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On the importance of ice algae-based energy in a summerly Arctic Ocean

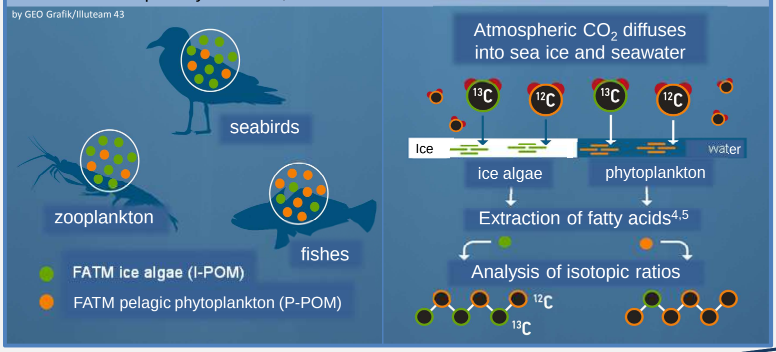
Food web insights revealed by biomarker approaches

by GEO Grafik/Illuteam 43

The underside of sea ice in polar regions represents a natural habitat for heterotrophic organisms, e.g. copepods and amphipods. These organisms constitute the under-ice community, which plays a key role in transferring ice algae-produced carbon into pelagic and benthic food webs of polar ecosystems. Animals at higher trophic levels show an indirect dependency on microalgae-produced biomass. In order to improve our understanding of the potential ecological consequences of a changing sea ice environment, we aim to quantify the extent to which ice algae-produced carbon is channelled into the under-ice community, and from there to pelagic food webs.

Methods.

Trophic interactions of abundant under-ice zooplankton were studied using **bulk stable isotope analysis (BSIA)** of natural abundance carbon and nitrogen[1], **fatty acid trophic marker (FATM) fingerprinting**, and **compound-specific SIA (CSIA)** of FATMs[2].
Sample collection was carried out during ARK XXVII-3 expedition of RV Polarstern (August-September 2012) within the Eastern Central Arctic Ocean north of 80°N. The under-ice habitat was sampled by the SUIT, the Surface and Under-Ice Trawl[3].



Results.

Based on fatty acid patterns, copepods *C. glacialis* and *C. hyperboreus* were feeding on both, ice algae and pelagic phytoplankton. Several amphipod species demonstrated high amounts of diatom-related fatty acids. Besides, *T. libellula* and *O. glacialis* indicated *Calanus*-integrated diets.
Based on diatom-specific FA 20:5(n-3), FA material derived from ice algae accounted for averaged 56 % in zooplanktonic consumers (**Table 1**).

Dinoflagellates are the main taxonomic group of P-POM, diatoms of I-POM. Taxonomic composition of I-POM and P-POM communities can be similar, e.g. diatoms can occur in both communities.

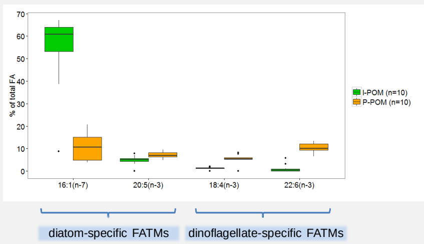
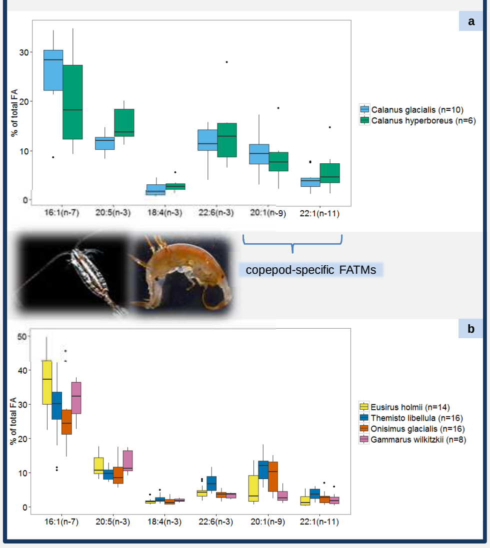


Fig. 1. FATM proportions of primary producers defined on total fatty acid content. Pelagic phytoplankton is abbreviated as P-POM, ice algae as I-POM.

FATMs are not getting biotransformed by consumers and are therefore originally traceable along marine food chains.

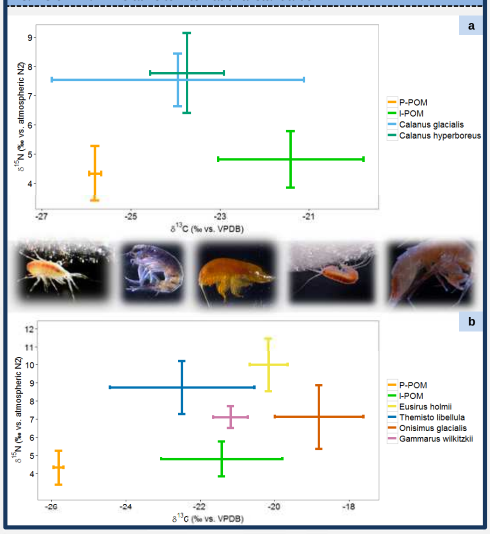
FATM FINGERPRINTING

Fig. 2. FATM proportions of Arctic copepods (**a**) and amphipods (**b**) defined on total fatty acid content.



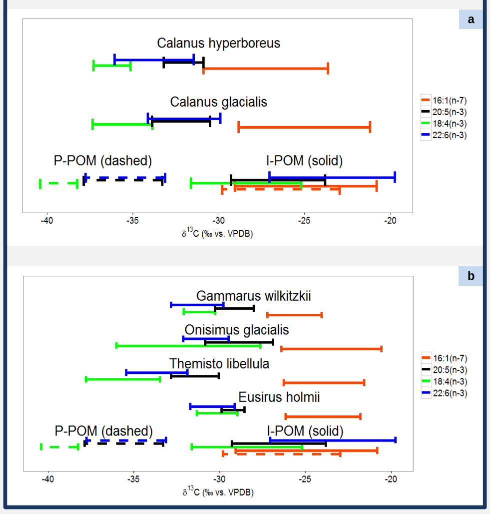
BSIA

Fig. 3. Stable isotope compositions of bulk carbon and nitrogen compounds for Arctic copepods (**a**) and amphipods (**b**). Isotopic ratios are expressed as: $\delta X = [(R_{Sample}/R_{Standard})-1] \times 1000$, where X is $\delta^{13}C$ or $\delta^{15}N$ and R_{Sample} represents $^{13}C/^{12}C$ or $^{15}N/^{14}N$ relative to international standards.



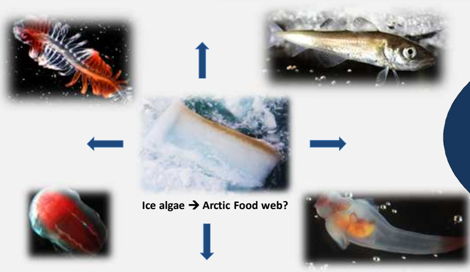
CSIA

Fig. 4. Compound-specific stable isotopic compositions of FATMs for Arctic copepods (**a**) and amphipods (**b**).
Extracted FATMs were separated by gas chromatography and individually analyzed in regard to their carbon stable isotope patterns.



Differences in $\delta^{13}C$ between primary producers allow quantification of proportional distribution of ice algae-derived carbon x in consumers based on certain FATMs (Two-end-member mixing model, [Table 1])[2].

Species	$x_{20:5(n-3)}$	$x_{22:6(n3)}$
Calanus glacialis	37.3±18.6	28.4±17.6
Calanus hyperboreus	39.1±16.7	16.7±15.0
Eusirus holmii	70.5±7.5	41.8±10.8
Themisto libellula	45.8±15.5	14.7±14.9
Onisimus glacialis	74.3±21.9	38.6±11.0
Gammarus wilkitzkii	71.3±12.6	34.3±12.7



Conclusions.

Fatty acid signatures reflect the potential carbon sources, which are supported by stable isotope values.
Even in summer, ice algae-produced carbon plays an important role for the diet of Arctic ecological key species.

References
[1] Søreide , J. E., Carroll, M. L., Hop, H., Ambrose, W. G., Hegseth, E. N., Falk-Petersen, S. Sympagic-pelagic-benthic coupling in Arctic and Atlantic waters around Svalbard revealed by stable isotopic and fatty acid tracers. *Mar. Biol. Res.,* **9**, 831-850 (2013)
[2] Budge, S. M., Wooller, M. J., Springer, A. M., Iverson, S. J., McRoy, C. P., Divoky, G. J. Tracing carbon flow in an arctic marine food web using fatty acid-stable isotope analysis. *Oecol.,* **157**, 117-129 (2008)
[3] 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)
[4] 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)
[5] Bligh, E.G., Dyer, W.J. A rapid method of total lipid extraction and purification. *Can. J. Biochem. Physiol*., **37**, 911-917 (1959)

Iceflux project-
Ice-ecosystem carbon flux in polar oceans

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