Body chemical contents and gut pigments of copepods in the western Arctic Ocean during summers of 2008 and 2010

Kohei Matsuno, Atsushi Yamaguchi and Ichiro Imai
(Hokkaido University)
Introduction

- Western Arctic Ocean: drastic sea ice reduction effects to marine ecosystem is concerned
- Copepods: key components of marine ecosystem While their importance, little information is available on regional and annual changes in body chemical contents.
- Measured parameters:
  - Water content: index of body nutrition
  - AFDM: index of lipid accumulation
  - Gut pigment: index of grazing activity

Purpose of this study:
Inter-species, regional and annual (2008 and 2010) changes of body contents of copepods in the western Arctic Ocean during summer were evaluated.
Materials and Methods: Sampling, measurement and data analysis

1 Sep. - 4 Oct. 2008 (37 stations)

7 Sep. - 9 Oct. 2010 (47 stations)

Sampling and measurement

NORPAC net: vertical tow from 150 m depth or bottom -5 m to surface

Dominant copepods stored at -80°C

WM, DM and AFDM immerse to DMF
gut pigment measurement by Turner fluorometer

Data analysis

Western (~170°W), Central (160~170°W), Eastern (~160°W)

Body content parameters were tested by one-way ANOVA and U-test in terms of inter-species, regional and annual changes
Results: Inter-species comparison

Western

**C. glacialis**: High AFDM

Central

**C. glacialis**: High AFDM

**C. hyperboreus**: High water content

Eastern

**M. longa**: High gut pigment

**C. hyperboreus**: High water content
Results: Inter-species comparison (relationships between parameters)

<table>
<thead>
<tr>
<th>Water (%WM)</th>
<th>AFDM (%DM)</th>
<th>NGP (ng chl a mg DM⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NGP and AFDM → negative relationship

<table>
<thead>
<tr>
<th></th>
<th>M. Longa</th>
<th>C. hyperboreus</th>
<th>C. glacialis</th>
</tr>
</thead>
<tbody>
<tr>
<td>AFDM, Lipid accumulation</td>
<td>Less ←</td>
<td>More →</td>
<td></td>
</tr>
<tr>
<td>Grazing activity</td>
<td>High ←</td>
<td>Low →</td>
<td></td>
</tr>
</tbody>
</table>

$r^2 = 0.928$, $p < 0.0001$

$r^2 = 0.681$, $p < 0.001$
Discussion: Inter-species changes in body chemical contents

Characteristics of each species

*C. hyperboreus* C6F
- high water content: little lipid accumulation
- development and reproduction in deep layer
- surface individual had less lipid accumulation

*C. glacialis* C5 and C6F
- high AFDM: much lipid accumulation
- diapause and molt to adult in deep layer
- reproduction at surface in next spring
- shallower diapause depth than *C. hyperboreus*
- diapausing individual stored much lipid

*M. longa* C6F
- high gut pigment: high grazing activity
- *Metridia* species has no diapause in life cycle
- Diel vertical migration, graze in surface at night
- actively feeding without diapause
Results: Regional and annual changes in *C. glacialis* C5

Regional pattern:

- **West**
  - High AFDM
  - Low NGP

Annual pattern:

- 2008 > 2010
Results: Regional and annual changes in *M. longa* C6F

- **Regional pattern:** West → Low Water, High AFDM, Low NGP
- **Annual pattern:** 2008 > 2010
Results: Regional and annual changes in hydrography

Integrated mean salinity

Integrated nutrients (DIN, μM)

Integrated chlorophyll a (mg m⁻²)

Regional pattern: West
- Low temperature
- High salinity
- High DIN

Annual pattern: salinity and DIN
2008 > 2010
Discussion: Regional and annual changes

<table>
<thead>
<tr>
<th></th>
<th>Regional pattern</th>
<th>Annual pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ice melt water</td>
<td>West &lt; Central, East</td>
<td>2008 &lt; 2010</td>
</tr>
<tr>
<td>Nutrients</td>
<td>West &gt; Central, East</td>
<td>2008 &gt; 2010</td>
</tr>
<tr>
<td>Primary productivity</td>
<td>West &gt; Central, East</td>
<td>2008 &gt; 2010</td>
</tr>
<tr>
<td>AFDM of copepods</td>
<td>West &gt; Central, East</td>
<td>2008 &gt; 2010</td>
</tr>
<tr>
<td>Lipid contents of copepods</td>
<td>West &gt; Central, East</td>
<td>2008 &gt; 2010</td>
</tr>
</tbody>
</table>

High lipid accumulation of copepods in the western region and in 2008 might be caused by the high primary productivity which supported by less ice melt water and high nutrients concentration.
Summary

Inter-species changes in chemical contents are reflect of their life cycle

*C. hyperboreus*: less lipid accumulation
*C. glacialis*: much lipid accumulation

- differences in diapause depth within *Calanus* species

*M. longa*: high grazing activity
- feeding without diapause

Regional and annual changes

Western region and 2008
- Less ice melt water
- High nutrients and primary productivity
- Much lipid accumulation of copepods

Central, Eastern 2010
- Much ice melt water
- Low nutrient
- Low PP
- Less lipid

Sea ice reduction is considered to decrease lipid accumulation of copepods
- The effects of sea ice reduction on marine ecosystem