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Diel Vertical Distribution Patterns of Zooplankton along the Western Antarctic Peninsula
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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.

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 taxa and taxa 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 indicated DVM.

Results: vertically migrating zooplankton

<table>
<thead>
<tr>
<th>Taxon</th>
<th>WMD (m)</th>
<th>N:D</th>
<th>Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calanoid copepods</td>
<td>218</td>
<td>2.1</td>
<td>Metridia gerlachii</td>
</tr>
<tr>
<td>Calanoid copepods</td>
<td>211</td>
<td>1.4</td>
<td>Calanus acutus</td>
</tr>
<tr>
<td>Thysanoessa macrura (krill)</td>
<td>281</td>
<td>0.9</td>
<td>Thysanoessa antarctica</td>
</tr>
<tr>
<td>Ostracods</td>
<td>218</td>
<td>0.3</td>
<td>Thysanoessa antarctica</td>
</tr>
</tbody>
</table>

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 (Marra et al. 2018) 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 (Ciesielski 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 gerlachii, 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.

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Steinberg, D., Ruck, K.E., and 8 others. 2008. 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.

MOCNESS tow

Sorting samples onboard ship

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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 Cigar for his assistance in data analysis. This research was supported by the National Science Foundation Antarctic Oligotrophic Ecosystems Program (OPP-0823101, PLR-1446240).

References