10-9-2015

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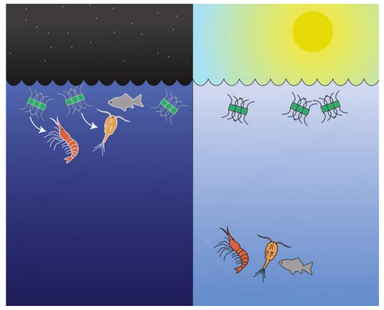
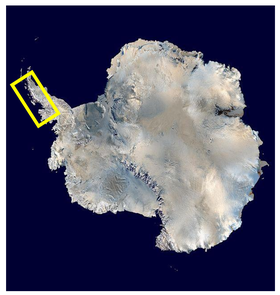
Introduction & Objectives

The Western Antarctic Peninsula (WAP) region has undergone significant warming and decrease in sea ice cover over the past several decades (Ducklow et al. 2013). The ongoing Palmer Antarctica Long-Term Ecological Research (PAL LTER) study indicates these environmental changes are affecting the WAP marine pelagic ecosystem, including long-term and spatial shifts in relative abundances of some dominant zooplankton (Ross et al. 2008, Steinberg et al. 2015). Largely unexamined in the WAP are changes in zooplankton as a function of depth due to diel vertical migration.

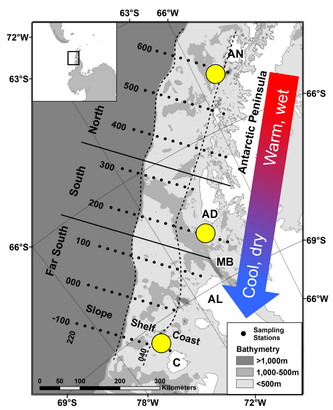
Diel vertically migrating (DVM) zooplankton, and fish, move between surface waters at night where they feed, and the mesopelagic zone where they reside during the day (largely to avoid visual predators). However, during the austral summer in polar regions, since there is only a brief daily period of (or no) darkness, zooplankton may not exhibit vertical migration behavior.



The goal of this study was to analyze diel vertical distribution patterns of zooplankton along the WAP's north to south climate gradient.



Yellow box indicates PAL LTER study region along the Western Antarctic Peninsula.



Solid lines separate the north, south, and far south regions. Yellow circles mark MOCNESS sample sites.

Methods

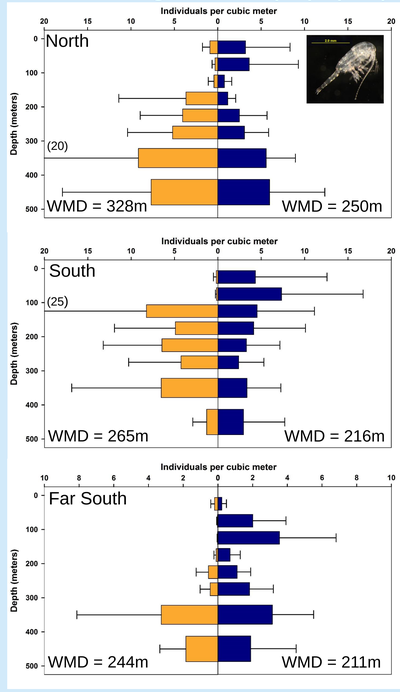
We determined occurrence and magnitude of zooplankton diel vertical migration during austral summer by conducting day and night Multiple Opening and Closing Net and Environmental Sensing System (MOCNESS) tows at discrete depth intervals through the epipelagic and mesopelagic zones from 2009-2015, and with epipelagic net tows from 1993-2013. Night densities in surface waters for each taxon were compared with daytime densities, and the mean night to day ratio (N:D) and weighted mean depth (WMD) were calculated. N:D ratios above ~1.5, and shallower WMD in night vs. day indicates DVM.

MOCNESS tow

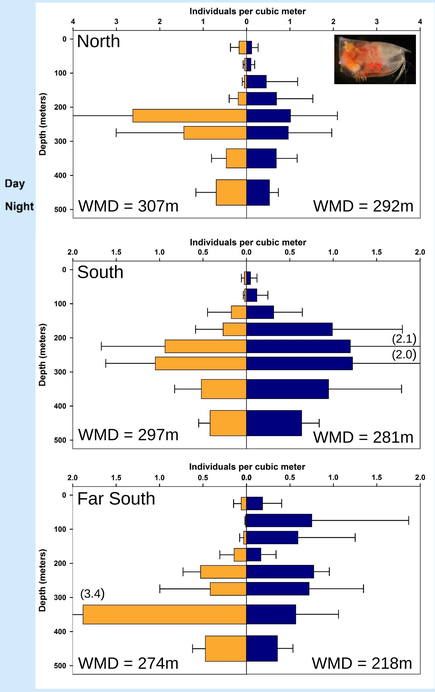
Sorting samples onboard ship

Results: vertically migrating zooplankton

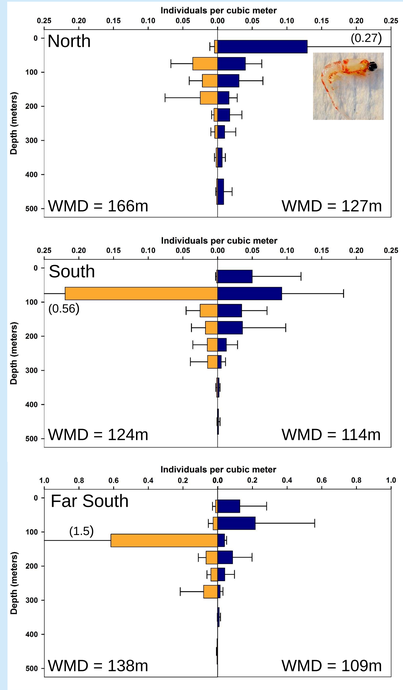
Metridia gerlachei (copepod)



Ostracods



Thysanoessa macrura (krill)



Depth intervals for all figures are mean abundance (n = 2-6 yrs.) ± 1 SD. The far south was least sampled.

Calanoid copepods (e.g., *Metridia gerlachei, Calanus propinquus*), ostracods, and chaetognaths exhibited strong DVM (i.e., N:D >>1), with N:D usually increasing southward. For the krill species, *Thysannoessa macrura,* DVM was greatest in the north and decreased southward. The Antarctic krill, *Euphausia superba,* only migrated in the north, as did the gelatinous salp, *Salpa thompsoni*–where this species is most abundant. Pelagic snails, *Limacina* pteropods migrated in north and south. Amphipods did not appear to migrate.

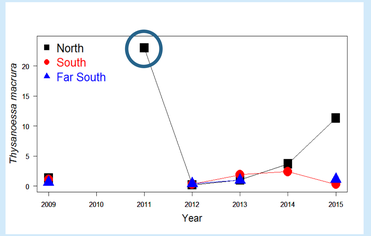
Taxon	N:D ratio in surface 150m	North	South	Far South
Euphausiids (krill)				
	*Euphausia superba**	1.8	0.3	0.1
	Euphausia crystallorophias	2.9	2.1	0.5
	Thysanoessa macrura	6.8	1.2	0.8
Calanoid copepods				
	Calanoides acutus	0.9	2.4	1.5
	Calanus propinquus	2.7	0.9	3.7
	Rhincalanus gigas	1.4	1.0	0.9
	Paraeuchaeta antarctica	0.3	1.0	9.7
	Metridia gerlachei	7.2	34.5	580.6
	Other calanoids	2.7	2.1	6.2
Ostracods		2.7	4.3	14.7
Hyperiid amphipods				
	Primno macropa	0.8	0.7	0.6
	Themisto gaudichaudii	0.1	0.0	0.0
	Hyperoche medusarum	0.2	0.1	1.4
	Vibilia stebbingi	0.4	1.0	0.0
Chaetognaths		2.7	4.3	14.7
Gastropods				
	Pteropods (*Limacina helicina*)	1.8	3.4	0.7
	Other gastropods	0.1	2.5	2.6
Salps		3.7	0.2	0.0

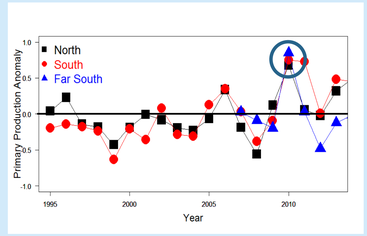
*Determined from epipelagic net tows 1993-2013

Conclusions

- Regardless of near continuous light in austral summer, some zooplankton species still undergo DVM along the WAP. This is supported by one other study (Marrari et al., 2011) for a location in Marguerite Bay.
- The strength of DVM differed along a latitudinal gradient with some species showing stronger migration in the north (e.g., krill) and some in the south (e.g., ostracods).
- Prior studies in the Arctic indicate stronger DVM in krill occurred in ice-free regions (Berge et al., 2009) and that phytoplankton blooms decreased DVM as zooplankton continued to feed in surface waters (Cisewski et al., 2010). In contrast, we found that DVM increased for some species in regions with more ice– the south and far south (e.g., *Metridia gerlachei*, and other calanoid copepods) and appears to increase for some species with increasing primary production (e.g., ostracods).
- This temporal and spatial variability in zooplankton diel vertical migration behavior has implications for both the pelagic food web and for biogeochemical cycling in the region.

Future Work





N:D ratio for krill, *Thysanoessa macrura*, indicates some correlation with primary production. Positive primary production anomalies occur in the same year as strong vertical migration of *Thysanoessa macrura* in 2011. Primary production anomaly is not significantly correlated ($p > 0.05$) but this is strongly skewed by the N:D 2011 north ratio.

Acknowledgements

We thank the Captain, officers, and crew of the ARSV *Laurence M. Gould,* and Raytheon Polar Services and Lockheed Martin personnel for their support. We are grateful to the many student volunteers that assisted during the PAL LTER cruises. We thank Joe Cope for consult on data analyses. This research was supported by the National Science Foundation Antarctic Organisms and Ecosystems Program (OPP-0823101, PLR-1440435).

References

Berge, J., Cottier, F., and 13 others. 2009. Diel vertical migration of Arctic zooplankton during the polar night. Biol. Lett. 5, 69–72.

Cisewski, B., Strass, V.H., and 2 others. 2010. Seasonal variation of diel vertical migration of zooplankton from ADCP backscatter time series data in the Lazarev Sea, Antarctica. Deep. Res. Part I Oceanogr. Res. Pap. 57, 78–94.

Ducklow, H.W., Fraser, W. R., and 8 others. 2013. West Antarctic Peninsula: An ice-dependent coastal marine ecosystem in transition. Oceanography 26(3), 190-203.

Marrari, M., Daly, K. L., and 2 others. 2011. The zooplankton of Marguerite Bay, western Antarctic Peninsula vertical distribution and habitat partitioning. Deep-Sea Research II 58, 1614-1629.

Ross, R. M., Quetin, L. B., and 3 others. 2008. Palmer LTER: Patterns of distribution of five dominant zooplankton species in the epipelagic zone west of the Antarctic Peninsula, 1993-2004. Deep-Sea Research II 55, 2086-2105.

Steinberg, D. K., Ruck, K. E., and 8 others. Long-term (1993-2013) changes in macrozooplankton off the Western Antarctic Peninsula. Deep Sea Research I 101, 54-70.