Searching for Nature Stories 2017

# Fight or Flight

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# Content

# 1. Abstract

Fig. 1 *Monodonta labio*

Fig. 2 *Monodonta labio* collected from the field trip site

*Monodonta labio*, with the common name toothed top shell snail, are usually seen in groups on boulders, stones and seawalls. The shell length of *Monodonta labio* is around 2-4 cm, and is usually in dome-like shape. The body is pale with long tentacles at the edge and the head.

The objectives of this project are to study the effect of wave action on the motility and distribution of *Monodonta labio*.

*Monodonta labio* were collected in Tung Chung Bay, Tung Chung. Experiments on the above objectives are carried out in the school laboratory. Their behaviour and results of the experiments were observed and recorded throughout the whole process.

After collecting the experimental results, it is observed that *Monodonta labio* shows greater motility when there is wave. However, there is no significant difference between their degree of motility with different strength of wave action. Moreover, *Monodonta labio* tend to move to areas that provide shelter for them.

# 2. Introduction

## 2.1 Introduction of research topic

*Monodonta labio* is a herbivorous sea snail which feeds on microalgae. They possess muscular foot for locomotion and anchorage. During our field trip, it was observed that they tend to stay on rocks and barely show any movement under ocean waves. This shows that attachment is important in protecting them from being washed away by wave. However, they can also choose to move to an area that they can be protected from wave action. We are interested to find out how they respond to wave action by choosing between motility and attachment. Hence, this report mainly focuses on the effect of wave actions on the motility and distribution of *Monodonta labio*. Experiments were designed to find out how *Monodonta labio* behave under different amplitudes of water waves.

## 2.2 Objectives of investigation

Objective 1:
To study the effect of amplitude of water waves on motility of *Monodonta labio*.

Objective 2:
To study the effect of amplitude of water waves on distribution of *Monodonta labio*.

## 2.3 Background information of *Monodonta labio*

*2.3.1 Classification*

| | |
|---|---|
| **Kingdom** | Animalia |
| **Phylum** | Mollusca |
| **Class** | Gastropoda |
| **Subclass** | Vetigastropoda |
| **Superfamily** | Trochoidea |
| **Family** | Trochidae |
| **Subfamily** | Monodontinae |
| **Genus** | Monodonta |
| **Species** | *Monodonta labio* |

*2.3.2 Description*

*Monodonta labio*, with a common name as toothed topshell or the lipped periwinkle, is a type of herbivorous sea snail. It has shell with rough, grained surface with moderate sutures between rounded whorls. The colour of shells varies from a dark reddish brown to pale brown, with spiraled dashes of cream or pink. Like all mollusks, it has a muscular foot used for locomotion and anchorage. Its foot is

usually the same size as the opening of the shell, and is a retractable as well as extendable organ.

*2.3.3 Distribution*

Central and East Indian Ocean, Indo-China, Indo-Malaysian Oceania, the Philippines, the Persian Gulf, West Indian Ocean to Micronesia, Western Pacific, Micronesia and Australia (Northern Territory, Queensland, Western Australia).

Fig. 3 Global distribution of *Monodonta labio*

# 3. Materials and Methods

## 3.1 Working schedule

| Date | Time | Field Trip | Venue | Event |
|---|---|---|---|---|
| 25/02/2017 | 08:00-10:00 | Field Trip (1) | Tung Chung Bay, Tung Chung | Analysis of habitat of *Monodonta labio* |
| 11/03/2017 | 08:30-11:00 | Field Trip (2) | Tung Chung Bay, Tung Chung | Collection of *Monodonta labio* |

## 3.2 Collection of *Monodonta labio*


Fig. 4 Location of sample collection

Fig. 5 Nearby areas of the field site

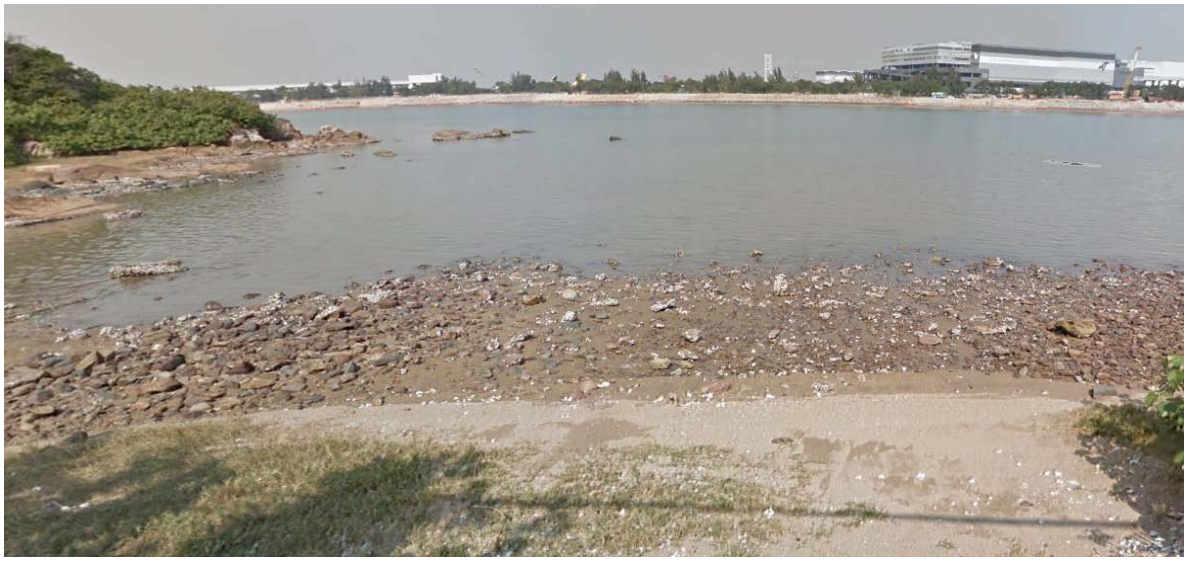

Fig. 6 Picture showing the habitat of *Monodonta labio*

*3.2.1 Field site information*

| Abiotic Factor | Data collected during field study |
|---|---|
| Air temperature | 20 degrees Celsius |
| Water temperature | 18.5 degrees Celsius |
| Light intensity | 8340 lux |
| Wind speed | 4.5m/s |
| Wind direction | from NE to SW |
| pH | 6 |
| Water current speed | 0.25m/s |
| Humidity | 86% |
| Salinity | 30 ppm |

*3.2.2 Field trip equipments for species sampling*

| Equipment | Quantity |
|---|---|
| Gloves | 8 |
| Forceps | 1 |
| Tank | 1 |
| Zip-loc bag | 2 |

*3.2.3 Field trip equipments for measuring abiotic factors*

| Abiotic Factor | Equipment | Description |
|---|---|---|
| Air temperature | Digital thermometer | To measure the air temperature |
| Water temperature | Digital thermometer | To measure the water temperature |
| Light intensity | Photometer | To measure the light intensity |
| Wind speed | Anemometer | To measure the wind speed |
| Wind direction | Compass | To determine the wind direction |
| pH value of water | pH paper and pH color chart | To measure the pH value |
| Water speed | Anemometer | To measure the wind speed |
| Relative Humidity | Hand-held whirling hygrometer | To measure the relative humidity of the air |
| Salinity | Refractometer | To measure the salinity of water |

During our field trip

*Monodonta labio* at the field site

Collected *Monodonta labio* placed in school laboratory

# 4. Results

## 4.1 Design of experiment

16 *Monodonta labio* were collected from the field site. In the experiment, they were placed in 5 different zones with varying environmental conditions. A robotic paddle, which is driven by a LEGO EV3 large servo motor, is programmed to swing at different angles to vary the amplitude of water waves using the LEGO MINDSTORMS software. The unit of power of the robotic paddle is presented as the percentage of its maximum power output.–A camera is used to capture the movement and distribution of the *Monodonta labio* under the action of a certain amplitude of waves in 20 minutes. The table below shows the controlled variables, independent variables and dependent variables of this investigation.

| | |
|---|---|
| **Controlled variables** | - Dimensions of tank<br>- Salinity of water in tank<br>- Volume of water in tank<br>- Temperature of water in tank<br>- Dimensions of robotic pedal<br>- Position of rocks in the tank<br>- Number and colour of the rocks in the tank<br>- Light intensity<br>- Number of *Monodonta labio* in each zone |
| **Independent variable** | - Amplitude of water waves |
| **Dependent variables** | - Motility of *Monodonta labio* measured by the number of *Monodonta labio* that shows movement (Objective 1)<br>- Distribution pattern of *Monodonta labio* measured by the number of *Monodonta labio* found in different zones (Objective 2) |

*Table 1 Variable Table*

### *4.1.1 Assumptions*

Assumption 1

The amplitude of the wave is the only factor affecting the *Monodonta labio*'s choice between attachment and motility. The size, age and development stage does not affect its choices and movement pattern. All *Monodonta labio* can display movement according to its free will.

Reasoning: In the investigation, except for the amplitude of the waves, other variables are kept constant in different setups.

Assumption 2

The *Monodonta labio*'s choice between attachment and motility and their movement pattern during the investigation in school laboratory are similar to the behaviour they exhibit in their natural habitats.

Reasoning: The setup of the tank simulates the natural environment that encourages *Monodonta labio* to respond naturally to external environmental changes.

*4.1.2 Apparatus and materials used for experiments*

| **Apparatus** | **Quantity** | **Purpose** |
|---|---|---|
| 10”x16”x10” Tank | 1 | Holding the *Monodonta labio* |
| Robotic paddle | 1 | Controlling the frequency and amplitude of water waves |
| Stopwatch | 1 | Measuring the duration allowed for the experiment |
| Electronic balance | 1 | Weighing amount of salt to be used in preparing salt water |
| Glass rod | 2 | Mixing salt and distilled water |
| Beaker (500mL) | 2 | Transferring water to tank |
| Bucket (3L) | 2 | Holding and storing salt water |
| Camera | 1 | Filming the movements of *Monodonta labio* |
| Gloves | 8 | Transferring the *Monodonta labio* between various locations |
| Seawater (obtained from Tung Chung Bay) | 1L | To be put in the tank for the survival of *Monodonta labio* |
| Stones (obtained from Tung Chung Bay) | 4 | To imitate the natural environment of *Monodonta labio* |
| Distilled water | 6L | To dissolve the sea salt to make salt |

| | | |
|---|---|---|
| | | water |
| Sea salt | 180g | To dissolve in distilled water to make salt water |
| Sand | 2kg | To secure the position of the stones |

*4.1.3 Setup of experiment*

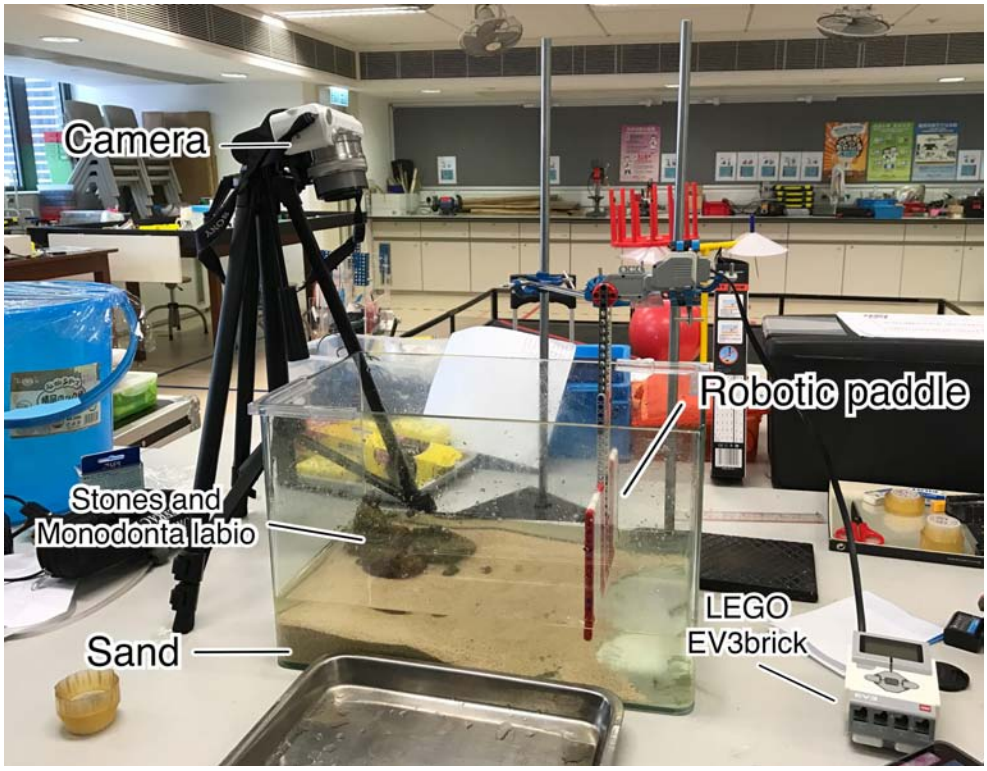


Fig. 7 Setup of experiment

Fig. 8 The different zones for the initial distribution of *Monodonta labio* in experiment

| **Zone** | **Number of *Monodonta labio* to be placed** | **Description** | **Characteristics** |
|---|---|---|---|
| 1 | 2 | Area near the top of the elevated rock | Out of water, not exposed to wave motion |
| 2 | 4 | Area that provides shelter | In water, not exposed to wave motion, surrounded by a few rocks |
| 3 | 3 | Area in front of the rocks | In water, exposed to wave motion |
| 4 | 3 | Area between the wall of tank and the rocks | In water, not exposed to wave motion, surrounded by less rocks |
| 5 | 4 | Area near the top of a rock | Out of water, exposed to wave motion |

## 4.2 Objective 1: To study the effect of amplitude of water wave on motility of *Monodonta labio*

*4.2.1 Hypothesis*

The greater the amplitude of water wave, the less active *Monodonta labio* is.

*4.2.2 Procedures*

1. Set up the tank with water level of 7 cm and sand level of 3cm seawater of salinity 3.8 ppt.
2. Set up the robotic paddle in the tank according to fig. 7.
3. Place the 16 *Monodonta labio* in Zone 1 - 5 according to fig. 8.
4. Record the number of *Monodonta labio* that showed movement in 2 minutes.
5. Repeat step 4 for 2 more times.
6. Switch on the robotic paddle and set its power as 35% and its angle as 10 degrees.
7. Measure the amplitude of the wave.
8. Repeat steps 4-5.
9. Repeat steps 6-8 by varying the robotic paddle's power and angle as 35% and 15 degrees, and 40% and 15 degrees respectively.

*4.2.3 Collected data*

| Amplitude of wave (cm) | Number of *Monodonta labio* showed movement in the first two minutes under wave action | | | |
|---|---|---|---|---|
| | 1st reading | 2nd reading | 3rd reading | Average |
| 0 | 2 | 2 | 0 | 1 |
| 0.5 | 4 | 3 | 5 | 4 |
| 1.5 | 3 | 3 | 3 | 3 |
| 3 | 8 | 0 | 1 | 3 |

*Table 2*

Analysis:

The *Monodonta labio* tends to attach to the rock and show no movement when there is no wave. They tend to move when there is wave, however, no significant difference between their degree of motility with different strength of wave action is observed.


Fig. 9 A photo taken during the experiment

**4.3 Objective 2: To find out the effect of amplitude of water waves on distribution of *Monodonta labio***

*4.3.1 Hypothesis*

*Monodonta labio* will tend to choose to move to an area that is out of water and away from wave action.

*4.3.2 Procedures*

1. Set up the tank with water level of 7 cm and sand level of 3cm seawater of salinity 3.8 ppt.
2. Set up the robotic paddle in the tank according to fig. 7.
3. Place the 16 *Monodonta labio* in Zone 1 - 5 according to fig. 8.
4. Record the number of *Monodonta labio* in each zone after 20 minutes.
5. Switch on the robotic paddle and set its power as 35% and its angle as 10 degrees.
6. Measure the amplitude of the wave.
7. Record the number of *Monodonta labio* in each zone after 20 minutes.
8. Repeat steps 5-7 by varying the robotic paddle's power and angle as 35% and 15 degrees, and 40% and 15 degrees respectively.

*4.3.3 Collected data*

| Amplitude of water wave (cm) | Number of *Monodonta labio* in different zones after exposing to 20 minutes of wave action | | | | |
|---|---|---|---|---|---|
| | Zone 1[1] | Zone 2[2] | Zone 3[3] | Zone 4[4] | Zone 5[5] |
| 0 | 3 | 3 | 2 | 5 | 3 |
| 0.5 | 1 | 7 | 5 | 2 | 1 |
| 1.5 | 0 | 9 | 5 | 1 | 1 |
| 3 | 0 | 10 | 4 | 0 | 1 |

*Table 3*

Analysis:

The distribution of *Monodonta labio* is more or less the same as those at the start when there is no wave. When the amplitude of water waves increases, more *Monodonta labio* are found in zone 2 which is surrounded by rocks and is not exposed to wave motion.

Fig. 10 Result of the experiment with amplitude of 3cm

[1] Out of water, not exposed to wave motion
[2] In water, not exposed to wave motion, surrounded by a few rocks
[3] In water, exposed to wave motion
[4] In water, not exposed to wave motion, surrounded by less rocks
[5] Out of water, exposed to wave motion

# 5. Discussion

## 5.1 Discussion on objective 1: To study the effect of amplitude of water waves on motility of *Monodonta labio*

The greater the amplitude of water waves, the stronger the force and direct wave action acted on *Monodonta labio*. From *Table 2*, *Monodonta labio* showed movement when there is wave and showed insignificant movement when there is no wave. Contrary to what we expected, when the amplitude of waves increases from 0cm to 3cm, *Monodonta labio* are more active. When facing natural ocean waves, it is observed that *Monodonta labio* would attach to rocks without much movement. Hence, it was deduced that they would use their muscular foot for anchorage and hold onto the surface when facing stronger water waves. However, there is an increase in motility of *Monodonta labio* when there is a greater amplitude of water wave.

In addition, there is no significant difference between their degree of motility with different strength of wave action so this only proves that they tend to move when there is wave. This unexpected finding draws our attention and we would like to carry out further investigation on how they move or how their positions differ when facing stronger water waves, which leads to objective two.

## 5.2 Discussion on objective 2: To find out the effect of amplitude of water waves on distribution of *Monodonta labio*

It is expected that *Monodonta labio* would prefer to stay out of water and not being exposed to wave motion (Zone 5). During the collection of *Monodonta labio*, it was noticed that they tend to stay out of water, attaching to the surface of the rocks. Hence, the hypothesis was the *Monodonta labio* tend to stay out of water to minimize the disturbance of water waves on them.

From *Table 3*, when the amplitude of water waves increases from 0cm to 3cm, more *Monodonta labio* is concentrated in Zone 2, which is in the water, surrounded by rocks and not exposed to wave motion.

When the amplitude of water wave is increased, *Monodonta labio* use their muscular foot for locomotion and move to a better protected area. The results show that they prefer to stay in areas in water and surrounded by rocks instead of areas out of water. It is because by gathering in an area surrounded by rocks, it provides shelter and protection and lowers the effect of water waves on them. On the other hand, in areas without rocks, they cannot gain anchorage on the sand surface. The effect of water wave on them is stronger as nothing is there to block the splashes

and swirlings of water waves. Therefore, it is observed that *Monodonta labio* tends to stay under water and seek protection when they choose a shelter.

## 5.3 Limitations

Due to the limited number of *Monodonta labio* collected from the site, the sample size is comparatively small. Moreover, a relatively small tank and only a few rocks are used, hence the number of zones is restricted to five. It is difficult to simulate all the possible environmental conditions in nature. As a result, the reliability of the results is lowered.

The movement pattern of *Monodonta labio* may be affected by the man-made environment. Since the experiment is carried out in a laboratory, not all the aspects of the natural environment can be set up. In nature, waves are likely not to be completely uniform. Therefore the behaviour of *Monodonta labio* in the experiment may be different from its natural behaviour.

Also, the experimental setup fails to provide much nutrients when compared to the natural environment. Since *Monodonta labio* feed on microalgae, it was difficult to provide them with suitable food during the experiments. The shortage of food supply for the *Monodonta labio* may affect their movement pattern as they may lack energy for anchorage with their muscular foot, which leads them to choose a protected shelter under water rather than staying in out-of-water areas. This lowers the reliability of the experimental results.

The rocks collected are relatively small and have rather smooth surface. In the natural habitat of *Monodonta labio*, the stones are larger in size and have more irregular shapes. This provides larger gaps in between stones for better protection. When choosing a protected shelter, wIthout these large gaps, *Monodonta labio* have no choice but to choose the area surrounded with rocks.

The solution prepared contains salt water mixed with small amounts of seawater from the site. Consequently, the solution may not contain minerals and other chemical substances in the same concentration as sea water. The accuracy of the results may also be reduced.

## 5.4 Sources of error

Due to the constraint of the tank size, water waves bounce back from the wall of the tank, which may affect the formation of waveform by the robotic paddle. Moreover, the rocks are positioned near the end wall. The waves that are formed at

the back end of the wall may directly interrupt the *Monodonta labio* and may disrupt the movement pattern of the *Monodonta labio*.

With the repeated trials, the *Monodonta labio* may be overloaded and become less sensitive and active to the change in amplitude of the waves.

## 5.5 Suggestions for improvement

The sample size of the *Monodonta labio* can be increased by going to the field site for a few more times and collect more samples. A larger tank can be used and the rocks can be placed further away from the wall of the tank. Equilibration time can be given to the *Monodonta labio* for them to adjust to the new amplitude of the waves before collecting data.

## 5.6 Further investigations

*Further investigation 1*

**What are the other factors affecting the motility of *Monodonta labio*?**

The water speed in the sea is much faster than our experimental setup. From our experiment, the *Monodonta labio* have different degree of motility in different amplitude, hence, we would like to investigate whether other factors, such as the water speed, will affect their degree of motility.

*Further investigation 2*

**What are the other factors affecting the choice of shelter of *Monodonta labio*?**

From our investigation, it was observed that *Monodonta labio* tends to stay in a protected area. We would like to find out more about what other factors may affect their choice, for instance, the size of shelter.

*Further investigation 3*

**Does motility of *Monodonta labio* vary in different seasons?**

Our experiments were conducted within a week, which is a rather short period of time. Hence, we were not able to draw any conclusion about the change in motility of *Monodonta labio* in various seasons. We are interested in finding more about this inquiry question. Another experiment with a longer experimental period, such as a year, allows us to observe their change in motility in a longer period of time.

*Further investigation 4*

**Does motility of *Monodonta labio* differ between day and night?**

The experiments were conducted during the daytime at the school laboratory. However, *Monodonta labio* may have different degree of motility during various time periods. For example, it may be more active during the daytime as they have to find

food and less active at nighttime after finding a shelter. Further investigations can be done to find out more about this topic.

## 6. Conclusion

The experimental results show that the *Monodonta labio* tend to attach to the rock and and show more movement when there is a wave. However, there is no significant difference between their degree of motility with different strength of wave action.

Secondly, *Monodonta labio* tend to move to area that is in the water, surrounded by rocks and is not exposed to wave motion when there is a wave.

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