Changes of physiological status in Antarctic krill *Euphausia superba* in response to light regime simulation

M. Teschke
S. Kawaguchi
B. Meyer

Alfred Wegener Institute for Polar and Marine Research – AWI
Australian Antarctic Division – AAD
Introduction

• Overwintering success is a decisive factor that influences krill condition, recruitment and population size.

• Which physiological mechanisms allow krill to survive during winter when the ocean is covered by ice and food (phytoplankton) is scarce?

• The reduction in metabolic rates (30 – 50%) is discussed as a major physiological response to the Antarctic winter.

➢ The mechanisms that causes the reductions are still not clearly known!
Research Objectives

- Are reduced metabolic rates resulting from lower food availability (starvation) or from major physiological changes (adaptation)?

- Which environmental parameters may affect the metabolism?

- Internal physiological processes in krill may be influenced or induced by the seasonal light regime in the Antarctic?

- **Investigate the effect of simulated Antarctic light regimes on physiological parameters of krill.**
Methods

• Krill maintenance

- **Aurora Australis on-board tank**
  - 200 L
  - 0°C
  - Dim light

- **AAD holding tank**
  - 1670 L
  - 0.5°C
  - nLD

- **Experimental tank I**
  - 100 L
  - 0.5°C
  - LL; 200 lx

- **Experimental tank II**
  - 100 L
  - 0.5°C
  - LD 12:12; 50 lx

- **Experimental tank III**
  - 100 L
  - 0.5°C
  - DD

**Timeline**
- 7 Feb 2005
- 17 Feb 2005
- 30 May 2005
- 22 Aug 2005

**Stages**
- Collection
- Maintenance
- Experiment
Methods

- Experimental design

➢ Simulated Antarctic light regimes for 12 weeks

LL  |  LD 12:12  |  DD

➢ All three experimental stocks were fed daily the same food concentration!
Methods

• Weekly measurements

• Feeding activity
  Clearance rate
  Daily C ration
  Size of digestive gland

• Metabolic activity
  Respiration rate
  Malate dehydrogenase (MDH) activity
Results

- Feeding activity → Clearance rate

**LL**

\[ Y = 0.6278x + 1.447 \]

\[ r^2 = 0.7810 \]

**LD 12:12**

\[ Y = 0.2786x + 1.447 \]

\[ r^2 = 0.7413 \]

**DD**

\[ Y = 0.0374x - 1.879 \]

\[ r^2 = 0.0792 \]
• Feeding activity → Daily C ration

**Results**

**LL**
- \( Y = 2.515x + 1.259 \)
- \( r^2 = 0.7807 \)

**LD 12:12**
- \( Y = 0.915x + 4.162 \)
- \( r^2 = 0.8499 \)

**DD**
- \( Y = 0.1583x + 3.894 \)
- \( r^2 = 0.0792 \)
• Feeding activity → Digestive gland size
• Metabolic activity → Respiration rate
Results

- Metabolic activity $\rightarrow$ MDH activity
Summary

• Changes of feeding and metabolic activity are not primarily the result of food supply!

• LL and LD 12:12 → showed an increase in all measured parameters over the experimental period.

• LD 12:12 → showed a more consistent increase and remained below those of krill held under LL.

• DD → did not respond to the high food availability.

➢ Feeding and metabolic activity of krill were affected by the different simulated Antarctic light regimes!
Conclusions

• Seasonal changes in the physiological status of adult krill appear to be more the result of seasonal adaptations in the animal physiology and behaviour irrespective of ambient food levels.

• The study underlines the important effect of the Antarctic light cycle on physiological parameters of krill such as feeding and metabolic rates.

➢ This may indicate an inherent adaptational overwinter strategy triggered by the Antarctic light regime!
Future work

• Characterization on the effects of light.

• What are the transducers for seasonal responses in relation to the Antarctic light regime (e.g. Melatonin, Serotonin)?

  ➢ ~1 pg mg_{fw}^{-1} (eyestalks) and ~0.2 pg µl^{-1} (hemolymph) immunoreactive melatonin (unpublished data).

• Investigate the nature of this hormone and its mode of action.
Acknowledgements

Australian Antarctic Division (AAD)

R. King
T. Yoshida

This work was funded by the German Academic Exchange Service (DAAD)