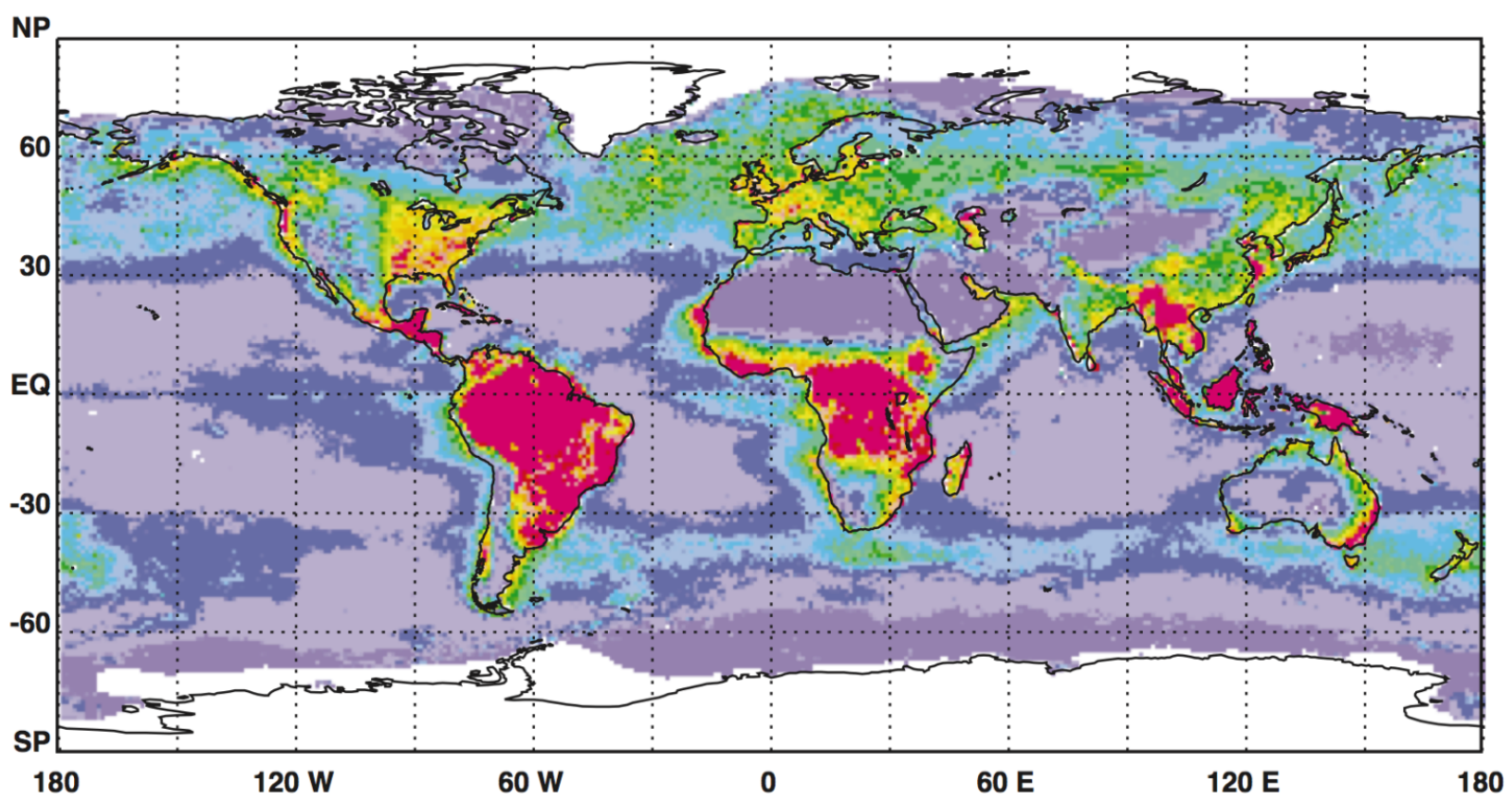




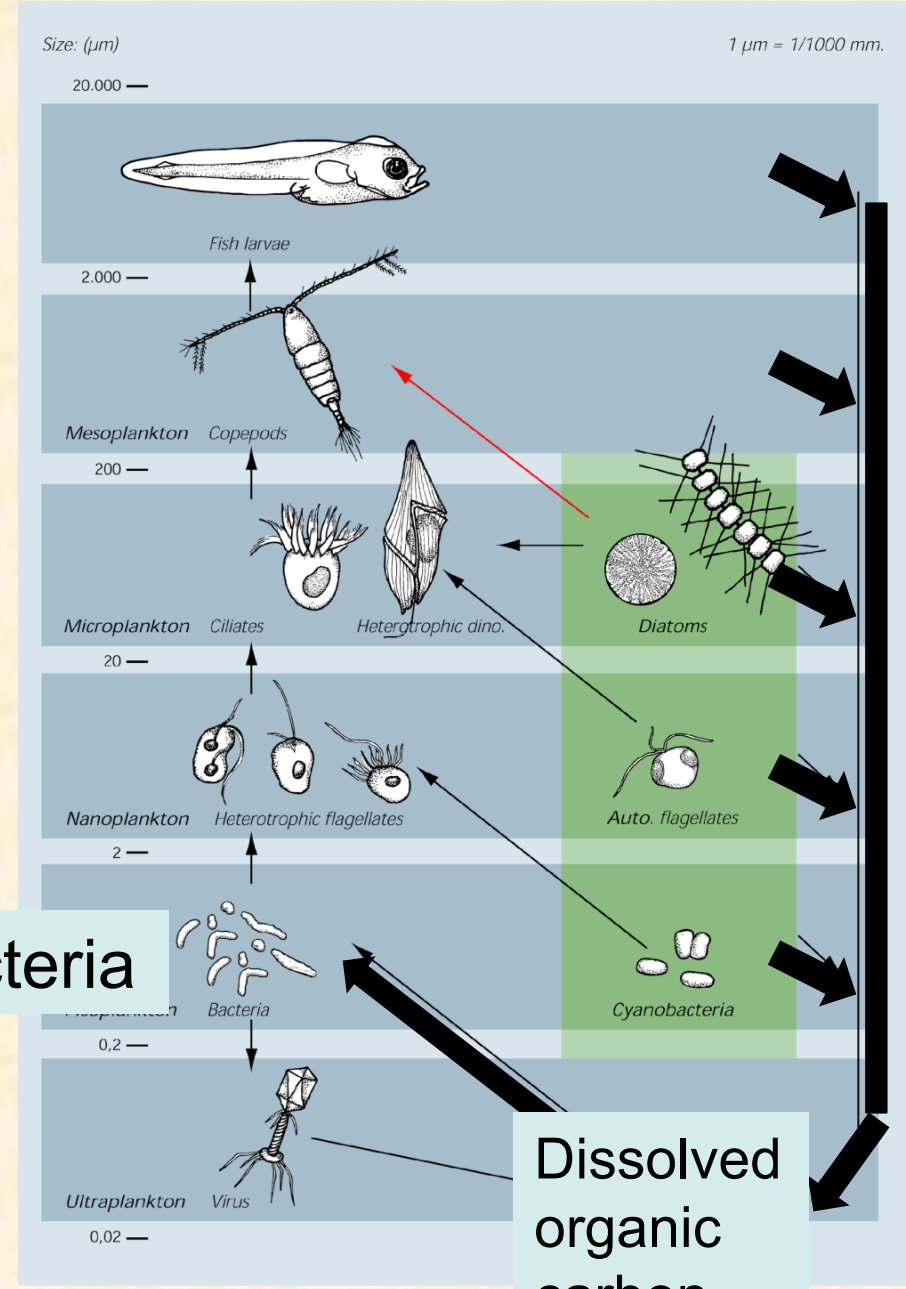
Jarone Pinhassi

Microscopic phytoplankton in the sea carry out as much photosynthesis as green plants on land (~140 million tons of carbon per day).

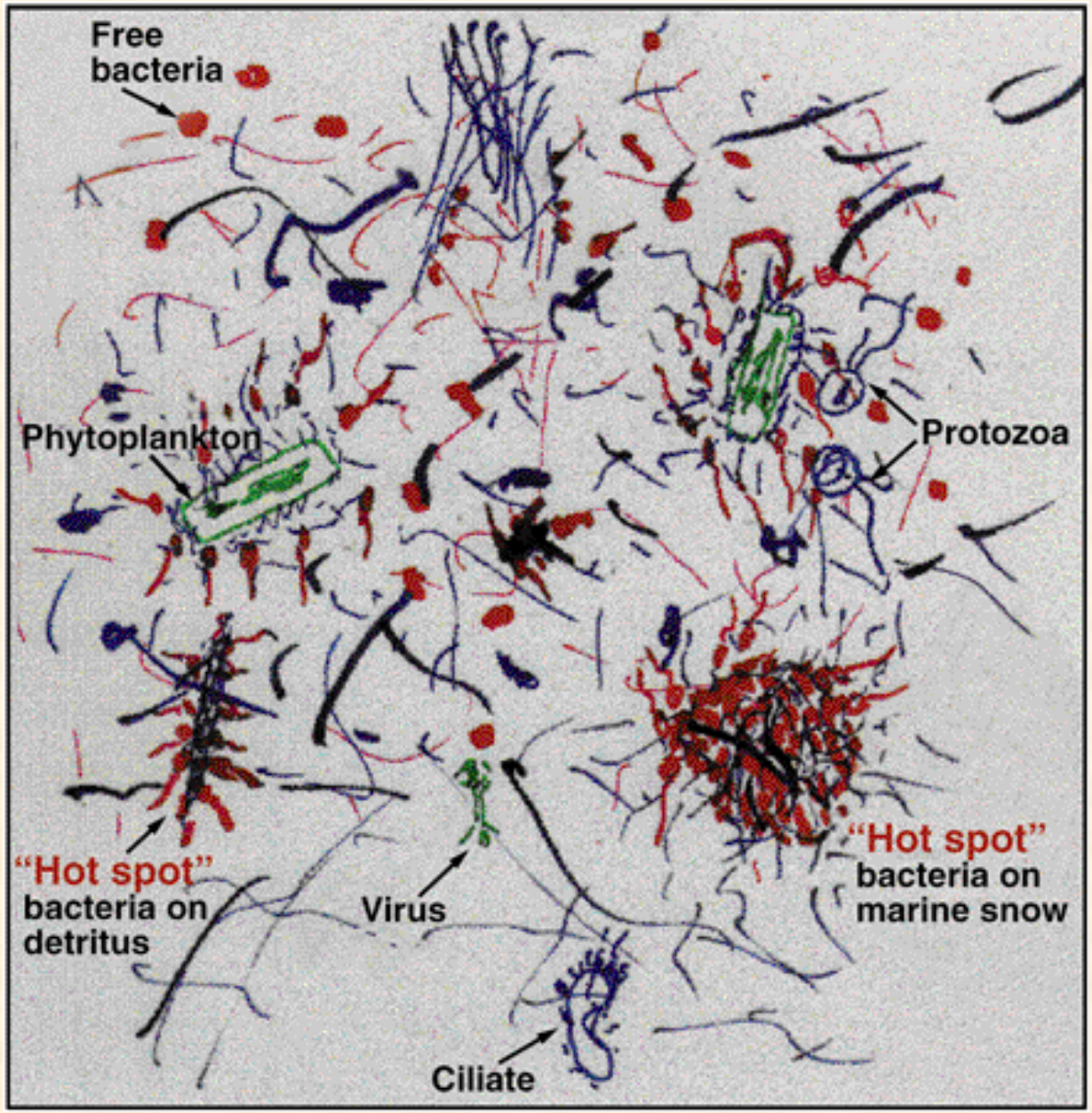
Field et al. Science 1998



And around 50% of the organic matter produced is processed by marine bacteria!

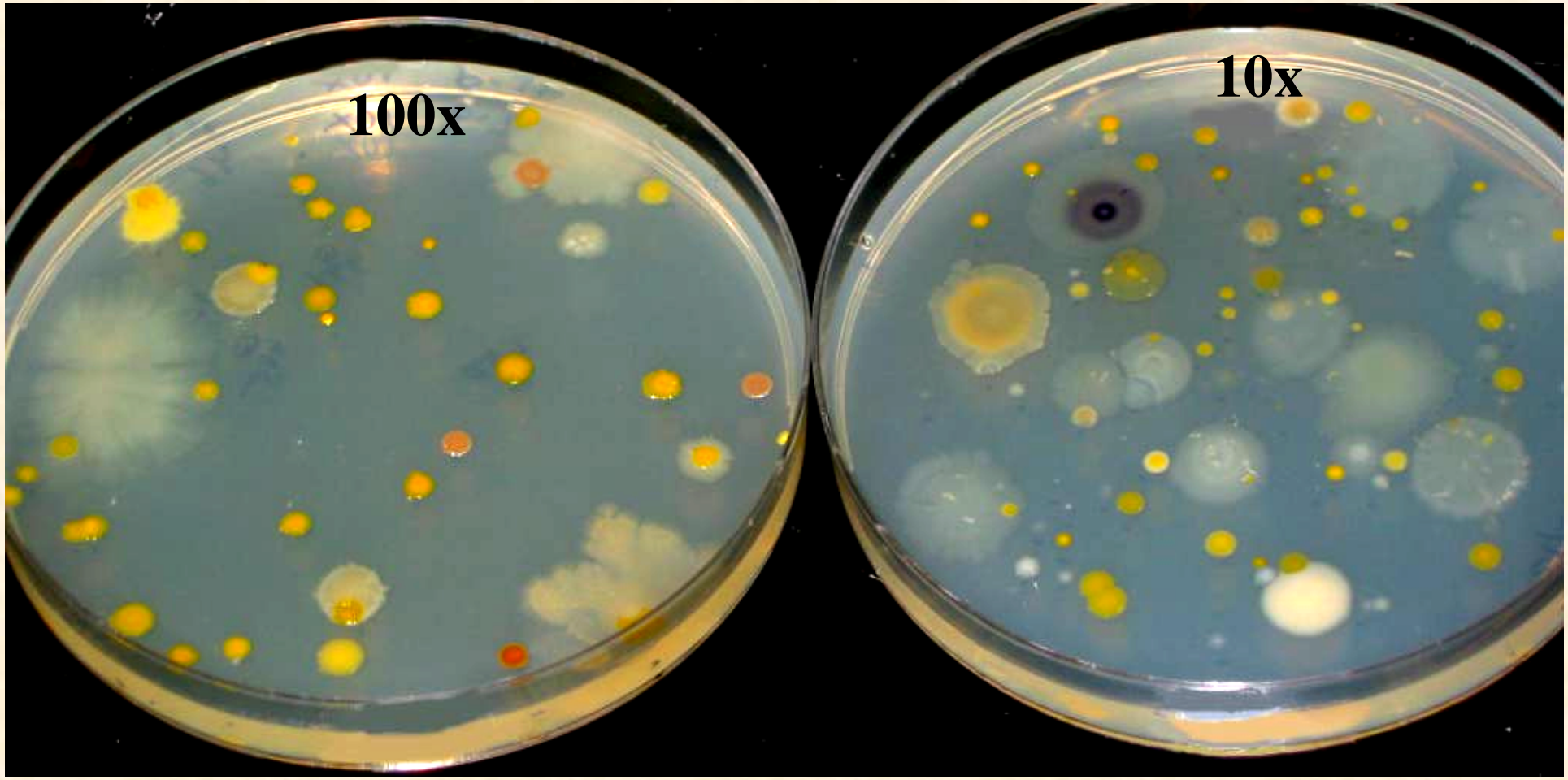

Size: (µm)
1 µm = 1/1000 mm.
20.000
Fish larvae
2.000
Mesoplankton
Copepods
200
Microplankton
Ciliates
Heterotrophic dino.
Diatoms
20
Nanoplankton
Heterotrophic flagellates
Auto. flagellates
2
Bacteria
Cyanobacteria
0,2
Ultraplankton
Virus
0,02
Bacteria
Dissolved organic carbon

Näringskedjan i artistisk/realistisk tolkning



Azam 1998, Science 280:694-696

Biologisk mångfald bland marina bakterier



Bakteriekolonier på agarplattor – många olika färger…

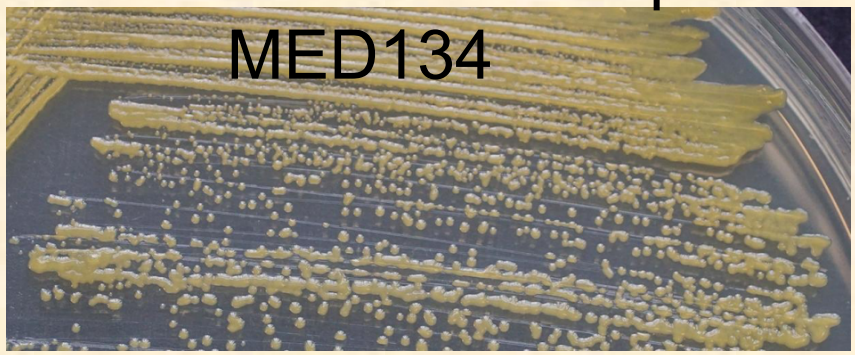
What is a model organism?

- A model bacterium can be a model in many ways…
- As representative of a **particular taxon** (e.g. a genus or a family).
- As representative of a particular **process**, it has (a set of) genes carrying out a certain ecological or physiological function.
- As general representative of bacteria in general.
- As representative of a **ocean province**.

Examples of marine model bacteria

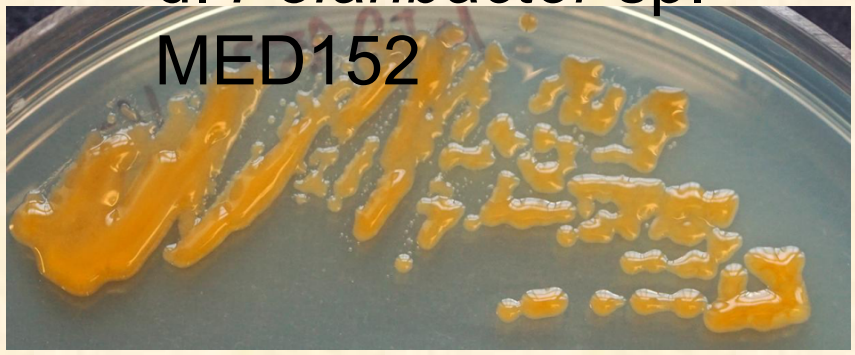
a. *Ruegeria pomeroyi* DSS-3

b. *Dokdonia* sp. MED134



c. *Vibrio* sp. AND4

d. *Polaribacter* sp. MED152

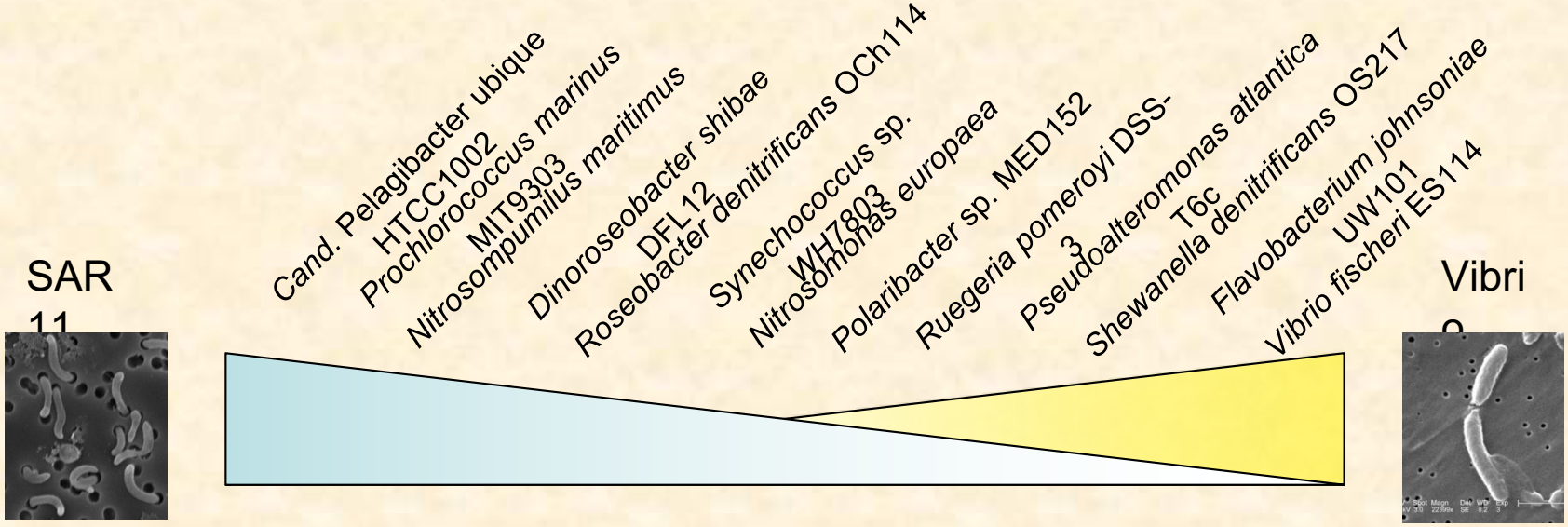


Photographs by Shalabh Sharma

Key model marine bacteria

- ***Prochlorococcus*** spp. and ***Synechococcus*** spp. (*Synechococcales, Cyanobacteria*) (Chisholm et al. 1992; Partensky et al. 1999).
- ***Candidatus* Pelagibacter ubique** HTCC1062 (*Pelagibacterales, Proteobacteria*) (Rappé et al. 2002).
- ***Ruegeria pomeroyi* DSS-3** (*Rhodobacterales, Proteobacteria*) (Moran et al. 2004).
- ***Dokdonia* sp. MED134** (*Flavobacteriales*, *Bacteroidetes*) (Gómez-Consarnau et al. 2007).
- ***Nitrosopumilus maritimus*** (*Nitrosopumilales, Thaumarchaeota*) (Könneke et al. 2005).
- ***Alteromonas macleodii*** (*Alteromonadales, Proteobacteria*) (Garcia-Martinez et al. 2002; Gauthier et al. 1995).

Schematic model of the oligotrophy-copiotrophy life strategy continuum



Distribution considers slow growth, cell size, genome size, rRNA gene copies, treansporters, transcriptional regulators, metabolic versatility etc.

Lauro et al. 2009. Proc. Natl. Acad. Sci. USA, 2009. **106**(37): p. 15527-15533

Topics studied using marine model bacteria

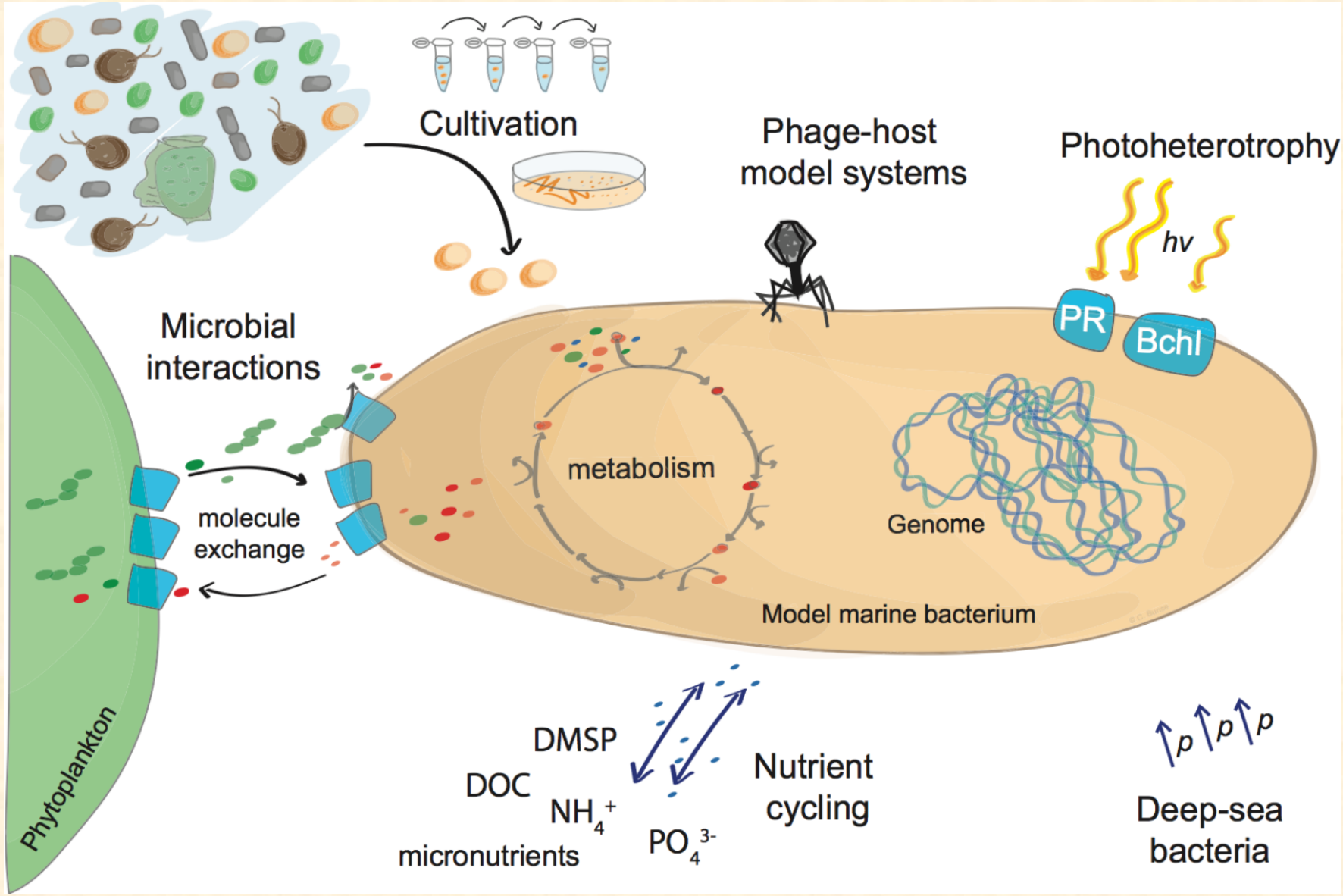
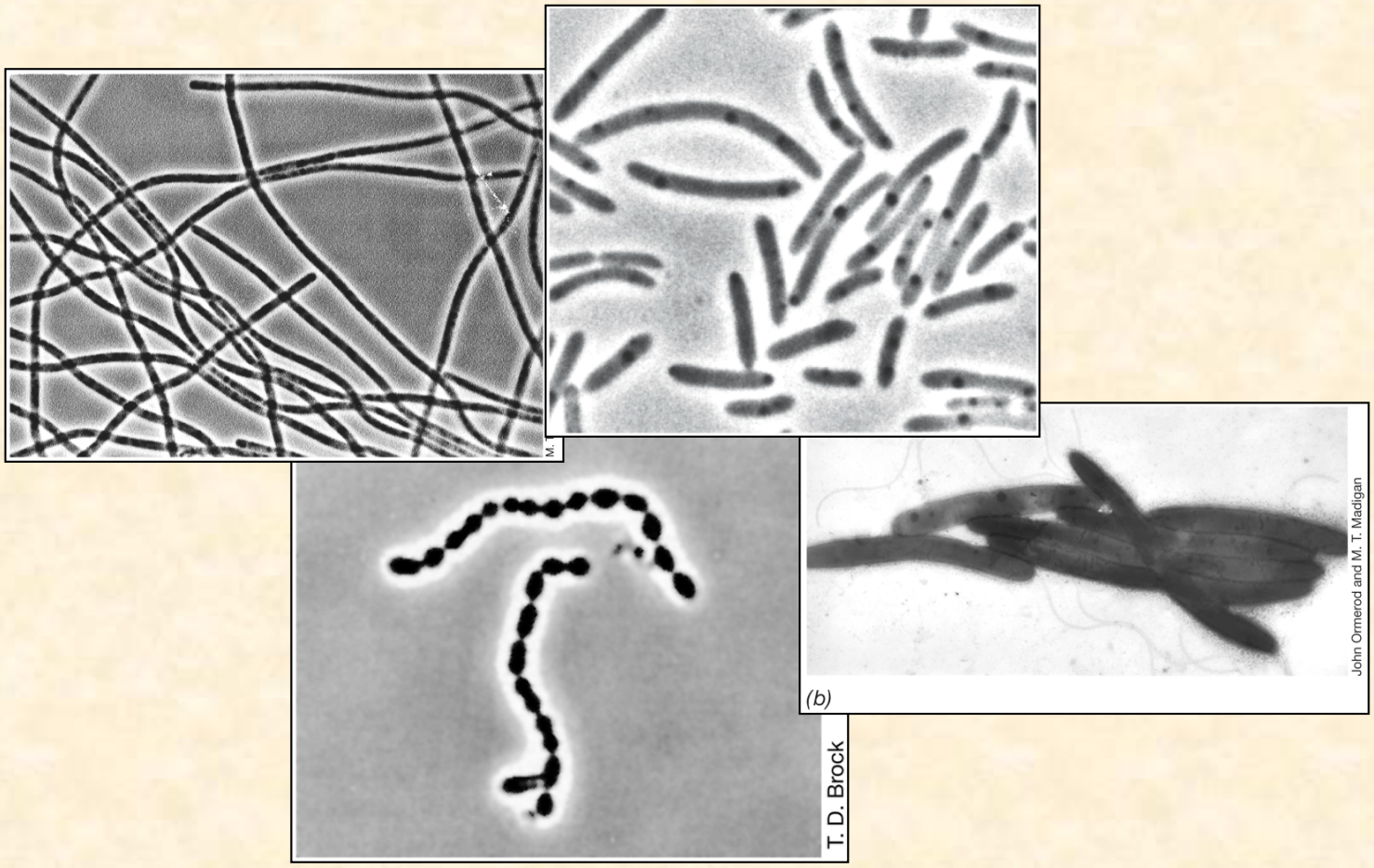


Image courtesy of Carina Bunse

…och många olika former.



Bakterier sedda genom ljusmikroskop.

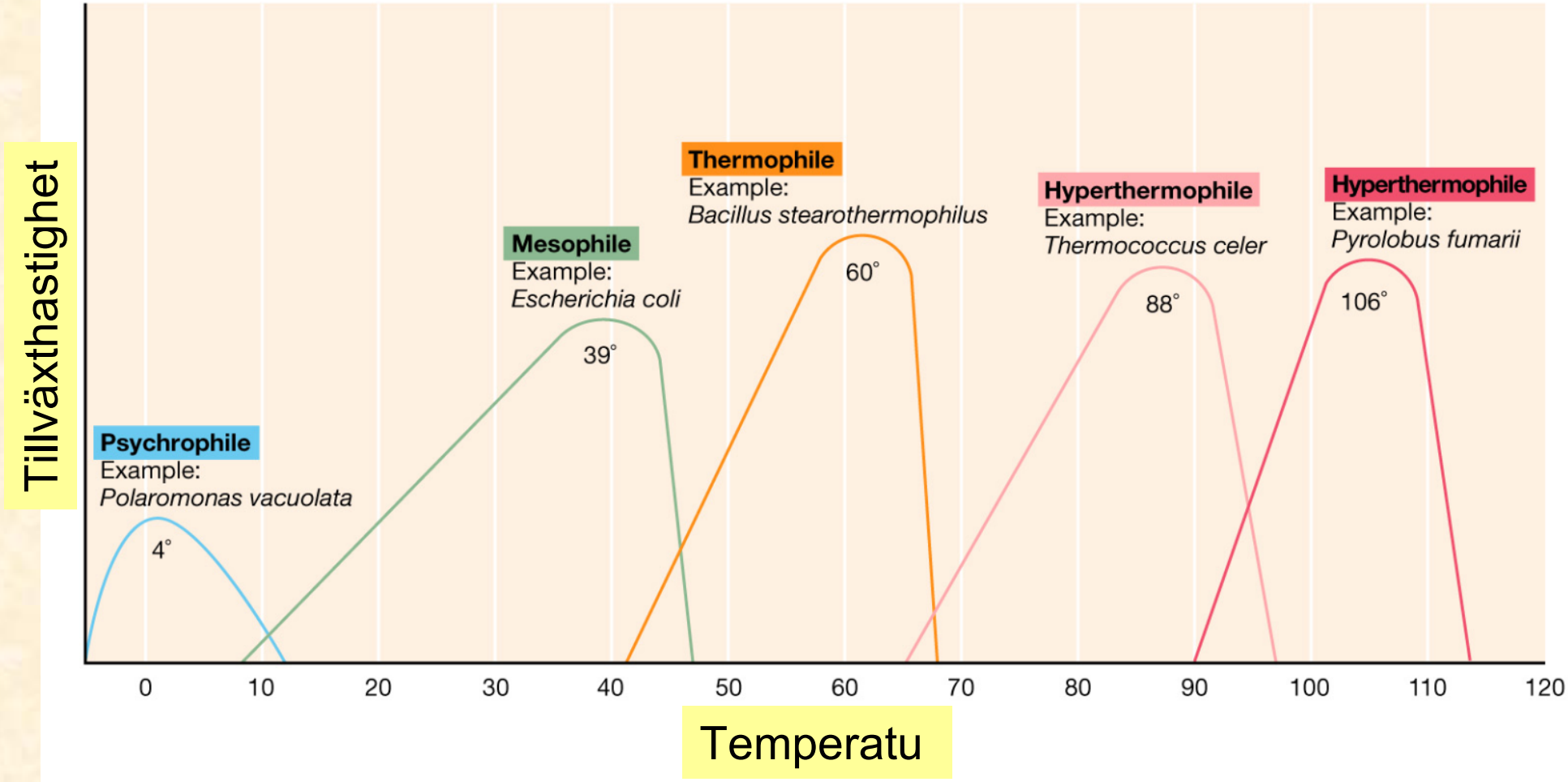
VIRUS OCH BAKTERIER I HAVET

Aquifex aeolicus (Bacteria), *Archaeoglobus fulgidus* (Archaea), *Aeropyrum pernix* (Archaea), *Methanothermobacter thermautotrophicus* (Archaea), *Methanococcus jannaschii* (Archaea), *Pyrococcus horikoshii* (Archaea), *Sulfolobus solfataricus* (Archaea), *Thermoplasma acidophilum* (Archaea), *Thermoplasma volcanium* (Archaea), *Thermotoga maritima* (Bacteria), *Pyrobaculum aerophilum* (Archaea), *Pyrococcus abyssii* (Archaea), *Pyrococcus furiosus* (Archaea), *Thermus thermophilus* (Bacteria), *Aquifex aeolicus* (Bacteria), *Archaeoglobus fulgidus* (Archaea), *Aeropyrum pernix* (Archaea), *Methanothermobacter thermautotrophicus* (Archaea), *Methanococcus jannaschii* (Archaea), *Pyrococcus horikoshii* (Archaea), *Sulfolobus solfataricus* (Archaea), *Thermoplasma acidophilum* (Archaea), *Thermoplasma volcanium* (Archaea), *Thermotoga maritima* (Bacteria), *Pyrobaculum aerophilum* (Archaea), *Pyrococcus abyssii* (Archaea), *Pyrococcus furiosus* (Archaea), *Thermus thermophilus* (Bacteria) *Thermus thermophilus* (Bacteria), *Aquifex aeolicus* (Bacteria), *Archaeoglobus fulgidus* (Archaea), *Aeropyrum pernix* (Archaea), *Methanothermobacter thermautotrophicus* (Archaea), *Thermotoga maritima* (Bacteria), *Pyrobaculum aerophilum* (Archaea), *Sulfolobus solfataricus* (Archaea), *Thermoplasma acidop-*

Köld är inget hinder för bakterier...

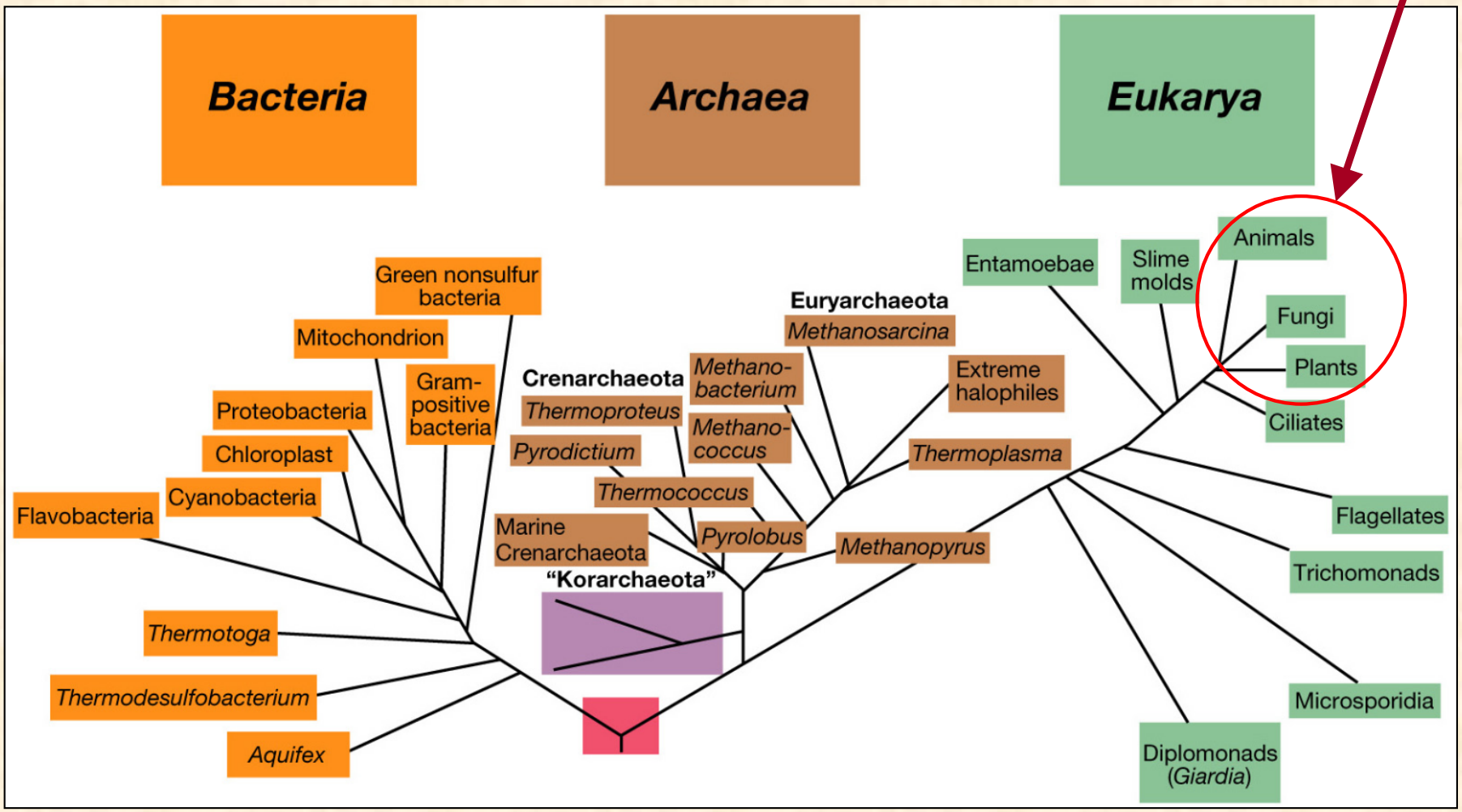

...inte heta källor heller!
En förutsättning är förmågan att kunna anpassa sig!.

Det finns bakterier anpassade att växa vid temperaturer mellan -2 till +114°c



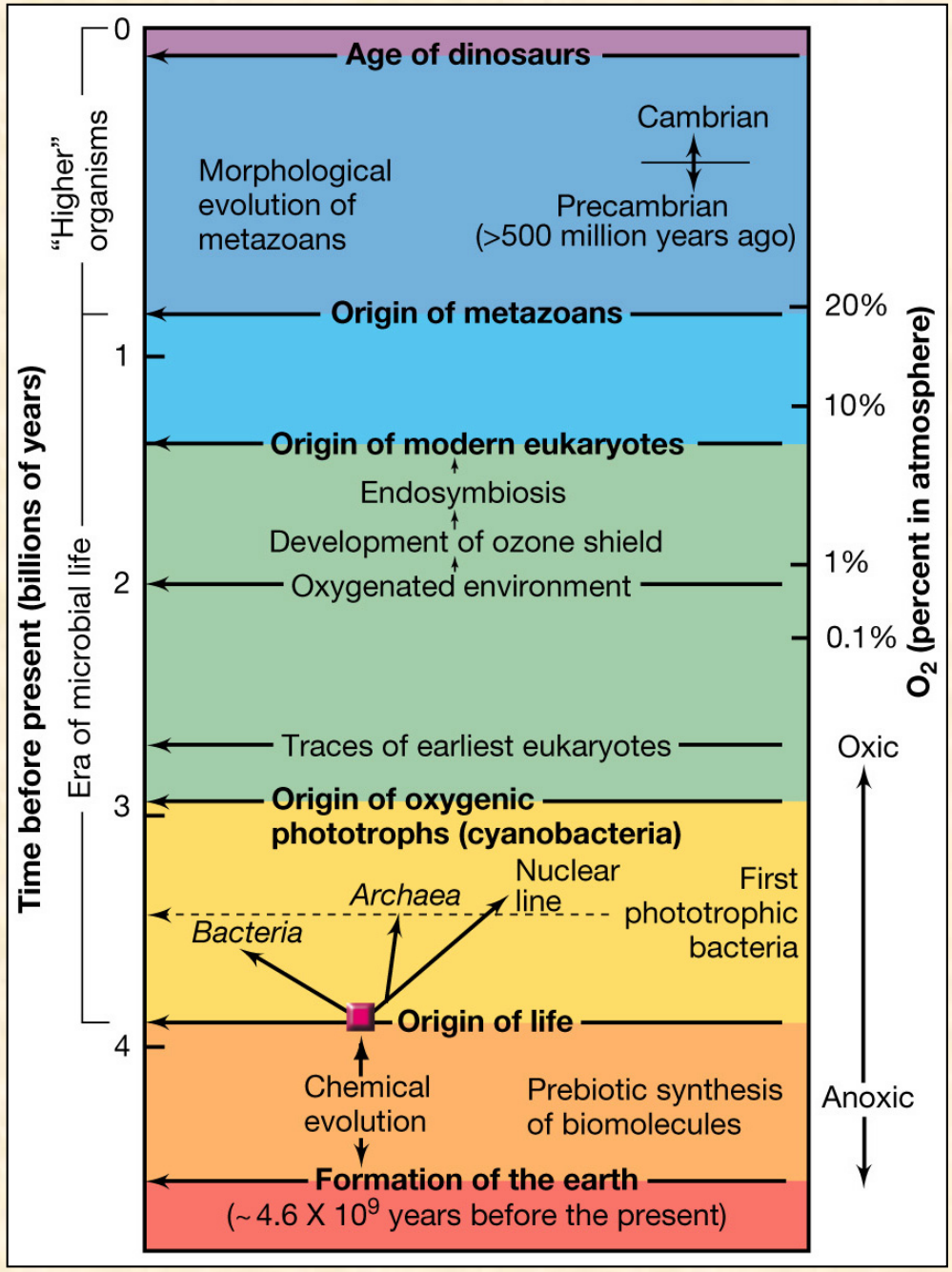
Alltså kan de trivas från antarktis iskalla vatten till Islands heta källor

Livets släktträd

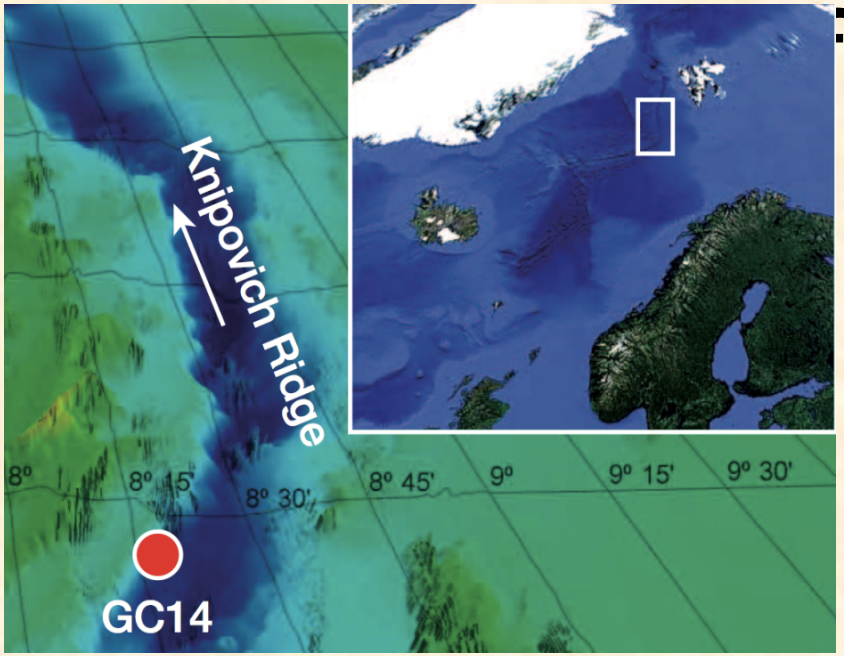


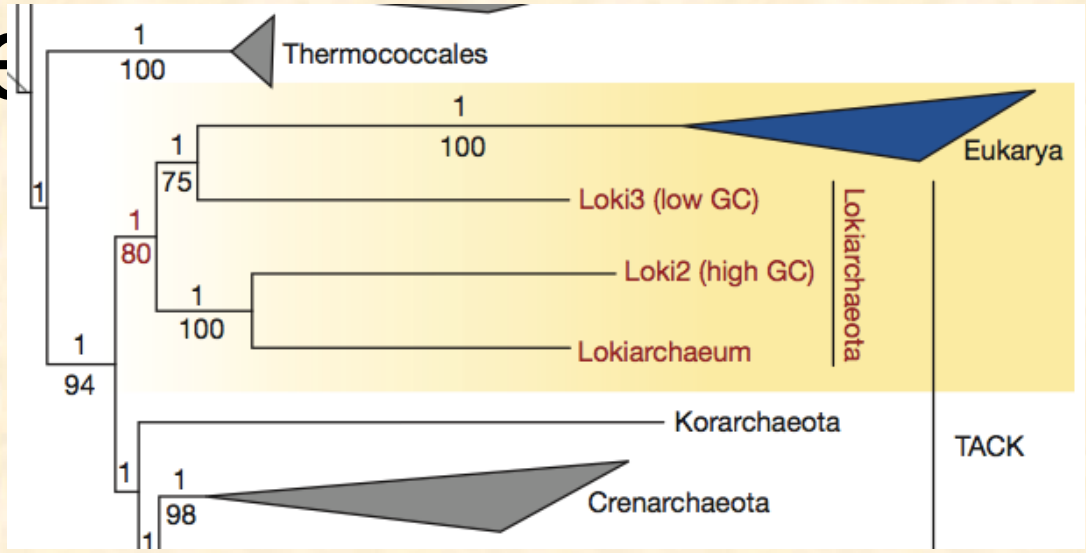
Bakterier utgör en enorm bank av biologisk mångfald

När uppstod olika livsformer på Jorden?



toward uncovering the evolutionary history of present





Arctic Ocean Archaea bridge the gap between prokaryotes and eukaryotes.

Spang et al. Nature 2015

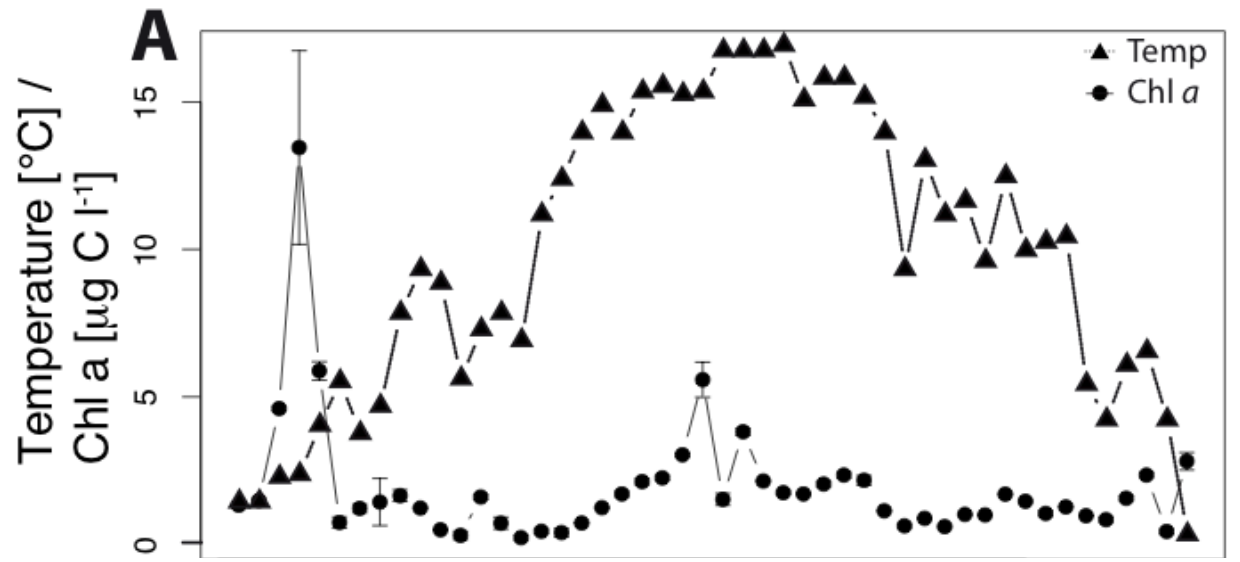
The question in marine microbial ecology...

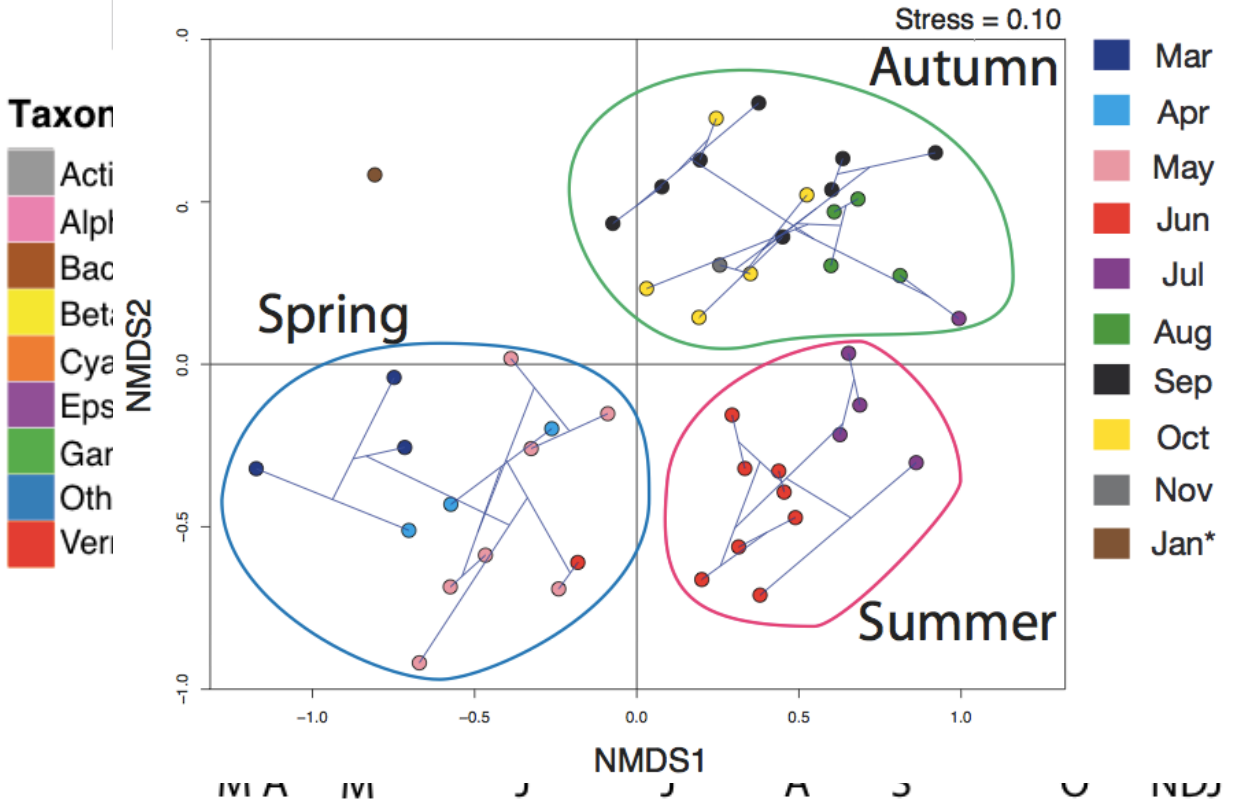
We have a relatively good idea of how bulk microbial processes shape the cycling of organic matter and nutrients in the sea.

We know much about the diversity of marine bacterioplankton.

We only recently began to understand the spatial and temporal distribution of specific bacteria, and about the molecular mechanisms that determine their role in biogeochemical cycles.

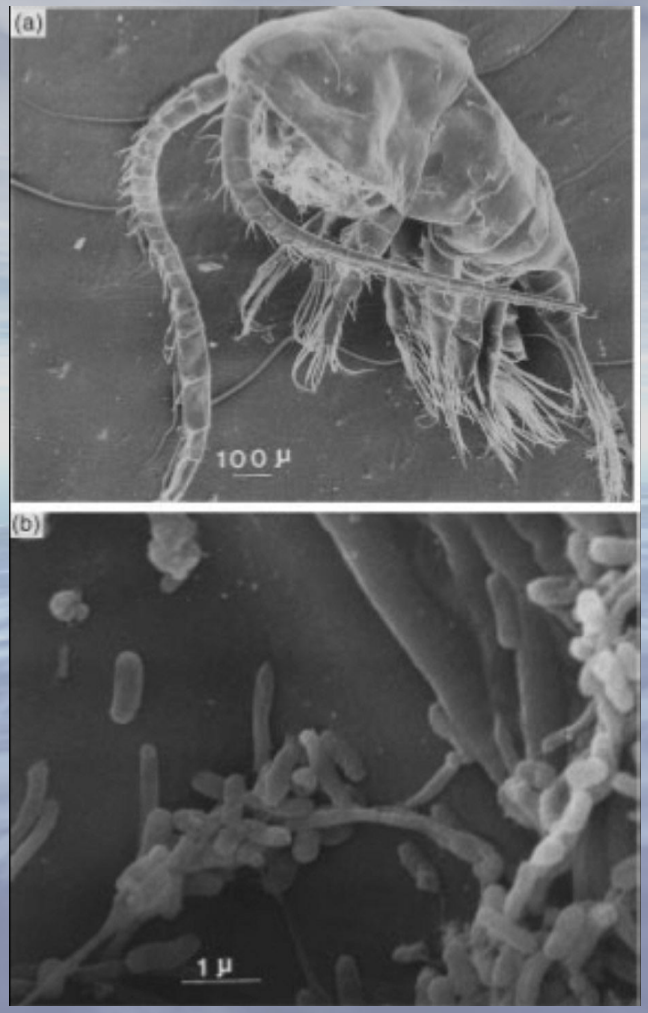
Sampling – not always a piece of cake…

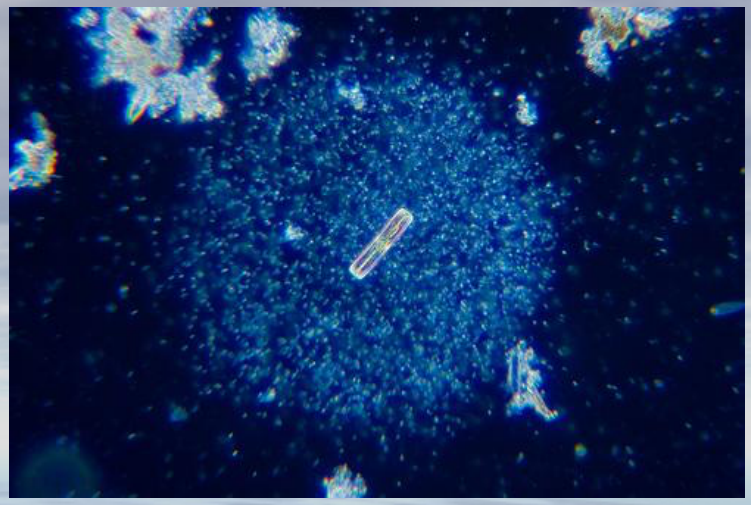




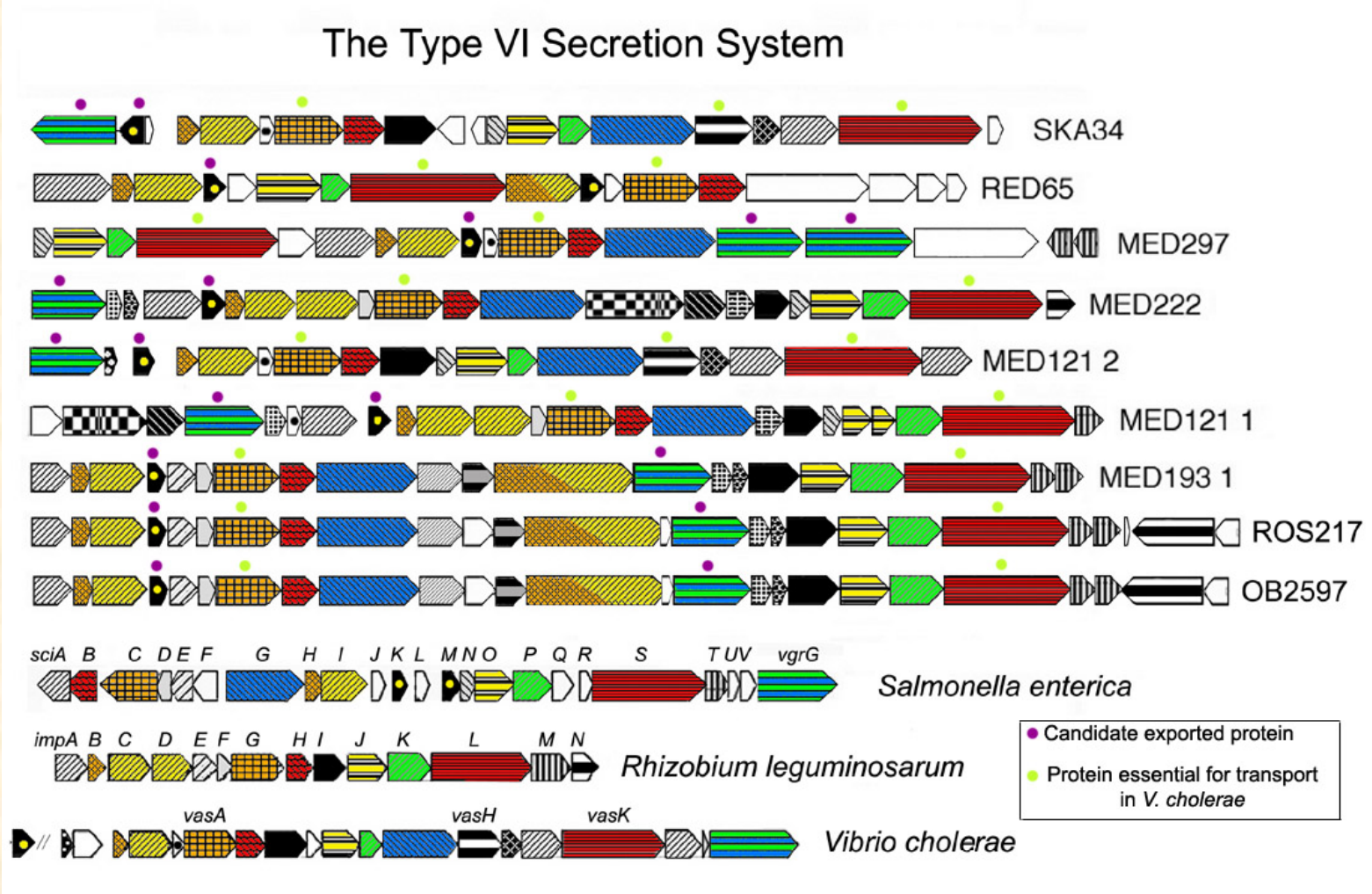
Lindh et al. Environ Microbiol 2015

Äter marina bakterier flercelliga organismer?





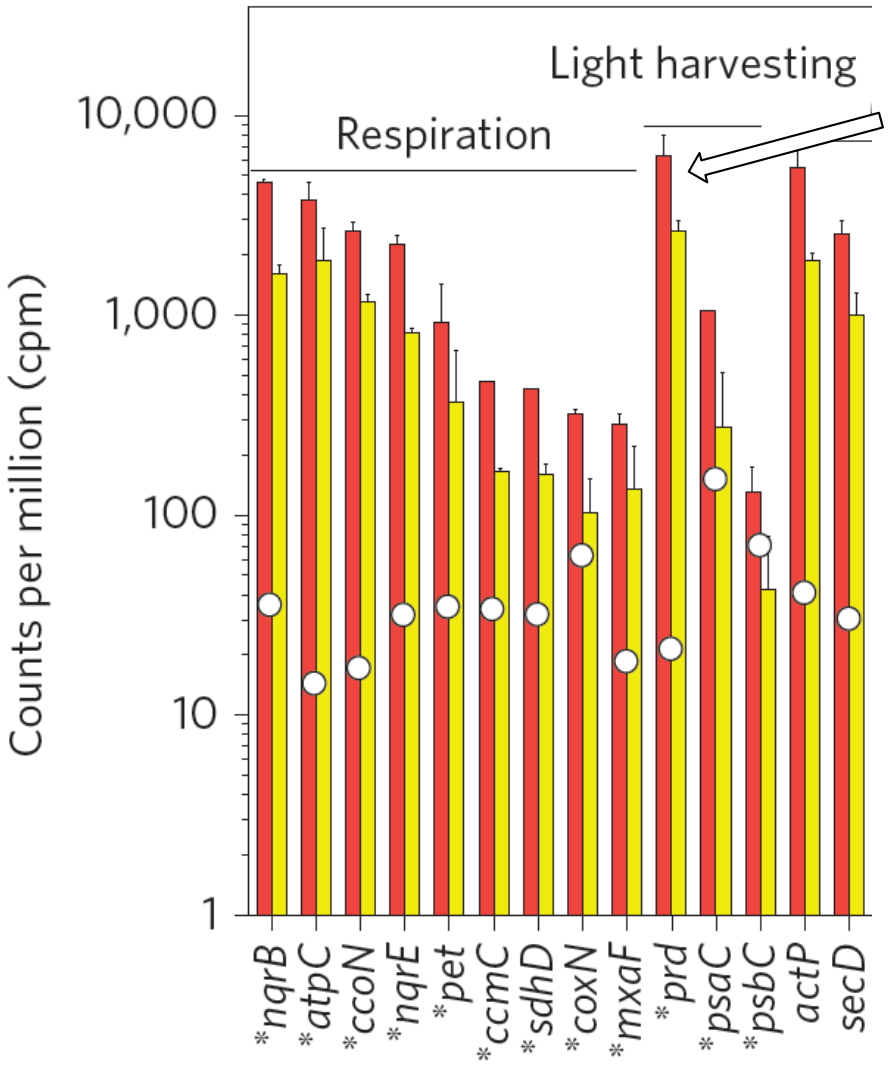
Virulensgener hos marina bakterier



Virulensgener finns hos **60** av **119** bakterier som har sekvenserats (med kartlagd arvsmassa).

Exempel på ny ämnesöverskridande forskning: samspel mellan fisk och mikrober.

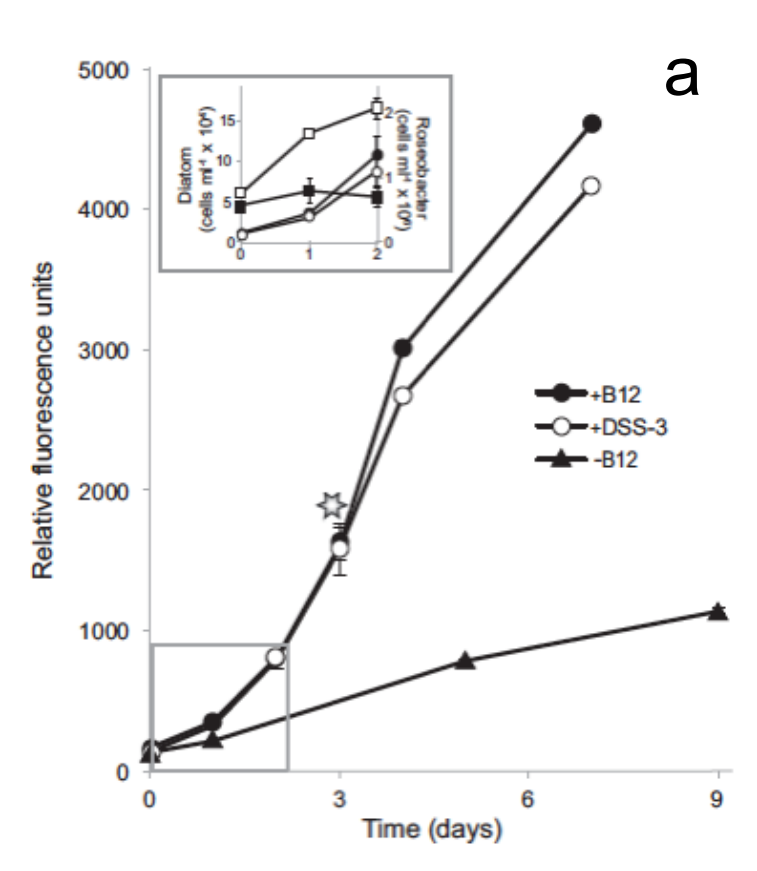
Challenging marine bacteria with ocean acidification

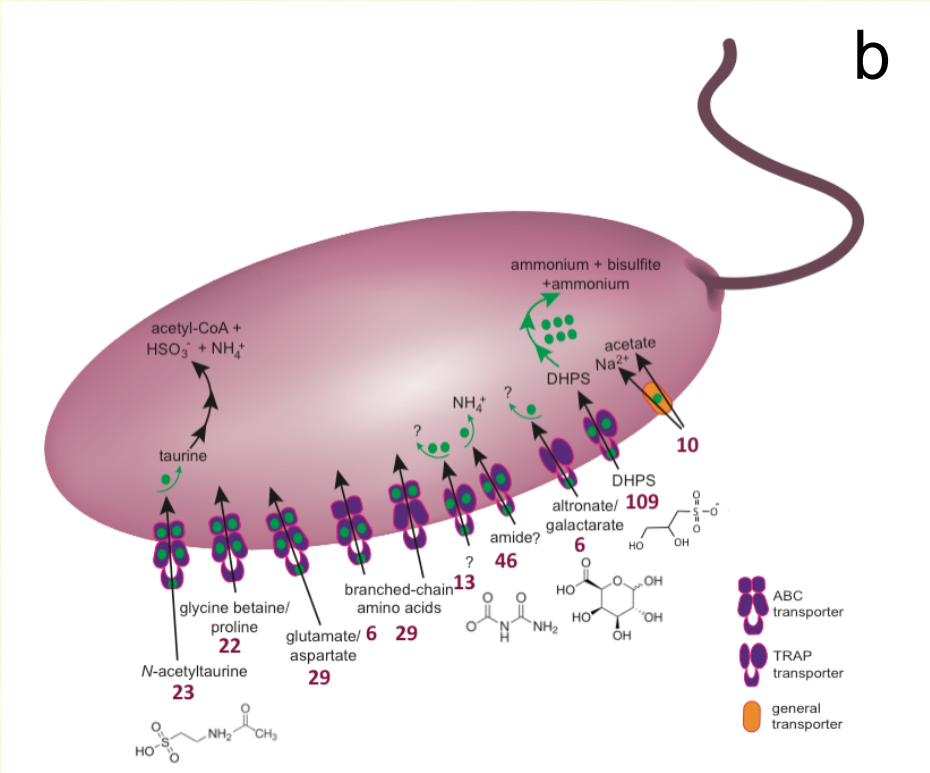


Acidification triggers pronounced responses in expression of pH homeostasis genes, and also rhodopsins!

Bunse et al. 2016. Nature Climate Change

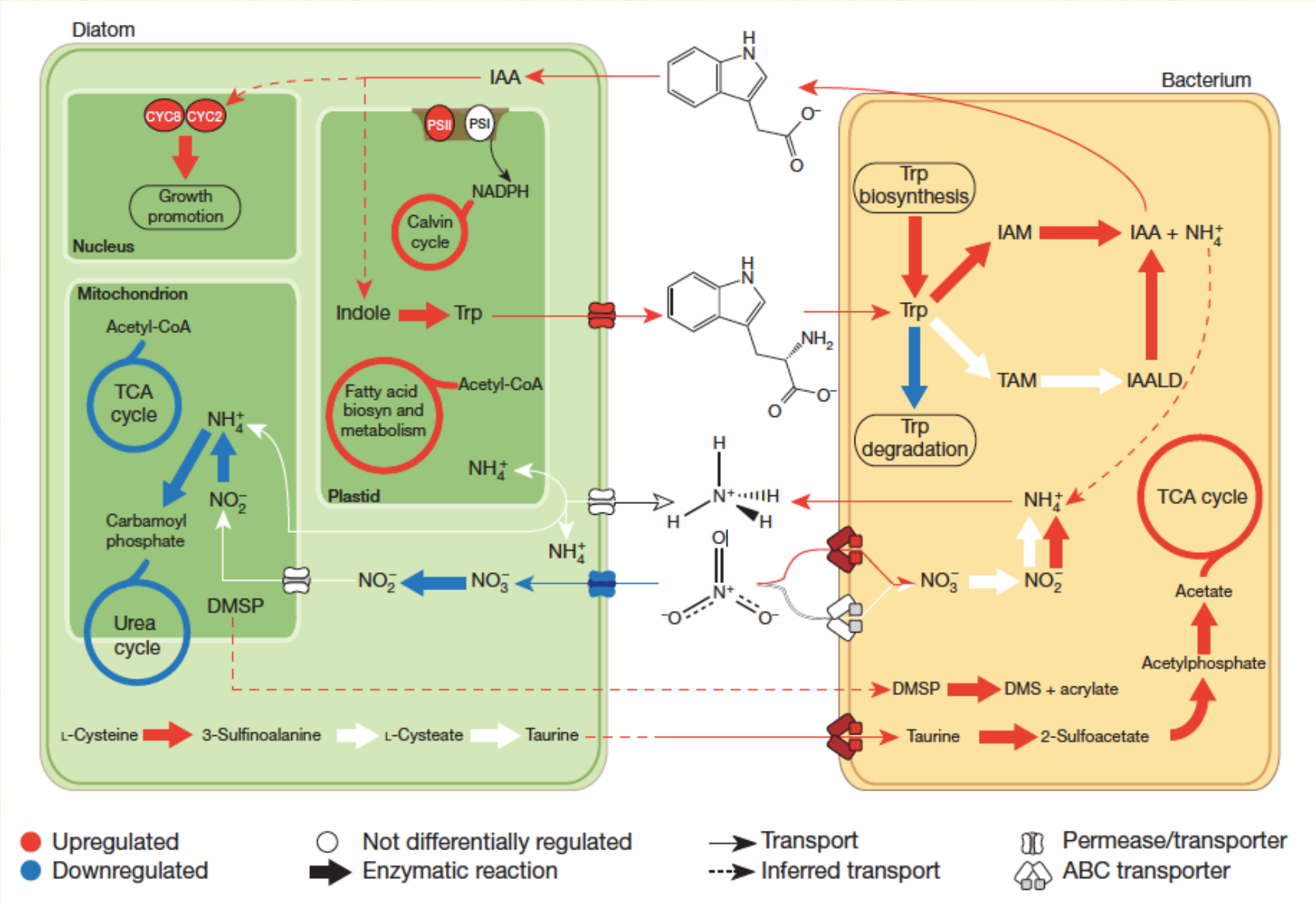
Tjänster och gentjänster mellan celler och organismer



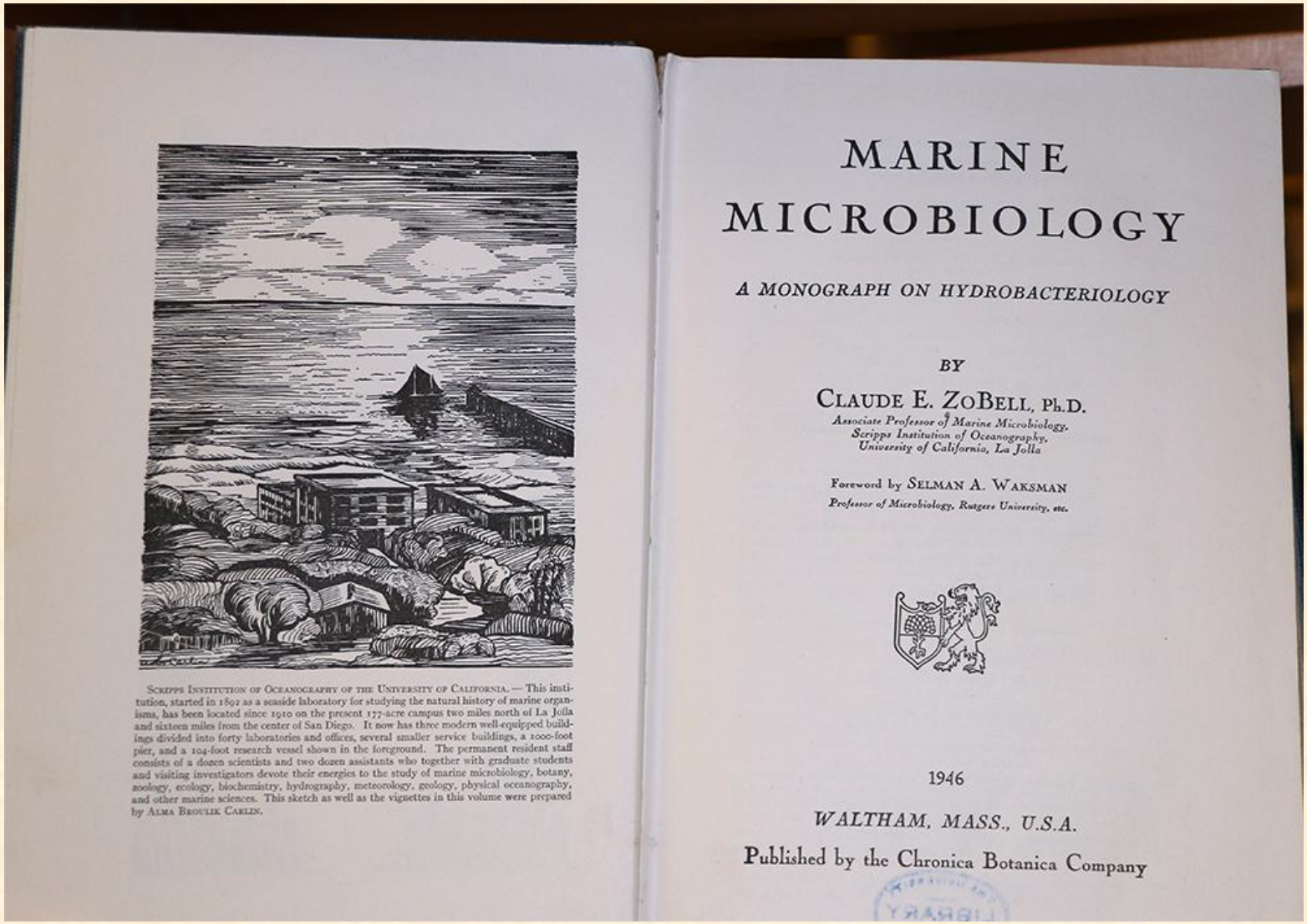


Co-culturing the diatom *Thalassiosira pseudonana* and the bacterium *Ruegeria pomeroyi*.
Durham et al. PNAS. 2015

Växthormoner bland mikrober?!



Model of *Pseudo-nitzschia multiseries–Sulfitobacter* interactions based on transcriptomic and targeted metabolite analyses (the hormone indole-3-acetic acid). Amin et al. 2015. Nature.



SCRIPPS INSTITUTION OF OCEANOGRAPHY OF THE UNIVERSITY OF CALIFORNIA. — This institution, started in 1892 as a seaside laboratory for studying the natural history of marine organisms, has been located since 1910 on the present 177-acre campus two miles north of La Jolla and sixteen miles from the center of San Diego. It now has three modern well-equipped buildings divided into forty laboratories and offices, several smaller service buildings, a 1000-foot pier, and a 104-foot research vessel shown in the foreground. The permanent resident staff consists of a dozen scientists and two dozen assistants who together with graduate students and visiting investigators devote their energies to the study of marine microbiology, botany, zoology, ecology, biochemistry, hydrography, meteorology, geology, physical oceanography, and other marine sciences. This sketch as well as the vignettes in this volume were prepared by ALMA BROULIK CARLIN.

MARINE MICROBIOLOGY

A MONOGRAPH ON HYDROBACTERIOLOGY

BY

CLAUDE E. ZOBELL, Ph.D.
Associate Professor of Marine Microbiology, Scripps Institution of Oceanography, University of California, La Jolla

Foreword by SELMAN A. WAKSMAN
Professor of Microbiology, Rutgers University, etc.

1946

WALTHAM, MASS., U.S.A.

Published by the Chronica Botanica Company

"There are very few questions regarding the science of the sea which can be satisfactorily answered without due consideration of bacteria."

Claude E. ZoBell, 1946