

“Microbial Biostabilization – an important ecosystem service at microscale”

Sabine U. Gerbersdorf, Moritz Thom, Holger Schmidt, Silke Wieprecht
Institute for Modelling Hydraulic & Environmental Systems
University Stuttgart

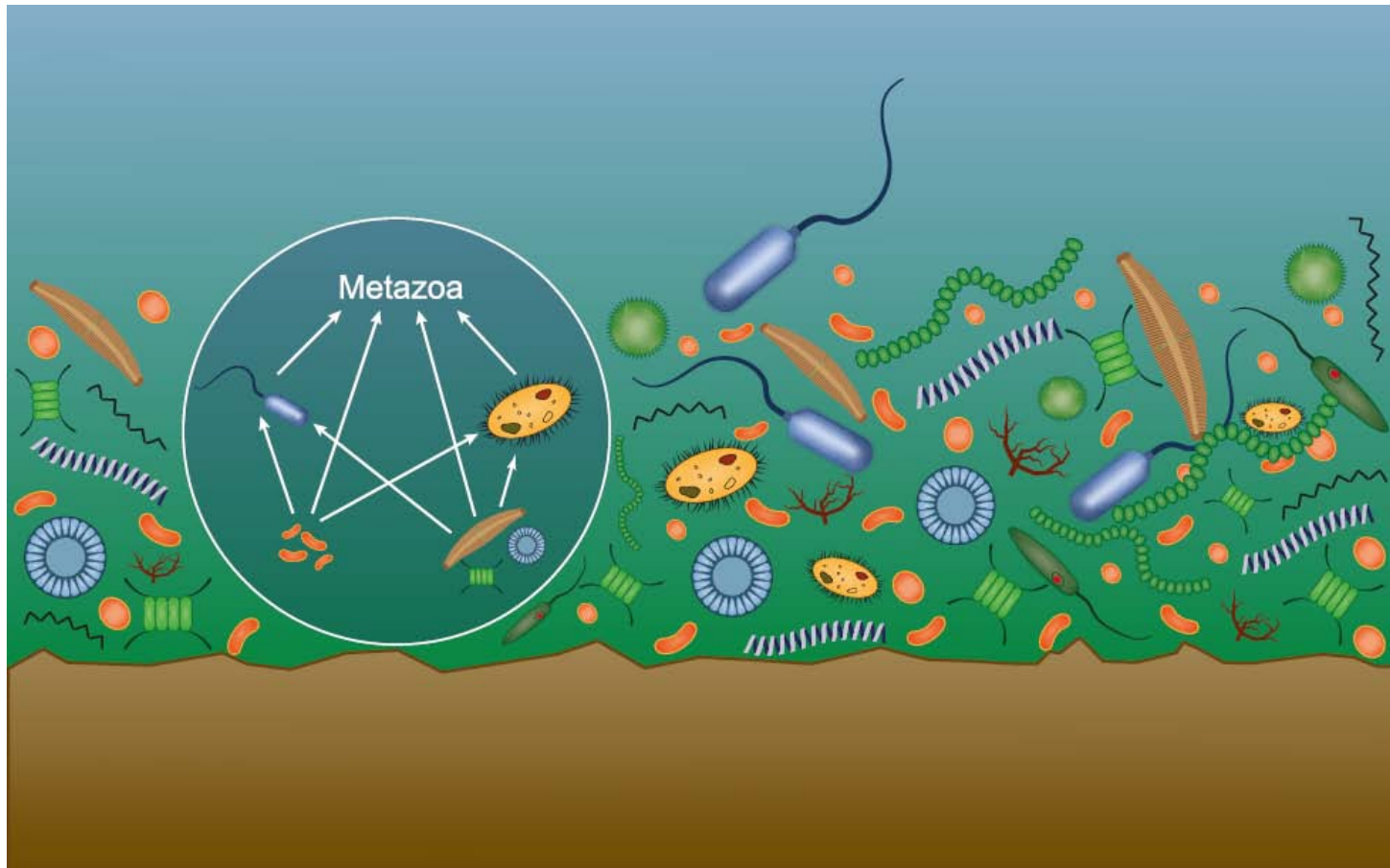
9th International SedNet Conference
Krakow, Poland
2015

“Microbial Biostabilization – an important ecosystem function at microscale”

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Life in a microbial city/biofilm...

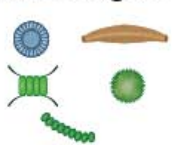


From:
Gerbersdorf &
Wieprecht 2015,
Review in
Geobiology

Protozoa



Microalgae



Bacteria



Fungi



EPS Sugars

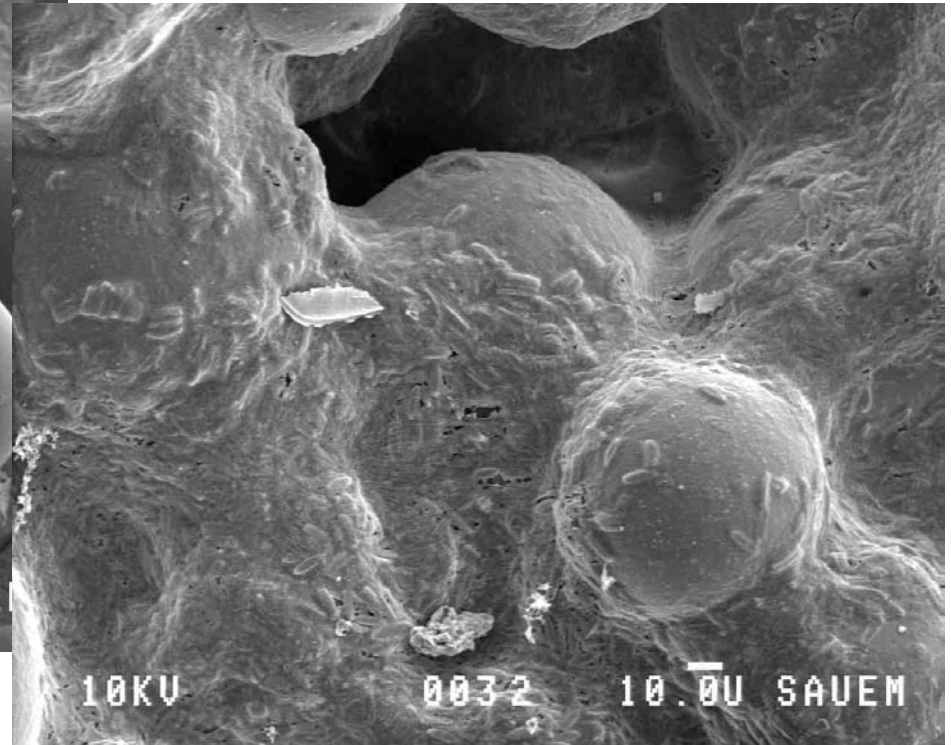
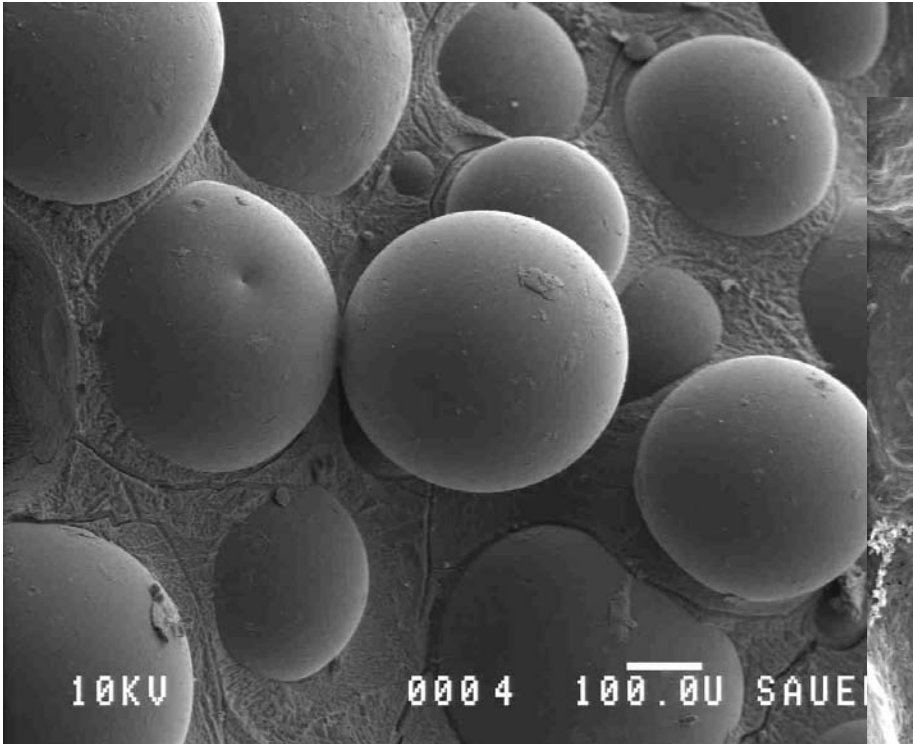


EPS Proteins



Biostabilization of sediments...how?

LTSEM image,
Biofilm on Glass Beads

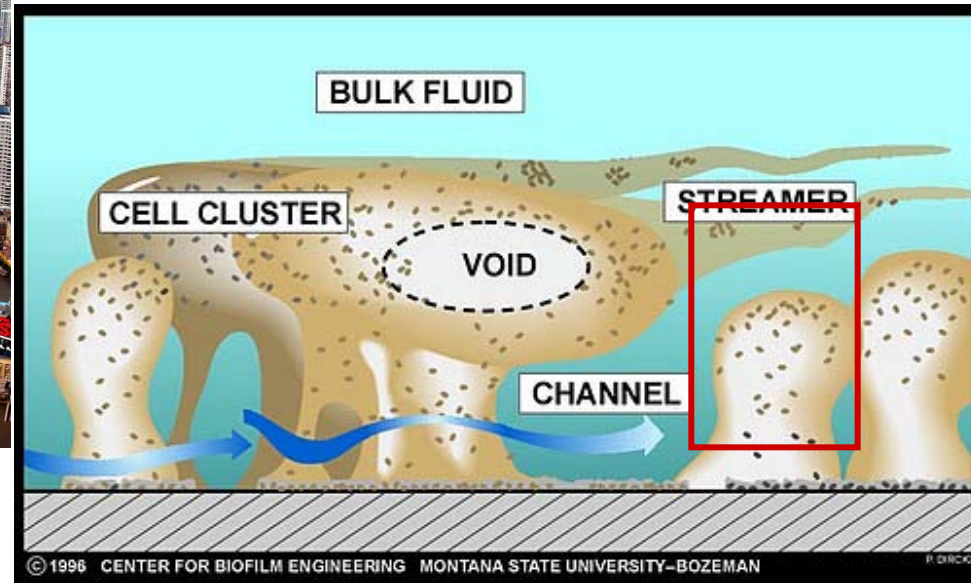


From: H. Lubarsky, C. Hubas, M. Chocholek,
F. Larson, W. Manz, D.M. Paterson, S.U. Gerbersdorf, PLoS One 2010

Biofilm are ubiquitous and have strength in numbers...

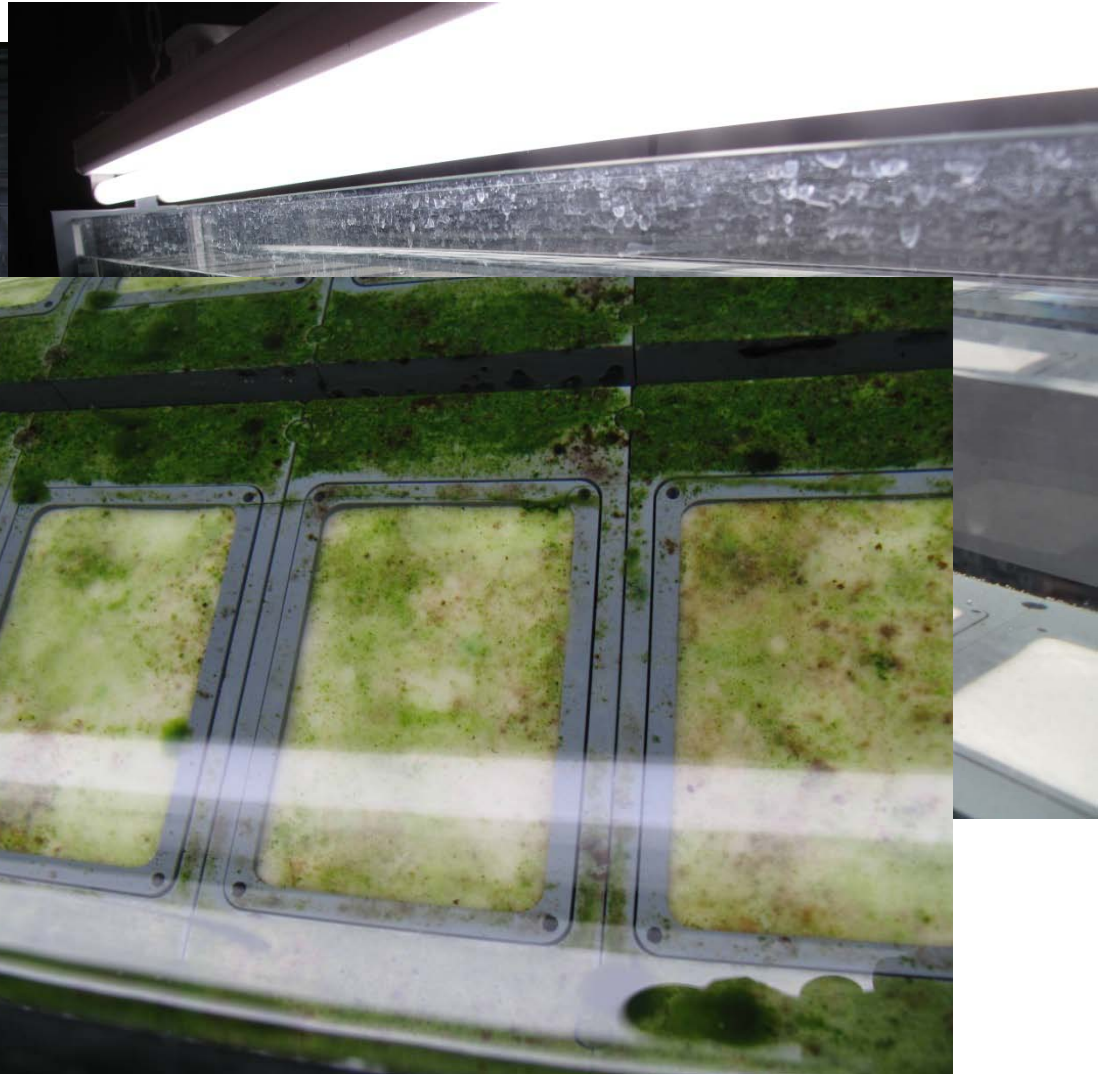


Shanghai, China: 15 – 20 Mio Inhabitants (2009) [Wikipedia]



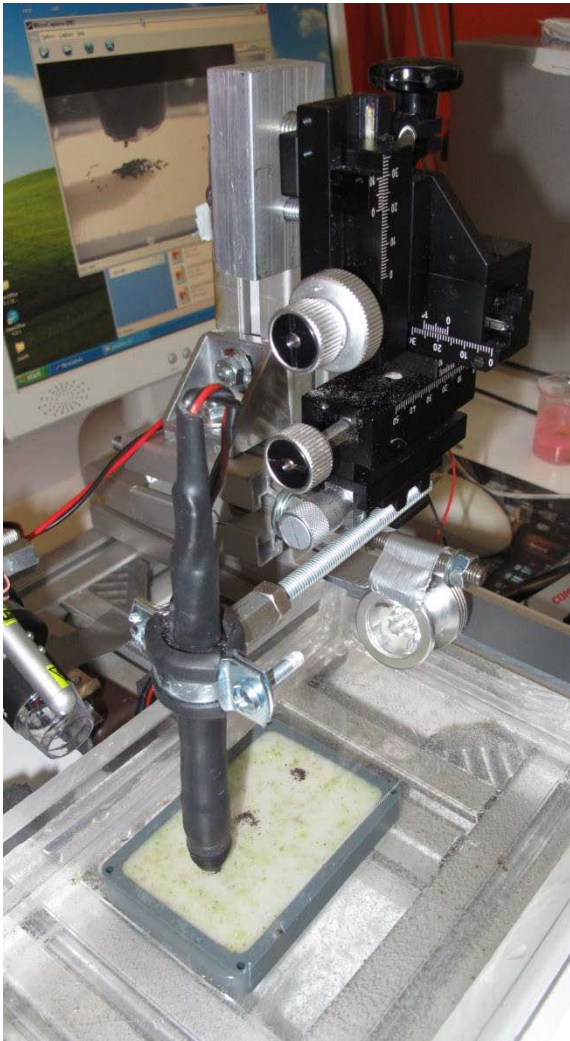
Biofilm: $10^6 - 10^{11}$ Inhabitants per „Skyscraper“ [Montana.edu]

Biofilm Growth in Flumes

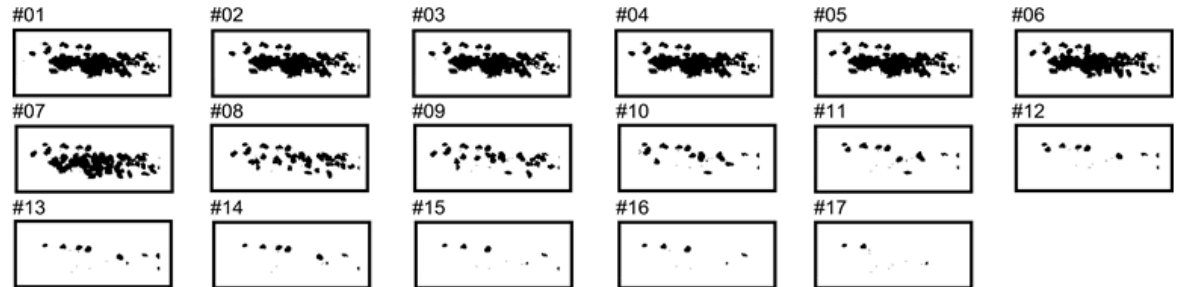


In: H. Schmidt, M. Thom, K. Matthies, S. Behrens, U. Obst, S. Wieprecht,
S.U. Gerbersdorf, Environmental Sciences Europe ESEU 2015

MagPI-IP system: Measuring Adhesion

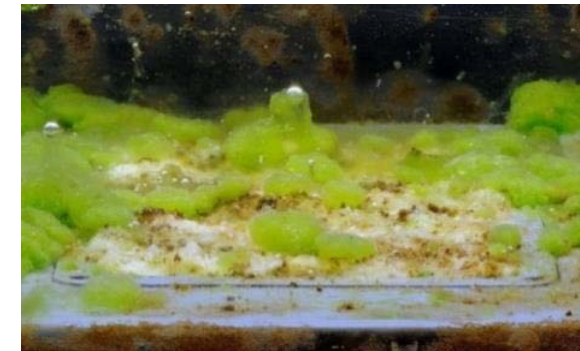
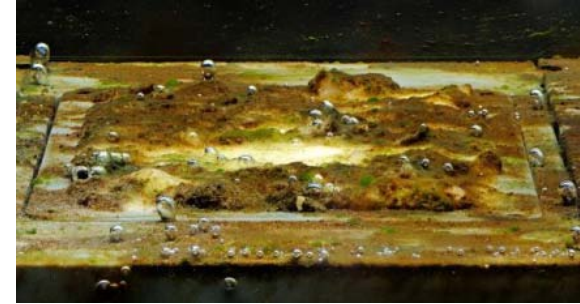
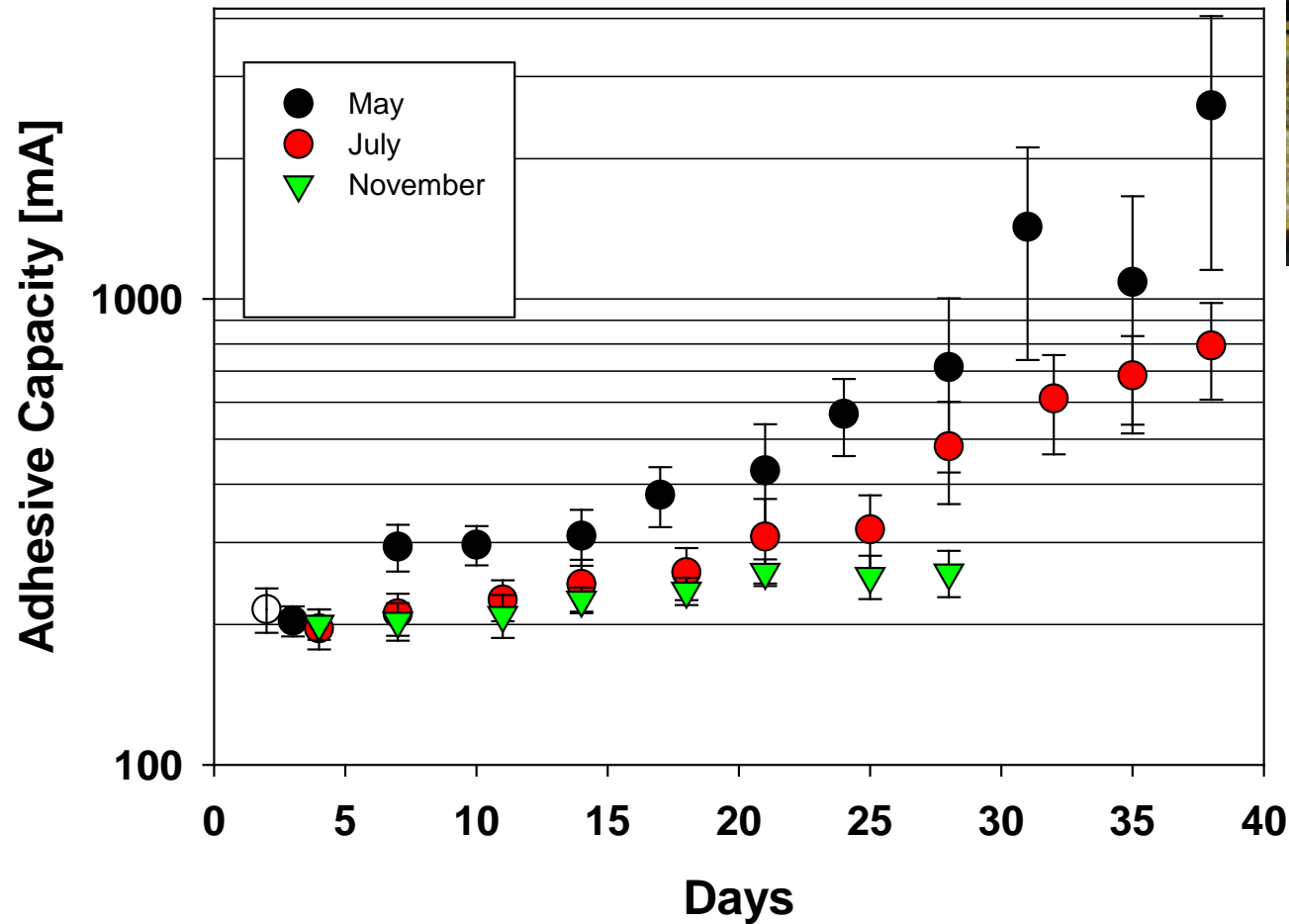


Magnetic Particle Induction –
Image processing

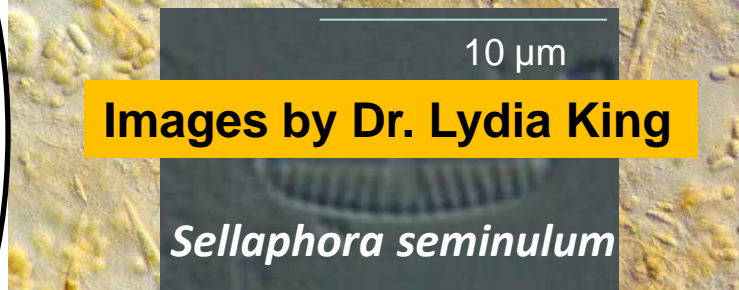
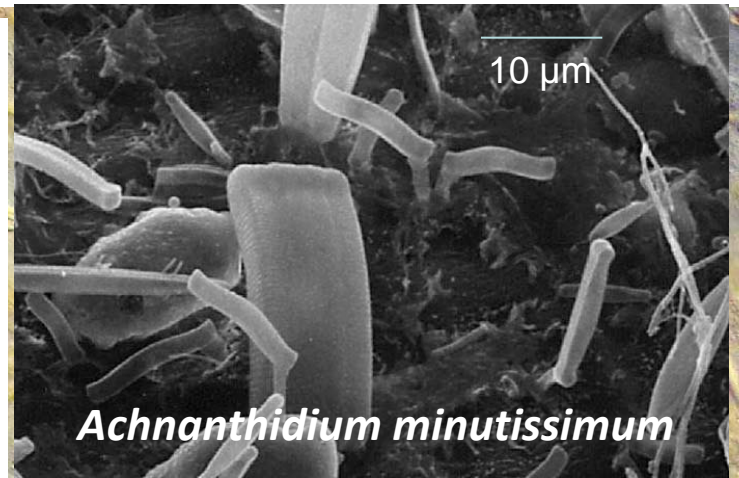
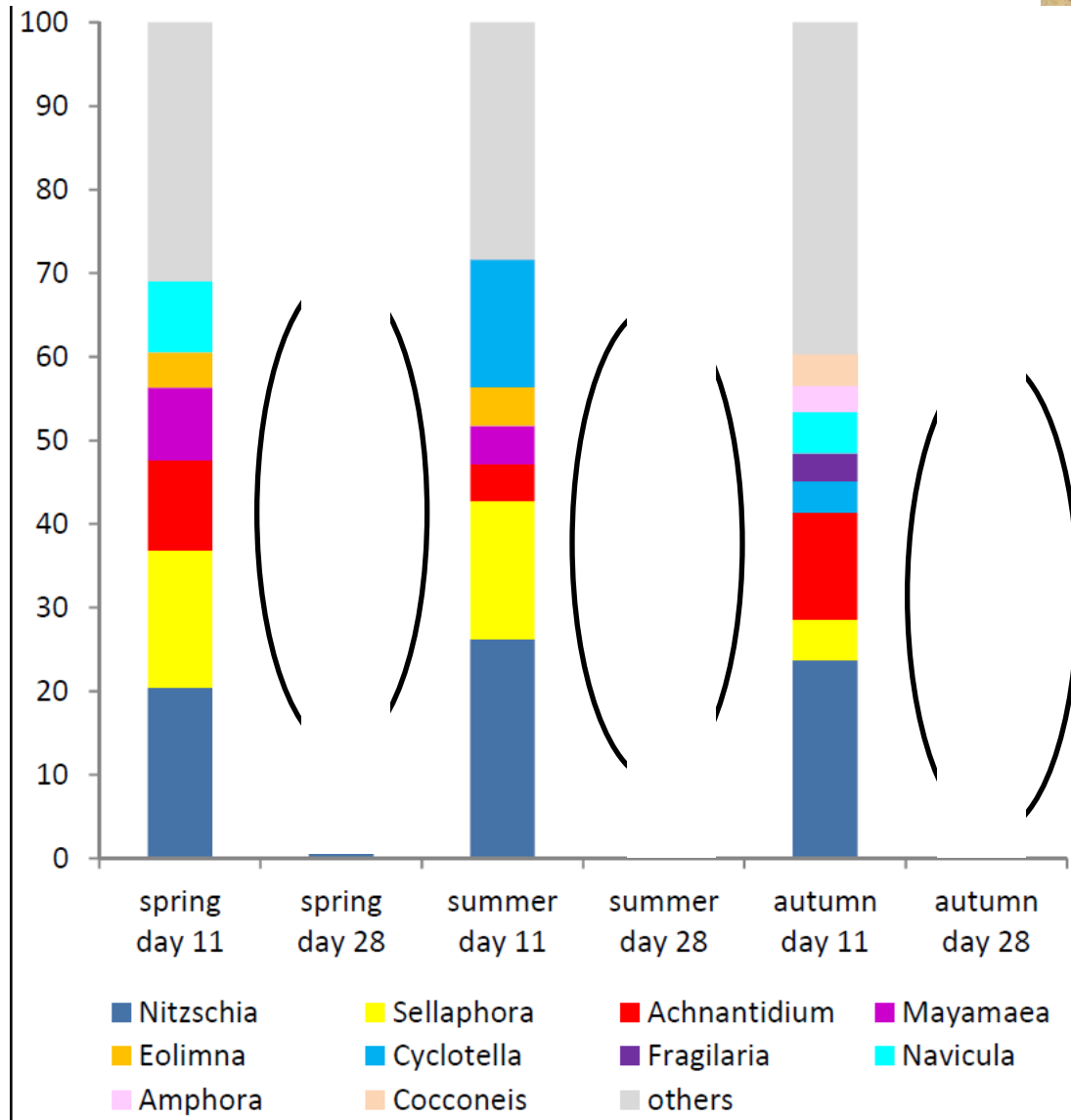


In: M. Thom, H. Schmidt, S. Wieprecht, S.U. Gerbersdorf IAHR 2015

Biostabilization in freshwaters: Adhesive Capacity

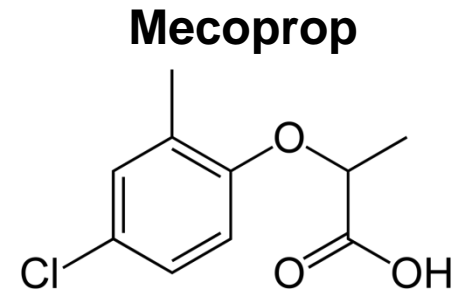
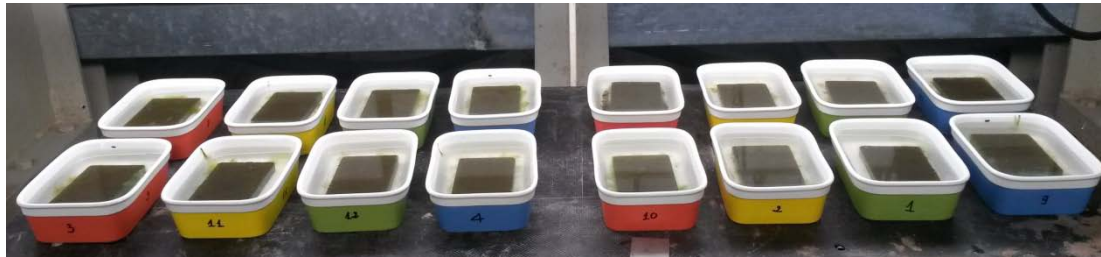


Biostabilization in freshwaters: Species Diversity



Images by Dr. Lydia King

Impairment of Biostabilization by emerging contaminants?



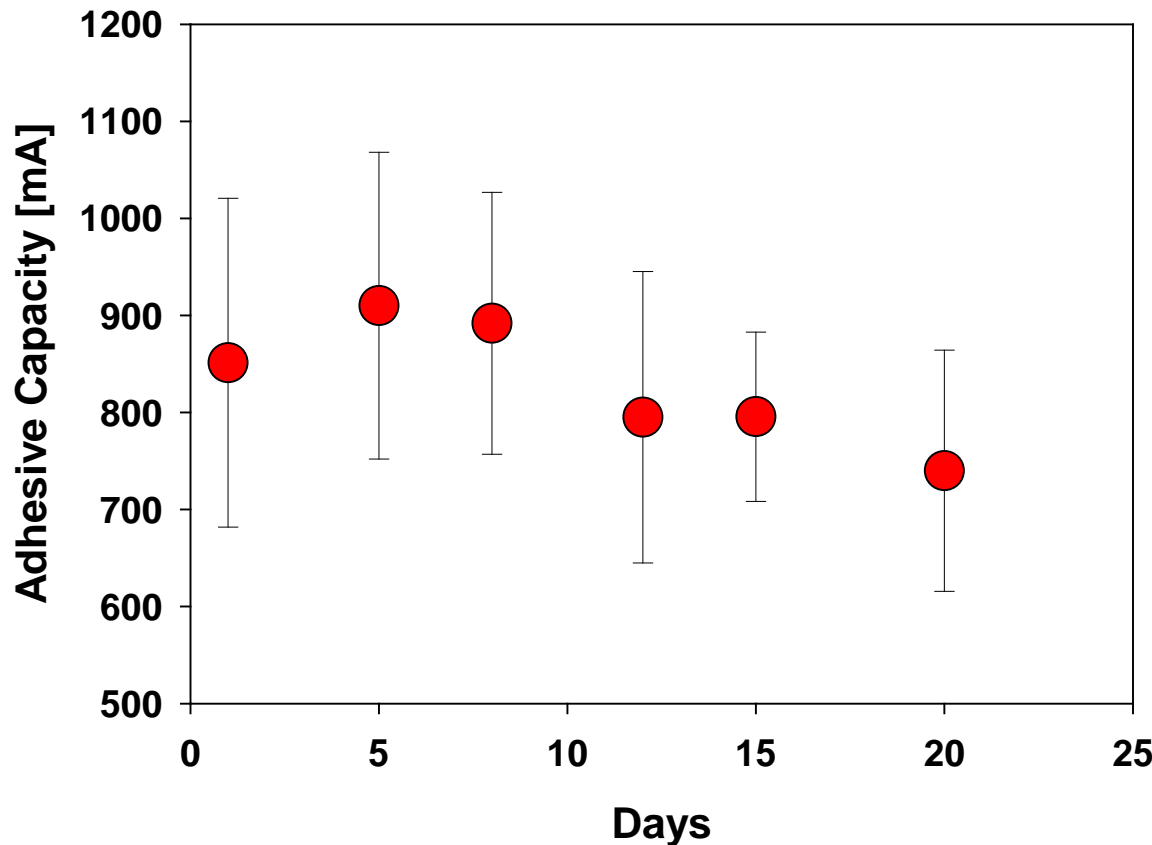
Control

2 μ g/L Mecoprop

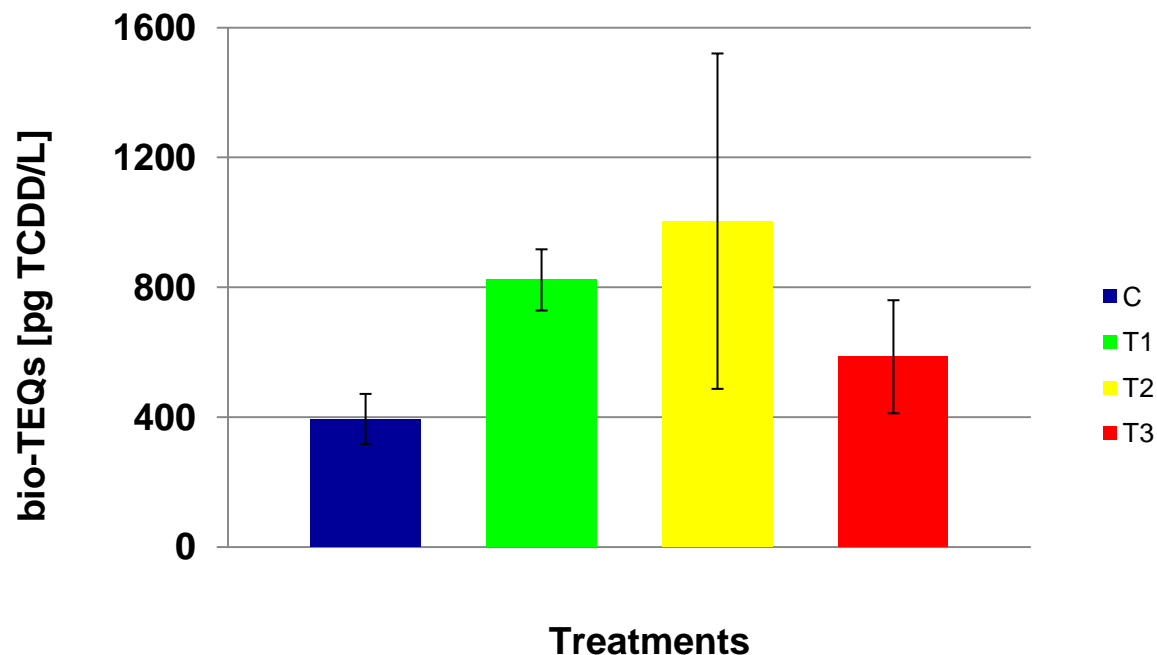
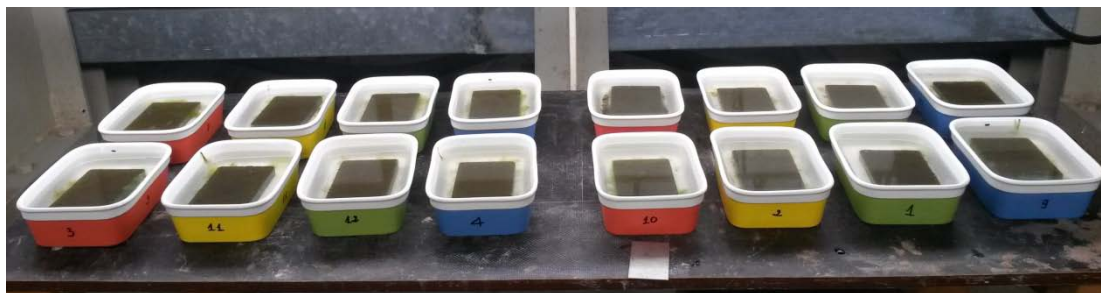
200 μ g/L Mecoprop

1 mg/L Mecoprop

Review on ATCs:
Gerbersdorf et al. 2015,
Environment International



Impairment of Biostabilization by PPCPs?



Control

2 µg/L Mecoprop

200 µg/L Mecoprop

1 mg/L Mecoprop

Summary

* Biostabilization is...

... significant in freshwater (fine) sediments

... done by microbial ecosystem engineers

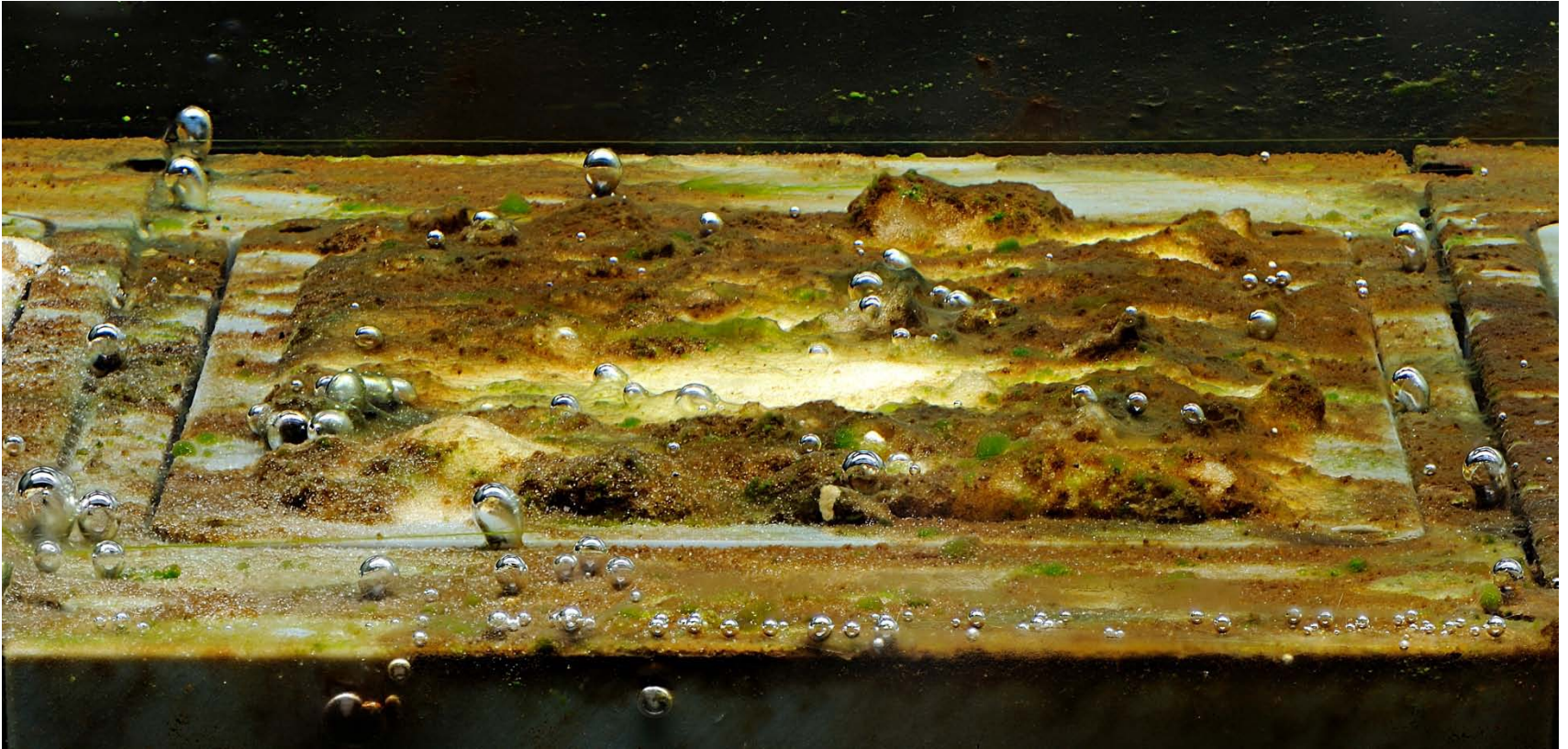
... represents an important ecosystem function by biofilm

... variable over seasons in lotic habitats

... highly vulnerable against emerging pollutants or ATCs

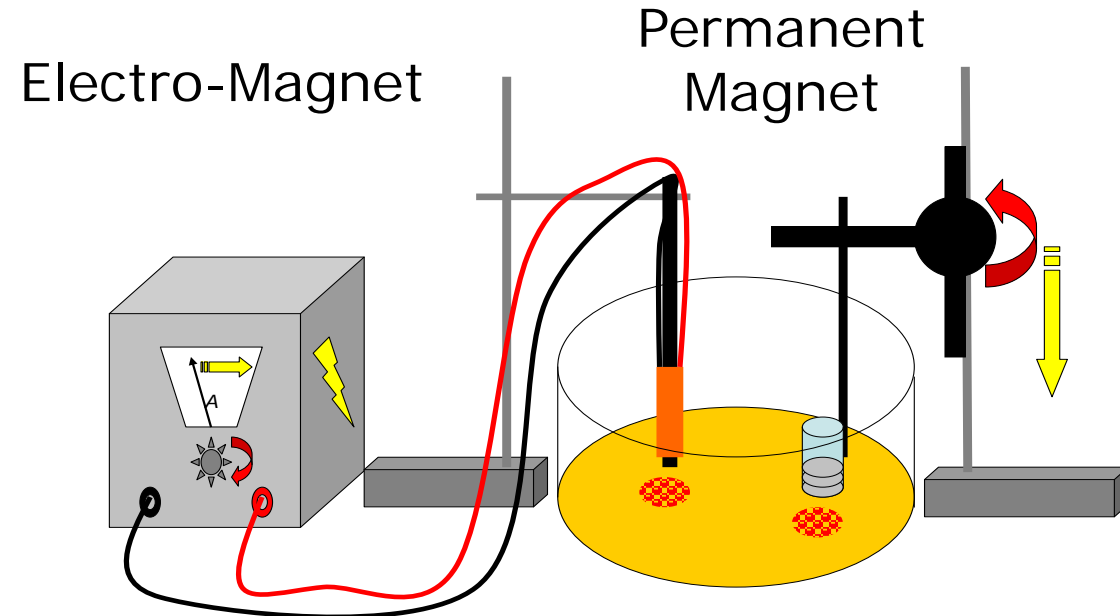


Thank you and ...Questions?



Determination of Adhesive Capacity

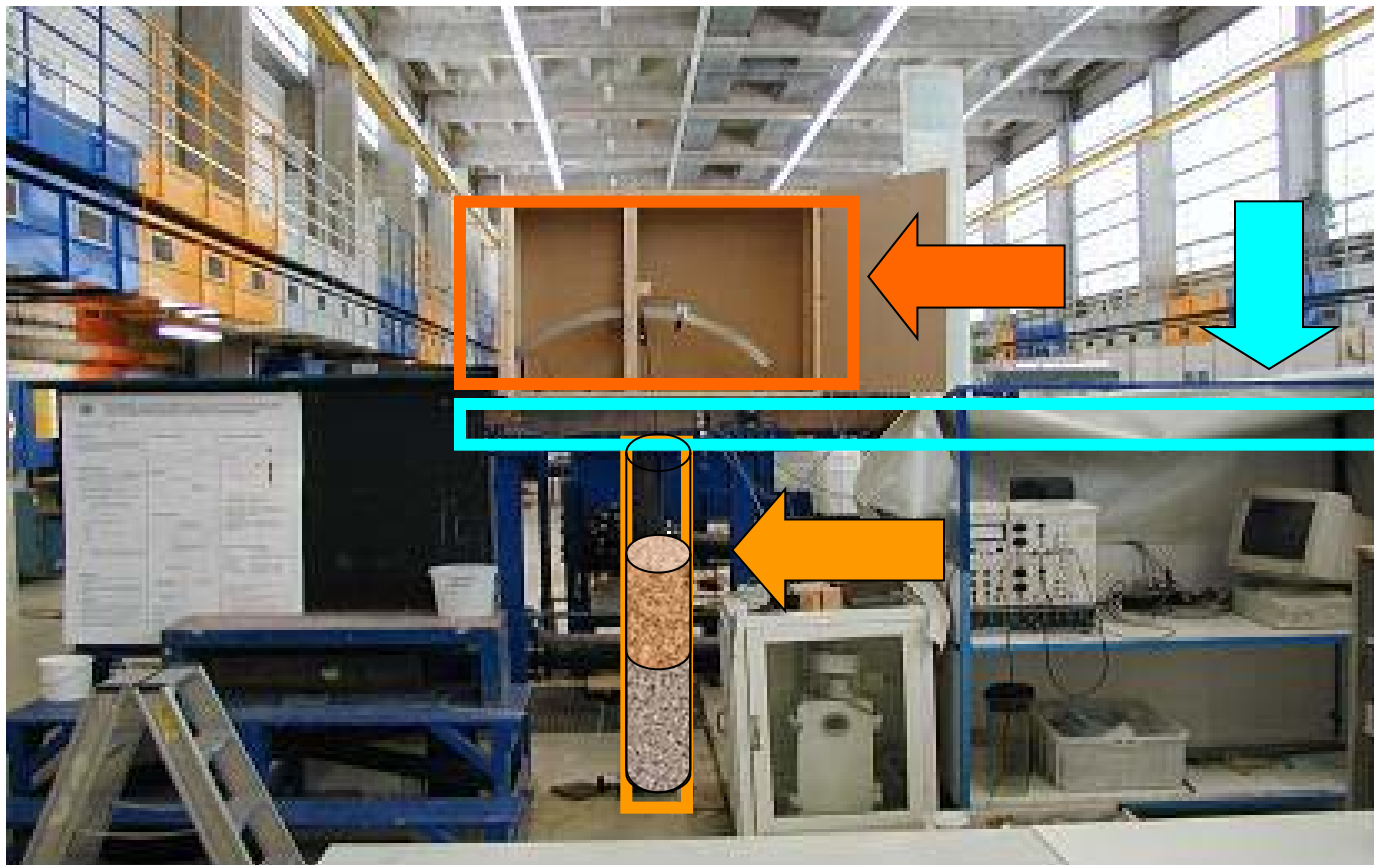
Magnetic Particle Induction - MagPI



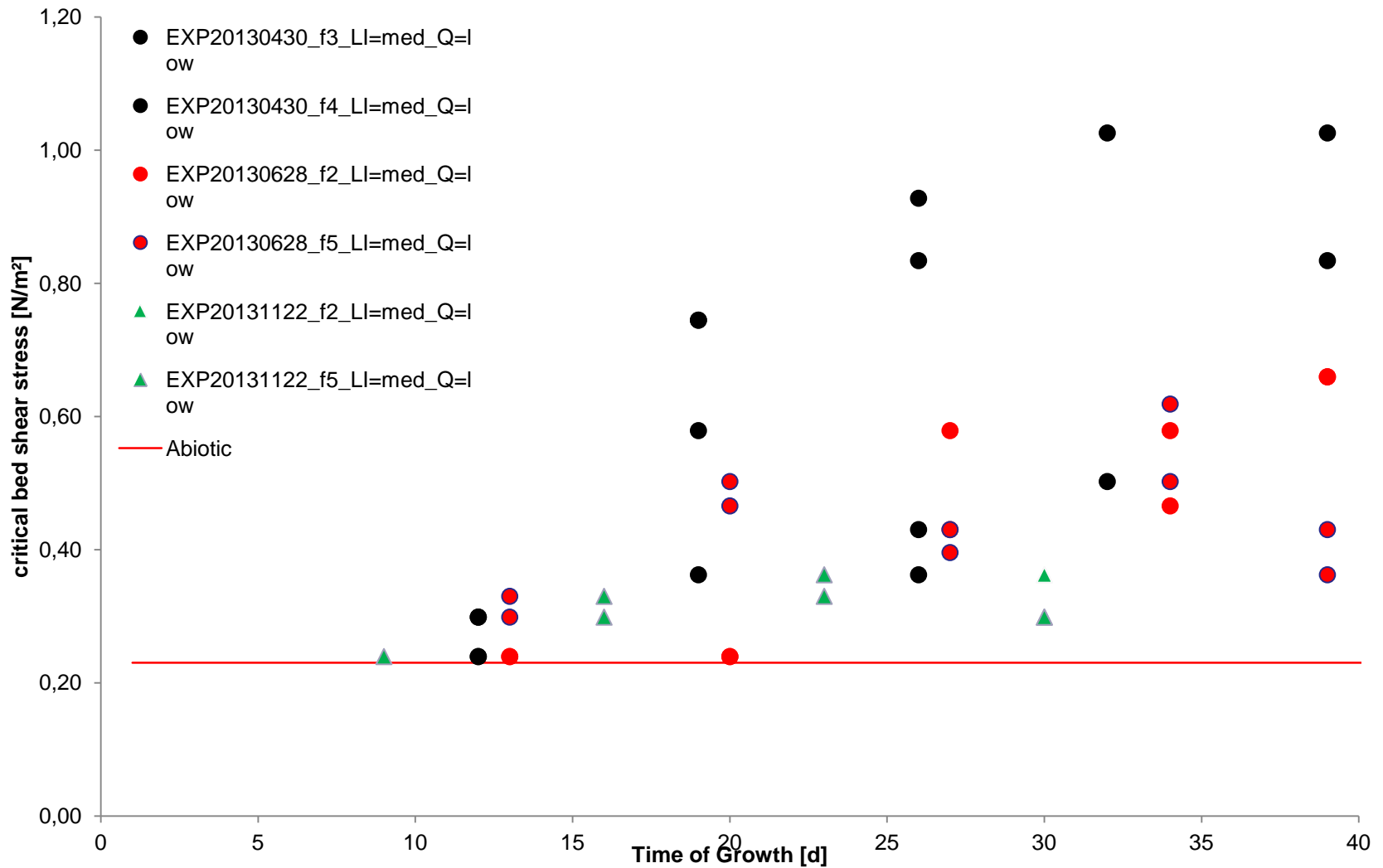
L&O Methods (2009): Larson, F., H. Lubarsky,
S.U. Gerbersdorf, D.M. Paterson

Determination of Critical Shear Stress

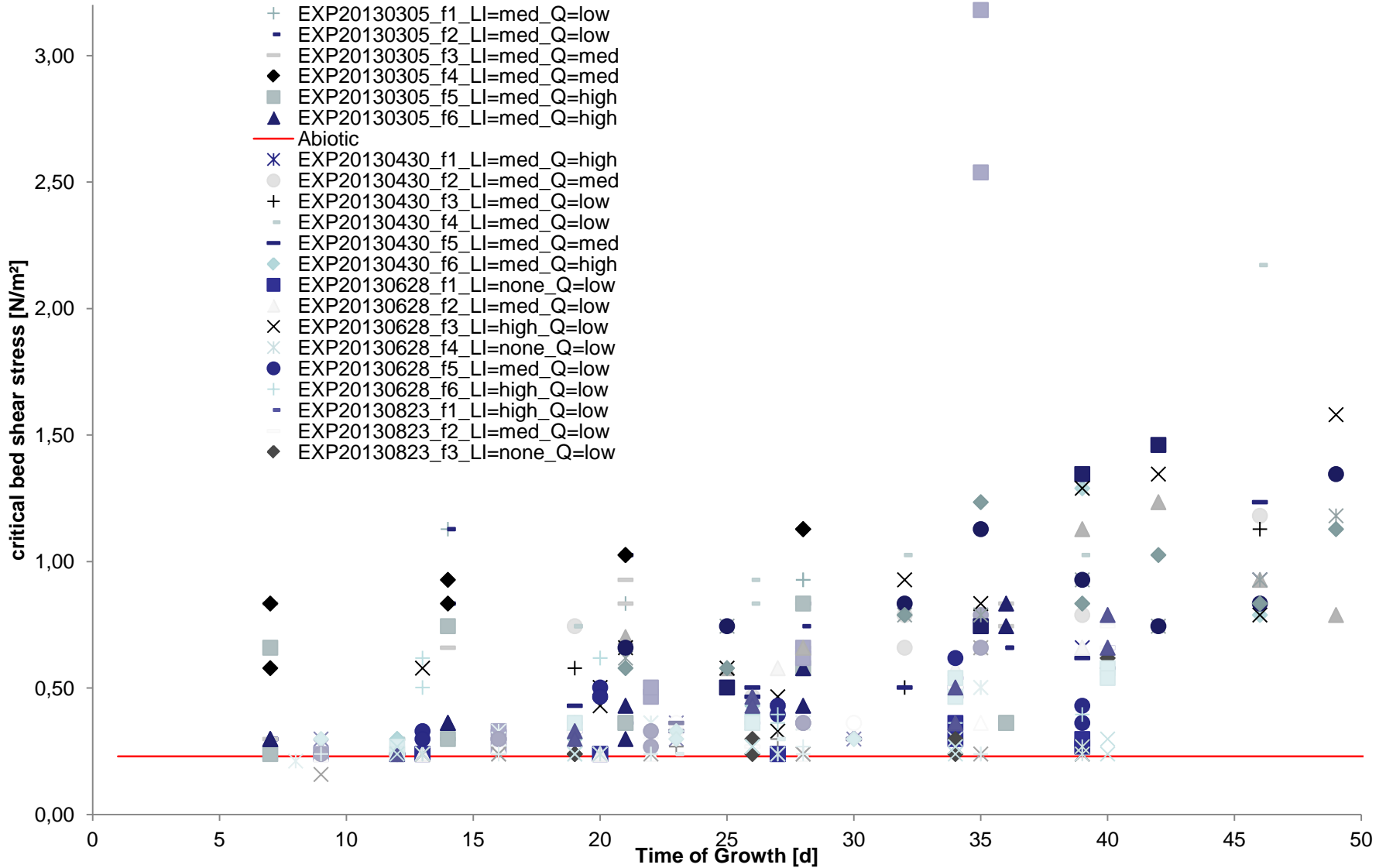
SETEG - Strömungskanal zur Ermittlung der tiefenabhängigen Erosionsstabilität von Gewässersedimenten



SETEG Data



SETEG Data

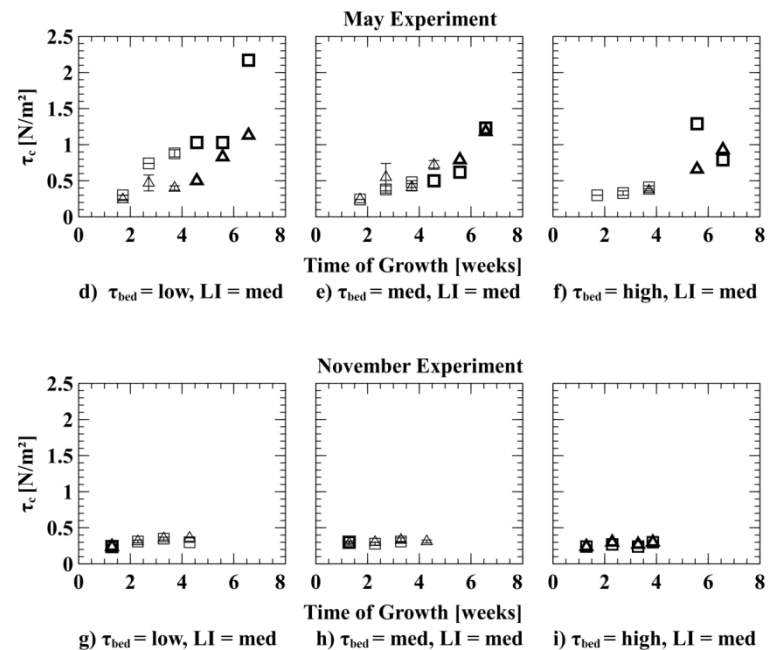


SETEG- Stability of biofilm-sediment-matrix

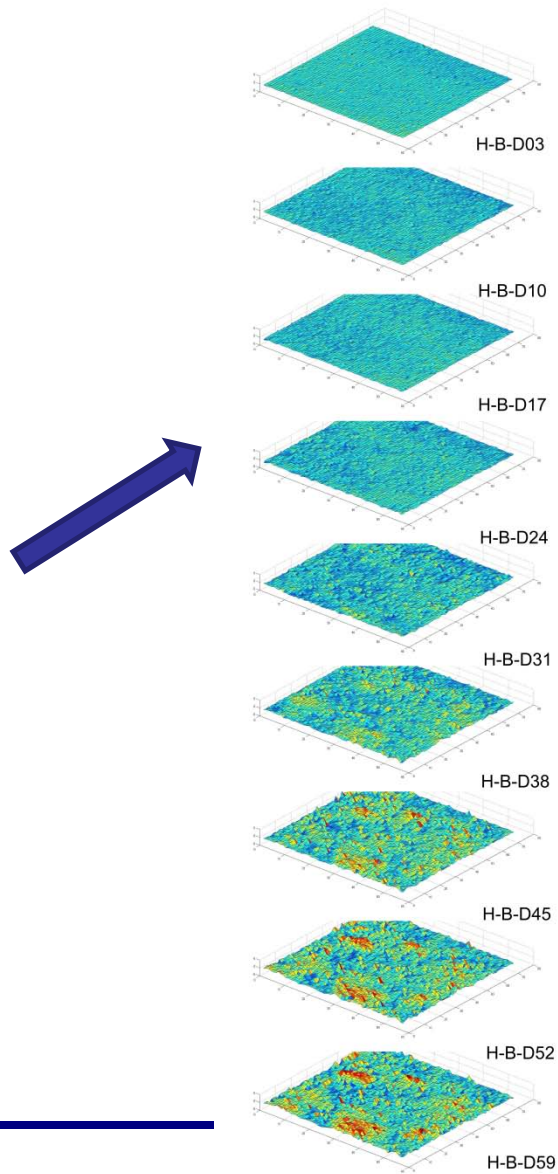


- SETEG
 - Costly procedure
 - destructive
 - Determination of critical bed shear stress

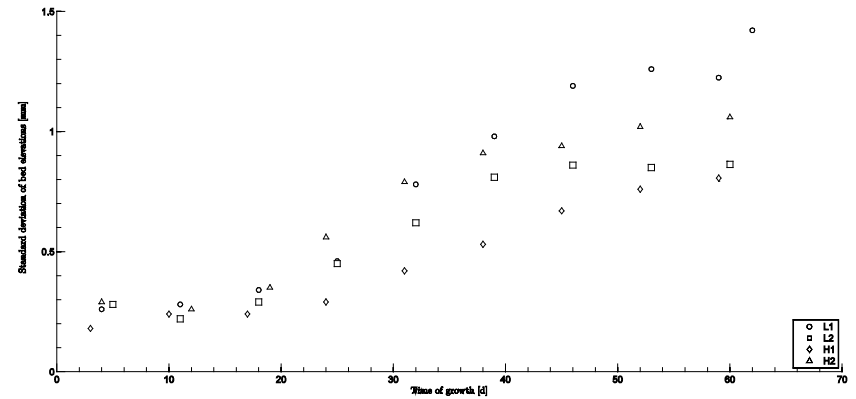
- Different erosion mechanisms
- Strong seasonal impacts
- „Slower“ biostabilization with Q_{high}
- Little influence on total stability by bacterial biofilms



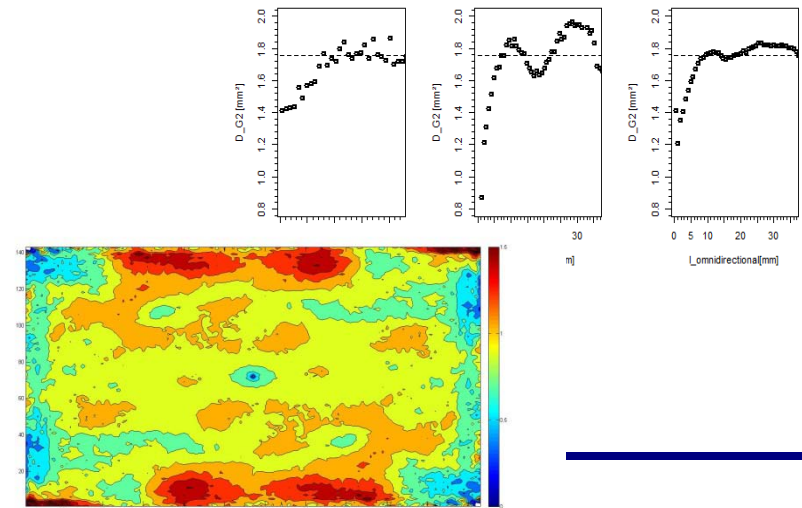
Biofilm topography II – Some Results



Roughness development vs. time

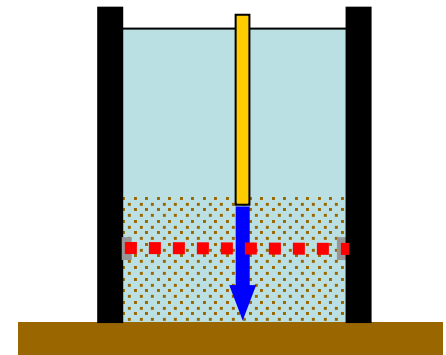
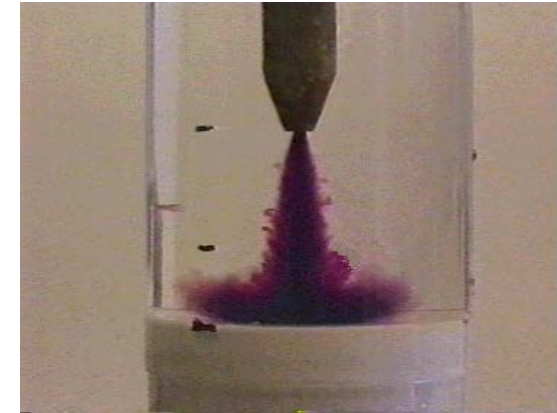


2nd order structure function >50 days



Determination of Stagnation Pressure

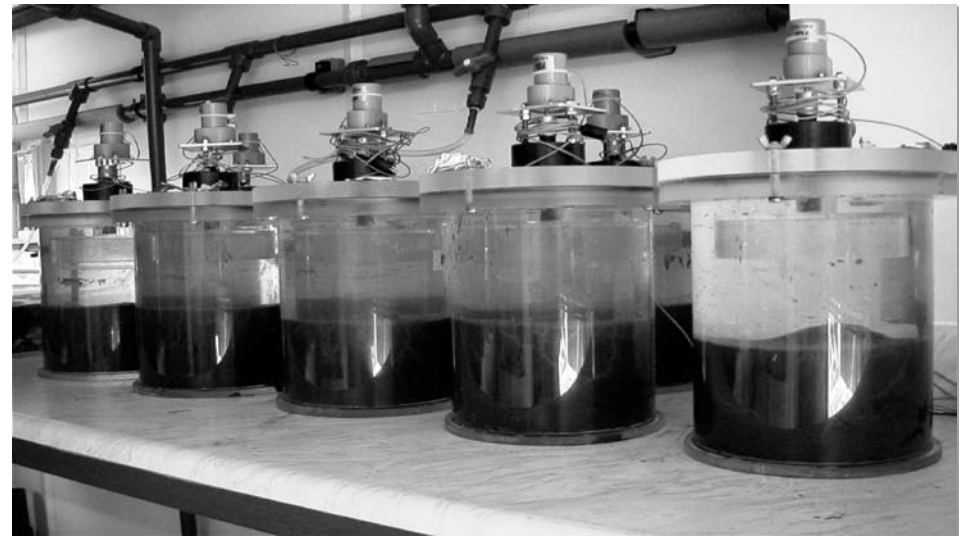
Cohesive Strength Meter - CSM



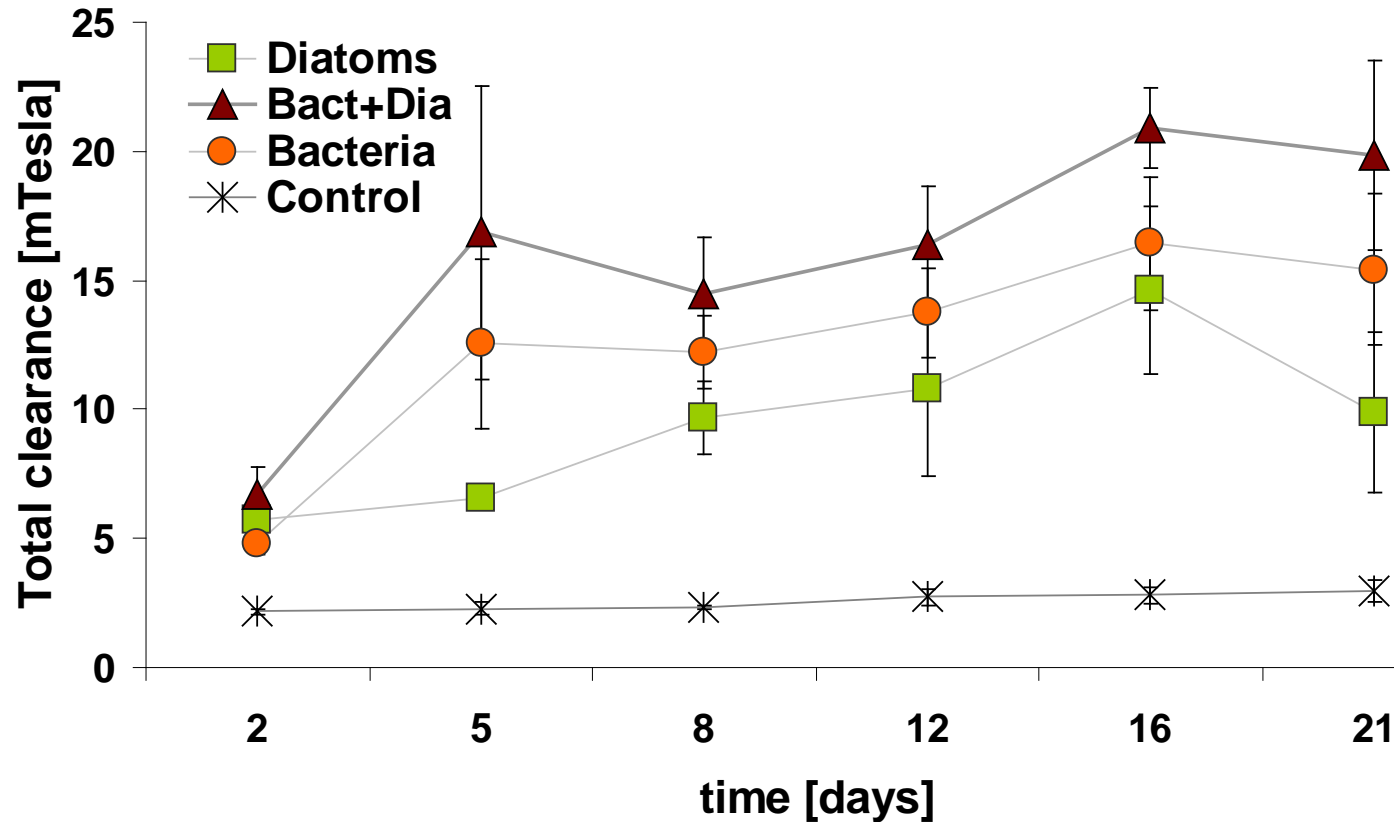
Determination of Critical Shear Stress



Gust Microcosms

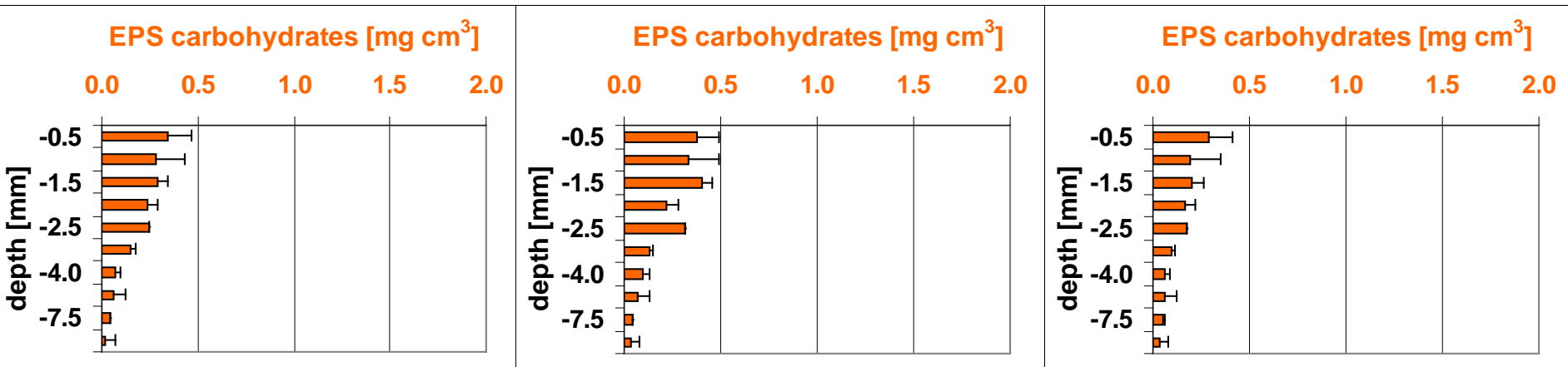
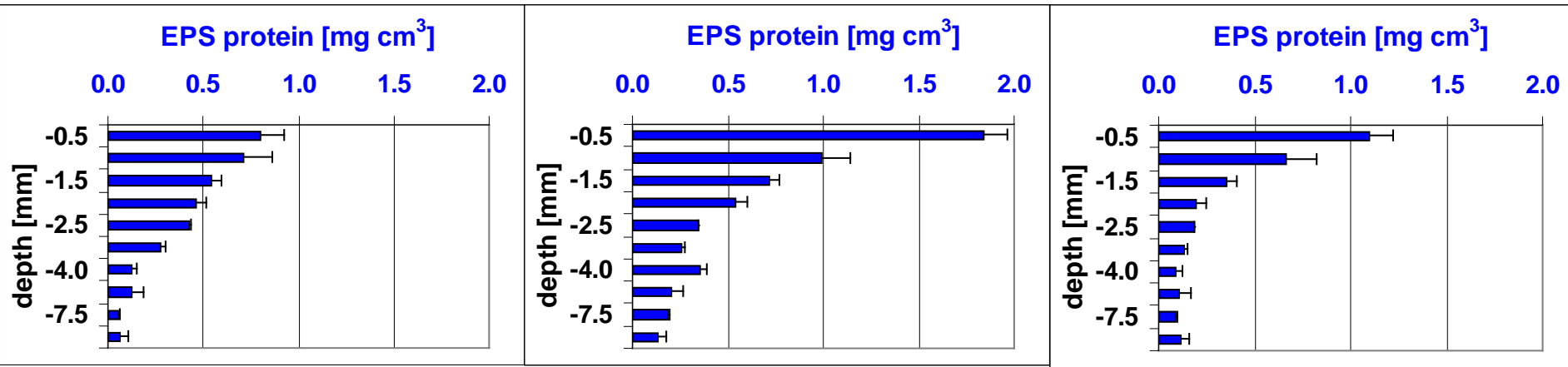


Small but powerful in sediments.....



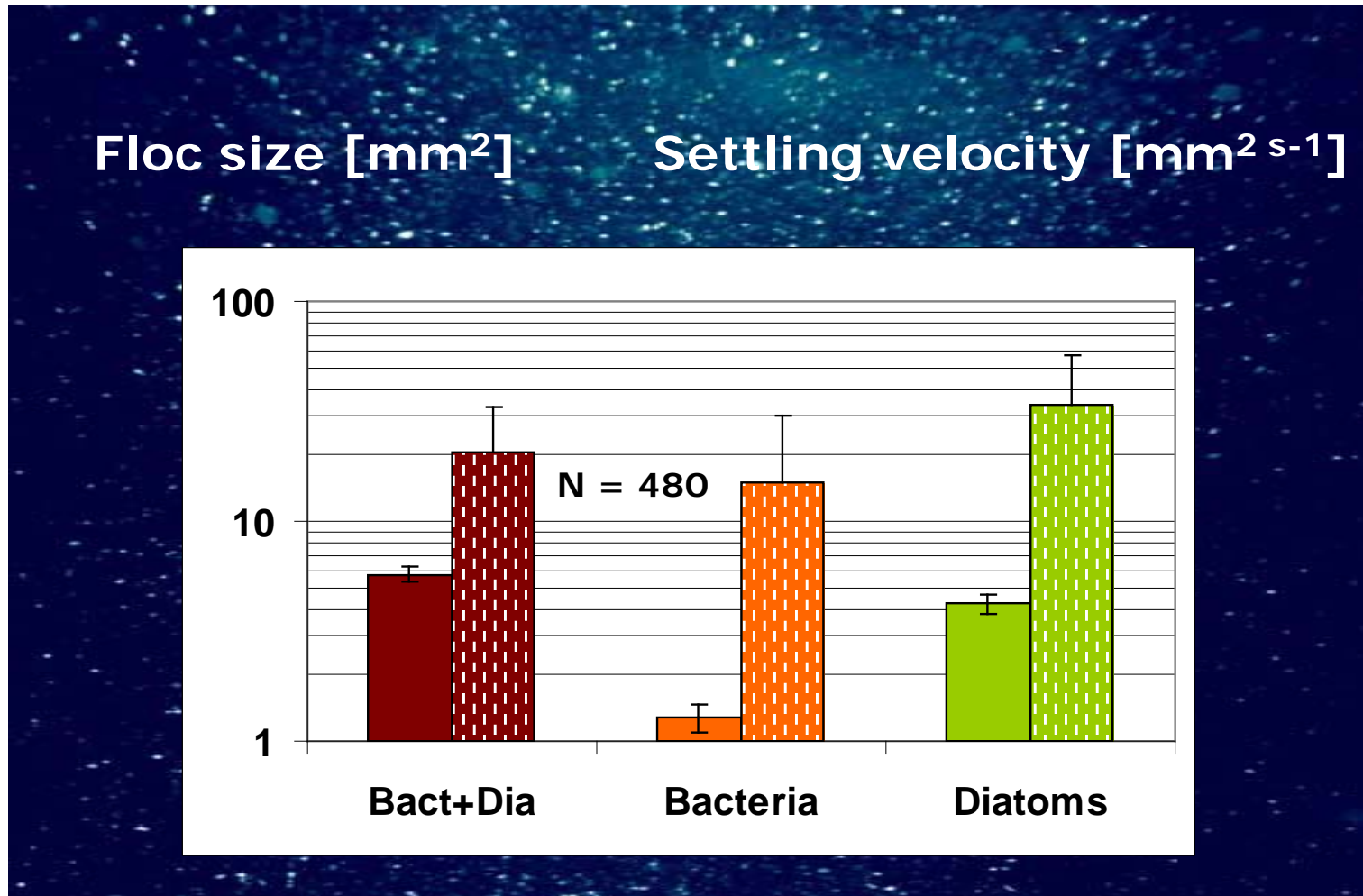
PLoS ONE (2010): H. Lubarsky, C. Hubas, M. Chocholek, F. Larson, W. Manz, D.M. Paterson, S.U. Gerbersdorf

Proteins have a structural Role...



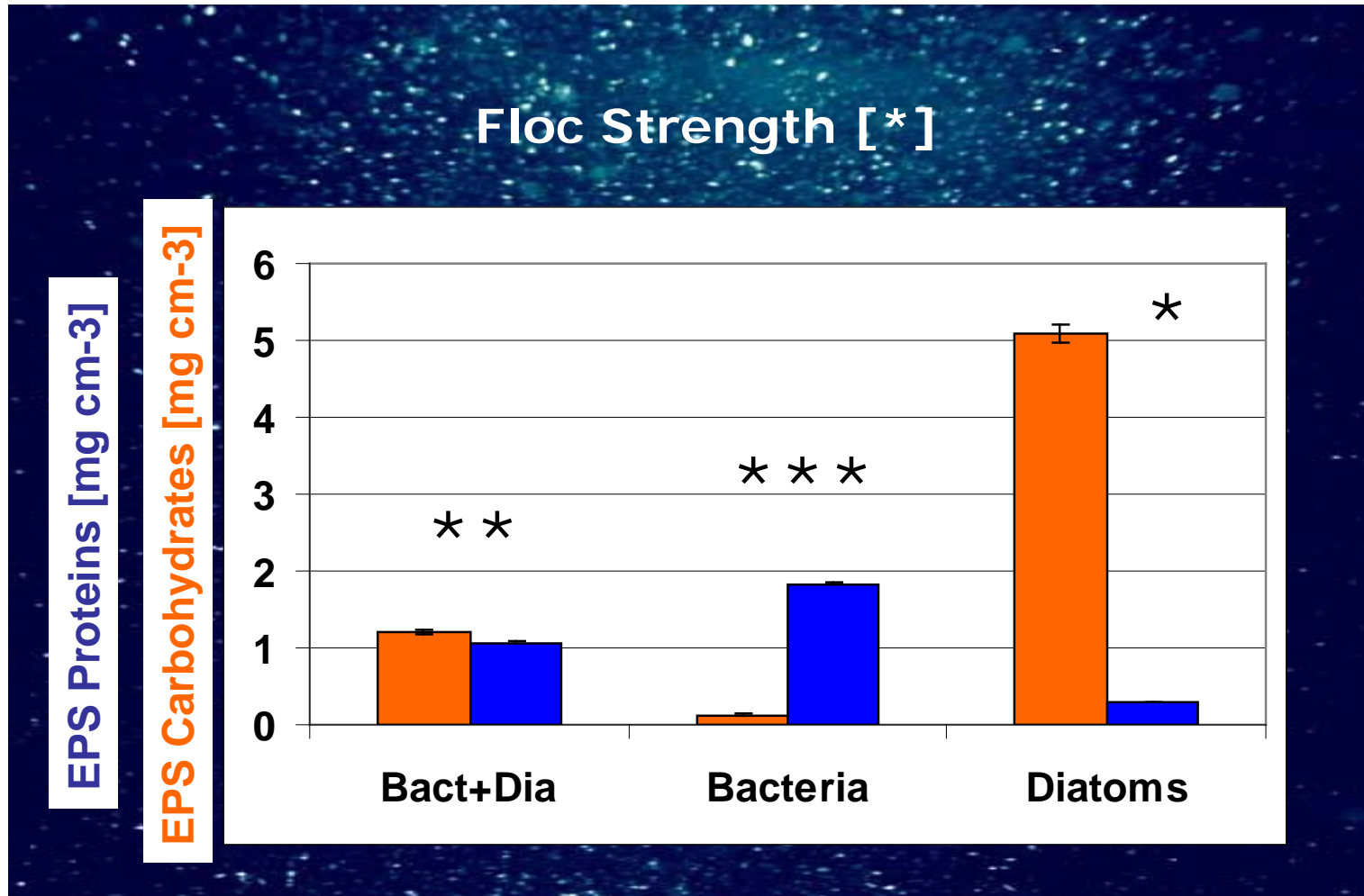
FEMS (2008): S.U. Gerbersdorf, W. Manz, D.M. Paterson

Small but powerful in Flocculation.....



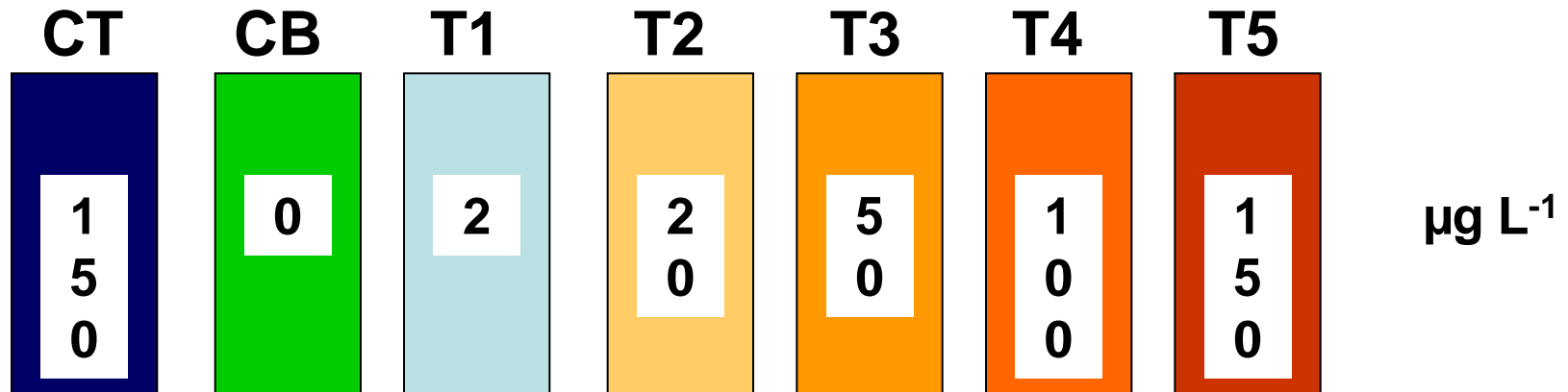
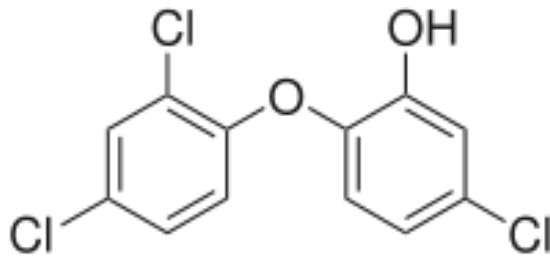
In prep.: S.U. Gerbersdorf, N. Burns, J. Watson, D.M. Paterson

Proteins impact Floc Strength...



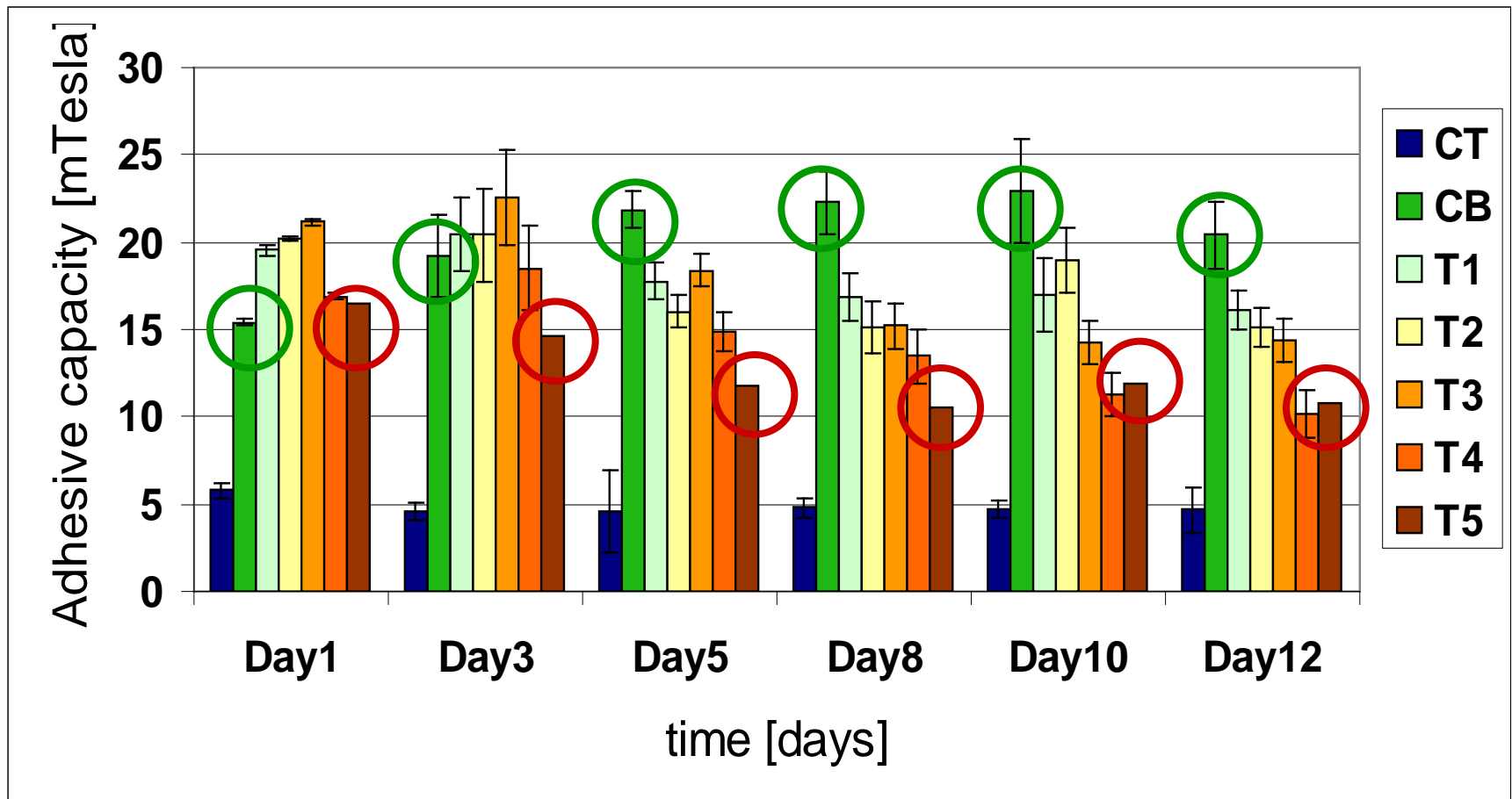
In prep.: S.U. Gerbersdorf, N. Burns, J. Watson, D.M. Paterson

Biofilm impaired by PPCPs (Triclosan)?



PLoS ONE (2012): H. Lubarsky, S.U. Gerbersdorf (first authors), C. Hubas, S. Behrens, F. Ricciardi, D.M. Paterson

Biofilm impaired by Triclosan!

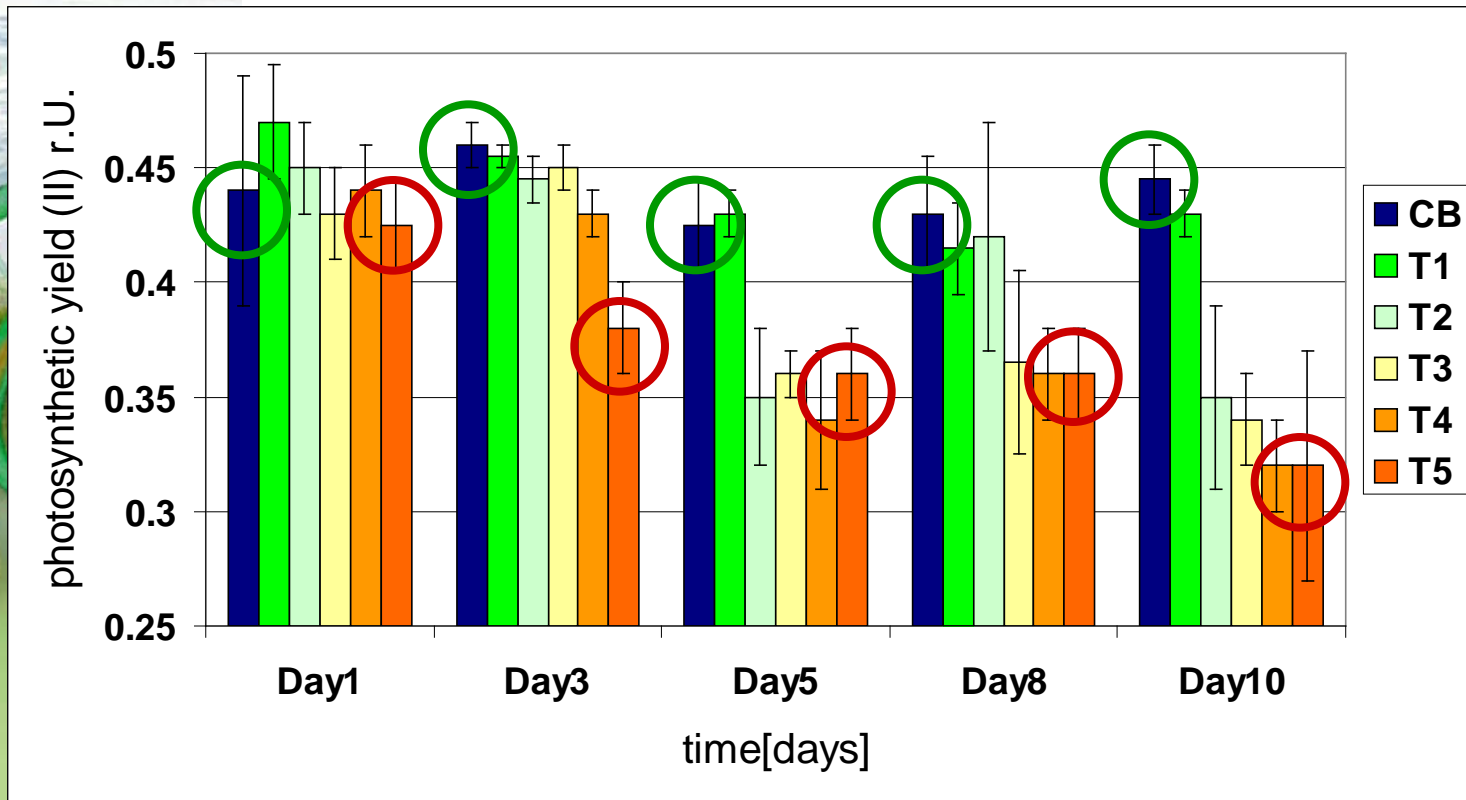
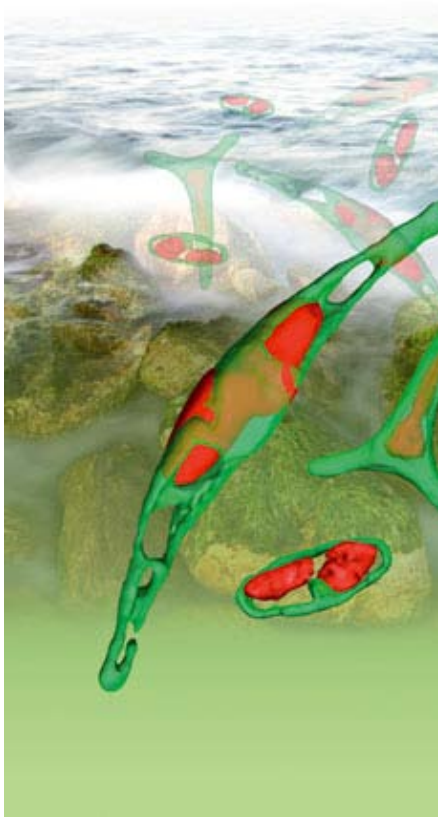


PLoS ONE (2012): H. Lubarsky, S.U. Gerbersdorf (first authors),
C. Hubas, S. Behrens, F. Ricciardi, D.M. Paterson

Cause & Effect of TCS: Microbial Producers

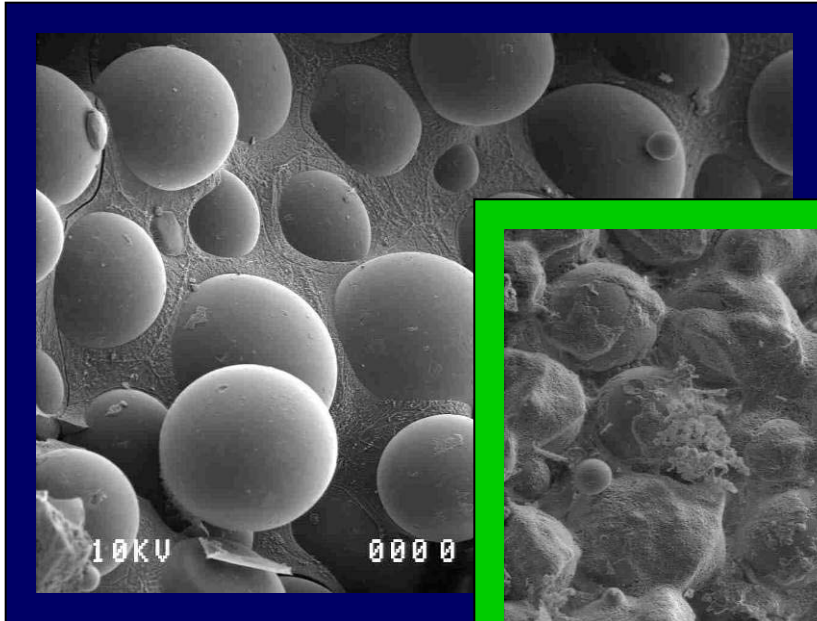
Biomass

Photosynthetic Activity

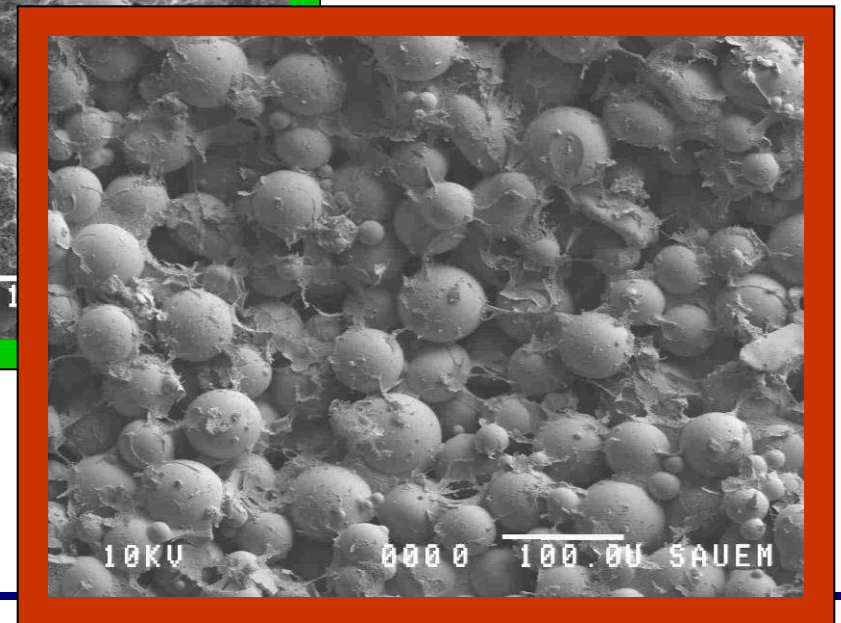
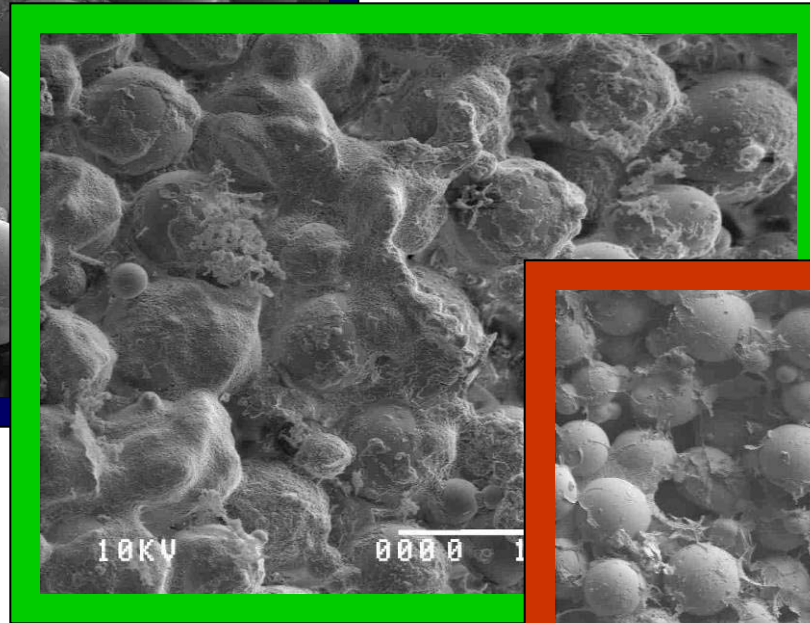


In prep.: H. Lubarsky, Franz, S., Schmitt-Jensen, M.,
 Streck, G., S. Behrens, S.U. Gerbersdorf

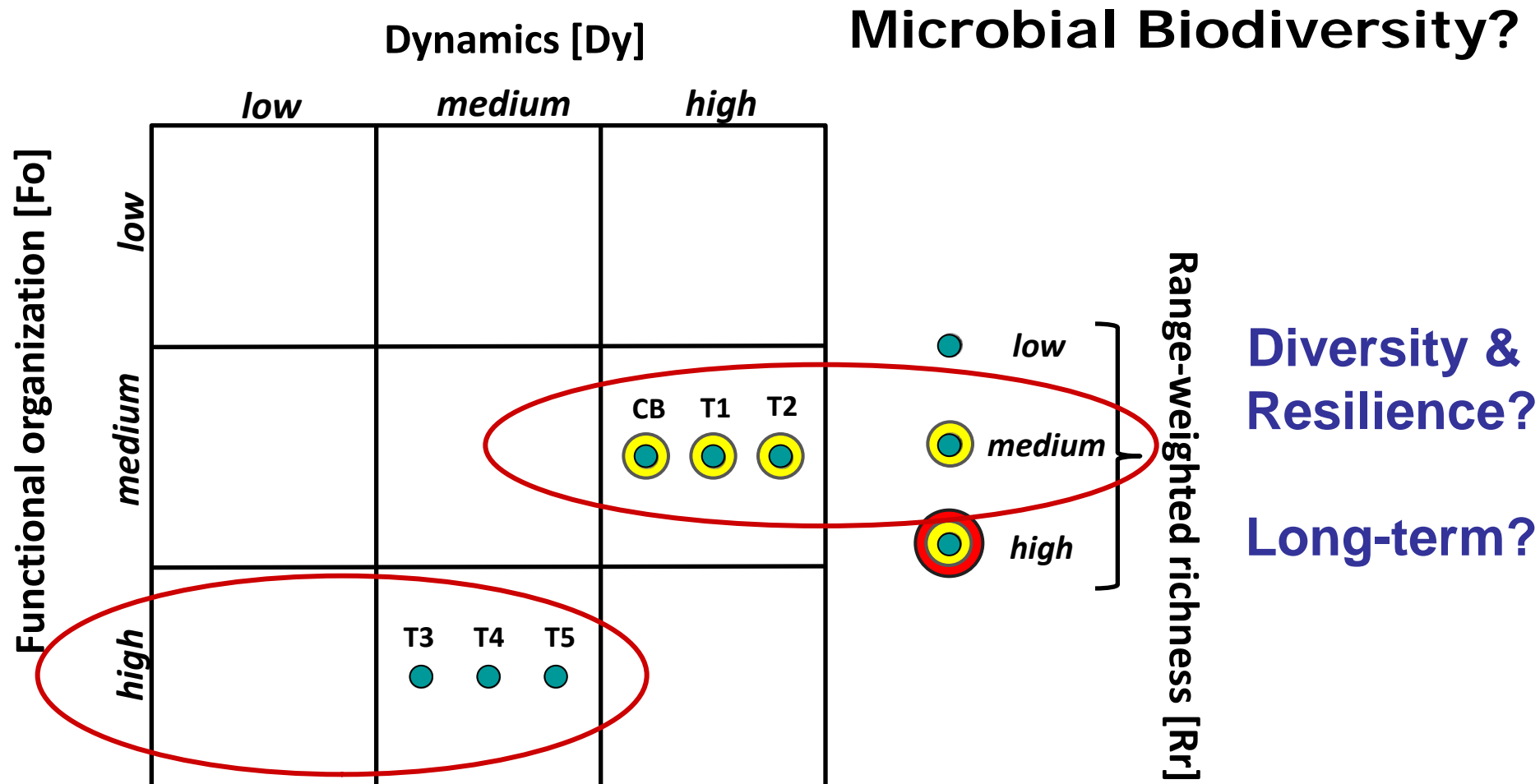
Visualization of TCS effects on biofilm....



LTSEM Images,
Substrate: Glass beads



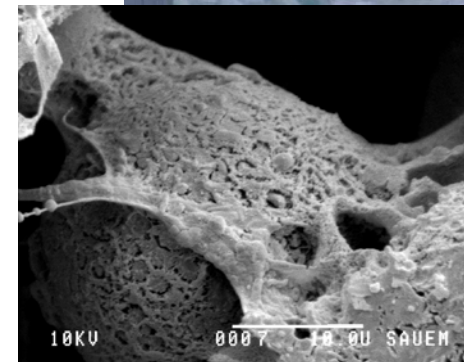
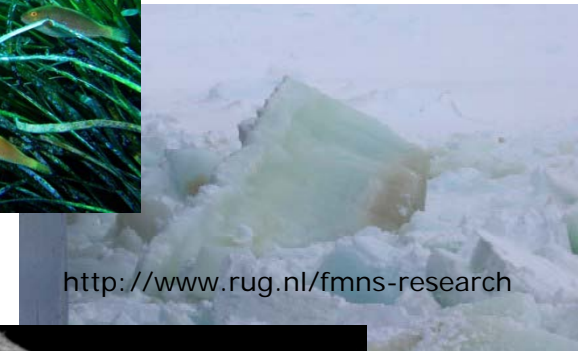
Lubarsky et al. 2012
PLoS ONE



PLoS ONE (2012): H. Lubarsky, S.U. Gerbersdorf (first authors), C. Hubas, S. Behrens, F. Ricciardi, D.M. Paterson

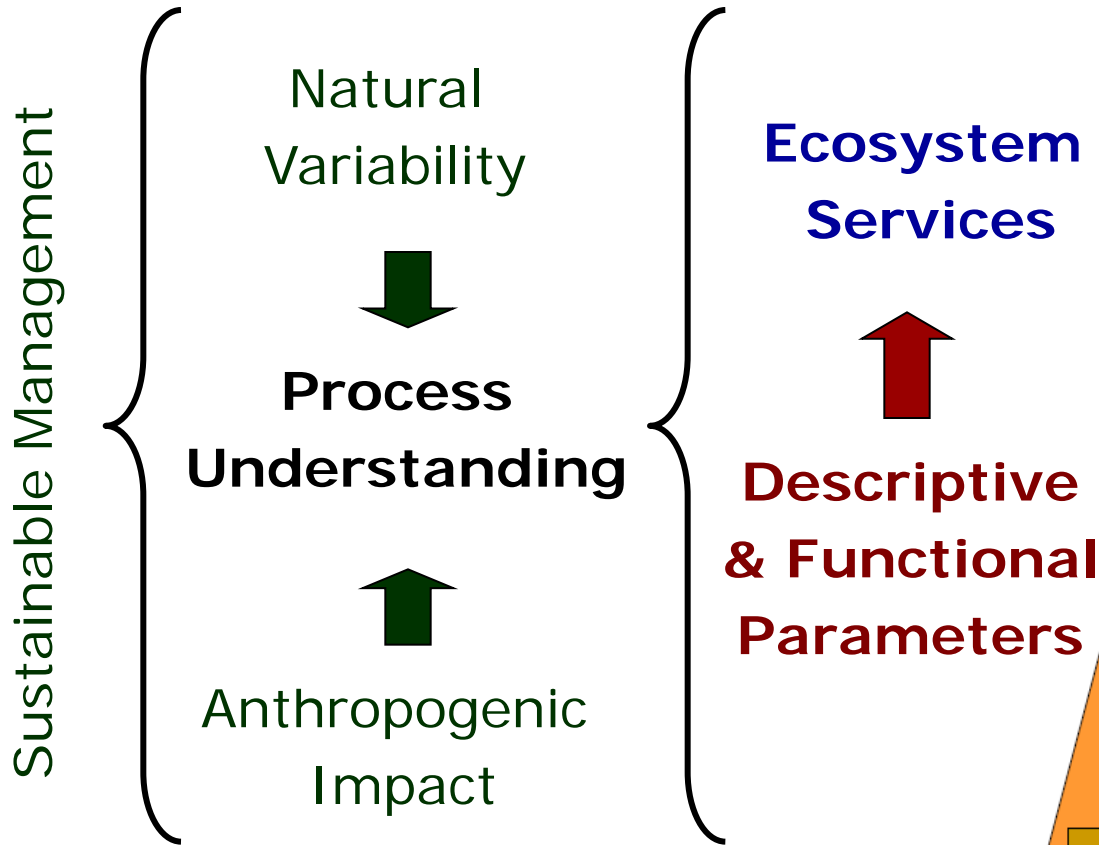
V. Summary

- Bacteria = Beaver?
= Ecosystem Engineers!
- EPS Matrix is the Glue!
Importance of Proteins
- Biodiversity & Physiology
of the Microbes
- Impact of natural Parameters &
anthropogenic Forcing
- Biogenic Mediation of
Sediments & Flocculation



FEMS (2008): Gerbersdorf et al.

V. Outlook



JSS (2011): Gerbersdorf, S.U., Hollert, H., Brinkmann, M., Wieprecht, S., Schuettrumpf, H. and W. Manz

