Variability in vertical distribution of mesozooplankton populations in a high productivity plume of the Galapagos Archipelago, Ecuador

17 November 2005

Running Head: Vertical distribution of mesozooplankton in the Galapagos Archipelago, Ecuador.

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Project Summary

Global patterns of high phytoplankton and zooplankton production are indicative of high levels of fish recruitment and thus are of significant import to marine mammal populations and coastal fishing communities. Whereas distribution of phytoplankton is associated with the euphotic zone, zooplankton exhibit diel vertical migration (DVM) in order to maximize energy gain and reduce the risk of predation, in turn affecting a significant percentage of carbon flux from the euphotic zone. Timing and extent of migrations are correlated with variation in size and physical parameters including light levels and depth of the mixed layer. I hypothesize that mesozooplankton assemblages (>300µm) will exhibit divergent daily and nightly vertical spatial distribution indicative of DVM within the high productivity plume west of Isabela Island in the Galapagos Archipelago, Ecuador. Further, there will be differences in vertical distribution of mesozooplankton between shallow (200 m) and deep-water (1200 m) habitats as the mesozooplankton will travel beyond 200 m when not constrained by depth limitations. Distribution will be established through repeated day and night 1 m diameter closing net tows (300µm mesh) from the R/V Thomas G. Thompson and consist of three discrete depth bins defined by the chlorophyll a maximum. Information on vertical spatial variability within mesozooplankton populations will contribute to our understanding of the poorly described marine environment surrounding the Galapagos Archipelago by defining regions of secondary productivity instrumental in supporting the unusual regional biota.
Introduction

Situated on a platform in the eastern equatorial Pacific at an intersection of three great oceanic currents, the Galapagos Archipelago lays at the eastern edge of a highly productive region in the otherwise unproductive open expanse of the Pacific Ocean. The archipelago’s western flanks induce upwelling of the Equatorial Under Current (EUC) bringing nutrients, high primary productivity (Houvenahgel 1984, Feldman 1986, Chavez and Brusca 1991), secondary productivity and fish recruitment (Witman and Smith 2003). Pan-Pacific current import fuels diversity within the islands fueling a mix of warm- and cold-water fauna on the central shelf (Okey et al. 2004). Though the terrestrial biota of the archipelago are famously documented, our understanding of the surrounding marine environs remains minimal by comparison.

Figueroa and Hoefel (unpubl), in an ongoing effort to determine species abundance and composition of Galapagos zooplankton, collected samples from across the archipelago and have reported that divergent patterns of distribution for copepods have emerged separating the western, central and southern regions. Edgar et al. (2004) further divide the islands into five bioregions supporting distinct mixes of fish and macro-invertebrate communities including the high productivity area west of Isabela Island as a distinct bioregion.

While phytoplankton lack the means of motility displayed by the secondary producers, zooplankton often exhibit diel vertical migrations to and from the euphotic zone to maximize energy gain and reduce risks of daylight predation from planktivorous nekton (De Robertis et al. 2000, Rollwagen Bollens and Landry 2000, Strom 2002, Tarling et al. 2002) in turn affecting a significant portion of carbon flux from the euphotic zone (Roman et al. 1995). De Robertis et al. (their figure 1, 2000) show timing of vertical migration to coincide with zooplankton size where larger animals ascend 30 minutes later and descend 45 minutes earlier than smaller bodied
organisms and suggest the larger organisms are more conspicuous to planktivorous predators. Longhurst (1976) suggests that larger zooplankton are faster swimmers exhibiting greater vertical migration than smaller class sizes correlating extent of migrations with size as well as with physical parameters including light levels and depth of the mixed layer.

New primary production in the eastern and central equatorial Pacific was estimated at 1 gigaton C per year by Chavez and Barber (1987) representing 18-56% of global new production. A basis of the marine food web, global regions of high primary and secondary production are associated with high levels of fish recruitment (Feldman 1986). While satellite imagery depicting sea surface color permits observation of the global distribution of primary producers we have no such applications describing distribution of secondary producers - the zooplankton- resulting in the need to establish distribution via direct measurement.

Proposed Research

Study area is in the high productivity plume to the west of Isabela Island (Figure 2, Table 1). A 200 m site (Station 1) and a 1200 m site (Station 2) will be sampled from the R/V Thomas G. Thompson (Figure 3). Target times for stations are 1200 and 0000 and were chosen to best capture zooplankton within depth extremes during non-migrational periods. A three-hour leeway is allowable in either direction from target times giving windows of 0900-1500 and 2100-0300. Conductivity, temperature and depth (CTD) data will first be collected to identify the location of the thermocline and chlorophyll a maximum (chl a max) via fluorescence. Three depth bins will be designated upon the initial cast per station and remained fixed throughout the following samples. Proposed depth bins for a subsurface chl a max would isolate the peak of the bloom by 10-20 m above and below the peak between a surface layer bin and a depth bin to 180 m. Based on Roman et al. non-El Nino conditions support a subsurface chl a max for which anticipated
depth intervals are 0-30m, 30-100m and 100-180m (their figure 4, 1995). A surface chl a max would likely require a deeper surface bin with anticipated depth intervals of 0-40m, 40-110m and 110-180m.

Depth-discrete vertical net sampling in each bin will profile the vertical distribution of mesozooplankton >300µm. Distribution will be established through repeated day and night net tows employing a 1 m diameter closing net rigged with 300µm mesh. All hauls will be split with a plankton splitter and shared with fellow scientist Natalie Tsui who will be examining coloration related to gut fullness. Mass of samples will be derived through displacement volumes where the difference of a parcel of water is taken from the volume of the sample and the water in a graduated cylinder. General composition of samples will be inferred by frequency of organisms enumerated through 100 counts and will not be species specific. A portion of the samples will be weighed wet prior to desiccated and again after 24 hrs in a 60° C oven for the ratio of gelatinous to crustaceous organisms.

Project Budget

Budget summary is inclusive of all major expenses for the eight day trip.

<table>
<thead>
<tr>
<th>Item</th>
<th>Project cost</th>
<th>Weekly total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thomas G. Thompson</td>
<td>$18,000 daily x 8 days</td>
<td>$144,000*</td>
</tr>
<tr>
<td>1 m plankton net 300µm mesh</td>
<td>$6 daily x 8 days</td>
<td>$48</td>
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<tr>
<td>Hydraulic winch</td>
<td>$45 daily x 8 days</td>
<td>$360</td>
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<td>CTD</td>
<td>$135 daily x 8 days</td>
<td>$1080</td>
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<td>Trip total</td>
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<td>$1488</td>
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</table>

*Operation cost not included in budget
References


Tables

Table 1: Station descriptions with latitude and longitude, estimated equipment and time required and allowable time windows for station sampling.

<table>
<thead>
<tr>
<th>Station</th>
<th>Latitude</th>
<th>Longitude</th>
<th>Equipment To be used</th>
<th>Estimated Time Req’d</th>
<th>Time constraints (be specific)</th>
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<tbody>
<tr>
<td>1</td>
<td>0° 35’ S</td>
<td>91° 21’ W</td>
<td>CTD, vertical closing nets</td>
<td>1.5 hrs per, 6 hrs total per stn.</td>
<td>0900-1500 and 2100-0300</td>
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<td>2</td>
<td>0° 10’ S</td>
<td>91° 36’ W</td>
<td>CTD, vertical closing nets</td>
<td>1.5 hrs per, 6 hrs total per stn.</td>
<td>0900-1500 and 2100-0300</td>
</tr>
</tbody>
</table>
Figure legends

Figure 1: De Robertis et al. 2000 show dawn and dusk migrations by size classes. (A) Euphausiid abundance during dusk ascent at 50 m depth. Lines separate class sizes. (B) Euphausiid abundance during dawn ascent at 50 m depth. Lines separate class sizes.

Figure 2: Map depicting the Galapagos Islands and Isabela Island.

Figure 3: Map depicting the study sites in the vicinity of Isabela Island.

Figure 4: Roman et al. 1995 show mean (±SD) vertical profiles of temperature (C) and in situ fluorescence (D) from October 1992. Values relate to an equatorial station at 0°, 140°W during a non-El Nino year.

Figures
Figure 2
Figure 4