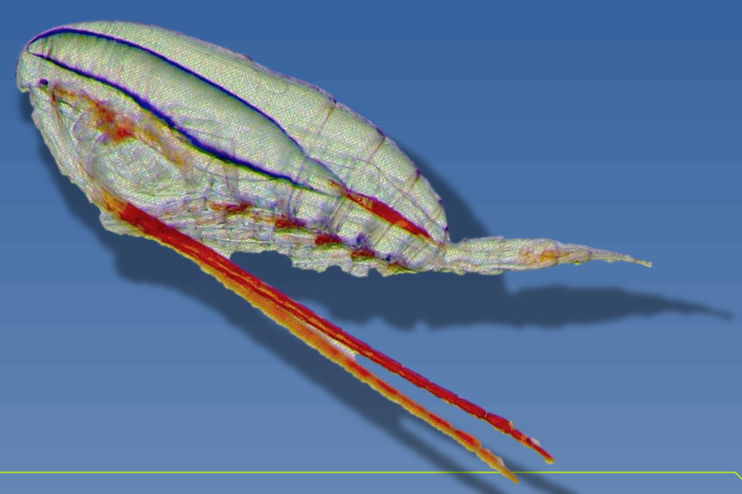
Effect of food and light on the development of the Arctic copepod *Calanus glacialis* during the winter-spring transition

Lauris Boissonnot ‡†, Janne E. Søreide ‡, Martin Graeve †

‡ University Centre in Svalbard, PO box 156, N9171 Longyearbyen, Norway

† Alfred Wegener Institute, Bremerhaven, Germany

Corresponding author: lauris.boissonnot@awi.de



Introduction

Calanus glacialis, endemic to the Arctic, accounts for up to 80% of the zooplankton biomass in Arctic shelf seas. This lipid-rich copepod accumulates essential polyunsaturated fatty acids from its algal diet, and converts the low-energy carbohydrates and proteins from algae into high-energy wax ester lipids.

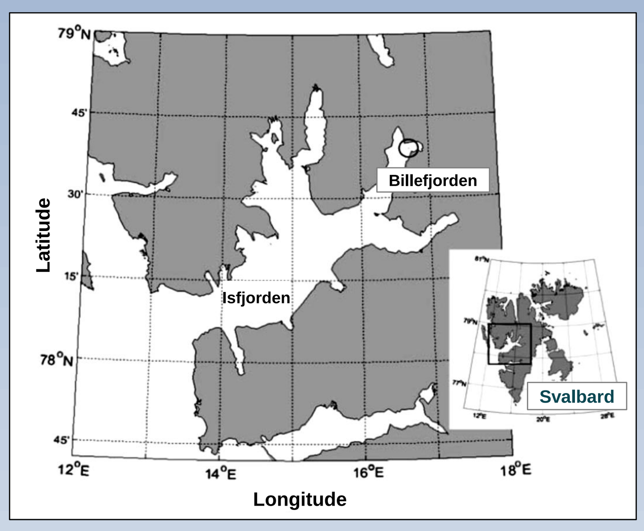
Climate warming will alter the current primary production regime, leading to earlier sea ice break-up and onset of the phytoplankton bloom. How the key Arctic grazer will respond to these changes is not well known.

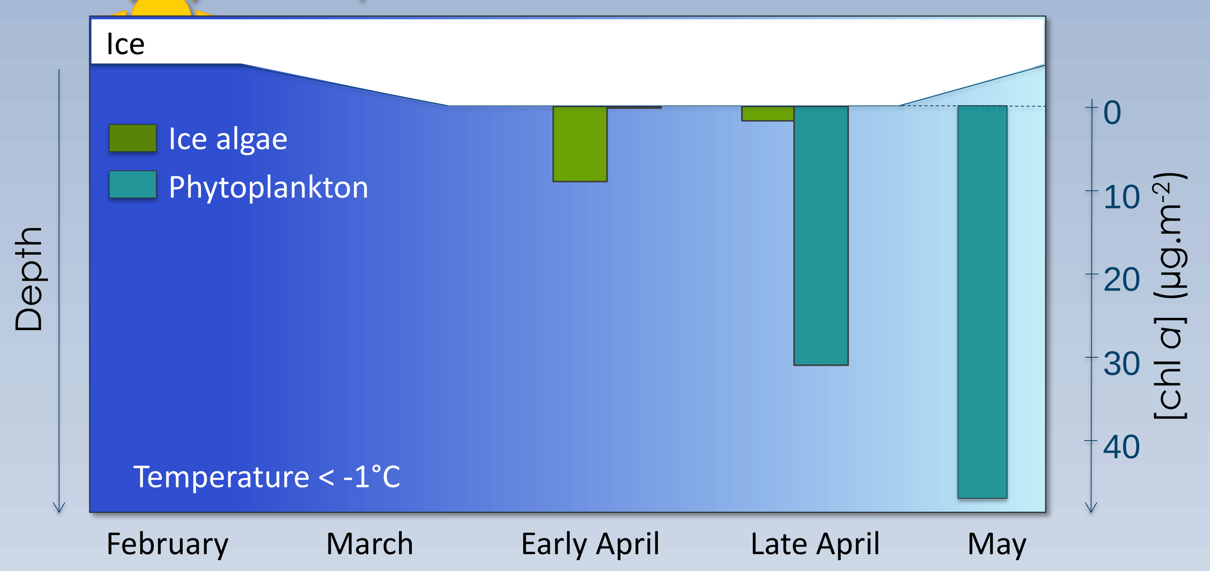
We combined field investigations and laboratory experiments to determine the importance of light and algal food for the development and growth of *Calanus glacialis* during the critical winter-spring transition time. Our main question was whether *C. glacialis* must feed before it molts from copepodid stage CIV to CV.

Material & methods

Field observations

In Billefjorden (78°N), from February to May 2013





→Population development

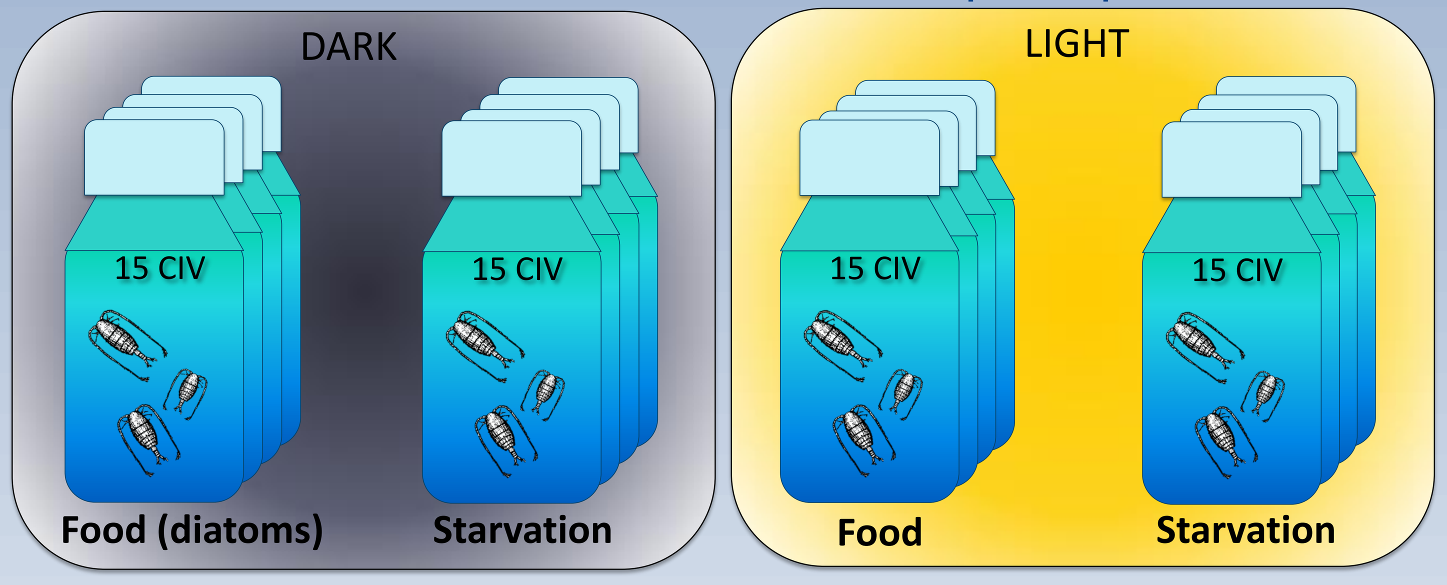
→Vertical distribution (180-100m, 100-50m, 50-20m, 20-0m)

→Nutritious status: total lipid (**TL**), polyunsaturated fatty acids (**PUFA**)

→Fatty acids (**FA**) and fatty alcohols (**Falc**) composition (GC analyses*)

One month experiment

- 4 treatments
- 4 replicates per treatment
- 15 CIV per replicate



→Monitoring of developmental rates (molting from CIV to CV)

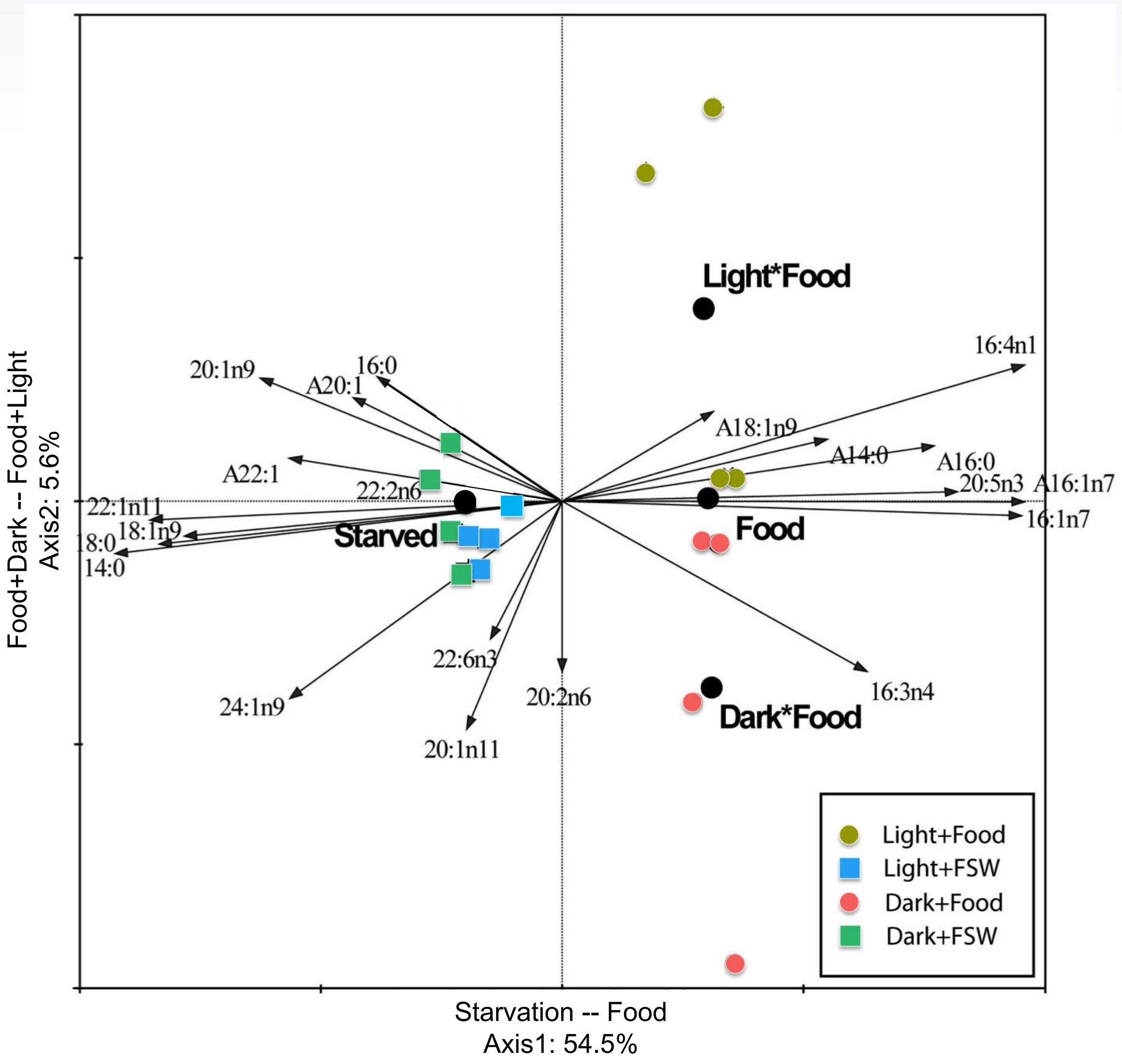
→Nutritious status: total lipid, polyunsaturated fatty acids

→Fatty acids and fatty alcohols composition (GC analyses*)

*Modified method from Foch *et al.* 1957

Results & discussion

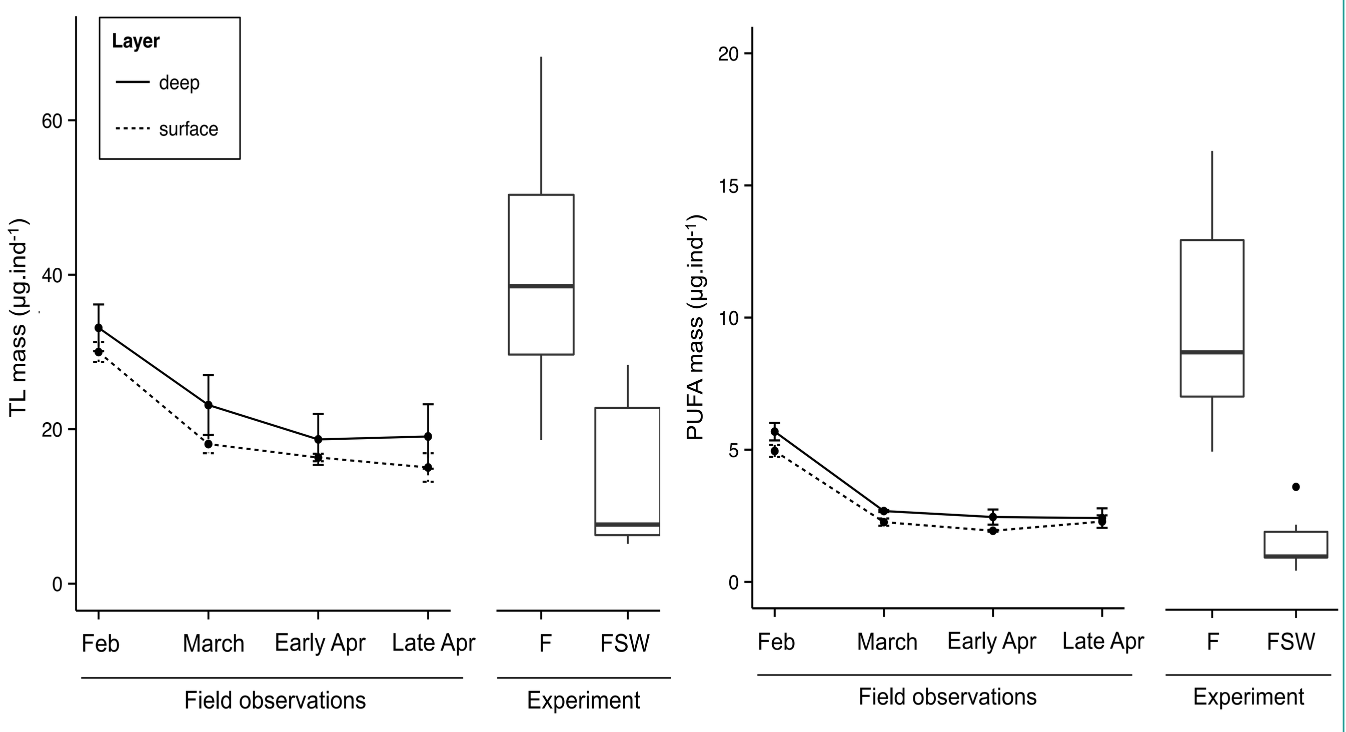
FA and Falc composition in *C. glacialis* at the end of the experiment



- Significant increase in diatom dietary FAs (C_{16} PUFAs, 20:5n3 and 16:1n7) in fed animals, and particularly in those exposed to light

→ **Food had a major impact on both lipid composition and lipid mass of *C. glacialis* with the highest mass-increase in those exposed to light**

TL and PUFA mass in field and at the end of the experiment, in treatments with food (F) and filtrated sea water (FSW)

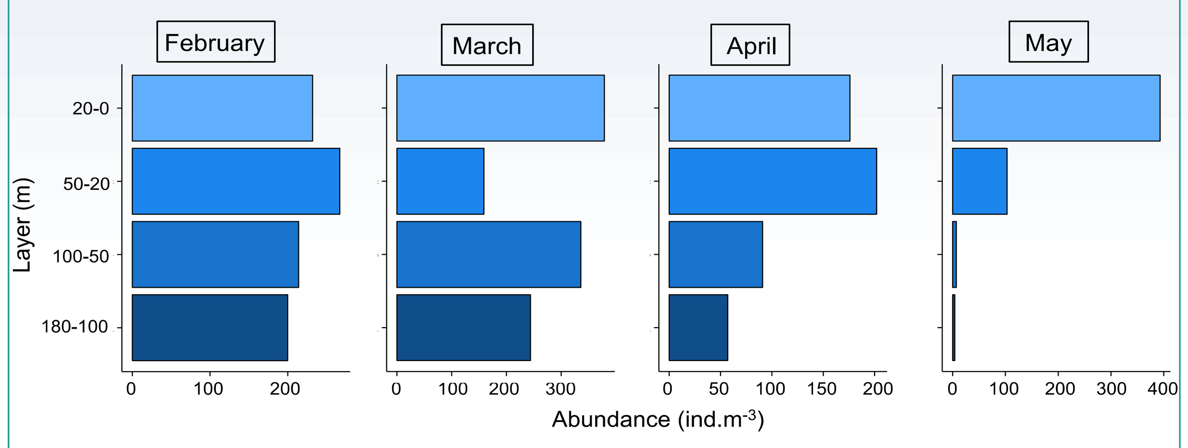


- TL and PUFA mass decreased from February to March (p<0.001)
- Starved individuals in the laboratory had similarly low TL and PUFA mass as those in field (p>0.05)

→ ***C. glacialis* metabolize stored lipids**

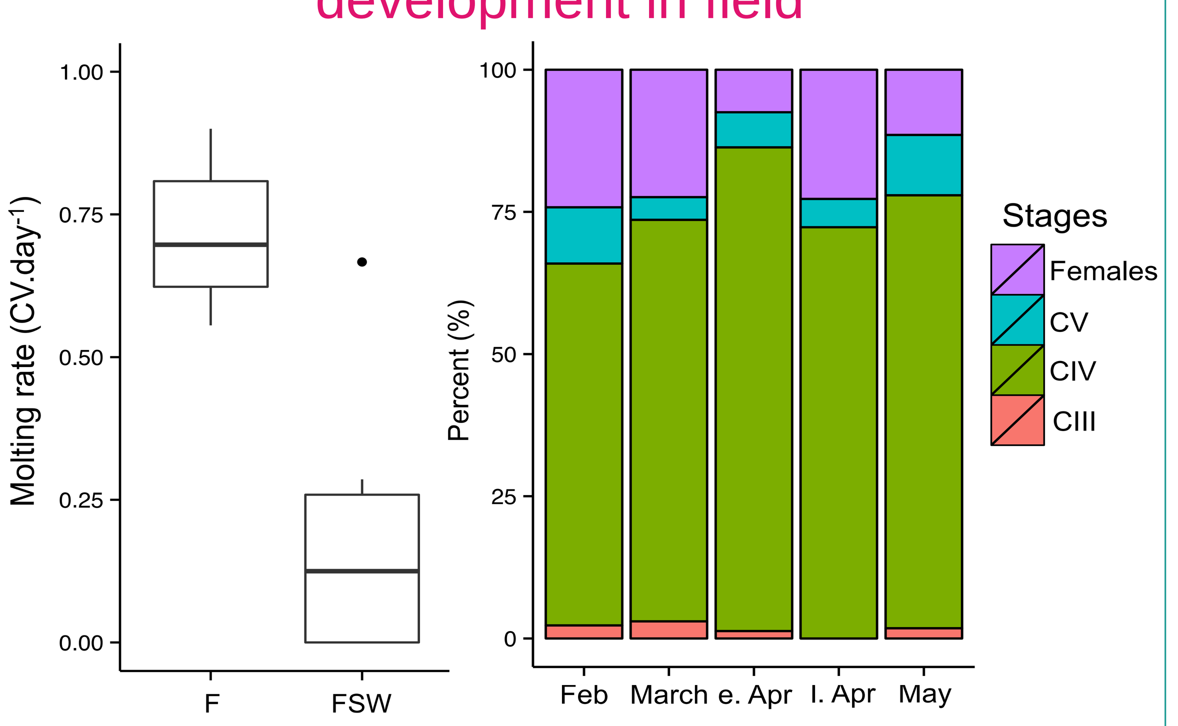
→**Time-lag from beginning of feeding to efficient assimilation of dietary fatty acids**

Vertical distribution of *C. glacialis*



- Seasonal ascent → **likely triggered by the return of the sun and algal food**

Daily molting rates in the lab - Population development in field



- Molting rates significantly higher (p<0.001) for fed animals
- No significant molting in field during the monitored time

→ **Molting from CIV to CV is food restricted with a response time of 3 weeks**

Conclusion

Timing of ascent is likely triggered by the return of the sun and partly by food. Timing of molt from CIV to CV is restricted by food.
The 3 weeks time-lag from feeding onset to molting suggests that efficient assimilation of ingested food is restricted by physiology (*e.g.* slow recovery of digestive enzyme activity after diapause). Sea ice algae may be an important «early-food» to physiologically prepare *C. glacialis* CIV to feed efficiently on the later phytoplankton bloom. A narrower time-window between the ice algal and phytoplankton blooms may lead to a mismatch since *C. glacialis* CIV may be too physiologically immature to assimilate the high-quality phytoplankton food typically found in an early bloom-phase.