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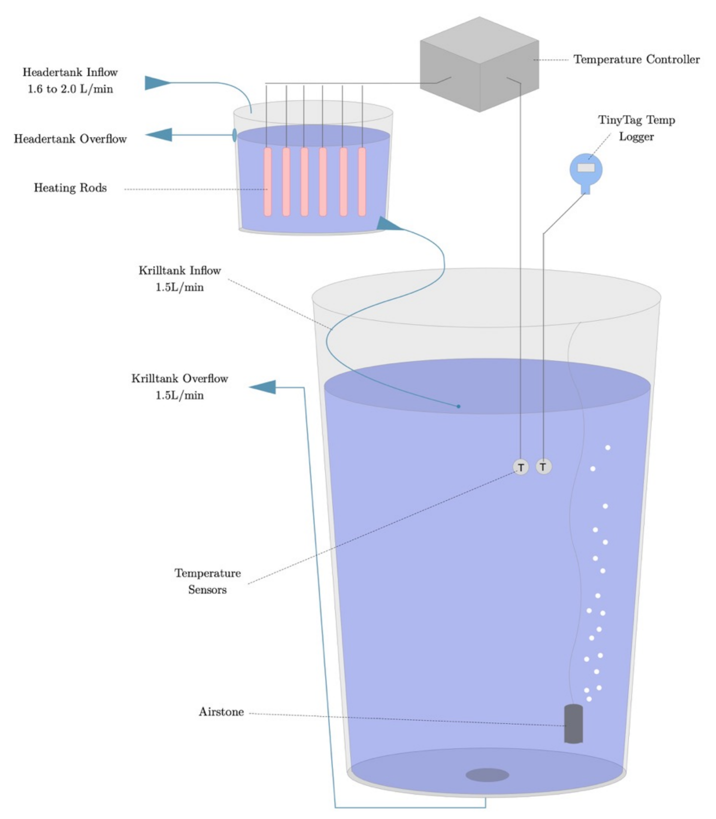
Increased seawater temperatures cause temporal shifts in catabolic pathways of Antarctic krill *Euphausia superba*

Background:

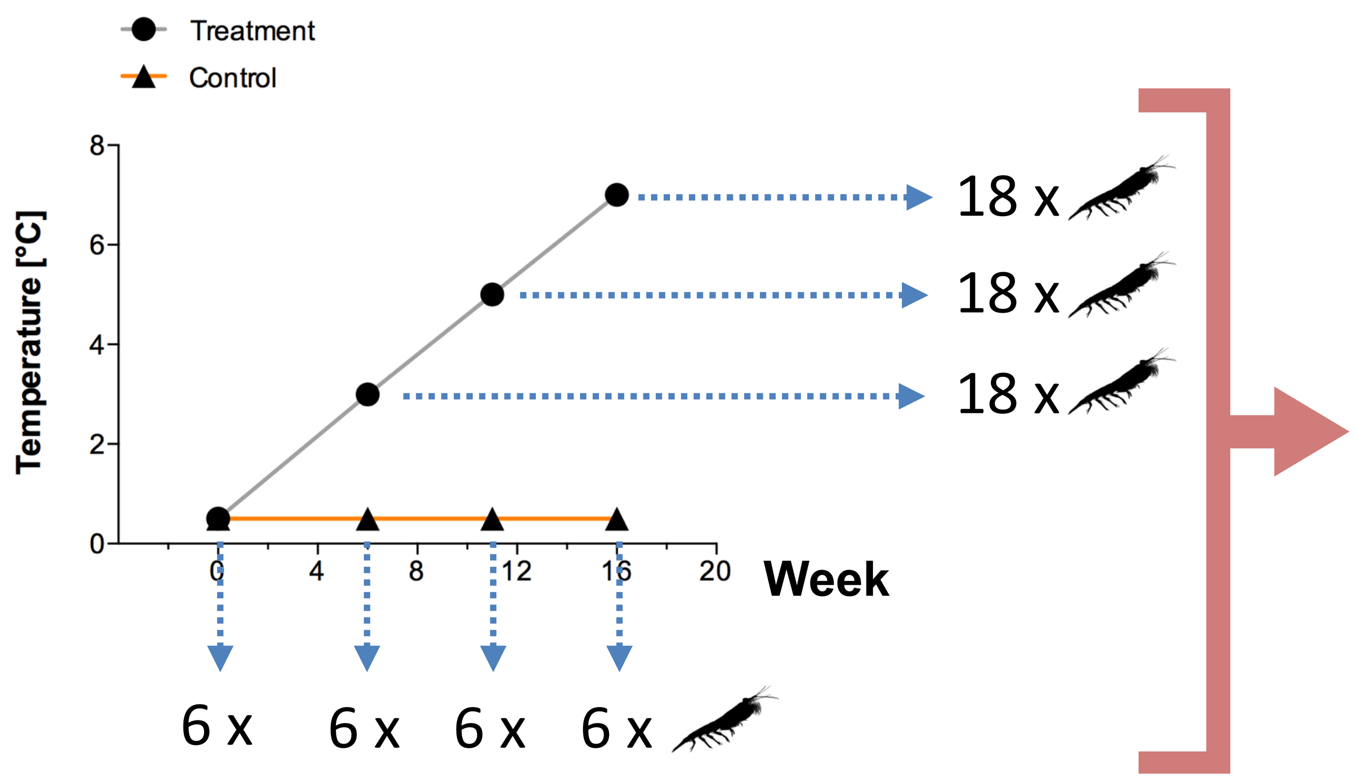
The Atlantic sector of the Southern Ocean is particularly susceptible to climate change and among the fastest warming regions worldwide. Antarctic krill *Euphausia superba* play a pivotal role in the Southern Ocean food web and fishery by sustaining a large number of predators and constituting the largest underexploited stock of forage fish. As such the response of the Southern Ocean ecosystem will largely depend on the response of the krill population to changes in its environment. Temporal and spatial shifts in the Southern Ocean are already observable today and the habitat of krill is projected to drastically change over the next century. Data on krill's physiological ability to acclimatize to increasing temperatures is scarce. However, to further aid the ability to predict ecosystem behavior it is essential to gain an understanding of the underlying mechanism of response.

The aim of this study was to elucidate the direct effects of rising seawater temperature on Antarctic krill catabolism.

Experimental Design:



Schematic overview of experimental tank holding 200 individual krill. Light conditions were kept constant, temperature was regulated within a range of 0.1°C. Krill were fed *ad libitum*.

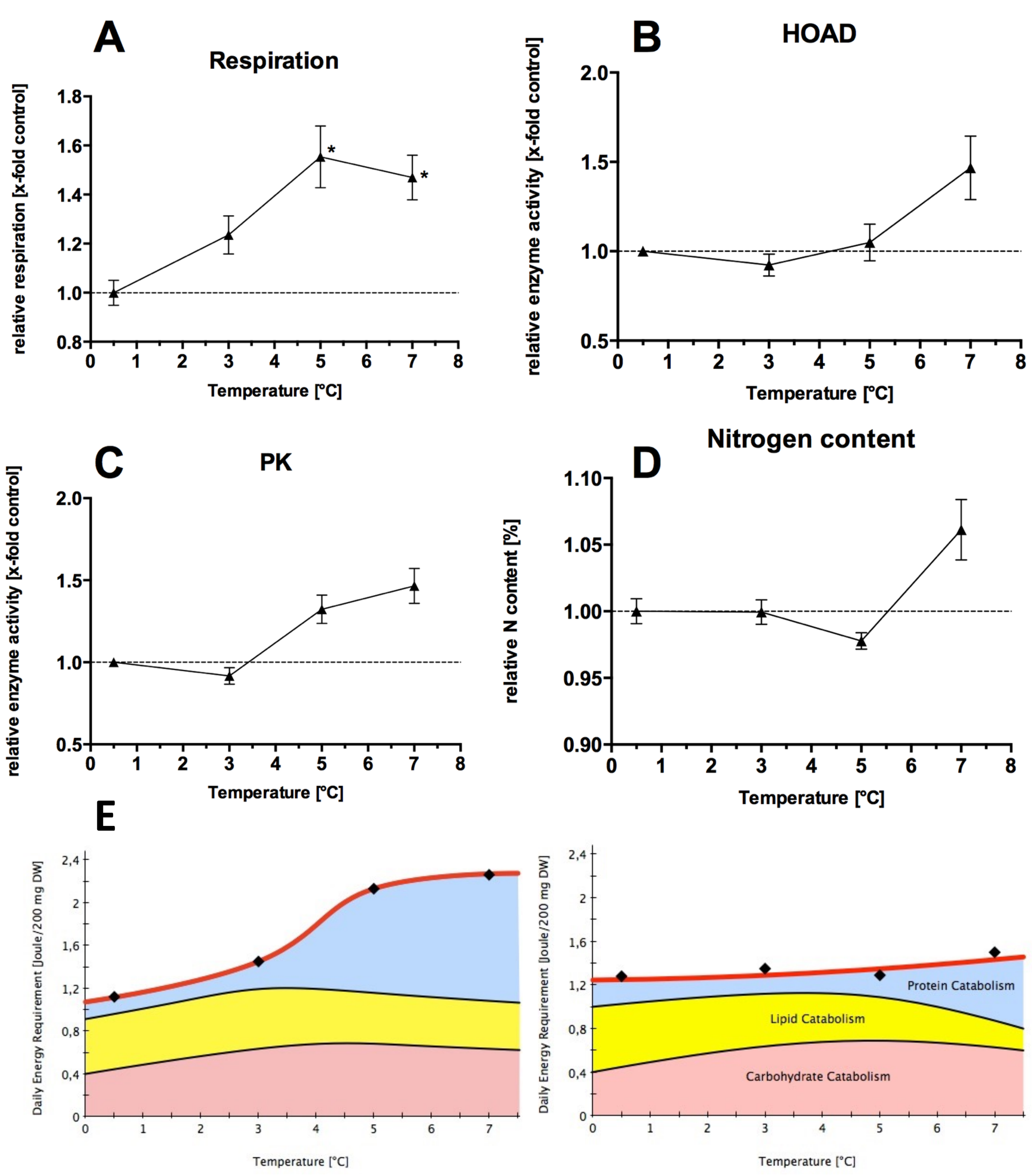


Sampling scheme of control and treatment tanks. Temperature was gradually increased from 0.5°C to 7°C over a period of 16 weeks. Temperature in control tank remained constant at 0.5°C. At each sampling point (0.5°C, 3°C, 5°C and 7°C) 18 individuals were sampled from the treatment tanks and 6 individuals from control tank.

Measured Parameters

- Morphometry
- Respiration
- C/N Analysis
- Enzyme Activity:
  - *Citrate Synthase*
  - *Malate Dehydrogenase*
  - *Pyruvate Kinase*
  - *3-Hydroxyacyl-CoA-*
  - *Dehydrogenase*

Results & Discussion:



Overall metabolic activity increased with temperature (A). In response to this increased energy demand krill experienced temporal shifts in its catabolism: a prolongation of lipid oxidation (B) and an earlier onset and increased reliance on protein catabolism (C and D). During winter when food is scarce Antarctic krill enters a state of quiescence and relies heavily on the utilization of lipid reserves that are generated in the preceding summer months. An increased energy demand during the summer that is met by both protein and lipid catabolism (E) has the potential to impede the buildup of reserves. With fewer lipids available during the winter krill's over-wintering ability will be affected. In addition, any energy channeled towards higher maintenance with increasing temperature will be lacking elsewhere, e. g. in maturation processes.

Further research is needed to validate the enzymatic reorganisation found in this study on a genetic level and to broaden the scope to include regulatory networks. It is crucial to gain a deeper understanding of the underlying mechanism driving this catabolic shift.

Putative consequences of temporal shifts in catabolism:

- **Prolonged lipid oxidation will impede buildup of important energy reserves for successive winter**
- **Increased energy demand must be met at the expense of other processes (e.g. maturation)**

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