EFFECT OF LIGHT REGIME ON THE SEASONAL CYCLE OF ANTARCTIC KRILL

Flavia Höring

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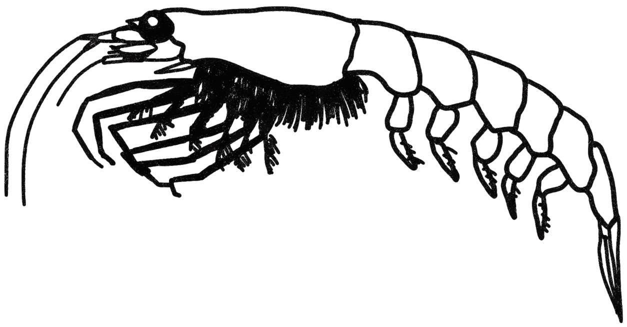


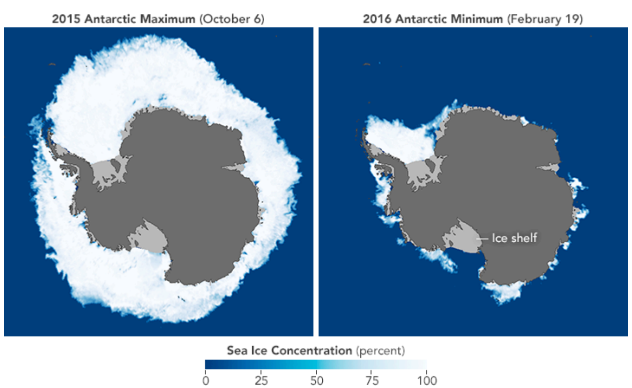
3rd International Symposium on Krill, St. Andrews, Scotland
Ecosystems: why are krill so successful?
14 June 2017

Why are krill so successful?

The Southern Ocean – a strongly seasonal habitat

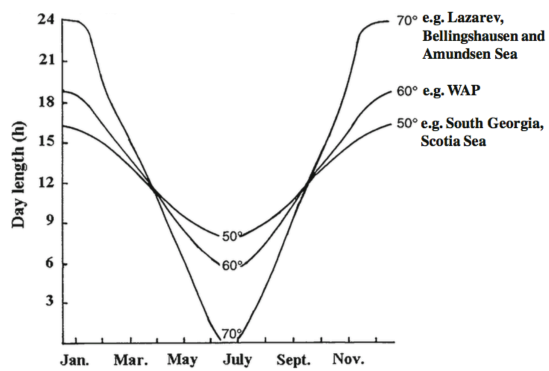
Sea ice extent

Spring **Summer**



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

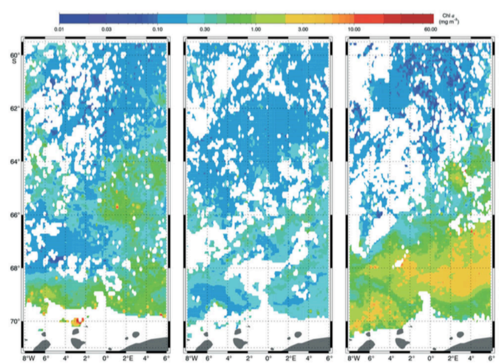
Photoperiod



Meyer 2012

Primary production

Seasonal and interannual variability

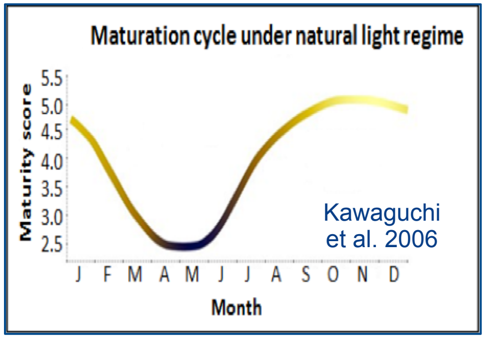


Autumn 2004 **Autumn 2005** **Autumn 2006**

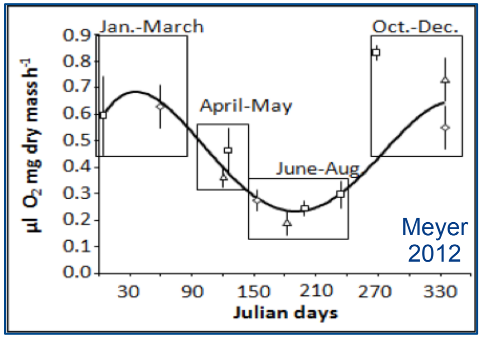
Meyer et al. 2010

Seasonal rhythms in *E. superba*

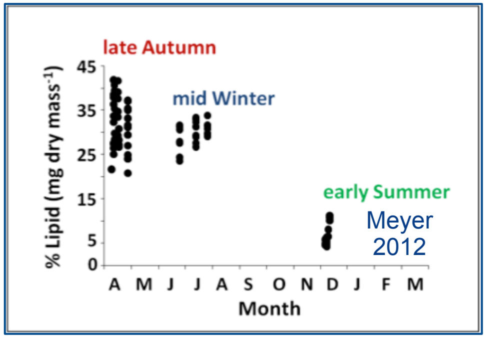
Maturation cycle



Respiration



Lipid dynamics



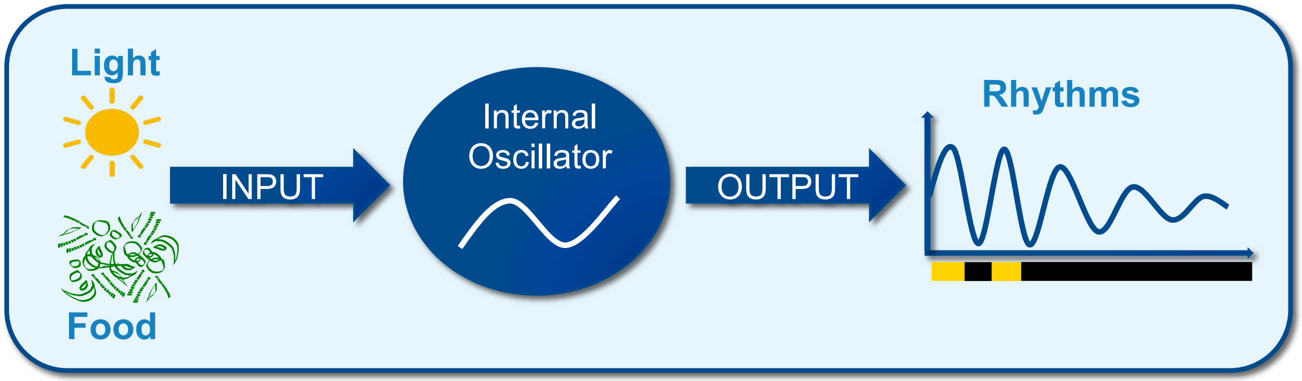
Latitudinal differences:

- 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?

Short-term studies only

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

- Clock genes and an endogenous timing system in Antarctic krill

Aim of the study

<u>Research objectives:</u>

- 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

<u>Hypotheses:</u>

I. Light regime triggers seasonal rhythms in Antarctic krill.

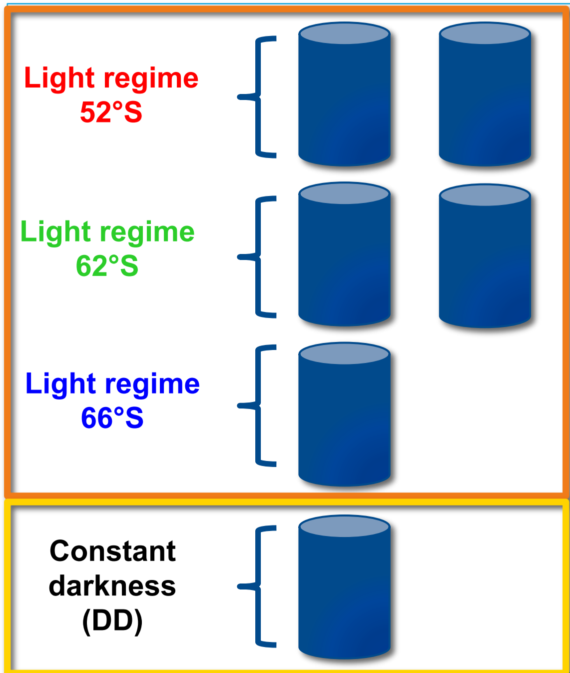
II. Seasonal rhythms are maintained by an endogenous timing system.

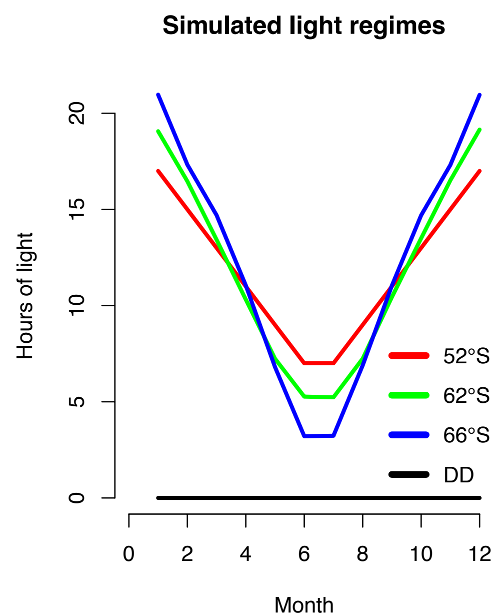
Long-term lab experiments

Australian Antarctic Division, Kingston, Tasmania

Experimental set-up

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

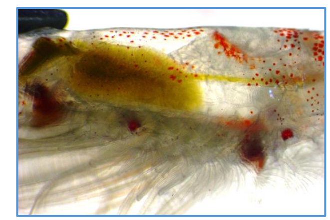




Hypothesis II: Seasonal rhythms are maintained by an endogenous timing system.

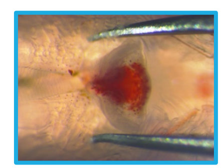
Recorded data

- Carapax length

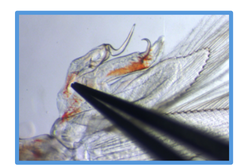


Thorax

- Gender and sexual maturity stage



Thelycum (female)



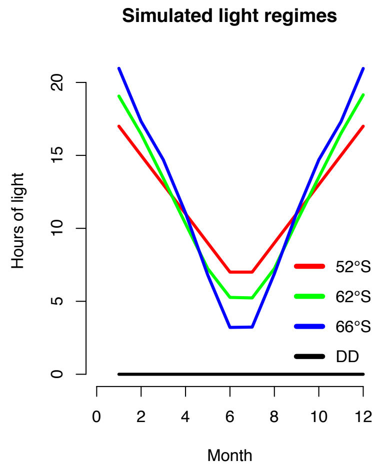
Petasma (male)

Photos: Fabio Piccolin

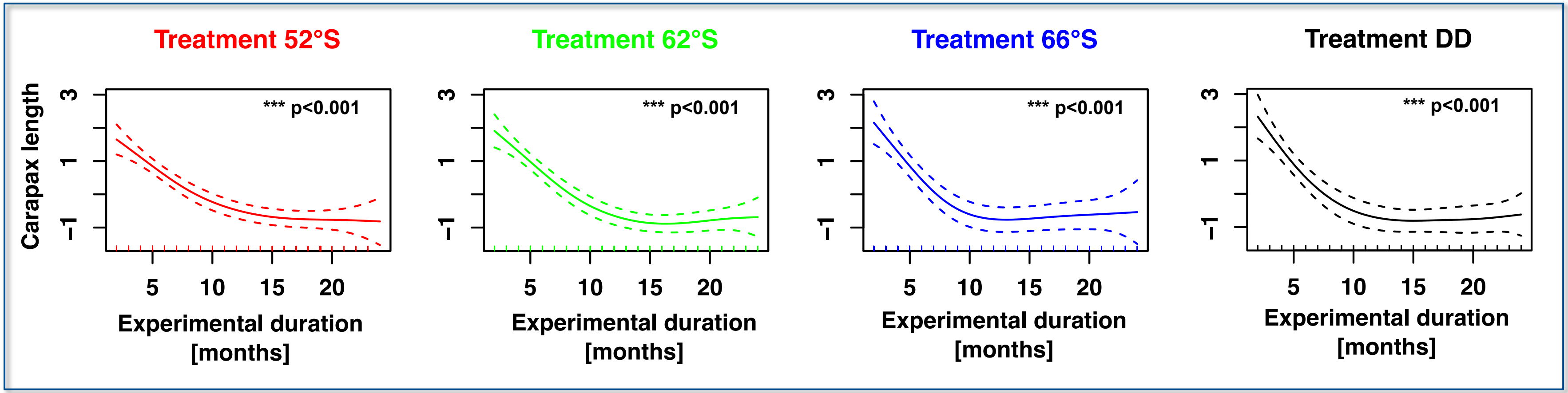
Growth

Generalized additive mixed model (GAMM):

Carapax length ~ General trend + Seasonal trend



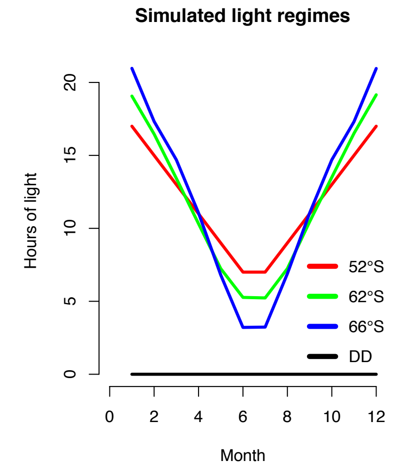
General trend



Similar trend in all treatments:

- ➢ Shrinkage in beginning of experiment – related to experimental conditions

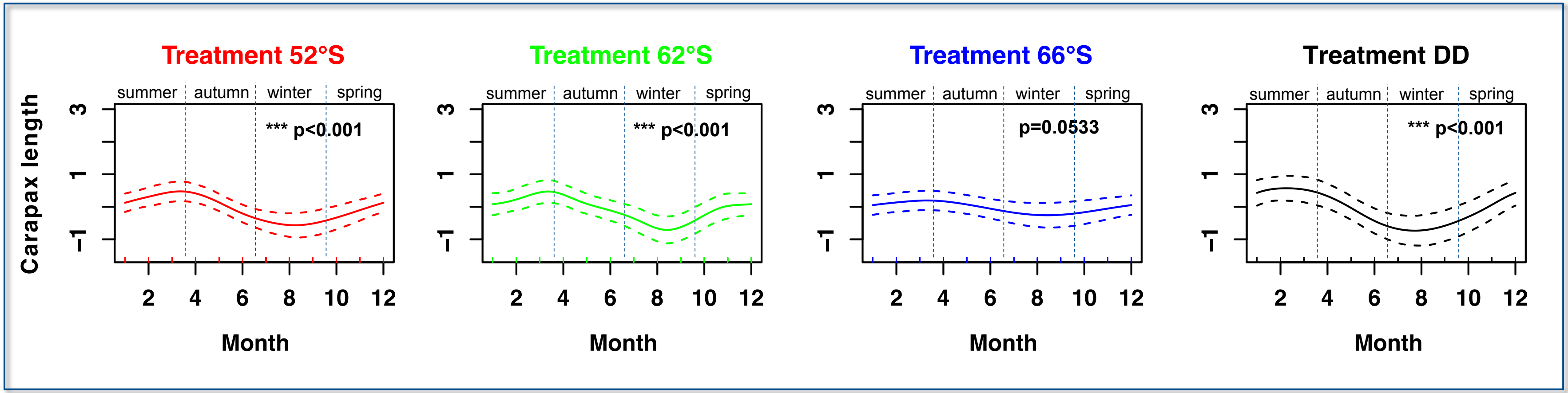
Growth



Generalized additive mixed model (GAMM):

Carapax length ~ General trend + Seasonal trend

Seasonal trend

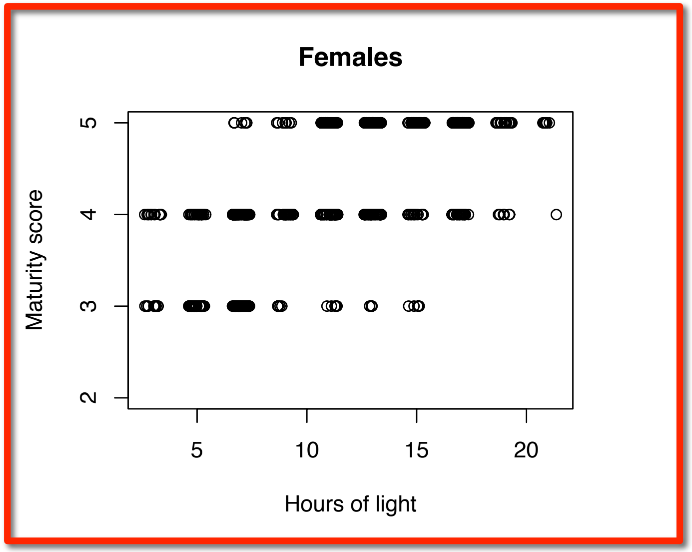


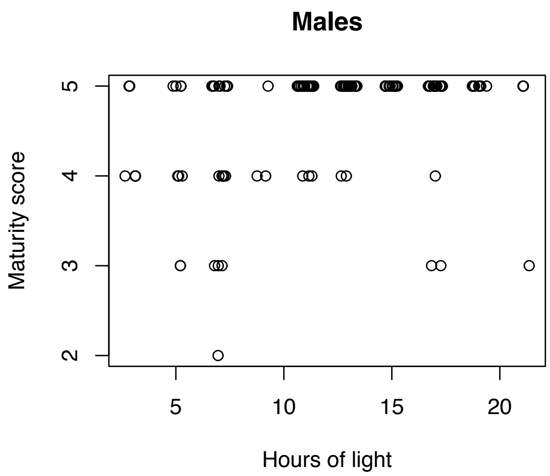
Similar trend in all treatments:

- 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

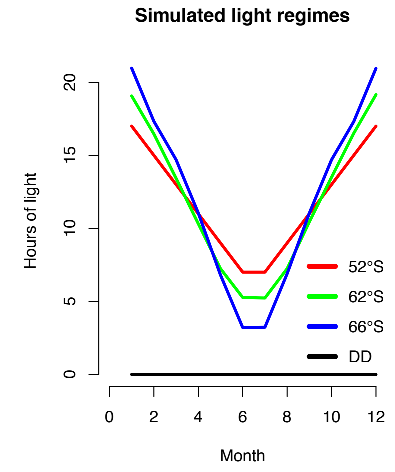




Relationship between maturity and photoperiod:

- Different pattern in females and males
- Further maturity analysis carried out with females only

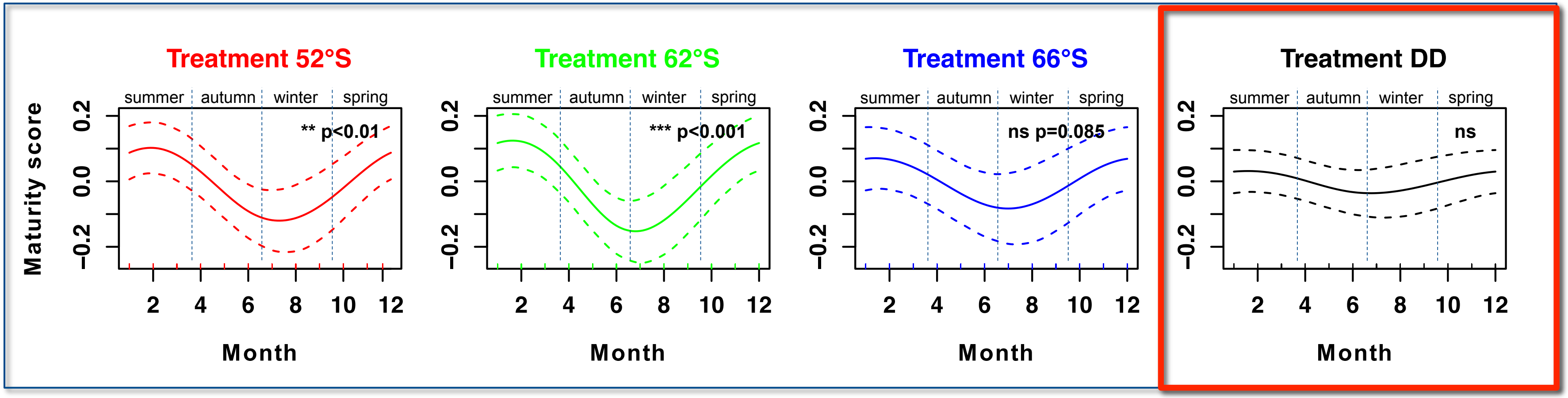
Maturity analysis



Generalized additive model (GAM):

Maturity score ~ Seasonal trend

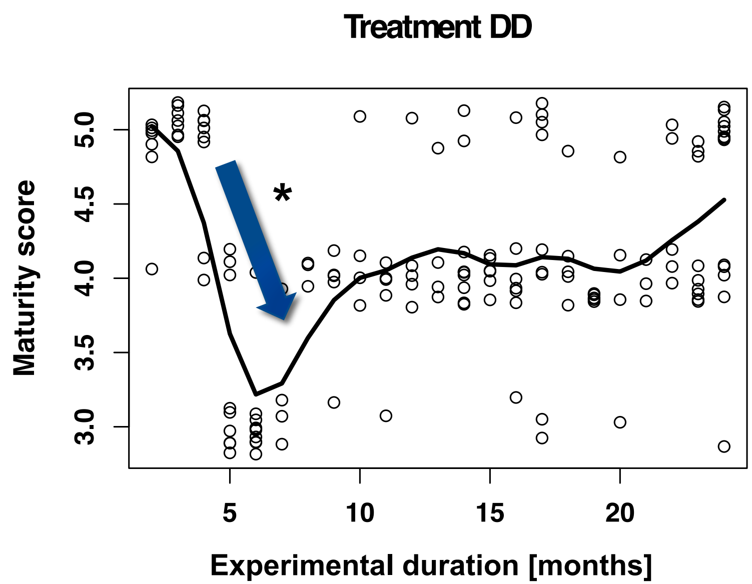
Seasonal trend



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

Maturity analysis

Maturity under constant darkness

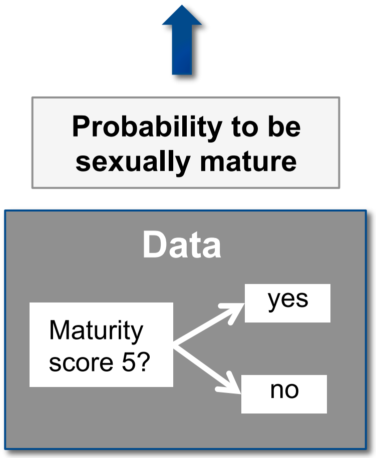


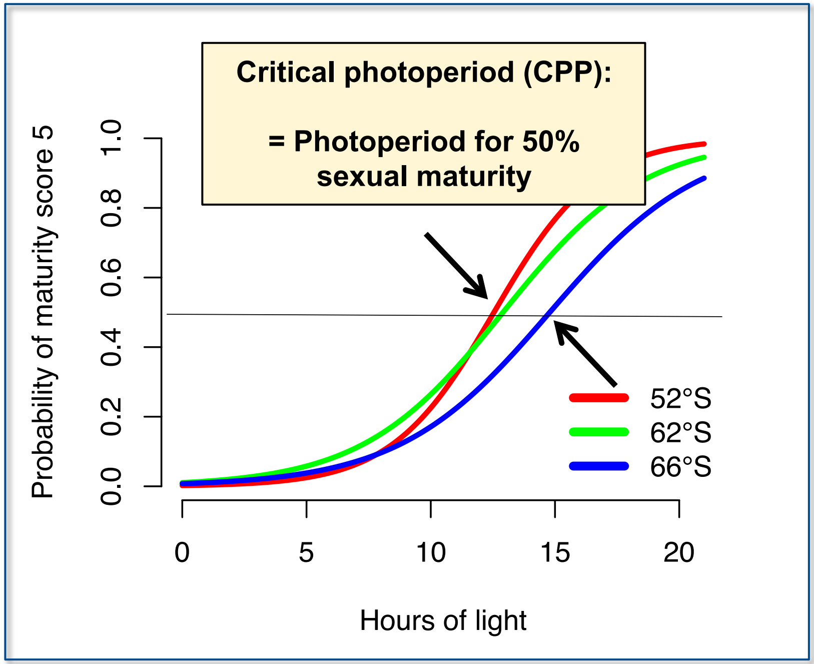
- Sexual regression in beginning of experiment
- Indication for an endogenous timing system

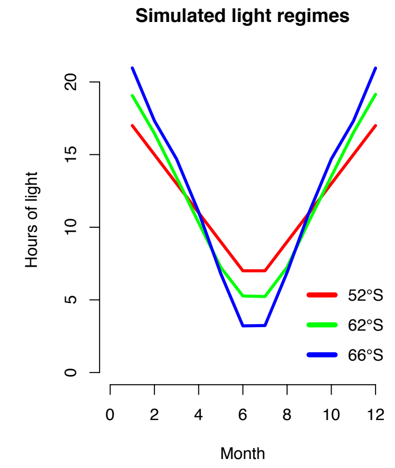
Maturity analysis

Binomial model:

Probability of maturity score 5 ~ Hours of light







- Probability of sexual maturity higher with longer photoperiod

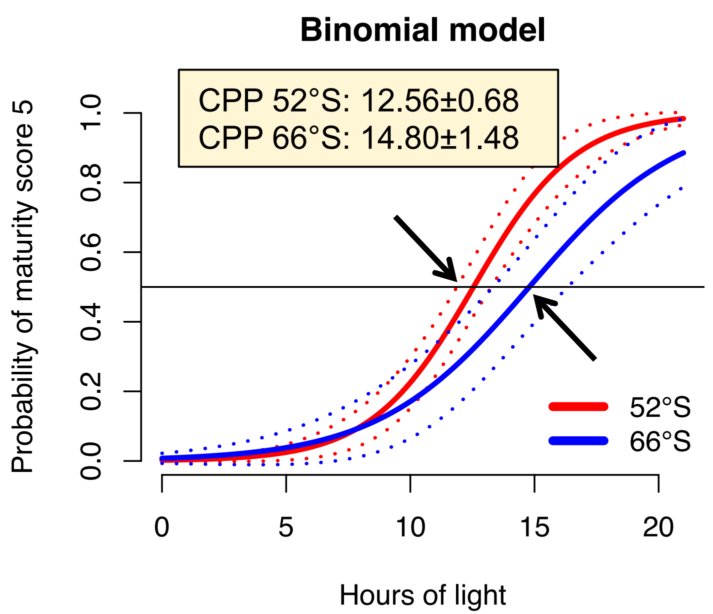
Are the critical photoperiods different between treatments?

Maturity analysis

Binomial model:

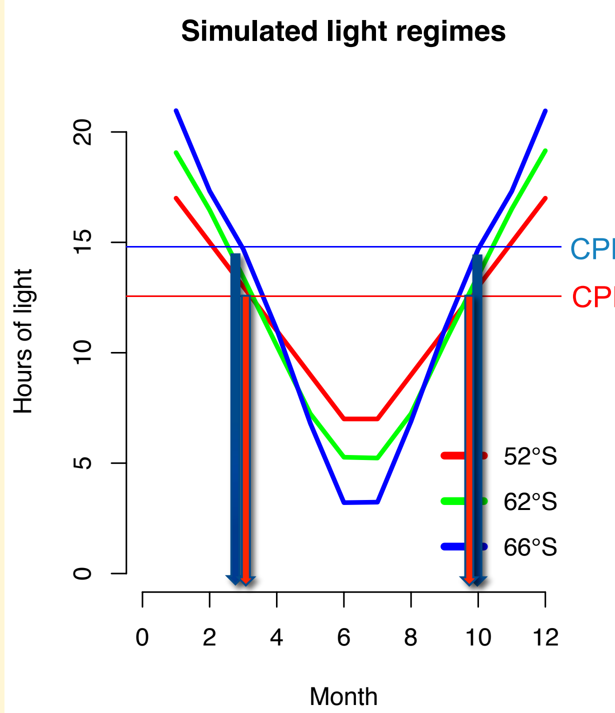
Probability of maturity score 5 ~ Hours of light

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)

Take-home message

Seasonal cycles of growth and maturity in *E. superba* are triggered by different latitudinal light regimes and governed by an endogenous timing system.

Acknowledgments

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