Project information

Project title

Arctic Tipping Points: impacts of acidification and increased temperature on early life-stages of benthic organisms

Year

2011/2012

Project leader

Paul Renaud, ApN

Participants

Norway

- Paul Renaud, ApN
- Mikko Vihtakari, PhD candidate: UiT, ApN, NPI
- Haakon Hop, NPI
- Claudia Halsband, ApN

International

- Iris Hendriks (IMEDEA, Spain),
- Jon Havenhand (U Gothenburg, Sweden),
- Johnna Holding (IMEDEA, Spain)

Flagship

Ocean Acidification

Funding Source

Fram Centre, EU - Arctic Tipping Points

Summary of Results

During the spring of 2010 and 2011, Arctic bivalve species were collected from Isfjorden (2010) and the Tromsø area (2011). Clams were spawned using normal protocols and gametes were combined under controlled conditions (densities, temperature, CO2 levels). Sperm from up to 20 individuals per species were filmed every 12-48 hours until they were no longer active. Embryos/larvae were raised in controlled temperature and CO2 conditions. Temperatures ranged from ambient to 8 degrees over ambient, and CO2 was at current (350 ppm) and projected 2100 (1000 ppm) levels. The experiments were terminated when larvae reached the D-stage (up to 8 days).

Not all species spawned or produced viable larvae. In the end we focused on early life stages of *Serripes groenlandicus* and *Ciliatocardium ciliatum* in 2010, and calcification in adult *M calcarea* in 2010 and 2011. In 2011 most of the experimental work was performed on *Mytilus galloprovincialis*.

I. Increased CO2 content led to a significant reduction in sperm motility and sperm speed. Since motility and speed are usually tightly linked with fertilisation success, this finding suggests acidificatin may negatively impact bivalveA second finding is the high levels of intraspeficic (individual) variability in sperm motility and speed. This coupled with the above results suggests that increased CO2 may also play a selective role, reducing the genetic diversity within bivalve species.
II. Sperm half-life is considerably longer in cold waters than in warmer experimental treatments. This has impacts for the effects of warming temperatures on reproductive success of Arctic bivalves since faster swimming speeds and/or a longer half-life suggest greater potential for fertilisation.
III. Temperature has a strong effect on manylarval stages whereas increased CO2 levels have limited impact. Increased temperature led to decreased growth and mortality, and surprisingly, decreased metabolic rates. There was no effect on these parameters in treatments at 2100 CO2 levels. All early life-stage data were collected on larvae up to the D-larval stage (pre shell-formation).

For the Management

For the management only

Published Results/Planned Publications

Vihtakari M, I Hendriks, PE Renaud, J Havenhand. Sperm half-life in Arctic bivalves. (to be submitted summer 2012)

Vihtakari M, I Hendriks, PE Renaud, J Holding. Effect of acidification and temperature rise on early life stages of a marine bivalve. (to be submitted summer 2012)

Remaining funds from the experimental project are being used for writing the following articles for a special issue on carbon capture and storage (Mar Poll Bull: deadline January 2012):

Halsband C & H Kurihara. Ocean acidification impacts on zooplankton in CCS leakage scenarios

McConville K, C Halsband, E Fileman, P Somerfield, HS Findlay, JI Spicer. No effect of CO_2 on feeding and reproduction of two calanoid copepods. Will copepods dominate future high CO_2 oceans?

Communicated Results

Results have been presented at the recently completed Arctic Tipping Points Summer School, and will be integrated into the new UNIS course on Climate Change in Arctic systems. Finalizing of results by the PhD student will lead to further presentations at national and international meetings.

Outreach: Youtube video "The Desperate Clam". http://www.youtube.com/watch?v=JW083KjNfk4

Results of the CCS study were presented at the International Zooplankton Production Symposium in Chile in 2011.

Interdisciplinary Cooperation

Marine chemistry, developmental and reproductive ecology, physiological ecology, biostatisitics.

These combinations of fields are required for any studies of early life history effects of acidification. Adequate (chemical) analytical facilities are lacking here so samples were analysed in the UK

Budget in accordance to results

Fram funding allowed repeating and expanding of experimental studies performed the previous year in Svalbard. This experimental study is part of the EU Arctic Tipping Points project, but funding in that project did not allow a second set of experiments. Results from the Svalbard experiments will be included in the publcations from this projects work. Since earlier studies had some technical problems, only some of the data were usable. This additional funding enabled travel and manpower for conduction these experiments in a facility in Spain (since no adequate experimental facilities exist in Tromsø). Fram funding, therefore, was an excellent boost that, in combination with EU funding, will produce at least two papers for the PhD of the stipendiat.

The second part of this project will help produce two articles for a special issue devoted to ecological effects of carbon capture and storage: one experimental study and one review article. This funding will pay for writing time between June 20011 and the deadline of January 2012.

Could results from the project be subject for any commercial utilization

No

Conclusions

a. This combination of effects on multiple early life-stages is the cutting edge in the field at this time. The lack of many significant impacts is similar to the few comparable studies that have been published, suggesting longer exposures may be important, and pointing to the need for, perhaps, looking at other life history stages or physiological proceses. Clearly, realistic 2100-level acidification levels will not immediately lea to reproductive crashes. Intriguing, however, is the potential impact on genetic variability.
b. The project has reiterated the need for adequate experiemtnal effects-studies facilities in the Tromsø area. Standardization of methods and analyses has been highlighted in this field such that publication outside these parameters is nearly impossible. Shipboard studies are currently not feasible and facilties in LYR and NyÅ are both very expensive and also not well instrumented. I recommend upgrading laboratories at Kråknes and/or Kårvika for this purpose.