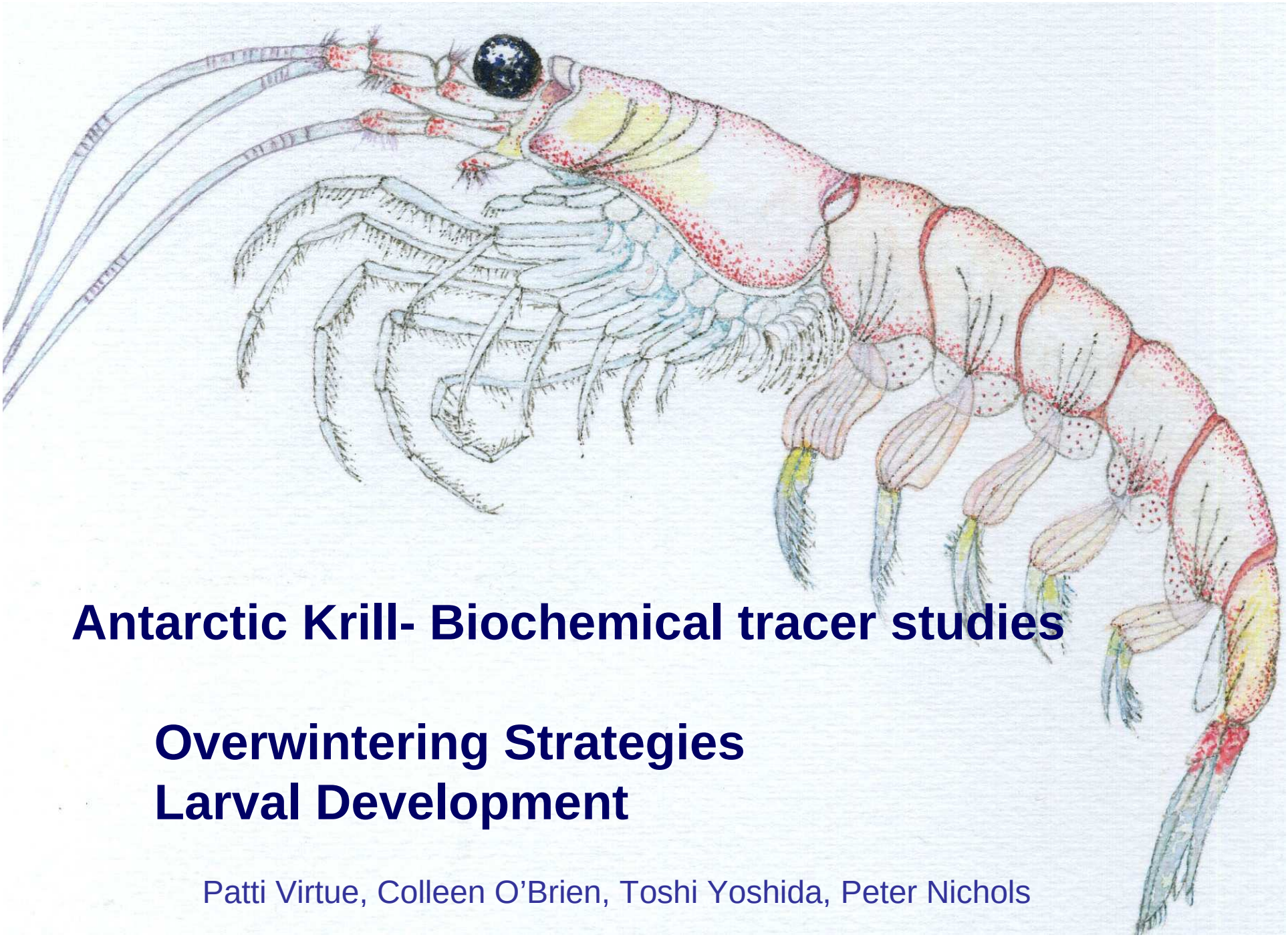


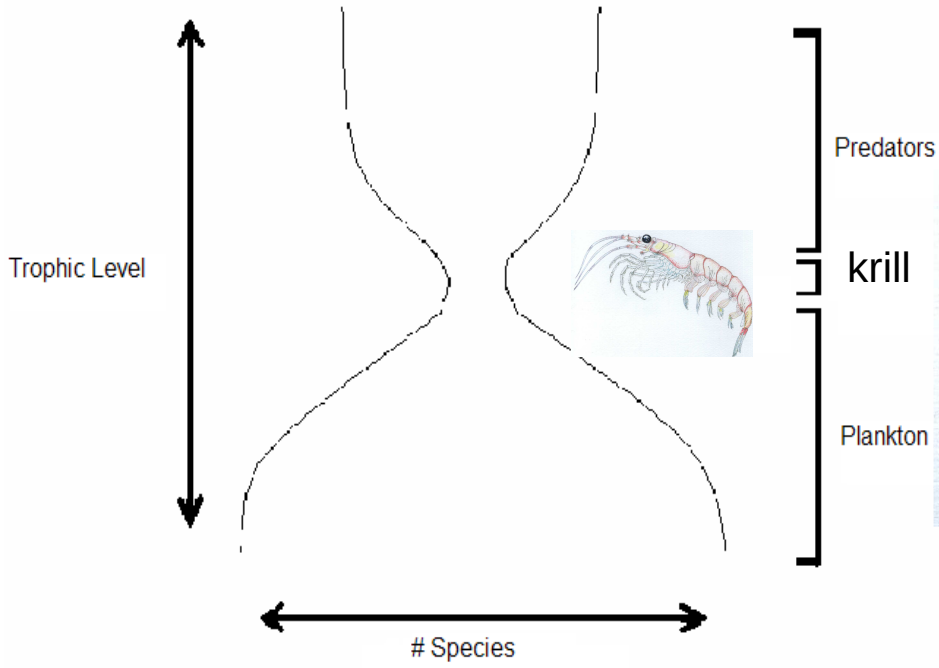
Antarctic Krill- Biochemical tracer studies

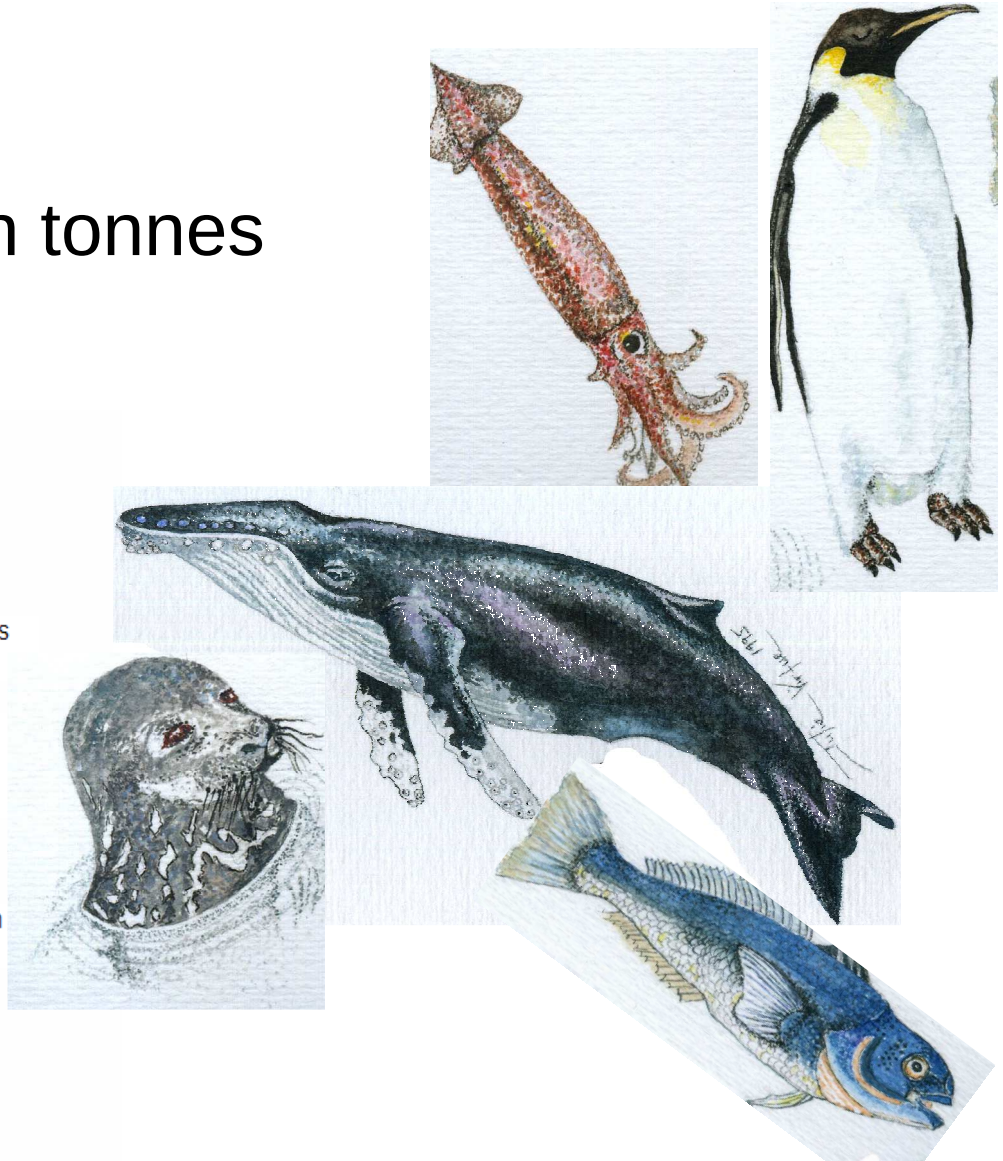
Overwintering Strategies
Larval Development

Patti Virtue, Colleen O'Brien, Toshi Yoshida, Peter Nichols

Antarctic krill -*Euphausia superba*

- Circumpolar distribution
- Forms dense swarms
- Biomass of ~ 500 million tonnes
- Wasp-waist ecosystem





The Krill Fishery

- Current catch

  ~ 120 000 tonnes
- Predicted to increase in next few years
  - Increased demand for krill products for aquaculture and human consumption (particularly krill oil)
  - Improved processing techniques

Krill oils

Cardiovascular disease

Rheumatoid arthritis

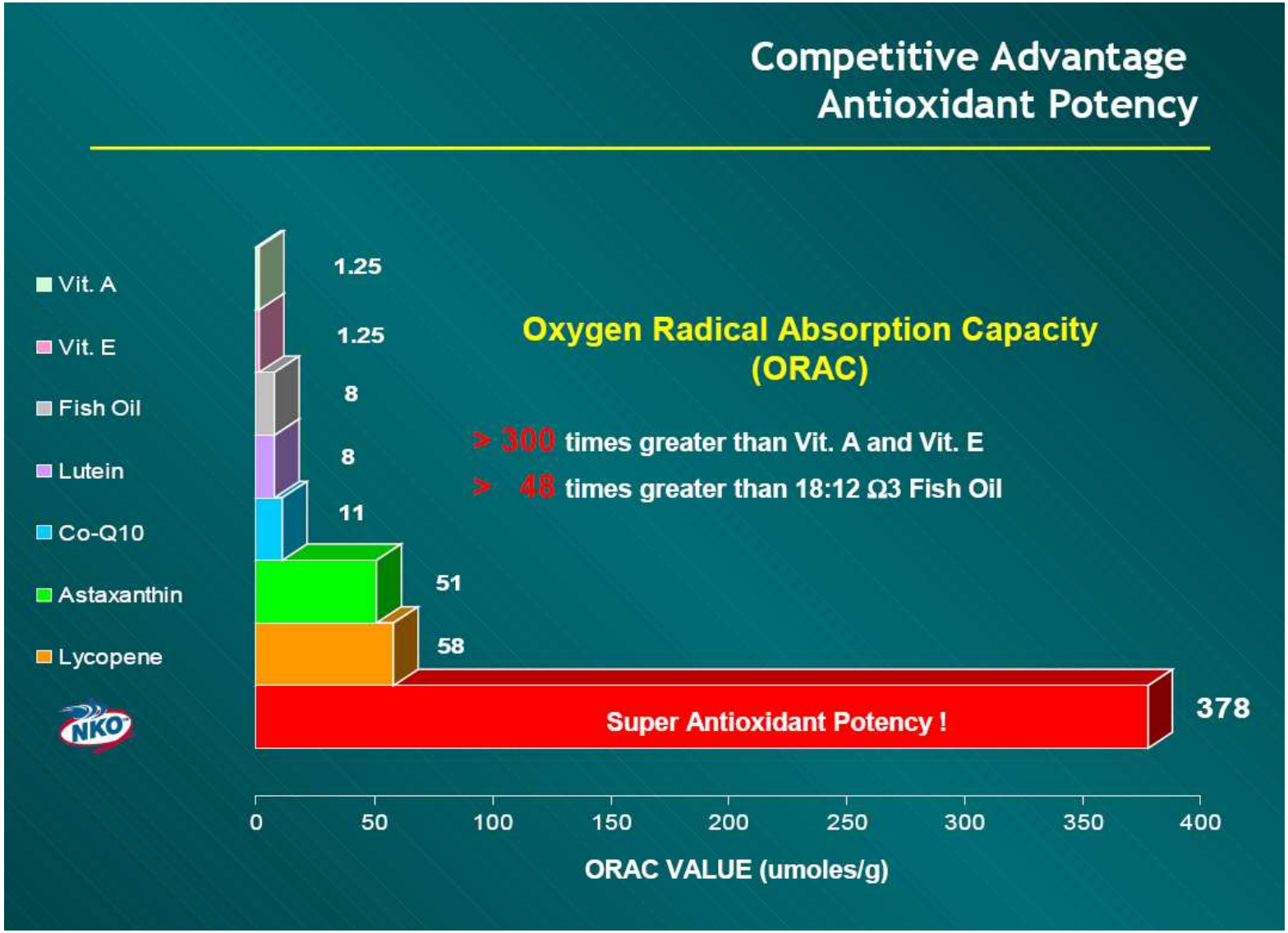
Skin cancer

Facial wrinkles

PMS

Transdermal delivery systems

"Krill is a unique oil that is rich in Omega-3 fatty acid, which repairs aging cells so well, studies show it's up to 300 times more rejuvenating than vitamins A and E!"



Aker's projections

- Krill oil costs US$ 200 per litre wholesale, with 100 tonnes yielding ~140,000 litres, the return is expected to be ~ US$12 million per year.
- Krill meal, depending content of proteins and astaxanthin, will at least have a value of US$ 1500 per tonne, giving a return of US$24 million a year.
- A financial analyst with the Swedish bank Enskilda in Norway has estimated the value of the Aker krill venture in terms of net profit to be US$ 3.6billion.

Krill Overwintering

- Over 50 % of krill habitat covered by ice in winter
- Very low phytoplankton concentrations in water column

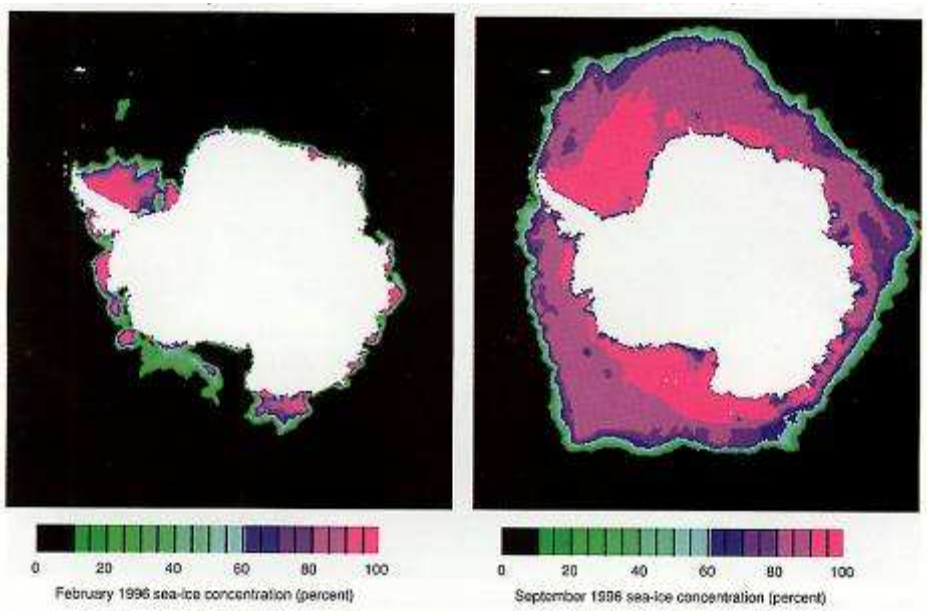
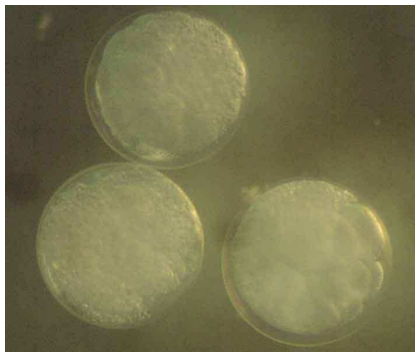


Figure 2. During the height of Antarctic summer, in February, the pack ice may cover as little as 4 million square kilometers (*left*). By mid-winter, in August, however, the sea-ice extent may amount to as much as 19 million square kilometers, more than doubling the effective size of the continent (*right*). (Satellite images courtesy of Jim Maslanik, National Sea Ice Data Center.)

Life history of *Euphausia superba*



Eggs

Spawning
(Summer)

50m

100m

250m

500m

750m

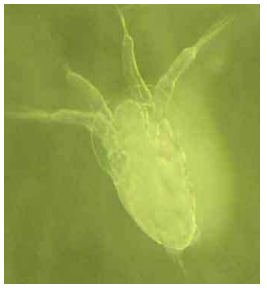
1000m

1500m

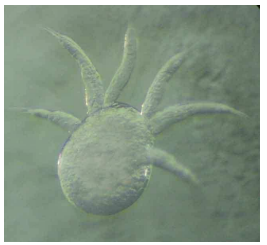
2000m

Hatch

Calyptopis III



Metanauplius



Nauplius I

Autumn-
Winter

Development

Overwintering Strategies

- Ingestion of alternative food sources
  - Sea-ice algae
  - Copepods
  - Detritus
- Lipid storage
- Shrinkage
- Hibernation

Sample Collection

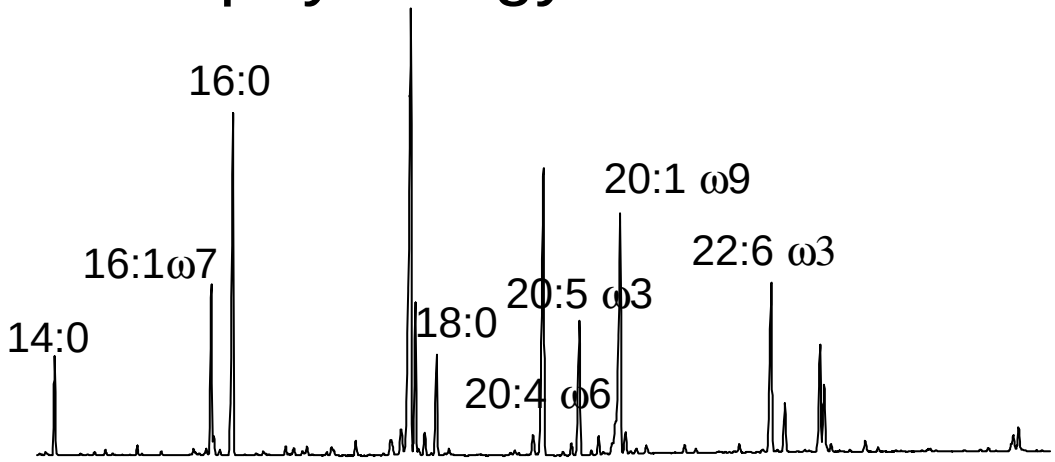
- Samples were collected off East Antarctica (110°- 130°E) as part of the Sea Ice Physics and Ecosystems eXperiment (SIPEX) in September-October 2007.

Lipid Analysis

-Total lipid- condition

-Lipid class- storage/structural

-Fatty acid profiles- diet/physiology



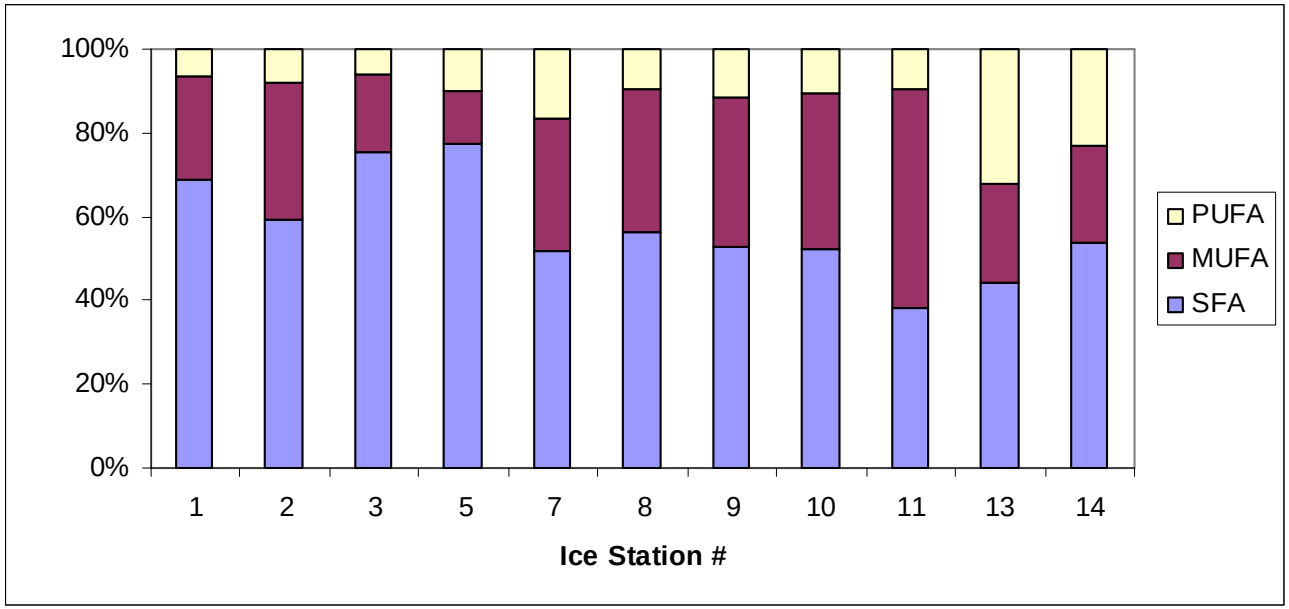
Microscopy

Microscopy used to determine the species composition of:

- Melted ice cores
- Krill stomach contents

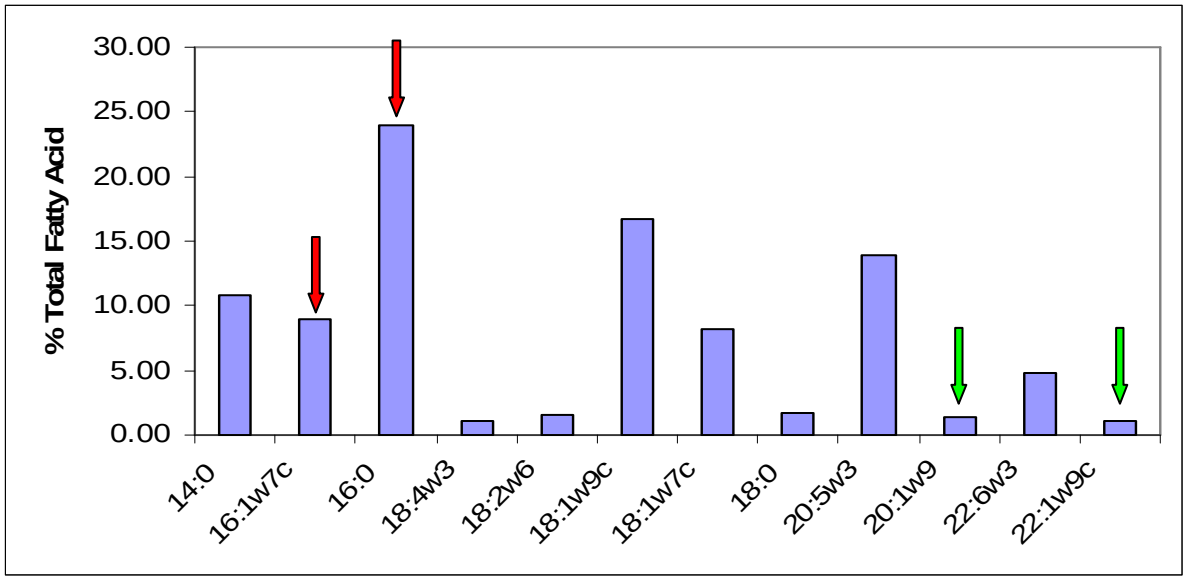
Ice Cores

- Ice cores, although dominated by diatoms, contained very low levels of polyunsaturated fatty acids.



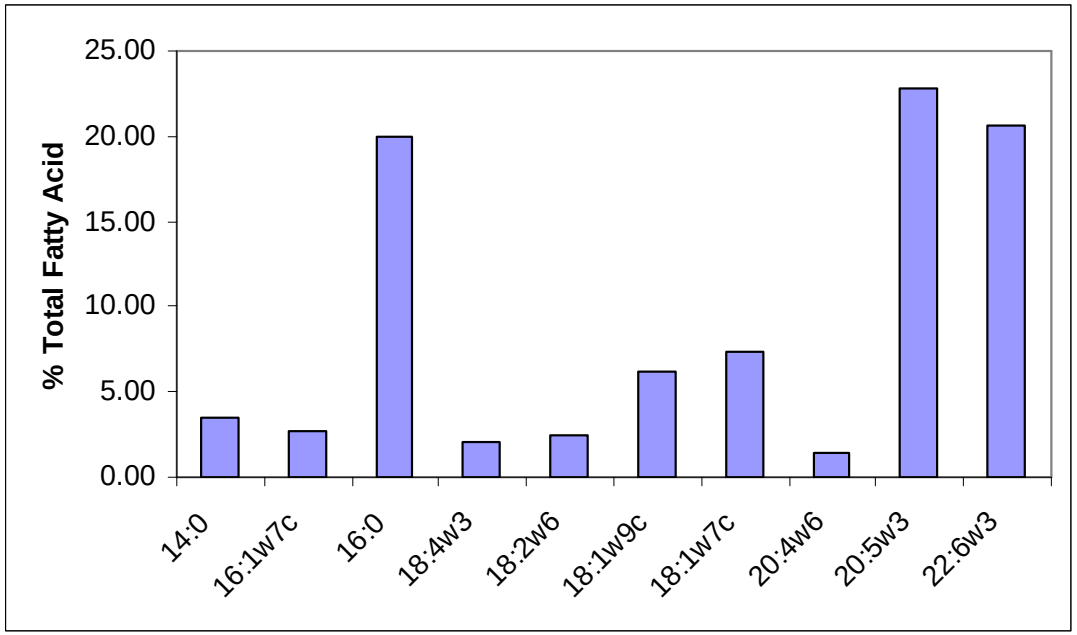
Krill Fatty Acid Profiles

- Low PUFA/SFA ratio
- Low ratio of 16:1ω7 to 16:0 – generally not indicative of a diatom-based diet
- Traces of copepod markers



Larval Fatty Acid Profiles

- Higher PUFA/SFA ratio than adults, but still lower than expected for larvae with this level of lipids
- Small amounts of C17 bacterial markers

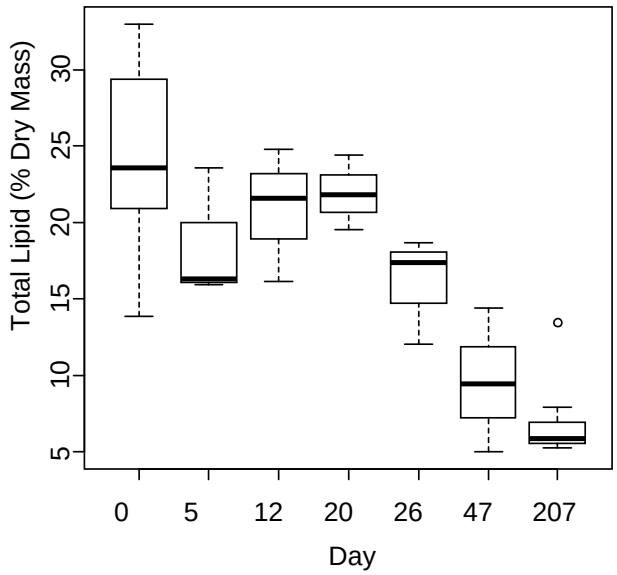


Krill Condition

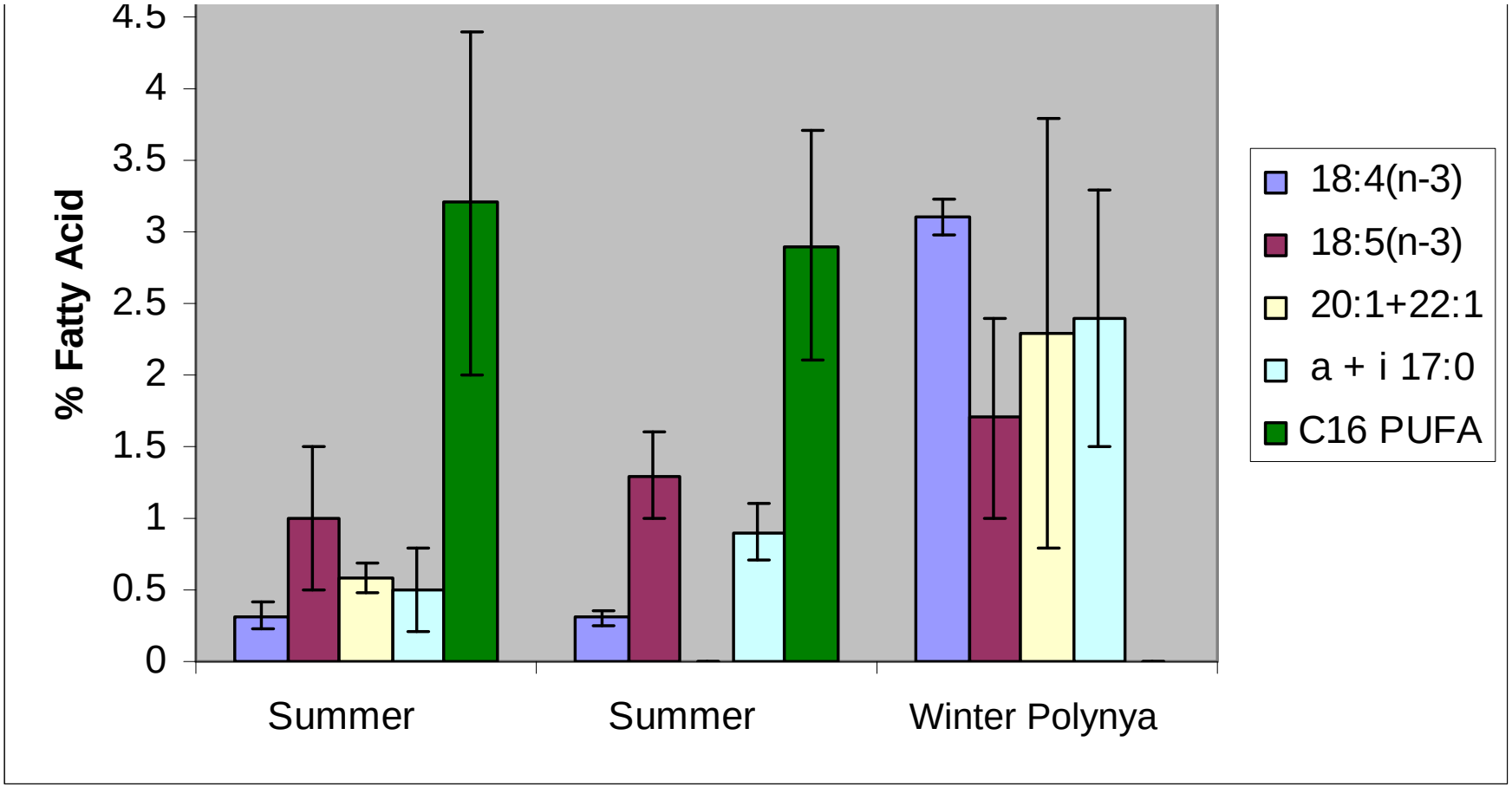
- Adult:
  - Dry mass 252 ± 58.7 mg
  - Total lipid content 24.1 ± 6.7 %
    - Similar to summer levels
- Larvae:
  - Dry mass 0.9 mg
  - Total lipid content 6.6 %

Starvation Experiments

- Larvae severely depleted after five days starvation
- Adults survived 207 days (until end of experiment)



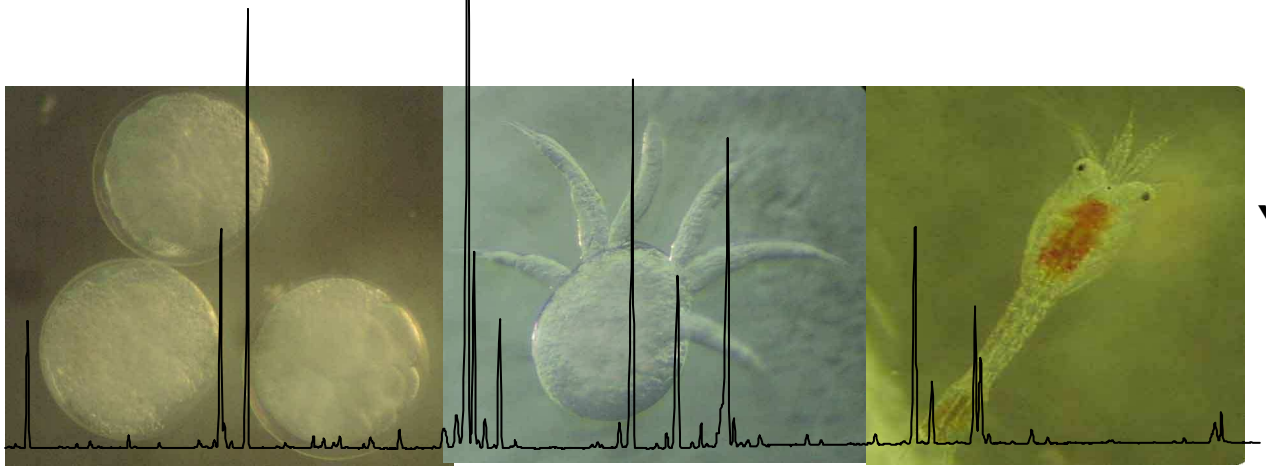
Winter growth and condition of Ice Krill (*Euphausia crystallorophias*) off East Antarctica



18:4 non-diatom phytoplankton/protozoans
18:5 dinoflagellate
20:1 crustaceans
a + i bacteria
C16 PUFA diatoms

Krill egg hatching success rate

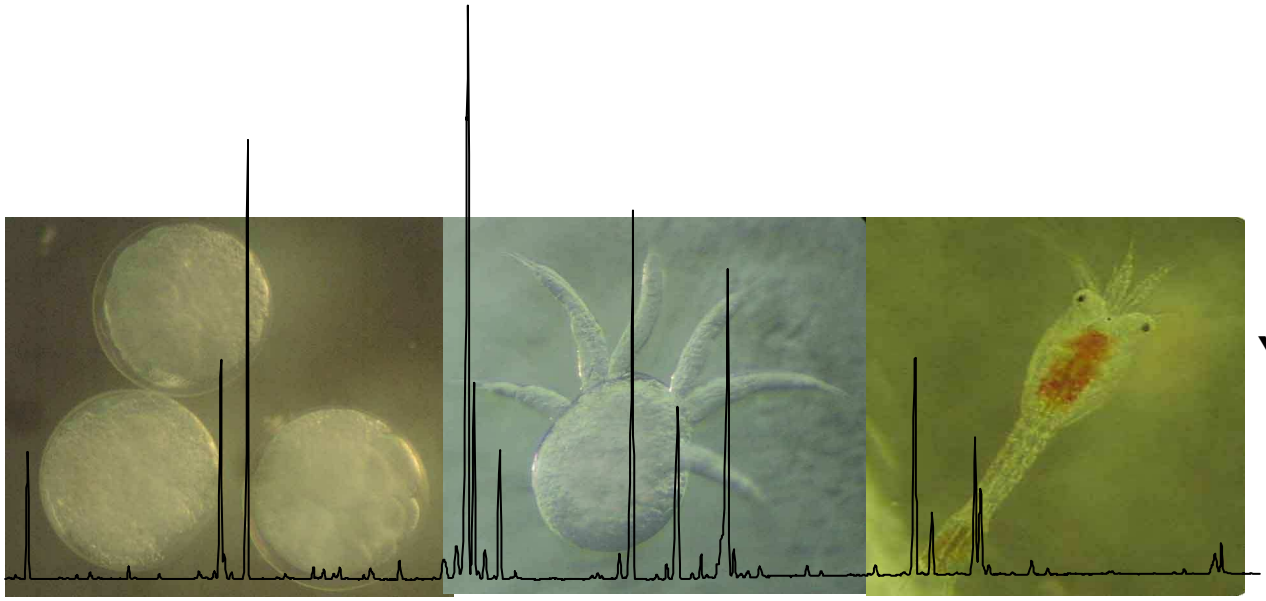
- Specific fatty acids play important roles in embryogenesis and larval development of krill.
- Levels of the fatty acids LA and AA and the DHA/EPA ratio effect hatching success.
- The long chained PUFA are utilised at a greater rate compared to SFA and MUFA during the embryonic and larval development of krill.



Yoshida et al 2009

Krill egg hatching success rate

- Dietary condition of maternal krill affects the quality of embryos, and in turn the hatching success and larval survival.



Yoshida et al 2009

Conclusions

- Krill larvae highly dependent on ice algal community
- Adult krill less so as they store lipid
- Detritus and/or protozoa may be an important food source for larval krill and copepods at this time of year.
- Copepods do not appear to be a major food source for krill in this area.
- Krill caught in late September were in good condition – enough food available to meet energy requirements.
- BUT – low in essential PUFAs which are necessary for reproduction