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

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1 m depth, Swedish west coast, 31 Jan

F. Larsson
7 m depth, Potter Cove, Antarctica
overlying water

naviculoid diatoms on the sediment surface

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

And they are tough 😊
Different experimental sites
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\(^{-1}\)
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
— Benthic diatoms were active (epifluorescing) under very low light conditions (single μmol photons m⁻² s⁻¹) \textit{in situ}\n
Wulff et al Hydrobiologia 2004
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
Ok, let's put them in the fridge first and then we fry them with UVR

64 days in the dark

From darkness to light shock

Wulff et al Diatom Res 2008
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.
Mostly pennate diatoms
**Two way ANOVA**

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Duration: 14 days

Light: 25 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
We were inspired by the dirt on the ground ;-)
Can they survive in the sea?

Photosynthetic activity, $F_v/F_m$

Salinity
Extracellular polymeric substances (EPS) — major component of the biofilms that build up on exposed marine surfaces (biofouling)
A simple set-up to follow "EPS production / migration"
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?
Another future for the benthic jewelry box?

Biofuel (fatty acid profile suitable for biodiesel)

Nanotechnology, solar cell panels and battery applications

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

Mancuso Nichols et al 2014

SEM photos by Melissa McQuoid
Thanks to all "partners in crime" who have contributed in one way or another ;-)