Insights into the ecology of zooplankton in an acidified ocean

M. Brady Olson
Shannon Point Marine Center, Western Washington University
Zooplankton

Direct effects

\[ H^+ \]
\[ CO_2 \]
\[ CO_3^{2-} \]

Pteropods can represent >60% of Juvenile Pink Salmon diet in Gulf of Alaska

Armstrong et al. 2005

Pteropod CaCO\(_3\) shells can begin to dissolve within 48h in corrosive waters

Orr et al. 2005
Direct Effects

Can we make generalizations about the effects of OA on zooplankton?

Challenging because:

1) Spatial and temporal variability in OA
2) Different life history sensitivity to OA
Zooplankton

Direct effects
- $H^+$
- $CO_2$
- $CO_3^{2-}$

Indirect effects
- Resources
- Competitors
- Predators
Indirect Effects

Photosynthetic machinery that ‘fixes’ $\text{CO}_2$ into organic sugars is undersaturated at present day $p\text{CO}_2$ concentrations. Higher photosynthesis under elevated $p\text{CO}_2$.

Cells got bigger under high $p\text{CO}_2$.

Sun et al. 2011

Toxic *Pseudo-nitzschia multiseries*

Photosynthetic rate

Irradiance (µmol photons m$^{-2}$ s$^{-1}$)

Higher photosynthesis under elevated $p\text{CO}_2$.
Indirect Effects

- Ingestion
- Assimilate
- Metabolize
- Respiration
- Excretion
- Non-metabolized
- POC Feces
- Growth, reproduction, molts, mucus, leakage

CO₂ → Ingestion → Assimilate → Metabolize → Respiration → Excretion → Non-metabolized → Growth, reproduction, molts, mucus, leakage
All these changes in phytoplankton biology and ecology have been documented to occur under ocean acidification scenarios!
Will zooplankton consume phytoplankton prey grown under different \([pCO_2]\) at different rates?

More cells were ingested that were grown under high \(pCO_2\)

What are the ecological implications of this?

Olson et al. unpubl.
2011 Salish Sea
Elevated 
DOC production 

Changes in secondary production 

Carbon-rich POC 

2011 Salish Sea 

Elevated ingestion 

2100 Salish Sea