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Consortium 1: Pelagic ecosystems
WP 1.14: Adaptations to ocean acidification in mesozooplankton

Evolutionary response to ocean acidification

[1]Julia A. F. Lange, [1]Maarten Boersma, [2]Klaus Schwenk
[1]Alfred-Wegener-Institut Helmholtz-Zentrum for Polar and Marine Research, Biologische Anstalt Helgoland
[2]Institute of Environmental Science University Koblenz-Landau

Introduction

Very few studies exist dealing with the **evolutionary responses** of species to ocean acidification (OA), even though the selective forces of OA are potentially strong. Hence, we investigate **selection processes** in zooplankton. Potential patterns of adaptation to OA will be uncovered by integrating field observations, laboratory experiments and genetic analyses.

Long-term selection experiment

To investigate the adaptability of mesozooplankton to OA a long-term selection experiment with *Acartia tonsa* a common copepod in the North Sea were set-up .

- 100 l plastic tanks with artificial sea water (ASW; 32 psu) at 18° C and constant darkness
- 15.000-20.000 individuals per tank
- pCO_2 selection lines (SL): 800 µatm A, B, C; 200 µatm D, E, F
- ph-value: 200 tanks: 8.5 ±0.2; 800 tanks: 8.0 ±0.2
- running time until now: 12 months / 24 generations

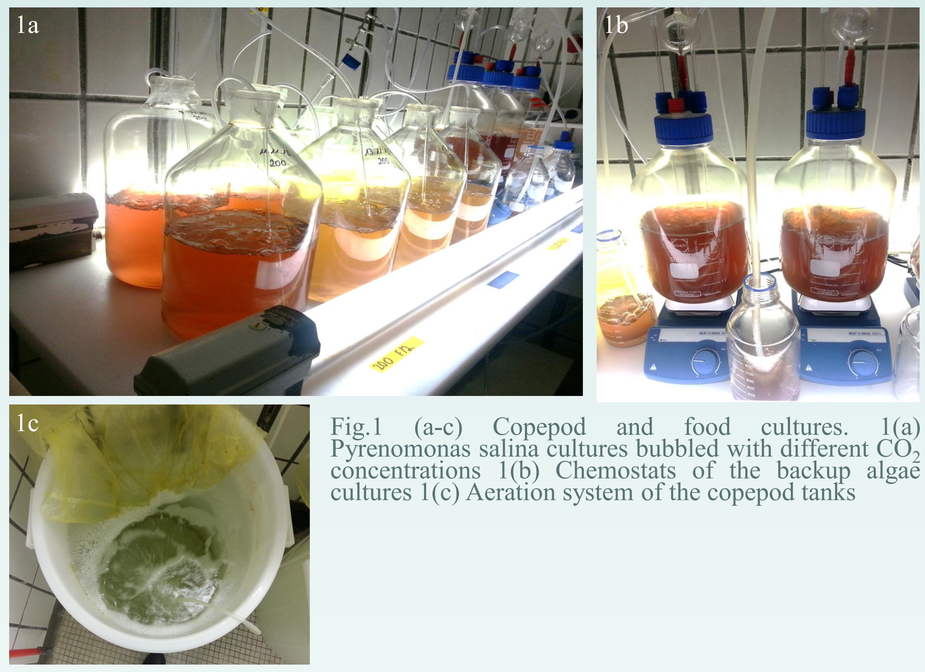

Fig.1 (a-c) Copepod and food cultures. 1(a) Pyrenomonas salina cultures bubbled with different CO_2 concentrations 1(b) Chemostats of the backup algae cultures 1(c) Aeration system of the copepod tanks

Transplantation experiments

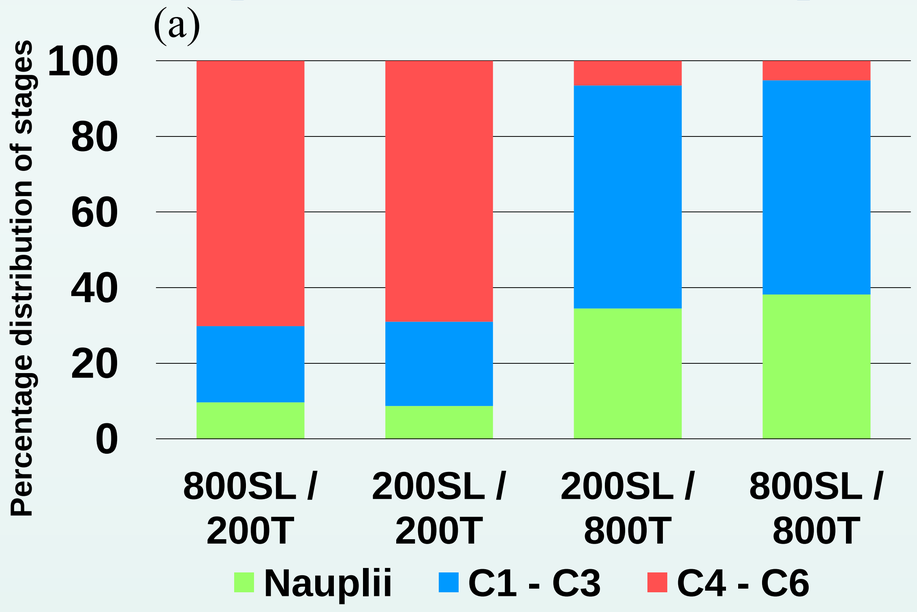

Fig.2 (a,b) Transplantation experiments results. The x-axis shows the experimental treatments; (800 SL) selection line manipulated with 800 µatm CO_2, (200 SL) selection line manipulated with 200 µatm CO_2, (800 T) treatment with 800 µatm CO_2 manipulated water and food, (200 T) treatment with 200 µatm CO_2 manipulated water and food. **(a)** Diagram of the developmental stage distribution. The left y-axis shows the percentage of the respective stages. The legend shows the developmental stages; (Nauplii) nauplii stages 1-6, (C1 - C3) copepodite stages 1-3, (C4 - C6) copepodite stages 4-6. The ANOVA showed only a significant treatment effect ($p < 0.05$), but none for the selection line nor for an interaction (Data pooled from N = 3 replicates). **(b)** Diagram of the percentage of hatched nauplii. The left y-axis shows the percentage of the hatched nauplii. The legend shows the two sampling points; The ANOVA showed only a significant selection line effect ($p < 0.05$), but none for the treatment nor for an interaction (Data pooled from N = 3 replicates).

Set up

To test if the copepods adapted to their selection line conditions within **6 month / 12 generations** transplantation experiments were conducted (4 treatments, 3 replicates). The copepods from both CO_2 SLs were cross incubated with different water pCO_2 concentrations in connection with the corresponding food. Developmental rate, egg production and hatching rate were measured.

Results

***A. tonsa* developed much slower under high CO_2 conditions** but there was no difference between the SLs and thus **no detectable adaptations to CO_2 regarding the developmental speed**. Furthermore there was no detectable difference between the high and low CO_2 treatments and selection lines according the amount of produced eggs. Additionally the hatching rate did not vary between the CO_2 treatments whereby **the nauplii from the high CO_2 selection lines hatched significantly faster in the first 24 hours.**

On going studies and future plans

Mesozooplankton / Metabarcoding

Differences in species composition and genotype frequency between experimental populations (suffering under ocean acidification compared to present-day CO_2 conditions) were detected by metabarcoding. Samples were taken during a mesocosm experiment in the Gullmarsfjord in Sweden 2012.

Gene expression

We plan to carry out an lab experiment with *A. tonsa* to investigate gene expression pattern in various CO_2 environments. From previous experiments we already known that copepods suffer most under a low food quality due to a changed stoichiometry of the algae. Under high CO_2 conditions (800 µatm pCO_2) they spend most of their energy in reproduction and therefore develop slower. We therefore focus on genes which are involved in growth processes, moulting and reproduction.

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