Searching for Nature Stories 2015

Home Sweet Home

Team 16 Diocesan Girls’ School
S5 Chan Kit Laam Kelly
S5 Kwok Wing Hei Phoebe
S5 Pang Sin Ting
S5 Tang Yue Man Michelle
# Content

1. Abstract p. 3
2. Introduction
   2.1 Introduction of research topic p. 4
   2.2 Objectives p. 4
   2.3 Research questions p. 4
   2.4 Background information of *Diogenes pugilator* p. 5
3. Materials and Methods
   3.1 Working schedule p. 6
   3.2 Collection of hermit crabs p. 6-7
   3.3 Population density p. 7-8
4. Results
   4.1 Collected data p. 9
   4.2 Behavior of hermit crab p. 10
   4.3 Experiments p. 10-16
5. Discussion
   5.1 Discussion on objective 1 p. 17
   5.2 Discussion on objective 2 p. 17
   5.3 Limitations p. 18
   5.4 Improvements p. 18
   5.5 Possible errors p. 18-19
   5.6 Conclusion p. 19
6. Bibliography p. 20
1. Abstract

*Fig. 1 Diogenes pugilator*  
*Fig.2 Diogenes pugilator* that we have collected in the beach

Diogenes pugilator is a species of hermit crabs, sometimes being called as the small hermit crab. It lives inside an empty snail shell to protect its soft hind body just like the other normal hermit crabs. The left claw of it is larger than the right, which is exactly the opposite of those common hermit crabs. Furthermore, the small hermit crab is grey in colour while the common hermit crab is orange-red.

In this project, our objectives are to study the effect of shell size on shell selection and to study the effect of intraspecific competition on shell selection of the small hermit crabs.

Small hermit crabs were collected in Sha Ha Beach, 9 Sha Ha Road, Tai Mong Tsai Road, Sai Kung. The small hermit crabs were used to carry out experiments in the school laboratory for our research topic. Their behaviour and results of the experiments were observed and recorded throughout the whole process.

From the results of the experiments, it was found that hermit crabs are more likely to choose shells with larger lumen size than their original ones. However, hermit crabs do not necessarily change shells with longer lengths than the original one. Moreover, the time required for the hermit crabs to change their shells is shorter when they are under intraspecific competition.
2. Introduction

2.1 Introduction of research topic

Hermit crabs are soft crabs that are only protected by the shells they temporarily live in. Hermit crabs are unique because they must find and use a shell from another creatures, and they are also unique from other crabs since they do not have a 'regular shelter’ for themselves. A hermit crab carries this "borrowed" shell around with them, and the shell protects their soft abdomen and holds and regulates moisture within the shell (important for the function of the gills for breathing). Hermit crabs do change shell and some change quite frequently. Our teammates found that they are smart enough to move their ‘house’ and we are interested in how ‘picky’ they are to choose their own shelter.

Hence, we developed curiosity in their preference of selecting shell for shell changing. It is mainly focused in the role of shells’ size and the intraspecific competition on shell selection.

During our field trips, we observed that there are habits of hermit crabs in shell selection, namely the color of the shell and shell type or shape. Later on, we decided to investigate more comprehensively on the role of shell sizes since it can be further categorized as the length of the shell and the lumen size; and this is a factor keeping less constant throughout our observations in those occupied shells of hermit crabs.

Fig.3 Common type of hermit crab in Hong Kong

2.2 Objectives

1. To study the effect of shell size on shell selection
2. To study the effect intraspecific competition on shell selection

2.3 Research questions

1. Does varying shell length sizes affect hermit crab selection?
2. Do the hermit crabs prefer a shell with larger lumen size than the original one, or a smaller one?
3. How does the intraspecific competition affect shell selection of hermit crab?
2.4 Background information of *Diogenes pugilator*

2.4.1 Classification

<table>
<thead>
<tr>
<th>Kingdom</th>
<th>Animalia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phylum</td>
<td>Arthropoda</td>
</tr>
<tr>
<td>Class</td>
<td>Malacostraca</td>
</tr>
<tr>
<td>Order</td>
<td>Decapoda</td>
</tr>
<tr>
<td>Family</td>
<td>Diogenidae</td>
</tr>
<tr>
<td>Genus</td>
<td><em>Diogenes</em></td>
</tr>
<tr>
<td>Species</td>
<td><em>Diogenes pugilator</em></td>
</tr>
</tbody>
</table>

Binomial name: *Diogenes pugilator*

2.4.2 Description

*Diogenes pugilator*, with a common name of ‘hermit crab’, is a yellowish-green hermit crab. Its carapace may reach up to 11 mm in length. Like all hermit crabs it has a soft and delicate abdomen that it protects with an otherwise empty snail shell. The abdomen is asymmetrical and twisted to fit inside the shell's coil. *Diogenes pugilator* differs from most hermit crabs by having the left claw considerably larger than the right (and not the other way round). Both claws are covered in minute hairs. Its carapace is a square shape and has tufts of hair on the upper left and right sides.

![Diagram of Diogenes pugilator](image)

2.4.3 Distribution

Angola, Black Sea, Equatorial Guinea, Mediterranean Sea, North Sea, Red Sea, Senegal, Singapore Strait, South Atlantic Ocean

Fig. 4
3. Materials and Methods

3.1 Working schedule

<table>
<thead>
<tr>
<th>Date</th>
<th>Venue</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>14/12/2014</td>
<td>Field trip (1)</td>
<td>Analysis of habitat of organism D.Pugilator</td>
</tr>
<tr>
<td>21/12/2014</td>
<td>Field trip (2)</td>
<td>Collection of D.Pugilator</td>
</tr>
<tr>
<td>7/2/2015</td>
<td>Field trip (3)</td>
<td>Collection of D.Pugilator</td>
</tr>
</tbody>
</table>

3.2 Collection of crabs

The hermit crabs were collected in Sha Ha Beach, 9 Sha Ha Road, Tai Mong Tsai Road, Sai Kung (fig.5 refer to the map as shown below). A total of 12 hermit crabs were collected from this beach. The collection has taken place for twice, in the evening of 21st December, 2014 and 7th February, 2015.

From that beach, it is observed that most of the hermit crabs are carrying a spiral shape shell. So wherever is a shell that is similar to such type, it is a possibility of hermit crab; they were collected by hands generally. When the shell with hermit crab was picked, length of the shell and length of the lumen size were measured. Those shells without hermit crab were also picked, their distribution in that specific quadrat and the size are measured as well. Hermit crabs collected is immediately placed in the tank, which is a simulation of their habitat- sand and sea water from that beach, after measuring size. Extra sand and seawater from that beach were also collected so as to simulate the hermit crabs’ habitat more comprehensively, incase those in the tank (set-up) need to be changed.

![Fig. 5 location of sample collection](image_url)
### Field site basic information

<table>
<thead>
<tr>
<th></th>
<th>21/12/2014</th>
<th>7/2/2015</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Date</strong></td>
<td>09:00-11:00</td>
<td>08:30-10:00</td>
</tr>
<tr>
<td><strong>Temperature</strong></td>
<td>16°C</td>
<td>18°C</td>
</tr>
<tr>
<td><strong>Wind Speed</strong></td>
<td>25 km/h</td>
<td>27 km/h</td>
</tr>
<tr>
<td><strong>Salinity</strong></td>
<td>2.6g/100g of water</td>
<td>2.6g/100g of water</td>
</tr>
<tr>
<td><strong>Humidity</strong></td>
<td>73%</td>
<td>75%</td>
</tr>
<tr>
<td><strong>Current tide</strong></td>
<td>Low tide</td>
<td>Low tide</td>
</tr>
<tr>
<td><strong>Highest tide</strong></td>
<td>00:00</td>
<td>22:00</td>
</tr>
<tr>
<td><strong>Lowest tide</strong></td>
<td>1st time: 05:00&lt;br&gt;2nd time: 18:00</td>
<td>1st time: 04:00&lt;br&gt;2nd time: 16:00</td>
</tr>
</tbody>
</table>

### Field trip equipments for species sampling:

- Tray x 2
- Forceps x2
- Gloves x5
- Quadrat x1

### Field trip equipments for measuring abiotic factor:

<table>
<thead>
<tr>
<th>Factors</th>
<th>Equipment</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salinity</td>
<td>refractometer</td>
<td>To measure the salinity of water</td>
</tr>
<tr>
<td>Temperature</td>
<td>digital thermometer</td>
<td>To measure the temperature</td>
</tr>
<tr>
<td>pH value of sea water</td>
<td>pH meter</td>
<td>To measure the pH value</td>
</tr>
<tr>
<td>Relative humidity</td>
<td>hygrometer</td>
<td>To measure the relative humidity of air</td>
</tr>
<tr>
<td>Wind Speed</td>
<td>anemometer</td>
<td>To measure wind speed</td>
</tr>
<tr>
<td>Wind direction</td>
<td>compass</td>
<td>To determine the wind direction</td>
</tr>
</tbody>
</table>

### 3.3 Population density

In total, 12 hermit crabs were collected from the first and the second field trip of collections. In order to study the relationship between the shell type and shell selection, the distribution of available shells in their habitat was studied.

The population density of hermit crab shell, was ascertained by quadrat sampling, with 1.0m x 1.0m quadrats. Sampling was carried out in the morning when the tide is the lowest of the
day, so that hermit crabs and shells are more easily to be observed. The following investigations were carried out:

A transect is laid down along the area to be studied, and quadrat of the size 0.5m x 0.5m was placed continuously at sites. 10 quadrats were set along one side of the transect. The position of the quadrats and the organisms enclosed by the quadrats are recorded. The number and species of shells found in each quadrat was recorded immediately.

Density = (total count of hermit crab shells / number of quadrats) / area covered by one quadrat

<table>
<thead>
<tr>
<th>Quadrant</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>no. of shells</td>
<td>12</td>
<td>11</td>
<td>10</td>
<td>9</td>
<td>19</td>
<td>23</td>
<td>12</td>
<td>7</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>spiral shape</td>
<td>12</td>
<td>9</td>
<td>7</td>
<td>8</td>
<td>19</td>
<td>21</td>
<td>12</td>
<td>7</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>non-spiral shape</td>
<td>0</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>light color</td>
<td>7</td>
<td>2</td>
<td>0</td>
<td>3</td>
<td>5</td>
<td>6</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>dark color</td>
<td>5</td>
<td>9</td>
<td>10</td>
<td>6</td>
<td>14</td>
<td>17</td>
<td>9</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
</tbody>
</table>

*During our field trips*
4. Results

4.1 Collected Data

Collected hermit crabs

<table>
<thead>
<tr>
<th>Hermit crab</th>
<th>Lumen size (mm)</th>
<th>Shell length (mm)</th>
<th>Colour of shell</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5</td>
<td>18</td>
<td>Dark</td>
</tr>
<tr>
<td>2</td>
<td>5</td>
<td>17</td>
<td>Dark</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>20</td>
<td>Dark</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>19</td>
<td>Spiral dark/light</td>
</tr>
<tr>
<td>5</td>
<td>3</td>
<td>19</td>
<td>Dark</td>
</tr>
<tr>
<td>6</td>
<td>5</td>
<td>22</td>
<td>Light</td>
</tr>
<tr>
<td>7</td>
<td>5</td>
<td>18</td>
<td>Dark</td>
</tr>
<tr>
<td>8</td>
<td>6</td>
<td>22</td>
<td>Dark</td>
</tr>
<tr>
<td>9</td>
<td>4</td>
<td>16</td>
<td>Dark</td>
</tr>
<tr>
<td>10</td>
<td>6</td>
<td>24</td>
<td>Dark</td>
</tr>
<tr>
<td>11</td>
<td>6</td>
<td>21</td>
<td>Spiral dark/light</td>
</tr>
<tr>
<td>12</td>
<td>5</td>
<td>21</td>
<td>Spiral dark/light</td>
</tr>
<tr>
<td>13</td>
<td>5</td>
<td>20</td>
<td>Dark</td>
</tr>
<tr>
<td>14</td>
<td>5</td>
<td>20</td>
<td>Dark</td>
</tr>
<tr>
<td>15</td>
<td>2</td>
<td>28</td>
<td>Dark</td>
</tr>
<tr>
<td>16</td>
<td>4</td>
<td>19</td>
<td>Dark</td>
</tr>
<tr>
<td>17</td>
<td>5</td>
<td>16</td>
<td>Spiral dark/light</td>
</tr>
</tbody>
</table>

Fig. 6

Colour of shells

Fig. 7

Among the 17 collected hermit crabs, 71% (12) of them are with dark shells, around 24% (4) are with spiral of dark and light colour shells, only 5% (1) is with light shell. From the data, it reflects that most of the hermit crabs are with dark shells. What is more, it is discovered that the shells of the hermit crabs are similar to the snails shells found nearby, although there are many other sources of "home" for the hermit crabs such plastic bottles, aluminium cans, hermit crabs prefer to tuck in natural snail shells.
4.2 Behaviour of hermit crabs

It is observed that the hermit crabs usually tuck their bodies into the sand to camouflage, but they would also come out from the sand to search for food. They are not really scared of human. Yet, when their bodies are being touched, they would hide themselves inside the shells which act as a protective shelter. Then, they would become active again just in a few minutes. It is discovered that except micro organisms, they would also eat crab food made by shrimp. Under intraspecific competition, when a small pieces of artificial food is placed in front of them, the nearest crab would quickly grab the food although it was not sure if it is eatable.

4.3 Experiments

In the experiments, we have mainly investigate on 2 aspects to explore hermit crab’s behaviour in changing their shells as we noticed that shells are their protective shelters, which are paramount tools to them. The first area is their preference of shells and the second is the time required for them to change their shells under intraspecific competition. For every experiment, we have collected 2 sets of data to increase the accuracy of the results.

Aspect 1: Hermit Crab’s Preference of shells

Hypothesis

We assume that hermit crabs will select shells depending on their lengths of shells rather than the lumen sizes of shells.

4.3.1 Effect of single hermit crab on shell selection of different lengths of shells.

Objectives of experiment 4.3.1

To study the effect of single hermit crab on shell selection of different length of shell. To find out which shell does the hermit crab prefer among 3 shells with different lengths but same lumen size.

Design of experiment:

The control variables of the experiment were the lumen size of 3 shells. Assuming that the temperature and the humidity remain constant. The independent variable of the experiment was
the length of shell while the dependent variable is the hermit crab's preference of the shell.

Set-up:
hermit crab x2
fish tank x2
sand x 120g
seawater x 40g
3 shells with different length and same lumen size x 2 set
1. The distribution of the sand and the water is 2/3 and 1/3 of half of the tank to imitate their living environment near the seashore.

Procedure:
1. A hermit crab is placed in a tank with sand and water provided.
2. Place 3 shells of different sizes with same lumen size, which is 1 cm.
3. Observe and record the result of the preference of the hermit crab after 24 hours.
4. Repeat step 1-3 to record another set of experiment.

Information of hermit crabs before experiments:
1st experiment:
Original shell length of hermit crab: 1.8 cm
Original lumen size of hermit crab: 0.7 cm

2nd experiment:
Original shell length of hermit crab: 2 cm
Original lumen size of hermit crab: 0.5 cm

<table>
<thead>
<tr>
<th>Length of shell provided (cm)</th>
<th>1st Hermit Crab's preference</th>
<th>2nd Hermit Crab's preference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.8</td>
<td>Did not choose</td>
<td>Chosen</td>
</tr>
<tr>
<td>2</td>
<td>Did not choose</td>
<td>Did not choose</td>
</tr>
<tr>
<td>2.2</td>
<td>Chosen</td>
<td>Did not choose</td>
</tr>
</tbody>
</table>
### Percentage change in shell length

<table>
<thead>
<tr>
<th></th>
<th>Experiment 1</th>
<th>Experiment 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Original length of shell (cm)</td>
<td>1.8</td>
<td>2</td>
</tr>
<tr>
<td>Final length of shell chosen (cm)</td>
<td>2.2</td>
<td>1.8</td>
</tr>
<tr>
<td>Percentage change in length of shell (%)</td>
<td>+22.2</td>
<td>-10</td>
</tr>
</tbody>
</table>

**Analysis:**
The hermit crab from the 1st experiment chose the shell with length of 2.2 cm, which is larger than its original shell length of 1.8 cm. For the hermit crab from the 2nd experiment, it chose the shell with 1.8 cm long, which is shorter than its original shell length of 2 cm.

### 4.3.2 Effect of single hermit crab on shell selection of different lumen size of shells.

**Objectives**
To study the effect of single hermit crab on shell selection of different lumen sizes of shell. To find which shell does the hermit crab prefer among 3 shells with vary lumen sizes but same length.

**Design of experiment:**
The control variables of the experiment were the length of shells provided. Assuming that the temperature and the humidity remain constant. The independent variable of the experiment was the lumen size of shells while the dependent variable is the hermit crab's preference of the shell.

**Set-up:**
hermit crab x2  
fish tank x2  
sand x120g  
seawater x40g  
3 shells with different lumen size and same length x 2 set  
1. The distribution of the sand and the water is 2/3 and 1/3 of half of the tank respectively to imitate their living environment near the seashore.

**Procedure:**
1. A hermit crab is placed in a tank with sand and water provided.
2. Place 3 shells of different lumen size with same length, which is 2.4 cm.
3. Observe and record the result of the preference of the hermit crab after 24 hours.
4. Repeat step 1-3 to record another set of experiment.

**Information of hermit crabs before experiments:**
1st experiment:  
Original shell length of hermit crab: 2.6 cm  
Original lumen size of hermit crab: 0.4 cm
2nd experiment:
Original shell length of hermit crab: 2.2 cm
Original lumen size of hermit crab: 0.3 cm

**Result**

<table>
<thead>
<tr>
<th>Lumen size provided(cm)</th>
<th>1st Hermit crab’s preference</th>
<th>2nd Hermit crab’s preference</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.8</td>
<td>Did not choose</td>
<td>Did not choose</td>
</tr>
<tr>
<td>1</td>
<td>Did not choose</td>
<td>Did not choose</td>
</tr>
<tr>
<td>1.3</td>
<td>Chosen</td>
<td>Chosen</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Experiment 1</th>
<th>Experiment 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Original lumen size (cm)</td>
<td>0.4</td>
<td>0.3</td>
</tr>
<tr>
<td>New lumen size (cm)</td>
<td>1.3</td>
<td>1.3</td>
</tr>
<tr>
<td>Percentage change of lumen size (%)</td>
<td>+225</td>
<td>+333</td>
</tr>
</tbody>
</table>

Analysis:
1st and 2nd hermit crab had chosen the shell with lumen size of 1.3 cm, which is larger than its original lumen size of 0.5 and 0.3 cm. The percentage change of lumen sizes is 225% and 333% respectively. This indicates that hermit crab usually change shells depending on their lumen size.

Conclusion of experiment 4.3.1 and 4.3.2
Both experiments indicate that hermit crab will choose shells with larger lumen size than it’s original one. However, it shows that hermit crabs do not necessarily change shells with longer lengths.
4.3.3 Effect of hermit crab on shell selection of lumen size smaller than its original one.

Shells with different lumen sizes

As we find out that hermit crab’s preference of shell depends on the lumen size, we started to ask “Will hermit crab choose shells with a smaller lumen size than its original shell?” Thus, We would like to further proof their favour in lumen size.

Objectives
To study the effect of single hermit crab on shell selection of lumen size smaller than its original lumen size. To investigate whether they will select a smaller lumen size of shell when there is no any other option.

Design of experiment:
The control variables of the experiment were the length of shells provided. Assuming that the temperature and the humidity remain constant. The independent variable of the experiment was the lumen size of shells while the dependent variable is the hermit crab's preference of the shell.

Set-up:
hermit crab x2
fish tank x2
sand x120g
seawater x 40g
3 shells with different smaller lumen size and same length x 2 set

1. The distribution of the sand and the water is 2/3 and 1/3 of half of the tank respectively to imitate their living environment near the seashore.

Procedure:
1. A hermit crab is placed in a tank with sand and water provided.
2. Place 3 shells of different lumen size with same length, which is 1.5cm.
3. Observe and record the result of the preference of the hermit crab after 24 hours.

4. Repeat step 1-3 to record another set of experiment.

Information of hermit crabs before experiments:
1\textsuperscript{st} experiment:
Original shell length of hermit crab: 1.8 cm
Original lumen size of hermit crab: 0.7 cm

2\textsuperscript{nd} experiment:
Original shell length of hermit crab: 1.7 cm
Original lumen size of hermit crab: 0.7 cm

Result:

<table>
<thead>
<tr>
<th>Lumen size provided (cm)</th>
<th>1st Hermit crab</th>
<th>2nd Hermit crab</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.3</td>
<td>Did not choose</td>
<td>Did not choose</td>
</tr>
<tr>
<td>0.4</td>
<td>Did not choose</td>
<td>Did not choose</td>
</tr>
<tr>
<td>0.5</td>
<td>Did not choose</td>
<td>Did not choose</td>
</tr>
</tbody>
</table>

Analysis:
From the above we can see that hermit crabs do not prefer shells with lumen sizes smaller than its own one. We can clearly see that a larger lumen size is a vital factor that deter their selection of shells.

\textbf{Aspect 2: Time required to change shells under competition}

\textbf{Hypothesis}: We assume that hermit crabs will change shells in a shorter period of time under intraspecific competition than without competition.

\textbf{4.3.4 Effect of intraspecific competition on time required for shell selection.}

\textbf{Objectives}
To study the effect of hermit crabs on shell selection under competition. To find out how long would the hermit crab(s) take to choose among the 3 shells.

\textbf{Design of experiment:}
The control variables of the experiment were the lumen size of 1 shell. Assuming that the temperature and the humidity remain constant. The independent variable of the experiment was the number of hermit crabs while the dependent variable is the hermit crab's preference of the shell and time required for it to change.

\textbf{Set-up:}
hermit crab x6
fish tank x4
sand x120g x4 set
seawater x40g x 4 set
1 shell x 4 set
1. The distribution of the sand and the water is 2/3 and 1/3 of half of the tank to imitate their living environment near the seashore.

Procedure:
1. Place 2 hermit crabs of similar size in a tank with sand and water provided.
2. Place 1 shell of lumen sizes bigger than that of the hermit crabs.
3. Observe and record the time required for the hermit crab to change shell under competition.
4. Repeat step 1-3 to record another set.
5. Prepare another set up with only 1 hermit crab in a tank.
6. Observe and record the time required for the hermit crab to change shell
7. Repeat step 5-6 and record the result.

Fig. 18

Result:

<table>
<thead>
<tr>
<th>Tank</th>
<th>The number of crabs in the tank</th>
<th>Time required to change shell (h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A with competition</td>
<td>2</td>
<td>2.30</td>
</tr>
<tr>
<td>B with competition</td>
<td>2</td>
<td>1.52</td>
</tr>
<tr>
<td>C without competition</td>
<td>1</td>
<td>4.92</td>
</tr>
<tr>
<td>D without competition</td>
<td>1</td>
<td>5.03</td>
</tr>
</tbody>
</table>

Analysis:
From the above results, we can conclude that the time required for hermit crabs to change shells would be shorter when there is intraspecific competition.
5. Discussion
5.1 Discussion on objective 1- Effect of shell size on shell selection

In this project, we study on the relationship between the length and lumen sizes of shells and the hermit crabs’ preferences on shell selection. From experiment 4.3.1-4.3.2, we find out that hermit crabs’ preferences of shells depend on mainly the lumen sizes rather than the lengths of the shells. Through experiment 4.3.3, we noticed that hermit crabs prefer larger lumen sizes than smaller ones. A larger space is essential for their rapid body growth. The differences in lumen sizes of their original and new shells may seem insignificant to us. Yet, it is discernible that even a change as little as 0.1cm in lumen sizes will greatly affect their choices of shells. If the shell cannot provide sufficient space for them to live in and at the same time they cannot select any favourable shells, they will be homeless and eventually die. Thus, it is an important discovery for us to know that hermit crabs do not enter shells at random, but select shells mainly according to the lumen sizes, which will greatly affect their willingness to change shells and their chances of living.

5.2 Discussion on objective 2- Intraspecific competition of hermit crab on shell selection

From experiment 4.3.4, we could see that the effect of intraspecific competition of hermit crab on time required to select shell is significant. The more the hermit crabs, in other words, the more intense the intraspecific competition, the faster the hermit crabs change its shell.

In this experiment tank A, a pair of hermit crab is placed in the same tank with only one extra shell placed, given that the lumen size of this new shell is larger than both hermit crabs’ initial one. With the presence of the other hermit crab, hermit crab 1 takes 2 hours 18 minutes to change its shell. A replicas is done in tank B, also two hermit crabs are placed there with only one extra shell placed, given that the lumen size of this new shell is larger than both hermit crabs’ initial one. Similar result is obtained that with the presence of the other hermit crab, hermit crab takes even shorter time, 1 hour 31 minutes to change its shell.

Whereas in tank C & D given the condition is without intraspecific competition, only one crab is placed per tank, both hermit crab 5 & 6 in tank C & D respectively, with one extra shell, given that the lumen size of this new shell is larger than both hermit crabs’ initial one, is placed per tank as well. Hermit crab 5 took 4 hours 55 minutes while hermit crab 6 took 5 hours 2 minutes to change its shell to the given one in the tank.

The mean time of hermit crab changes its shell under intraspecific competition is considered as 1 hour 55 minutes, while without competition is 4 hours 59 minutes. By the mean time, hermit crab not under intraspecific competition, takes 2.7times of the duration required to change shell under intraspecific competition. Therefore, under intraspecific competition, the hermit crab takes a shorter duration to change its shell.
5.3 Limitations

- Sampling size of the experiment is limited. During the first field trip, we were not able to collect enough hermit crabs even it was the lowest tide on that day, because the lower intertidal zone is narrow, it increased the difficulties for us to find hermit crabs.

- No suitable shells. We are not able to collect suitable shells for the experiments from the beach. Most of the shells collected are too small, some of the lumens are even blocked and the shells are too similar in terms of length or lumen sizes. Therefore the above factors limit the availability of samples and resources for carrying out more experiments to increase the reliability of the results.

- Habitat limitation. A perfect environmental condition could not be provided to the hermit crabs. Experiments are carried out in tanks, only temperature are being kept constant, however humidity is not a constant, the seawater evaporated and sand became dry, which may affect the behaviour of hermit crabs and bring minor impacts on the results.

5.4 Improvements:

- Increase the sample size by increasing number of field trips. Moreover, except checking the tidal information of any days, we should also consider the age of tide. During the highest astronomical Tide which is the perigean spring tide when both the sun and the moon are closest to the Earth, the tidal range is the largest causing tidal differences of inches at most. In this period of time, the lower intertidal zone is wider which would be more favourable for us to collect a larger sample size.

- Buy suitable shells from stores. As no suitable shells can be found on the beach, we have to buy from the stores which can provide relatively larger shells with different length and lumen size for our investigation.

- Add seawater to the tank periodically to maintain a constant humidity and provide a similar environment to the hermit crabs to increase the reliability of results.

5.5 Possible errors:

- The size of the hermit crabs collected from the beach are not exactly the same, which may causes errors in the experiments on hermit crabs shell selection under intraspecific competition. As two hermit crabs of slightly different sizes are placed in the same tank to compete for one shell, the perception of the lumen size of the provided shell may be different to each hermit crab, affecting their willingness to change their shells. Therefore, the accuracy of the results would decrease.

- Also, since hermit crab 1 & 3 have already occupied a new shell in tank A & B respectively, so both of them cannot be used repeatedly in tank C & D for the experiment of shell selection without intraspecific competition. It is assumed that they have already
occupied a new shell that they prefer, and are less likely to change to another shell if placed in tank C & D.

5.6 Conclusion

After conducting all the experiments, there could be two main ideas about the hermit crabs could be concluded.

Firstly, hermit crabs are more likely to choose shells with larger lumen size than their original ones. However, hermit crabs do not necessarily change shells with longer lengths than the original one.

Secondly, the time required for the hermit crabs to change their shells is shorter when they are under intraspecific competition.
6. Bibliography

1. Description and articles about *Diogenes pugilator*
   http://eol.org/pages/2949954/details

2. Choosing shells for your hermit crabs
   http://exoticpets.about.com/od/hermitcrabs/qt/hcshells.htm

3. Hermit crab in glass shells
   https://www.youtube.com/watch?v=DaU5etPejZA

4. Tide
   http://en.wikipedia.org/wiki/Tide#Timing

5. Habitat of hermit crab
   http://www.hkfishbook.com/articles/60455