Biogenic stabilisation of river and estuarine sediments by microbial assemblages

Photo: Fredric Larson, Irvine Davidson

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Marie Curie Actions

Overview

I. Introduction

II. Technical development

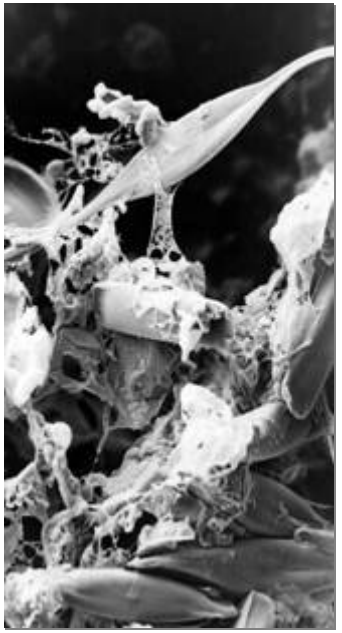
III. Stabilisation potential of individual and mixed assemblages

What is Biostabilisation?

- **Erosive response of sediment to hydraulic forces changed by organism**
- **Biological and Physico-Chemical parameters**
- **Different forms of Biostabilisation**

EPS

Extracellular polymeric substances

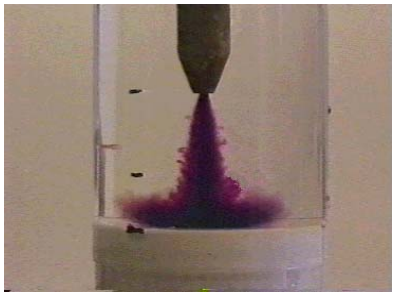


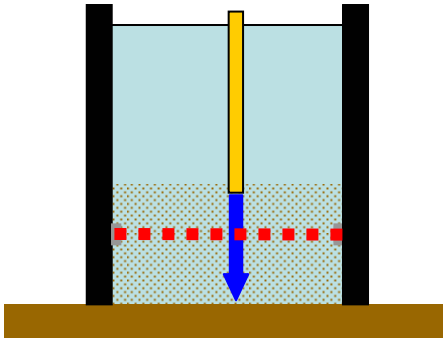
Sediment Stability

1. Climate change - to raise sea levels
2. Increased risk of flooding from flash storm events
3. Increased coastal erosion
4. Alter estuarine deposition
5. Lead to re-suspension of particles
6. Release of contaminants to interact with the food web

Measurement of sediment stability

CSM – Cohesive Strength Meter



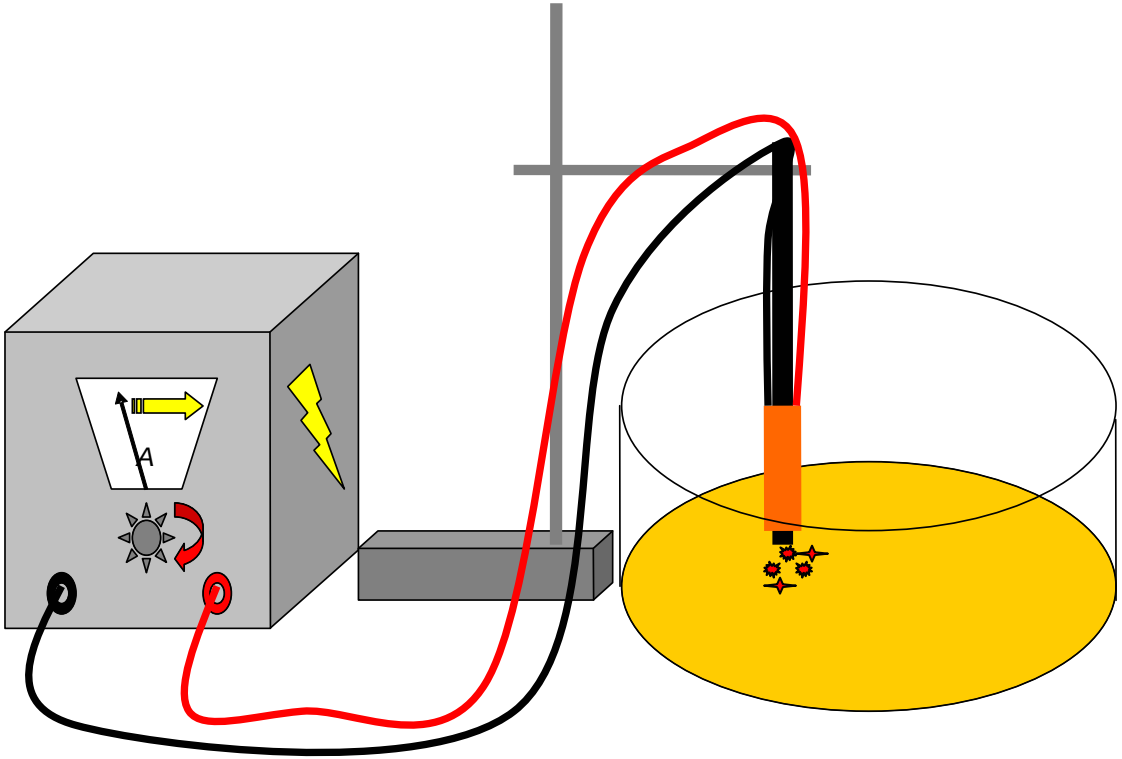


Gust Microcosm Floc Characteristics

SETEG System: measure of critical shear stress, at different sediment depths

Summary: The methods provide information on the overall sediment erosion behaviour.Techniques represent different scenarios of the sediment erosion.

Magnetic Particle Induction (MagPI)



F. Larson, H. Lubarsky, S. Gerbersdorf and D. Paterson, *Limnol. Oceanogr.: Methods 7* (2009) 490-497

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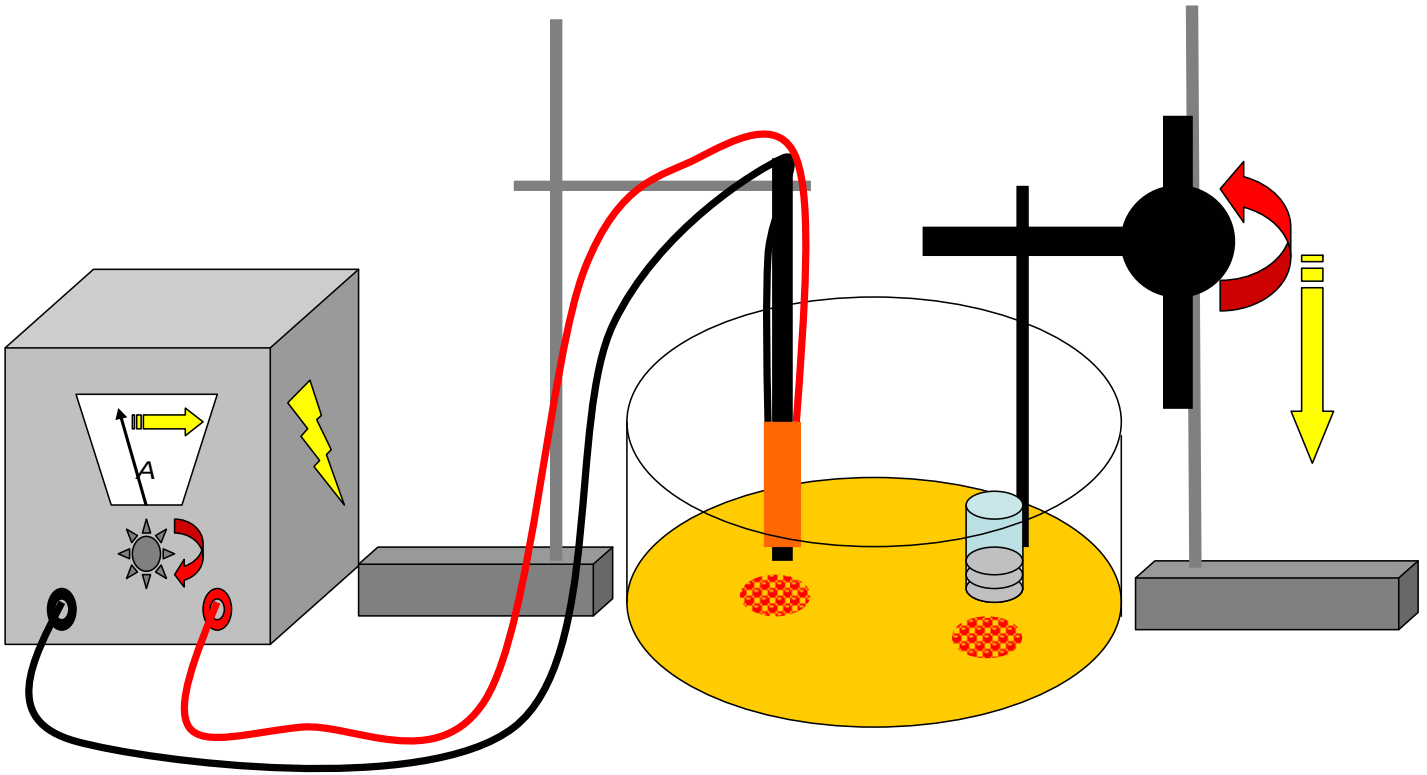

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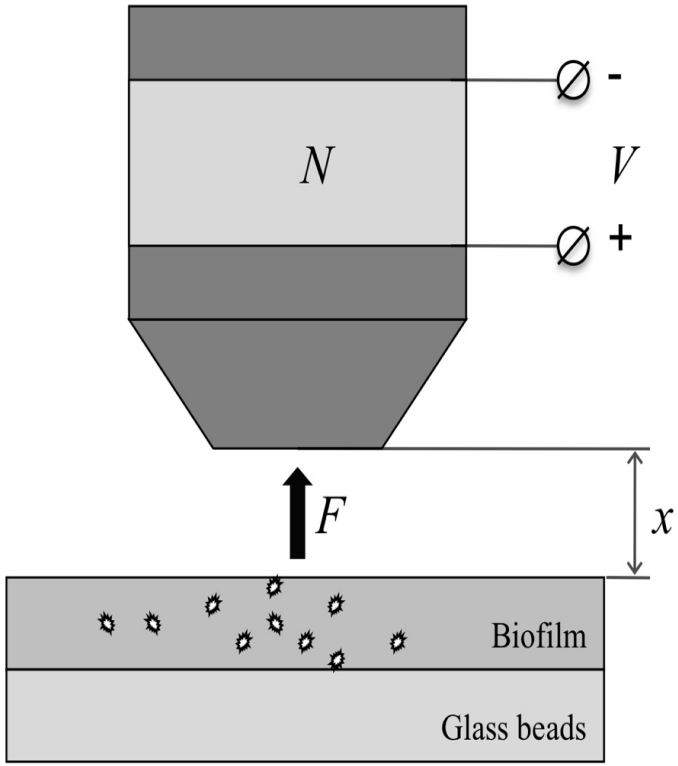
MagPI : Theory



$$F = \frac{B^2 A}{2\mu_0}$$

B is the magnetic flux density,

A is the area of the pole faces

μ Is the permeability of free space

$$B = \frac{\mu N I}{L}$$

N is number of turns

I is the current,

L is the length of the magnetic circuit

$$F = \frac{\mu^2 N^2 I^2 A}{2\mu_0 L^2}$$

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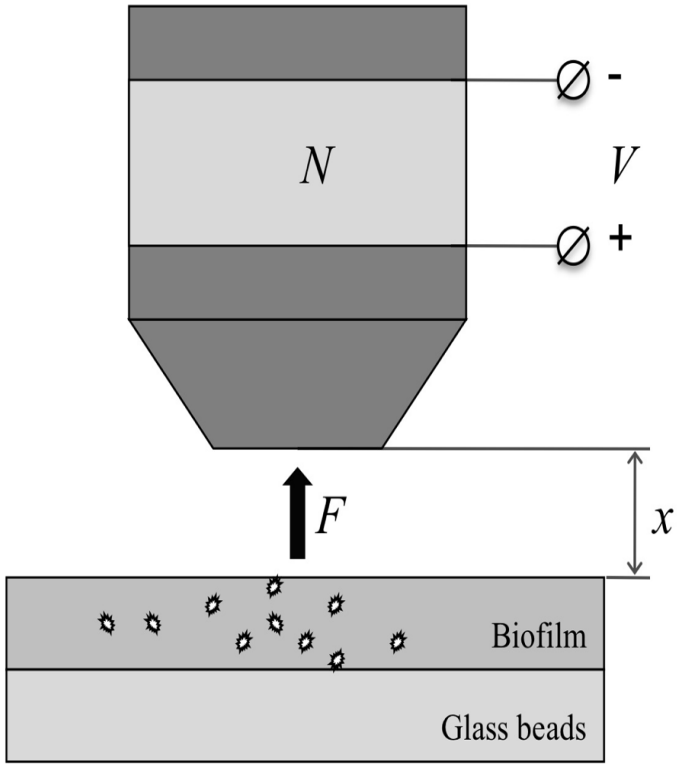
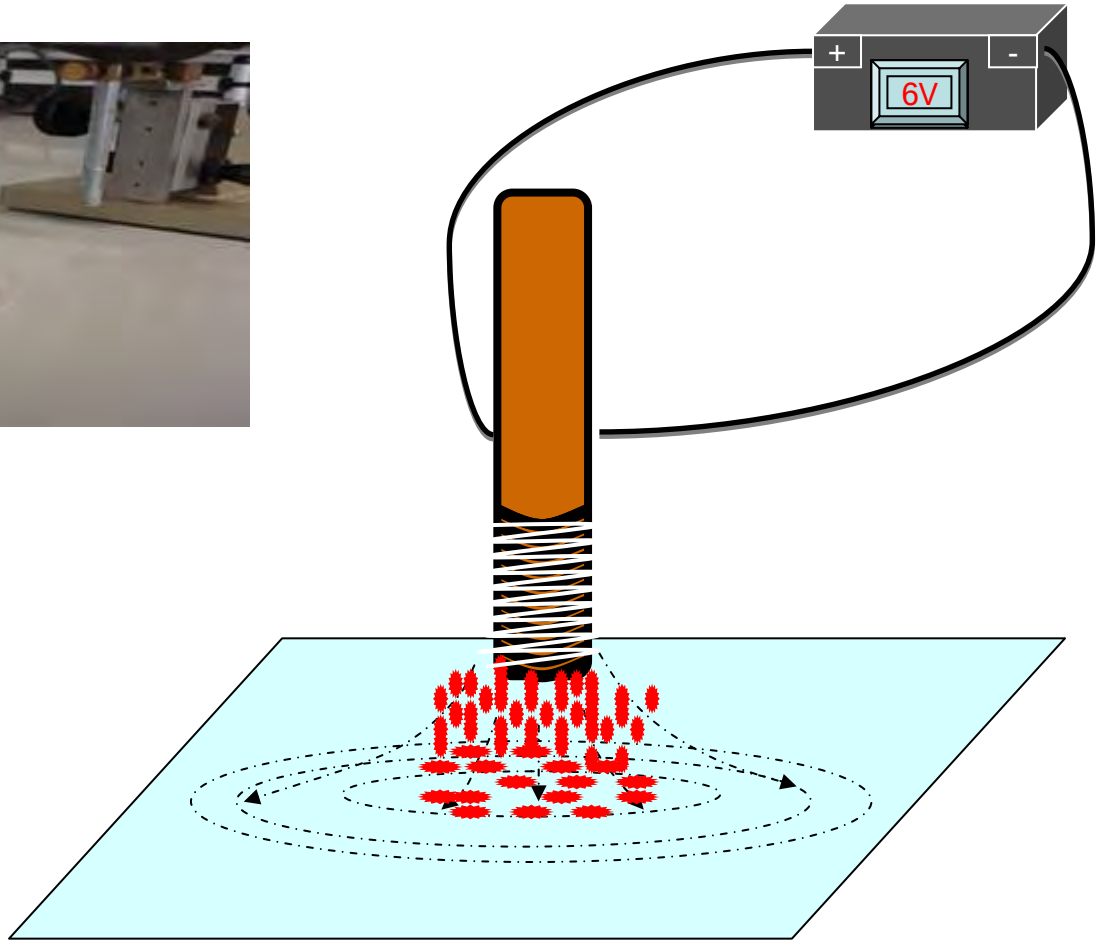
MagPI : Trial and error



How does it work ?

F. Larson, H. Lubarsky, S. Gerbersdorf and D. Paterson, *Limnol. Oceanogr.: Methods 7* (2009) 490-497

MagPI : Animation



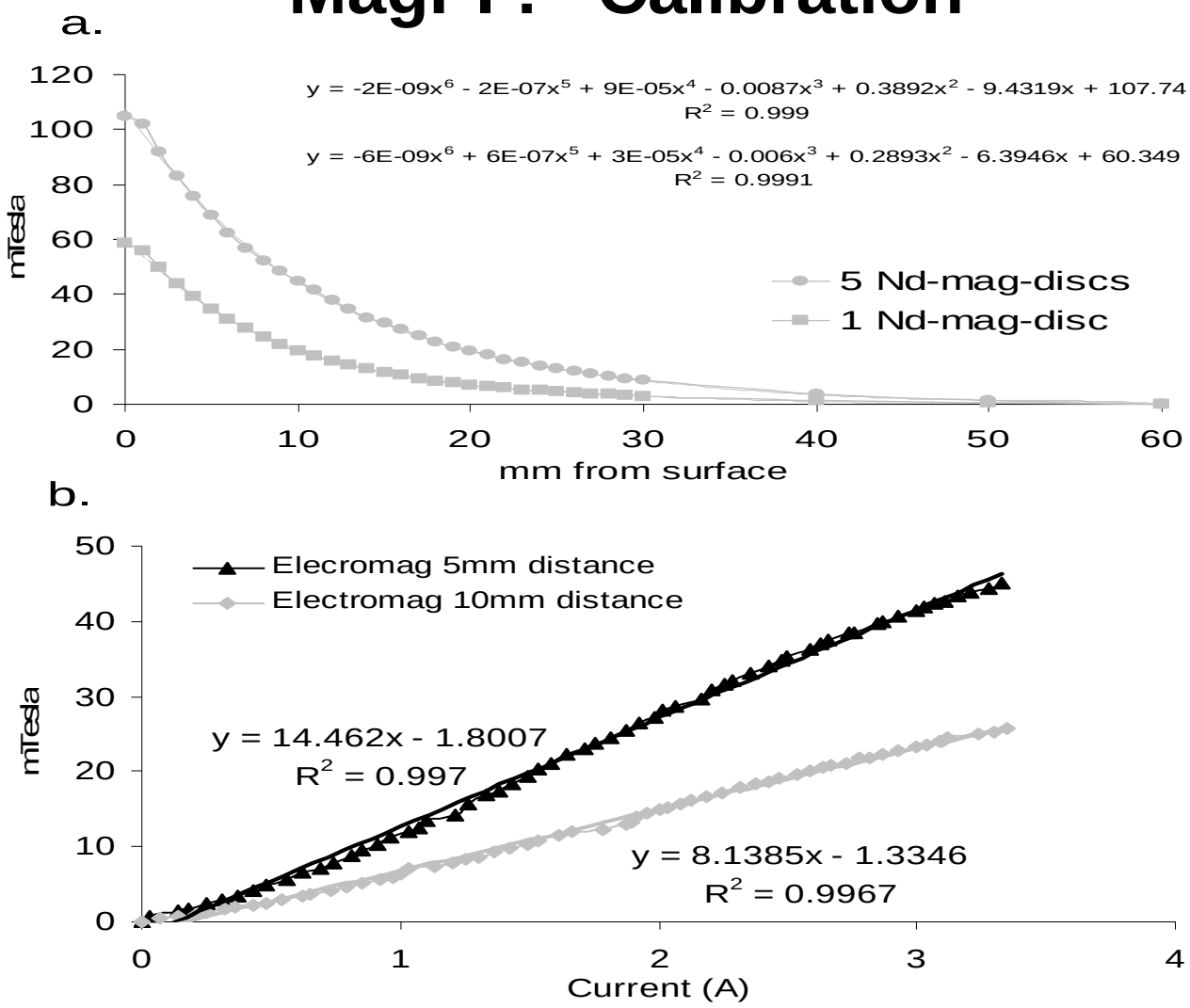
MagPI : Measure adhesion

F. Larson, H. Lubarsky, S. Gerbersdorf and D. Paterson, *Limnol. Oceanogr.: Methods 7* (2009) 490-497

MagPI : in the movie…

F. Larson, H. Lubarsky, S. Gerbersdorf and D. Paterson, *Limnol. Oceanogr.: Methods 7* (2009) 490-497

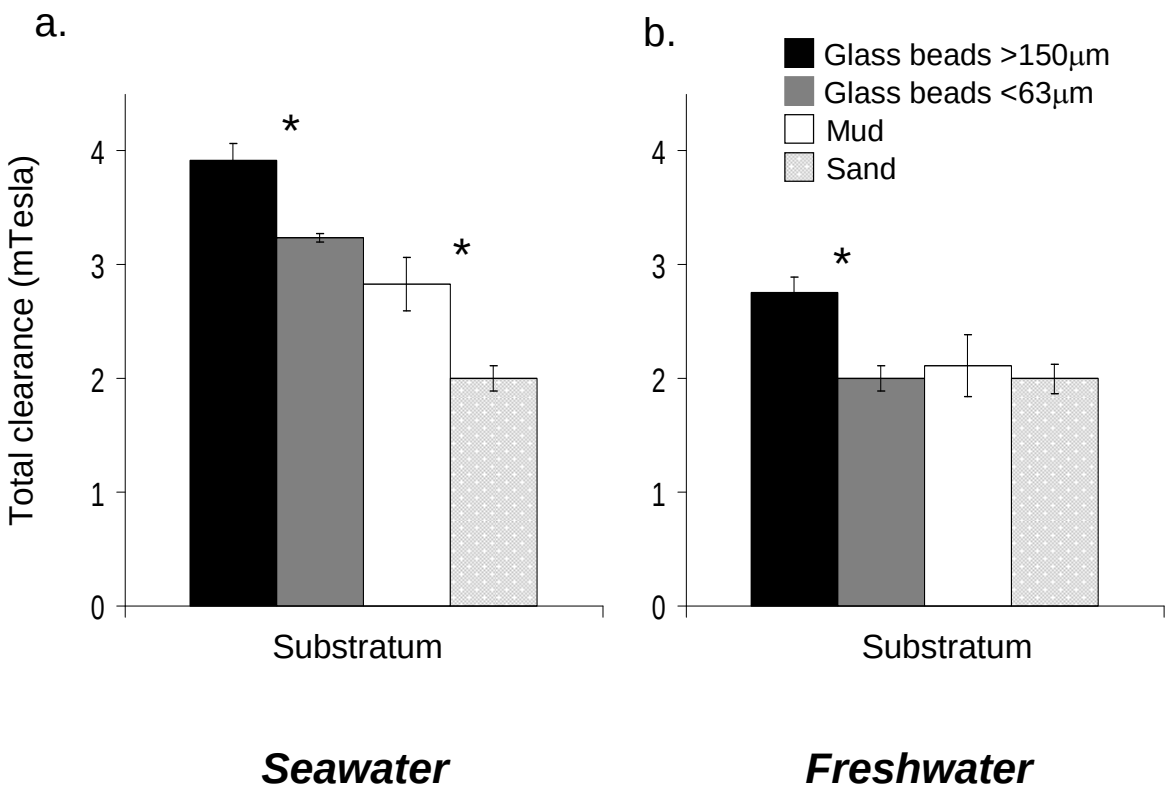
MagPI : Calibration

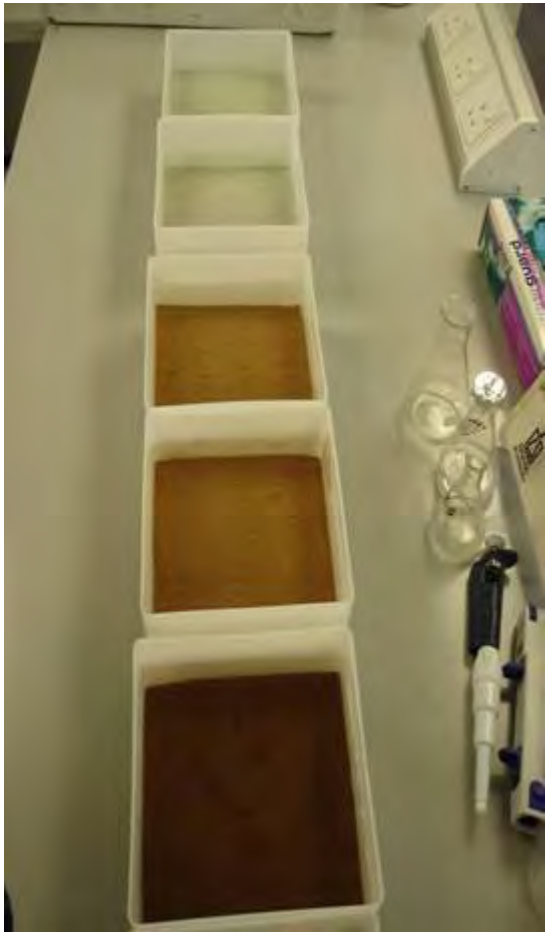


II Technical development

F. Larson, H. Lubarsky, S. Gerbersdorf and D. Paterson, *Limnol. Oceanogr.: Methods 7* (2009) 490-497

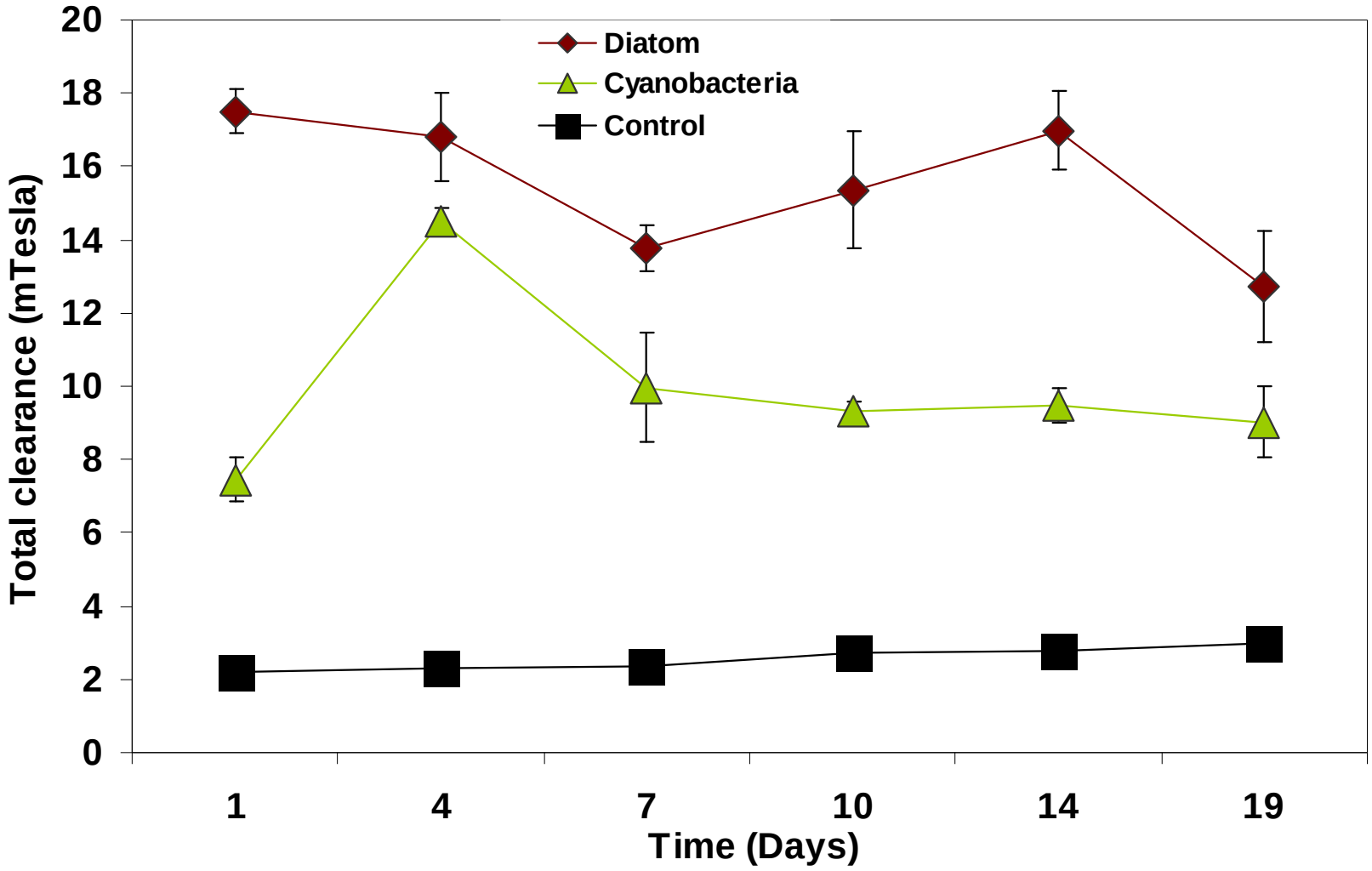
MagPI : Calibration II





II Technical development F. Larson, H. Lubarsky, S. Gerbersdorf and D. Paterson, *Limnol. Oceanogr.: Methods 7* (2009) 490-497

MagPI : First application



II Technical development

F. Larson, H. Lubarsky, S. Gerbersdorf and D. Paterson, *Limnol. Oceanogr.: Methods 7* (2009) 490-497

MagPI : to sum up…

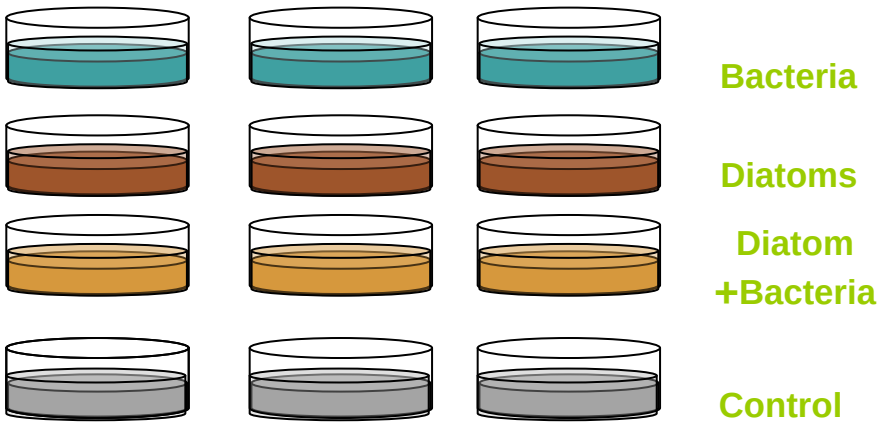
- Straightforward & economic, rapid & precise
- High sensitivity (e.g. young stages of biofilm).
- Applications in physical, environmental, and biomedical research
- Range of substrata: subtidal / intertidal sediments, stromatolites…can be developed.
- Calibration by gauss meter allows inter-comparison between different equipment, experiments and laboratories

F. Larson, H. Lubarsky, S. Gerbersdorf and D. Paterson, *Limnol. Oceanogr.: Methods 7* (2009) 490-497

III. The stabilisation potential of microbial assemblages – single and combined

Aim of experiment :

to identify the potential of EPS producers (single and combined) for EPS secretion and their biostabilisation capacity



III. Experiment on single and mixed assemblages (Lubarsky *et. al. shortly to be submitted*)

Experimental design

- Glass beads (<150 um)
- Illumination (200-250um photons m-2 s-1)
- Constant temperature 15^0C
- Aeration
- 6 replicates of each treatment

Methods used

1. EPS (Carbohydrate, Protein)
2. Bacterial cell number
3. Secondary production
4. Chl *a*
5. Community composition
6. Stability measurement MagPI, CSM

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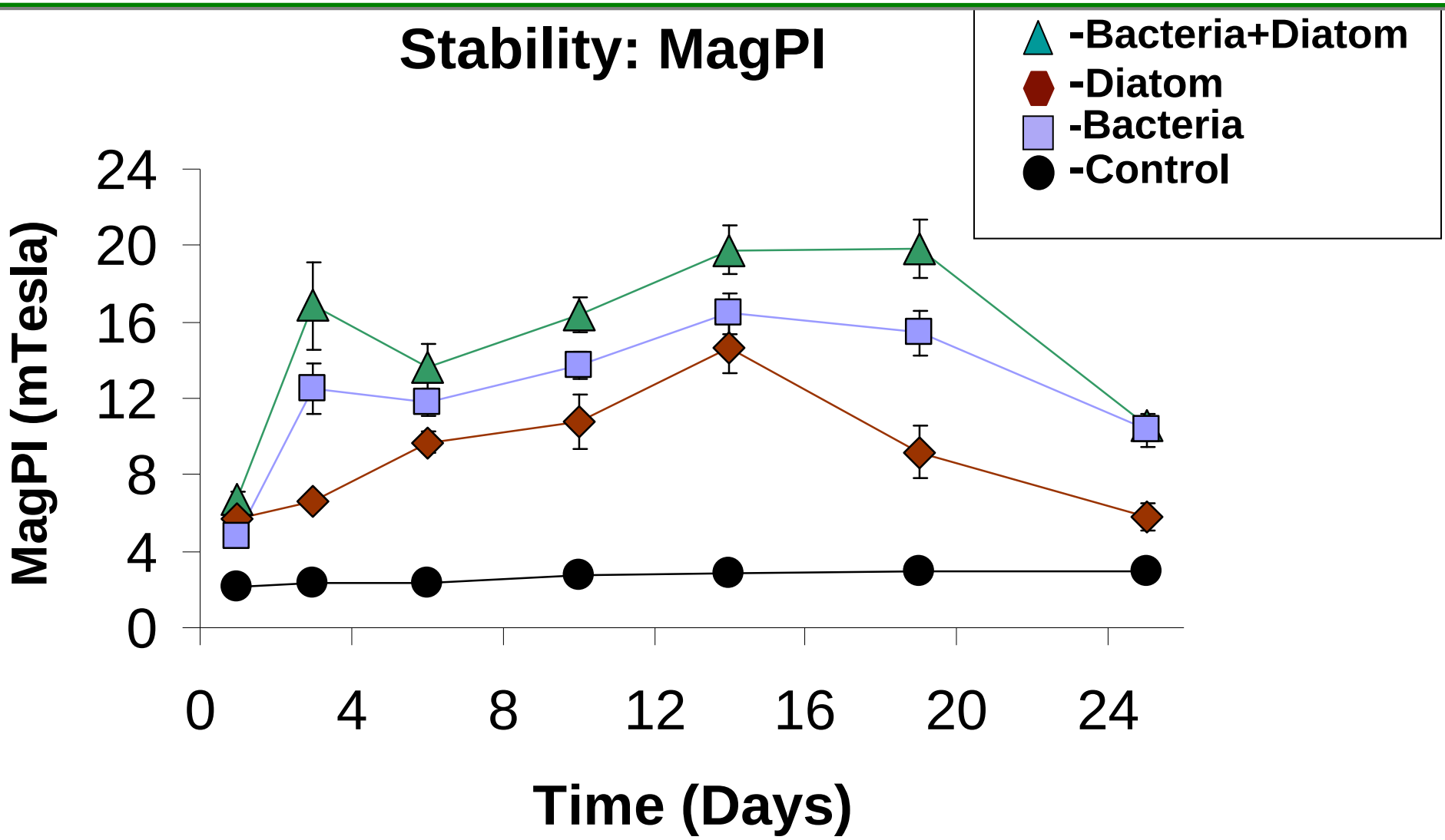

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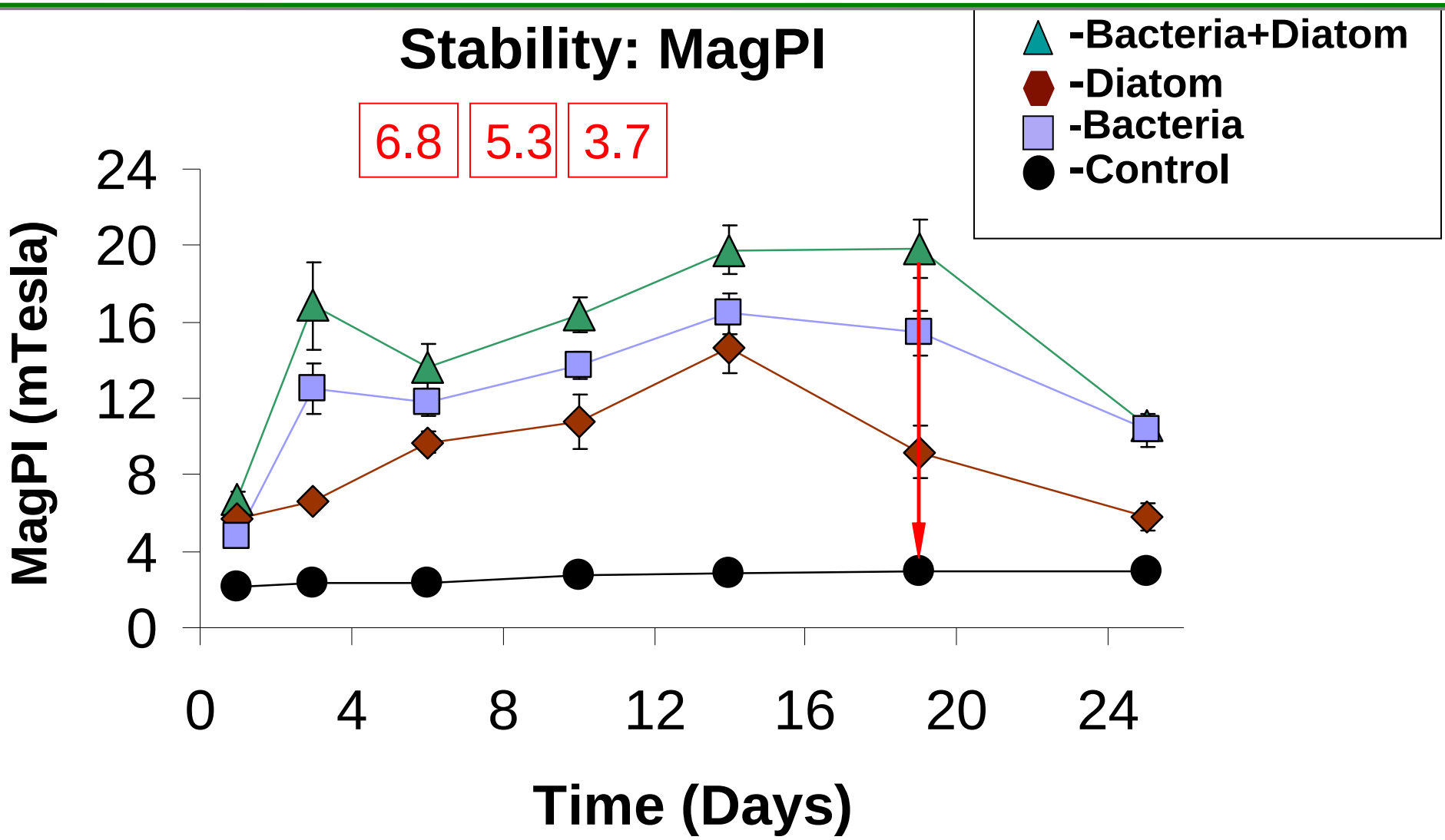

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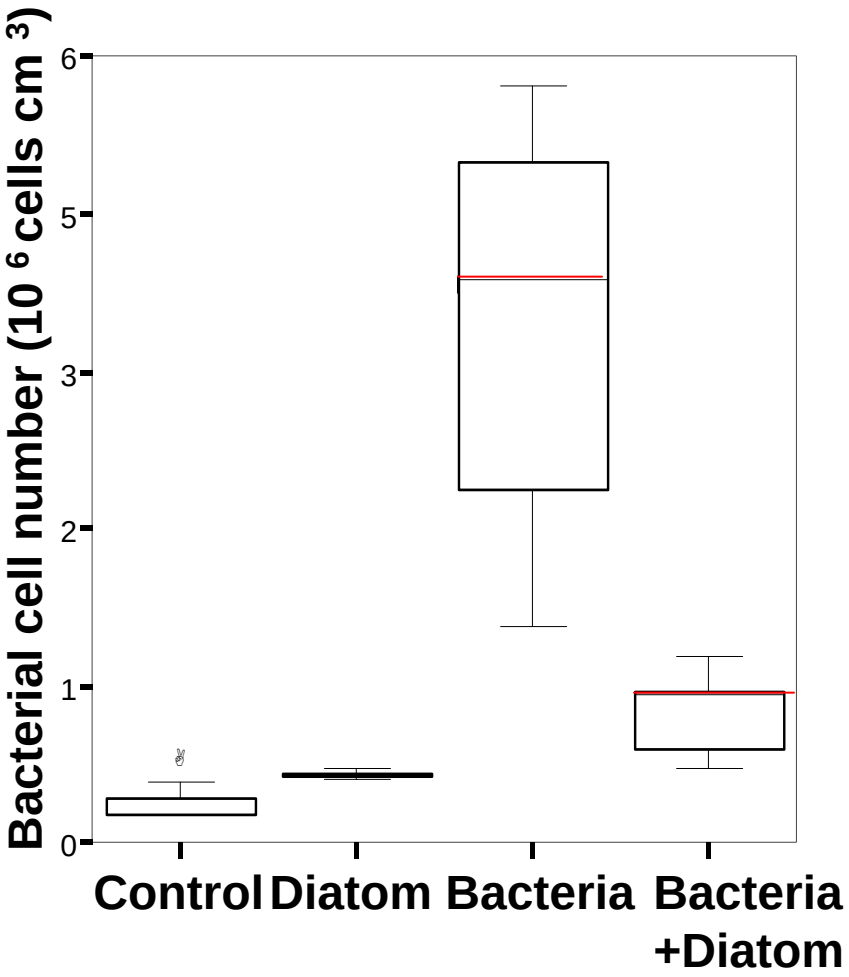
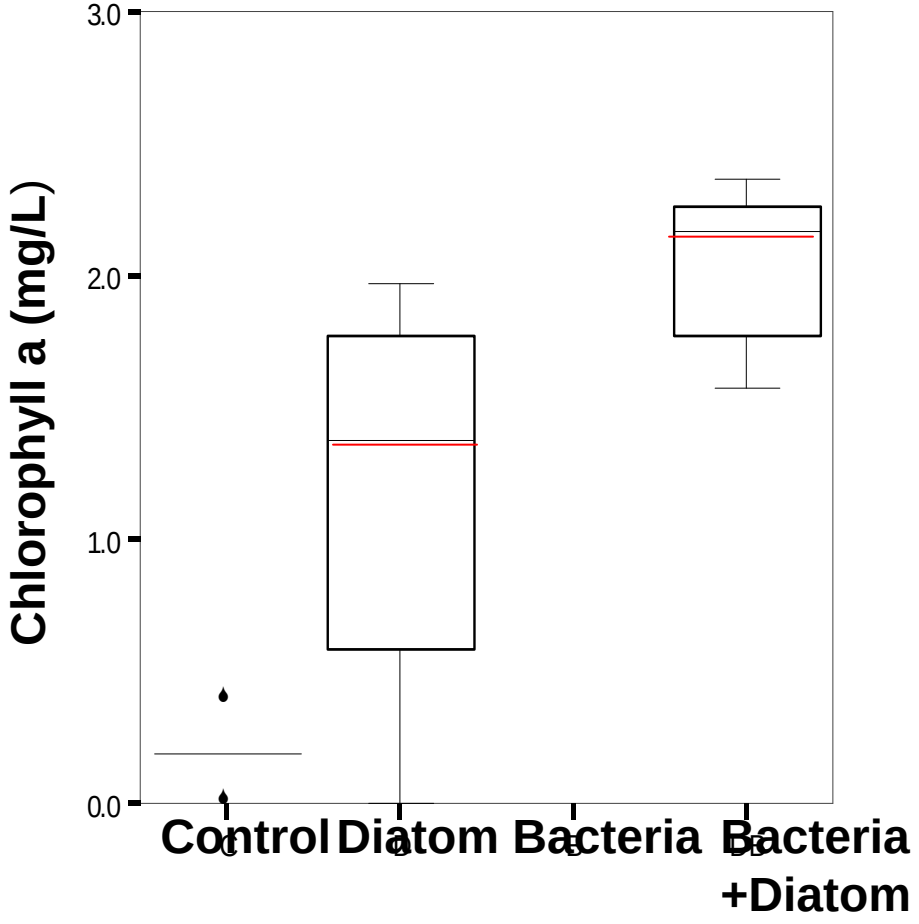
Cell numbers, Biomass





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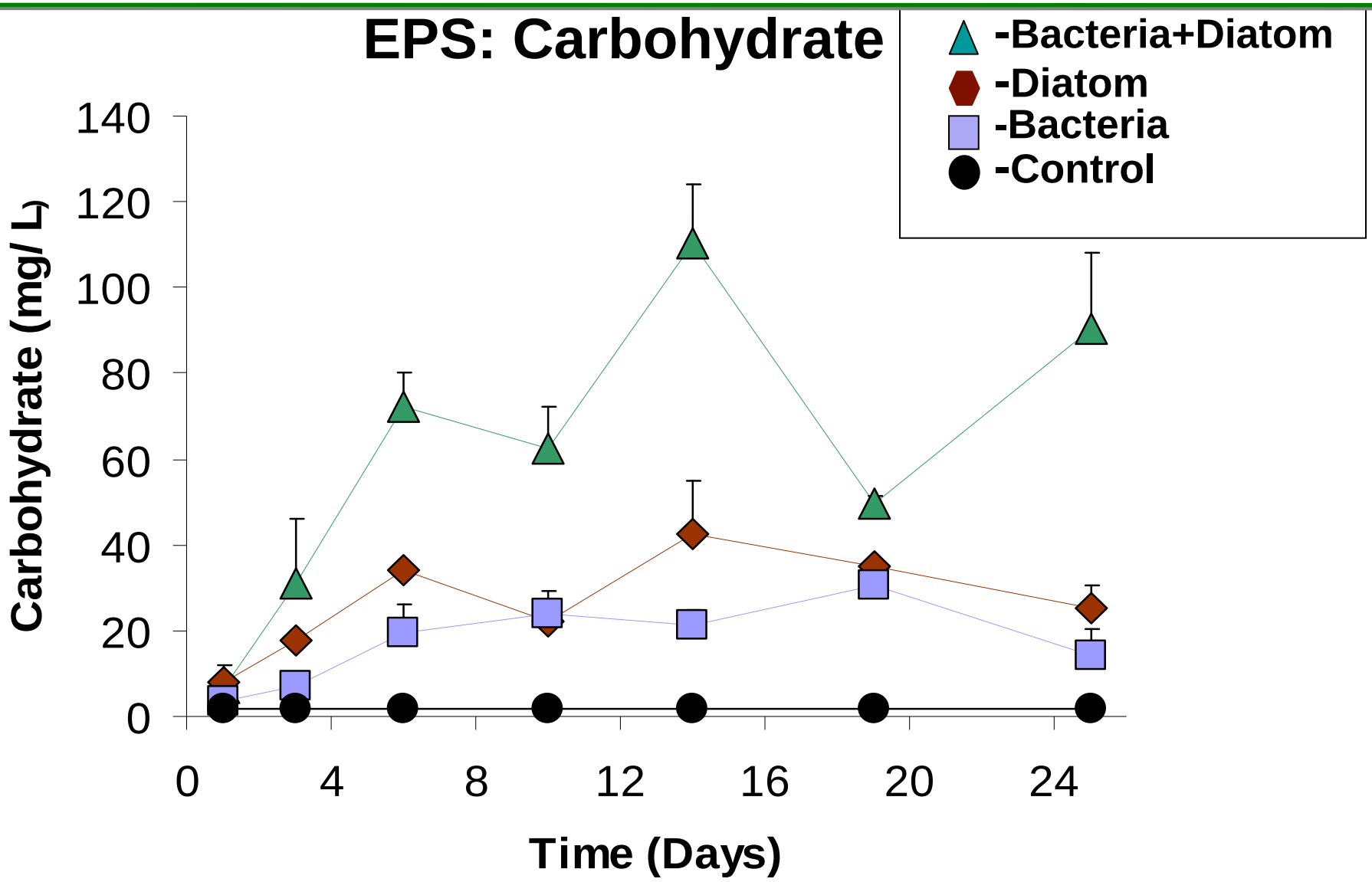

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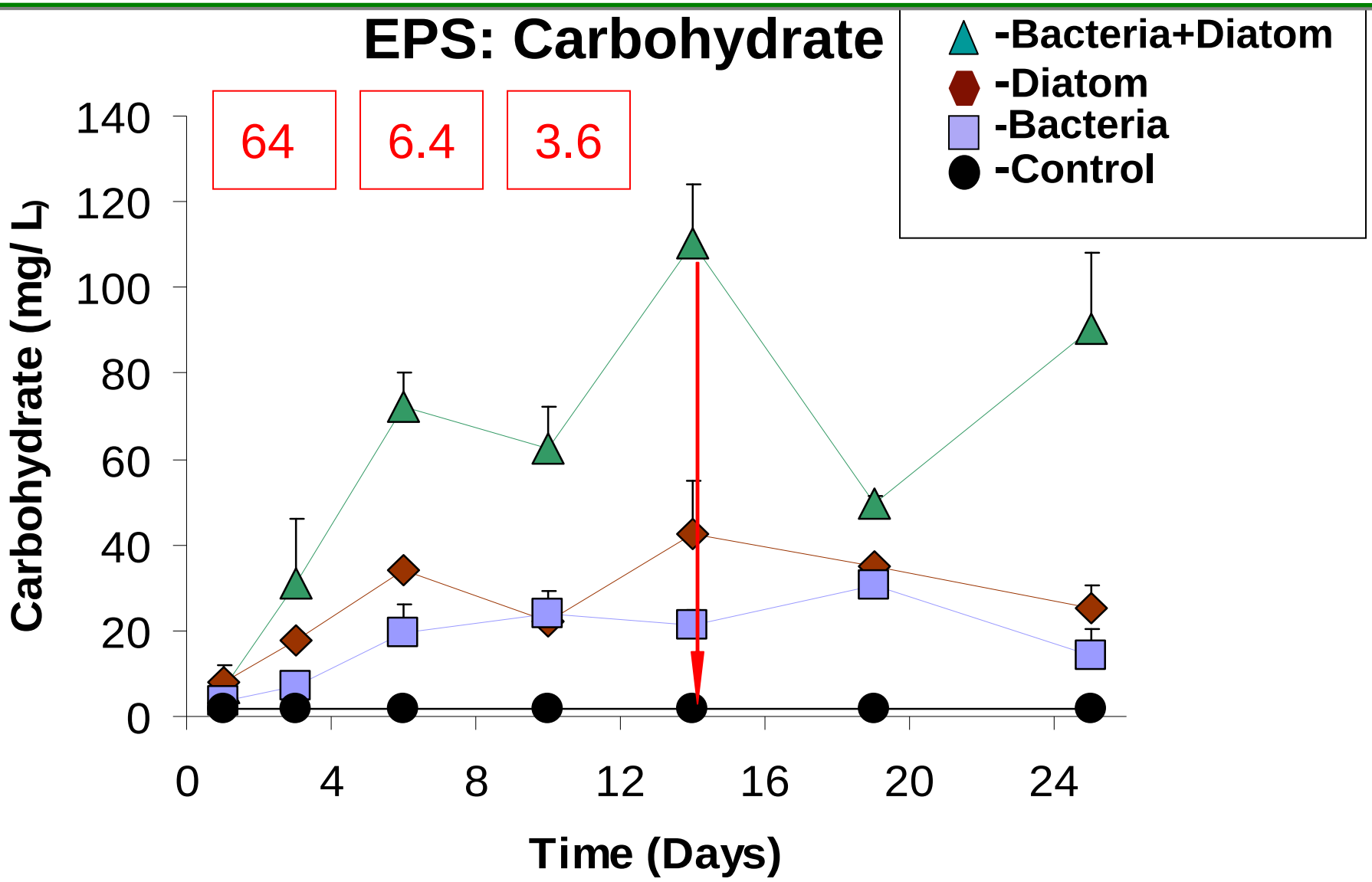

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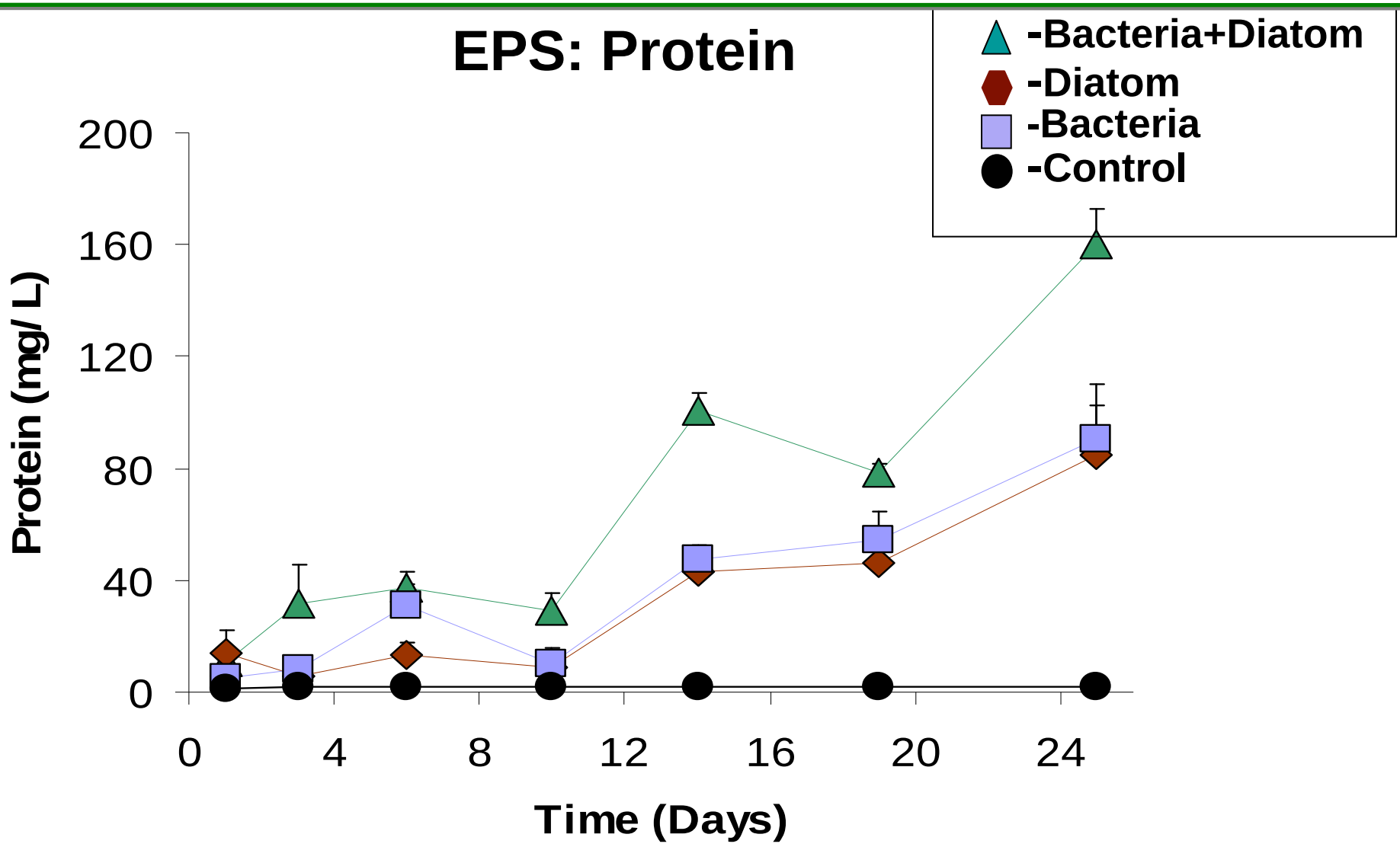

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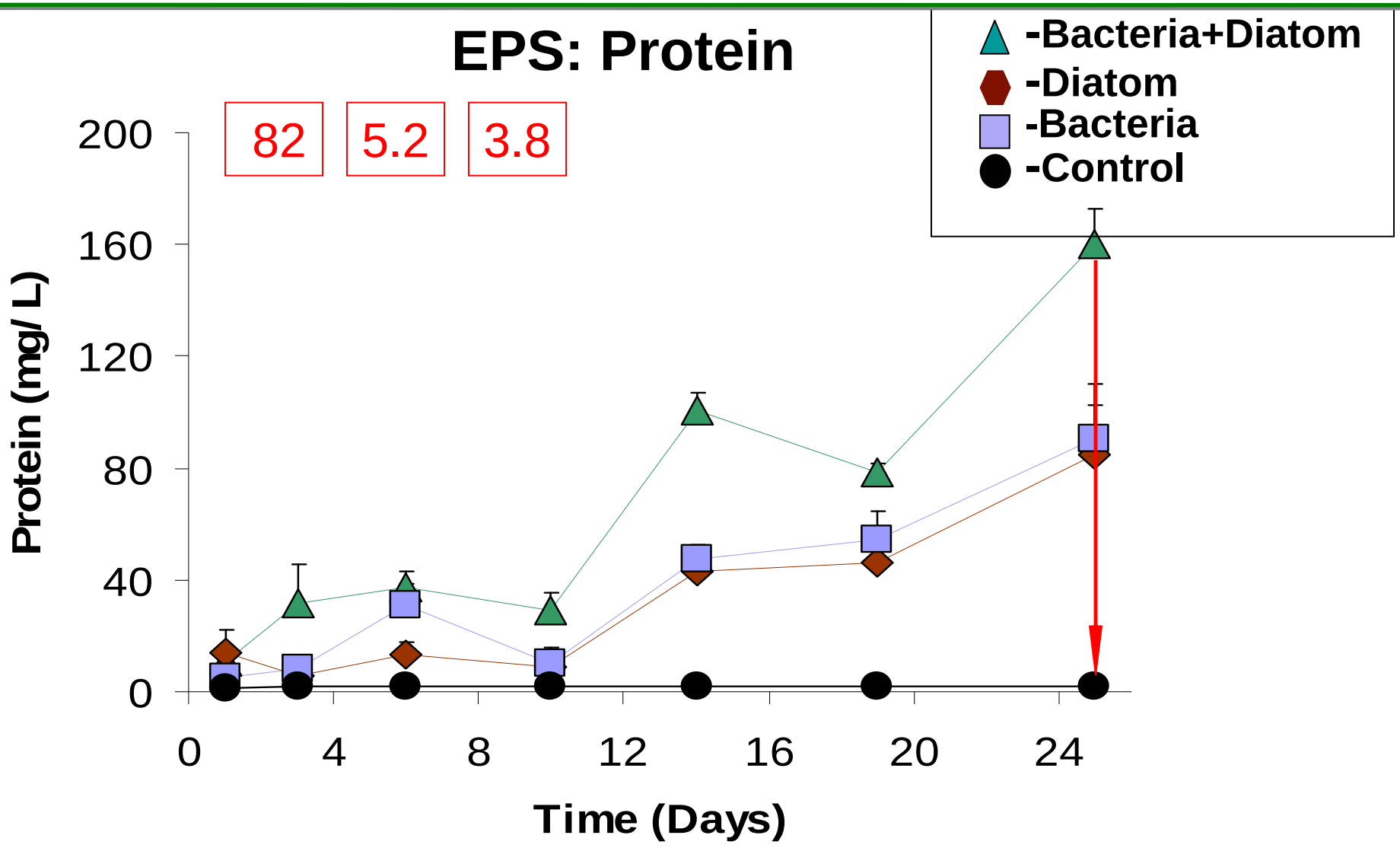

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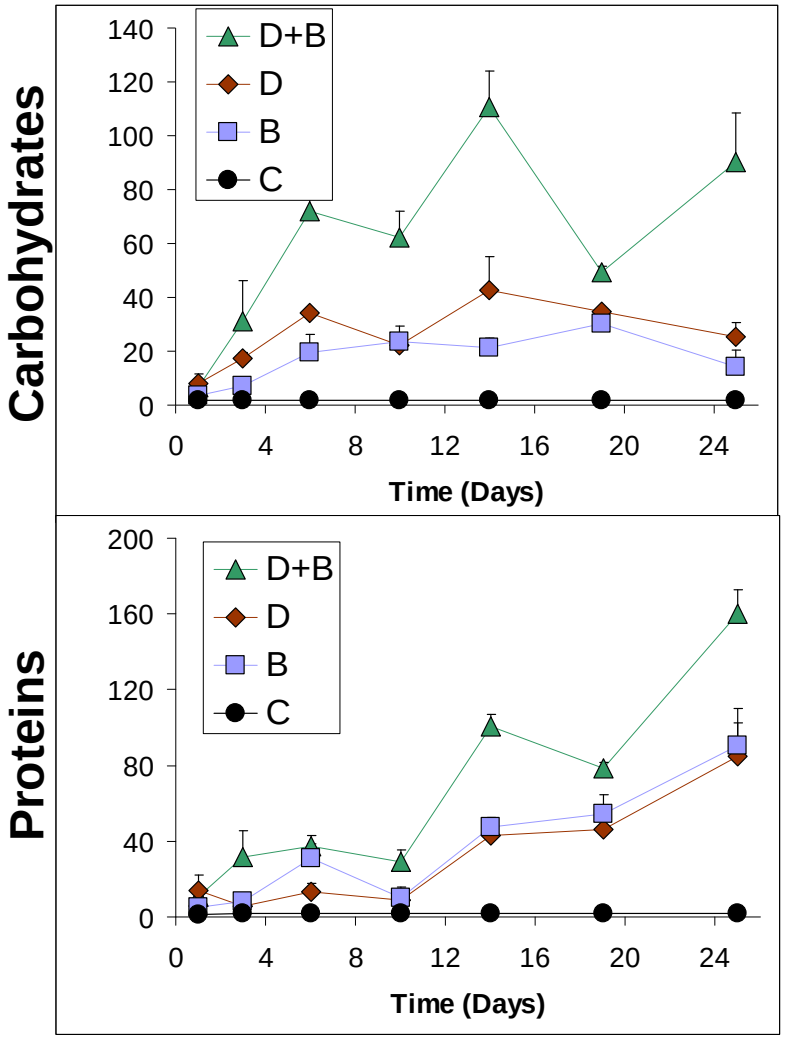
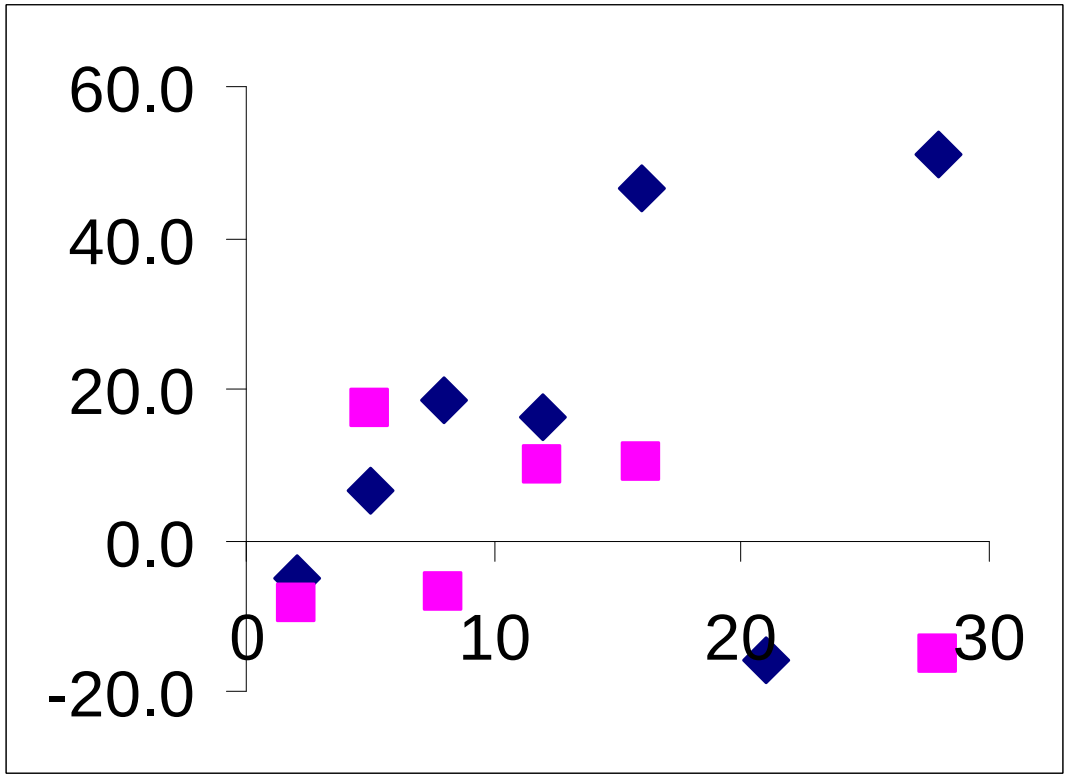
EPS: Carbohydrates Proteins



= (DB) – (B + D)



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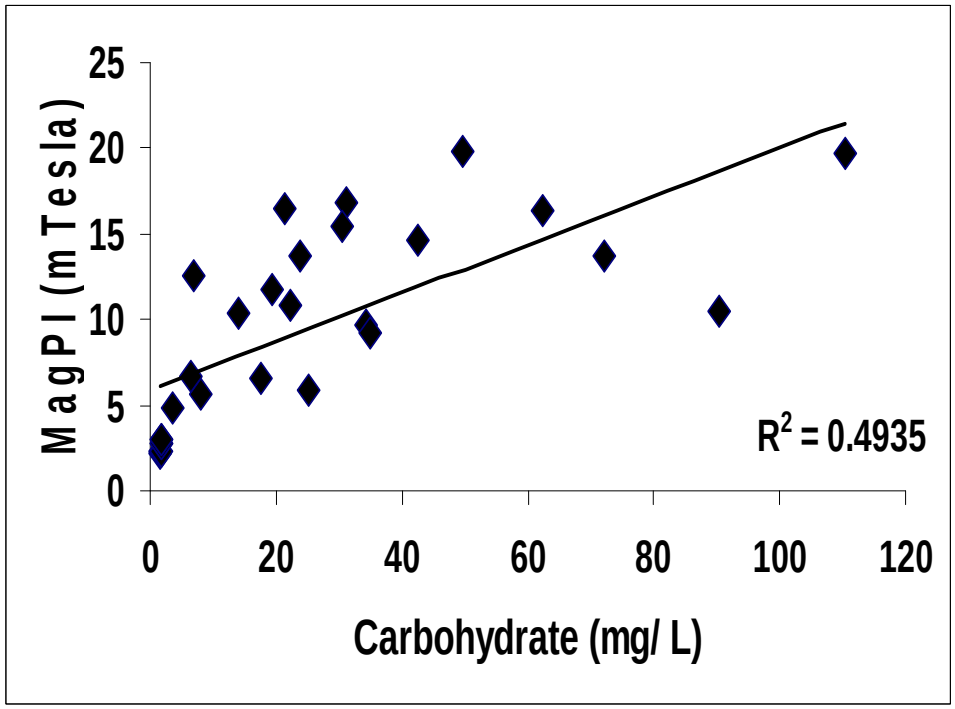
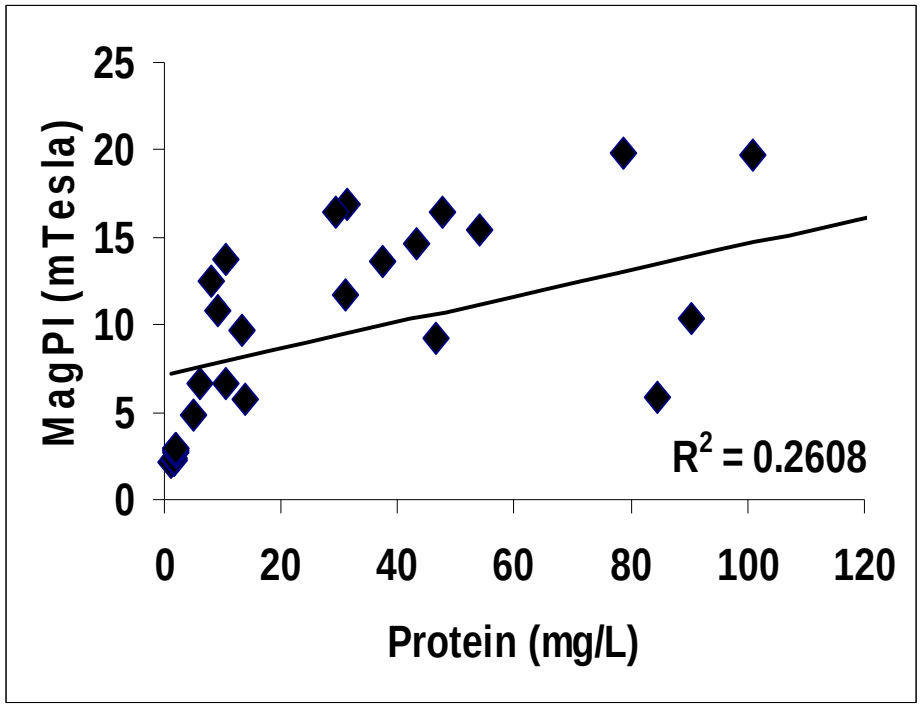
Regression between Stability and EPS





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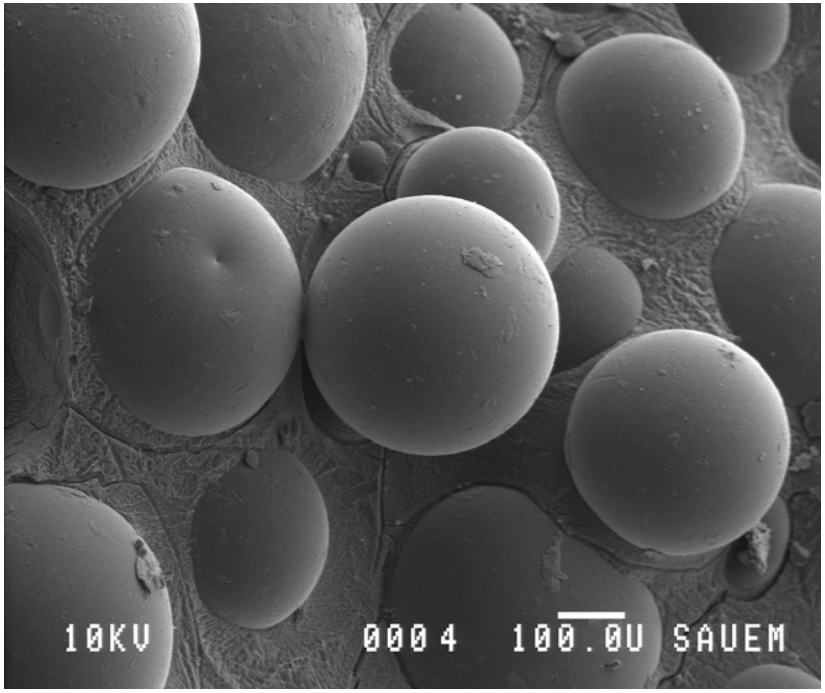
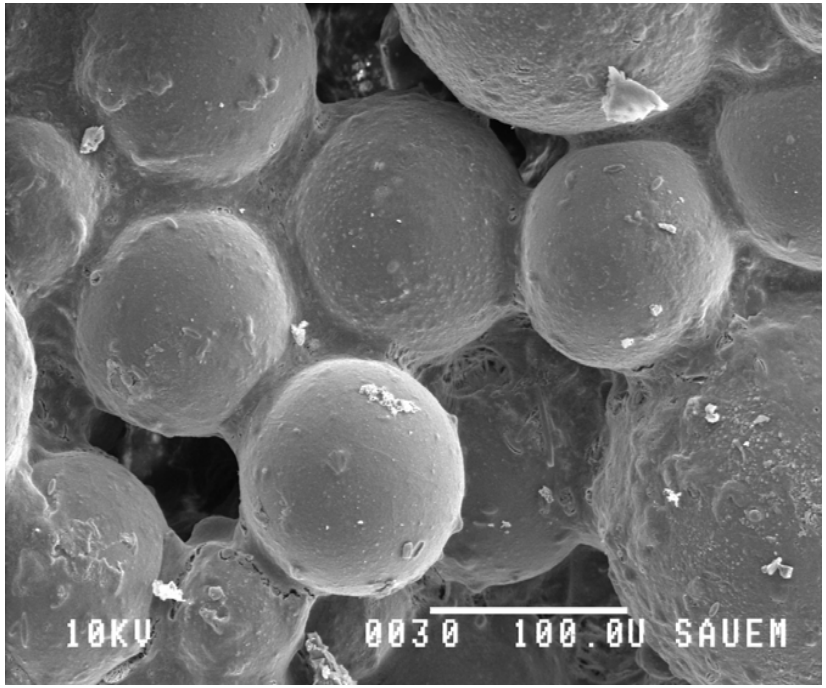
Low Temperature Scanning Electron Microscope: LTSM



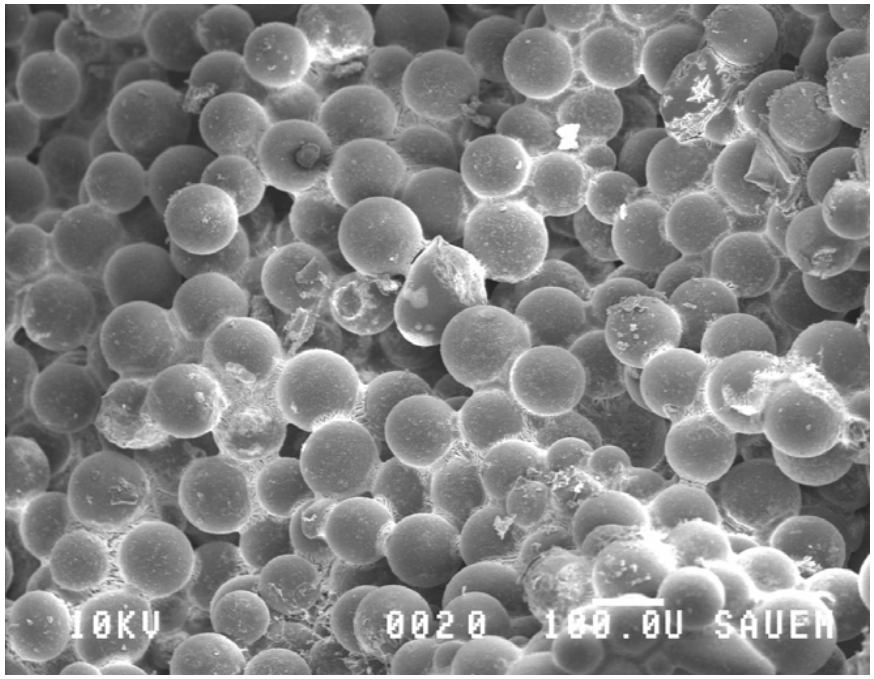
Control



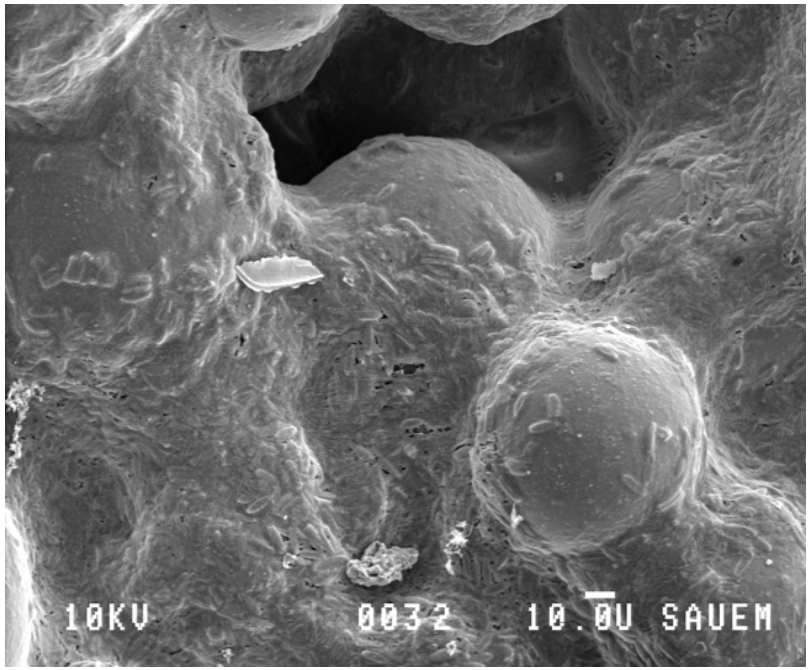
Mixed assemblage

III. Experiment on single and mixed assemblages (Lubarsky *et. al. shortly to be submitted*)

LTSM Images to be continued…



Bacterial



Mixed assemblage

III. Experiment on single and mixed assemblages (Lubarsky *et.al. shortly submitted)*

Conclusion :

- Impressive stabilization effects by the microbial assemblages
- The erosion resistance was highest in the mixed assemblage
- EPS production was highest in mixed assemblage
- Bacteria have been actively suppressed by the diatoms?
- Diatoms could have profited from the presence of bacteria?
- What is the contribution on sediment stability by single species?

Thank you for attention!