Pan-Svalbard Assessment of Decadal-scale Climate Forcing and Ecosystem Variation: Evidence from Bivalve Growth Rates

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From Variability to Change: “Trees of the Sea”

- Bivalves record and preserve biological and environmental information in the hard parts of their bodies
- Allows us to search for patterns and to reconstruct linkages between climatic phenomena and bio-responses
  - Scales of days to centuries

Information from shells

- Variations in growth rates
  - Relationships to environmental drivers
- Environmental conditions from constituents imbedded in the shell
  - Temperature, salinity, food sources
Objective

Identify growth rates, interannual growth patterns, and relationships between environmental forcing and biological responses of Serripes groenlandicus from locations spanning a wide range of environmental conditions of Svalbard and the Barents Sea.
- 30 year lifespan
- Circumpolar
- Soft-sediment dweller
- Suspension feeder
- Distinct external growth bands

Serripes groenlandicus

Barents Sea

Svalbard, Norway
Sampling Locations and Sample Material

- 11 collection sites between 1996-2009
- Different env. settings
- 3-69 samples/site
- 260 total samples
Absolute Growth Rates

Size (mm) vs. Age (yr)

- Hopen Bank
- Storfjorden
- Adventfjord
- Kongsfjord
- Forelands Sundet
- Groenfjord
- Ripfjord
- Smeerenburgfjord
- Moffen
- Western Bank
- Liefdefjord
Site Variation in Absolute Growth

ANOVA, P<0.001

Sampling sites
Atlantic currents
Polar front
Arctic currents

Hopen Island
Bear Island

SM LF FS WB MO GF KF RF AF HB SF

100 m 250 m 500 m 1000 m 2000 m 2500 m
Warm shelf water from the West Spitsbergen Current (WSC)
Standardized Growth Index

Sample from White Sea 1946-1968

Raw growth increments → Detrend for ontogenetic changes → Standardized Growth Index
Standard Growth Index
All Sites (n=260)
## SGI vs. Environmental Parameters

<table>
<thead>
<tr>
<th>Site</th>
<th>ACRI</th>
<th>Kola Temp</th>
<th>WSC Temp</th>
<th>Ny Å Temp</th>
<th>Ny Å Precip</th>
<th>Hopen Precip</th>
<th>Max Ice</th>
</tr>
</thead>
<tbody>
<tr>
<td>RF</td>
<td>+</td>
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<td>SB</td>
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</tbody>
</table>
SGI related to environmental drivers

Rijpfjord SGI vs. WSC Temperature

Kongsfjord SGI vs. Kola Temperature

Spitsbergen Bank SGI vs. Arctic Climate Regime Index

ALL SGI vs. Arctic Climate Regime Index
# Relationship to Environmental Forcing - Multiple Regression

<table>
<thead>
<tr>
<th>Site</th>
<th>Equation</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rijpfjord</td>
<td>SGI= 1.18 WSC T – 0.003 Ice BS + 0.44</td>
<td>0.69</td>
</tr>
<tr>
<td>Kongsfjord</td>
<td>SGI= 0.19 Kola T + 0.08 ACRI + 0.04 Ny Å pressure +56.0</td>
<td>0.29</td>
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<tr>
<td>Spitsbergen Bank</td>
<td>SGI= 0.10ACRI + 0.24 Kola T + 0.32 Max Ice – 4.91</td>
<td>0.62</td>
</tr>
<tr>
<td>All Sites</td>
<td>SGI= 0.054ACRI+ 0.01 Ice Free days +0.88</td>
<td>0.39</td>
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</tbody>
</table>
Summary and Conclusions

• Absolute growth rate varies spatially in the region - ultimately regulated by water mass characteristics (Atlantic water)
• Similarity in overall growth rate does not correspond to similarity in temporal growth patterns (interannual variability)
• Temporal patterns in growth rates are influenced by both large scale environmental factors, and their local manifestations
• Physical variables regulate bivalve growth through their influence on the primary production and food supply to the benthos
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