Copepod Community Structure and Climate Warming along the Western Antarctic Peninsula

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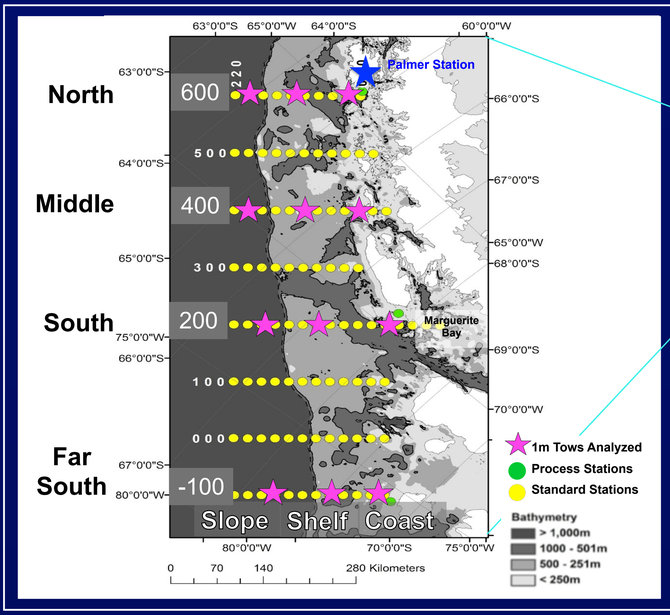
Introduction

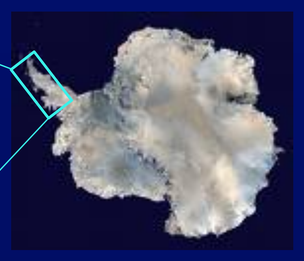
The Western Antarctic Peninsula (WAP) is one of the most rapidly warming regions on Earth, where loss of sea ice is affecting food web dynamics from plankton to top predators (Ducklow et al., 2012). Macrozooplankton abundance and community structure in the WAP reflect this with documented changes in temporal and spatial distribution of many zooplankton taxa, including Antarctic krill (*Euphausia superba*) and salps (*Salpa thompsoni;* Ross et al., 2008, Steinberg et al., 2012). Copepods play a critical role in the zooplankton community as grazers of phytoplankton and microzooplankton, and as food for carnivorous zooplankton and fish. However, there is no previous work on long-term changes in the WAP copepod community.

Questions

What is the copepod community structure of the WAP? Are there spatial-temporal changes in abundance of copepods along the WAP? How are these changes tied to environmental variables?



Study Site



The Palmer Long-Term Ecological Research (LTER) study region consists of a fixed sampling grid on the continental shelf of the Western Antarctic Peninsula. Stations included in our time-series analysis are indicated with a pink star.

Methods

Sample Collection

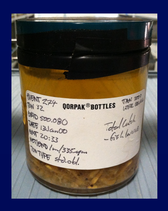
Zooplankton collected from 1994-2013 at stations along the WAP (20-yr time series)

0-300m double oblique tow
1m square mouth, 333um net

Historical samples stored at Smithsonian Institution

Size Fraction & Microscopic Analysis

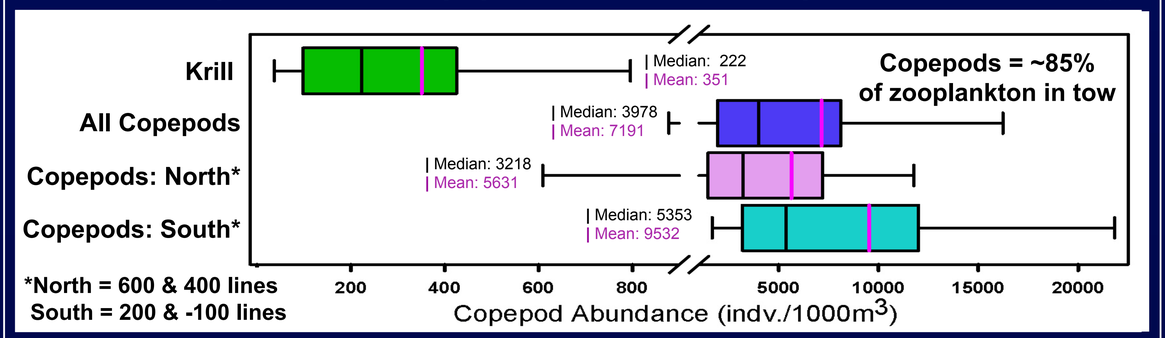
- Preserved samples separated into 3 size fractions.
- 1-1/180 split of each size fraction identified & counted
- Copepods identified to genus and/or species



3 Size Fractions:
200-1000µm
1000-5000µm
>5000µm

Total samples analyzed: 194

Results 1: Importance of Copepods in the WAP Zooplankton Community



- Copepods are the numerically dominant zooplankton
- Copepod abundance is variable, ranging across 3 orders of magnitude
- Greater copepod abundance in South than North (t-test, T = 6694, p = <0.001)

Results 2: Copepod Community Composition

Dominant W. Antarctic Peninsula Copepods

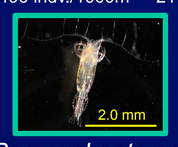
(Time-series mean abundance - % of all copepods; n=194)

Metridia gerlachei
(2047 indv./1000m³ – 29%)

Oithona sp.
(1581 indv./1000m³ – 22%)

Calanoides acutus
(1496 indv./1000m³ – 21%)

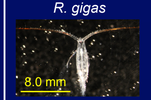
Clausocalanus sp.
(755 indv./1000m³ – 11%)



Paraeuchaeta sp.
(677 indv./1000m³ – 10%)

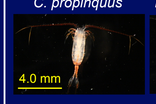
All other species
(542 indv./1000m³ – 7%)

R. gigas

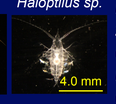


Oncaea sp.

C. propinquus



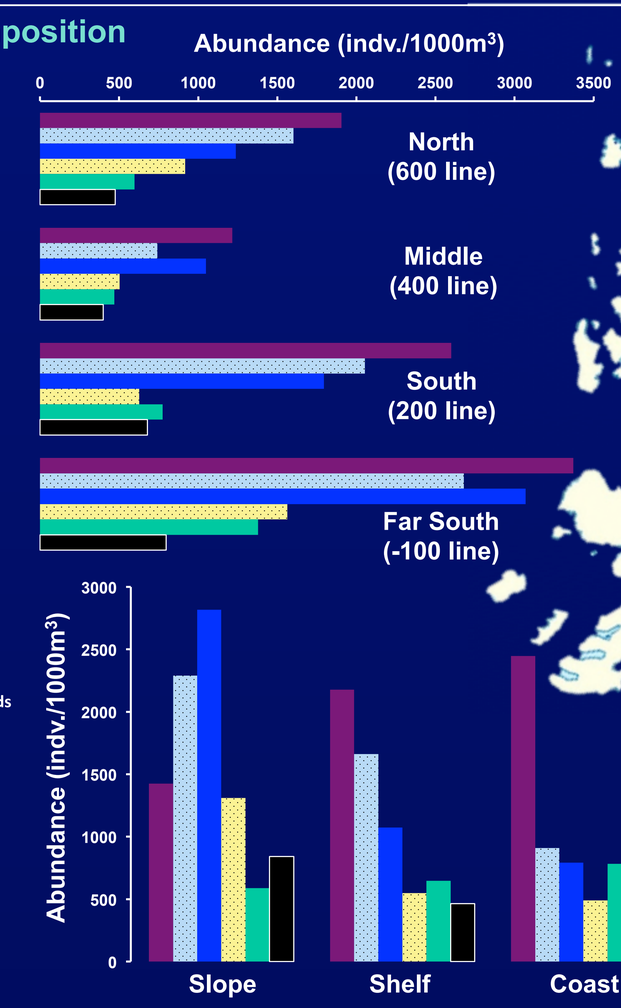
Haloptilus sp.



Heterorhabdus sp.

G. tenuispinus

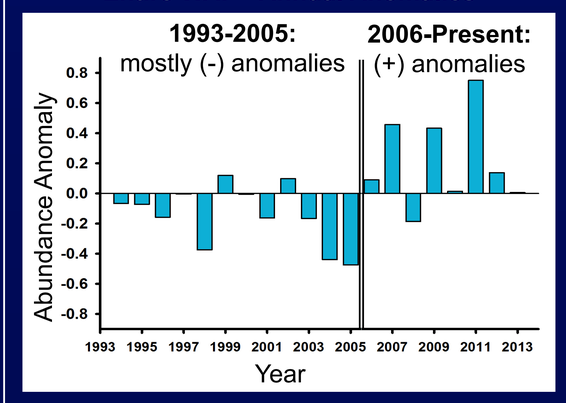
	Abundance (indv./1000m³)	% of copepods
Oncaea sp.	166	2%
Rhincalanus gigas	122	2%
Farrania frigida	75	1%
Heterorhabdus sp.	53	<1%
Scolecithricella minor	47	<1%
Calanus propinquus	36	<1%
Haloptilus sp.	23	<1%
Gaetanus tenuispinus	11	<1%
Aetideidae spp.	5	<1%
Candacia sp.	2	<1%
Euchirella sp.	1	<1%
Pleuromamma robusta	<1	<1%



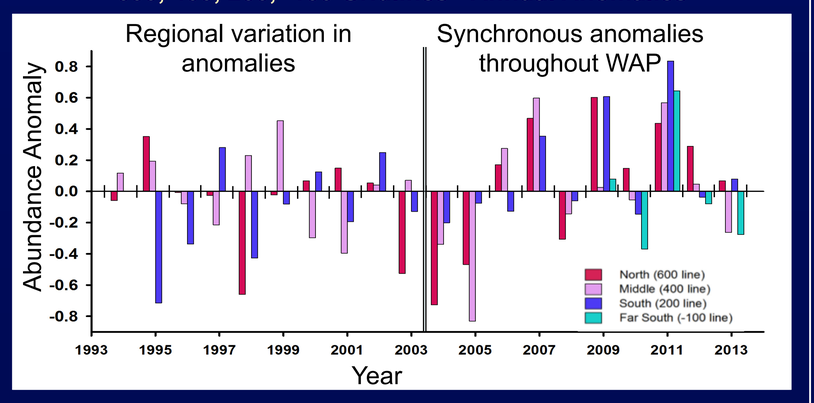
- 5 dominant copepods compose >90% of the copepod community
- The coast is dominated by *M. gerlachei*, while offshore *C. acutus* & *Oithona sp.* are most abundant.

Results 3: Copepod Time-Series Anomalies 1994 - 2013

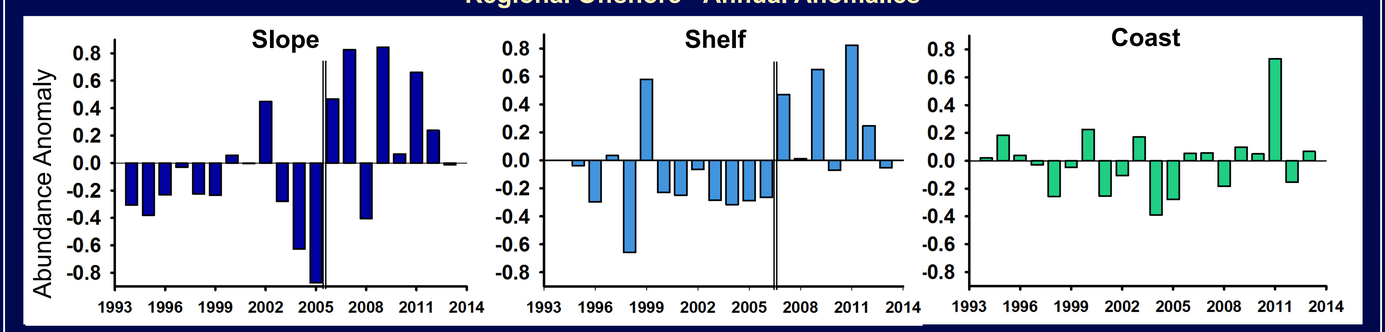
Entire WAP - Annual Anomalies



600, 400, 200, -100 Gridlines - Annual Anomalies

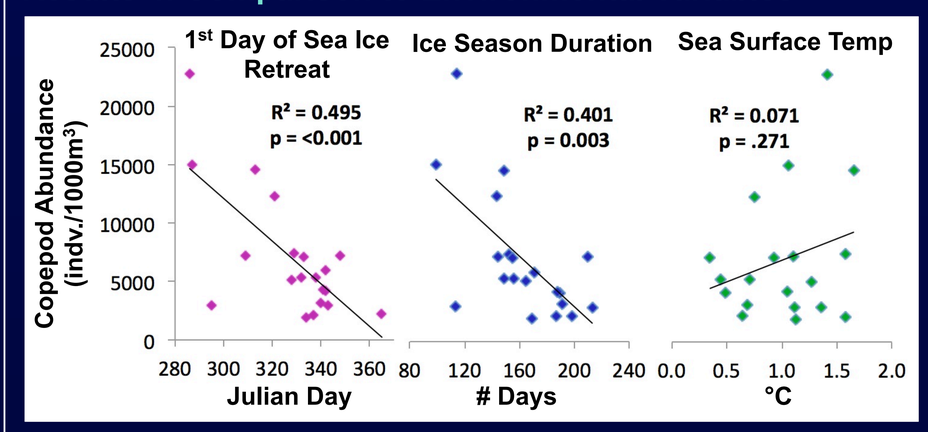


Regional Offshore - Annual Anomalies



- Shift from (-) to (+) anomalies in 2005/2006 more pronounced in Slope & Shelf
- Less extreme anomalies along the Coast

Results 4: Comparison to Environmental Variables



Sea Ice Retreat vs Total Copepods	R²	p
North (600 line)	0.147	0.05
South (200 line)	0.431	0.001

Stronger correlation between sea ice & copepods in South

Sea Ice Retreat vs. Dominant Copepods	R²	p
Metridia gerlachei	0.385	0.003
Oithona sp.	0.535	<0.001
Calanoides acutus	0.262	0.021
Clausocalanus sp.	0.267	0.02
Paraeuchaeta sp.	0.012	0.645

- Higher annual mean copepod abundance correlates with years of an earlier sea ice retreat and fewer sea ice days.
- No correlation with sea surface temperature

Abundance of certain taxa (e.g. *Oithona sp, M. gerlachei*) are more closely tied to sea ice.

Conclusion

There are 5 dominant copepod taxa in the WAP whose relative abundances do not change as much North to South as they do from coast to offshore. There appears to be a long-term increase in many copepod taxa along the WAP which becomes spatially more synchronous over time. Sea ice retreat and duration were important variables affecting copepod abundance, especially in the South. Considering the rapid climate warming and loss of sea ice in the WAP, resulting shifts in the zooplankton community could include increases in copepod abundance.

References

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