Larvae abundance in sheltered versus exposed areas

by

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Abstract

Water flow is important for the distribution and survival of larvae. It is important to determine what effect water flow has on the abundance of larvae because it may alter the recruitment of certain phylum. If water flow were to change, it could carry larvae to unfavourable conditions, which could have detrimental effects on the recruitment of larvae and affect the adult population. Sheltered and exposed areas differ in the amount of wave exposure and water flow they receive. Two sites were visited: Grappler inlet, a sheltered site, and Wizard Islet, an exposed site. Salinity, temperature and chlorophyll a levels were measured and three plankton tows were done at each site. The samples were preserved in formaldehyde immediately after each tow. Using a dissecting microscope, the samples were analysed and the number and phylum of each individual was recorded. There were variations in salinity, temperature and chlorophyll a levels between the sheltered and exposed site. Once the samples were counted, a one-way ANOVA was used to determine if there was any significant difference between larvae abundance at each site. There was no significant difference between Grappler inlet and Wizard islet. There were large numbers of arthropod larvae compared to the other phyla. The result implies that there is no difference in larvae abundance between Grappler inlet and Wizard islet.

Keywords: coast, inlet, nauplii, spionid, wave exposure

Introduction

Some benthic organisms rely on currents to disperse their planktonic larvae. Currents and wave action can carry larvae to the location where they will settle and live out their adult lives. There are multiple advantages associated with dispersal, such as wide distribution of gametes, gene flow and ability to tolerate disturbances (Ableson, 1997). Currents and wave action change depending on geographic location. Some areas are exposed and subject to high wave action, while others are sheltered and receive very little wave action. The exposed areas are often locations such as a coast near the open ocean, while the sheltered areas are bays or inlets. Sheltered and exposed sites interact, and the rate at which water is exchanged between them varies with tidal amplitude and bay morphology (Gaines and Bertness, 1992). The amount of wave exposure in an area may affect the abundance and distribution of larvae. Large scale and
local flow patterns are important for larval transport and settlement (Schwalb, 2010). The amount of flow can affect the viability of larvae; some larvae can live both within sheltered bays inlets and the waters near exposed coast without affecting their viability (Gaines and Bertness, 1992). In order for larvae to survive, they must find the best habitat to settle in. If they do not, they may be eliminated by predation, competition or unfavourable conditions. The amount of wave exposure will affect the ability of a larva to actively transport themselves to a favourable location (Ableson, 1997). In low turbulence conditions, distribution is controlled by gravitational disposition and downward swimming efforts (Ableson, 1997), which allows larvae to better navigate toward a desired location.

With the importance of water flow in mind, this study set out to compare the differences in larvae abundance between a sheltered and exposed area. It is predicted that there will be fewer larvae at the exposed site than the sheltered site.

**Methods**

Six plastic bottles were prepared (500 mL volume) by measuring out 100 mL of sea water and pouring this amount into each of the empty bottles. The water line was marked on each bottle using a piece of tape. After the bottles were marked, they were rinsed with fresh water. Ten millilitres of formaldehyde was measured and added to each bottle. Two additional bottles were rinsed with fresh water. These bottles were used to take a surface level phytoplankton sample at each site.

Two sites were visited: Grappler inlet (48.832 N, 125.117 W) and Wizard Islet (48.858 N, 125.156 W). At each site, salinity and temperature were taken using a refractometer and
thermometer respectively. An empty bottle was filled with surface water to be used for a chlorophyll a reading. At each site, 3 plankton tows were done at a depth of 2.7 meters. Approximately 90 mL (up to the previously marked water line) of the sample was added to the designated bottle.

To measure chlorophyll a, 2 mL of the phytoplankton sample was measured and placed it in a cuvette. Then, the Aquaflor was used to obtain a reading. The reading was done 3 times per sample to ensure accuracy. In the lab, each plankton sample was analysed. A dissecting microscope (Olympus SZ61), lights and a petri dish with a grid was used to slowly go through each sample. To reduce the volume of each sample, the bottles were swirled and poured into a graduated cylinder. Fifty millilitres of the sample (approximately one third of the original tow volume) was poured into a dish and a pipette was used to add a portion of this sample to the petri dish. When a thin layer of the sample was on the dish, each grid was observed and the abundance and phylum of the organisms present was recorded. The organisms were classified by phylum as either Arthropoda, Polychaeta, Mollusca, Echinodermata or Cnidaria. This process was repeated with the rest of the sub sample and all the samples thereafter. Once the samples were counted, the difference in the volume of water filtered in each tow was accounted for using a flow meter calculation. A one way ANOVA was run using Microsoft Excel 2007 to determine if there was a significant difference between the number of each phylum of larvae at each site.
Results

There were slight variations between salinity, temperature and chlorophyll a at each location (Table 1). Using Microsoft Excel 2007, a one-way ANOVA was run on the data for each phylum. There was no significant difference between Grappler inlet and Wizard islet for any of the larvae phylum (Arthropoda, Polychaeta, Mollusca, Echinodermata or Cnidaria; Table 2). There were many more Arthropod larvae present than any other phylum (Figure 1).

<table>
<thead>
<tr>
<th>Site</th>
<th>Salinity (ppt)</th>
<th>Temperature (°C)</th>
<th>Chlorophyll a (µg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grappler inlet</td>
<td>26</td>
<td>14.5</td>
<td>0.019</td>
</tr>
<tr>
<td>Wizard islet</td>
<td>22</td>
<td>13</td>
<td>0.032</td>
</tr>
</tbody>
</table>

Table 1. Measurements of salinity, temperature and chlorophyll a taken using a salinity refractometer, thermometer, and Aquaflor respectively.

<table>
<thead>
<tr>
<th>Phylum</th>
<th>Df</th>
<th>F</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arthropoda</td>
<td>1</td>
<td>1.53</td>
<td>0.28</td>
</tr>
<tr>
<td>Polychaeta</td>
<td>1</td>
<td>2.1</td>
<td>0.22</td>
</tr>
<tr>
<td>Mollusca</td>
<td>1</td>
<td>0.28</td>
<td>0.53</td>
</tr>
<tr>
<td>Echinodermata</td>
<td>1</td>
<td>0.35</td>
<td>0.58</td>
</tr>
<tr>
<td>Cnidaria</td>
<td>1</td>
<td>0.11</td>
<td>0.76</td>
</tr>
</tbody>
</table>

Table 2. Results of the one-way ANOVA done in Microsoft Excel 2007. There are no significant differences in larvae abundance between Grappler inlet and Wizard islet.
Figure 1. Graphs of the abundance of three phylum of larvae. There was no significant difference between Grappler inlet and Wizard Islet (see table 2). Echinodermata and Cnidaria were not included as their numbers per cubic meter were equal to or below 1. a.) The abundance of arthropod larvae per cubic meter. b.) The abundance of Polychaeta larvae per cubic meter. c.) The abundance of Mollusca larvae per cubic meter.
It is important to determine what factors influence the transport and settlement success of planktonic larvae as it can lead to better understanding their biology and life history. It is crucial to combine field, lab and life history studies when making decisions about conservation of marine life. If a species is close to extinction and efforts are made to reintroduce farmed larvae into the wild, it would be important to know what conditions will maximize the success of the larvae. For example, if a species of worm has a higher settlement success near conspecific adults in moving waters (Walters, 1997), it would be wise to release any cultured larvae in an area that combines a population of adults with ideal water flow and hopefully increase the success of the larvae. Understanding the effects of currents and wave exposure on larvae is also important in determining future impacts on a population. As the climate changes and global warming comes into play, the dynamics of the ocean may shift. Marine organisms will be subject to increasing stressors and this will likely impact the population (Gardener et al., 2005; Beuchel et al., 2006; Millero, 2007 cited in Deschaseaux, 2009). If currents change, they may have the ability to transport larvae to unfavourable conditions. This would cause the larvae to die off and the increasing mortality of the larvae would affect the stability of the adult population; the successful recruitment of larvae is important when determining the numbers of adults in a population (Hempel, 1963). A fluctuation in the abundance of one species will have effects on other organisms that it is linked to via a food web. As a result, the effects will cascade through the food chain and change population dynamics of other species.

Though there were variations in salinity, temperature and chlorophyll a levels between
the sites, these differences must not have been enough to affect the viability of larvae found within the upper 3 meters of the water column. There was no significant difference between the abundances of phyla at the sheltered and exposed location. This contradicts the hypothesis, as it was predicted that there would be fewer larvae at exposed sites. This suggests that there is no difference between larvae abundance at the two locations. Though it was originally thought that larval abundance would be higher at sheltered sites, it was surprising to find that arthropod nauplii were not more abundant at Grappler inlet, as Nauplii may have higher survivorship in more calm conditions because flow rates can affect their ability settle on a suitable substrate (Ableson, 1997).

There were many more arthropod nauplii at each site compared to any other phyla (figure 1). The tows were not deeper than 3 meters and the depth in the water column maybe affect the distribution of phyla. Swimming behaviour in larvae can affect their vertical displacement in the water column (Young, 1995; Metaxas, 2001 cited in Schwalb, 2010). Nauplius and spionid larvae exhibit rapid and constant swimming behaviour compared to mollusca, echinodermata and cnidaria, and this may explain why their abundances were greater near the surface of the water column. There is a threshold condition at which larvae can activity control their placement in the water column and there is a limit as to where physical processes govern their dispersal (Sameoto, 2009). Arthropod larvae may have been able to hold their position in the water column at the shallow depth of the tows and therefore were more abundant.

As in many projects, this study contains sources of error. Only two sites were visited and though both sites were conditional opposites, it would have been more ideal to collect and go through samples from a greater number of sites. The time at which different invertebrates spawn
may have affected the results. If echinoderms do not commonly spawn at the time of the plankton tows, then there should not be very many echinopluteus larvae. This may explain why there were so many arthropod larvae compared to the other phylum. The abundance of a certain phylum may have been affected by observational error. I have never worked with larvae before and since they often do not resemble the pictures in the guidebook, it was left up to my inexperienced eyes to place them within a category. As time staring under the microscope increased, my ability to see clearly decreased. This may have contributed to observational error, as my ability to see distinct shapes was compromised.

In future studies, it would be ideal to visit more sites and at constant intervals throughout the year. This would allow a better comparison between sheltered and exposed sites rather than only one pair of sites; and if sites were visited at 2 week intervals, it would account for how the number of larvae changed over time and throughout the reproductive seasons. Finally, the time spent looking under the microscope would be spread out to reduce observer error.

**Conclusion**

There was no significant difference between larvae abundance at the sheltered versus the exposed site. This suggests that there is no correlation between the larvae abundance at these two sites. In order to determine the effect wave exposure may have on larvae abundance, more samples would need to be gathered at various sites throughout the year. This would give a more accurate picture of the differences in larvae abundance at sheltered versus exposed areas. Determining the effects of wave exposure on larvae abundance is important when thinking of
climate change and the future. If currents change it could shift the direction in which larvae are transported and affect their viability; and their survival will have an affect on the adult populations.

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References


