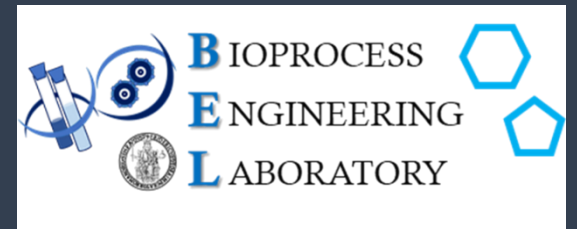
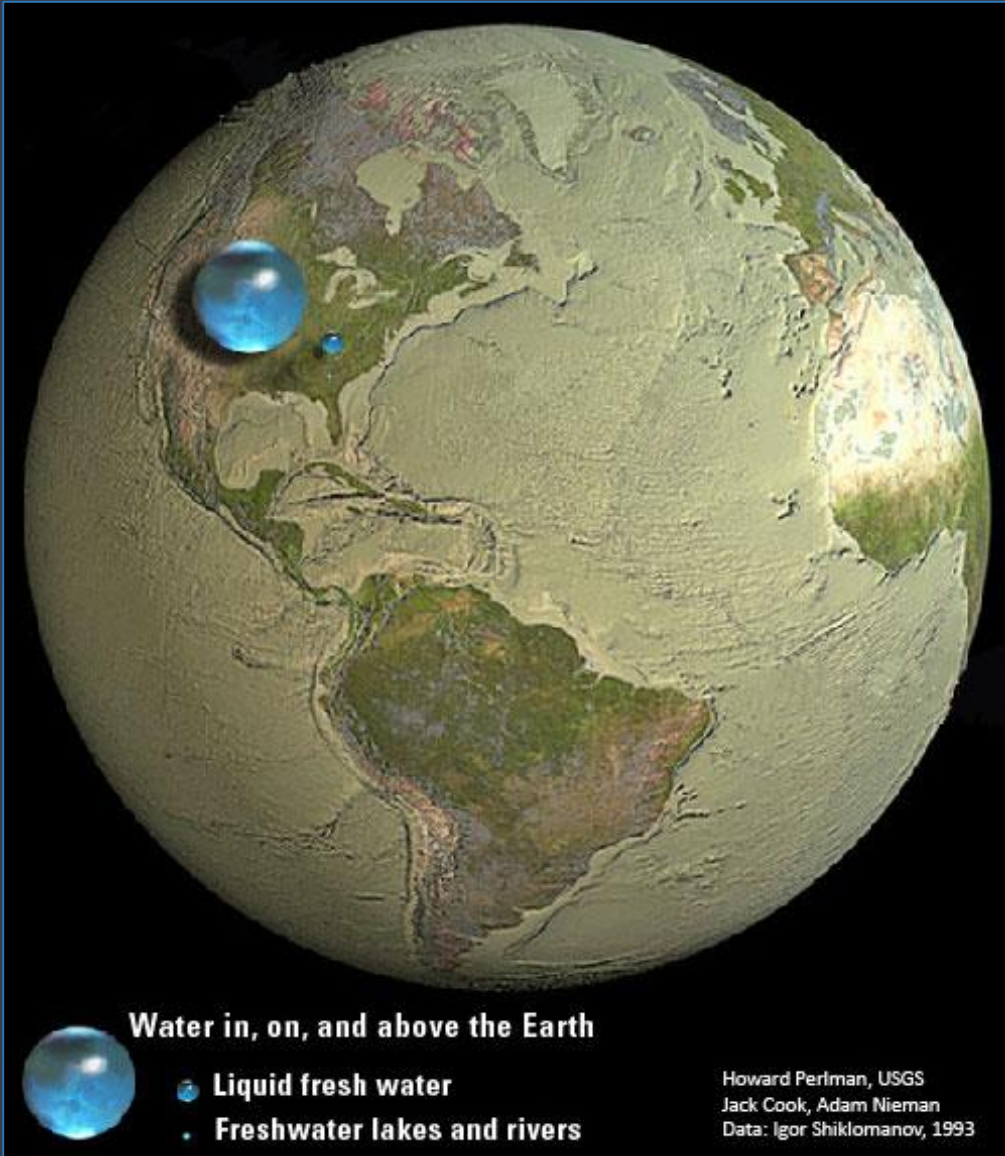


DESALINATION OF SALINE WATER STREAMS BY MICROALGAE AND CYANOBACTERIA: A POTENTIAL TO EXPLORE

PhD: Domenico Palatucci

Supervisors: Prof. Antonino Pollio; Prof. Antonio Marzocchella

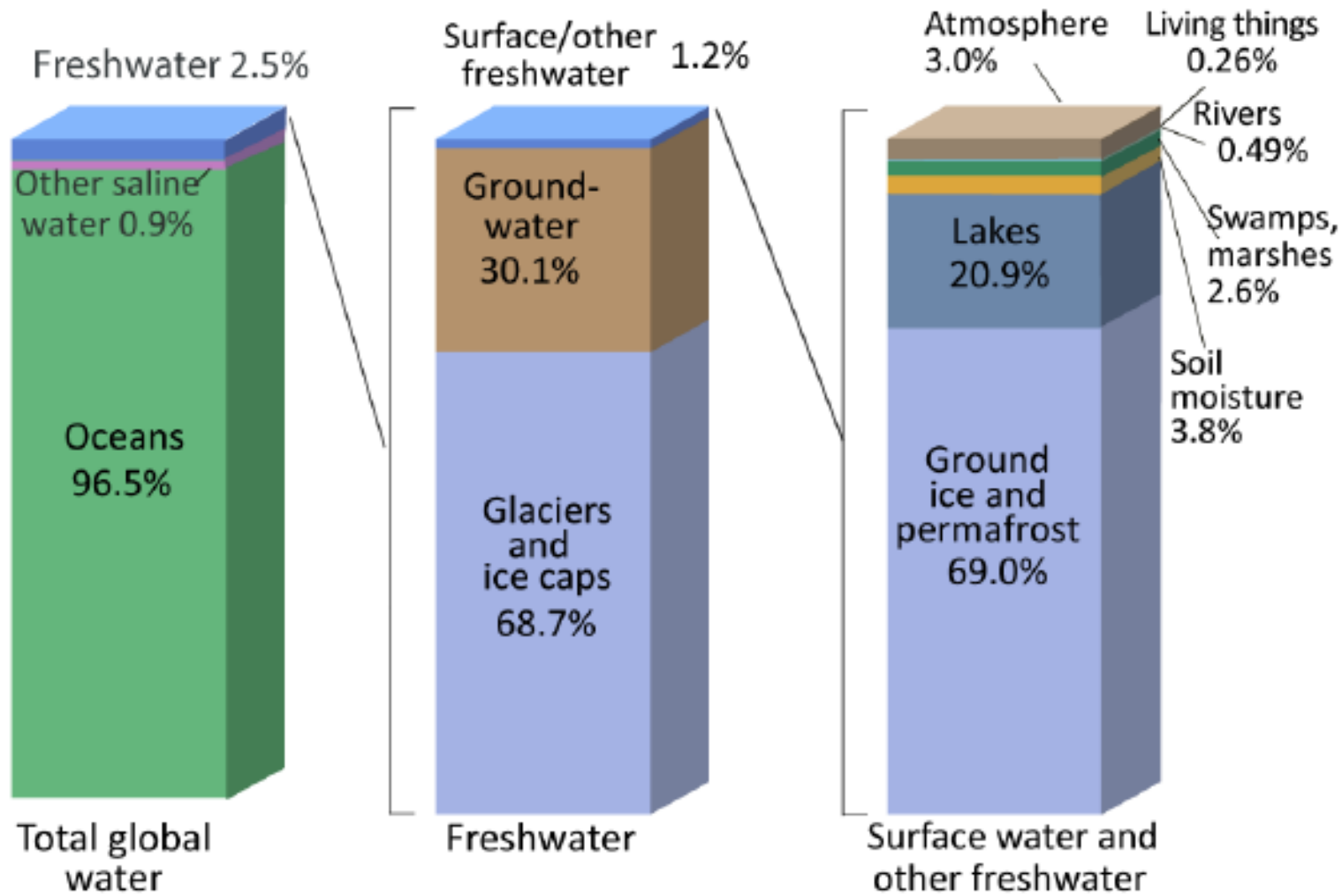




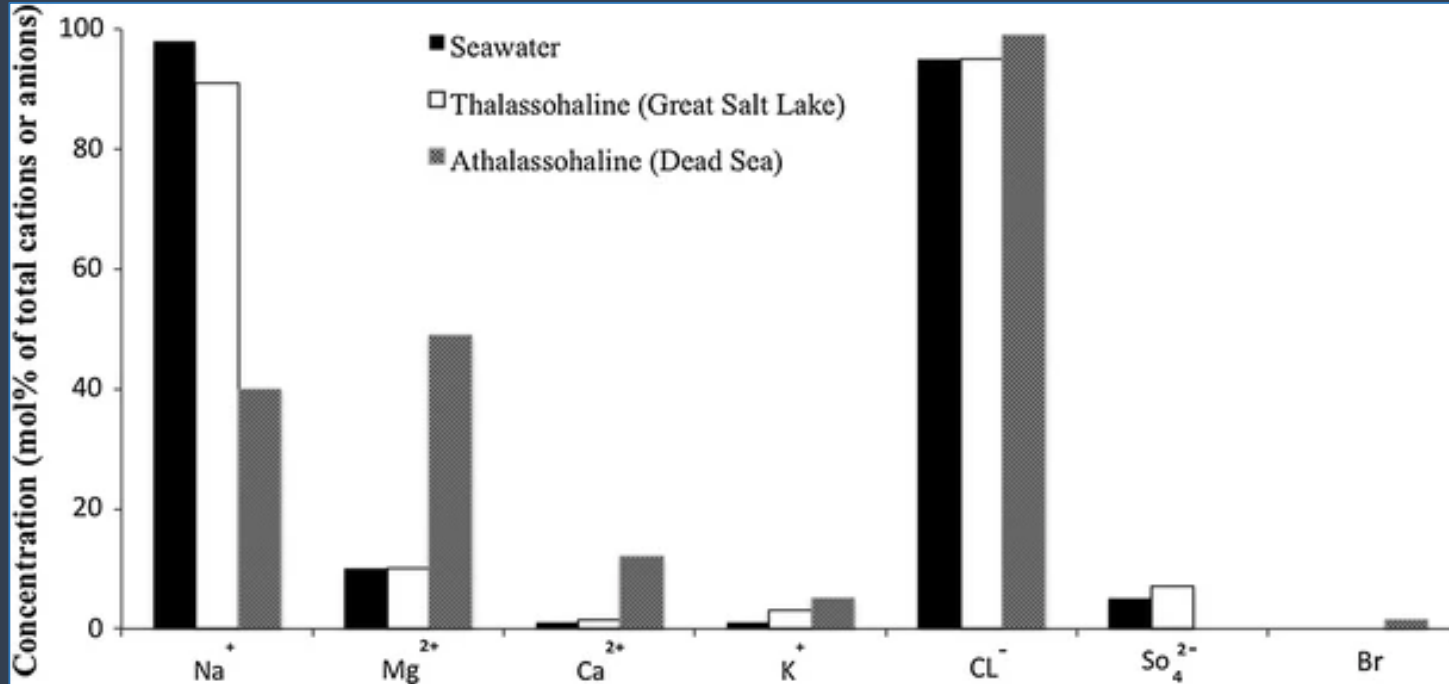
WATER and EARTH

- Preciousness
- Liquid Water
- ~ 75% of planet surface
- Crust ~ 3×10^{-4} Earth's mass
- Mantel ~ 2×10^{-2} Earth's mass
- $M_{\oplus} = 5.9722 \times 10^{24}$ kg
- Hydrogeological Cycle
- Classification
 - Chemical-physical properties
 - Space Water HDO/H₂O

Where is Earth's Water?



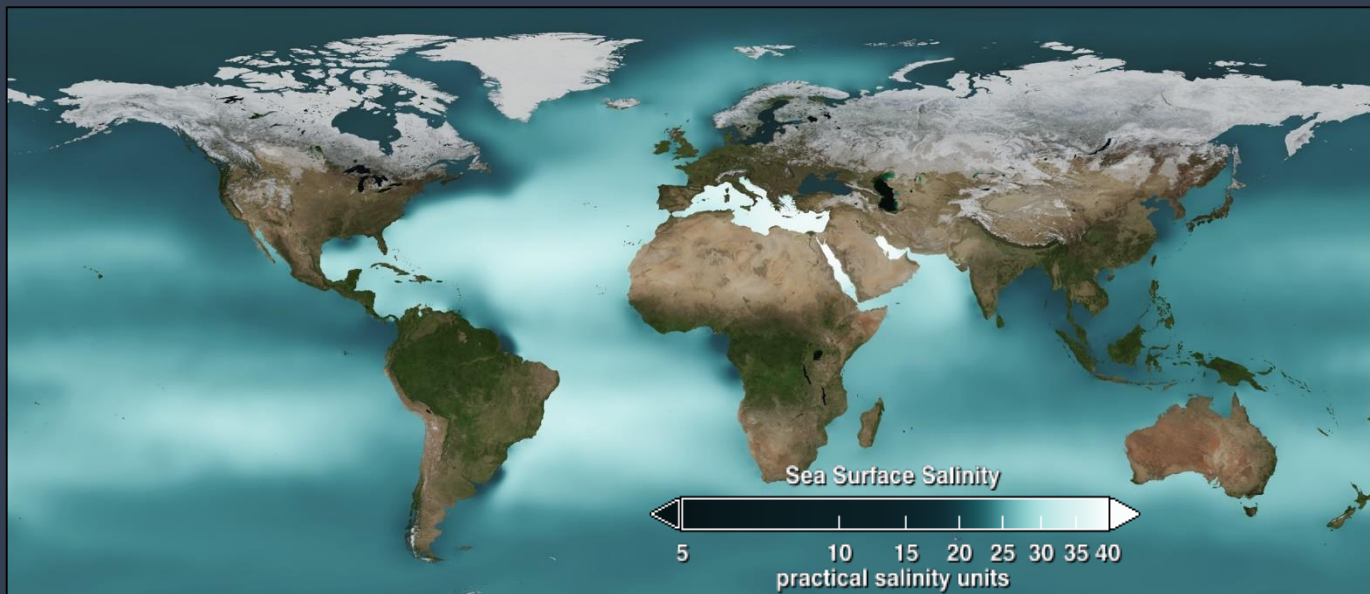
Source: Igor Shiklomanov's chapter "World fresh water resources" in Peter H. Gleick (editor), 1993, *Water in Crisis: A Guide to the World's Fresh Water Resources*. (Numbers are rounded).



Oren, (2006)

Salinity

- Sea and ocean 3.5%
- Hypersaline >3,5%
- Thalassohaline
- Athalassohaline
- Water activity
 - Chaotrope (disorder)
 - Kosmotrope (order)
 - Hofmeister series

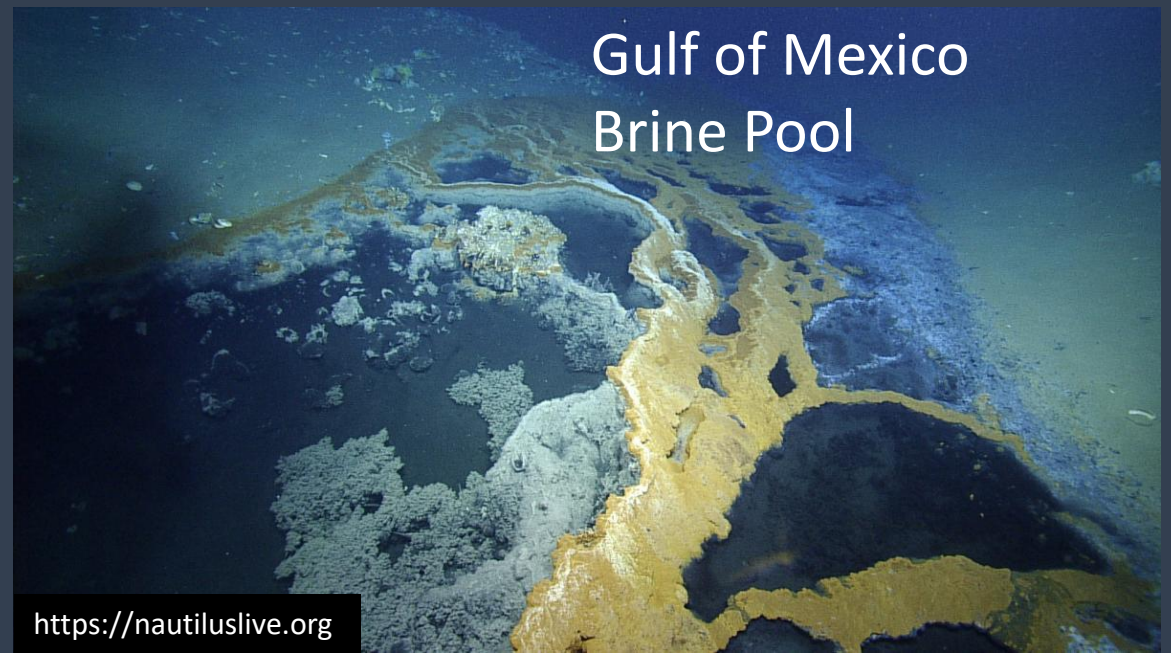


NASA/Goddard Space Flight Center Scientific Visualization Studio The Blue Marble Next Generation data is courtesy of Reto Stockli (NASA/GSFC) and NASA's Earth Observatory.



International Space Station, NASA, March_2020

SALINE AND HYPERSALINE LIQUIDS OF NATURAL ORIGIN



<https://nautiluslive.org>



margheritadisavoia.com

SALINE AND HYPER-SALINE LIQUIDS OF ANTHROPIC ORIGIN



Acidic mine drainage



Desalination plant outfall at San Ramón, California



Nile Valley, Egypt, source NASA's satellite

WATER and LIFE

- Photosynthesis
 - Oxygenation
 - Carbon cycle
 - Primary carbon producers
- Solvent for Metabolism



AIWPS[®] Type 1 Facility at Delhi, California

WILLIAM J. OSWALD

(1919-2005)

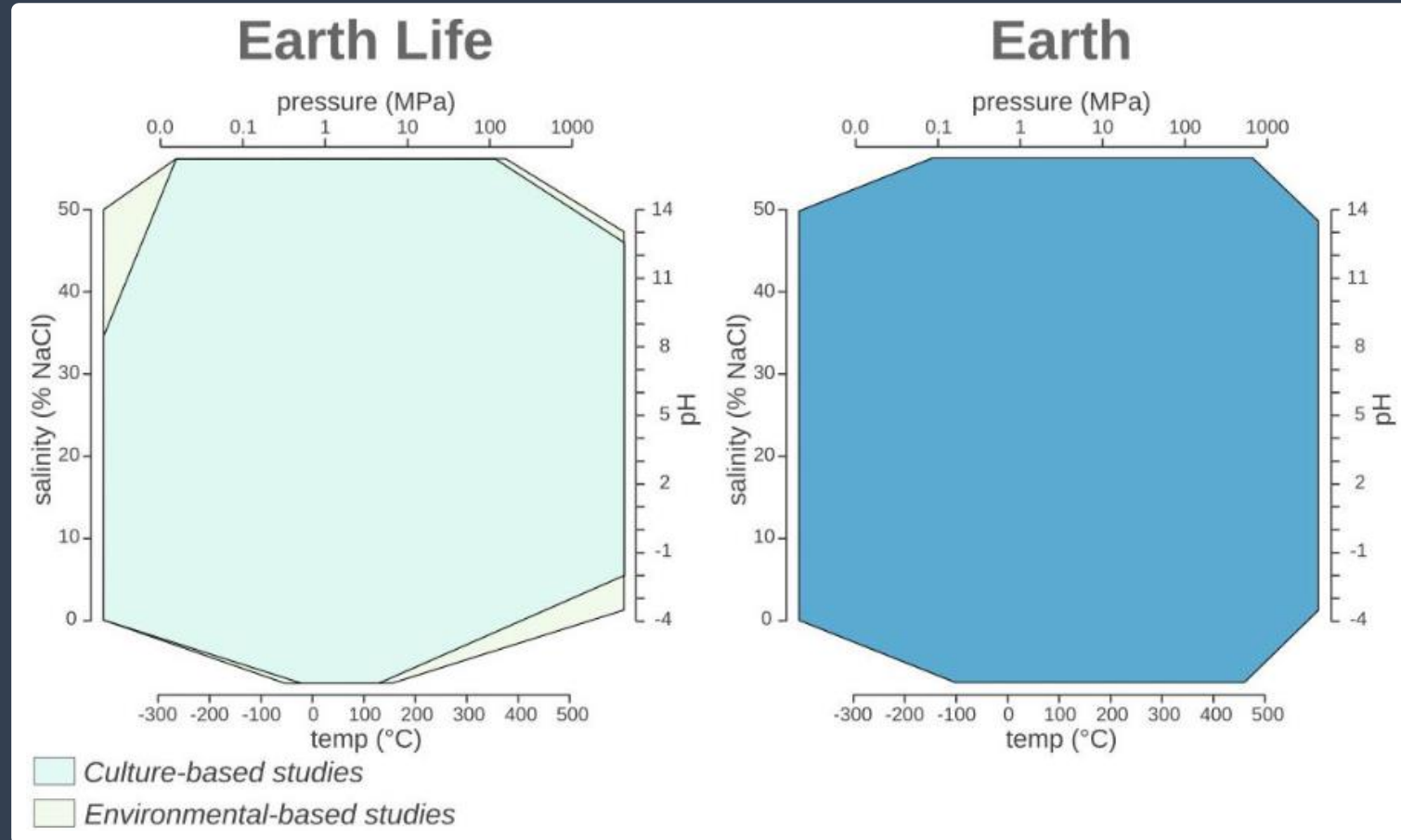
Pioneer in algae-based
wastewater treatment

Raceway Pond

Advanced Integrated
Wastewater Pond Systems
(AIWPS)

Santa Helena, California,
1966

Extremophiles and the Limits of Life in a Planetary Context



Merino et al.,(2019)

A square bacterium

A. E. Walsby

Marine Science Laboratories, Menai Bridge, Gwynedd, UK

I have come across a bacterium which has the form of a thin square sheet. In most bacteria such a shape would be precluded by the osmotically-generated internal hydrostatic pressure but this organism, found in a saturated brine pool, has little or no cell turgor pressure. Its shape is probably determined by the pattern in which the cell envelope particles assemble. These square bacteria are so thin and transparent and are so unlike any bacteria previously described that I would have overlooked them if they had not possessed gas vacuoles, and I had not been looking for different forms of gas-vacuolate organisms. The squares derive buoyancy from their gas vacuoles and float at the brine surface.

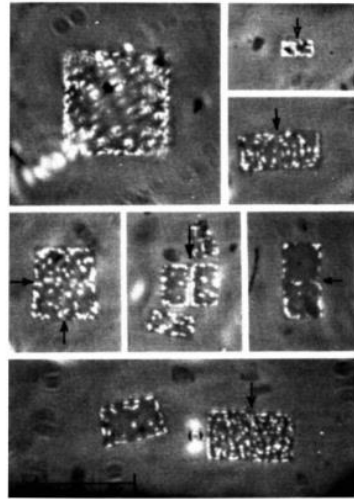


Fig. 2 Phase contrast light micrographs of the square bacterium illustrating the range of cell size. The light areas are gas vacuoles. Division lines, just detectable on the original print are indicated by the arrows. Scale bar, 10 μ m.

HALOPHILES and HALOTOLERANT

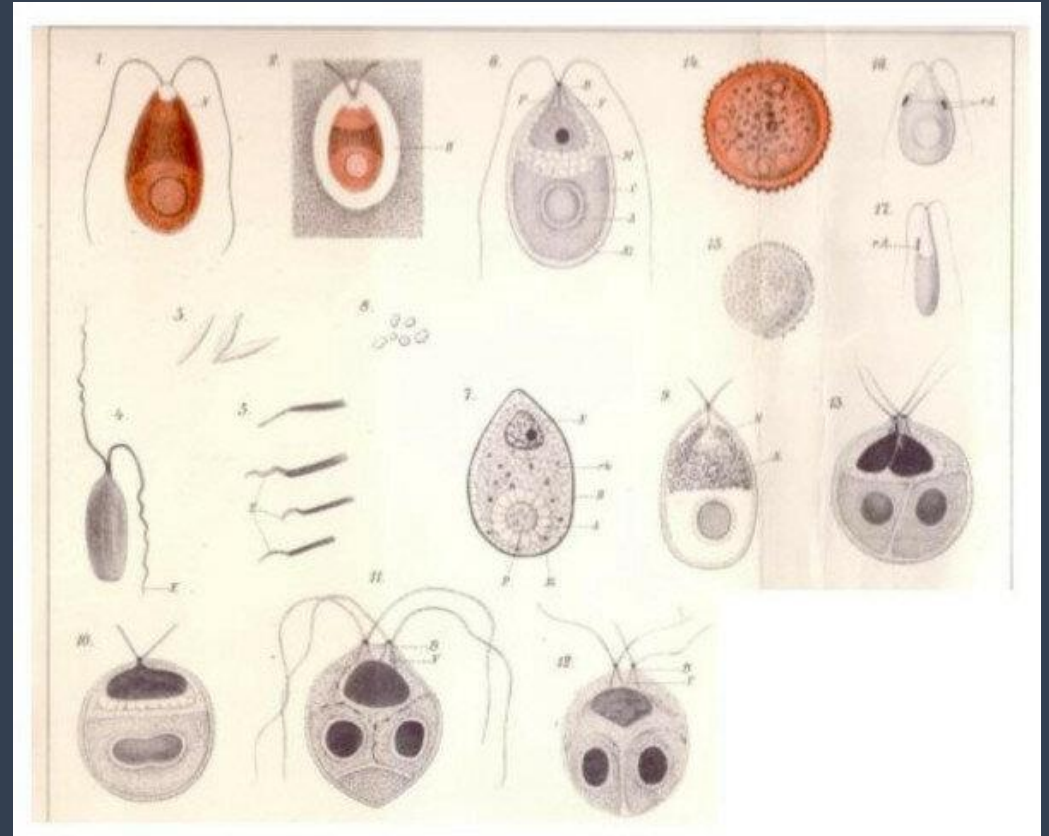
- Adaptation Strategies

- SALT IN

- OSMOLYTE SYNTHESIS

- OSMOPHOBIC EFFECT

- OMOLOGOUS PROTEIN

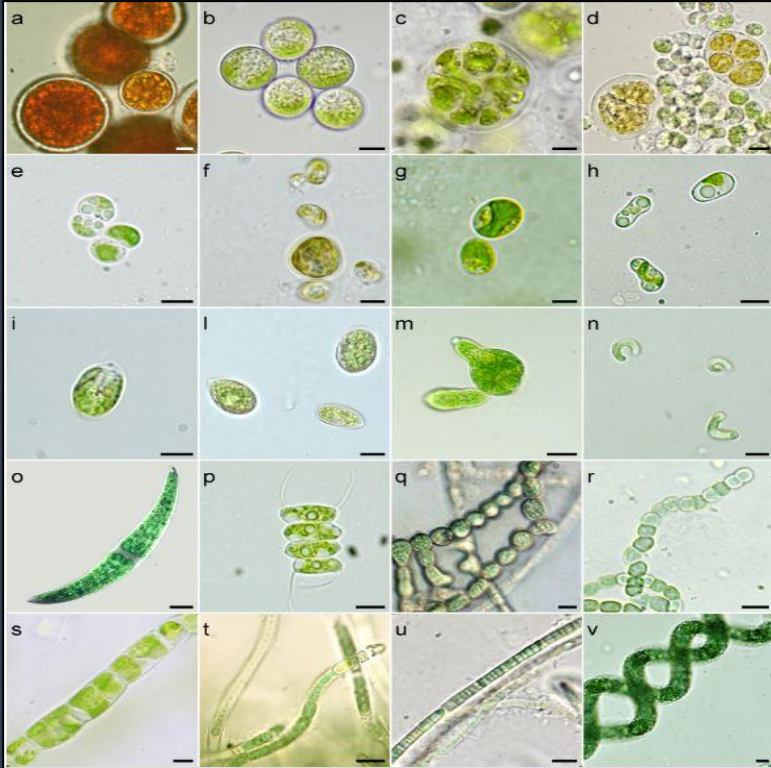




CYANIDIALES

- Unicellular red microalgae
- Acidic hot spring, fumaroles, acidic mine drainage
- $0 < \text{pH} < 5$
- Temperature up to 60°C
- High salinity
- Source of biomolecules and high value chemicals

Cyanidiales strains tested



Acuf Collection

- 1000 total strains
- 300 cyanidiales strains

Name	Strain ID	Origin
<i>G. phlegrea</i> Pinto	Acuf_009	Italy
<i>G. sulphuraria</i> Merola	Acuf_014	Italy
<i>G. sulphuraria</i> Merola	Acuf_016	Italy
<i>C. caldarium</i> Geitler	Acuf_019	Italy
<i>G. sulphuraria</i> Merola	Acuf_137	Japan
<i>C. caldarium</i> Geitler	Acuf_182	Indonesia
<i>G. maxima</i> Sentsova	Acuf_392	Iceland
<i>G. maxima</i> Sentsova	Acuf_445	Iceland
<i>G. phlegrea</i> Pinto	Acuf_667	Turkey
<i>Cy. merolae</i> De Luca	Acuf_733	Italy
<i>G. maxima</i> Sentsova	Acuf_743	Turkey

How NaCl tolerance is distributed among a group of so closely related microbes?

Generalist

NORMALIZED CELL/ML

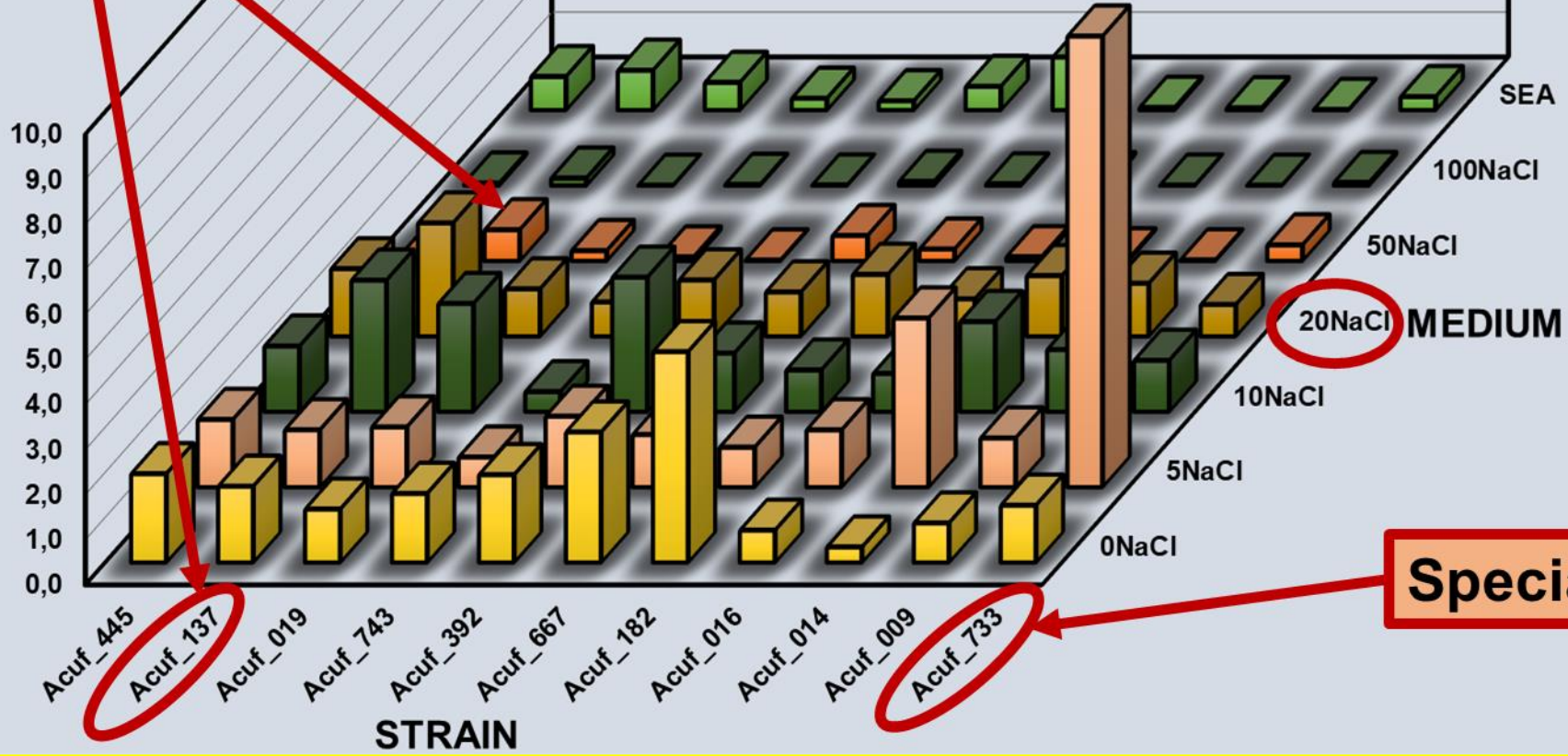
10,0
9,0
8,0
7,0
6,0
5,0
4,0
3,0
2,0
1,0
0,0

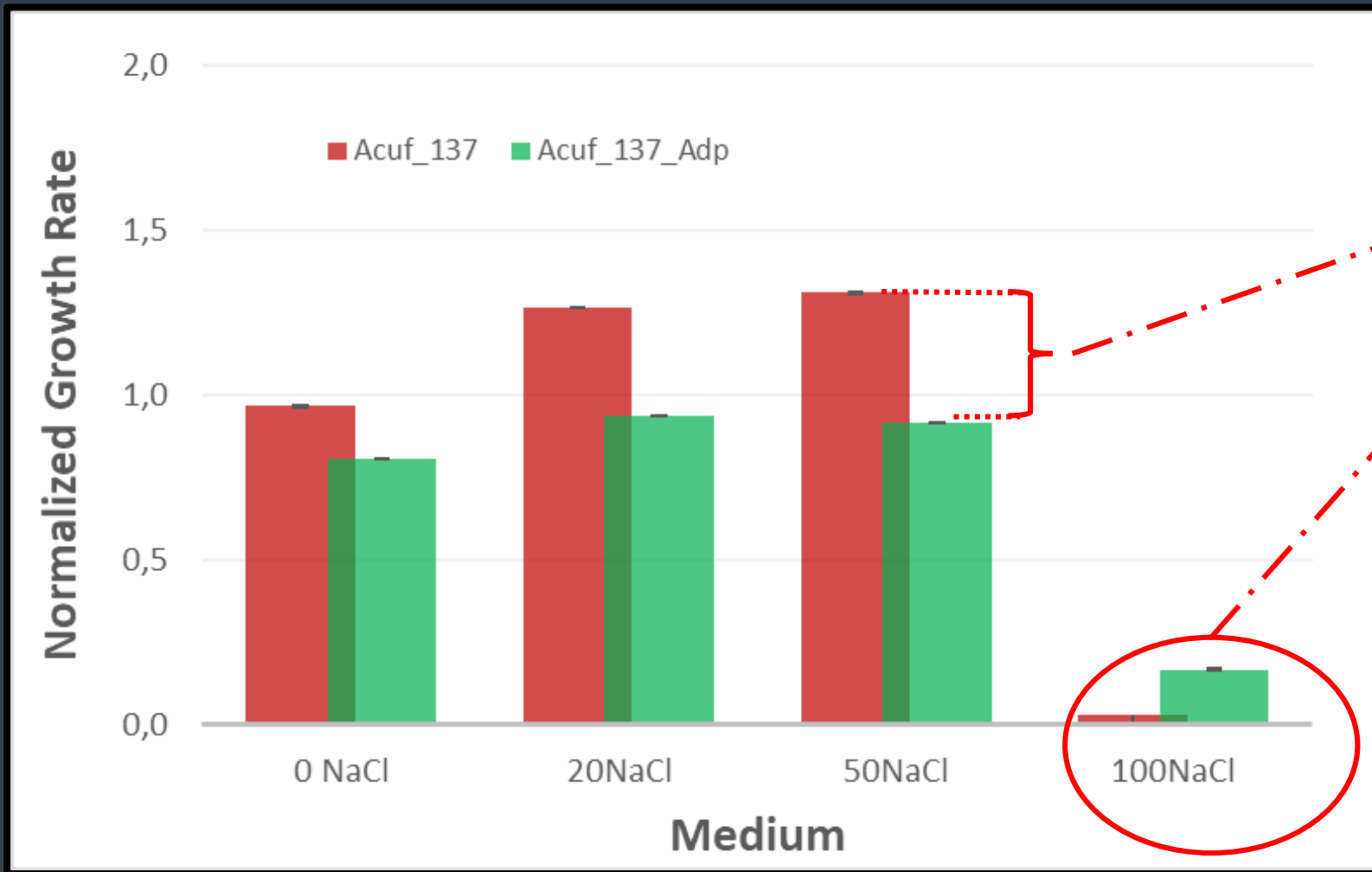
Acuf_445
Acuf_137
Acuf_019
Acuf_743
Acuf_392
Acuf_667
Acuf_182
Acuf_016
Acuf_014
Acuf_009
Acuf_733

STRAIN

SEA
100NaCl
50NaCl
20NaCl MEDIUM
10NaCl
5NaCl
0NaCl

Specialist



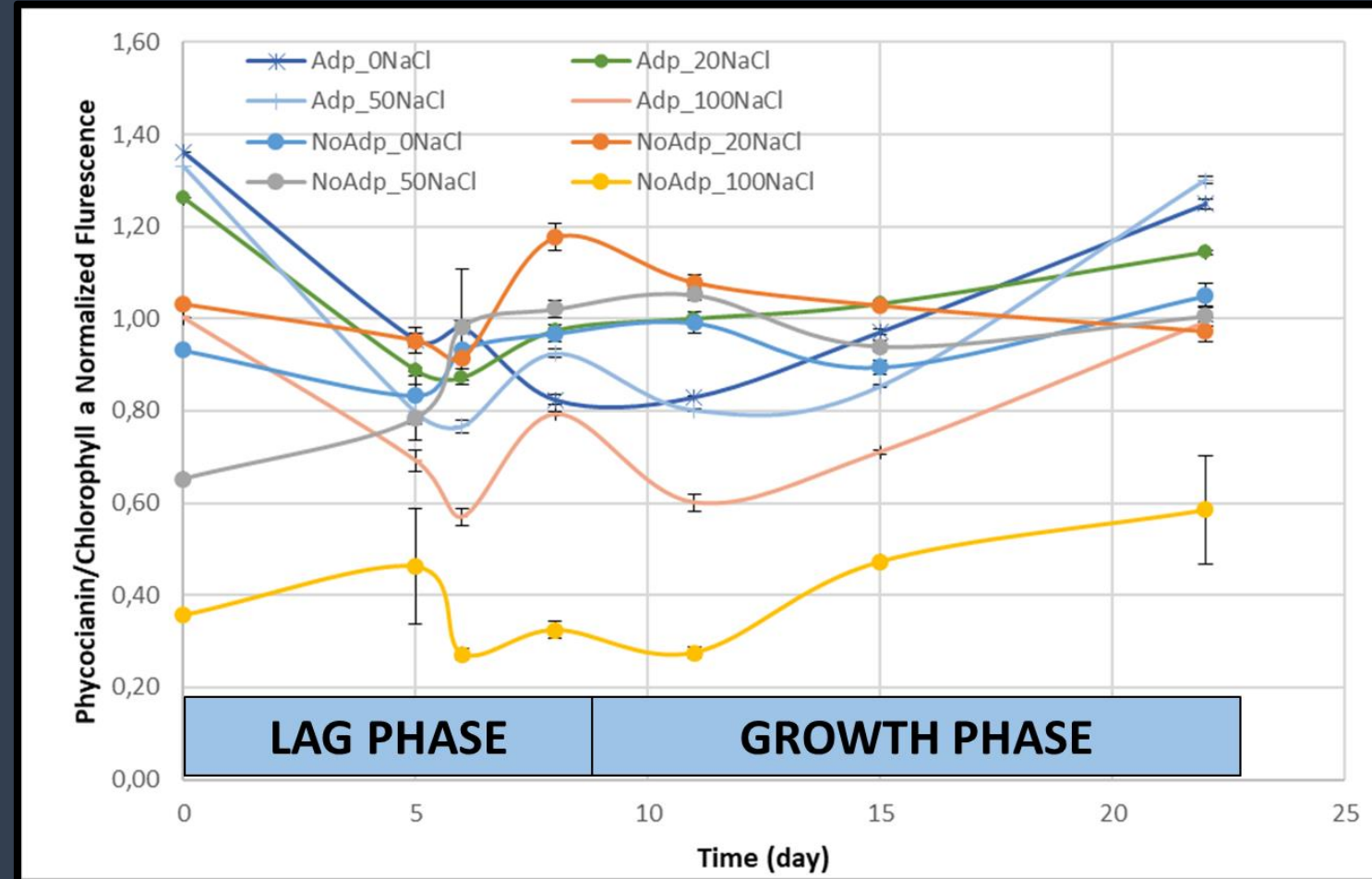
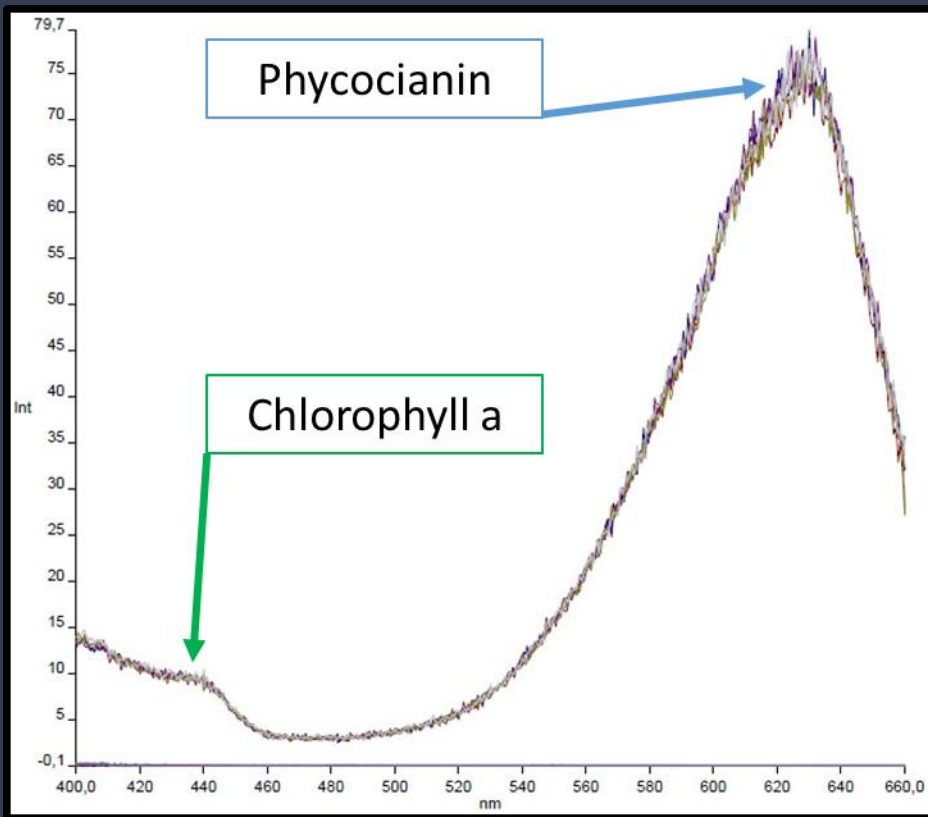


High-Salinity Pre-adaptation

- Salt Strees Effect
- 5% Salinity
- 10% Salinity
- Reactor type effect

Hight-Salinity Pre-adptation

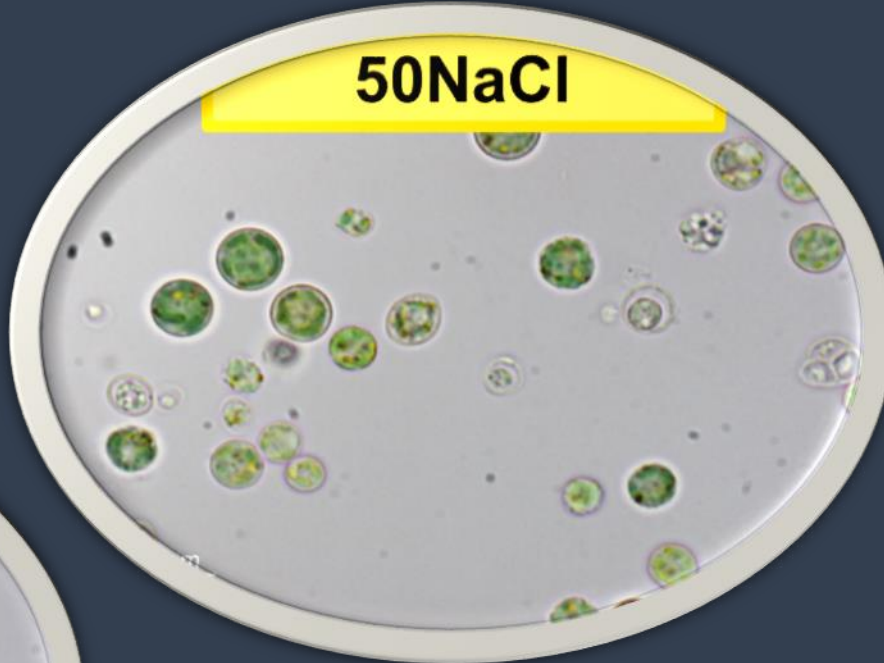
- Phycocianin/ Chlorophyll a



Supersaturated



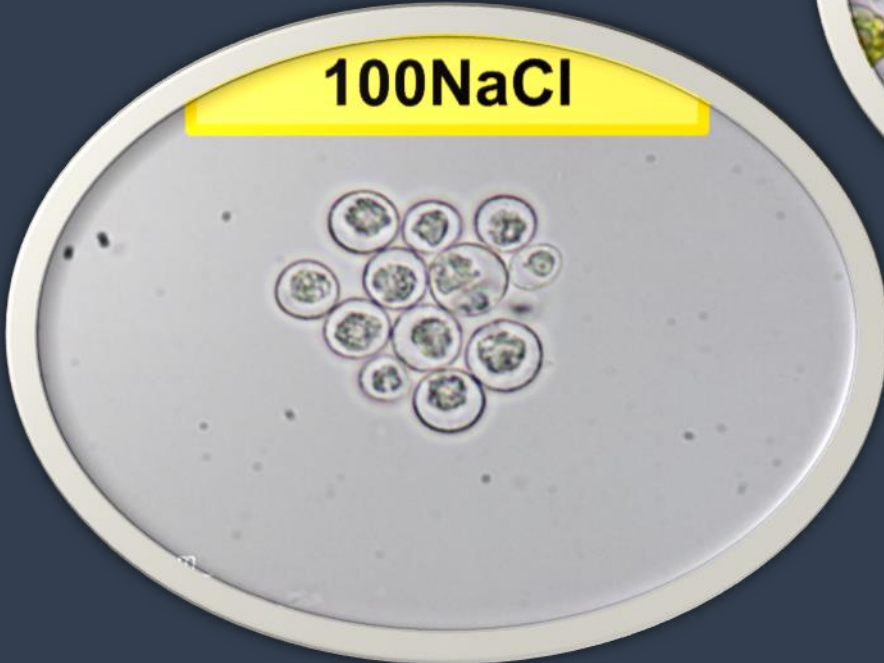
50NaCl



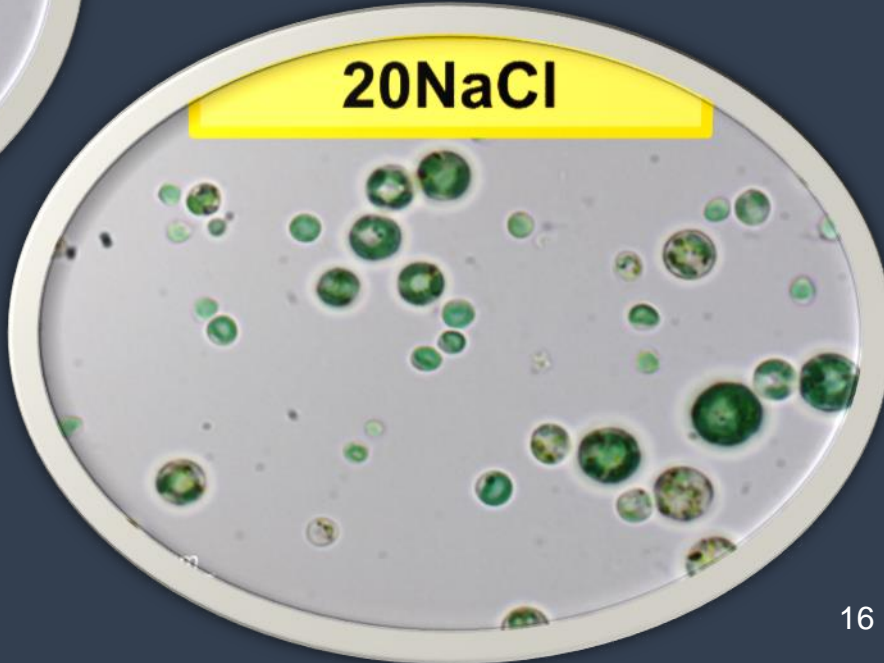
CONTROL



100NaCl



20NaCl



An aerial photograph showing a vast, undulating sea of white, fluffy clouds that stretch to the horizon. The sky above is a clear, bright blue. The perspective is from a high altitude, looking down on the cloud layer.

Thank's for your Attention!