

Project: AFI 5/09

THE QUANTITATIVE IMPORTANCE OF COPEPODS IN THE DIET OF ANTARCTIC KRILL

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Location of fieldwork: Scotia Sea, on board the RRS *James Clark Ross* (cruises JR 159 and JR 161)

Rationale:

Antarctic krill, *Euphausia superba*, are generally considered to rely on phytoplankton as their main food source. The opinion is based on their high abundances in zones of rich phytoplankton, on the very fine mesh size of their filtering mouthparts and the large number of diatoms in their stomach. However, phytoplankton blooms last for short times only and algae can be regionally and seasonally very rare in the Southern Ocean. Models have suggested that even across the productive SW Atlantic during summer and autumn, ambient phytoplankton concentrations are too low to sustain krill growth. Thus, during large parts of the year and in many krill habitats they must find alternative food or starve. A quantitative assessment of omnivory in krill is essential for our understanding of their energy budget, survival and population development under changing environmental conditions.

The aim of this project is to study the diet of krill under different primary production regimes (i.e. open-water bloom or non-bloom, ice algae blooms). Therefore, krill stomach content, stable isotope- and fatty acid composition are analysed from ~15 different scientific and fishery cruises in the Scotia Sea and Lazarev Sea between 1999 and 2006. From each cruise a number of stations were assessed to account for short-term as well as seasonal differences in krill response to low phytoplankton abundance.

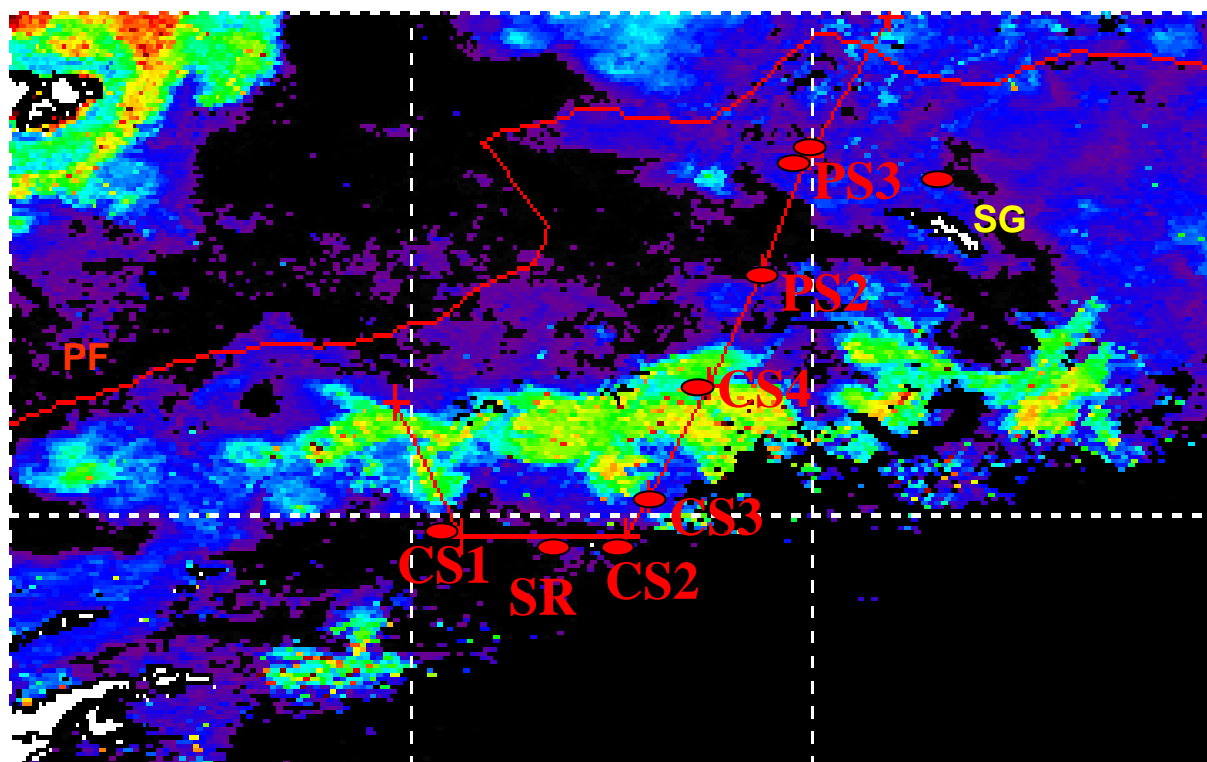
In addition, onboard feeding experiments were planned with krill being incubated with a mixture of copepods and phytoplankton. Ideally this was to study krill feeding on copepods as a functional response of the phytoplankton abundance. However, intensive stomach content analyses during the first year of the project had shown that while krill often feed omnivorously in the field, it was on protozoans rather than copepods. Copepods were never a major item in the stomachs of *Euphausia superba* and the number of their mandibles was much lower than in other euphausiids well known as copepod-feeders. Therefore we concluded that observations of krill feeding on copepods in the lab were most likely artefacts caused by a changed feeding behaviour in confinements. This was an unexpected, but clear finding, allowing us to answer a major question of this study at an early stage.

Instead of carrying out more unreliable feeding incubations, we planned to focus the attention on krill fecal pellets. Firstly, because pellets of freshly caught krill truly reflect their nutrition under field conditions and secondly because the large number and size of krill fecal pellets make them potentially important for the carbon export into the deep ocean.

Work at sea:

Most of the krill collected and analysed so far was derived from cruises in summer and autumn (plus a few samples from the South Georgia winter fishery). JR 159/161 was the only spring cruise and therefore of special interest. Krill were caught with an RMT 28 at 9 different stations along a transect from the retreating ice edge near Signy to the northwest of South Georgia (Fig. 1). As Fig. 1 shows, some of the krill were sampled within a large phytoplankton bloom, while others derived from areas of low phytoplankton abundance (given as Chl *a*).

60°W 50°W 40°W 30°W



Chlorophyll *a* (mg m⁻³)



Fig. 1: Scotia Sea krill sampling stations and chlorophyll *a* distribution during JR 161 (Nov 2006)

Upon capture, ~50 krill were immediately frozen at -80°C for stomach content- and fatty acid analyses back in Cambridge. Another ~50 freshly caught krill were placed in buckets with seawater to allow for gut evacuation. The fecal pellets were collected, measured and their sinking rates were measured in a 1 l cylinder. Sub-samples of the pellets were prepared for carbon and nitrogen analyses (dried at 60°C in tin capsules) or fatty acid analysis (adding Chloroform:Methanol) and stored in the freezer.

Preliminary results:

Only fecal pellet production- and sinking rates have directly been measured on board. Pellets were sinking with a rate of up to 45 cm min⁻¹ (~650 m d⁻¹), which means that pellets produced in the top 20 m (where most of the krill had been caught) could theoretically sink out of the mixed layer on a timescale of hours rather than days. However, sinking rates clearly varied between stations with rates being about twice as high at Condensed Station 2 (CS2) than CS4 (Fig. 2).

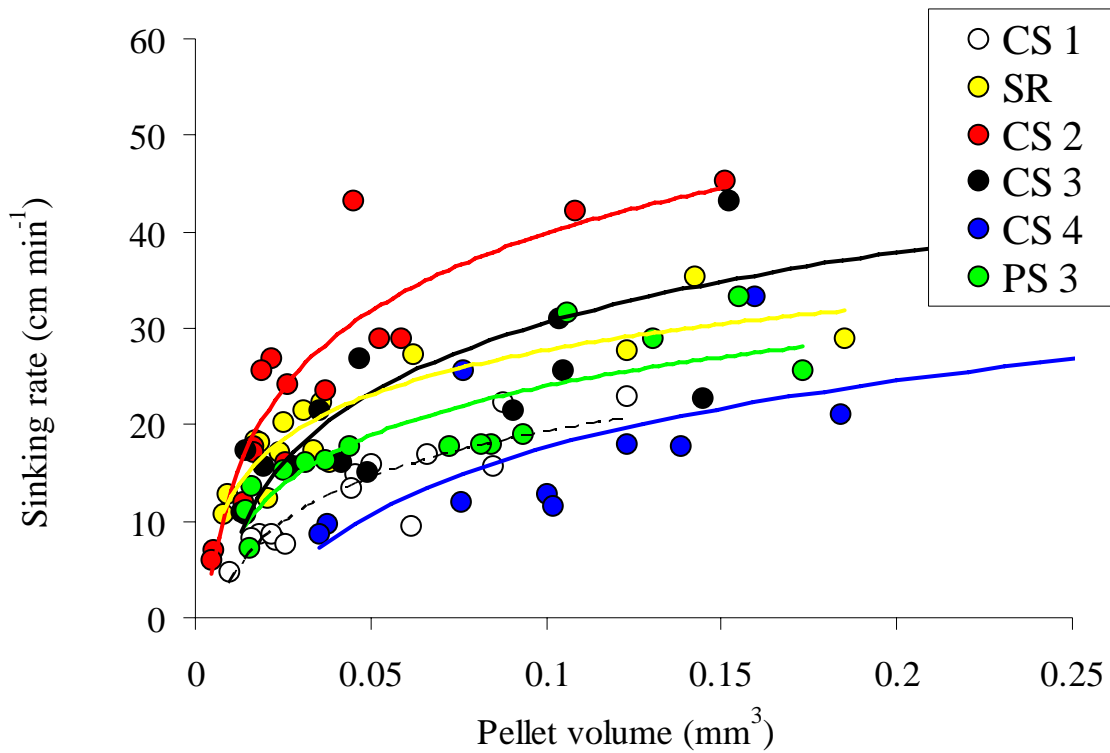


Fig. 2: *Euphausia superba*, fecal pellet sinking rates at different stations during JR 161

A comparison between pellet sinking rate and the amount of phytoplankton in the water column suggests that pellets sink more slowly when krill are feeding under bloom conditions (Fig. 3, I. y-axis). Possibly, with a high food concentration krill are processing food very rapidly and pellets are packed loosely, while at low food concentration food is well digested and pellets are dense. Carbon, nitrogen, silica and fatty acid analyses of the pellets will shed more light onto differences in assimilation efficiency and pellet sinking rates. For an overall budget of carbon export by krill fecal pellets, lower sinking rates during phytoplankton blooms might be compensated by much higher pellet production rates (Fig. 3, II. y-axis).

(continued overleaf)

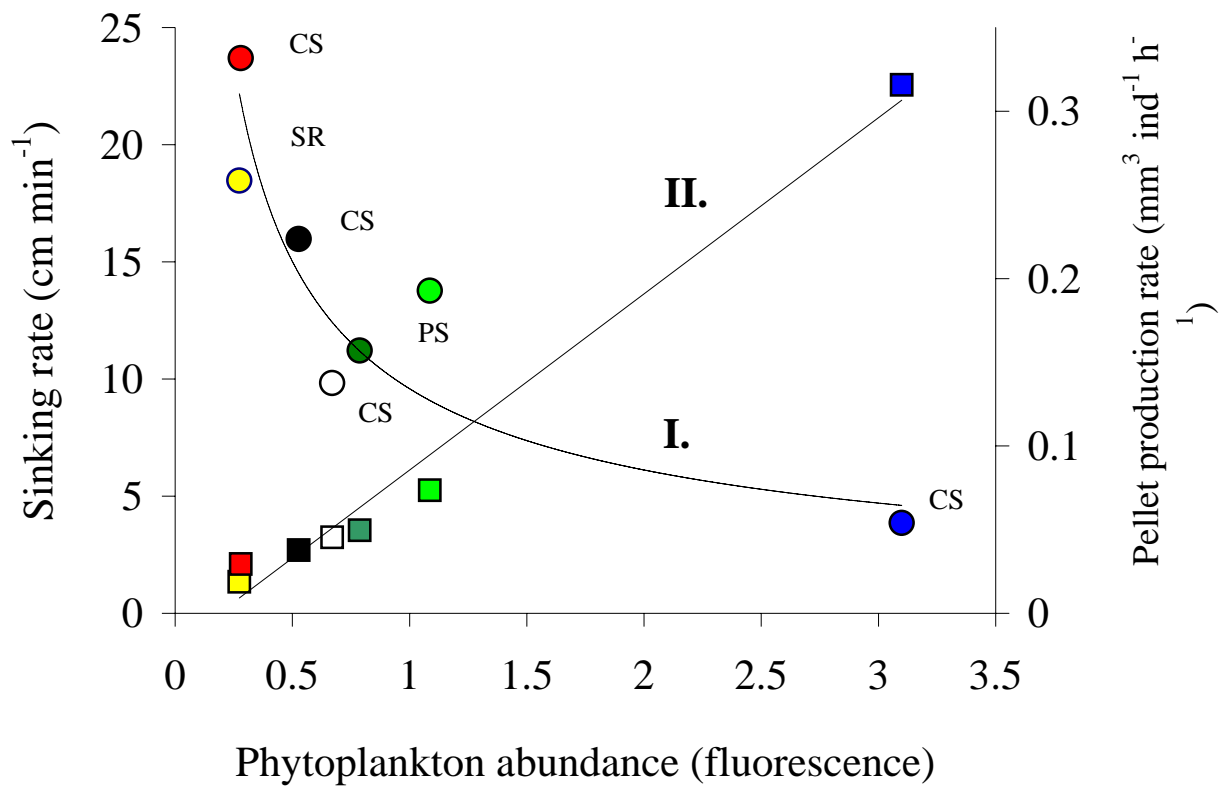


Fig. 3 *Euphausia superba*, fecal pellet sinking rates (I. y-axis) and production rates (II. y-axis) in relation to the phytoplankton abundances at different stations during JR 161

Thanks to the crew and scientists aboard the RRS *James Clark Ross* for their help in collecting the krill.