Effect of light wavelength on phototaxic open water marine invertebrates

Bio 494
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Abstract

Light intensity emanating from a light trap will affect capture rates of marine open water invertebrates, but little is known of the affect different light wavelength have on capture rates. Green, yellow, red, and white light sticks were used to show wavelength capture rate differences. The results were mixed. Polychaetes responded poorly (nearly 0%) to both green and white light during the first testing set but responded strongly (>80%) to green light and somewhat less (>15%) to yellow light during the second. The opposite was true for shrimp with a strong (>48%) response to green and white during the first set and no response during the second.

**Keywords:** marine invertebrates, phototaxis, light wavelength, light intensity, polychaete, shrimp, crab, fish, Cubozoa

Introduction

Many invertebrates such as crab megalopae (Shanks 1985, Carr & Pitt 2008), mantis shrimp (Cheroske et al. 2006), and oysters (Tokusoglu & Balaban 2004) are positively phototaxic. Sand hoppers had a high degree (>80%) of positive phototaxis (Mezzetti et al. 1997) whereas blue crab larvae had only a weak response (<42%) (Lopez-Duarte & Tankersley 2007). The degree of positive response by marine invertebrates was dependent on light intensity (Pascoe 1990). Light traps of different design and light intensity should attract different phototaxic marine organisms (Holmes & O’Connor 1991).

Light trap design is an important consideration when planning marine capture studies. Lindquist et al. (2001) used two and three chamber traps to compare the effect of light intensity on capture rates in Florida. Southern Ocean Antarctic krill were studied using single chamber traps equipped with a high powered strobe (150 W) to compare the effect of strobe frequency on capture rates (Wiebe et al. 2004). In French Polynesia, a floating light trap was designed by Hickman & Porter (2007) to study the locomotion and reproduction of scissurellid gastropods. An automated light trap was used by Thorrold (1992) to sample juvenile cephalopods at multiple locations. A LED-based light trap was used by Flamarique et al. (2009) to monitor for sea lice.
on fish. Kehayias et al. (2008) used cyalume light sticks on plankton nets as a more cost effective way to collect fish.

Light traps and plankton nets have positive and negative effects. Light traps tend to attract and capture large fish or late-stage, photopositive, larval fish, as compared with plankton tows or a standard trawl net (Thorrold 1993, Porter et al. 2008). Plankton tows or standard trawl nets are likely to capture less-developed individuals that are not able to swim into traps or early-stage larvae that are not photopositive (Thorrold 1993, Wilson et al. 2003). Meekan et al. (2001) found that an increase in light trap size increased the catch rate of larval fishes. Holmes & O’Connor (1991) found that light traps collected fewer individuals but more crustacean species. Catch rate of light traps was also affected by water clarity (Moltschaniwskyj & Doherty 1995), current, and turbidity (Lindquist & Shaw 2005). Lindquist and Shaw (2005) suggested that light traps may not be the best device to use when encountering strong currents or high turbidity. Juvenile fish may not be able to swim against the current (Carleton et al. 2001).

To improve the efficiency of a light trap in diverse environments, different designs have been investigated (Moltschaniwskyj & Doherty 1995). None of the designs allowed for the manipulation of different light wavelengths. This study was designed to determine the effect of different light wavelengths on light box capture of photopositive, near-shore marine invertebrates.

**Materials and Methods**

Different light wavelengths were used in an attempt to attract marine open water invertebrates. Each light trap (BioQuip #2821) was fitted with a different color (green, yellow, red, and white) light stick (BioQuip #2822A-E). The traps were set on the substrate at a depth of
one meter and anchored in place off of Smiling Cove Marina Dock (15°13’04.72”N, 145° 43’ 26.36” E) of Saipan, Northern Mariana Islands. Traps were set in place one hour after sunset and retrieved an hour later. Upon retrieval all specimens were taken to the laboratory and placed in separate aerated holding containers. The site was sampled three times on June 13-15, 21-23 2013).

The captured specimens were identified, relaxed, photographed, and preserved. Relaxation was accomplished by use of either menthol (few crystals in a closed container with the specimen) or cooling within a refrigerator. Two specimens of each species were preserved in 10% formalin and then transferred to 70% ethanol for later histological work (except the Box Jelly). Cubozoa was preserved in 100% Alcohol directly for DNA analysis. If histological work was not required, specimens were placed in either 70% or 80% ethanol. Representative examples of all specimens were preserved in 95% ethanol for future DNA analysis.

Results

Forty-eight percent (11 out of 23) of the shrimp collected were attracted to the green light during the first set, but none during the second set. The reverse was true for polychaete worms with none attracted to green light during the first set, but 80% (16 out of 20) during the second.

There was limited attraction of shrimp to white light (35 %) and no light (17%) during the first set, but no attraction to yellow or red during the second set. Polychaetes responded just the opposite with 15% attracted to yellow and 1% to red light during the second set, but only a slight response (3 specimens) to white light during the first set and no response to a lack of light. Two
crab, and fish were collected, and only one box jelly was collected. Fish and box jellies were only collected during the second set (Table 1).

Table 1: The marine open-water invertebrates caught during two sets (3 days).

<table>
<thead>
<tr>
<th>Color</th>
<th>Shrimp</th>
<th>Crab</th>
<th>polychaete worm</th>
<th>Fish</th>
<th>Box Jelly</th>
</tr>
</thead>
<tbody>
<tr>
<td>No light</td>
<td>4 (17%)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>White</td>
<td>8 (35%)</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Green</td>
<td>11 (48%)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Totals</td>
<td>23</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

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<tr>
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<th>Fish</th>
<th>Box Jelly</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green</td>
<td>0</td>
<td>1</td>
<td>16 (80%)</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Yellow</td>
<td>0</td>
<td>0</td>
<td>3 (15%)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Red</td>
<td>0</td>
<td>0</td>
<td>1 (5%)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Totals</td>
<td>0</td>
<td>1</td>
<td>20</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

**Discussion**

The light trap was successful at capturing the larval stages of crabs, fish, and polychaetes. However, results were not consistent. Possible differences in moonlight intensity during the collecting set, differences in intensity of the light sticks, ambient light around the dock, and reproductive cycles might be factors contributing to these results. To access weather the use of light trap could be effectively worthwhile in collecting, it should calculate and analyze the lunar phase, make sure to have the new moon for the light when collecting. Also, find a better location which limited the ambient light from the environment.
References


