Ecophysiological Studies in Krill Research at the Alfred-Wegener Institute

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Photo: Carsten Pape

Understanding the impact of global warming on ecosystems

- **A tractable approach is to focus on "keystone species" whose biology is so pervasive as to dictate ecosystem functioning.**

Understand ecosystem functioning and the impact of global warming

- ***We need to progress beyond correlative studies towards a mechanistic understanding***

The central aims of the krill group at AWI

- ***Understanding the mechanisms causing synchronization between the seasonal development of krill and the seasonal cycles of environmental features***
- ***The effect of changing sea ice condition on the life cycle of krill***
- ***Identify the most critical stages in krill's life cycle, which are sensitive to environmental changes***
- ***Testing different scenarios of climate change in stage structured life cycle models***

Overwintering of krill

Until the end of the 1990s was the prevailing view that krill had a flexible approach to overwintering, with some ontogenetic differences, but beyond this the exact mechanisms were subject to vigorous debate.

- ***Reduced metabolism, feeding activity, lipid utilization and body shrinkage***

- ***Switching to alternative food sources other than phytoplankton in the water column:***
  - ice biota,
  - zooplankton
  - seabed detritus

How to overcome these uncertainties?

- **To investigate to what extent seasonal variation in larval and adult krill physiology is mediated by environmental factors with strong seasonality in the Southern Ocean.**

- **Which physiological functions are adopted by adults and larvae to survive the winter season and the relative importance of each.**

The approach

- **Parameters thought to be associated with proposed overwintering mechanisms were determined during different seasons with a consistent experimental and analytical setup to ensure a high degree of comparability.**

  - allows to determine the relative importance of each component measured

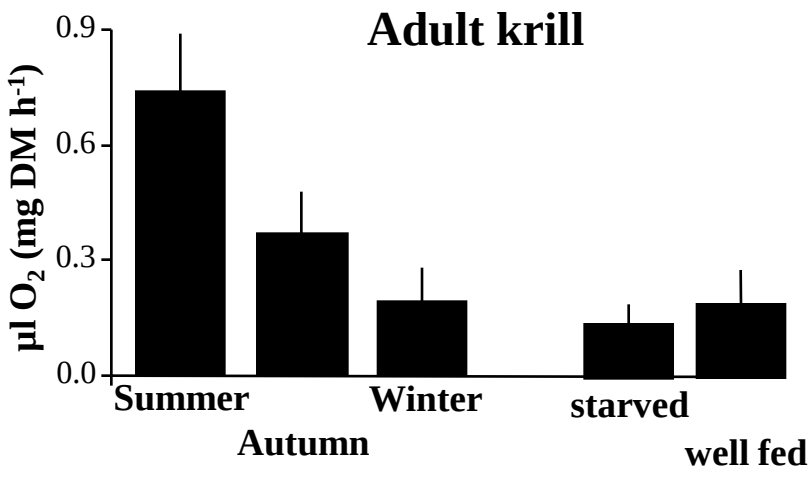
  - allows to make a clear comparison of the mechanisms adopted by larvae and adult krill

  - allows the identification of environmental factors that drive the variation in the physiological function of krill throughout the seasonal cycle

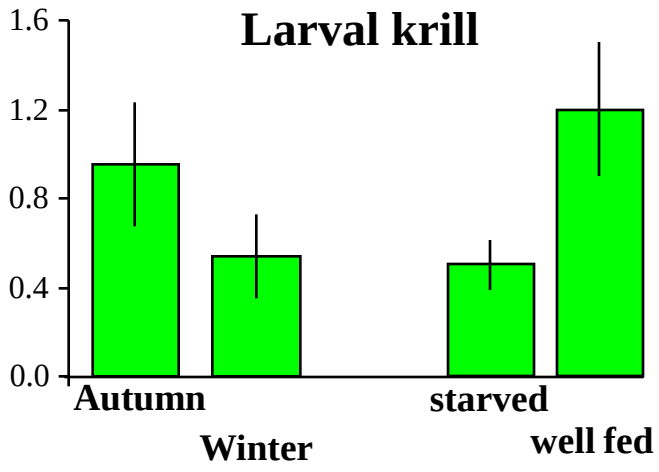
The study area

Results on the Overwintering of krill

Metabolic activity

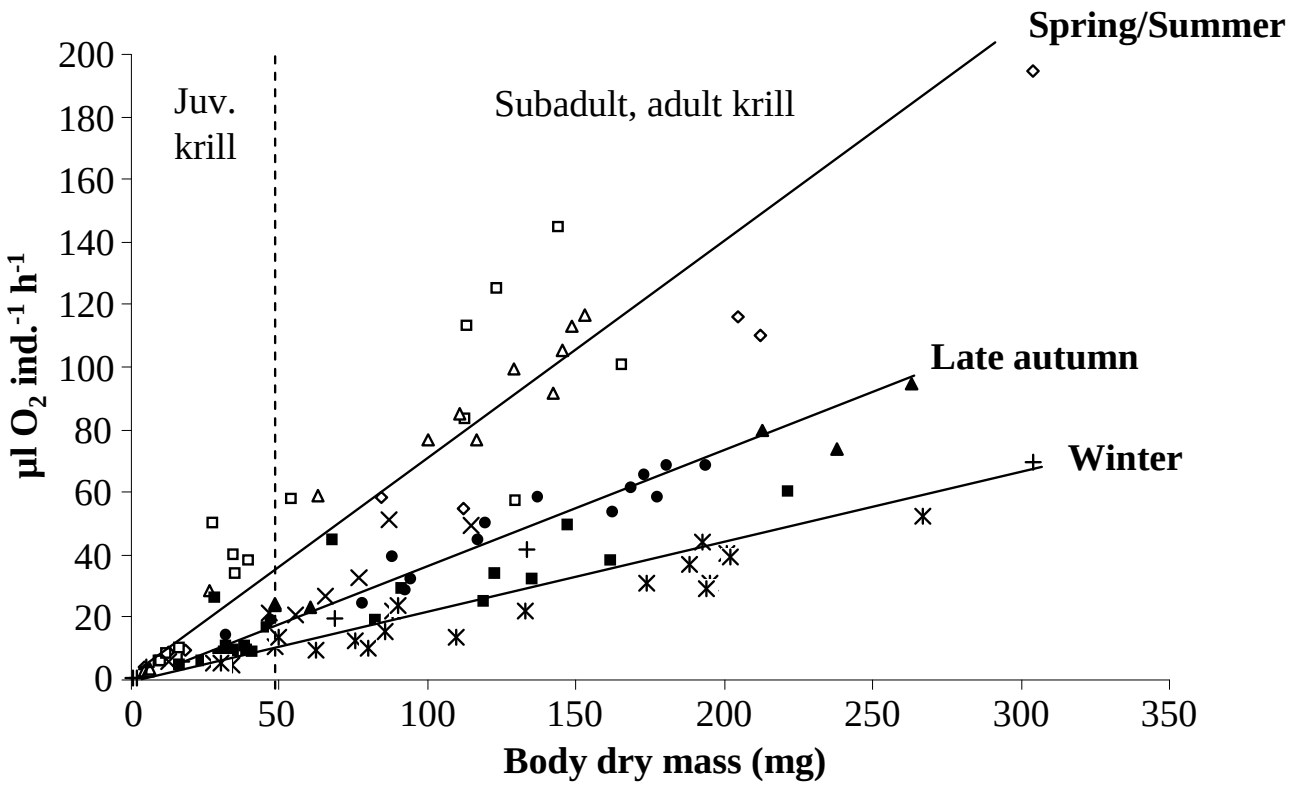


Meyer et al. 2010, MEPS in press,



Meyer et al. 2009, L&O
Meyer et al. 2002, L&O

Metabolic activity



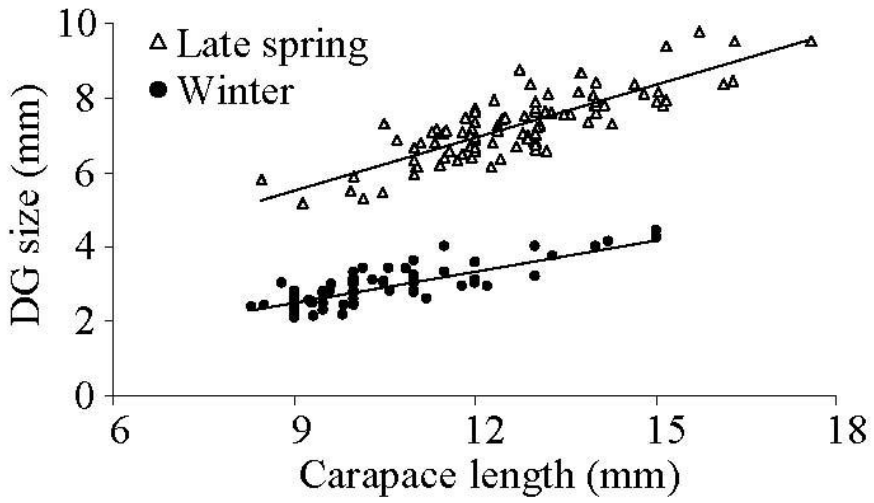
October-March
- Kawaguchi et al. 1986
- Torres et al. 1994a
- Meyer et al. 2009a [16]

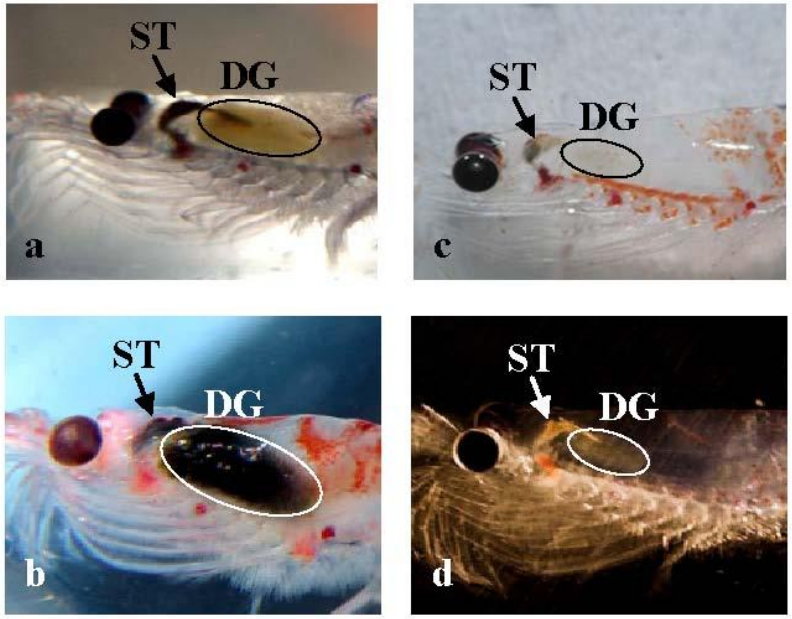
April-May
- Kawaguchi et al. 1986
- Atkinson et al. 2002 [1]
- Meyer et al. 2009a [16]

June-end of September
- Kawaguchi et al. 1986
- Torres et al. 1994a
- Meyer et al. 2009a [16]

Meyer et al. 2010, MEPS in press

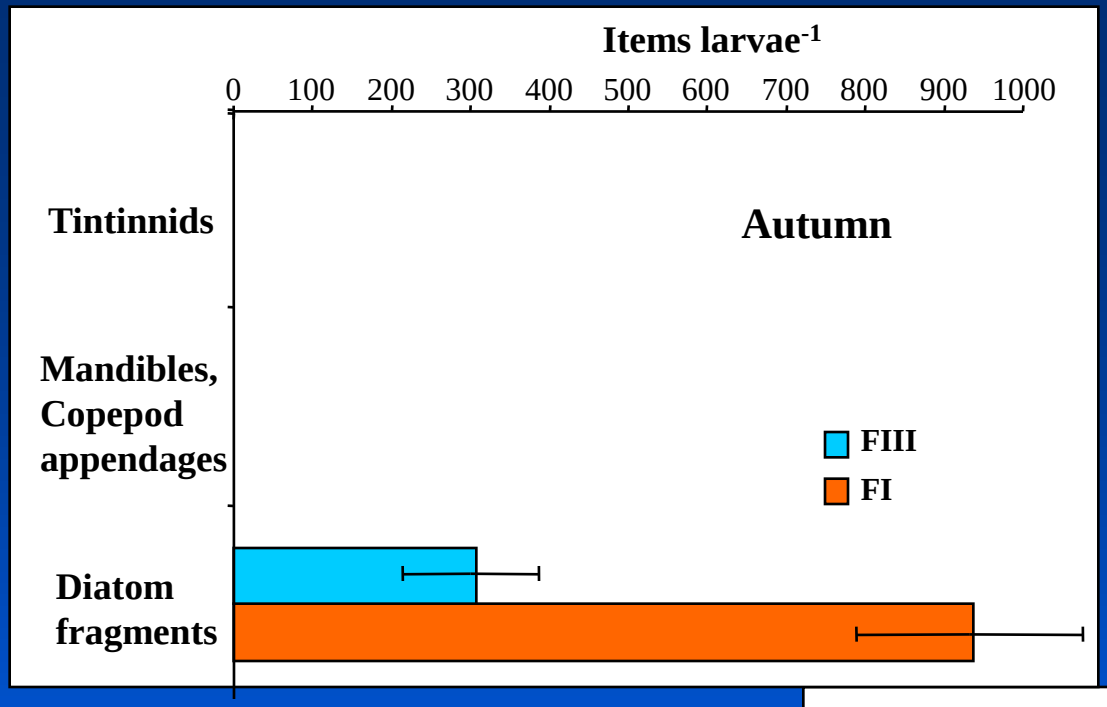
Feeding activity of adult krill

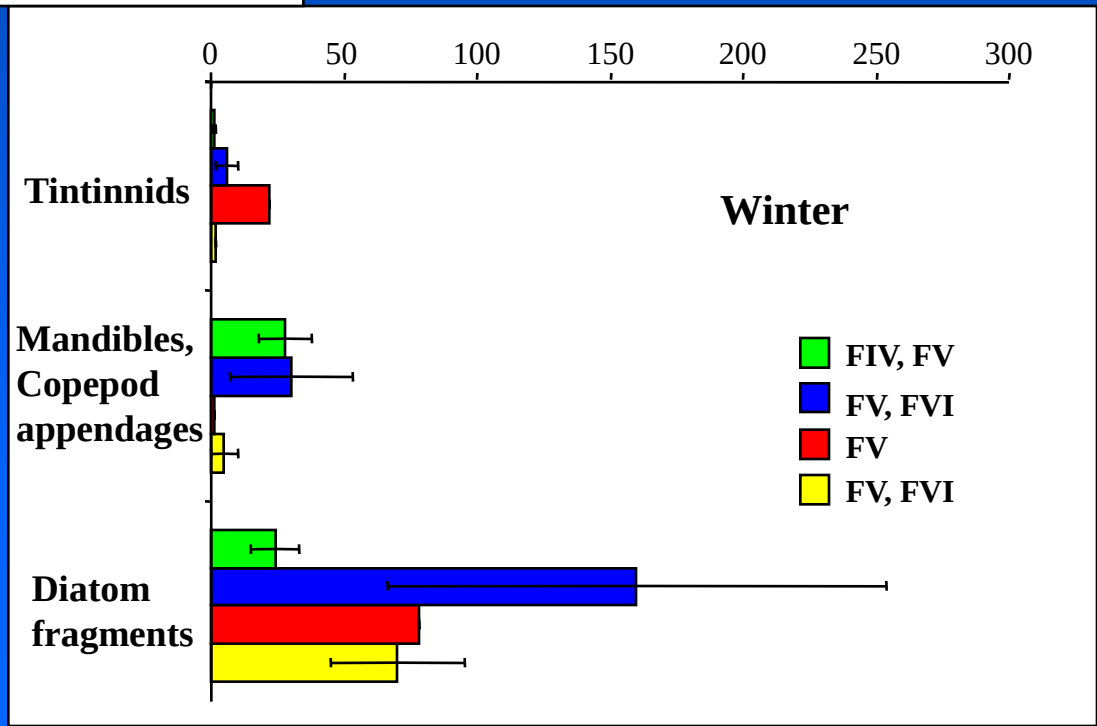




Meyer et al. 2010, MEPS in press

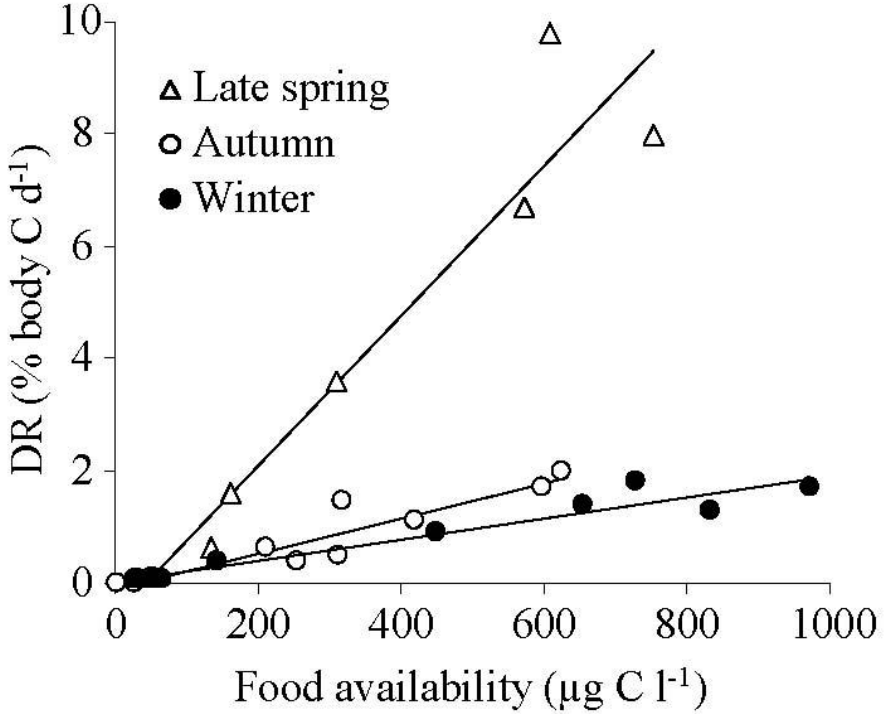
Feeding activity of larval krill





Meyer et al. 2009, L&O

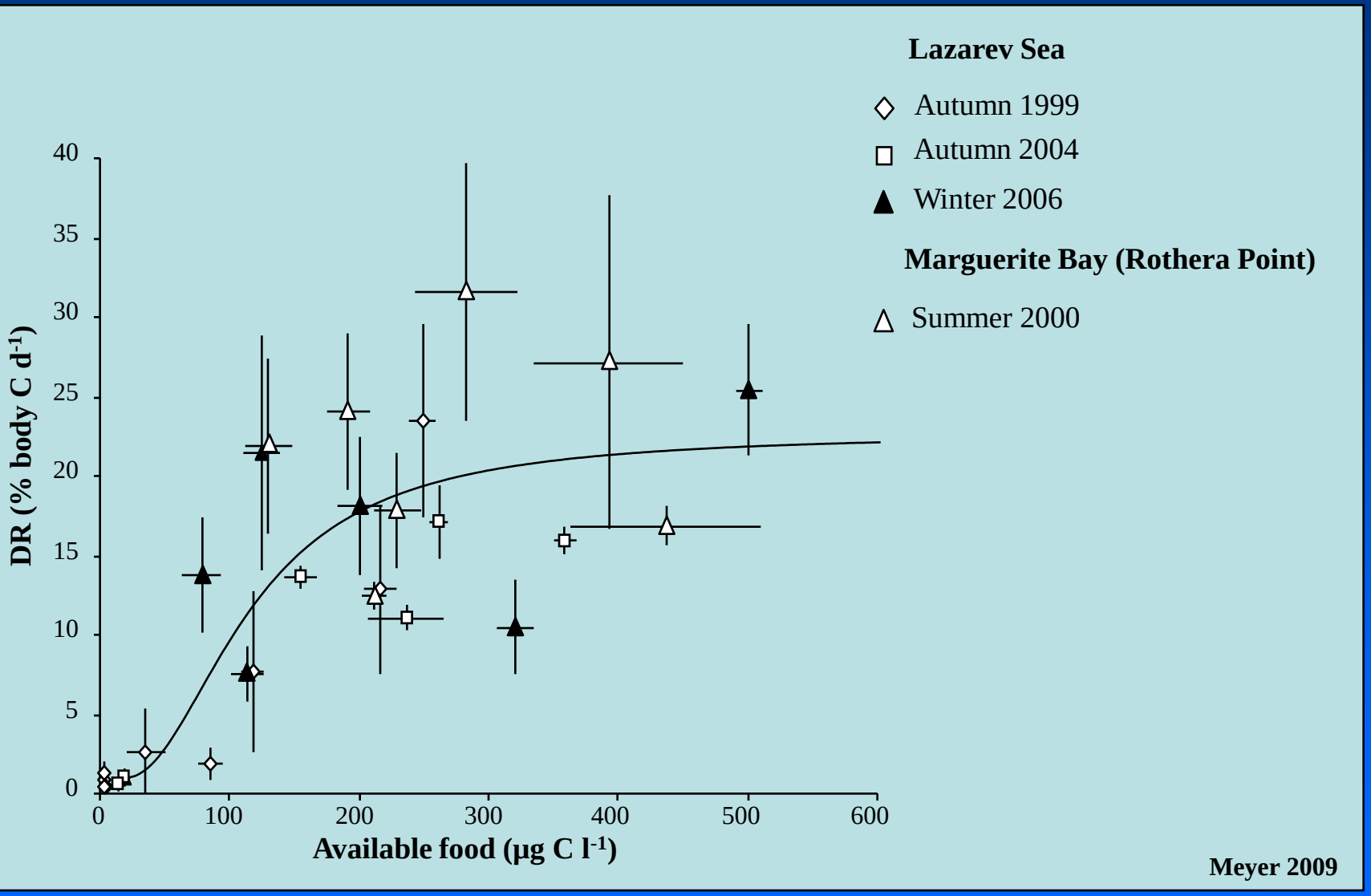
Feeding activity of adult krill



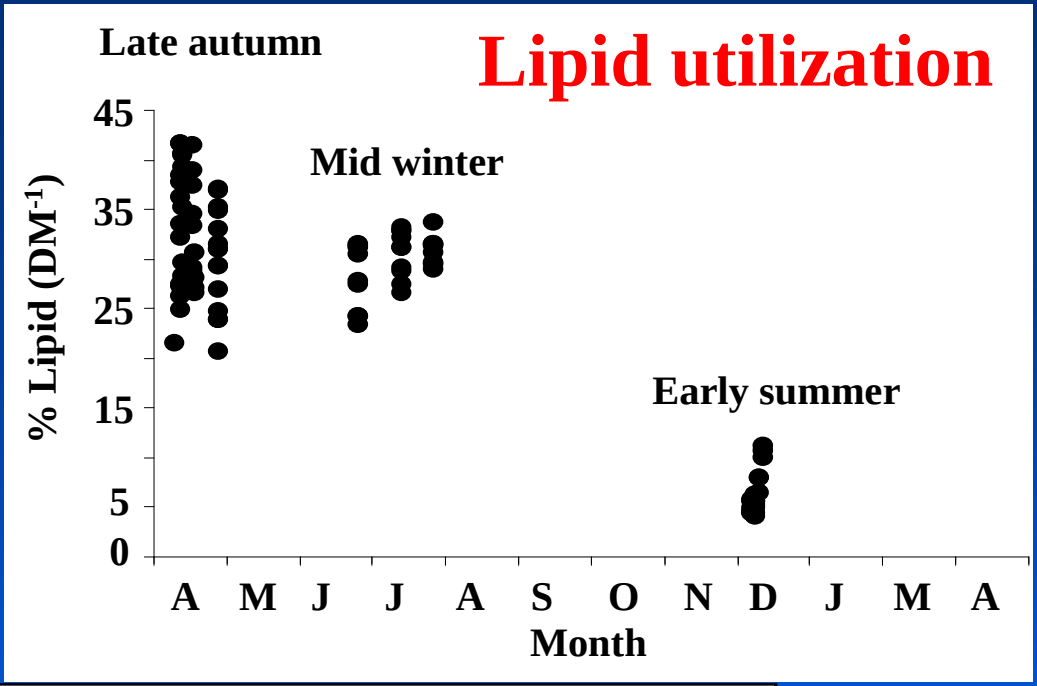
- **Only minor responds in feeding activity, after exposure to high food concentrations for up to 2 weeks**

Meyer et al. 2010, MEPS in press

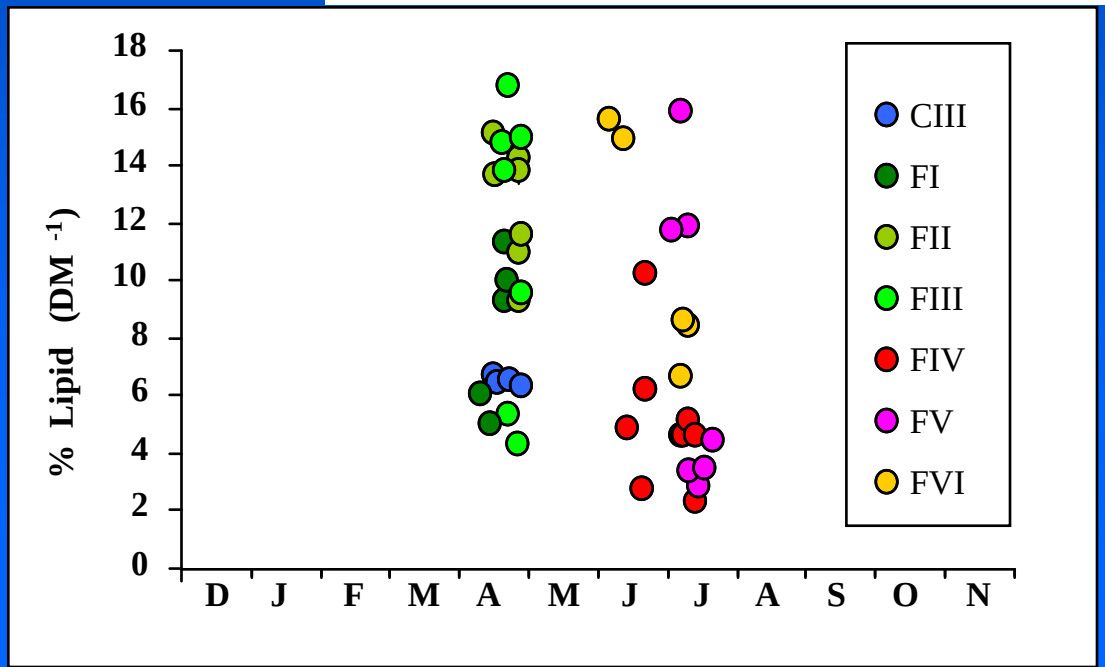
Feeding activity of larval krill



Lipid utilization



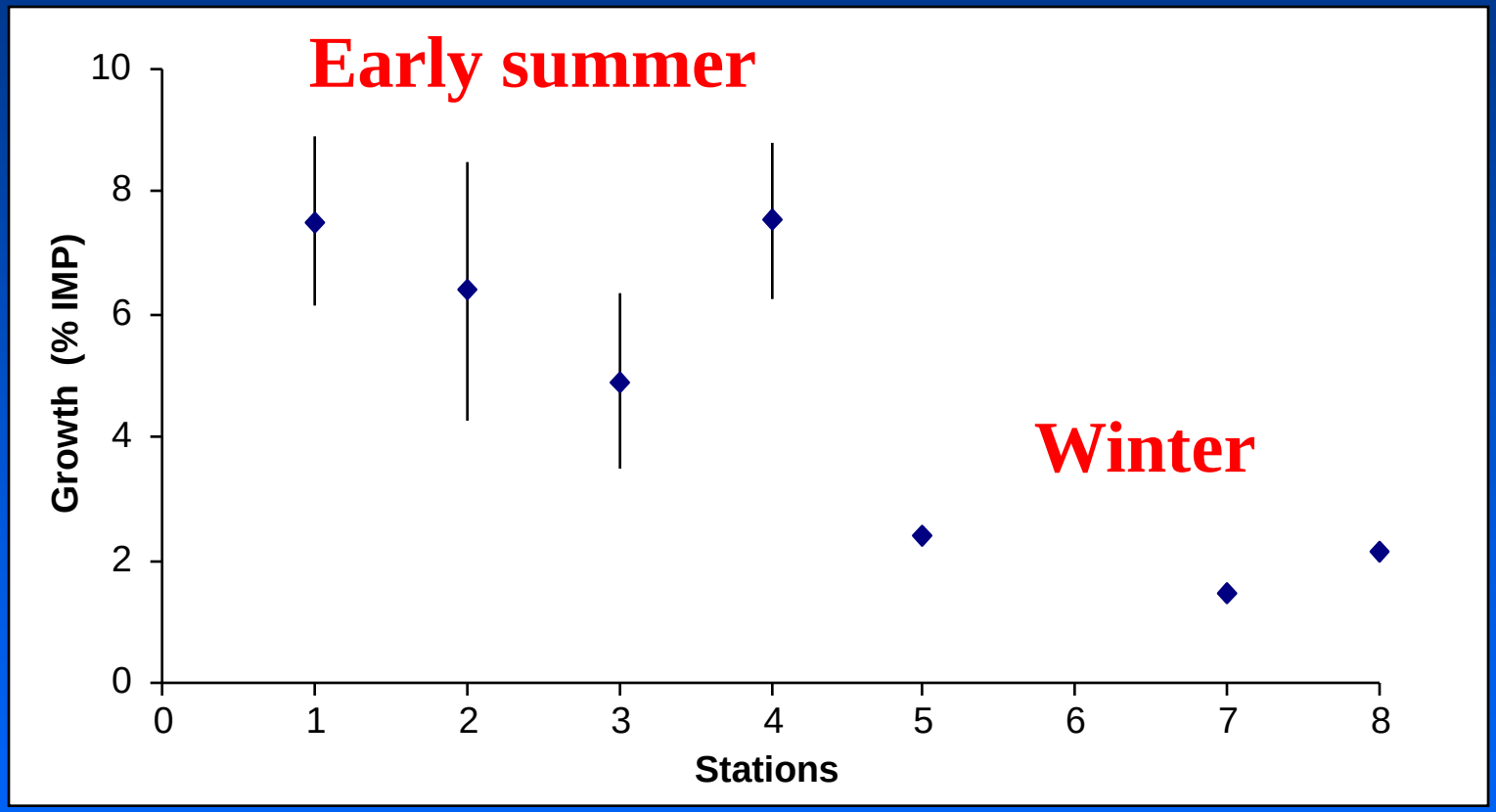
Adult krill



Larval krill

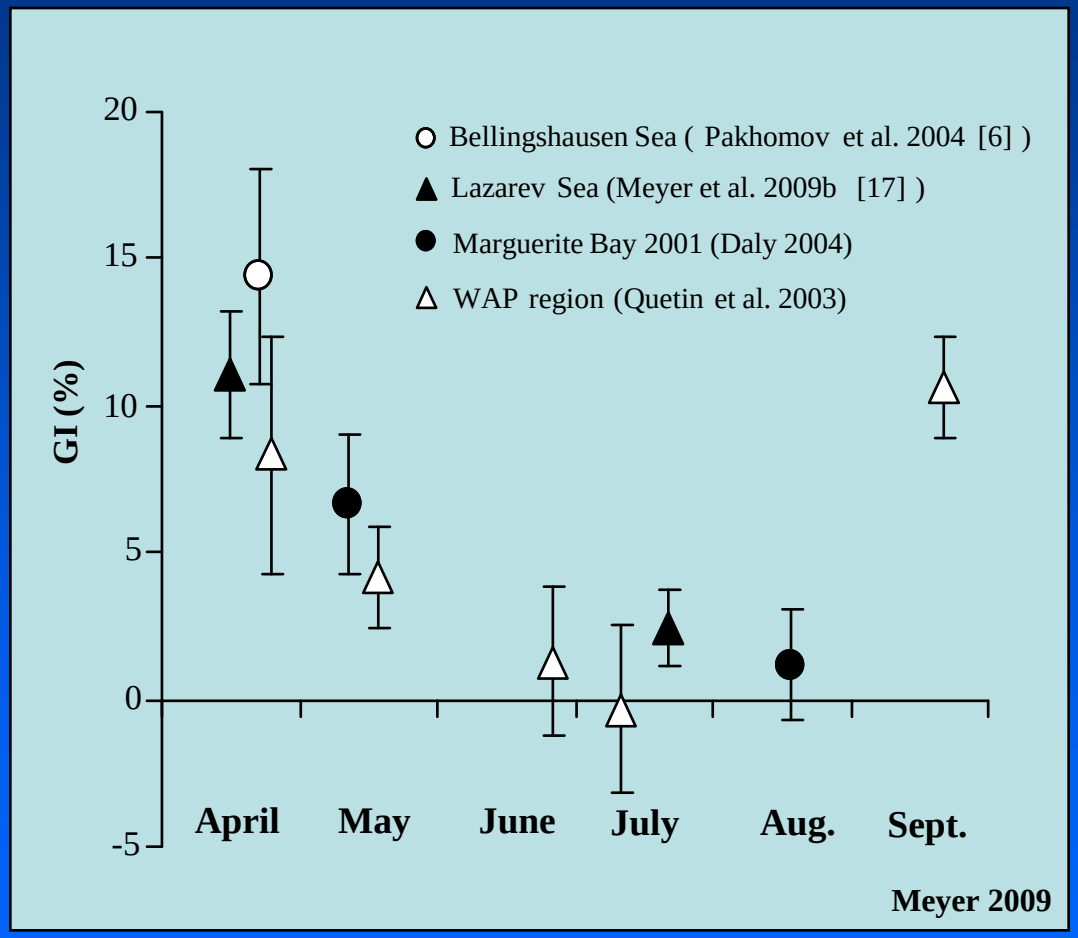
Meyer 2009

Growth activity of adult krill



Meyer et al. 2010, MEPS in press

Growth activity of larval krill



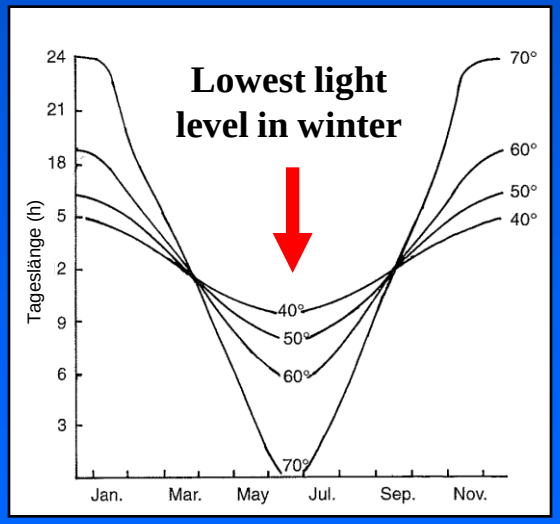
➢The metabolic depression of adult krill during winter is not a matter of food availability

- **Food availability:**
  Winter → < **0.1 µg Chl *a* L^{-1}**
  Summer → **10 - 30 µg Chl *a* L^{-1}**

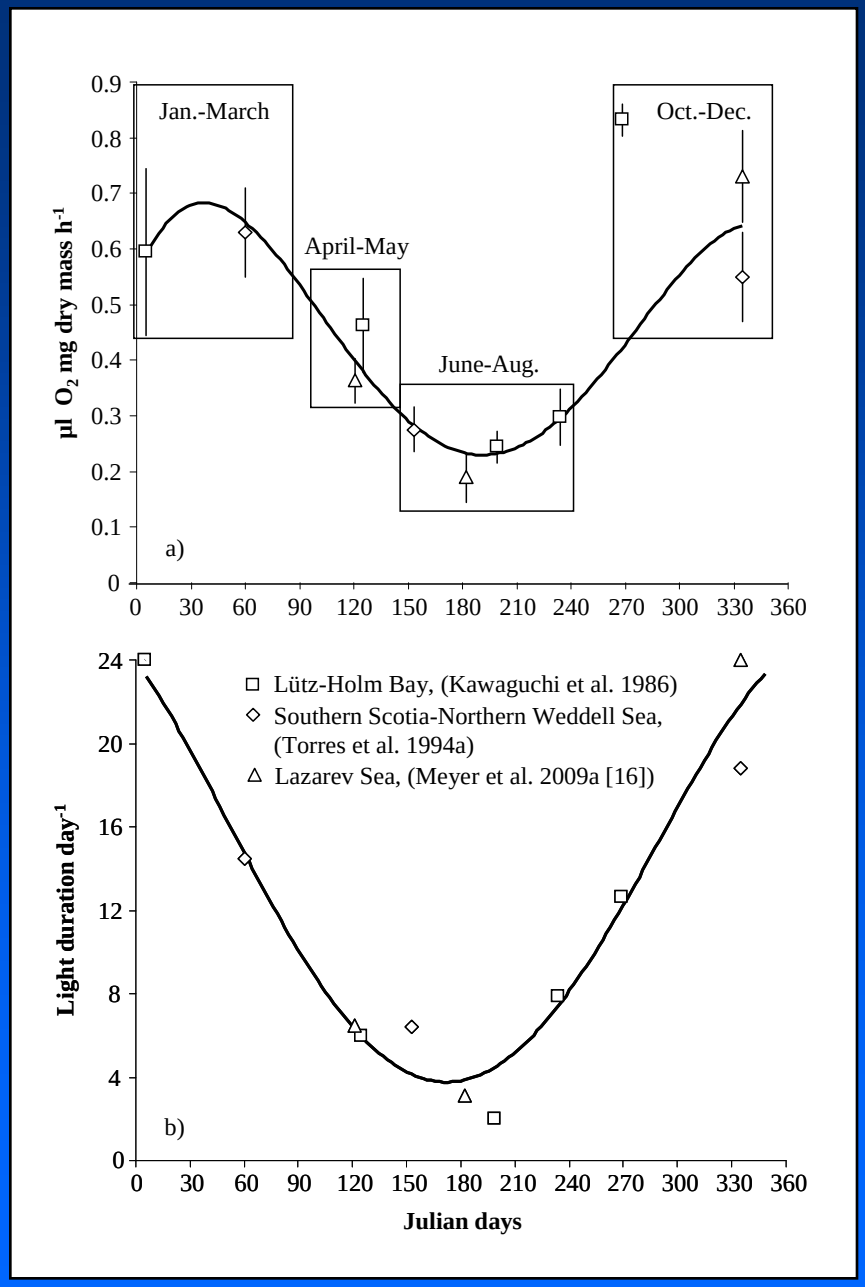
- **Sea ice cover:**
  Winter → **$20 \cdot 10^6$ km^2**
  Summer → **$4 \cdot 10^6$ km^2**

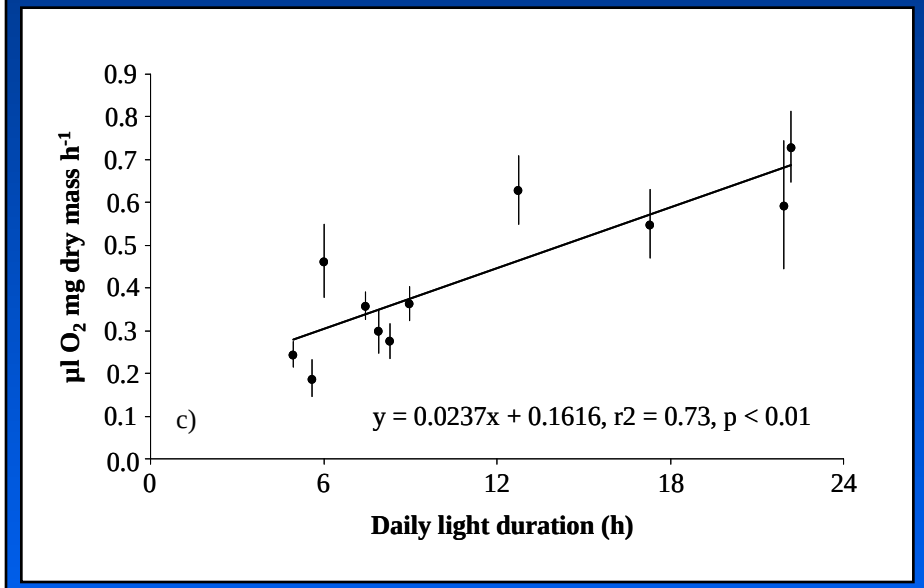
- **Light intensity and duration:**

The annual cycle of day length (Photoperiod) and light intensity is a reliable measure of the course of the seasons.



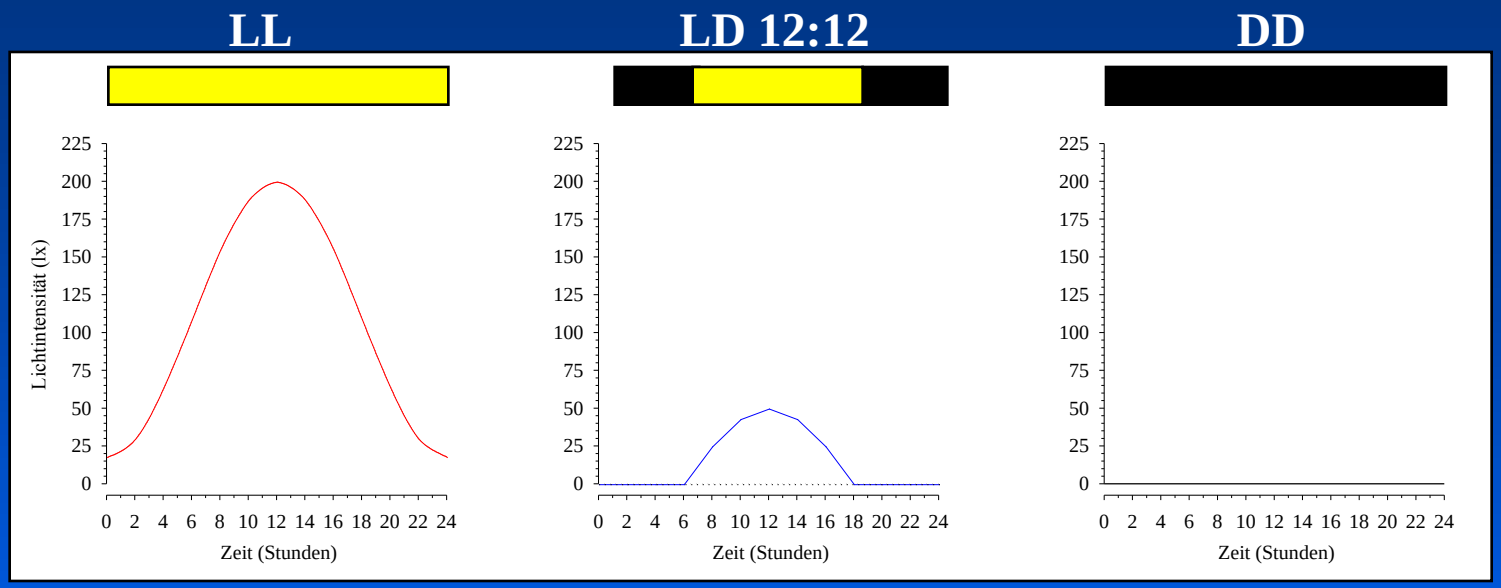
Metabolic activity of adult krill in the field





Meyer 2009

Laboratory experiments



- Weekly measurements
  - → Feeding activity
  - → Metabolic activity
  - → Sexual maturity

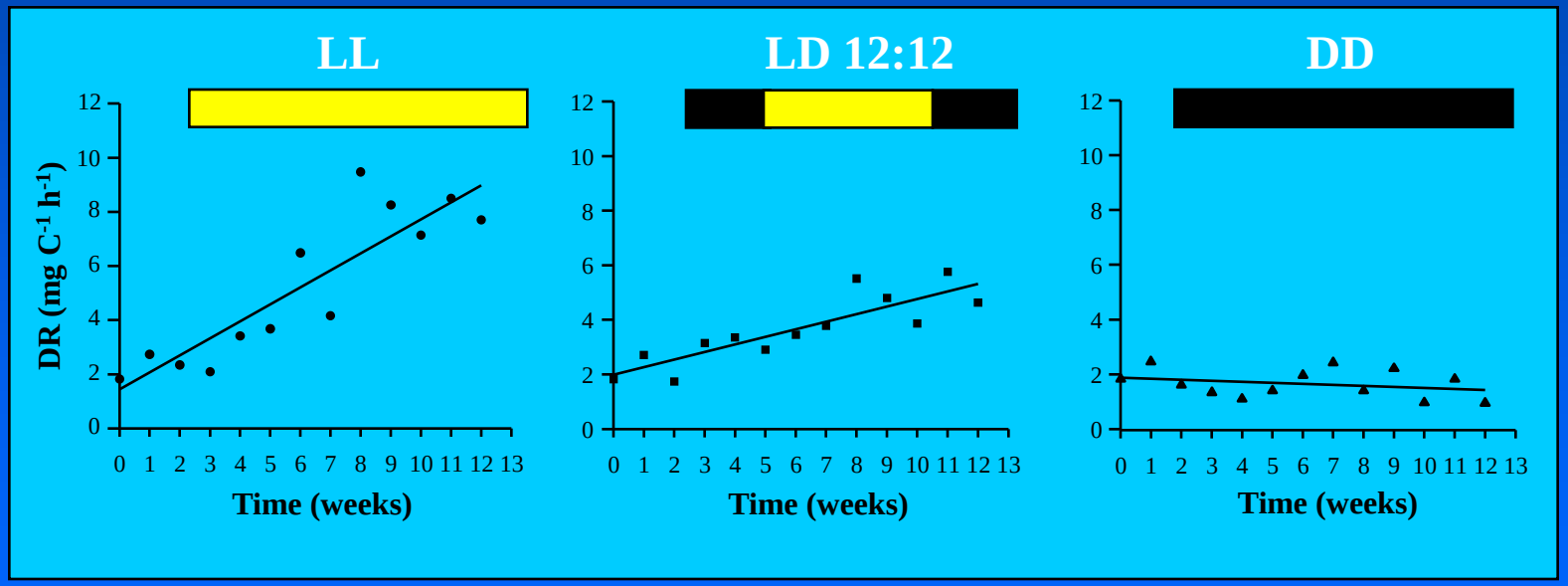
Laboratory experiments

Australian Antarctic Division (AAD)

Laboratory experiments

Australian Antarctic Division (AAD)

Feeding activity



Teschke et al. L&O, 2007, 2008

Conclusions

Adult krill

- **INHERENT physiological functions, influenced by the Antarctic light regime**

- **Importance of overwintering-mechanisms proposed:**
  a) reduced metabolism and lipid utilization
  b) reduced feeding activity

Larval krill

- **FLEXIBLE physiological functions, influenced by the available food supply**

Open questions

Adult krill

- *What is the specific response mechanism in the seasonal cycle of day-length?*
- *Does krill exhibit circadian rhythmicity and can we identify the genes involved?*
- *Does the shift of metabolic activity between seasons takes place abruptly with the final larval moult or if there is a subtle transition during juvenile stage*

Larval krill

- *Which biological and physical environmental condition enhance larval development and growth (Habitat quality)*

Diving in Antarctic winter in the Lazarev Sea