Effects of Food and Temperature on The Lipid Accumulation Strategy of Arctic Copepods: Experimental Approach

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Rational

One of the most crucial organisms in Arctic and sub-Arctic food webs are large lipid rich copepods. Their size (2-7mm) and high energy content makes them directly sought after food source by pelagic fish, birds, and whales.

Lipid accumulation by copepods is a life history trait that makes them extremely successful in the highly seasonal environments – but if any processes, such as climate change, threatens this strategy the whole North Atlantic and Arctic ecosystem could tip/collapse.

Increased glacial melt due to increasing temperatures in the Arctic regions is causing freshening of oceans with increased stratification, that is predicted to affect phytoplankton community structure from larger diatoms towards dominance of smaller flagellate & dinoflagellates.

Therefore, an important question is, Will increasing temperatures, freshening and predicted phytoplankton change in the Arctic affect copepod lipid accumulation rate and type? The lipid type accumulated, wax esters (WE), is crucial for maintaining the life history trait of entering diapause at depth, and the structure and composition of the WE depends on the food source.

Experiment - Methods

Fed ad libitum mixture of :
Rhodomonas baltica – cryptophyte 8µm R
Thalassiosira weissflogii – diatom 12µm T
Heterocapsa triquetra – dinoflagellate 17µm H

Calanus finmarchicus females from Disko Bay, Greenland were fed mixture of RTH and eggs harvested over 2-3 days, let hatch and fed a mixture of RTH food till reaching stage C1 (ca 3 weeks).

9 treatments: 3 food types, 2 temperatures, 2 salinities
Started with stage C1 and let terminated when the copepods had reached stages C4 and C5

Rhodomonas		*Thalassiosira*		*Heterocapsa*	
5°C	28 PSU	5°C	28 PSU	5°C	28 PSU
	33 PSU		33 PSU		33 PSU
7°C	33 PSU	7°C	33 PSU	7°C	33 PSU

$WE\ (mg) = 0.167 \times A^{1.42}$

Vogedes et al. 2010 JPR

C4 and C5
- ✓ Photo
- ✓ Length
- ✓ Lipid sack
- ✓ Intact WE

Results

1. Visual difference between food treatments

R. baltica

T. weissflogii

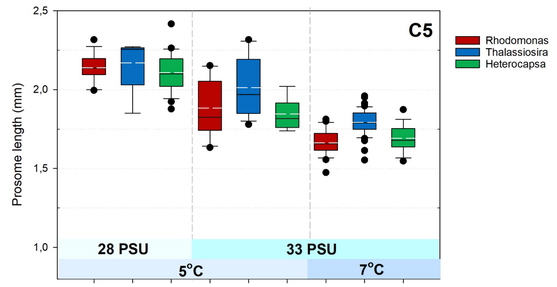
H. triquetra

The oil sac was clearly most prominent in the copepodites that had fed on the diatom, *T. weissflogii* and less so in the ones that had fed on *H. triquetra* or *R. baltica*. Photos from trial 7°C, 33 PSU.

Results cont.

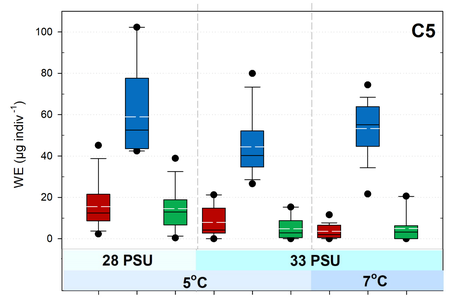
2. Size

⏚No significant difference in size within treatments ⏚C5 were smaller at 7°C compared to the 5°C treatment. ⏚Salinity did not affect size



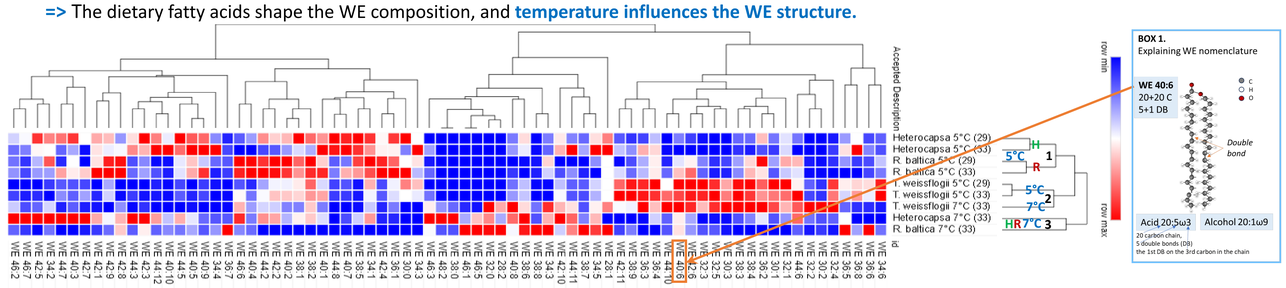
3. Wax ester content

The lipid sack (Wax esters) is significantly larger in the copepods feeding on the **diatom**, compared to the **flagellate** and **dinoflagellate** diets



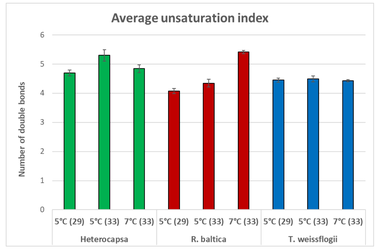
4. Wax ester composition – intact WE

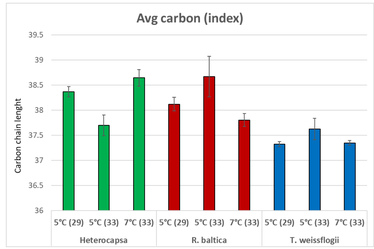
The heat plot shows the relative composition of different wax ester types (see explanation box) ranging from 28 – 46 carbon and 0-12 double bonds. Cluster analysis shows 3 main groups: 1) RH at 5°C 2) T at both 5 and 7°C and 3) RH at 7°C.
=> The dietary fatty acids shape the WE composition, and **temperature influences the WE structure.**



WE Saturation and chain length
The average WE saturation index (# DB) was lowest for T < R < H (4.5, 4.6, 4.9 DB).

The average WE carbon chain length was lowest for T < R = H (27, 28.2, 28.2 Carbon). With some non-consistent treatment variation.





Conclusion:

⏚**Change in the food environment from diatom to flagellate/dinoflagellate based diets due to ocean warming in the Arctic and Subarctic Seas, can be detrimental for the copepod life history trait of lipid accumulation and thus survival at depth during diapause**

⏚**This could have serious consequences for the Polar and sub-polar marine ecosystems.**