A Primer on Bacteria in the Ocean

presented to the

House Subcommittee on Fisheries and Oceans

by

James T. Hollibaugh, Professor
Department of Marine Science
University of Georgia

8 June, 2005

Bacterioplankton Factoids

Average size:

0.5 μm (0.5 millionths of a meter) in diameter

Average biomass:

20 fg C/cell (20 x 10^{-15} grams carbon per cell)

Abundance in the ocean:

varies seasonally, with location and with depth

10^{9}-10^{10} per liter in coastal water

10^{7} to 10^{9} per liter in the open ocean

Doubling times: generally days to weeks

Biodiversity: 10's of thousands of different types

(Sargasso Sea, probably more in sediments)

Oceanic Bacterioplankton

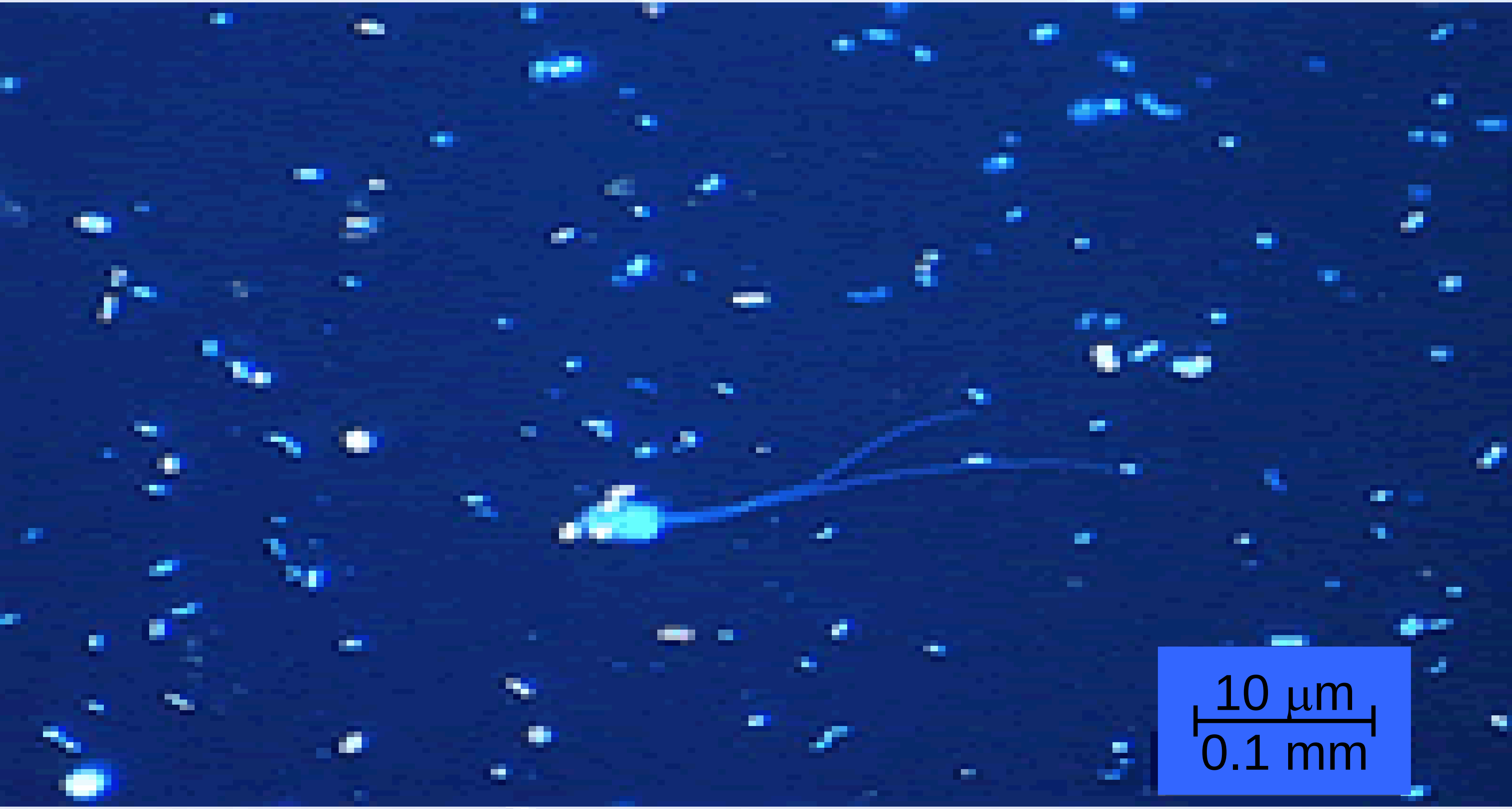
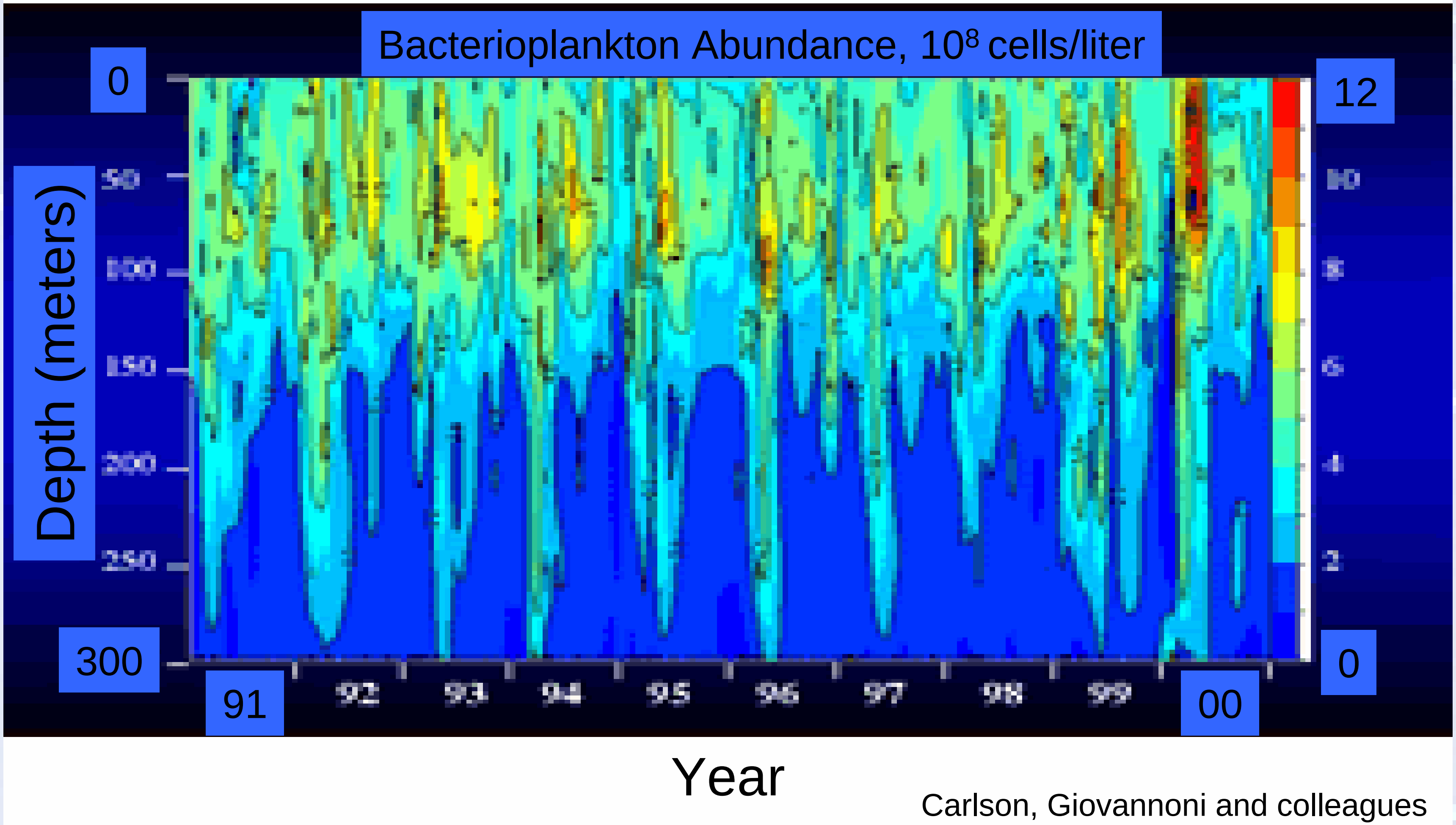


Photo courtesy Carlson, Giovannoni and colleagues



Carlson, Giovannoni and colleagues

Oceanic Microbial Observatory BBSR OSU/ UCSB

Thus:

Total biomass of bacterioplankton in the ocean:
~ 1 billion metric tons

Average surface area of the bacteria in 1 m^3 of water: 0.1 to 1 m^2

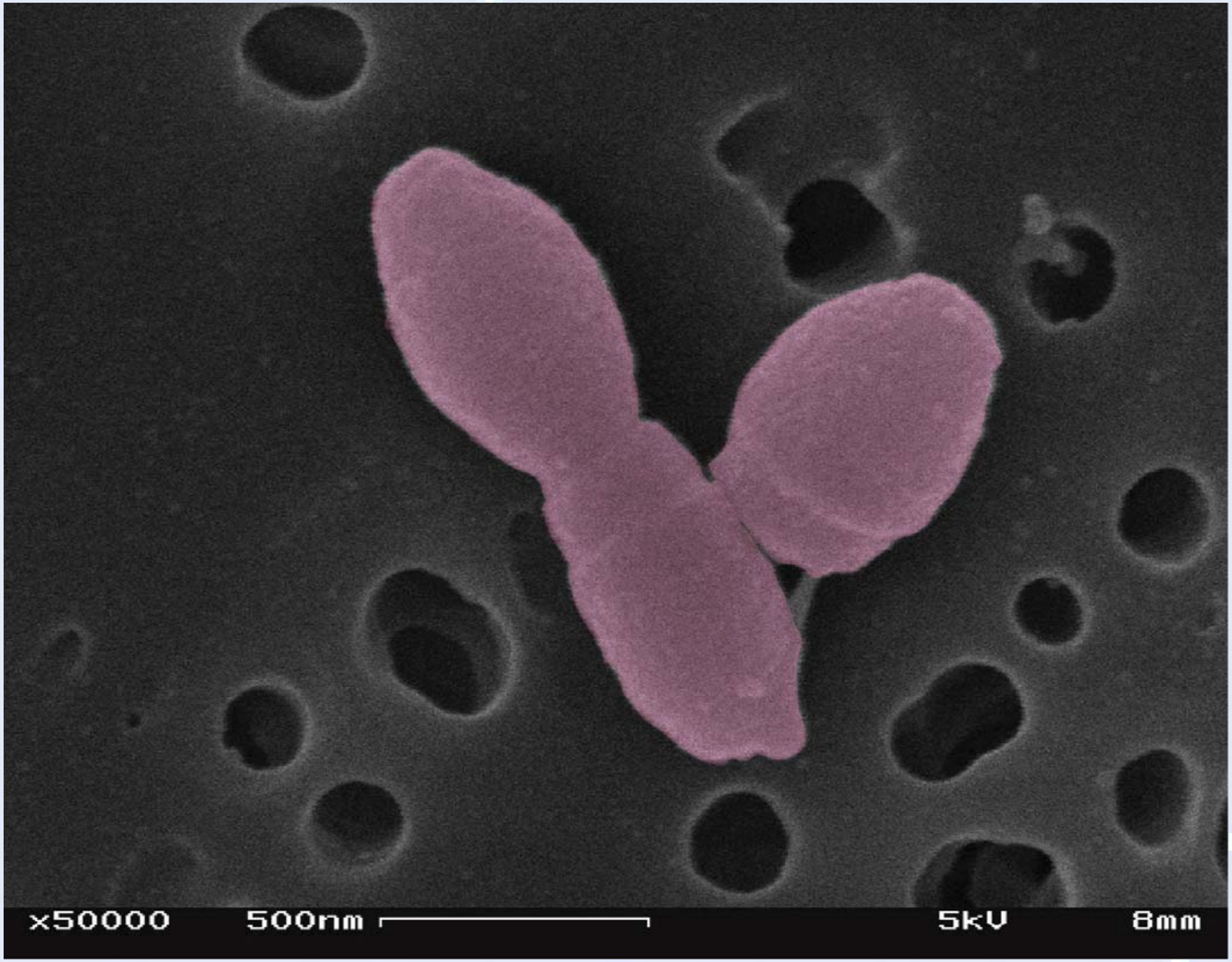
Or, since the average depth of the ocean is ~4,000 m, the average surface area of bacteria in the ocean is **~400 to 4000** times the surface area of the ocean

Bacterioplankton cell membrane is the largest biochemically active surface in the ocean

What do they do (why do we care)?

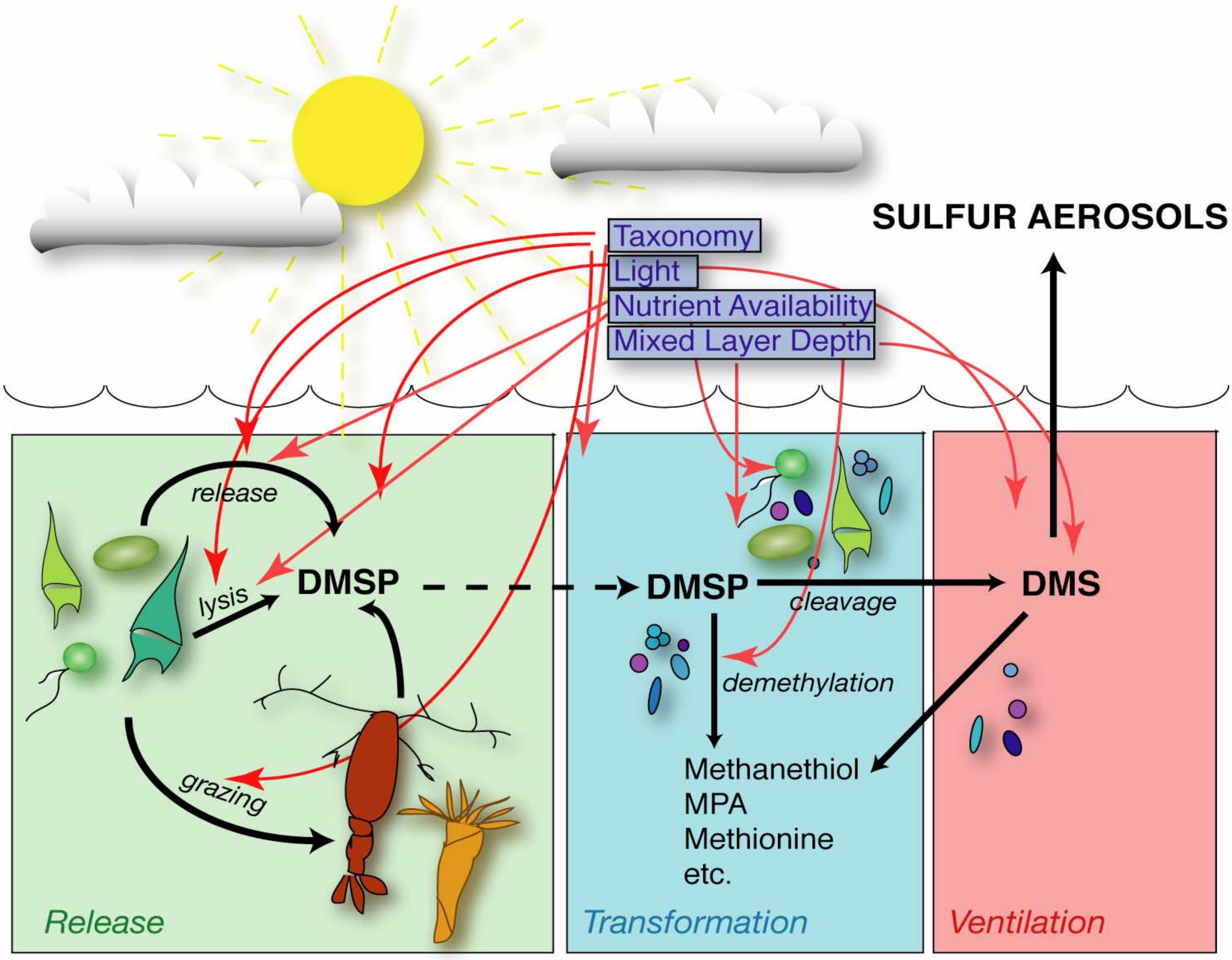
- Break down organic matter, regenerate nutrients, carbon dioxide
- Break down pollutants
- Degrade spilled hydrocarbons
- Play key roles in geochemical cycles
- Transform metals (i.e. mercury methylation)
- Regulate nitrogen availability – eutrophication and productivity
- Regulate radiatively active (green house) trace gases: methane, nitrous oxide, carbon monoxide, etc.

Jannaschia CCS1 – A DOE Genome Sequencing Project

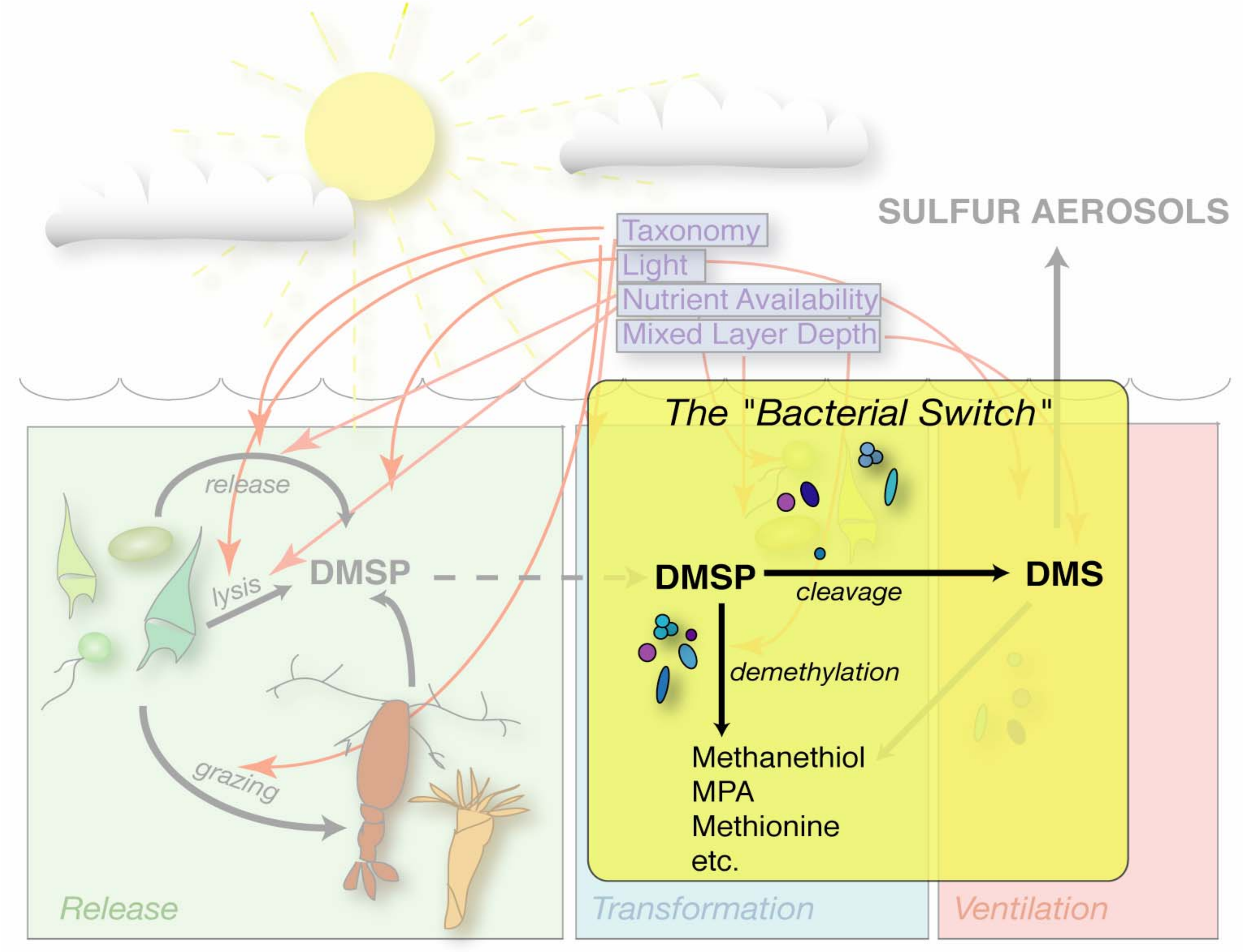


SIMO Sapelo Island Microbial Observatory

Courtesy M.A. Moran and colleagues

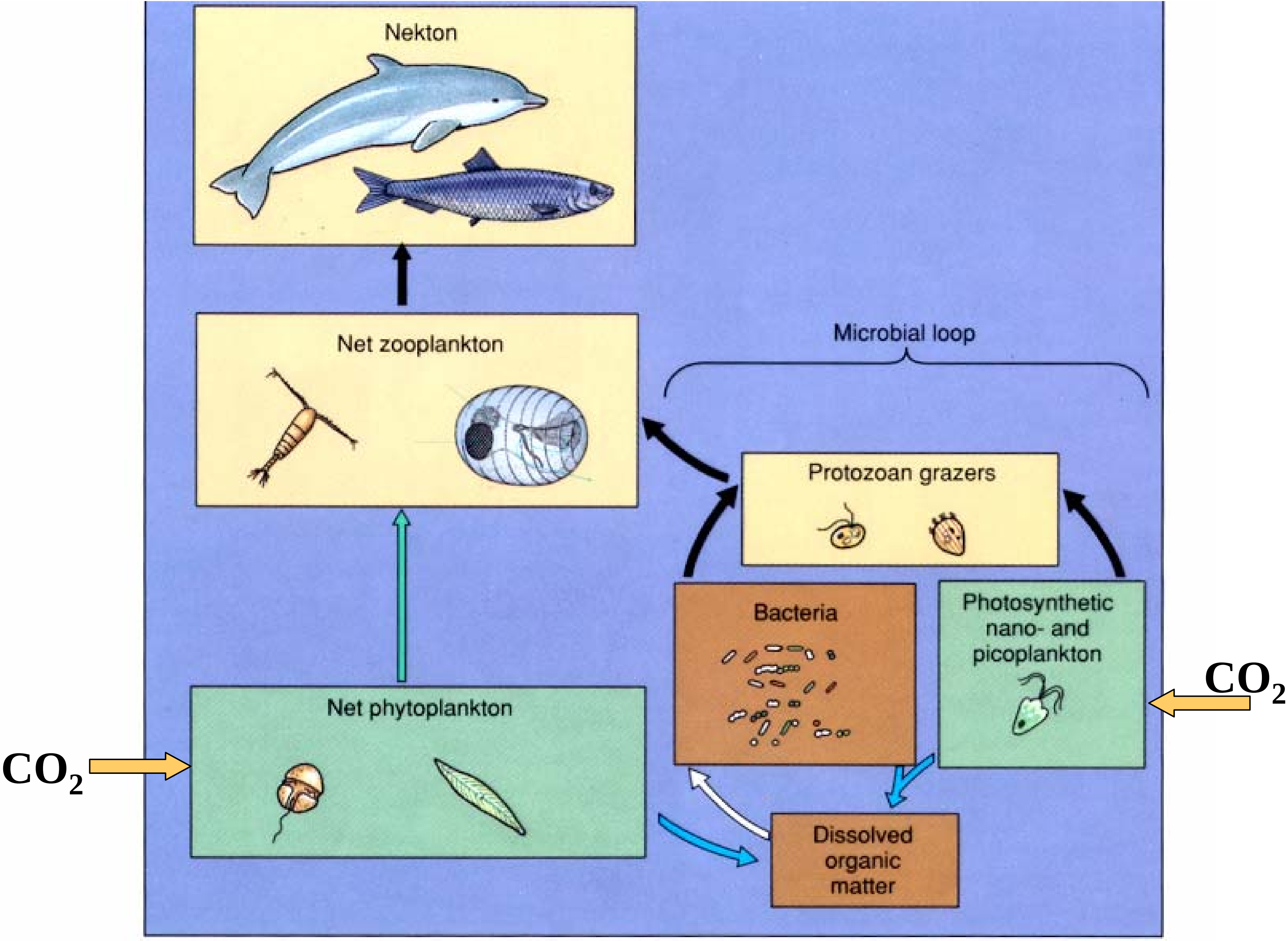


SULFUR AEROSOLS
Taxonomy
Light
Nutrient Availability
Mixed Layer Depth
release
lysis
DMSP
grazing
DMSP
cleavage
DMS
demethylation
Methanethiol
MPA
Methionine
etc.
Release
Transformation
Ventilation


SULFUR AEROSOLS
Taxonomy
Light
Nutrient Availability
Mixed Layer Depth
The "Bacterial Switch"
release
lysis
DMSP
grazing
DMSP
cleavage
DMS
demethylation
Methanethiol
MPA
Methionine
etc.
Release
Transformation
Ventilation

How do they affect fisheries?

- Food chain/web efficiency: The “microbial loop,” link or sink?
- Pathogens – probably more important than is known at present
- May play a role in HAB – micronutrients, toxins
- Commensals/symbionts - they have known roles in vent and seep organisms, fish light organelles, probably more extensive and diverse interactions



54 **Classic Epipelagic Food Web Including Microbial Loop**
Figure 14.24

Gulf of Mexico Cold Seep Community

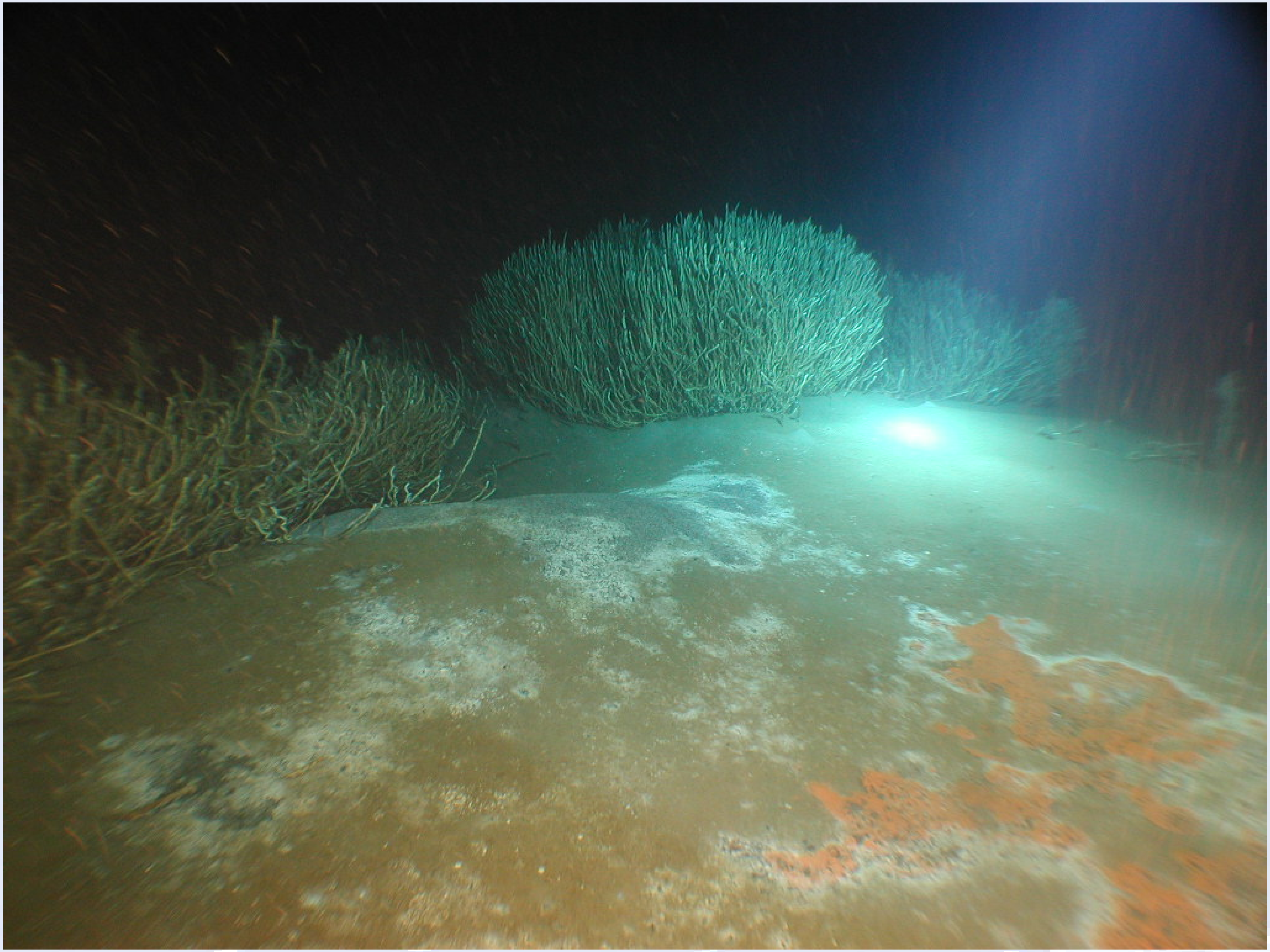


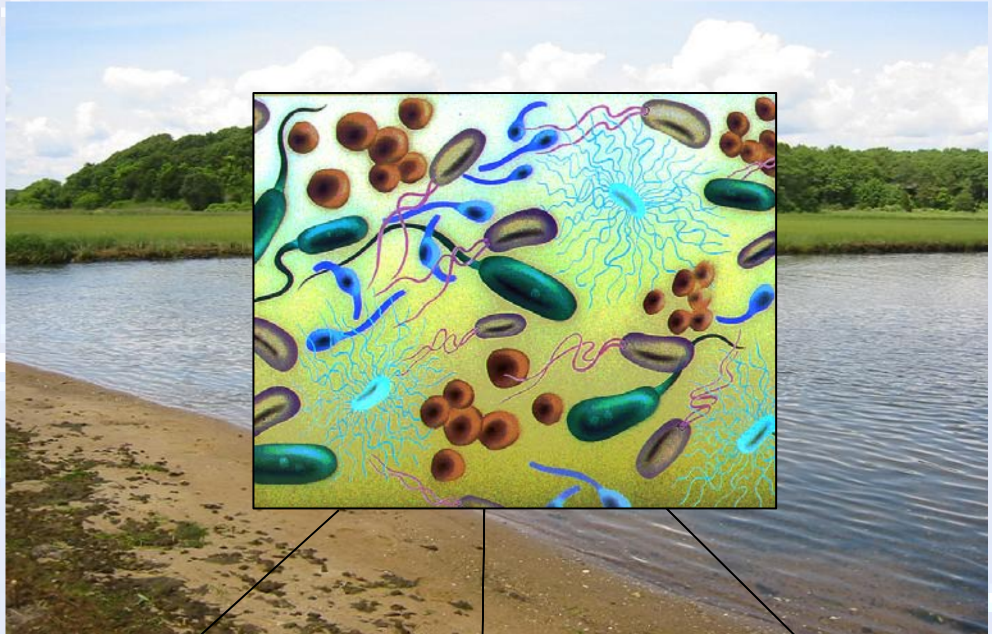
Photo taken from DSV Johnson SeaLink and courtesy Samantha Joye

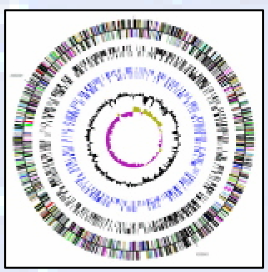
What are they good for?

- Biotech applications (i.e. “vent polymerase” for PCR, novel restriction enzymes, etc.)
- a reservoir of largely unknown biogeochemical pathways – novel enzymes and other proteins
- Potential industrial processes – fermentors, bioreactors
- Drugs and novel chemicals
- And so on

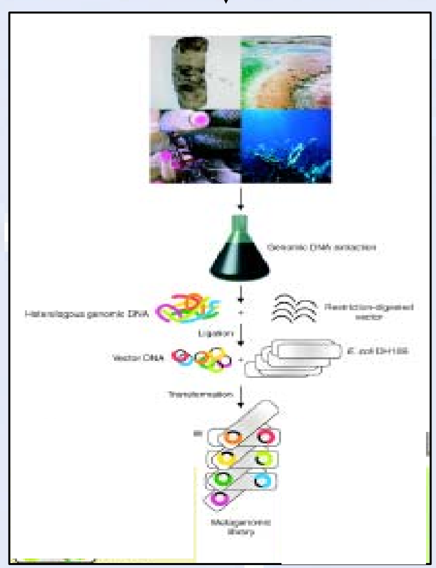
Future Directions

- Probing the ecology of marine bacteria and their role in myriad processes using molecular biology.
- Response of polar microorganisms to ocean temperature change – foodweb implications
- Role in human health
- Interactions with other marine organisms as commensals and pathogens

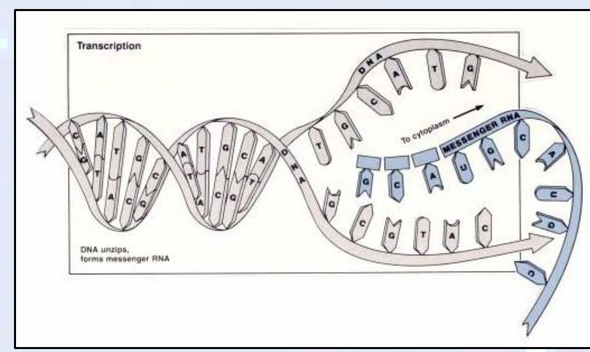




Genomics



Metagenomics



Transcriptomics

For Additional Information

Microbial Ecology of the Oceans. David L. Kirchman, Editor. Wiley and sons, New York, 2000. 542 pp.

James T. Hollibaugh. Email: marsdir@uga.edu, Phone: 706/542-5868

Questions?