Carbon sources of Antarctic Krill species:

Evaluating regional and seasonal variability in ice-covered waters using lipid and stable isotope analyses

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Iceflux project- Ice-ecosystem carbon flux in polar oceans

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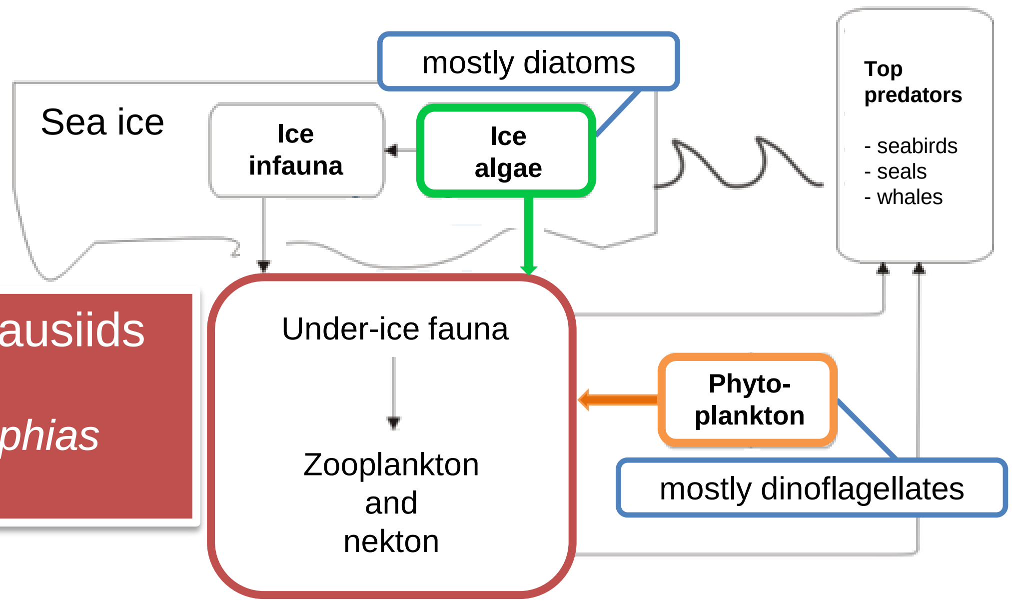
Background

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



Antarctic euphausiids

- *E. superba*
- *E. crystallorophias*
- *T. macrura*

Still unknown:

- Extent of dependency on ice-related primary production
- Potential ecological consequences of changing sea ice environment

Objectives

- Evaluating the contribution of ice-algae produced carbon to the diet of Antarctic euphausiids for

  - Different **seasons**
    - Austral winter/early spring 2013
    - Austral summer 2014

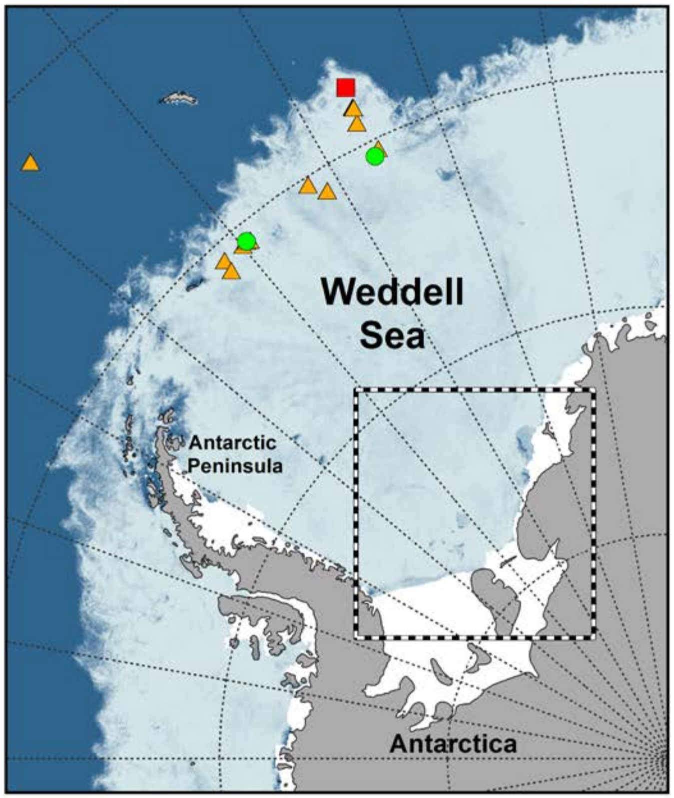
  - Different **regions**
    - Northern Weddell Sea (2013)
    - Filchner region (2014)

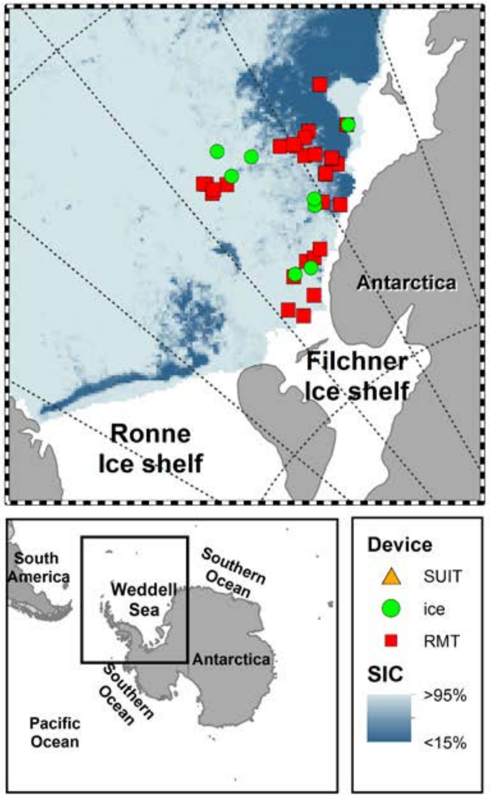
  - Different **developmental stages**
    - Larvae, juveniles, adults

HELMHOLTZ ASSOCIATION

Sample collection

Austral winter/spring 2013 **Austral summer 2014**



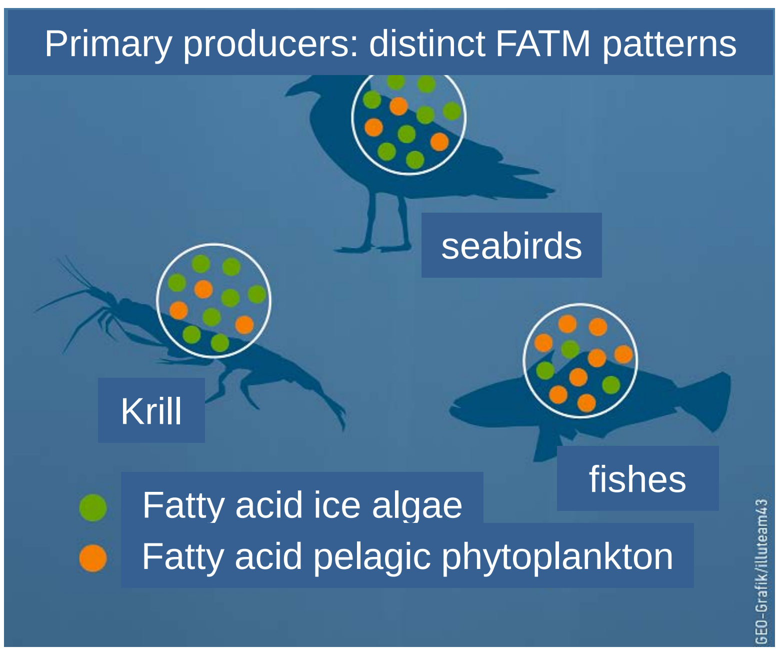


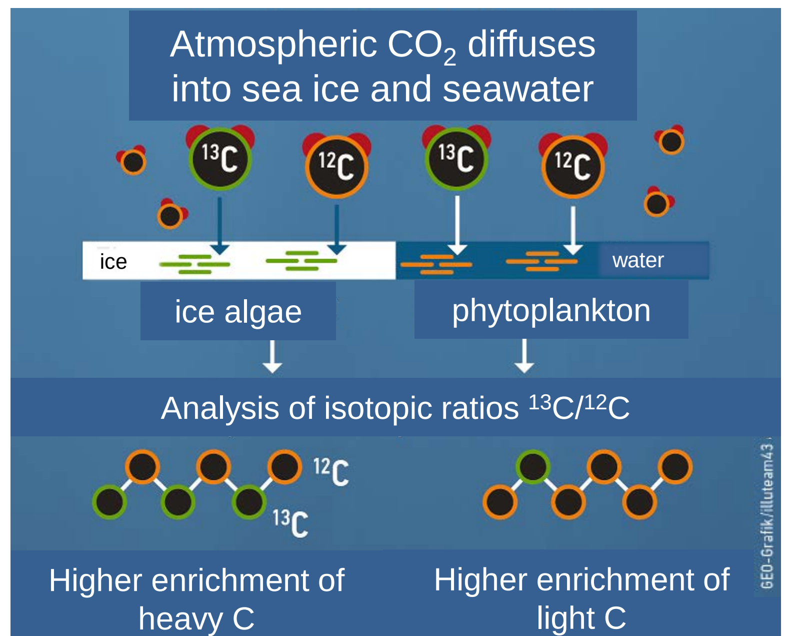
SUIT
Surface and **U**nder-**I**ce **T**rawl

RMT
Rectangular **M**idwater **T**rawl

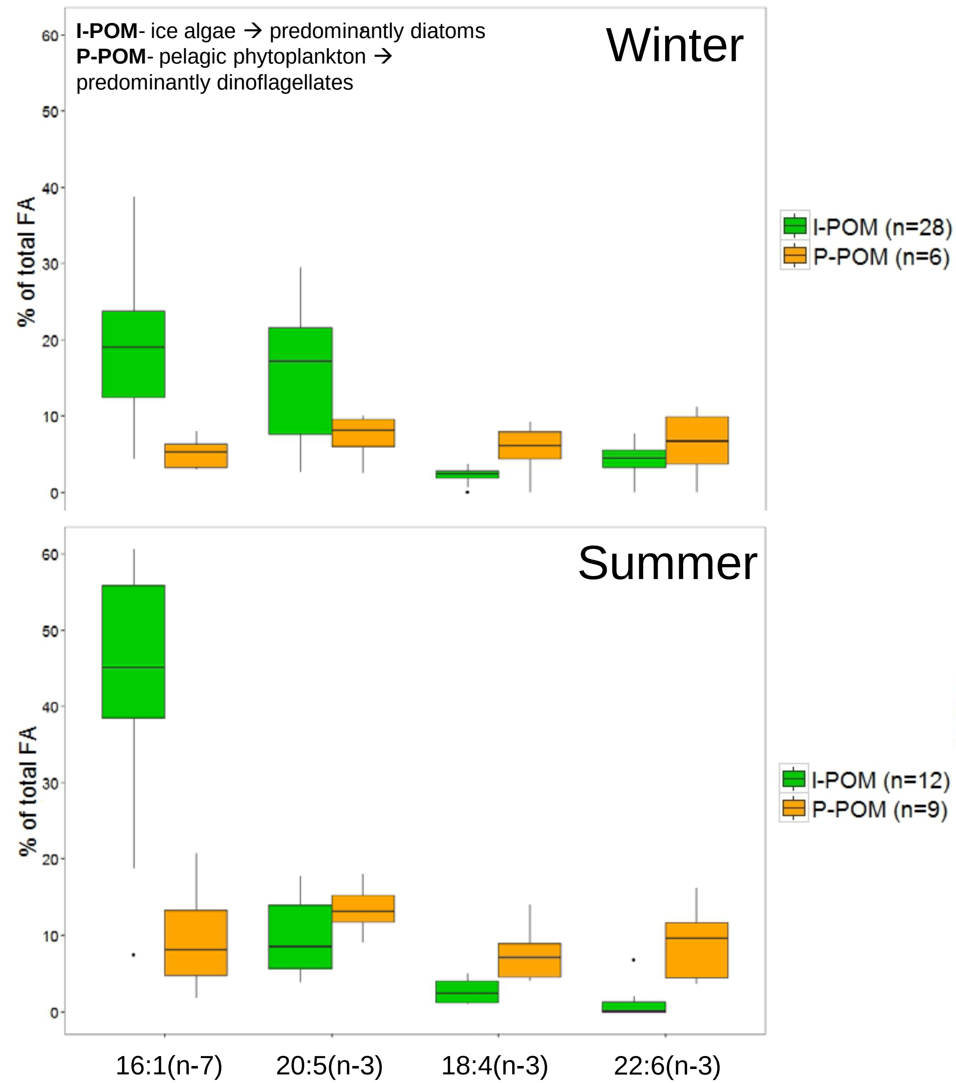
Methods

- Investigation of lipid content and stable isotope composition
  - **Fatty acid composition**: qualitative evaluation of diets using **F**atty **A**cid **T**rophic **M**arkers (**FATM**)- *Gas chromatography* (GC)
  - **Lipid class composition**: qualitative evaluation of energy storage modes, condition- *High performance liquid chromatography* (HPLC)
  - **Bulk stable isotope composition**: highlight the contribution of ice algae produced carbon- *Isotope ratio mass spectrometry* (IRMS)



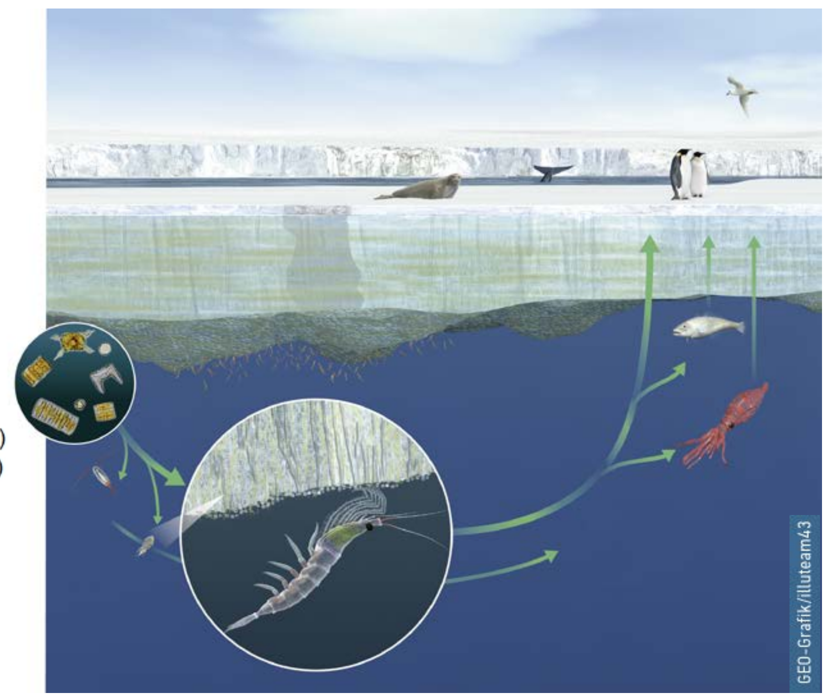


Results- *Primary producers*



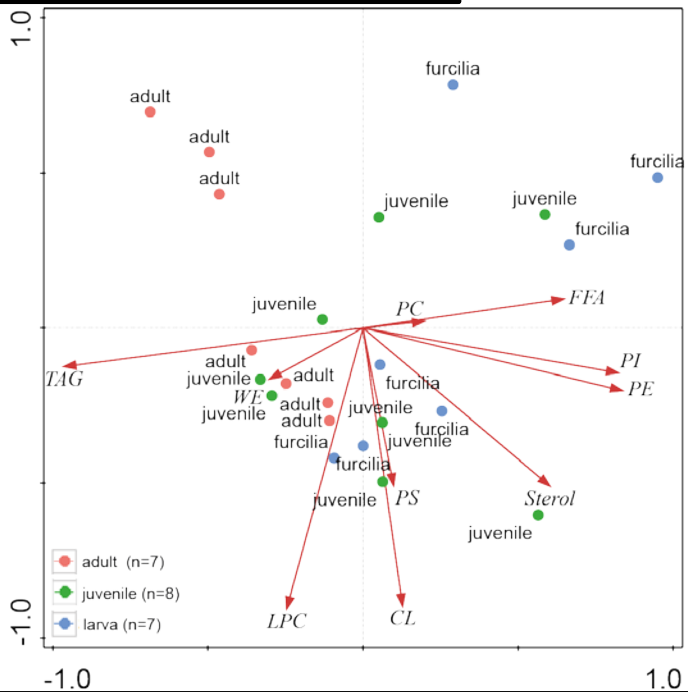
FATM

- 16:1(n-7), 20:5(n-3) — Diatom-specific
- 18:4(n-3), 22:6(n-3) — Dinoflagellate-specific



Results- Winter/spring 2013

Lipid class analysis



Main storage lipid: TAG
→ ontogenetic differences

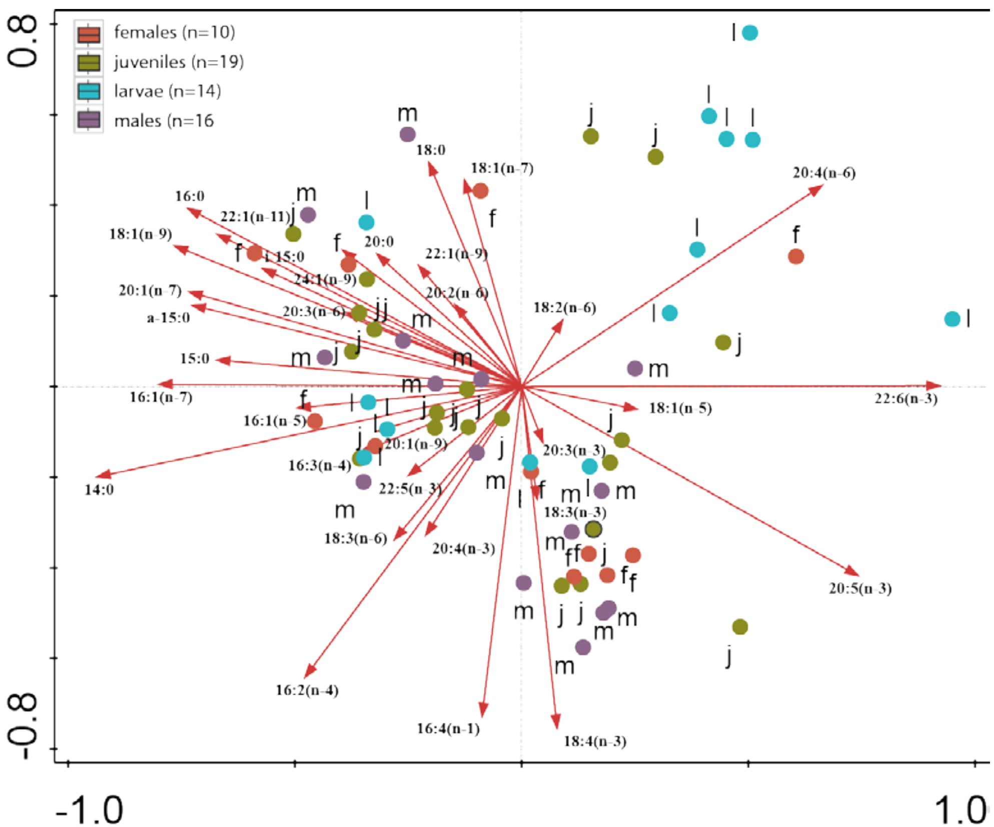
%	Storage lipids
adult (n=7)	46.1 ± 9.6
juvenile (n=9)	32.8 ± 9.8
larva (n=7)	30.4 ± 11.2

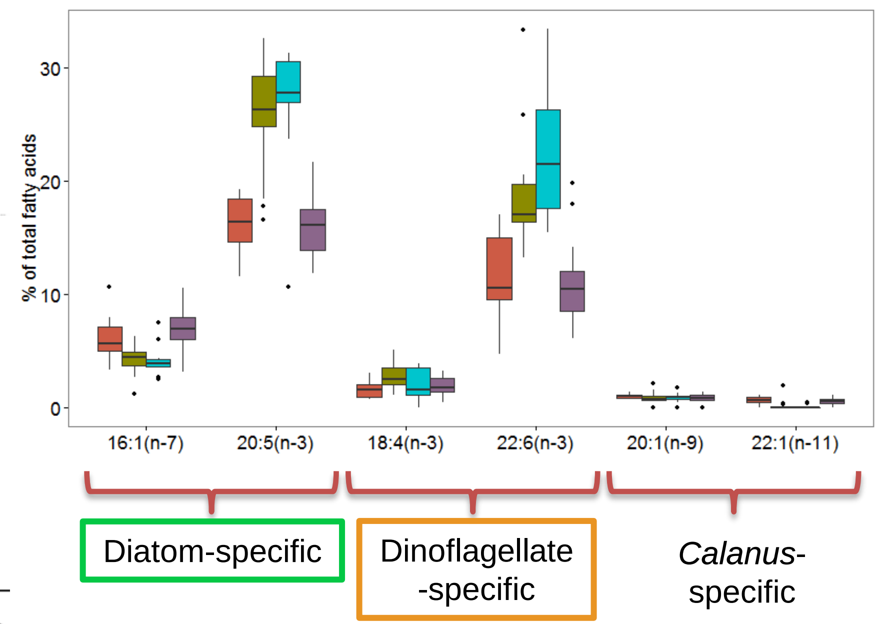
%	Neutral Lipids			Polar Lipids		
	TAG (Triacylglycerol)	St (Sterol)	FFA (Free fatty acid)	PE (Phosphatidyl-ethanolamine)	PI (Phosphatidyl-inositol)	PC (Phosphatidyl-choline)
adult	39.4 ± 10.8	2.9 ± 1.7	3.7 ± 1.2	9.6 ± 3.7	0.6 ± 0.7	41.2 ± 5.0
juvenile	20.3 ± 13.1	6.2 ± 2.9	6.1 ± 2.3	17.8 ± 6.2	2.5 ± 1.3	42.4 ± 3.4
furcilia	12.2 ± 10.1	6.4 ± 4.6	6.7 ± 2.0	19.8 ± 5.1	4.7 ± 1.6	42.1 ± 7.9

Results- Winter/spring 2013

FATM analysis

Euphausia superba stages + adults

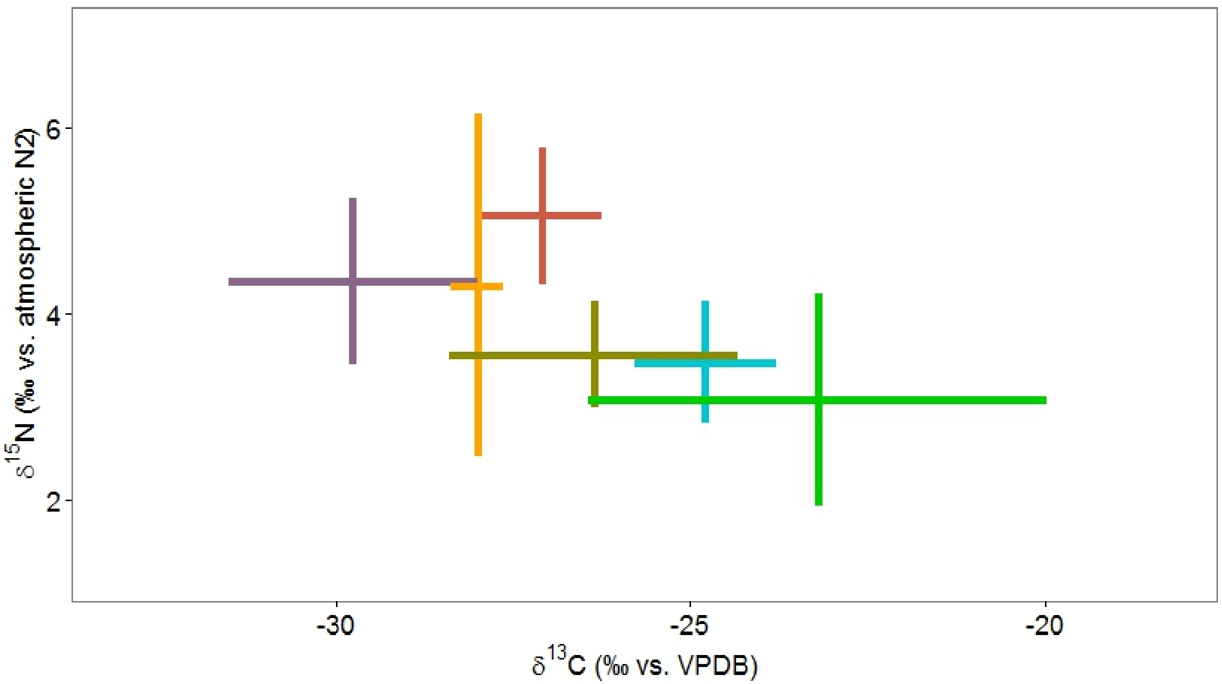




- Ontogenetic differences between early developmental stages and adults
- No *Calanus*-based diet

Results- Winter/spring 2013

Bulk stable isotope analysis

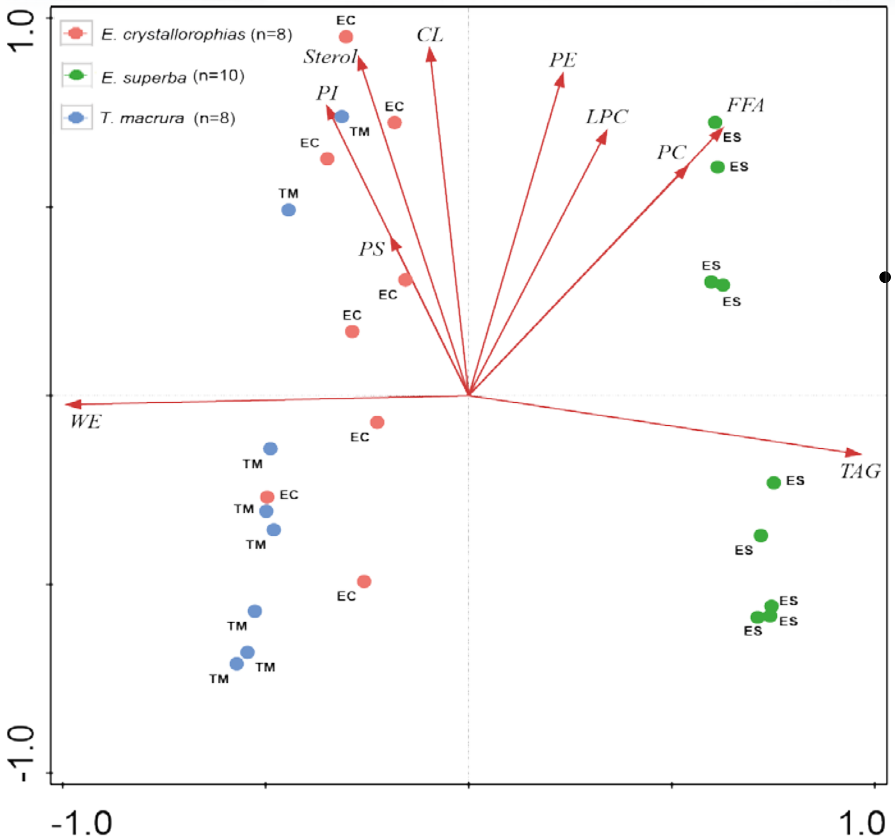


%	Proportional contribution ice algae carbon α[1]
larva	57.5 ± 16.8
juvenile	35.7 ± 26.5
male	0 ± 0
female	14.3 ± 12.4

- Adults: higher enrichment of heavy N → higher trophic level, higher degree of carnivory
- Larvae: higher enrichment of heavy C → higher contribution of ice algae-produced carbon to diet

[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)

Results- Summer 2014



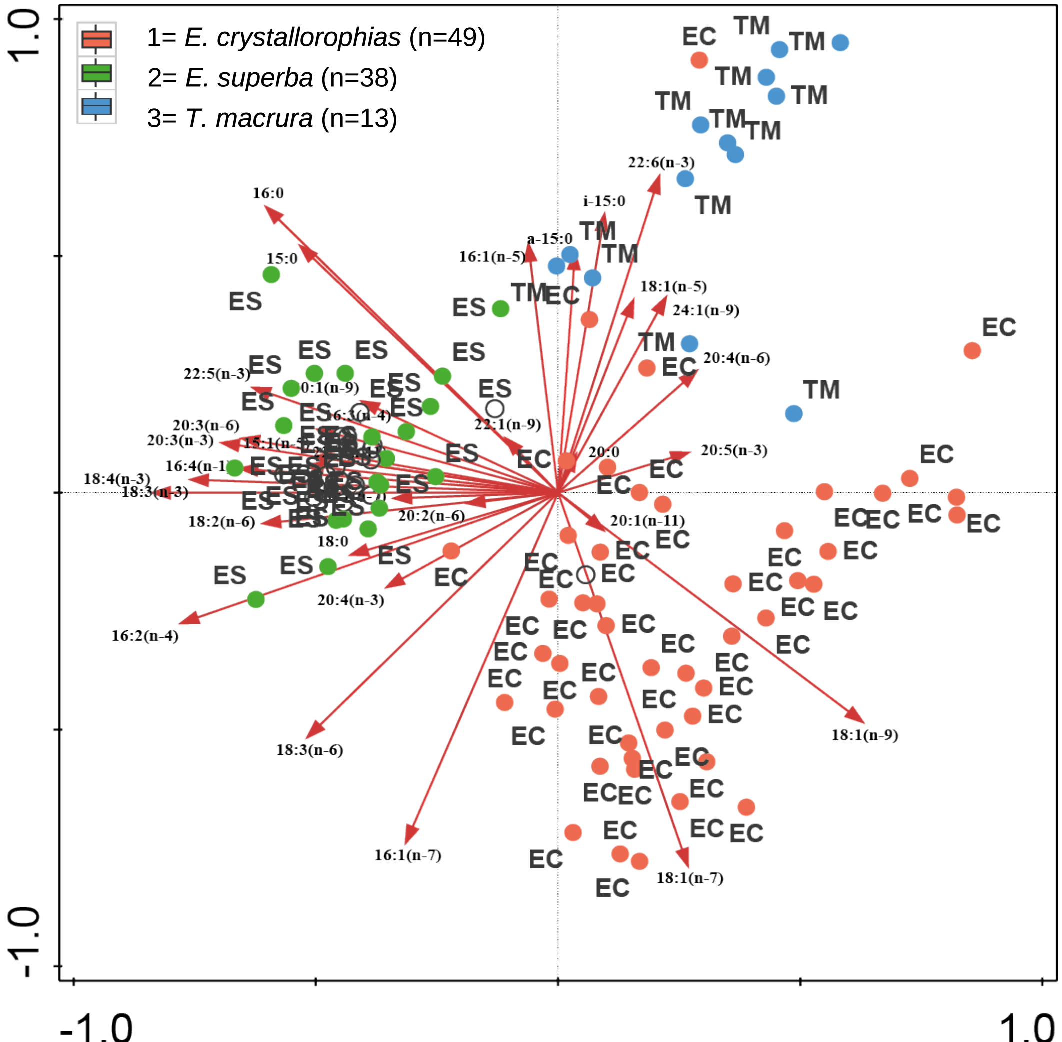
Lipid class analysis

- Main storage lipids:
  TAG in *E. superba*
  WE in *E. crystallorophias* and *T. macrura*

%	Neutral (storage) lipids
E. crystallorophias (n=8)	50.2 ± 7.8
E. superba (n=10)	44.2 ± 12.7
T. macrura (n=8)	57.3 ± 15.3

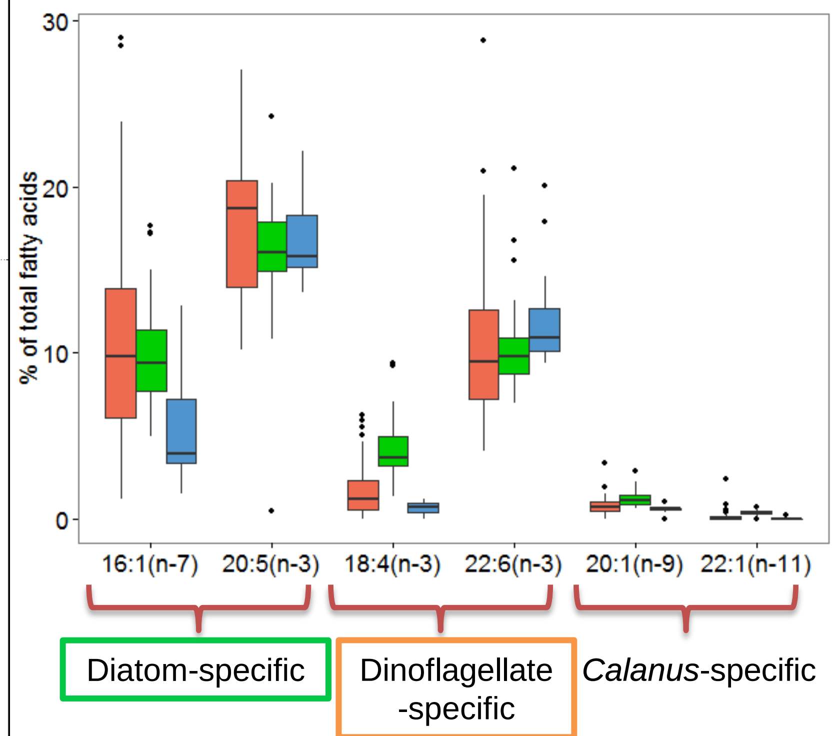
%	Neutral Lipids			Polar Lipids		
	WE (Wax ester)	TAG (Triacyl-glycerol)	FFA (Free fatty acid)	PE (Phosphatidyl-ethanolamine)	PI (Phosphatidyl-inositol)	PC (Phosphatidyl-choline)
E. crystallorophias	41.1 ± 11.1	3.3 ± 2.7	4.0 ± 4.1	7.7 ± 3.1	1.7 ± 1.4	38.1 ± 3.9
E. superba	0.2 ± 0.2	35.7 ± 17.8	7.0 ± 5.2	6.8 ± 3.3	0.7 ± 0.7	46.4 ± 8.6
T. macrura	54.6 ± 17.3	0.6 ± 0.2	0.9 ± 0.8	4.2 ± 4.0	2.1 ± 2.5	35.6 ± 8.3

Results- Summer 2014



FATM analysis

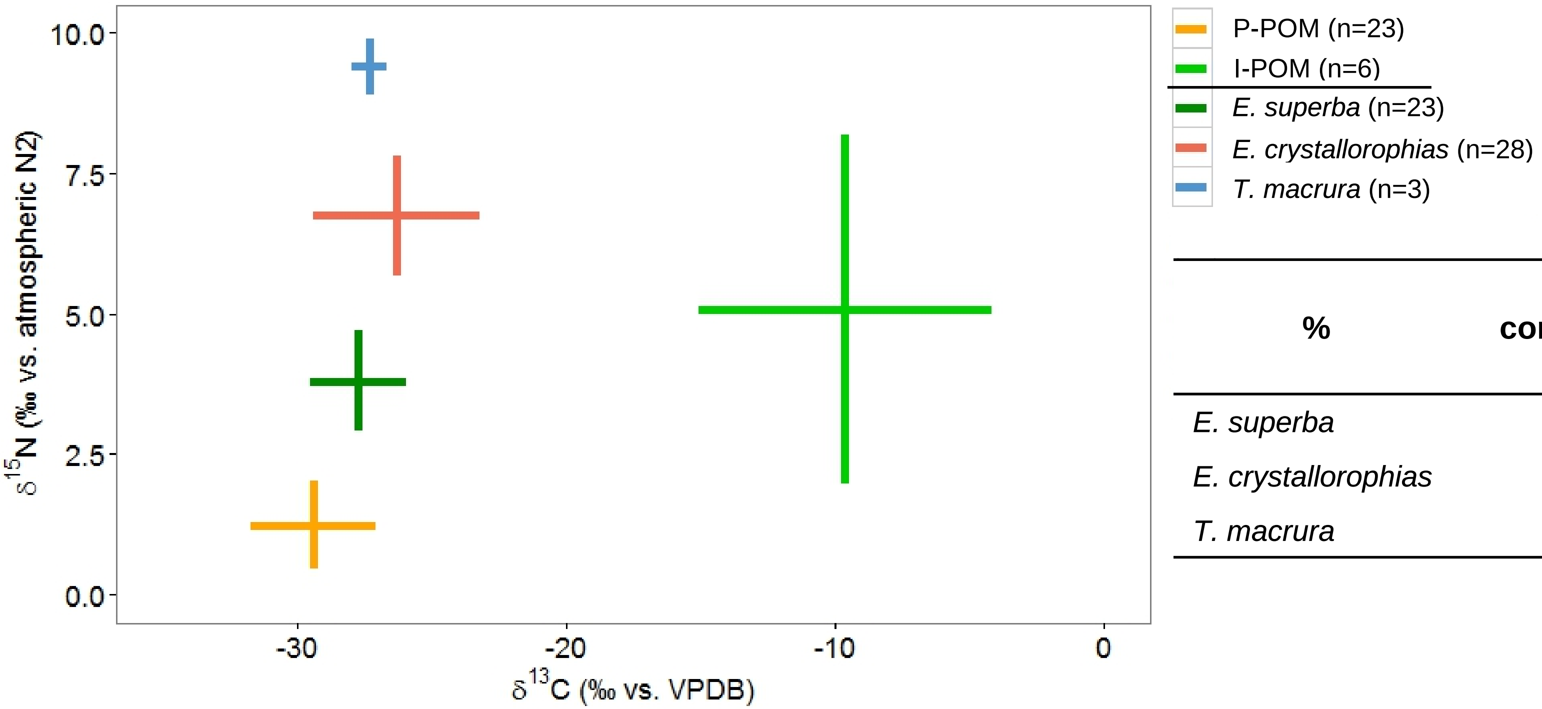
3 adult krill species



- species-specific FA pattern
- No *Calanus*-based diet

Results- Summer 2014

Bulk stable isotope analysis



%	Proportional contribution ice algae carbon α
E. superba	8.8 ± 7.6
E. crystallorophias	15.8 ± 14.8
T. macrura	10.1 ± 3.3

- Low contribution of ice algae derived carbon to all euphausiids
- *T. macrura*: highest degree of carnivory

Summary & Conclusions

- **FATM**
  - distinct patterns for I-POM, P-POM, and all euphausiid species
  - higher amounts of 20:5(n-3) and 22:6(n-3) in early *E. superba* stages

- **Lipid classes**
  - different storage modes for different species
  - high amounts of polar (membrane) lipids, especially in *E. superba*
  - higher amounts of membrane lipids in early *E. superba* stages (20:5(n-3) and 22:6(n-3)= membrane FA)

- **BSIA**
  - I-POM more enriched in heavy carbon stable isotope in summerly Filchner area
  - high similarity in $\delta^{15}N$ and $\delta^{13}C$ for *E. superba* in both datasets
  - winter/spring: highest ^{13}C enrichment in *E. superba* larvae
  - summer: highest degree of carnivory in *T. macrura* → dilution of baseline signal with increasing trophic level

Carbon sources of Antarctic Krill species not clearly determinable by FATM patterns → BSI patterns indicate a more pelagic related diet for both regions and seasons

Thank you!

Iceflux & Marine Chemistry team

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