Declined pH Changes Juvenile Blue King Crab Morphology and Decreases Growth and Survival

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Introduction

Blue king crabs (BKC), Paralithodes platypus, have been an important fishery species in the Bering Sea. Large fluctuations in biomass of this species in the Pribilof Islands and the St. Matthew Island regions suggest that recruitment processes are complex and are sensitive to environmental variability. In addition, there is a potential for blue king crab to be affected by decreases in ocean pH as a result of increasing atmospheric pCO2 levels, a process known as ocean acidification. In this study, juvenile blue king crabs were exposed to three pH levels in a long-term experiment to determine the effects of ocean acidification.

Study objectives

- Determine how ocean acidification affects BKC
  - Morphology
  - Growth
  - Mortality

Methods

Animals

- Laboratory reared
- Year-0 C1 juveniles, 2-3 mm carapace length

Water acidification

- Filtered seawater at ambient salinity
  - Salinity: 32 psu
  - Temperature ambient or chilled to <10 °C when necessary
- Water acidified with pCO2
  - Acidified tank at pH 5.5: bubbled with CO2
  - Acidified water mixed with ambient into treatment head tanks
- Three treatments
  - Ambient
  - pH 7.8 (Global pH predicted for c. 2100)
  - pH 7.5 (Global pH predicted for c. 2200)

Experimental setup

- Crabs held in individual containers
- Tubs received flowing treatment seawater
- Water flow was provided to each crab
- 30 crabs per pH treatment
- Fed to excess 3x per week

Data collection

- Water chemistry
  - pH and temp measured daily
  - Dissolved inorganic carbon (DIC) and total alkalinity measured weekly
- Checked daily for molting and mortality
- After each molt
  - Measured wet mass 7 days after molt
  - Carapace photographed under microscope
  - Measured carapace using image analysis program
    - Carapace length (CL)
    - Carapace width (CW)
    - Orbital width (OW)
    - Rostrum width (RW)
    - 1st spine length (SL)

Results

<table>
<thead>
<tr>
<th>Treatment</th>
<th>pH</th>
<th>pCO2 (atm)</th>
<th>DIC (mmol/kg)</th>
<th>Alkalinity (mmol/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambient</td>
<td>8.07±0.07</td>
<td>390±64 54±37</td>
<td>3.69±0.05</td>
<td>0.09±0.01</td>
</tr>
<tr>
<td>pH 7.8</td>
<td>7.80±0.03</td>
<td>766±59 44±96</td>
<td>1.96±0.04</td>
<td>0.05±0.00</td>
</tr>
<tr>
<td>pH 7.5</td>
<td>7.49±0.03</td>
<td>1627±00 83±52</td>
<td>2.03±0.04</td>
<td>0.03±0.00</td>
</tr>
</tbody>
</table>

Water chemistry

- pHs within nominal range
- pH 7.8 undersaturated with respect to aragonite
- pH 7.5 undersaturated with respect to calcite and aragonite
- Seasonally variable temperature within BKC thermal tolerance range

Mortality

- Mortality highest at 7.5
- Mortality rate decreased with time
- By the end of the experiment the mortality rates were similar among treatments
- Evidence for phenotypic plasticity

Conclusions

- Blue king crab juveniles are sensitive to ocean acidification
- Ocean acidification altered morphology, reduced growth, and increased mortality
- Rapid reduction in mortality rate during the experiment suggests that phenotypic plasticity may allow blue king crabs to adapt
- But reduced growth and any increased mortality could harm stocks