Differential feeding behavior of three coexisting krill species in the St. Lawrence estuary (Canada): a fatty acid and stable isotope approach

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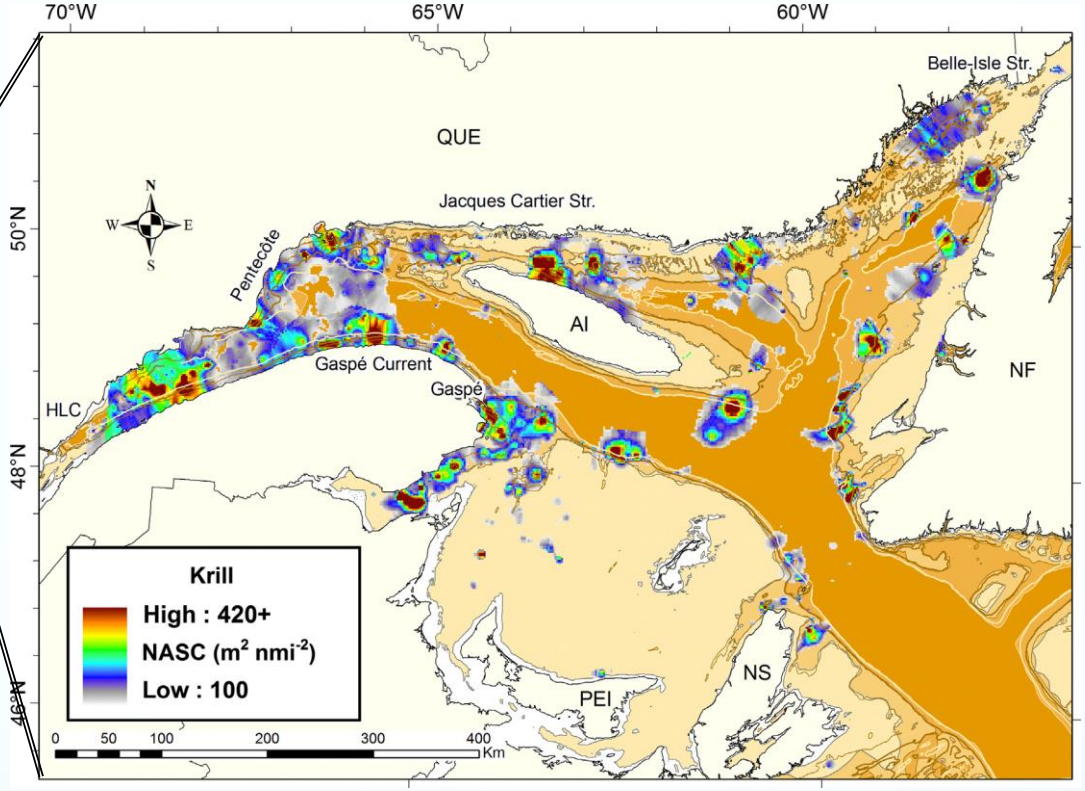
9-13 May 2016

Krill in the St. Lawrence system



Estimated biomass (2014):
1 million tons

McQuinn et al., 2015

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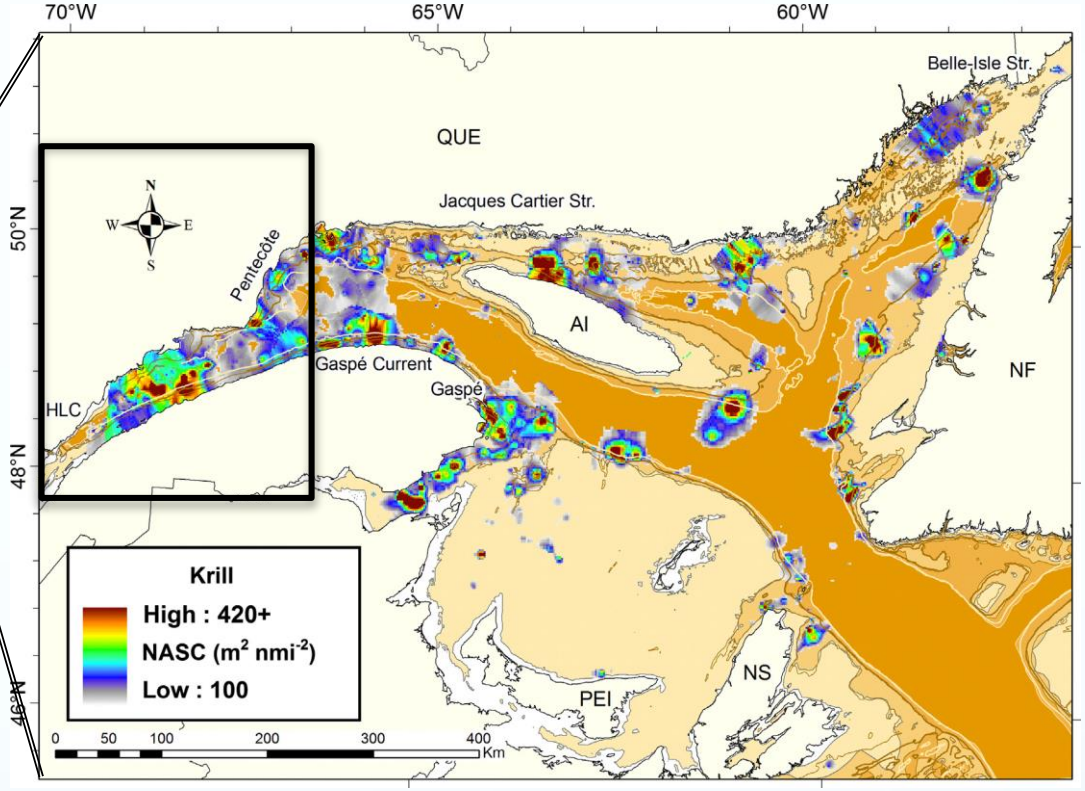

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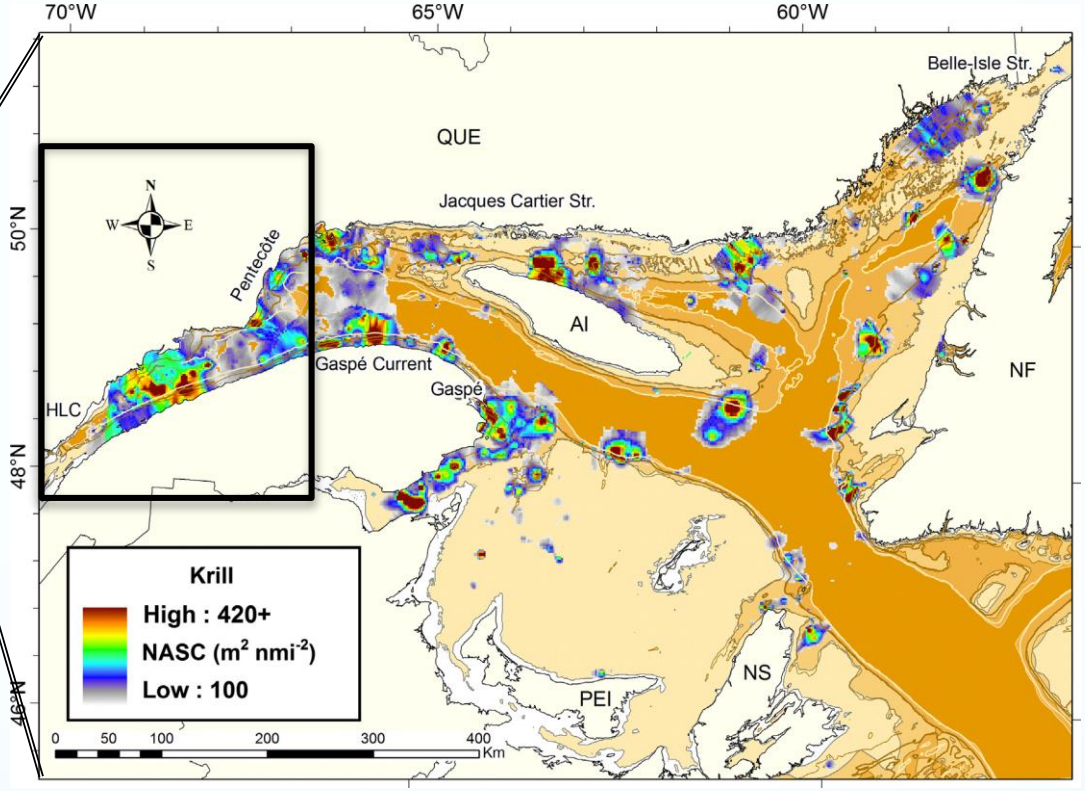

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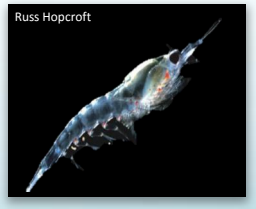
Meganyctiphanes norvegica
(temperate/boreal)

Thysanoessa inermis
(arctic/boreal)



Thysanoessa raschii
(boreal/arctic)

Warm adapted

Cold adapted

Mauchline and Fisher, 1969

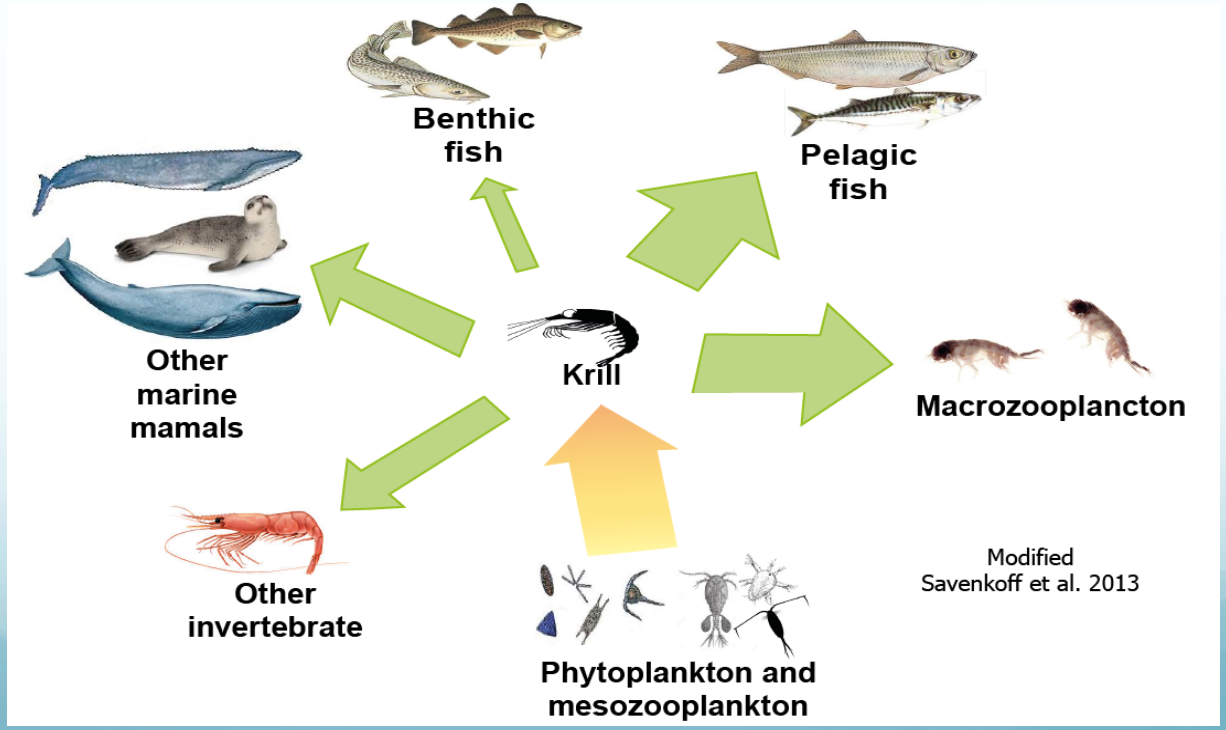
Ecological importance of krill

M. norvegica

T. inermis

T. raschii

Energy transfer (mostly lipids)



What we need to know about krill :

We suppose that a trophic niche separation should occur between species

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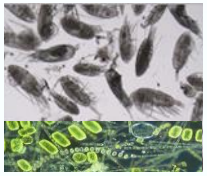
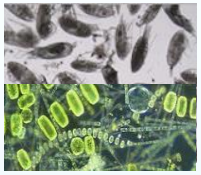
omnivorous

M. norvegica

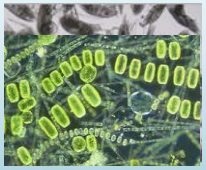


Carnivorous tendency

T. inermis



T. raschii



Herbivorous tendency

Agersted, 2014; Hünerlage et al., 2014; Plourde et al., 2014

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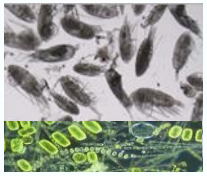

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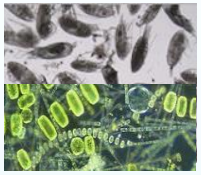

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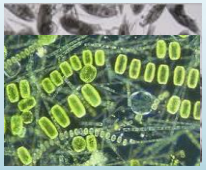
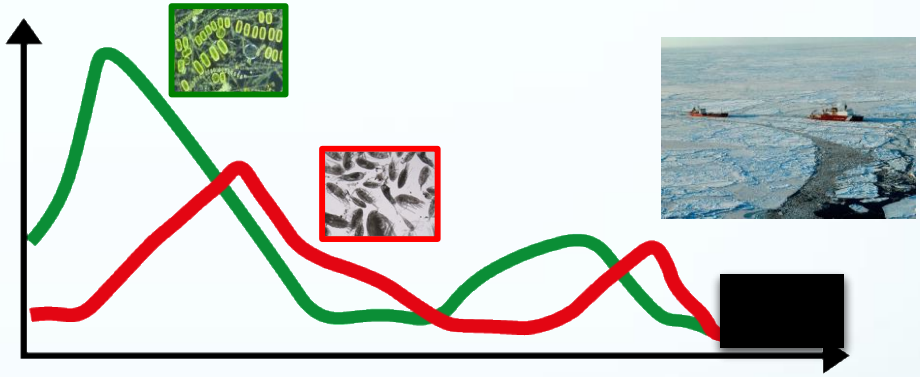


Herbivorous tendency

Feeding behavior should fluctuate in time

General plankton cycle in a subarctic ecosystem



Spring Summer Fall Winter

(Ice cover)

Agersted, 2014; Hünerlage et al., 2014; Plourde et al., 2014

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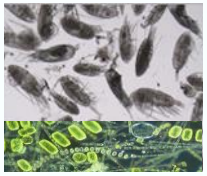
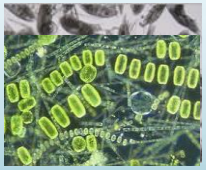


Carnivorous tendency

T. ner

T. ras



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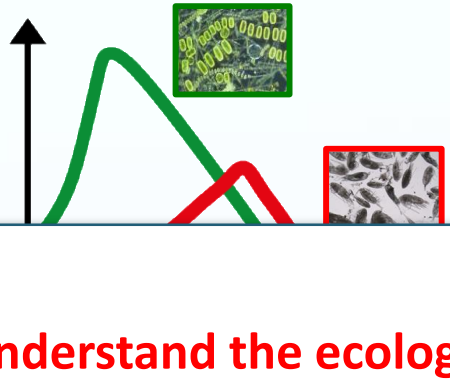


This information is critical to understand the ecological role of the krill species in the St. Lawrence system

Spring Summer Fall Winter

(Ice cover)

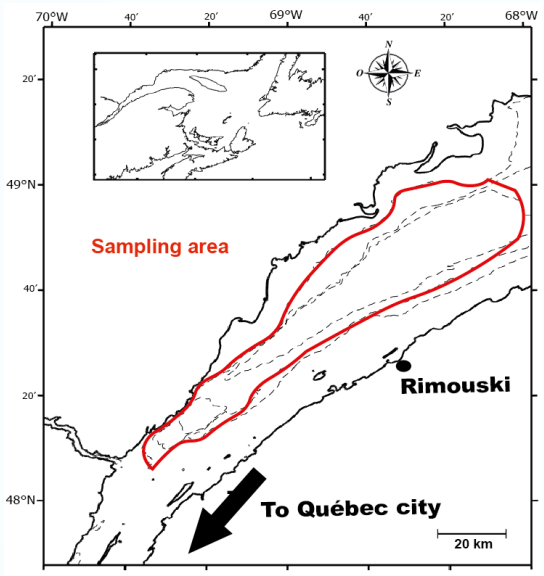
Agersted, 2014; Hünerlage et al., 2014; Plourde et al., 2014

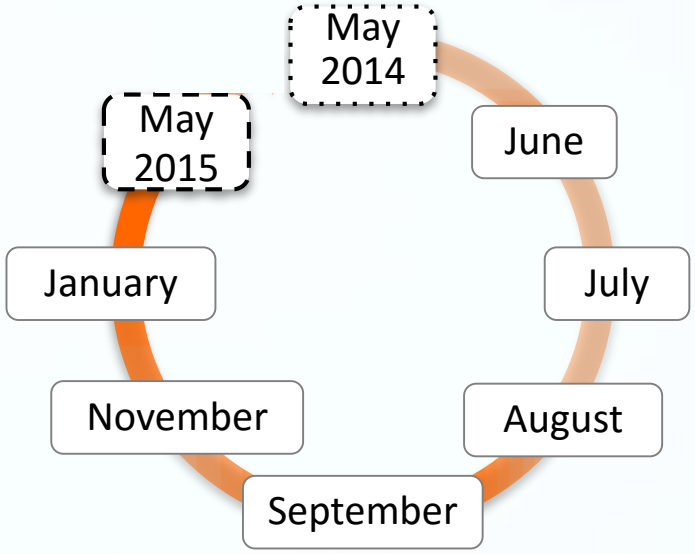
Specific objectives :

1) To compare seasonal variation of the lipid content and composition of individual krill in relation to changes of environmental factors using lipid classes

1) To compare how the feeding behaviour and the trophic position change during the year and among the 3 krill species

Material & Methods





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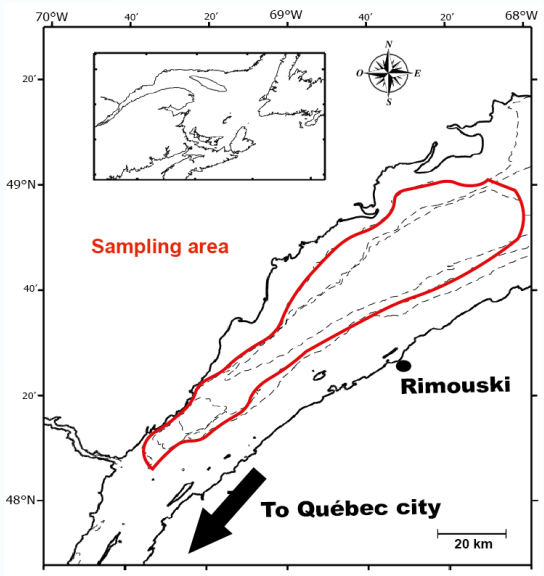
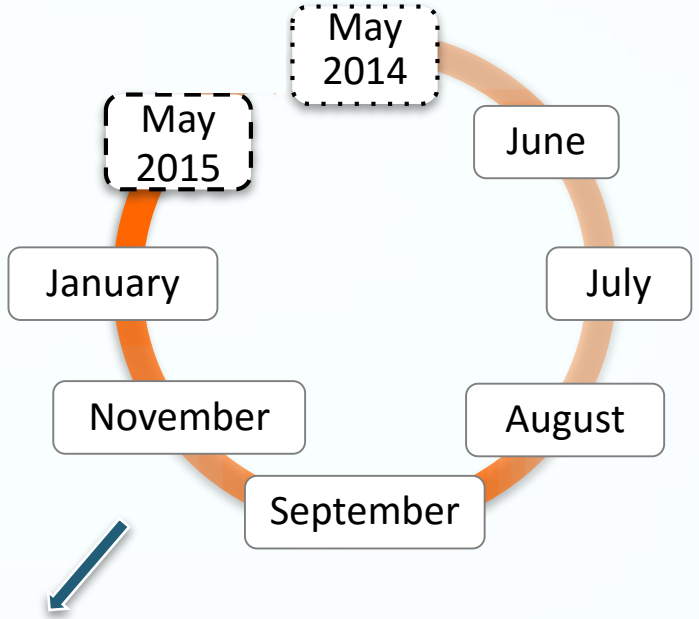




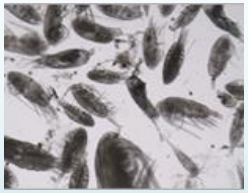
For each sampling date :

Krill

Lipid class (IatroScan)
Fatty acids (GC-MC)
Stable isotopes (IRMS)

Potential food sources :

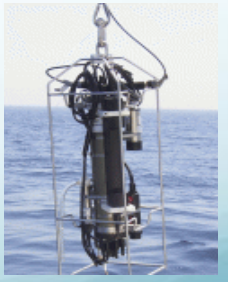
Phytoplankton & Chl *a*



Zooplankton

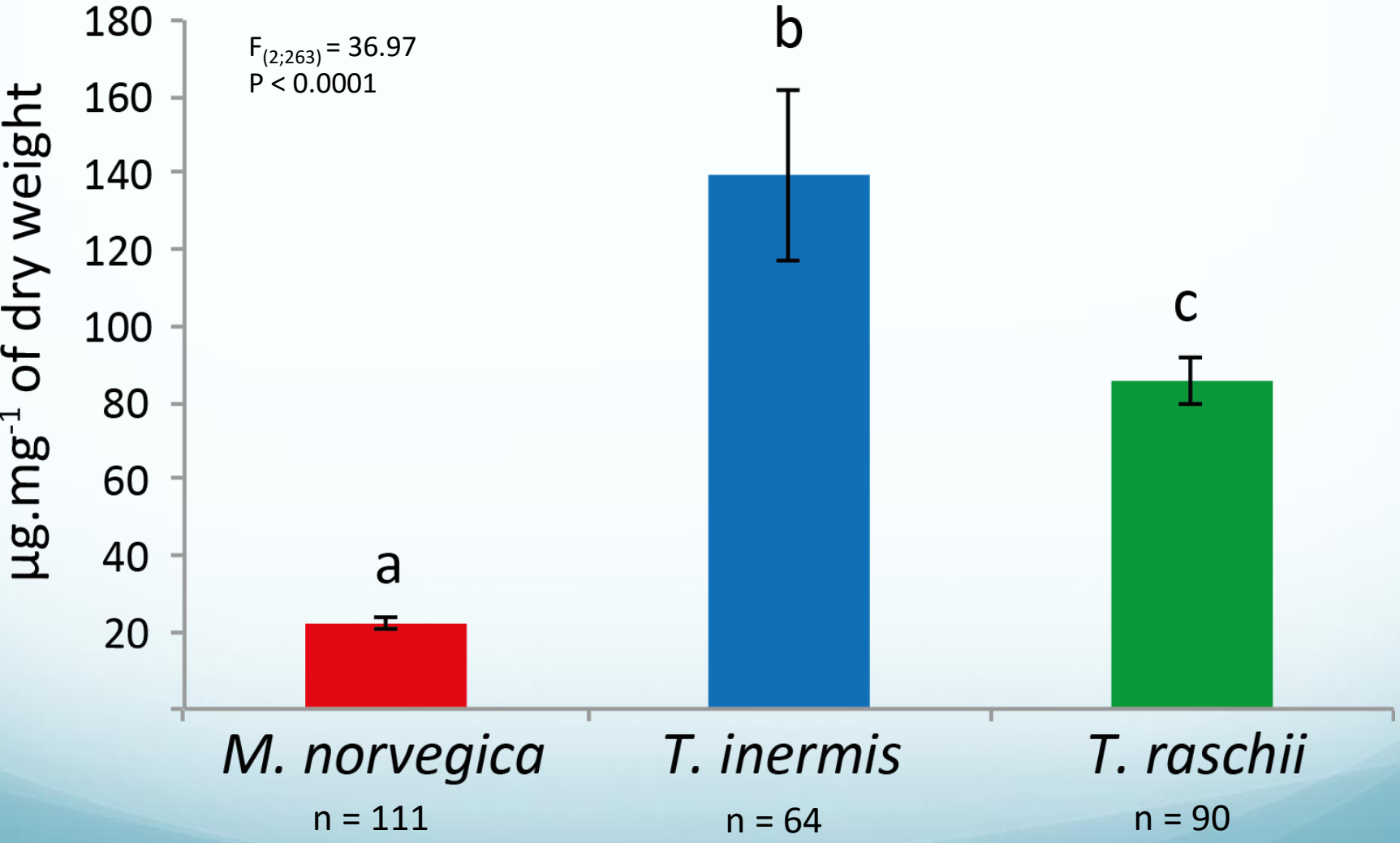
Particulate organic matter (POM)

Abiotic factors :



Salinity
Temperature

Results : Mean annual lipid contents of krill



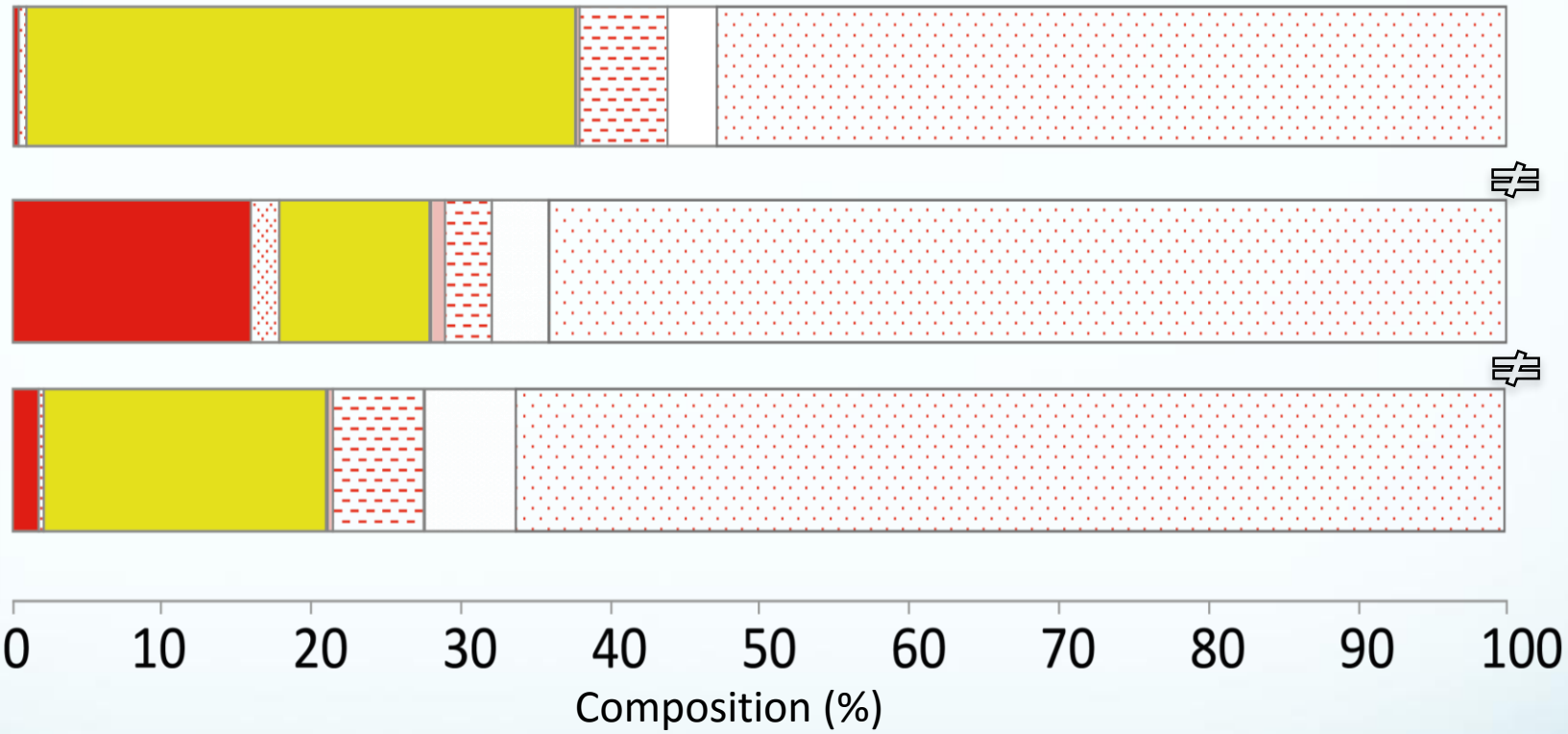
Mean annual lipid class composition of krill

M. norvegica

T. inermis

T. raschii

Pseudo-$F_{(2; 262)}$ = 116.2
$P_{(MC)}$ < 0.0001



Energy storage lipids

: Wax ester (WE)

: Triacylglycerol (TAG)

Other lipids

: Ketone

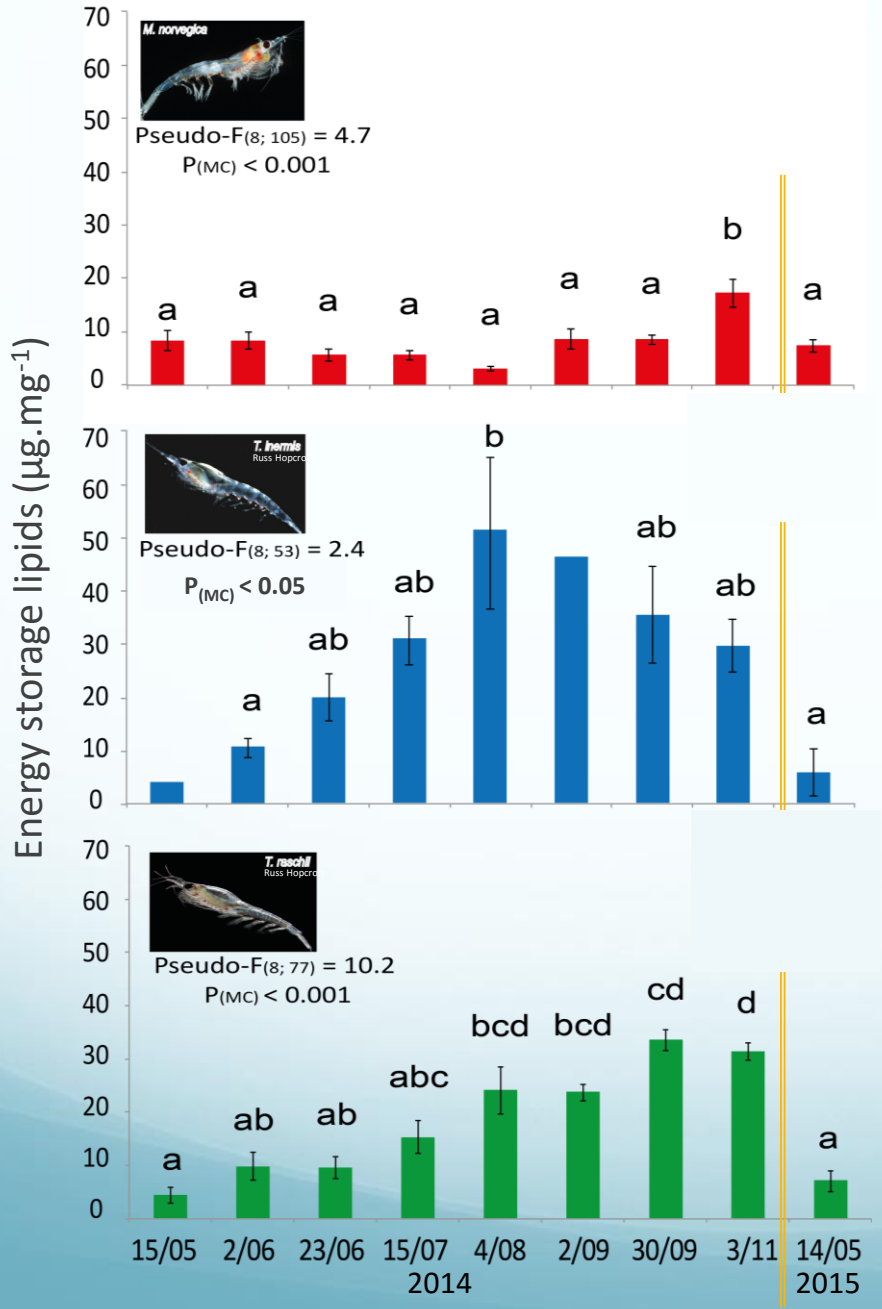
: Alcool

: Sterol

: AMPL

: Phospholipids

Seasonal variations in energy storage lipids (TAG + WE)



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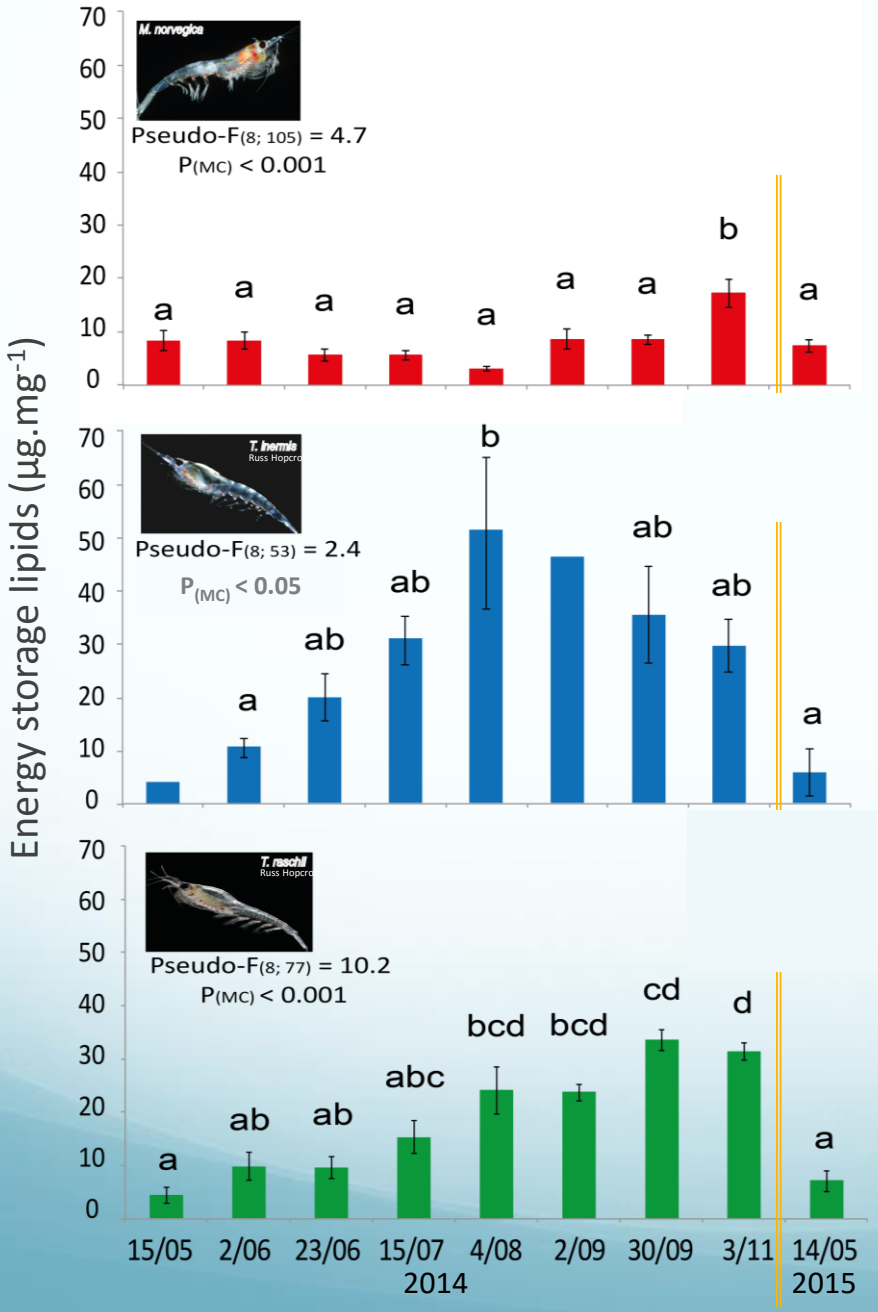
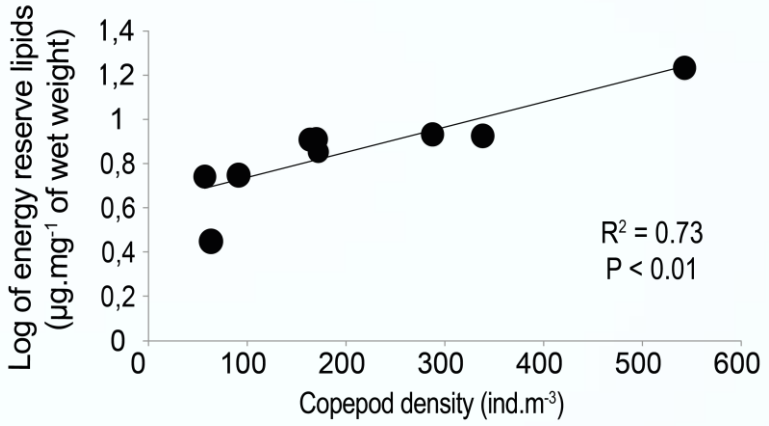
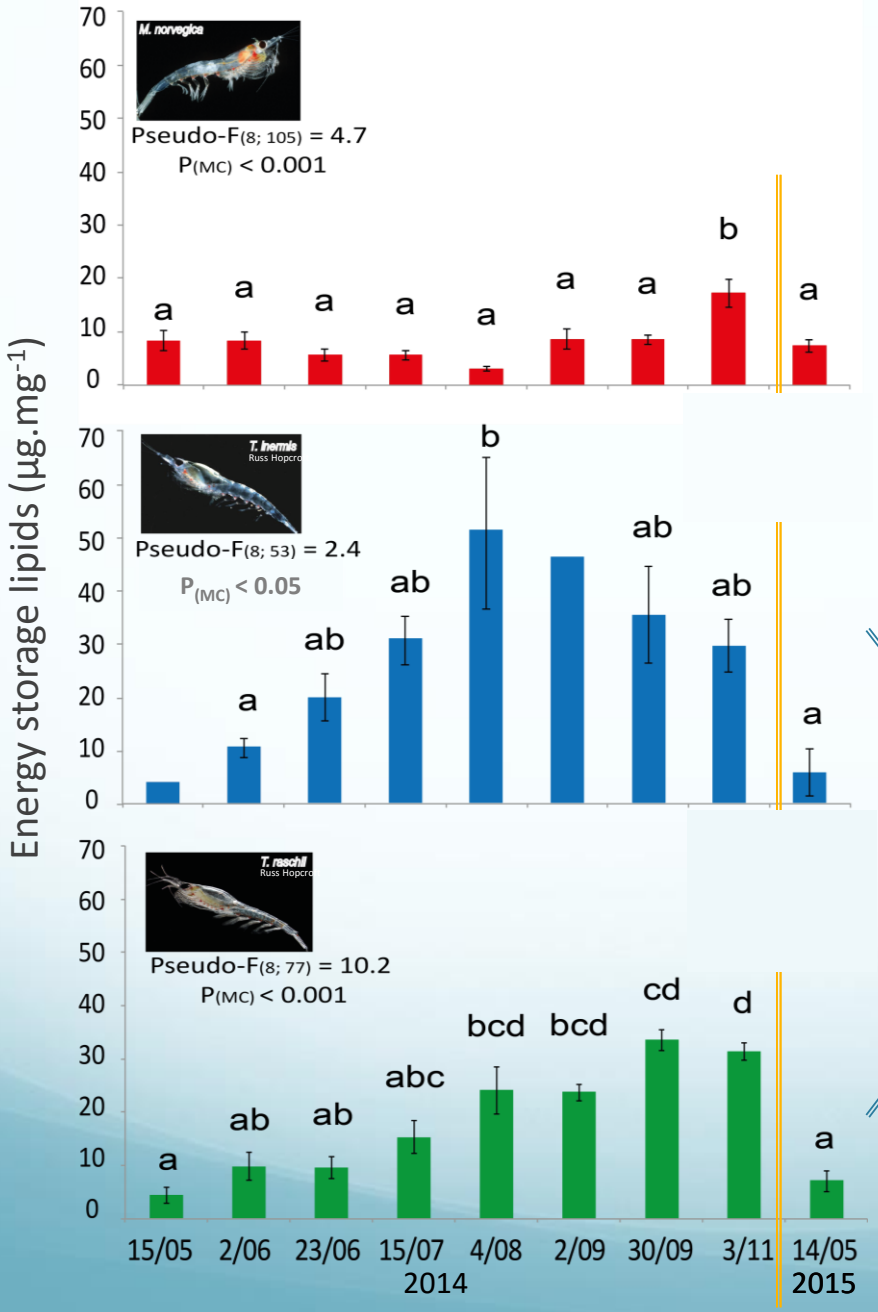
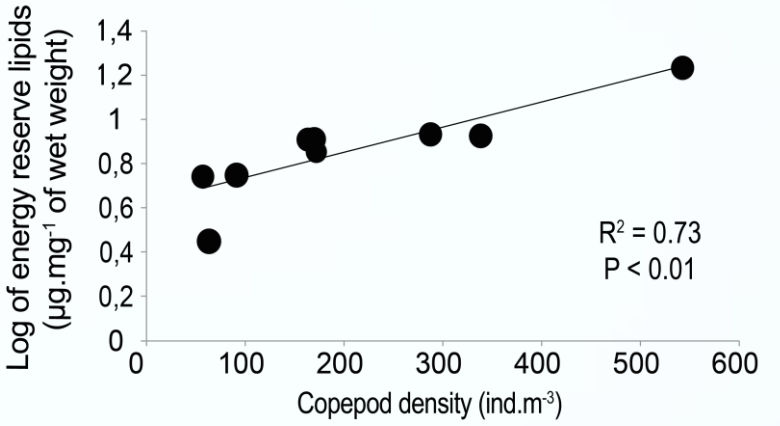




Correlated with the copepod densities suggesting a carnivorous feeding behaviour

Seasonal variations in energy storage lipids (TAG + WE)





Correlated with the copepod densities suggesting a carnivorous feeding behaviour

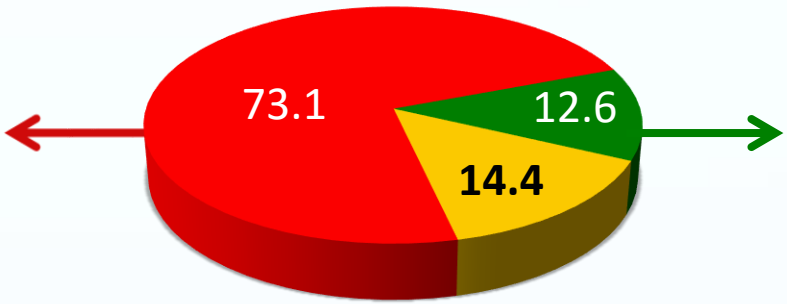
No correlation was found with any of the environmental factors

Suggesting a more omnivorous or generalist behaviour

Proportions of neutral fatty acids of *M. norvegica*

MUFAs Composition (%)

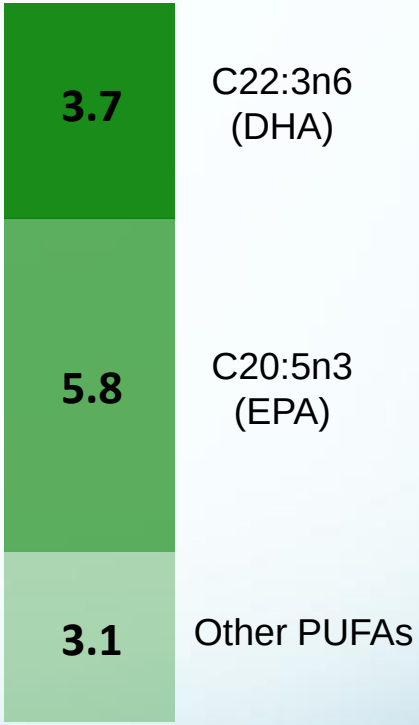
Zooplankton markers



May to August

PUFAs composition (%)

Phytoplankton markers



Fatty acid composition of *M. norvegica* suggests a “carnivorous” feeding behavior

Lipid results summary

- Lipid content and composition differ among species

  Thysanoessa spp. had higher lipid contents with a significant proportion of WE
  M. norvegica had a lower lipid content and was dominated by TAG

Feeding behavior :

- Energy storage lipids (TAG + WE) of *M. norvegica* were strongly related to copepod densities

- Neutral fatty acid composition of *M. norvegica* was dominated by MUFAs and zooplankton FATM

  ⇒ ***M. norvegica* seems to be a "carnivorous specialist"**

- In contrast, *Thysanoessa spp.* seem to be a more "omnivorous generalist" and feeds on phytoplankton and zooplankton

- Fatty acid composition of *Thysanoessa spp.* (coming soon…..)

Mean annual trophic levels of krill

M. norvegica

n = 53

T. inermis

n = 31

T. raschii

n = 51

M. norvegica

T. inermis

Omnivorous with a high proportion of zooplankton in their diet

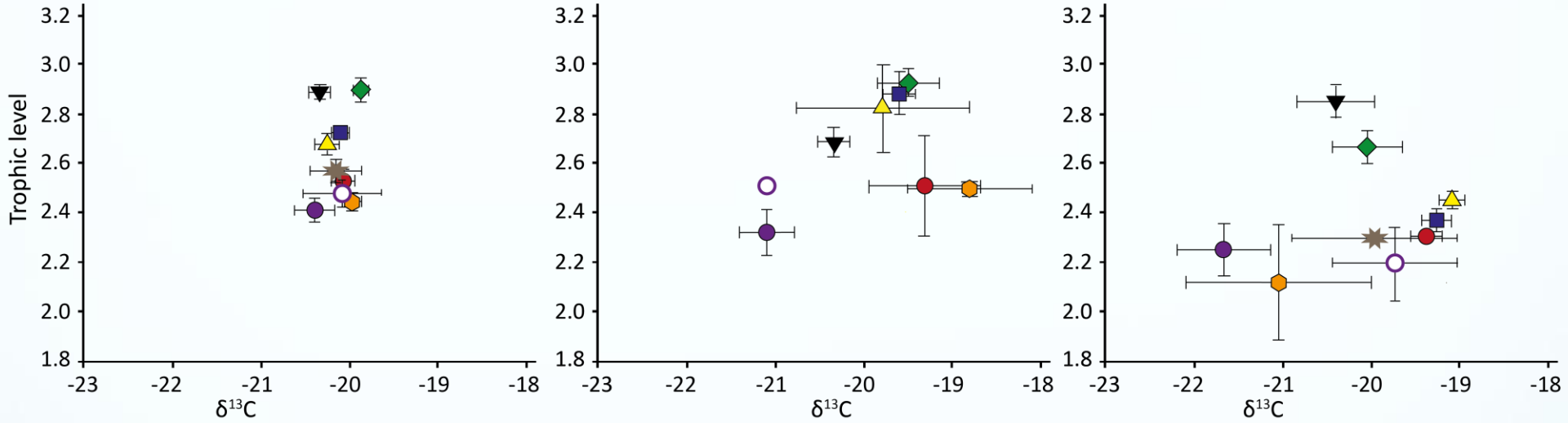
T. raschii → *Omnivorous with a herbivorous tendency*

Seasonal variations of the trophic space

M. norvegica

T. inermis

T. raschii



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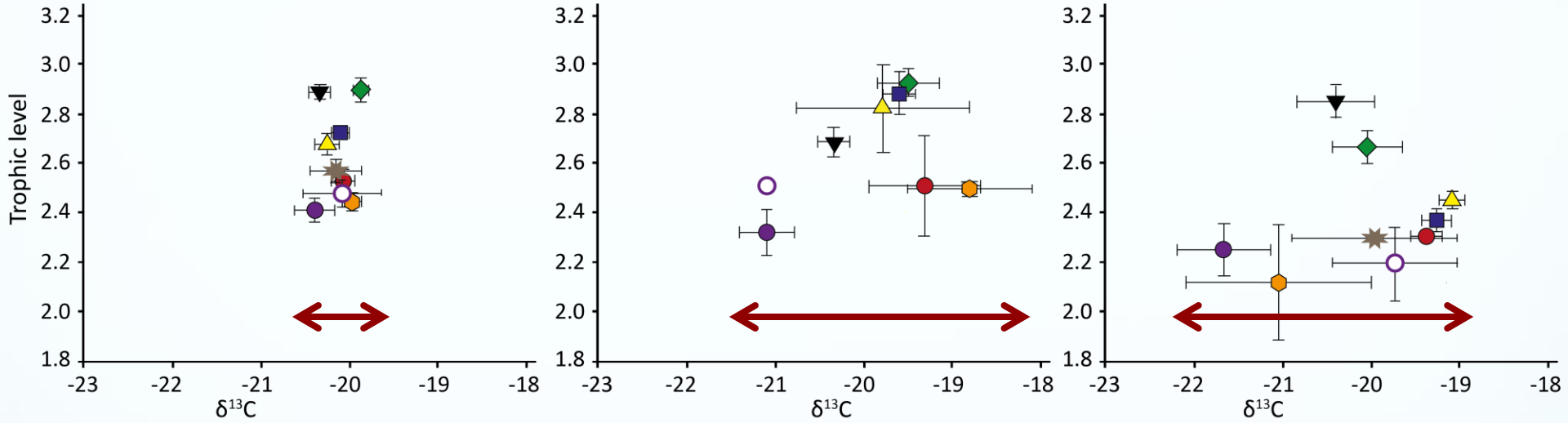


M. norvegica had a narrow $\delta^{13}C$ source window during the year

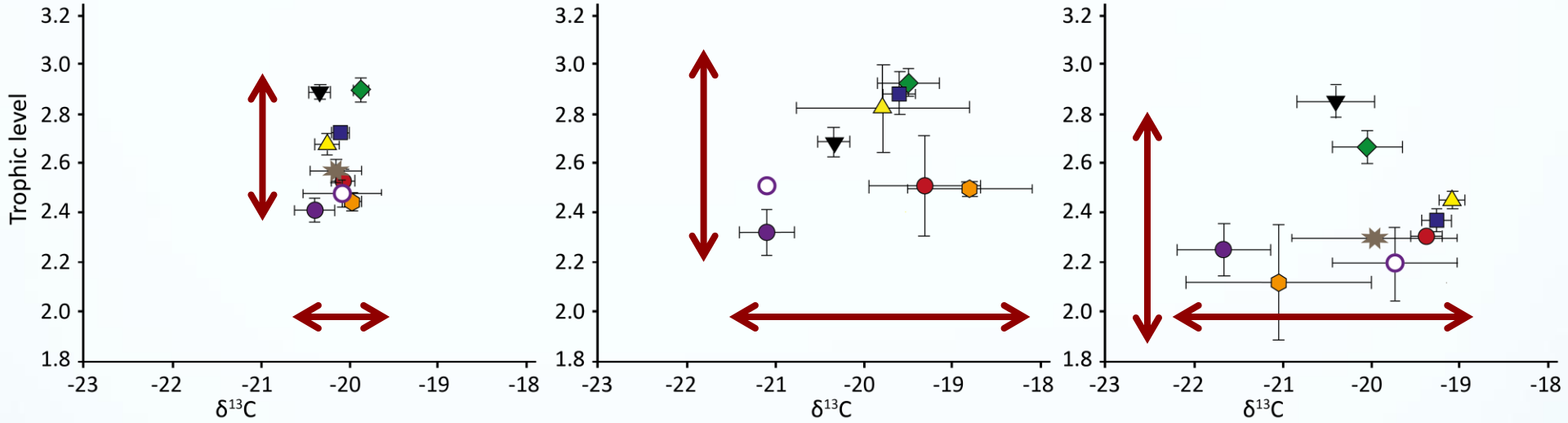
Suggesting that It feed on less resources

Seasonal variations of the trophic space

M. norvegica

T. inermis

T. raschii



M. norvegica had a narrow δ ^{13}C source window during the year

Suggesting that It feed on less resources

Annual variation of the trophic level differ among species

That suggest a differential feeding behavior among species that varied during the years

Take home message

- Quantity and quality of lipids transfer to the upper trophic levels depends on which krill species dominate the system

- Energy storage lipids of *M. norvegica* were related to the copepod densities whereas no relationship between *Thysanoessa spp*. and environmental factors were found.

- Trophic niche separation occured among these 3 krill species probably due to their differential feeding behavior

- *M. norvegica* and *T. inermis* seem to be more carnivorous than *T. raschii*

Acknowledgments

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Stéphane Plourde (MPO)

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Thank you for your attention