Examination of Thin Layers of Phytoplankton and Zooplankton with Emphasis on Bioluminescence

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Background/Introduction:

Thin layers of plankton are commonly found in coastal environments, with a vertical scale ranging from centimeters to a few meters, but extending horizontally over kilometers. The abundance of organisms in these layers is several orders of magnitude higher than background levels and are persistent, lasting hours to days. These layers are highly productive and can contain 50-70% of the total biomass of the water column. Thin layers are ubiquitous features in coastal environments with a profound influence on trophic interactions.

Traditional sampling methods have proved inadequate for examining thin vertical layers. Recent advances in platforms (i.e. autonomous profilers) and sensors (i.e. fast response fluorometers and instruments measuring bioluminescence) have made it possible to characterize these thin layers.

An examination of the planktonic species of these thin layers relative to the rest of the water column over a 2 week period in San Luis Obispo Bay. A traditional sampling method (Niskin bottle) was compared to a more recent method (autonomous profiler). We examined the change in the vertical positions of these layers as well as their impact on trophic interactions.

Methods

Profiler

Beginning on 7/7/2010 at 0635 PDT the profiler began to sample the water column at half hour increments at the Center for Coastal Marine Sciences Pier (Figure 1). Each profile takes approximately seven minutes to complete. Sampling was conducted based on profiler data. All profile data within a two-week period was also analyzed for any seasonal changes (Figure 4).

The profiler contains a CTD (which measures conductivity, temperature, and depth/pressure), Bathyphotometer (BP), and a turbidity sensor (Figure 2B). The BP utilizes an impeller that pumps water into the enclosed chamber to produce a turbulent flow that mechanically stimulates bioluminescence. A flow meter measures the rate at which water moves through the BP. This allowed calculation of the total flow volume filtered to extrapolate bioluminescence values applicable to a liter of water.

Reviewed profile data (Figure 3) to determine if and where thin layers were present. Then used profiler with attached net to sample organisms at desired depths (within layer, above layer, and below layer) for quantification and identification.

Bioluminescence (Photons/sec)

Results and Conclusions

• Diversity indexes were calculated for each method and compared using a t-test, which determined that the methods were not statistically different (P < 0.31). However, this could be attributed to the limited number of samples collected.

• Thin layers were not observed throughout the water column, which explains its lack of adherence to the pattern demonstrated in the vertical profile of the water column (i.e. temperature and salinity) primarily dictated the location of bioluminescence.

• Figure 3 shows an evening profile on 7/19/2010 noting depths that were sampled. These depths were then used to conduct t-tests comparing the abundance of a bioluminescent species, Noctiluca scintillans, should have a higher abundance in the peak of bioluminescence than in non-peaks (P < 0.018 for the shallow non-peak and P < 0.048 for the non-peak deep). I conducted similar t-tests for another bioluminescent species, Protoperidinium depressum. However, its ecology explains this result as this species has a reduced flash intensity in comparison with Noctiluca.

• Figure 4 shows a time series graphs across the two-week study period. In looking at the temperature graph (Figure 4A) a warm water body is evident on 7/16/2010, this same time period also shows very high levels of bioluminescence (Figure 4B). By the time the profiler sampling began on 7/19/2010, a colder body of water had moved in also showing less bioluminescence. Bioluminescent species were still present during the time period of data collection but in lower concentration. This clearly shows that the physical properties of the water body (i.e. temperature and salinity) primarily dictated the location of bioluminescence.

• Figure 3 shows an evening profile on 7/19/2010 noting depths that were sampled. These depths were then used to conduct t-tests comparing the abundance of a bioluminescent species, Noctiluca scintillans (Table 1, Figure 5). The results confirmed the hypothesis that the bioluminescent species should have a higher abundance in the peak of bioluminescence than in non-peaks (P < 0.018 for the shallow non-peak and P < 0.048 for the non-peak deep). I conducted similar t-tests for another bioluminescent species, Protoperidinium depressum, which were not statistically significant. However, its ecology explains this result as this species has a reduced flash intensity in comparison with Noctiluca.

• This study examined the planktonic species of these thin layers relative to the rest of the water column over a 2 week period in San Luis Obispo Bay. A traditional sampling method (Niskin bottle) was compared to a more recent method (autonomous profiler). We examined the change in the vertical positions of these layers as well as their impact on trophic interactions.

Table 1. Abundance of Noctiluca scintillans, a Bioluminescent Species

<table>
<thead>
<tr>
<th>Depth</th>
<th>7/14/10</th>
<th>7/20/10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Peak Shallow</td>
<td>20X</td>
<td>5X</td>
</tr>
<tr>
<td>Peak</td>
<td>8X</td>
<td>1X</td>
</tr>
<tr>
<td>Non-Peak Deep</td>
<td>20X</td>
<td>5X</td>
</tr>
</tbody>
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References