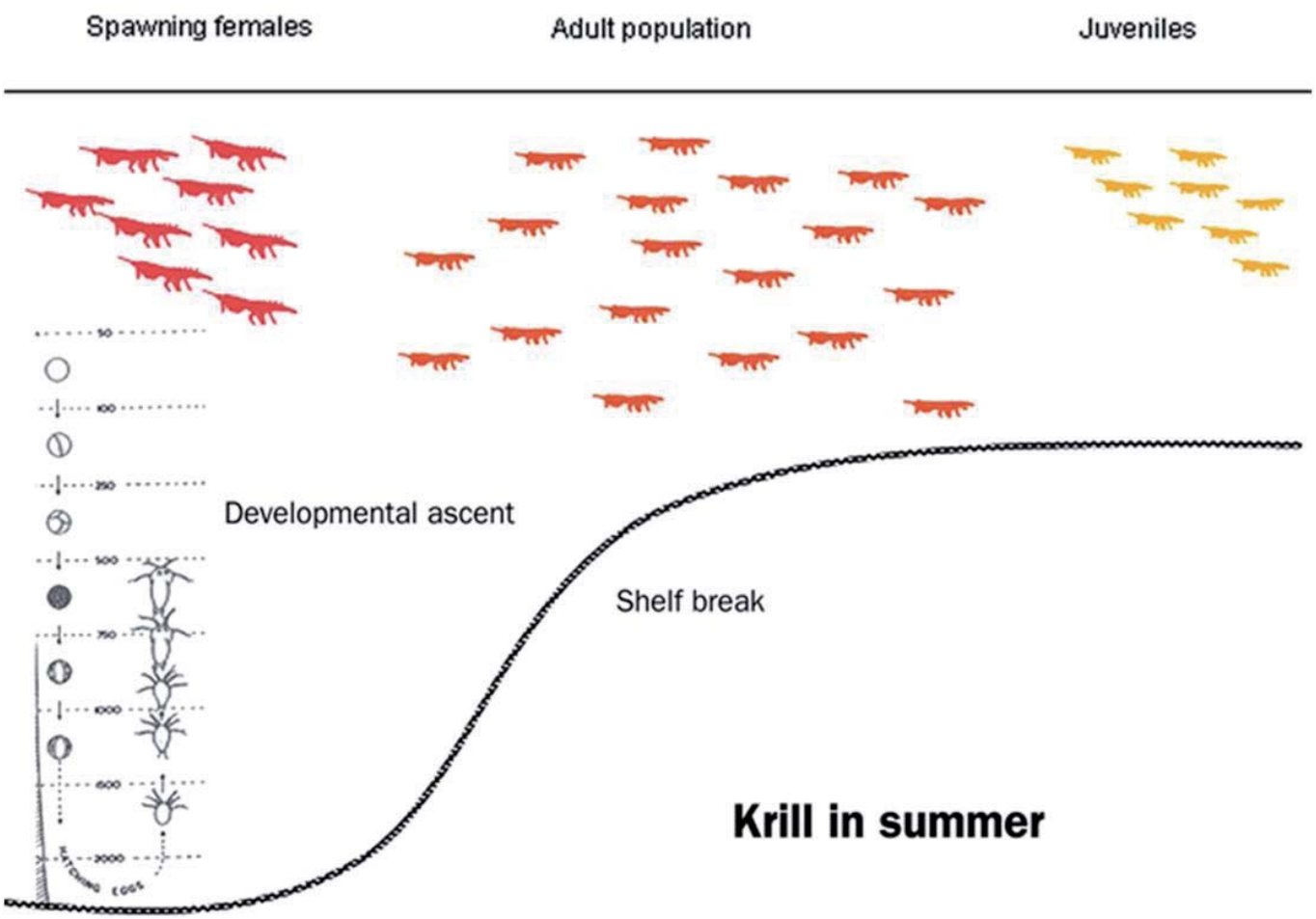
The effects of CO_2-induced ocean acidification on the survival and development of early larval stage Antarctic krill (*Euphausia superba* Dana)

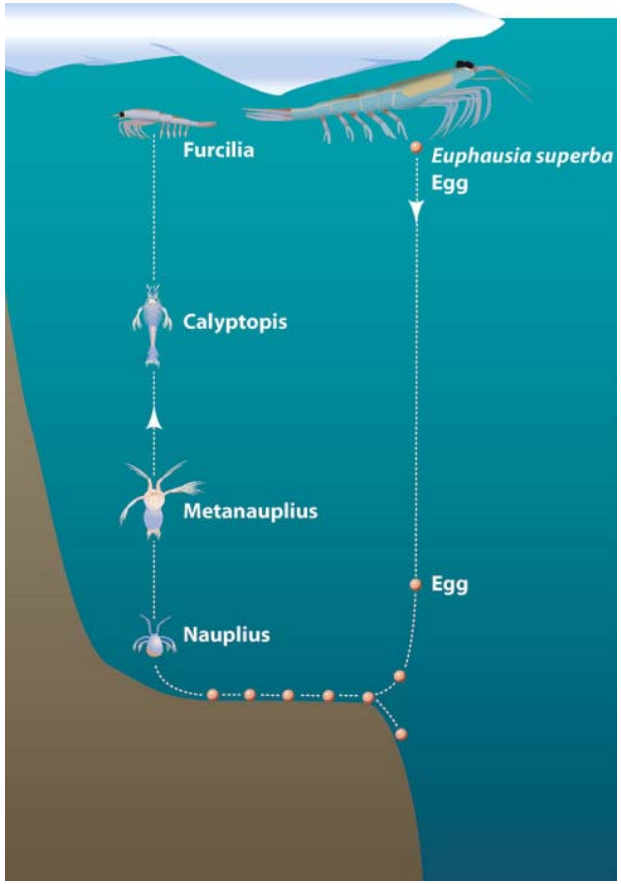
James P. Robinson, So Kawaguchi, Rob King, Patti Virtue, Haruko Kurihara, Atsushi Ishimatsu, and Stephen Nicol

Krill Lifecycle

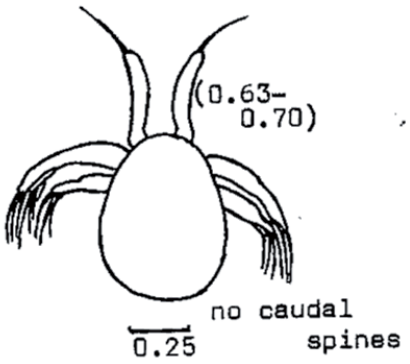


Source: Nicol, 2006

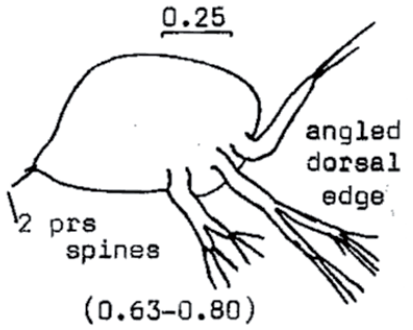
Developmental ascent



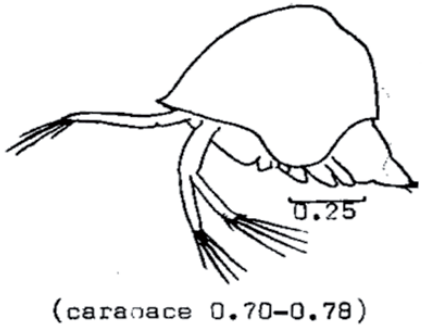
a) Nauplius I ~ 8 days



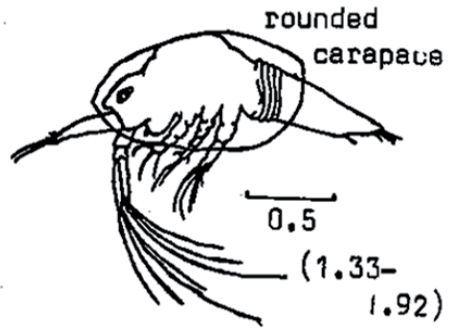
b) Nauplius II ~ 13 days



c) Metanauplius ~ 20 days



d) Calyptopis I ~ 30 days

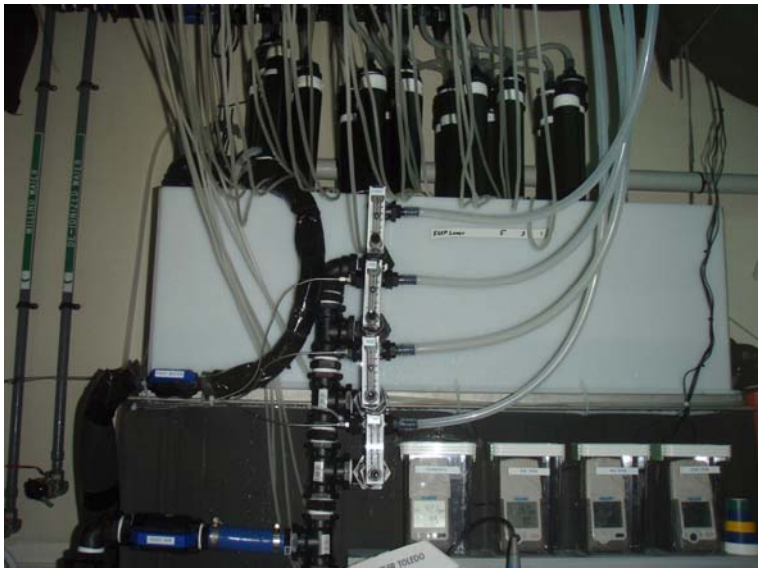


Specific Aims

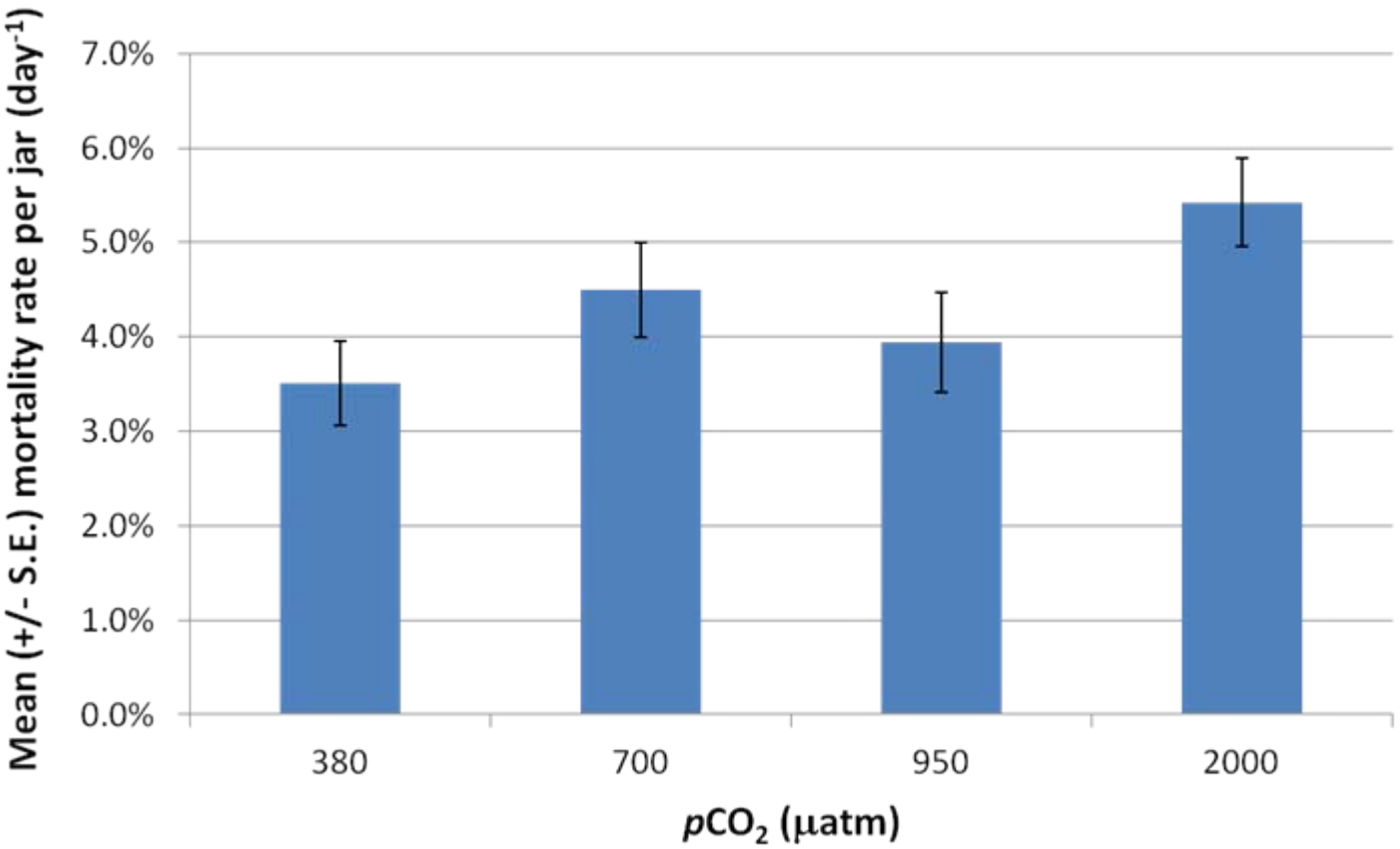
- Investigate the effects of elevated pCO_2 on:
- 1. Survival in the early larval stages
- 2. Successful development to calyptopis I
- 3. Swimming capability and activity level



Experimental set-up



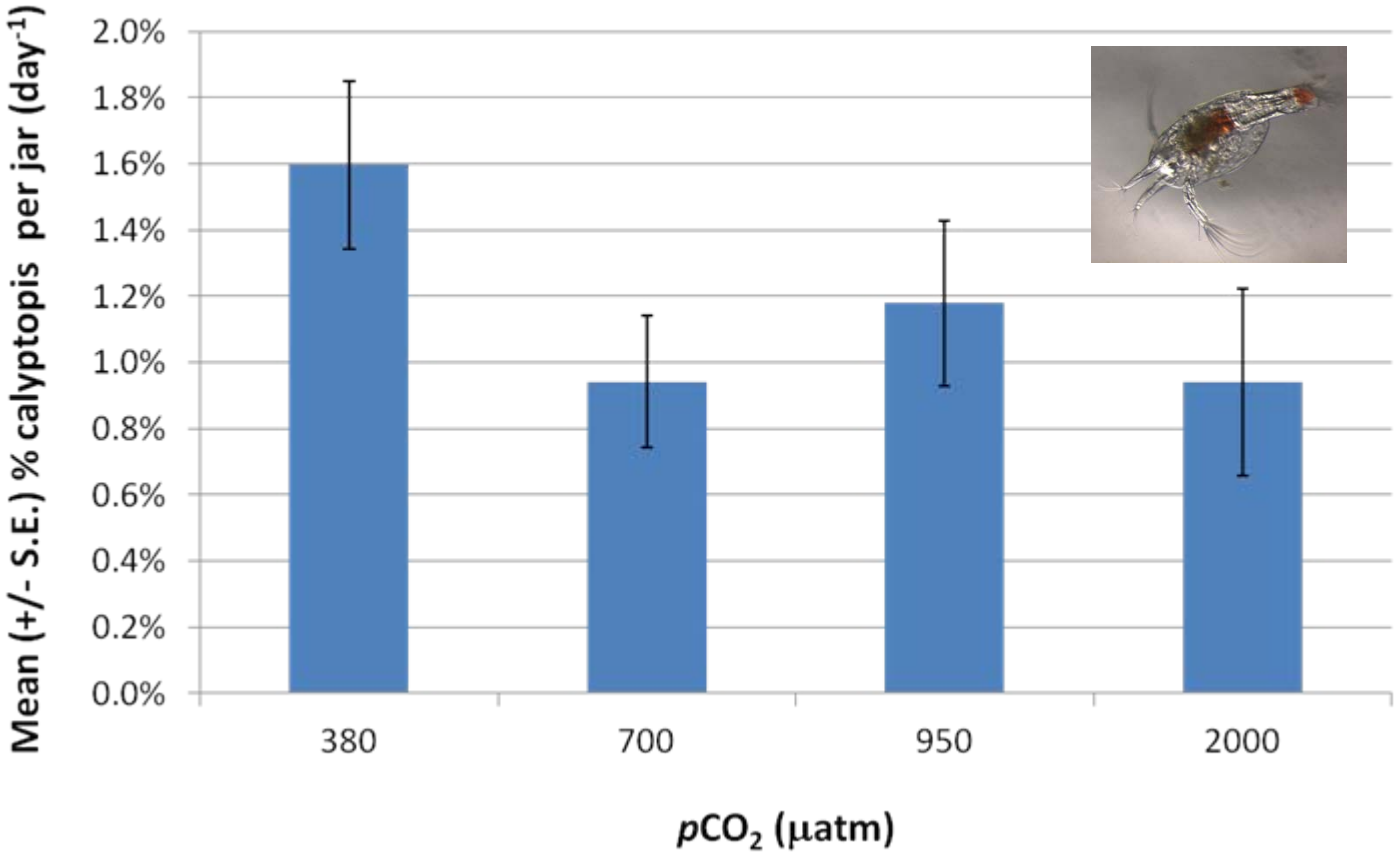
Mortality rate



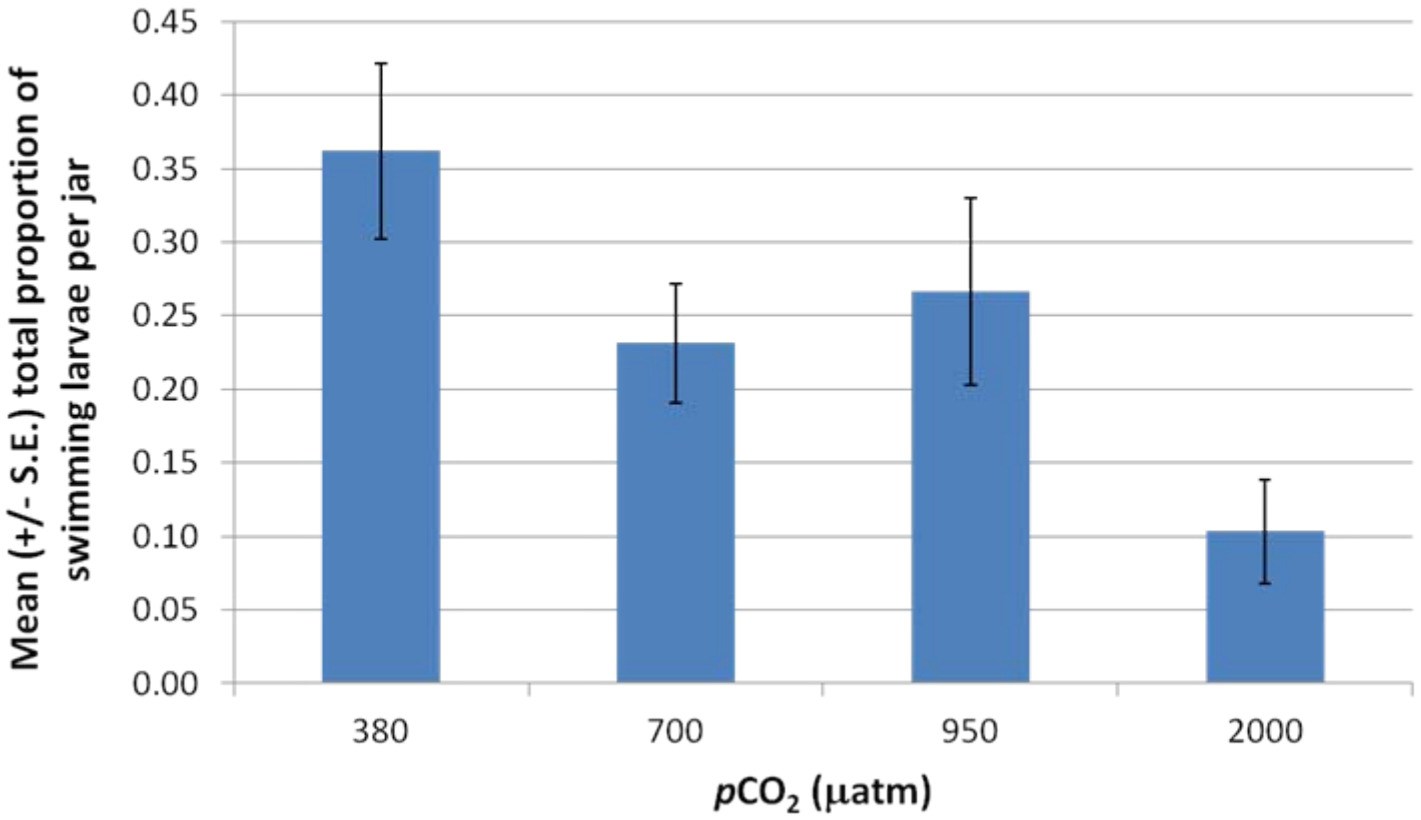
Developmental stages

- The proportion of surviving larvae in each jar which had reached the metanauplius or calyptopis I stage at the time of sampling.

Proportion of calyptopis I



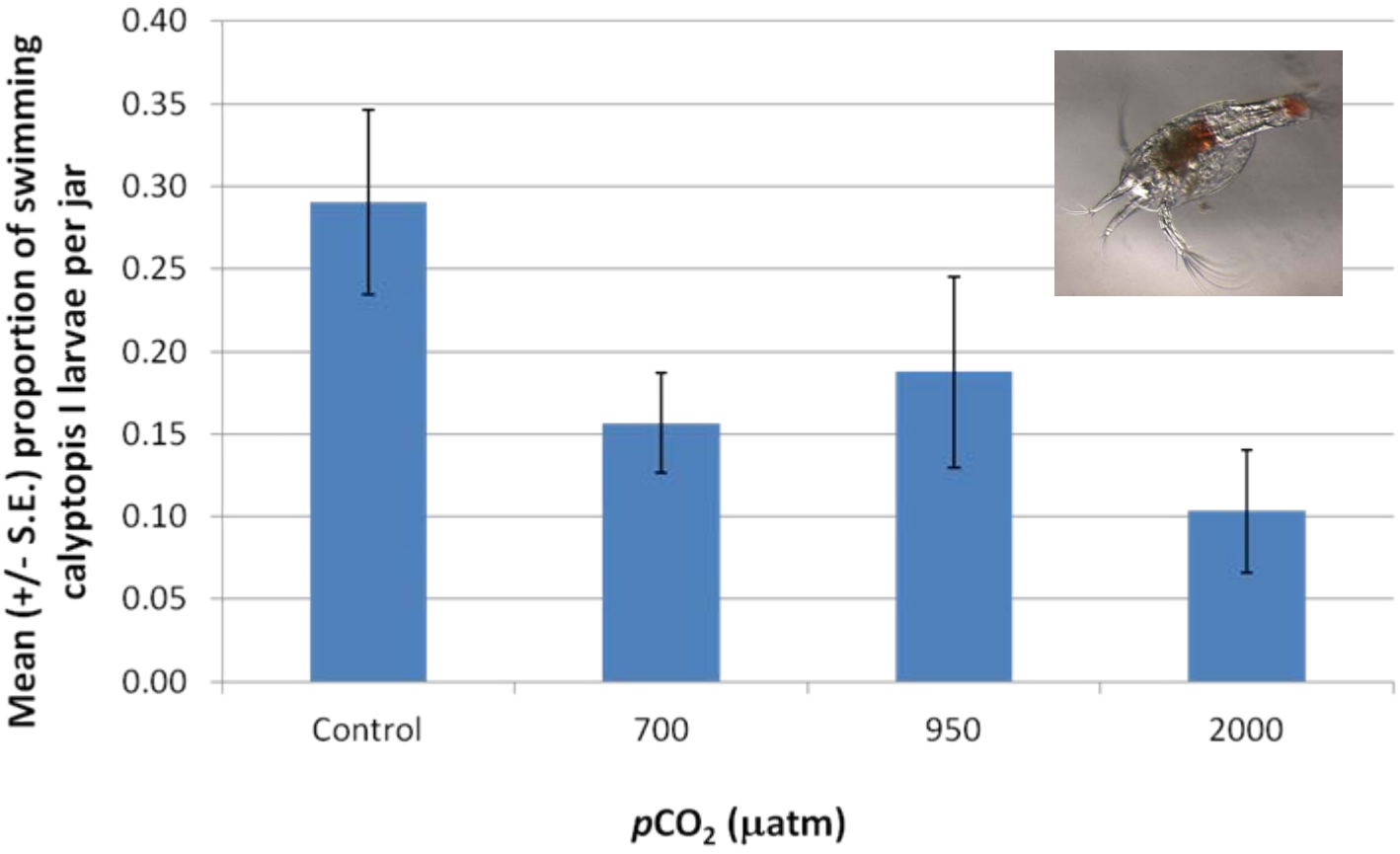
Active swimmers



Developmental ascent

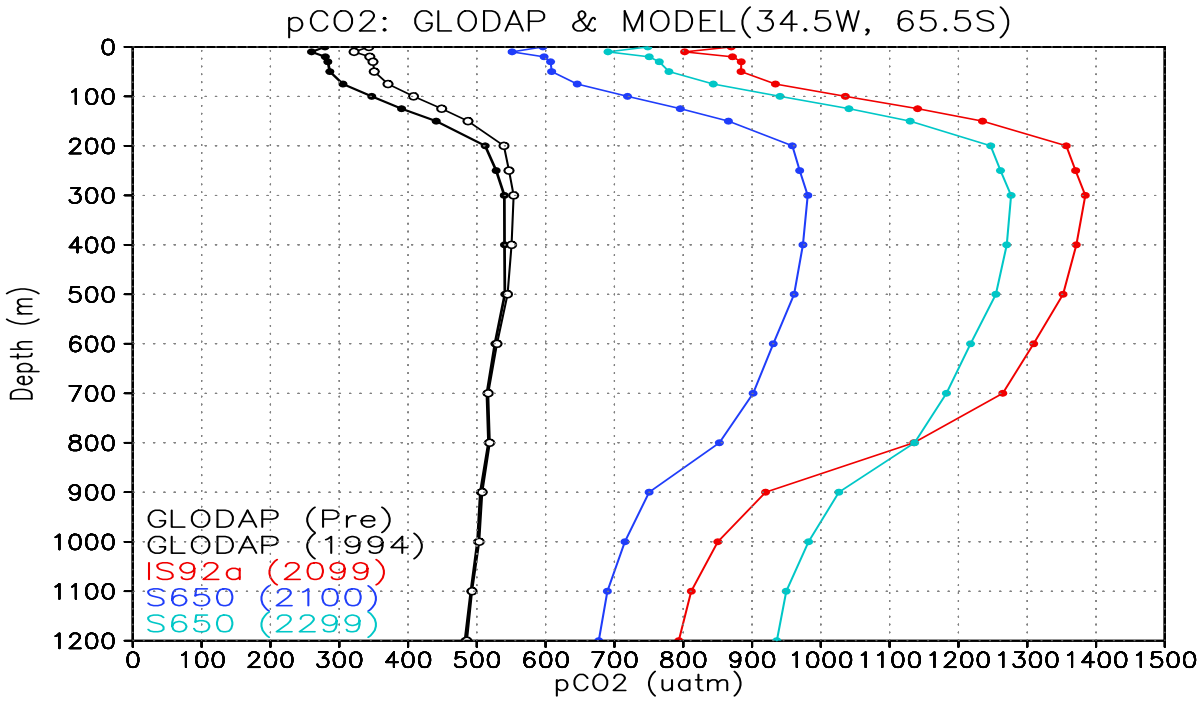
- Combining these results revealed:
- The proportion of calyptopis I larvae which could actively swim in the water column.
- These individuals represented larvae which could complete the developmental ascent.
- Providing a relative measure of changes to recruitment potential under elevated pCO_2.

Developmental ascent



CO_2 increase at depth

Weddell Sea



(Source: Kawaguchi et al. 2010)

Tipping point

- At what level of pCO_2 will we begin to see the negative effects on:
  - Embryonic development
  - Larval development
  - Maturation cycle
  - Krill population size
  - The Antarctic ecosystem

biology letters

Will krill fare well under Southern Ocean acidification?

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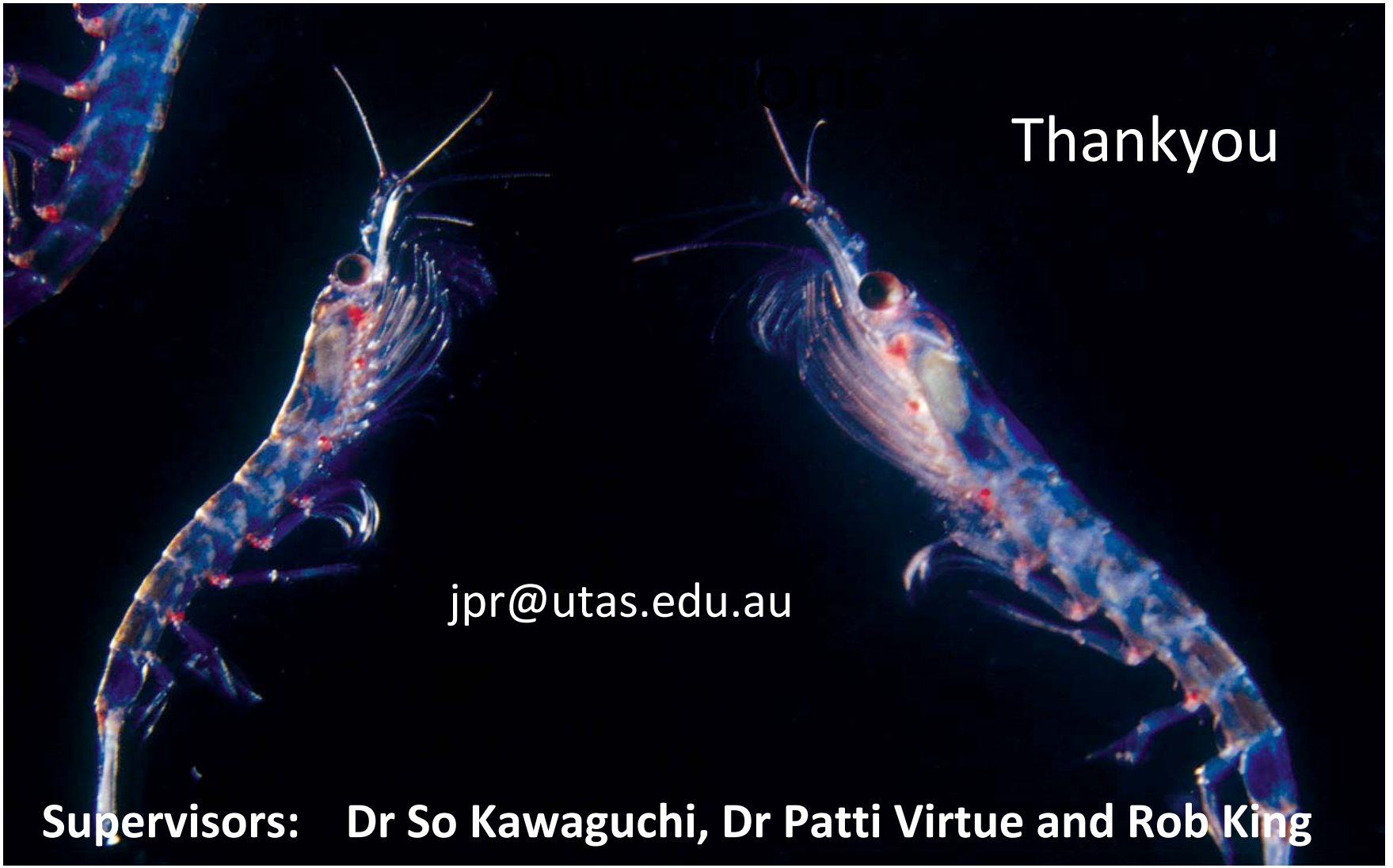
Abstract

Antarctic krill embryos and larvae were experimentally exposed to 380 (control), 1000 and 2000 µatm pCO_2 in order to assess the possible impact of ocean acidification on early development of krill. No significant effects were detected on embryonic development or larval behaviour at 1000 µatm pCO_2; however, at 2000 µatm pCO_2 development was disrupted before gastrulation in 90 per cent of embryos, and no larvae hatched successfully. Our model projections demonstrated that Southern Ocean sea water pCO_2 could rise up to 1400 µatm in krill's depth range under the IPCC IS92a scenario by the year 2100 (atmospheric pCO_2 788 µatm). These results point out the urgent need for understanding the pCO_2-response relationship for krill developmental and later stages, in order to predict the possible fate of this key species in the Southern Ocean.

Conclusion

- **Elevated pCO_2 has the potential to negatively affect larval survival, development, swimming ability and subsequent recruitment to the adult population.**
- **The experiment needs further replication to confirm the results.**


Questions
Thankyou
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