Benoit Lebreton[4], Carmen David[1,2], Hauke Flores[1,2]

[1] Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung, Bremerhaven, Germany
[2] University of Hamburg, Zoological Institute and Museum, Hamburg, Germany
[3] Wageningen Marine Research, Den Helder, The Netherlands
[4] UMR Littoral, Environnement et Sociétés (CNRS-Université de La Rochelle), Institut du Littoral et de l'Environnement, La Rochelle, France

ALFRED-WEGENER-INSTITUT
HELMHOLTZ-ZENTRUM FÜR POLAR- UND MEERESFORSCHUNG

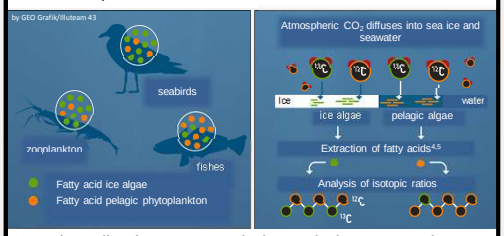
Sea ice algae as food source

High trophic dependency of important energy transmitters in the central Arctic Ocean

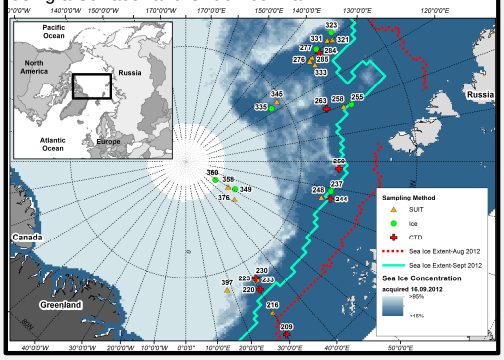
Polar ecosystems thrive significantly on carbon synthesized by sea ice-associated microalgae during long periods of the year. Continued alterations of the sea ice system might not only have dramatic consequences for the sympagic (ice-associated) ecosystem, but will also have a large impact on the pelagic food web due to the close connectivity between the sea ice and the pelagic system. Thus, it is crucial to identify to which extent ecologically important species in the Arctic Ocean trophically depend on ice algae-produced carbon versus carbon produced by pelagic phytoplankton.

METHODS

From the natural distribution of marker fatty acids[1] and fatty acid-specific carbon stable isotope compositions, we estimated the proportional contribution of ice algae-produced carbon to the carbon budget of important under-ice fauna species.

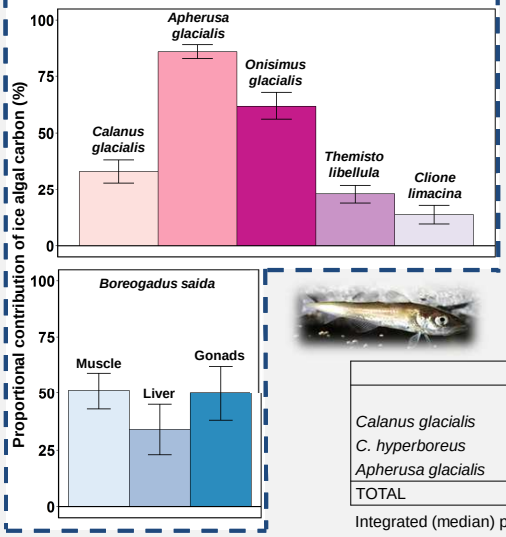


Sample collection was carried out during RV *'Polarstern'* expedition PS80 in the central Arctic Ocean north of 80°N using a Surface- and Under-ice Trawl[2].

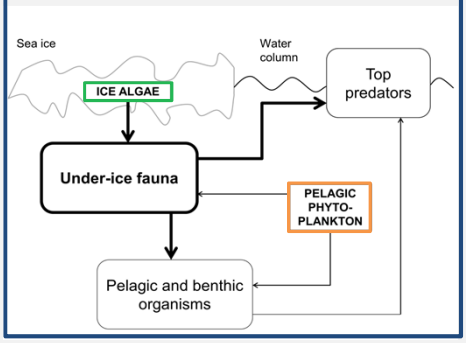


RESULTS- Mixing Models[3]

Based on the isotopic information of the fatty acids 20:5n-3 and 22:6n-3, **stable isotope mixing models** were applied to quantify the proportional contribution of ice algal carbon to the body carbon of the consumers[4, 5].

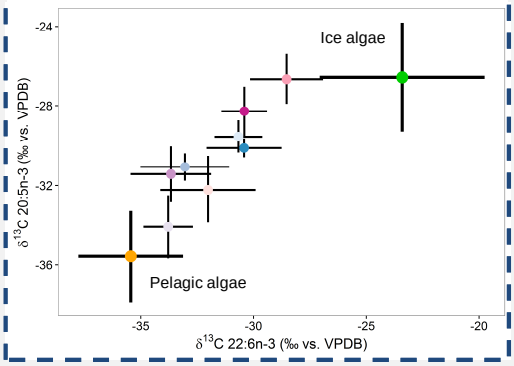


Under ice community: Transferring ice algae-produced carbon into associated food webs



RESULTS- Compound-specific stable isotope analysis

Carbon stable isotope values $\delta^{13}C$ in ice algae were higher than in pelagic algae, allowing for the differentiation of carbon sources in the consumers.



DISCUSSION

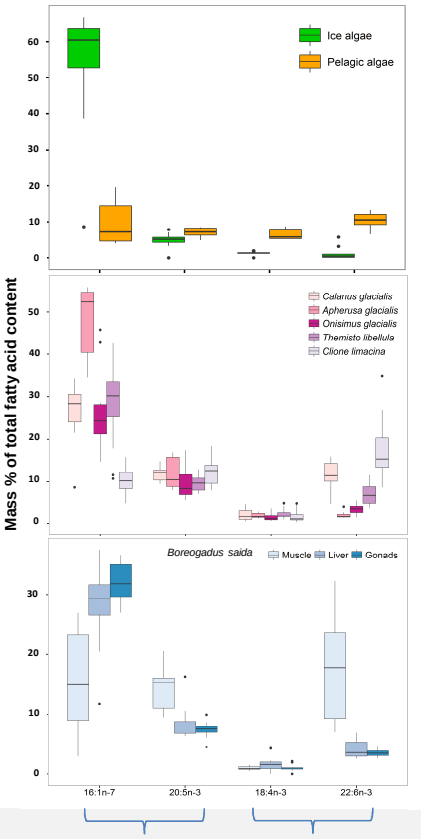
Our results showed an Arctic under-ice community with gradual differences in the dependency on ice algae-produced carbon. Ice-associated amphipods thrive significantly on ice algal carbon in the central Arctic Ocean. Surprising was the significant contribution of ice algal carbon to the carbon budget of predominantly pelagic species, e.g. *Calanus* spp., *Themisto libellula*.

Ice algal carbon demand (mg C m^{-2} d^{-1})			
	Under-ice	Pelagic	Total
Calanus glacialis	0.01-0.04	2.3-7.0	2.3-7.1
C. hyperboreus	0.00	0.5-1.5	0.5-1.5
Apherusa glacialis	0.01	0.00	0.01
TOTAL	0.02-0.05	2.8-8.5	**2.9-8.5**

Integrated (median) primary production rate by ice algae[6]: **0.7** mg C m^{-2} d^{-1}

RESULTS- Fatty acid analysis

Fatty acid profiles of ice algae were dominated by diatom-associated fatty acids. Pelagic algae had higher proportions of dinoflagellate-associated fatty acids, indicating a mixed taxonomic composition in the water column.



Conclusions

The Arctic sea ice-water interface is a functional node transmitting carbon from sea ice into the pelagic food web. Changes in sea ice properties will likely first impact on the sympagic food web, but will subsequently affect the pelagic system.

References

[1] Folch, J., Lees, M., Stanley, G.H.S. A simple method for the isolation and purification of total lipids from animal tissues. *J. Biol. Chem.* **226**, 497-509 (1957)
[2] van Franeker, J. A., Flores, H., van Dorssen, M. The Surface and Under Ice Trawl (SUIT). Frozen Desert Alive- The role of sea ice for pelagic macrofauna and its preadators, PhD thesis, University of Groningen, 181-188 (2009)
[3] Parnell, A. C., Inger, R., Bearhop, S., Jackson, A. L. Source partitioning using stable isotopes: coping with too mich variation. *PloS one* **5**, e9672 (2010)
[4] Kohlbach, D., Graeve, M., Lange, B. A., David, C., Peeken, I., Flores, H. The importance of ice algae-produced carbon in the central Arctic Ocean ecosystem: Food web relationships revealed by lipid and stable isotope analyses. *Limnol. Oceanogr.* **61**, 2027-2044 (2016)
[5] Kohlbach, D., Schaafsma, F. L., Graeve, M., Lebreton, B., Lange, B. A., David, C., Vortkamp, M., Flores, H. The importance of ice algae-produced carbon in the central Arctic Ocean ecosystem: food web relationships revealed by lipid and stable isotope analyses. Under review
[6] Fernández-Méndez, M. Primary productivity in Arctic sea ice and ocean. PhD thesis, University of Bremen (2014)

Iceflux project- Ice-ecosystem carbon flux in polar oceans

Corresponding author: doreen.kohlbach@awi.de