EFFECT OF LIGHT REGIME ON THE SEASONAL CYCLE OF ANTARCTIC KRILL

Flavia Höring

Mathias Teschke, Fabio Piccolin, Lavinia Suberg, Felix Müller, So Kawaguchi, Bettina Meyer
Why are krill so successful?

The Southern Ocean – a strongly seasonal habitat

Sea ice extent

Photoperiod

Primary production

Seasonal and interannual variability

NASA Earth Observatory maps by Joshua Stevens, using AMSR2 data supplied by GCOM-W1/JAXA.

Meyer 2012

Meyer et al. 2010
Seasonal rhythms in *E. superba*

Maturation cycle

Lipid dynamics

Respiration

Latitudinal differences:
- Lower lipid stores and higher feeding activities observed at lower latitudes in winter

How are these rhythms modulated?
Biological timing in *E. superba*

The concept of biological clocks

What do we know?

- Photoperiod has an impact on:
  - Maturity
  - Body composition
  - Respiration rate
  - Gene expression

- Clock genes and an endogenous timing system in Antarctic krill

Short-term studies only
Aim of the study

Research objectives:

- Investigation of the effect of different latitudinal light regimes on the phenology of *E. superba*
  1) Growth
  2) Maturity
  3) Lipid metabolism
  4) Gene expression

- Long-term lab experiments over 2 years with constant food supply

Hypotheses:

I. Light regime triggers seasonal rhythms in Antarctic krill.

II. Seasonal rhythms are maintained by an endogenous timing system.
Long-term lab experiments
Australian Antarctic Division, Kingston, Tasmania

Experimental set-up

Hypothesis I: Light regime triggers seasonal rhythms in Antarctic krill.

- Light regime 52°S
- Light regime 62°S
- Light regime 66°S
- Constant darkness (DD)

Hypothesis II: Seasonal rhythms are maintained by an endogenous timing system.

Simulated light regimes

Recorded data

- Carapax length

- Gender and sexual maturity stage

Photos: Fabio Piccolin
Growth

Generalized additive mixed model (GAMM):
Carapax length ~ General trend + Seasonal trend

General trend

Similar trend in all treatments:
- Shrinkage in beginning of experiment – related to experimental conditions
Growth

Generalized additive mixed model (GAMM):
Carapax length ~ General trend + Seasonal trend

Seasonal trend

Similar trend in all treatments:
- Seasonal trend observed in all treatments – influenced by light regime
- Rhythmic pattern under constant darkness – Indication for an endogenous seasonal timing system
Maturity analysis

Differences between females and males

Relationship between maturity and photoperiod:
- Different pattern in females and males
- Further maturity analysis carried out with females only
Maturity analysis

Generalized additive model (GAM): Maturity score ~ Seasonal trend

Seasonal trend

- Seasonal pattern observed under light regimes 52°S, 62°S and 66°S
- No seasonality under constant darkness
Maturity analysis

Maturity under constant darkness

- Sexual regression in beginning of experiment
- Indication for an endogenous timing system
Maturity analysis

Binomial model:
Probability of maturity score 5 ~ Hours of light

Data
Maturity score 5?
- yes
- no

Probability to be sexually mature

Critical photoperiod (CPP):
= Photoperiod for 50% sexual maturity

Are the critical photoperiods different between treatments?

➔ Probability of sexual maturity higher with longer photoperiod
Maturity analysis

Binomial model:
Probability of maturity score 5 ~ Hours of light

Analysis of critical photoperiods

- Critical photoperiods (CPPs) are different between treatment 52°S and 66°S
- CPP is longer in higher latitude light regime

What is the advantage of different critical photoperiods?

- Longer CPPs – an adaptation to the light regime at higher latitudes
- Krill is able to start sexual regression and maturation at the right time
Conclusions

1) Growth
   • Seasonal growth patterns are influenced by light regime
   • Growth patterns are modulated by an endogenous timing system

2) Maturity
   • The maturity cycle is light-dependent
   • The observation of sexual regression under constant darkness suggests an endogenous timing system in krill
   • Krill under the high latitude light regime have a longer critical photoperiod (an adaptation to more extreme light conditions)
Seasonal cycles of growth and maturity in *E. superba* are triggered by different latitudinal light regimes and governed by an endogenous timing system.