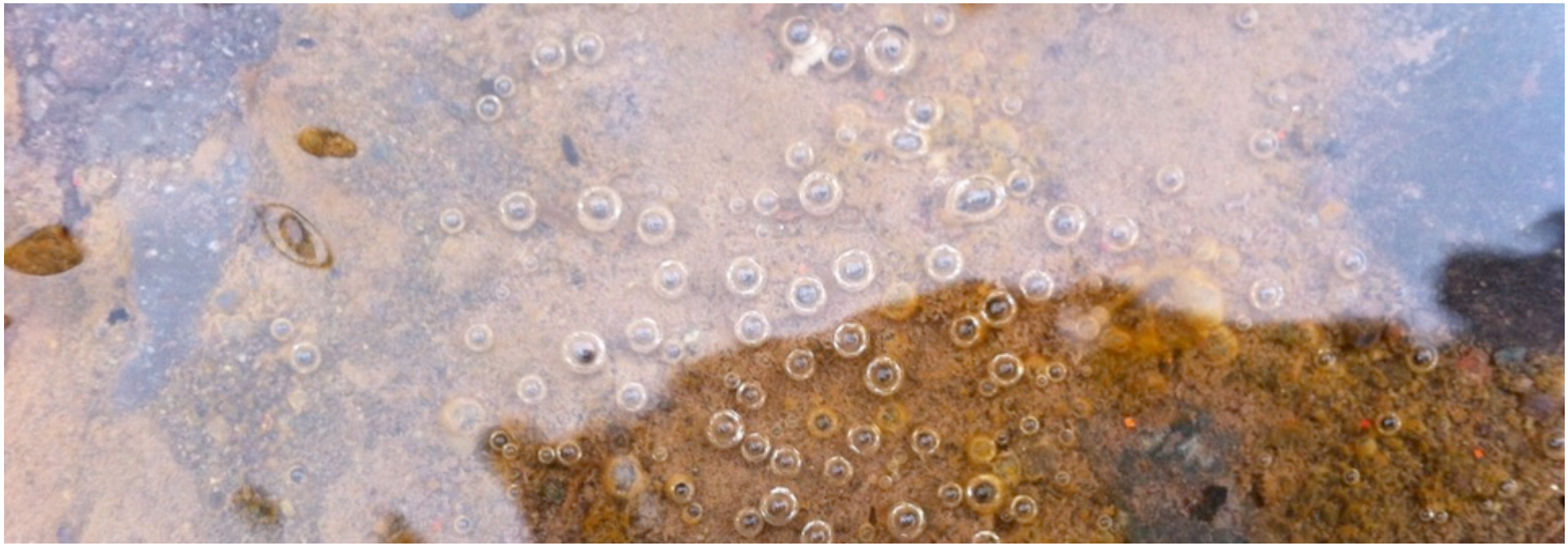
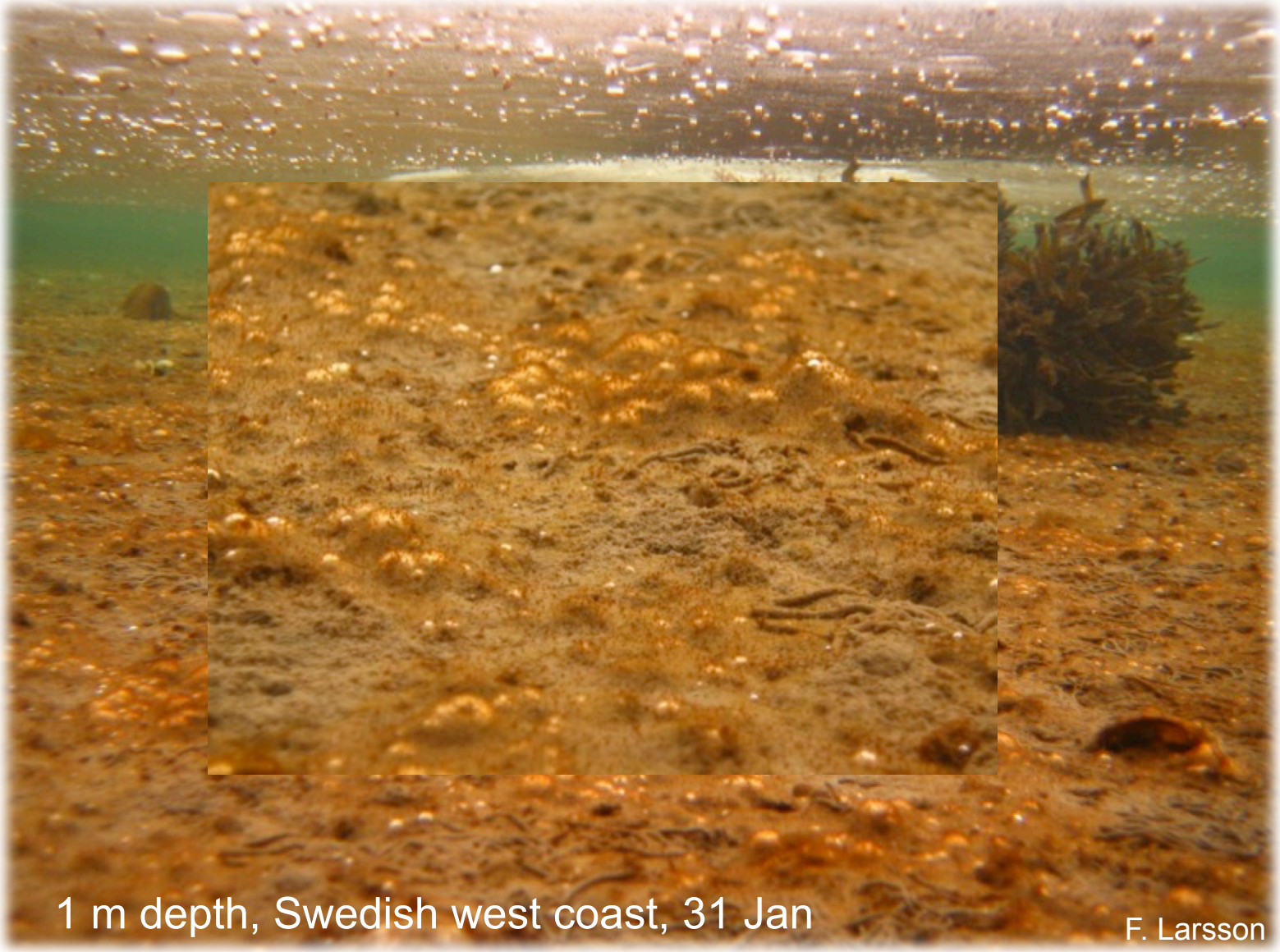
"COLD WATER MICROALGAE - WILL THEY BENEFIT FROM CLIMATE CHANGE?"



ANGELA WULFF, DEPT OF BIOLOGICAL AND ENVIRONMENTAL SCIENCES, UNIV. OF GOTHENBURG, SWEDEN


1 m depth, Swedish west coast, 31 Jan
F. Larsson

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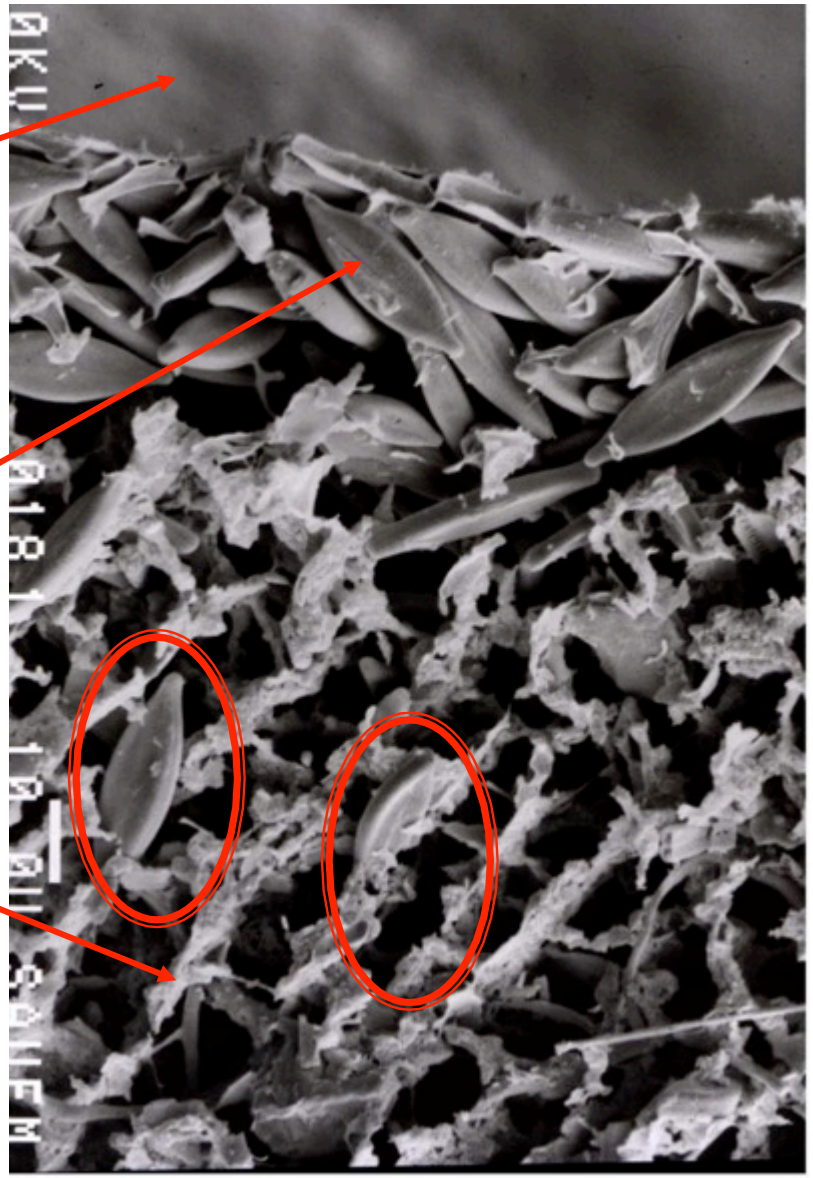
cryo-SEM

10 µm

overlying water

naviculoid diatoms on the sediment surface

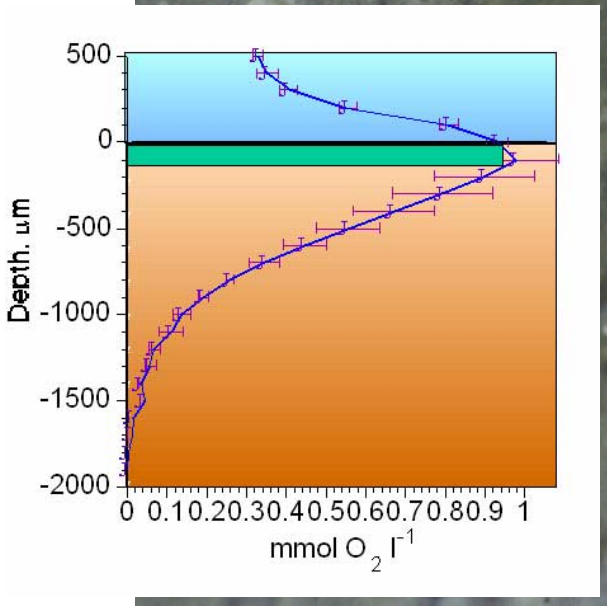
organic material



Alison Miles

UNIVERSITY OF GOTHENBURG

PAR penetrates down to 4 mm (UVR 1-2 mm)

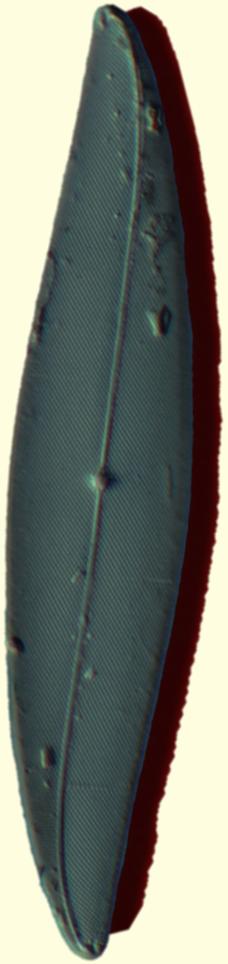


Oxygen micro-electrode

O_2

Alison Miles

UNIVERSITY OF GOTHENBURG



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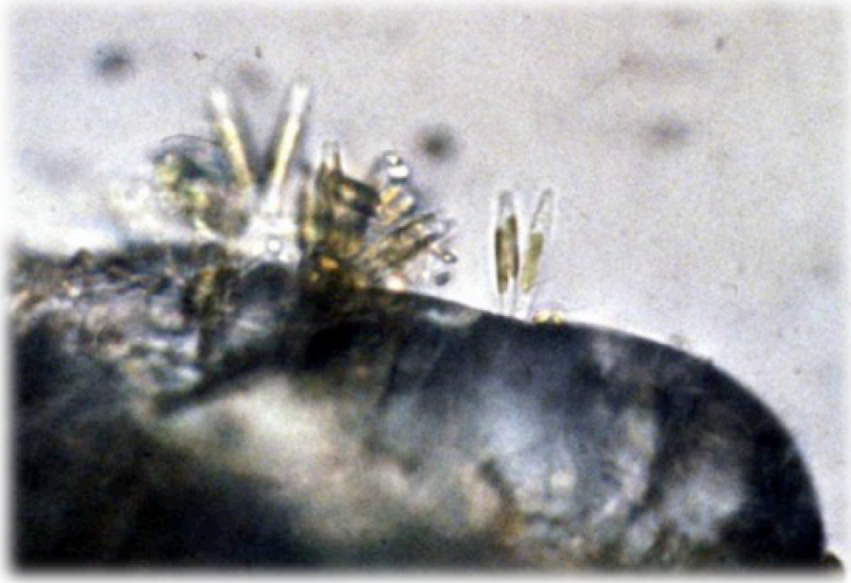

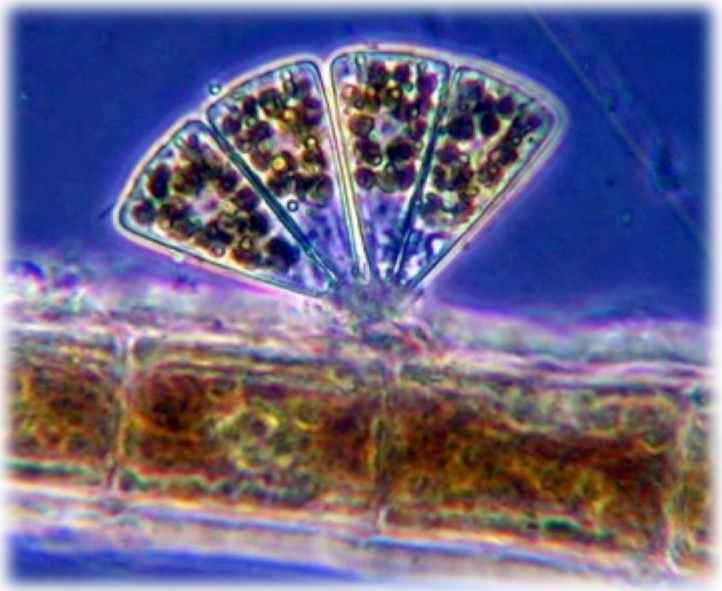

Being attached – another problem?

Benthic microalgae are present throughout the year, making up the basis for local food webs, and is a nursery ground for fish and fish prey

Can account for > 50% of the total primary production in shallow bays

In many polar areas the phytoplankton biomass is not sufficient for the benthic consumer abundance

Are benthic diatoms really important?

YES!

And they are tough ☺

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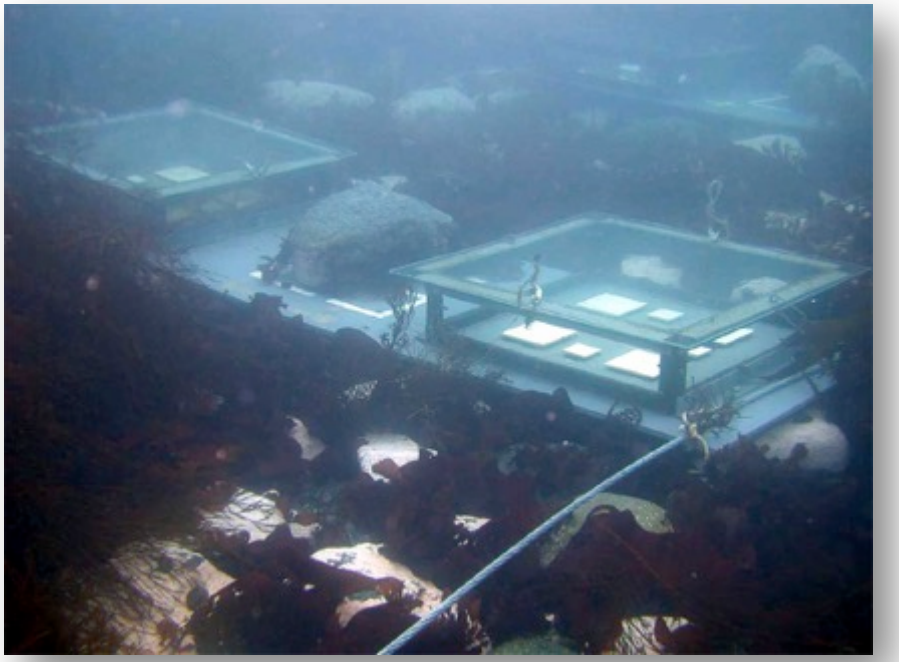
Different experimental sites



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Sampling mud — a dirty work ;-)

Sediment collection by divers in Antarctica

"…obligate benthic diatoms living as deep as 191 m substantially extends the known depth range of these primary producers…"

McGee et al MEPS 2008

Mid-day PAR at the 191 m site averaged 0.1 µmol photons m^{-2} s^{-1}

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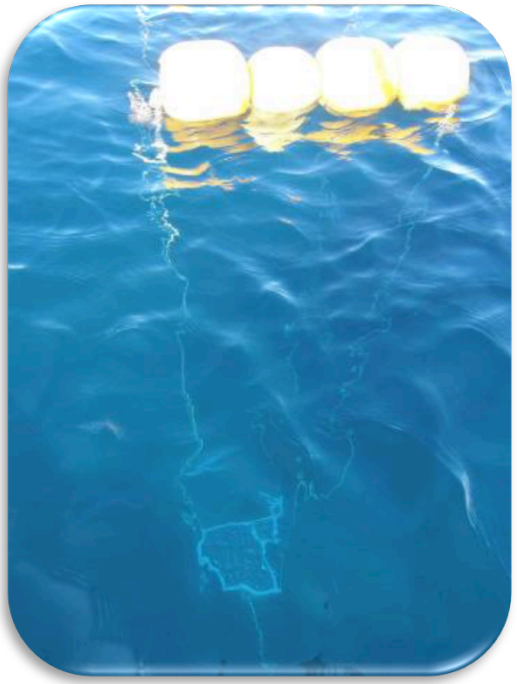
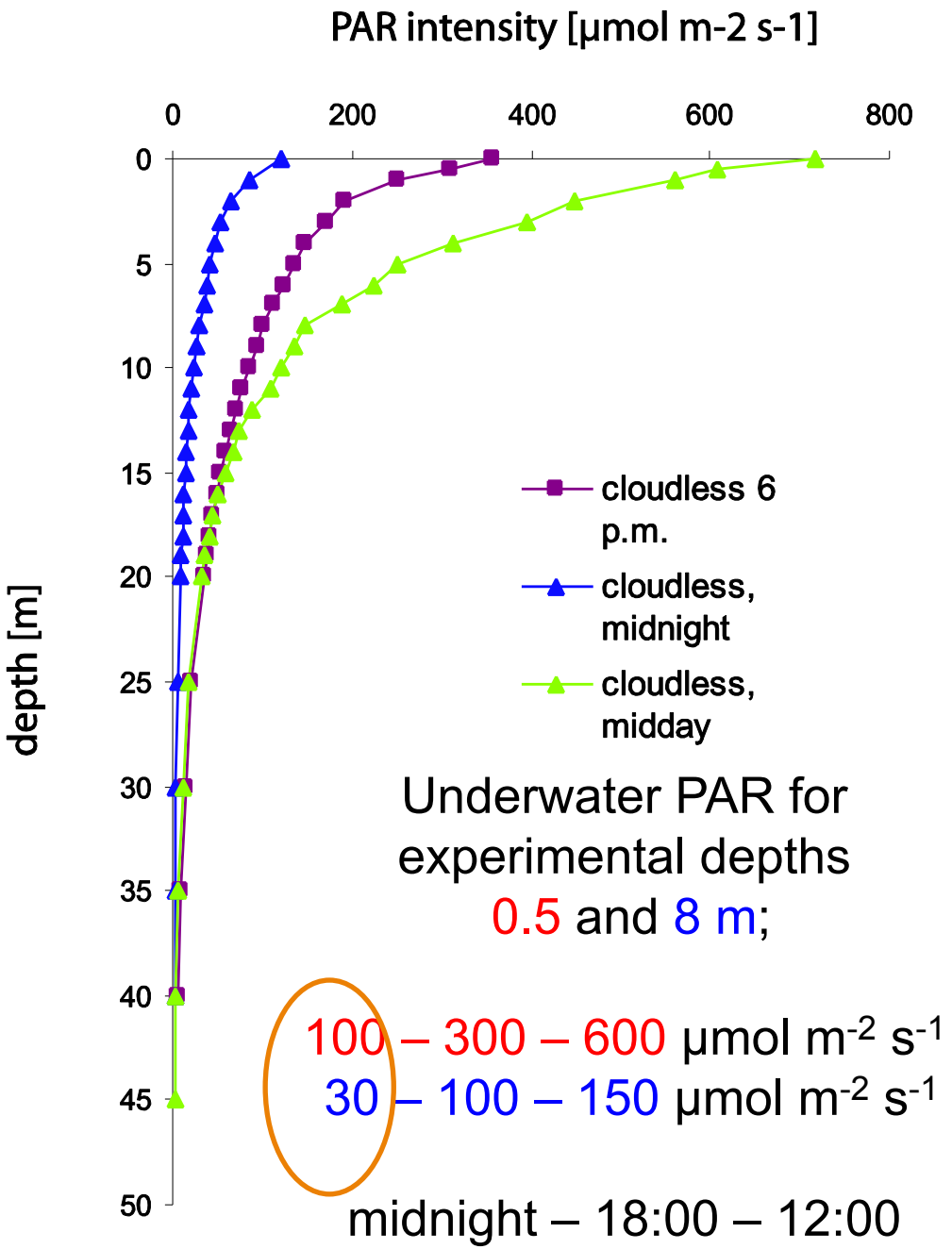




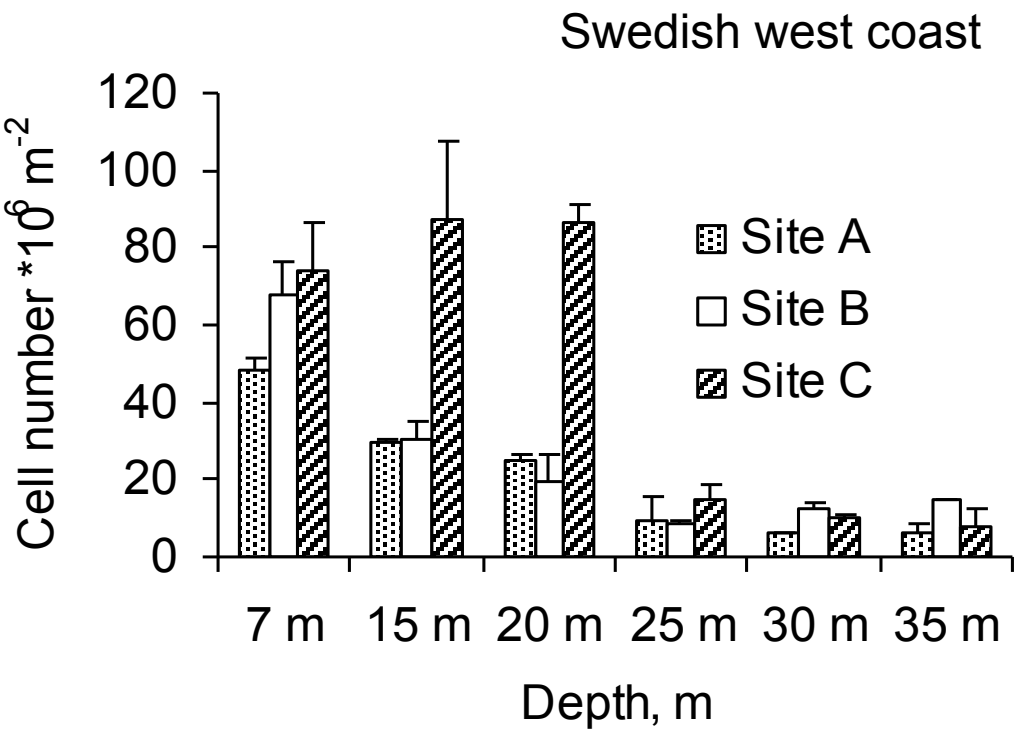
Underwater PAR for experimental depths 0.5 and 8 m;

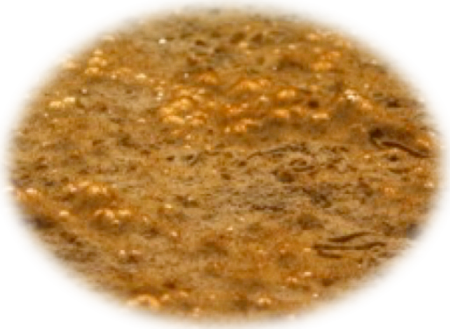
100 – 300 – 600 µmol m^{-2} s^{-1}

30 – 100 – 150 µmol m^{-2} s^{-1}

midnight – 18:00 – 12:00

Low radiation



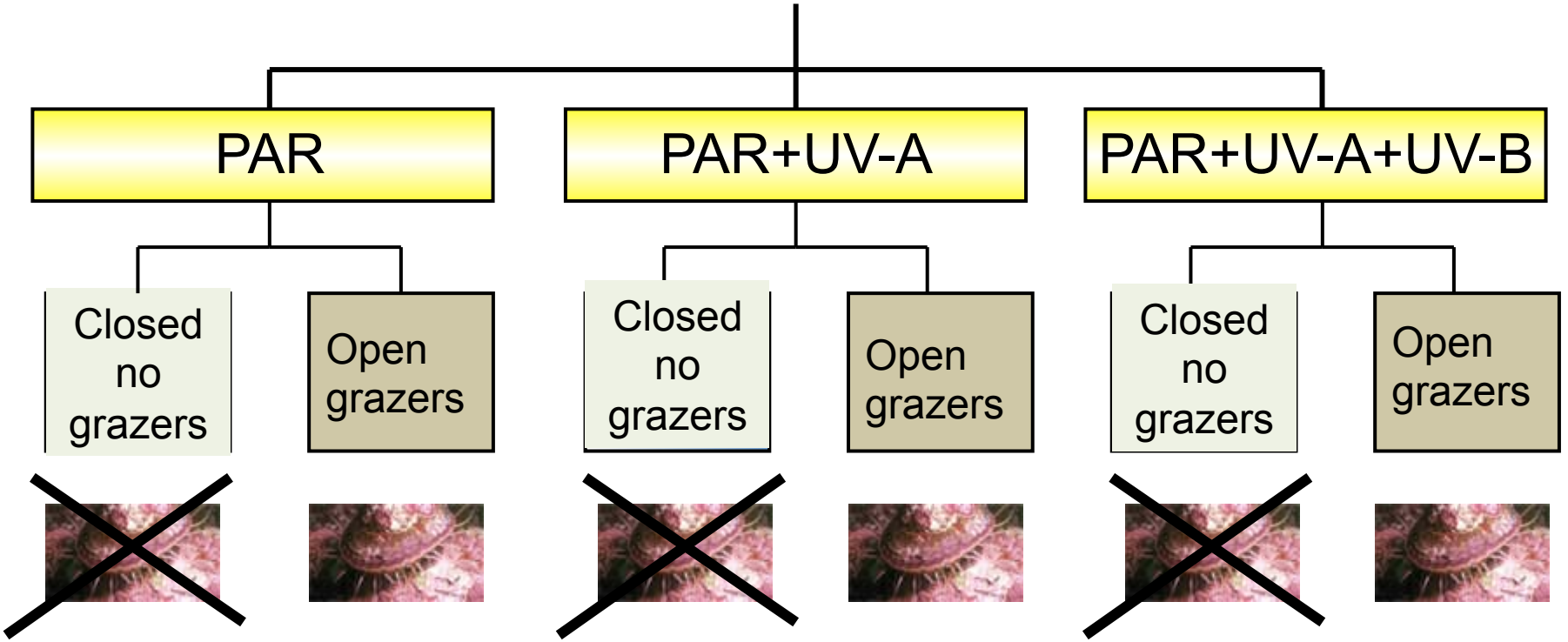


— Benthic diatoms were active (epifluorescing) under very low light conditions (single µmol photons m^{-2} s^{-1}) *in situ*

Wulff et al Hydrobiologia 2004

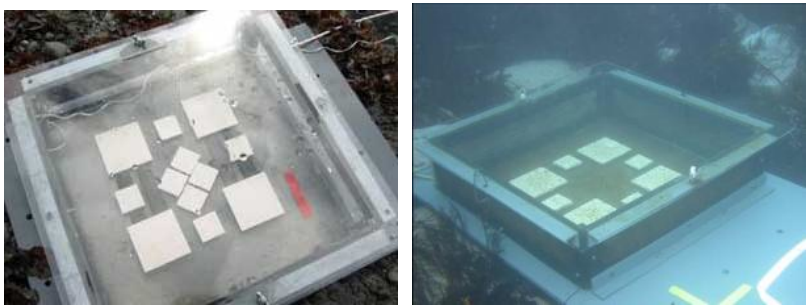
Very high radiation

5 months field experiment, Antarctica

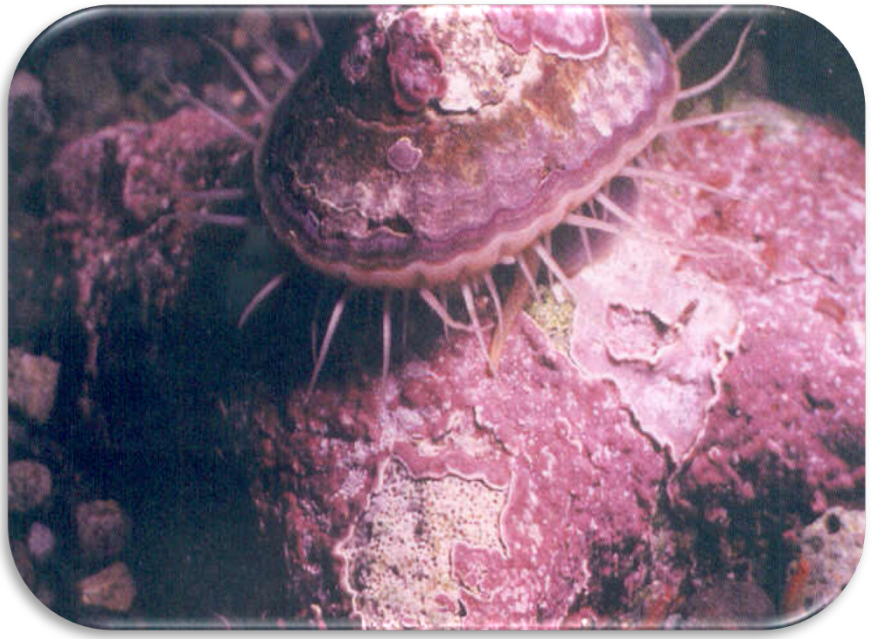


Controls for cages & light filters

N=4 ⟶ 32 cages



Effect of grazers but not of UV radiation



Ca 25% UV-B at 1.5 m depth

Zacher et al Global Change Biology 2007; Polar Biology 2007

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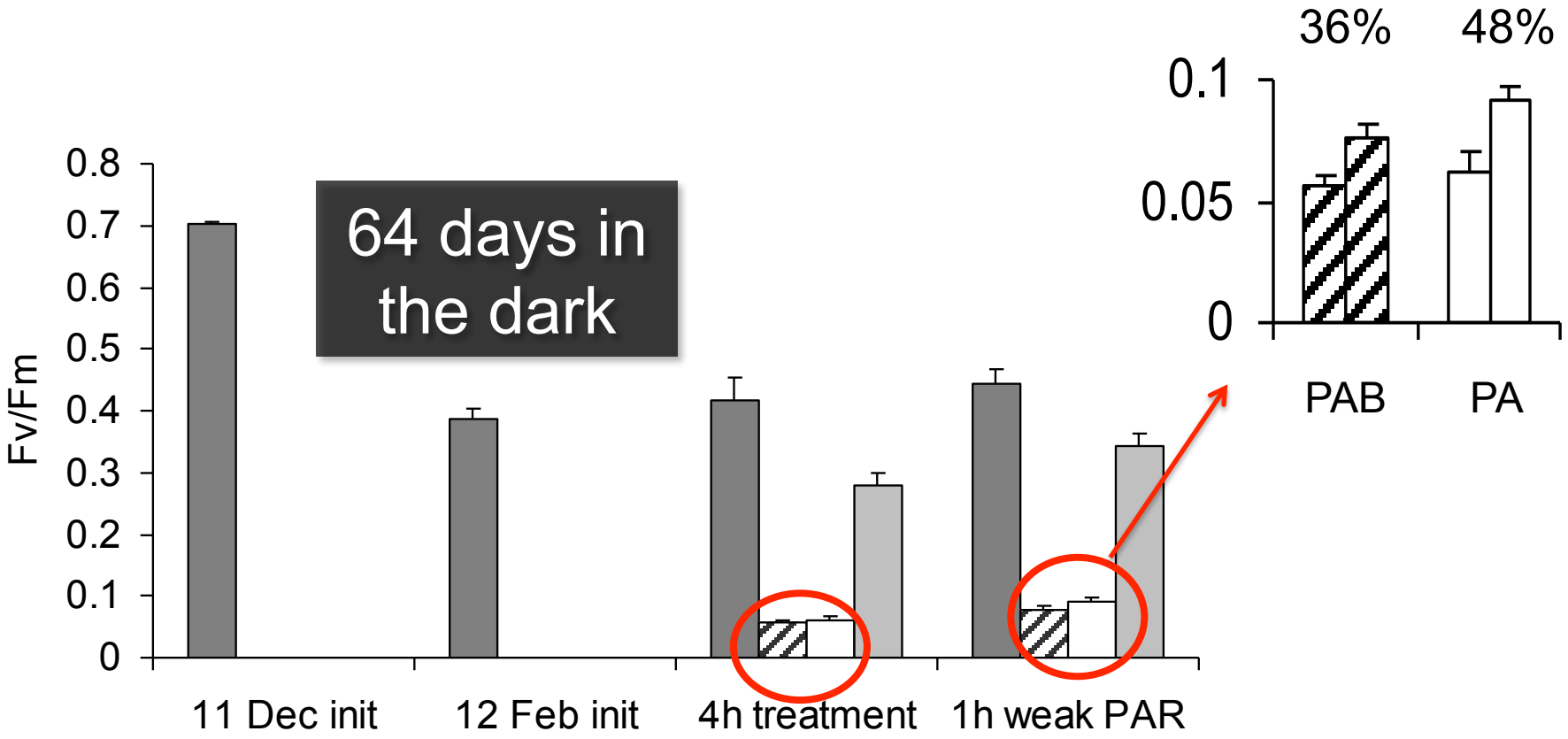
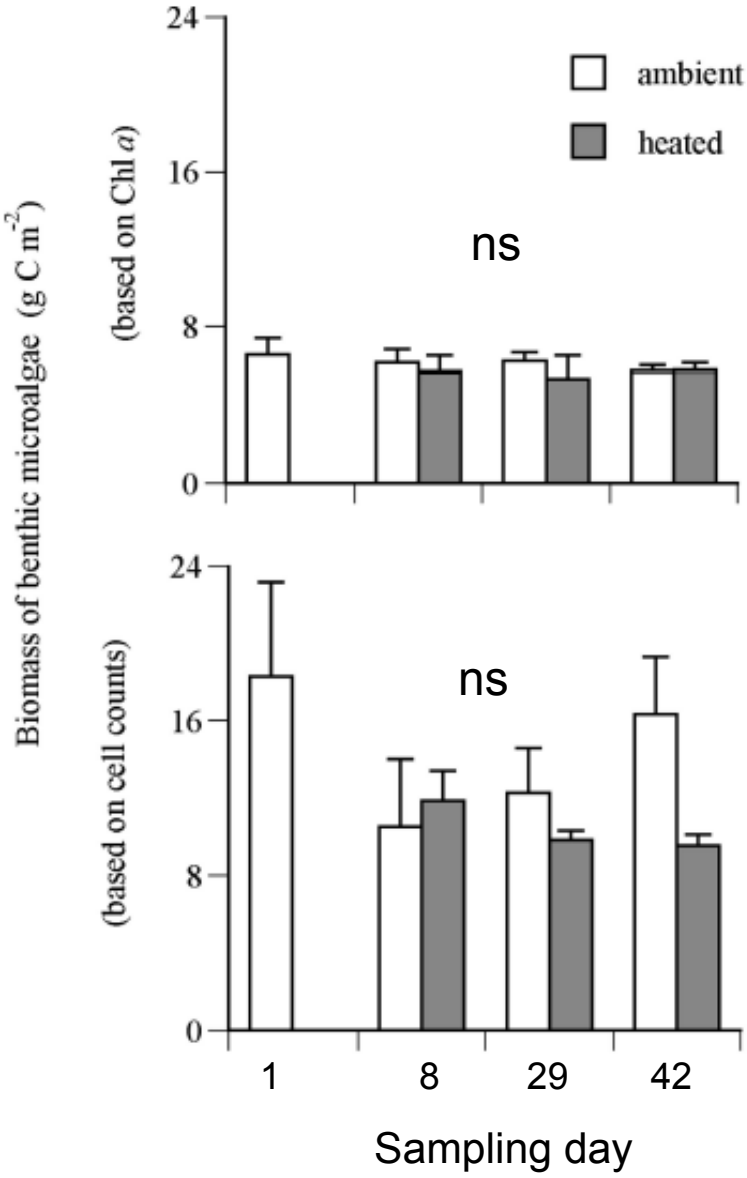
From darkness to light shock

Ok, let's put them in the fridge first and then we fry them with UVR



Wulff et al Diatom Res 2008



Temperature

In an outdoor set-up

the effect of increased temperature (+4°C) on a shallow-water system was studied for 1.5 months

Oxygen production, biomass, and species composition of benthic microalgae did not respond to warming

Heterotrophic variables responded more clearly to warming than did autotrophic variables

Alsterberg et al 2011

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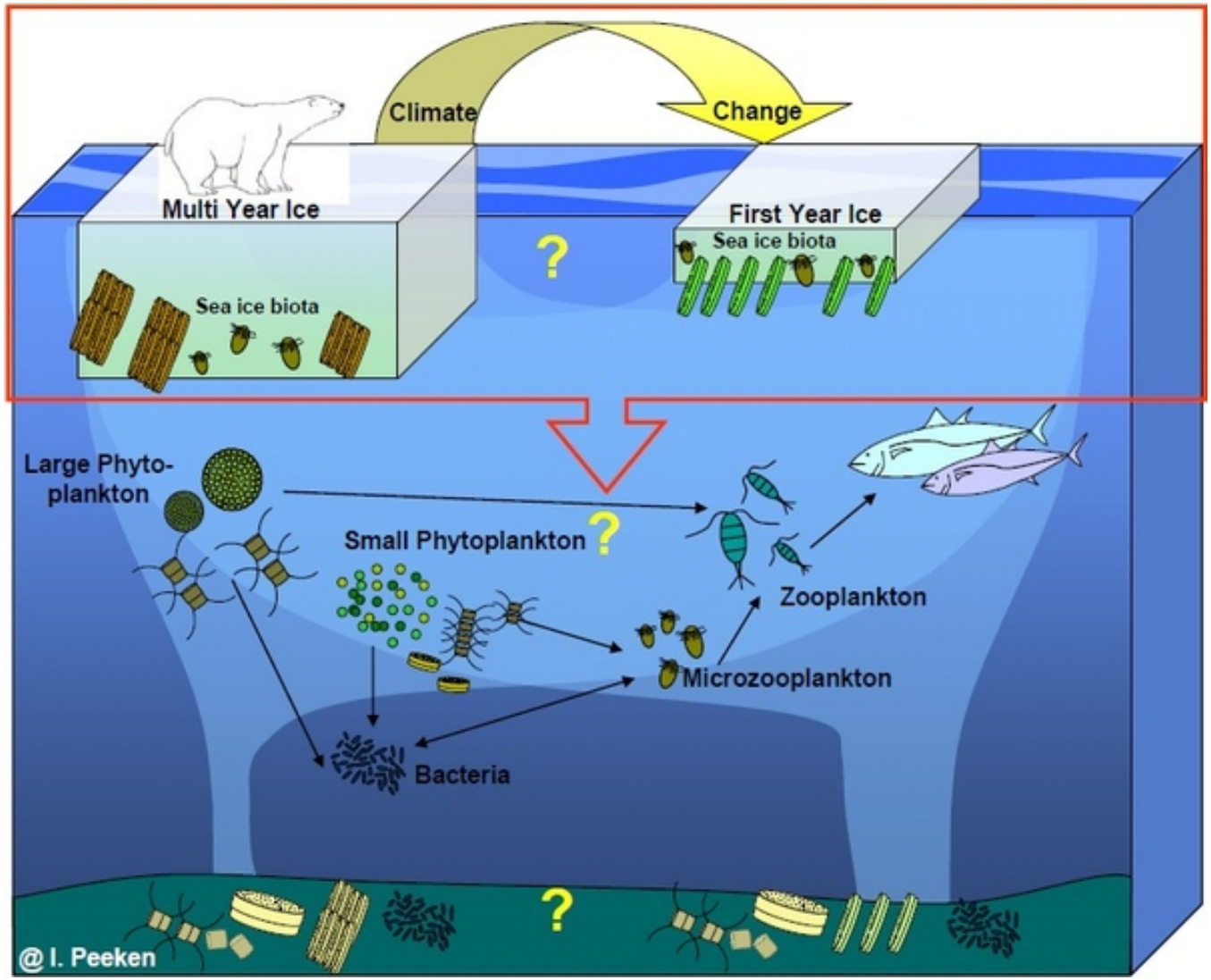
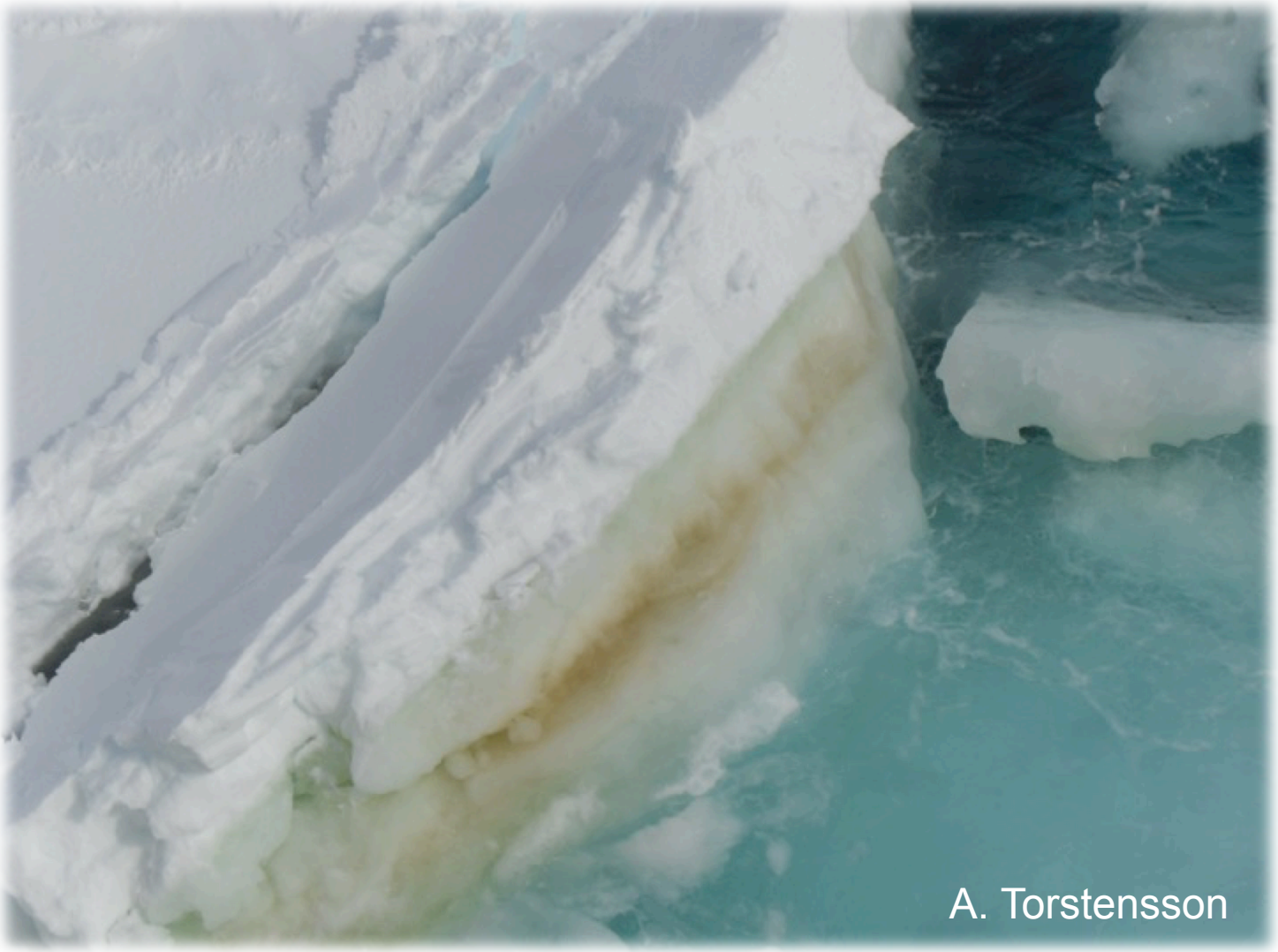
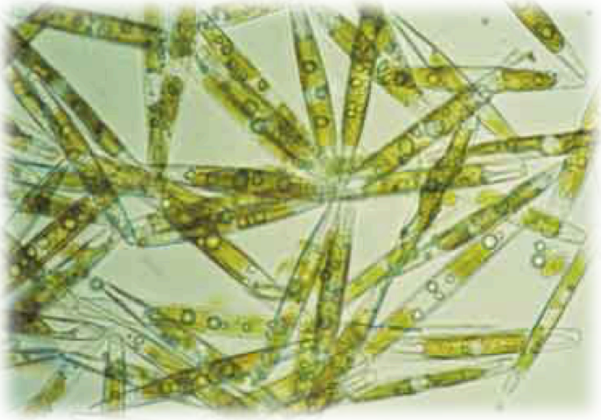
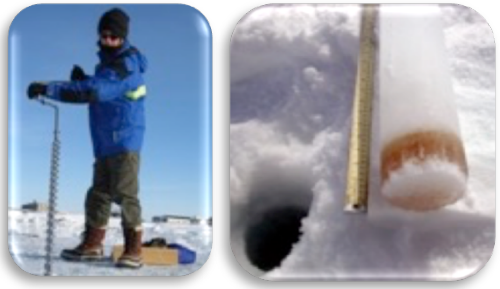



A. Torstensson

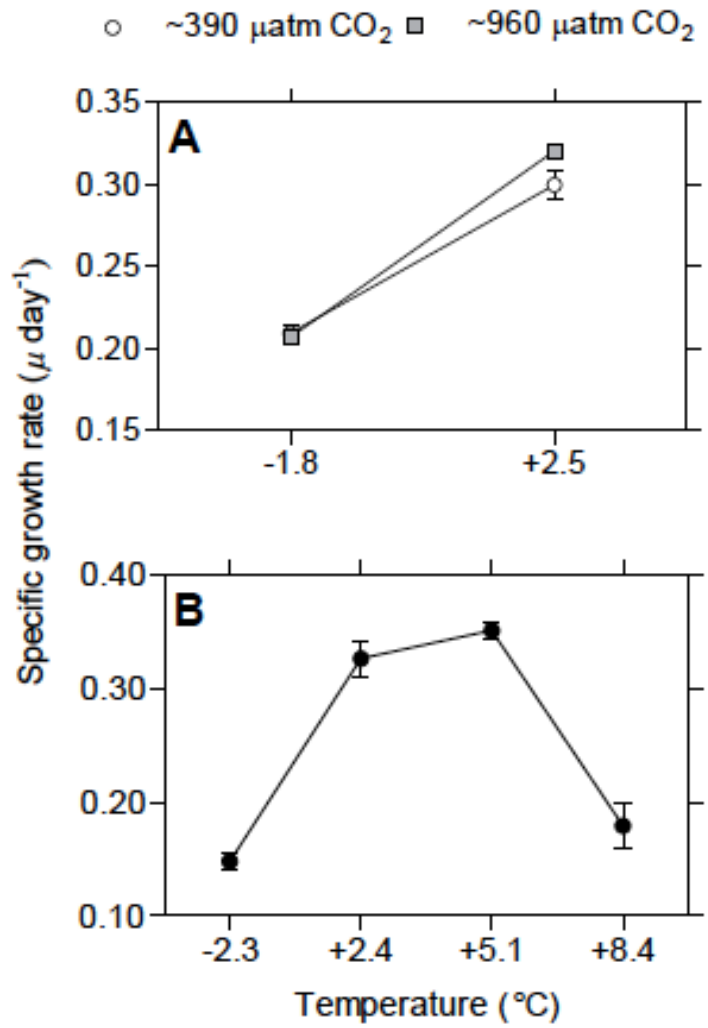
UNIVERSITY OF GOTHENBURG

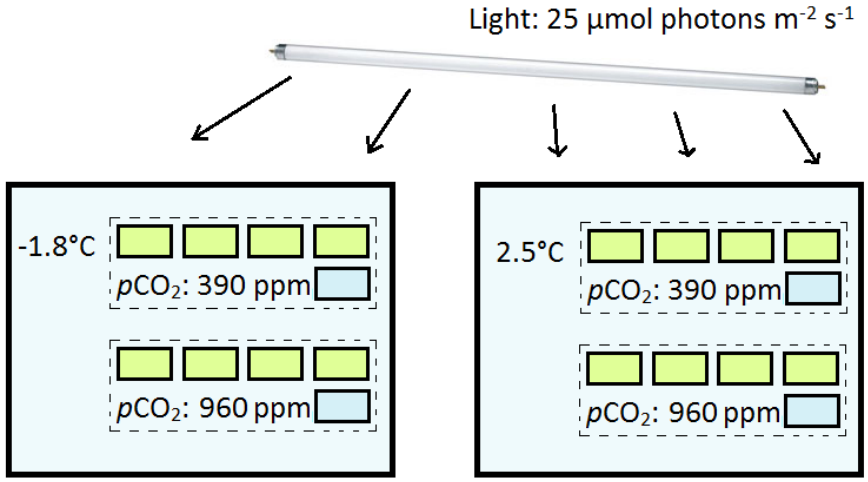
Mostly pennate diatoms





Temp + CO_2





Duration: 14 days

10 µm

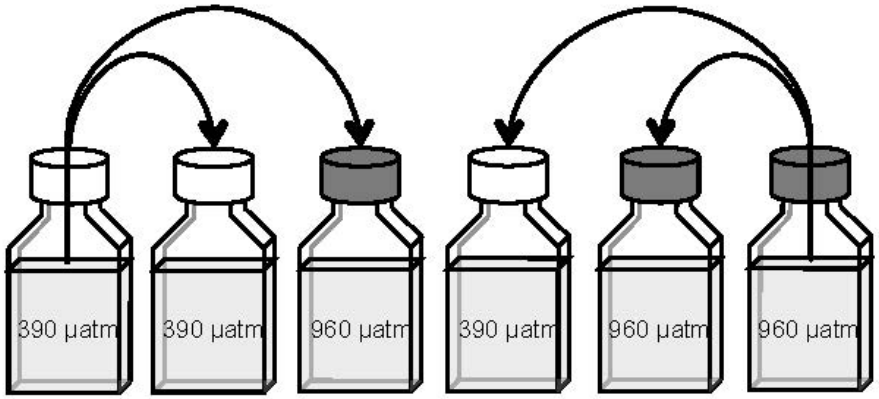
Two way ANOVA

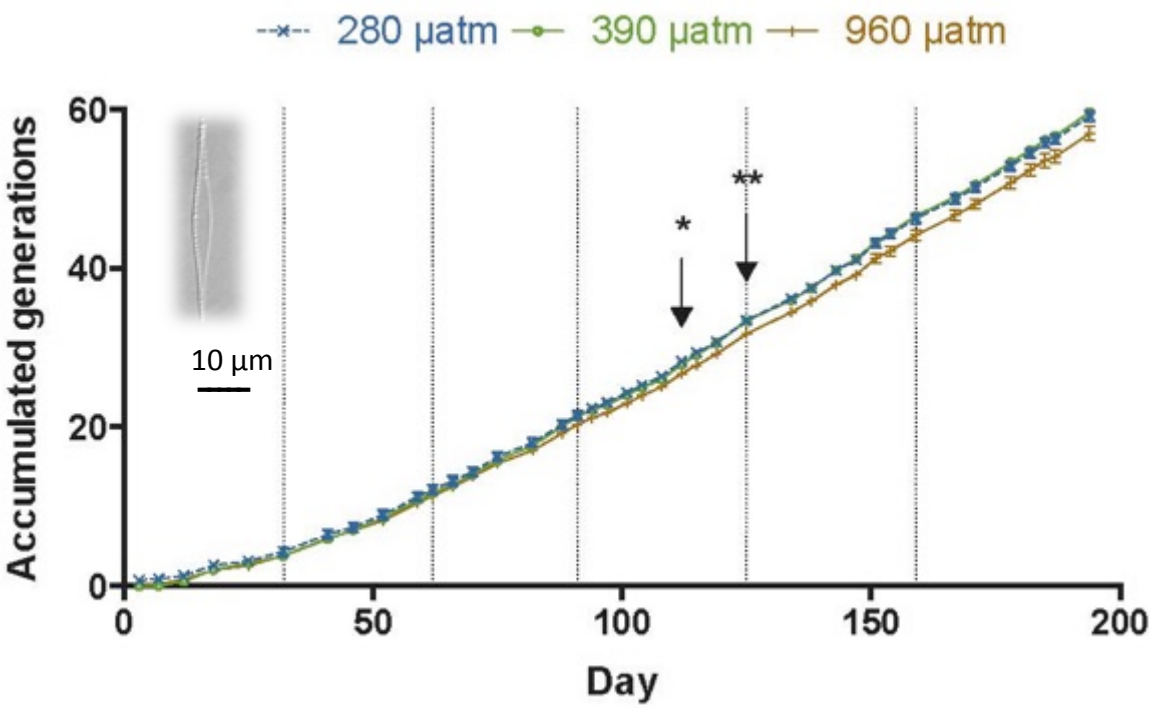
	df	*F*-value	*P*-value
Temp.	1	397	0.000
pCO_2	1	3.0	0.108
Temp.*pCO_2	1	5.1	0.044
Error	12		

Torstensson et al. Biogeosci 2013

Long term CO_2

-1.8°C, 30 µmol photons m^{-2} s^{-1}





After 112 days, a small reduction in growth could be detected at 960 µatm

Carbon metabolism was significantly affected, resulting in higher cellular release of DOC

Carbon overconsumption and DOC exudation may increase in a high-CO_2 world

Torstensson et al 2015

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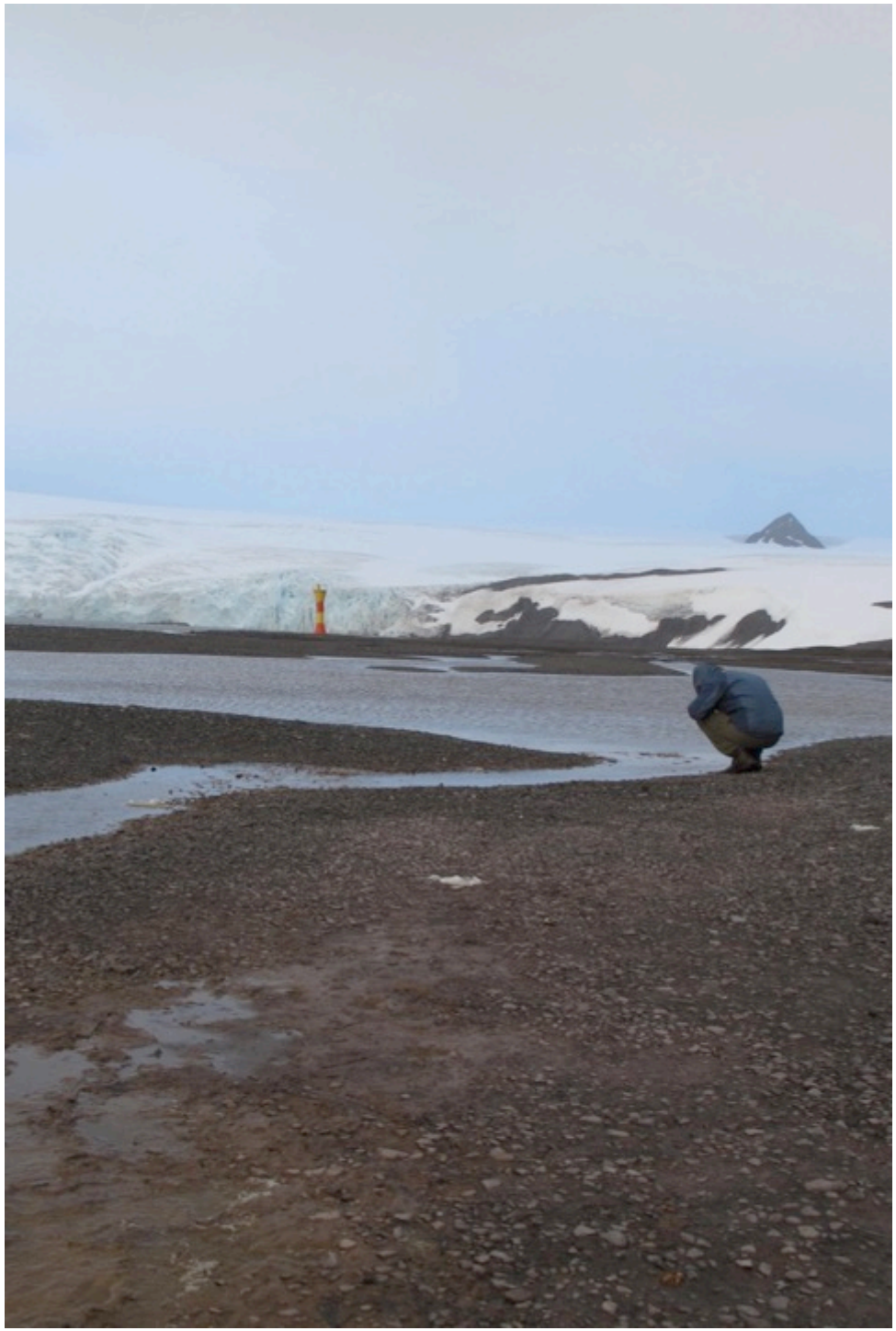
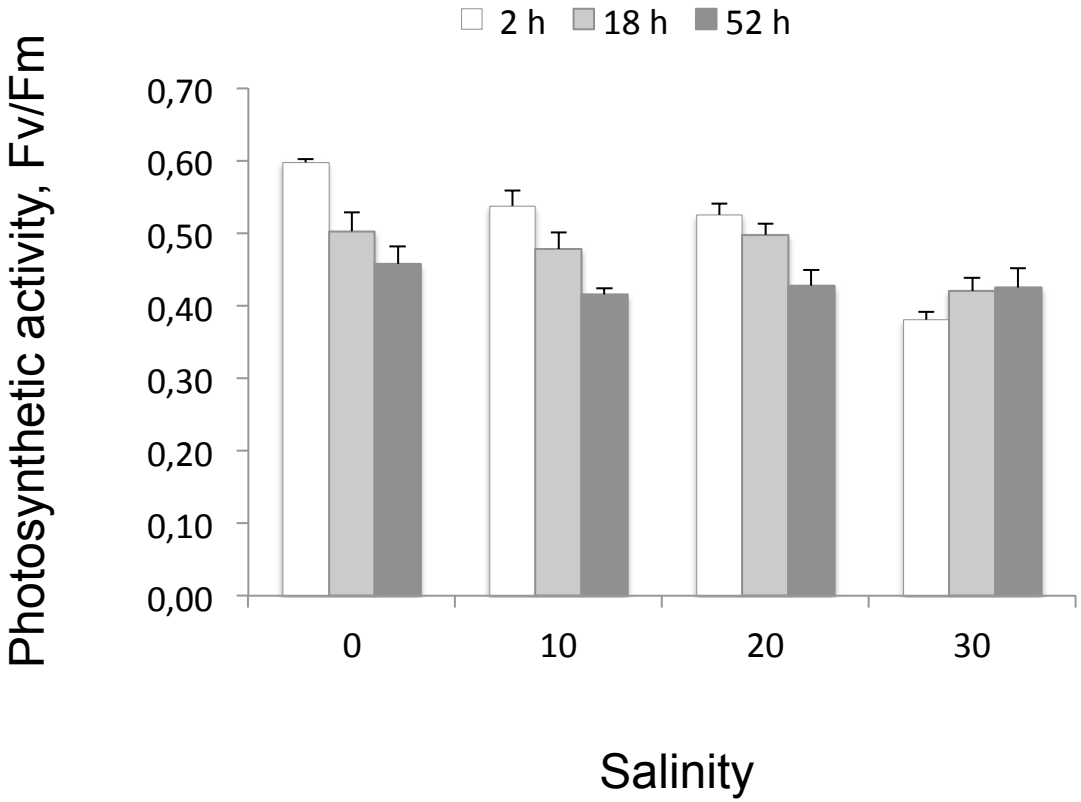
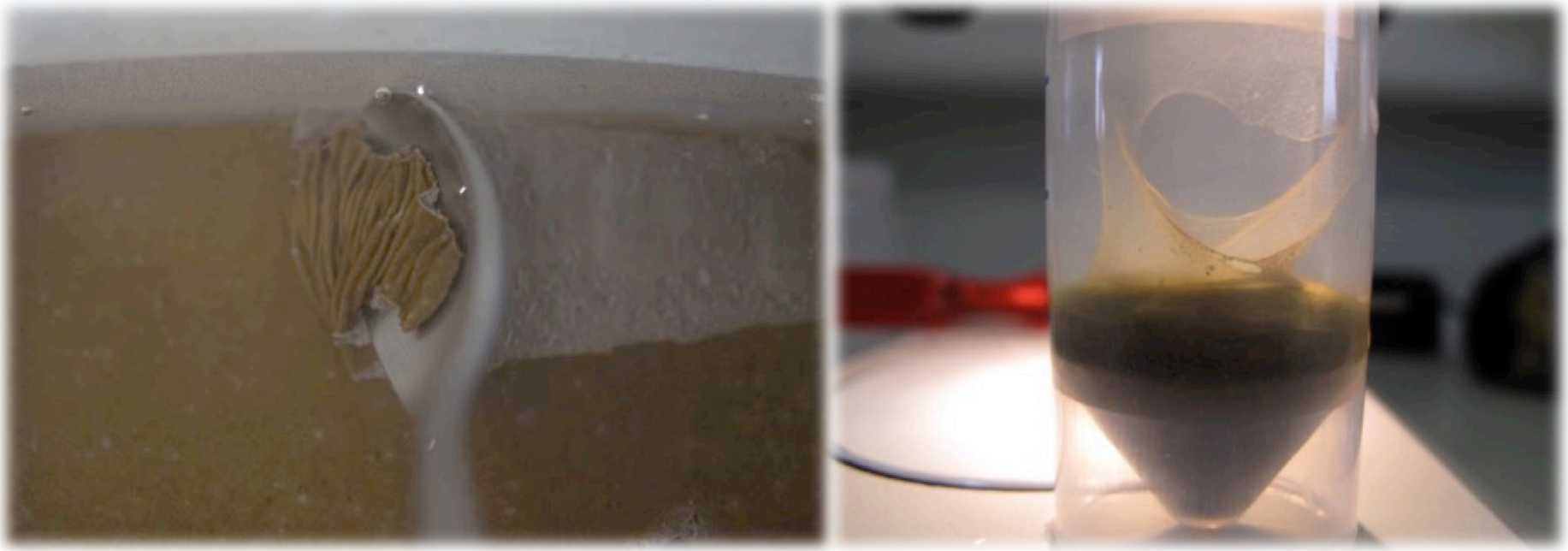
We were inspired by the dirt on the ground ;-)



Can they survive in the sea?





Extracellular polymeric substances (EPS) — major component of the biofilms that build up on exposed marine surfaces (biofouling)

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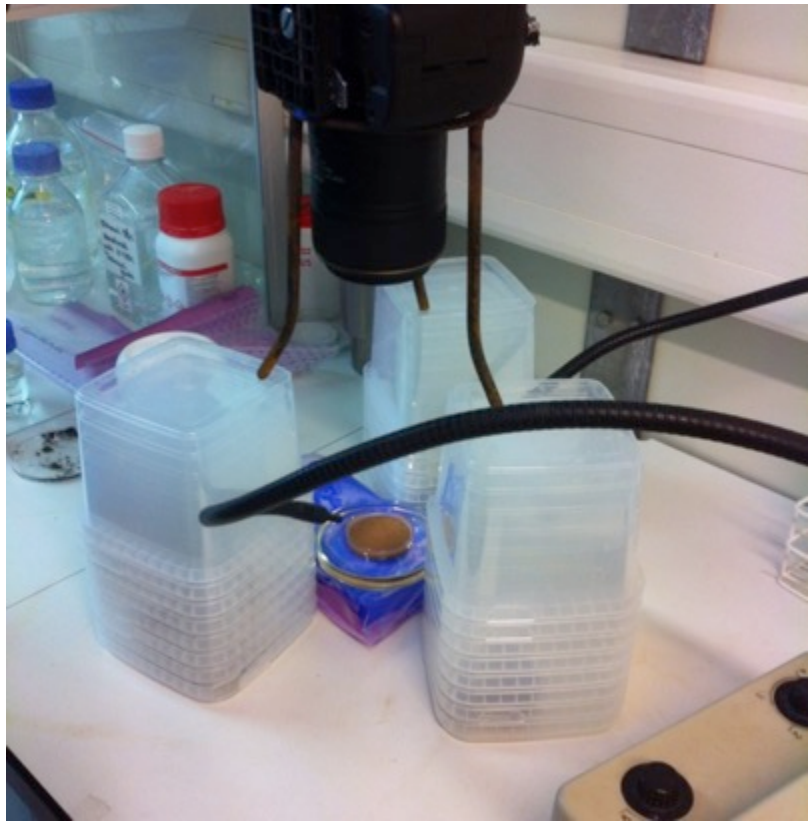
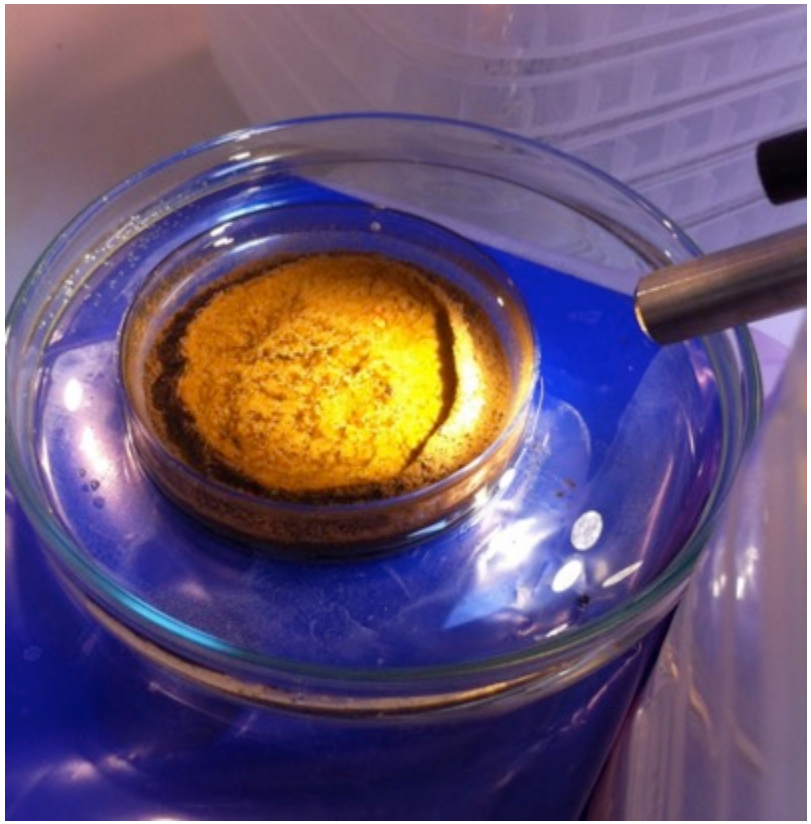
A simple set-up to follow ”EPS production / migration”





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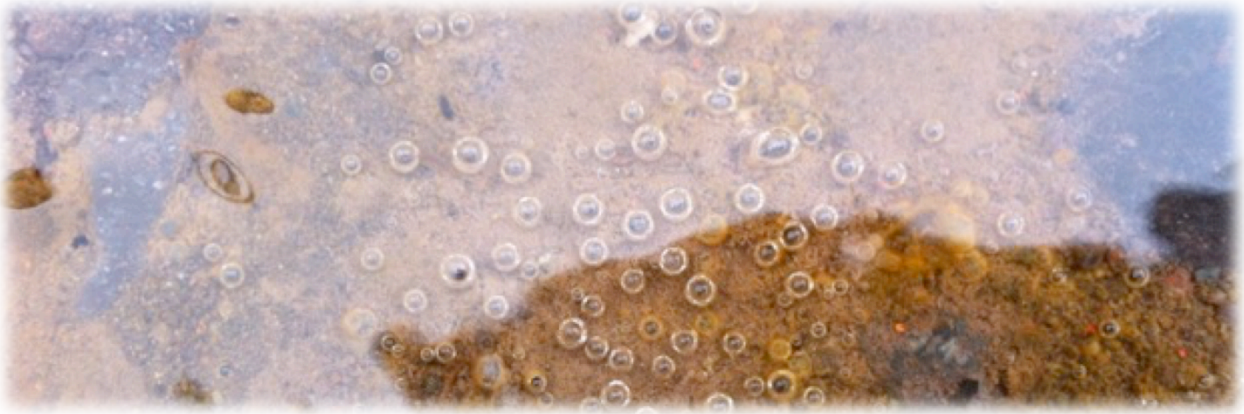
Is the tolerance of benthic diatoms to climate change a surprise?

- Benthic (and ice-inhabiting diatoms) are exposed to large fluctuations in temperature, radiation, nutrients etc)

- And they are exposed for continuous fluctuations of pH

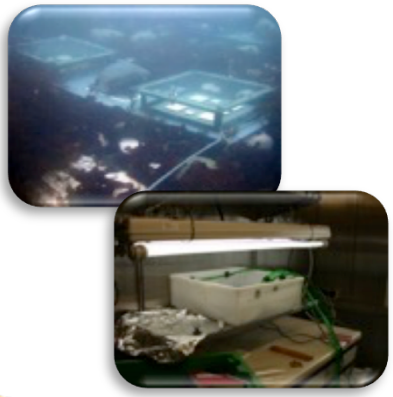


About experimental design / approach

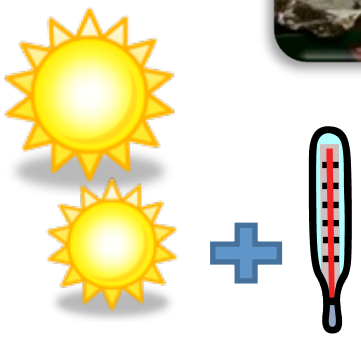
Single species or communities / assemblages?

Cascade effects – several trophic levels?

Field experiments and/or laboratory expts?



Single factor or multifactorial approach?



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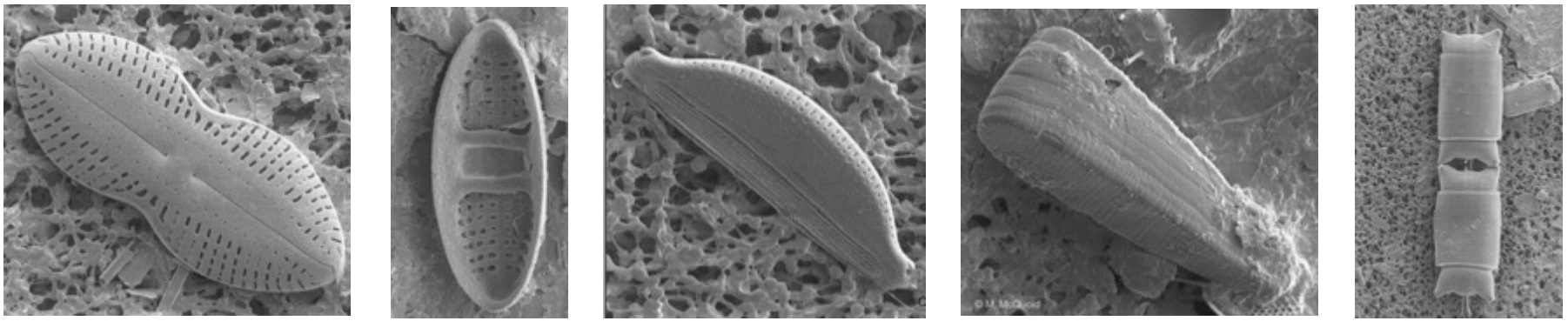
It (EPS) bonded wooden lap joints ….. four times the value of a commercial polyvinyl acetate (PVA) glue

Nanotechnology, solar cell panels and battery applications

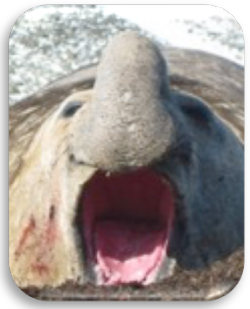
Mancuso Nichols et al 2014

Another future for the benthic jewelry box?

Biofuel (fatty acid profile suitable for biodiesel)



SEM photos by Melissa McQuoid



Thanks to all ”partners in crime” who have contributed in one way or another ;-)