Potential changes in iron availability through long-term changes in zooplankton

Sari LC Giering, S Steigenberger, EP Achterberg, R Sanders, DJ Mayor
Recycling

Mixing layer

New

Regenerated

Microbes
Zooplankton

Twilight zone

Nitrification

Microbes
Zooplankton

NO$_3^-$

NH$_4^+$

NO$_3^-$

NH$_4^+$
Recycling

Banse 1995, Honjo et al. 2008
Annual nitrate concentrations

Boyd et al. 2007
Mesozooplankton biomass

Annual average mesozooplankton (> 333 µm) biomass (mg C m\(^{-3}\)) in the upper 200 m (Moriarty and O’Brien 2013)
Why zooplankton?

• Physical disruption during digestion (Frey & Small 1979)

• Low gut pH: 5.4 – 6.7 (Tang et al. 2011)

• Lots of them!
Idea:

Increased recycling of iron (Fe) relative to nitrogen (N) by zooplankton may help to sustain phytoplankton production in HNLC conditions.
Irminger Basin in Jul/Aug 2010
Experimental design

• Mixed zooplankton (>0.2 mm) community

• Controlled temperature lab (wet, windy, cold!) in the middle of the night...

• Sampling for $\text{NH}_4^+$ and DFe
Nutrient release

(a) Metabolic waste product

(b) Digestion-derived
What governs the rate of release?

Tovar-Sanchez et al. 2007
What governs the rate of release?
So, how important is nutrient release by mesozooplankton?

<table>
<thead>
<tr>
<th></th>
<th>NH$_4^+$</th>
<th>DFe</th>
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<tbody>
<tr>
<td>Release by zooplankton (µmol m$^{-3}$ d$^{-1}$)</td>
<td>1-45</td>
<td>0.001 – 0.022</td>
</tr>
<tr>
<td>Uptake by phytoplankton (µmol m$^{-3}$ d$^{-1}$)</td>
<td>300-400</td>
<td>0.010 – 0.013</td>
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<tr>
<td>Release/Uptake (%)</td>
<td>0.2-13 %</td>
<td>6-59 %</td>
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</tbody>
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- Uptake measurements and assuming that
  - C:N ratio of 106:16 mol mol$^{-1}$
  - Fe:C ratio of 4.3 µmol mol$^{-1}$
Could iron recycling have been altered through changes in the abundance & distribution of mesozooplankton (known responses to climate change)?
• Coupled to historic abundance data of mesozooplankton in the Irminger Basin from 1958-2007
Long-term change in copepod biomass

Small: < 0.2 mm
Conclusion

• DFe:N regeneration ratio: 5–26 times larger than in phytoplankton requirements

• Fe:N decoupling → more Fe being available to support primary production

• Changes in zooplankton abundance and community composition will affect nutrient ratios and therefore the biogeochemical functioning of marine ecosystems
Thank you.

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