Searching for Nature Stories 2013
Investigative Field Study Competition
Report

Team 35: St. Paul's Secondary School

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Project title

The Blue Soldiers in Mangrove Habitat

Content

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1. Abstract

In this project, we would like to investigate the effect of increasing the salinity of saline (salt solution) on the behaviour of soldier crabs (*Mictyris longicarpus* 長腕和尚蟹) in choosing a shelter place. Soldier crabs are very common on Hong Kong mudflats where the salinity is very high. In our investigation, five different salinities of saline were tested. One of it was seawater.

A number of soldier crabs were caught for the investigation. They were placed in a plastic tray with saline added. Some stones were placed on one side in the tray to represent the on shore environment. The soldier crabs moved around freely and chose their own shelter. The number of soldier crabs that stayed on shore was recorded at every 15-second interval for 2 minutes.

From the results, we found that the higher the salinity of saline, the smaller number of the soldier crabs chose to stay on shore and the larger number of them chose to stay in saline. Therefore, we conclude that more soldier crabs would prefer to remain in aquatic environment when the salinity of saline increases. Moreover, the soldier crabs can survive in an extreme range of salinity and still retain certain degree of the freedom of movement.

(A soldier crab)

2. Introduction

Soldier crabs are invertebrates that belong to the family Mictyridae and the genus *Mictyris*. As the tide ebbs, hundreds of adult crabs emerge to forage. Soldier crabs are commonly found in mangrove and sandy shore, only a few are found in freshwater. A major difference of these habitats is the salinity. It is higher in the mangrove and sandy shore than in the freshwater. Studies reveal that they can withstand a wide range of salinities. Mangrove habitat supports numerous plant and animal species. They provide breeding and resting place for migratory birds as well as shore crabs like soldier crabs. In this investigation, we would like to investigate the influence of increasing salinity of saline on the choice of shelter place for soldier crabs.

We visited Sai Keng (mangrove habitat) on 16th March, 2013 (3 - 8 p.m.) to conduct preliminary tests. On 28th March, 2013 (2 - 6:30 p.m.), we visited the same place again to carry out the experiments, with an average air temperature 18.8℃, sea water temperature 20℃, rainfall 31.4 mm and relative humidity 89%-99%. It was a dim and rainy day with low light intensity.

The soldier crabs caught for the investigation are classified as follows:

Phylum	- Arthopoda
Subphylum	- Crustacea
Order	- Decapoda
Family	- Mictyridae
Genus	- *Mictyris*
Species	- *longicarpus*

Objective:

To investigate the effect of increasing salinity of saline on the behaviour of soldier crabs (*Mictyris longicarpus)* in choosing a shelter place.

Biological principle:

Biologists usually think that an organism inhabits in a habitat because it possesses some adaptive features which allow it to well adapt to the habitat. Soldier crabs are commonly found in mangrove habitat where the salinity of sea water is high. From this observation, people may postulate that soldier crabs can survive under high salinity. In this investigation we would like to justify this hypothesis by investigating whether the soldier crabs could stay in saline with extreme high salinity. The investigation was performed by finding out the number of soldier crabs that would stay in saline with different salinities.

Mictyris longicarpus is a common species in Hong Kong mudflats. Five different salinities of saline including that of seawater were provided to the crabs. They were put into a tray with small stones placed on one side to represent the on shore shelter. Saline was added to represent the sea water condition. The number of soldier crabs that remained on the stones was counted at fixed time intervals.

Throughout the investigation, some variables were kept constant. They included the volume of saline, the number of soldier crabs, the brand of salt, the temperature of saline, light intensity, the type, size and number of stones and the time for equilibration. The following table summarizes the investigational variables:

Variable table:

Independent variable	**Dependent variable**	**Controlled variable(s)**
The salinity of saline	The number of soldier crabs that remain on shore	- The volume of saline - The number of soldier crabs - The brand of salt - The temperature of saline - Light intensity - The type, size and number of stones - The equilibration time (2 minutes)

Assumptions:

A number of assumptions were made before conducting the investigation:

We assume that smaller the number of soldier crabs on shore, the more favorable the salinity of saline for them. This is because if the salinity is unfavorable, they will move on shore to escape from the unfavorable condition.

We assume that salinity is the only factor affecting the choice of shelter for the soldier crabs as the saline solutions differ by salinity only. During the investigation, the temperature and light intensity remained rather constant. In addition, we assume that the amount of dissolved oxygen in the saline does not affect the breathing of soldier crabs as they mainly depend on lungs for breathing.

We also assume that all soldier crabs caught for the investigation were able to move freely on shore or in saline with different salinities. They would stabilize themselves within the two minutes of equilibration and react to the salinity in the external environment by their physical movements.

Finally we assume that the behaviour of soldier crabs in the tray was the same as they were in their natural habitats. Each soldier crab will choose its own shelter place independently without any influence from other individuals and does not display flocking instinct in the investigation (flocking instinct is the association of individuals to stick together to form larger groups). Moreover, the developmental stage of soldier crabs (whether young or mature forms) would not affect its choice of shelter place.

3. Apparatus, materials and chemicals

Apparatus:

Apparatus	Quantity
Stopwatch	1
Plastic tray	1
Plastic partition	2
A pair of tongs	1
Beaker (500 mL)	4
Beaker (1000 mL)	2
Wash bottle	1
Electronic balance	1
Thermometer	1
Spade	2
Bucket	2
Sieve	1
Spoon	1
Glass rod	1
Camera	1

Material and chemicals:

(a) 15 *Mictyris longicarpus* (長腕和尚蟹)
(b) 5 L of distilled water
(c) 1 L of sea water
(d) Table salt
(e) Small stones

4. Procedure

	
1. Map of Sai Keng	**2. Mangrove habitat in Sai Keng**
	
3. Small round pellets of sand made by soldier crabs	**4. Soldier crabs caught in a sieve**
	
5. Mobility possessed by the soldier crabs	**6. Soldier crabs washed with distilled water after each trial**
	
7. Small stones put in the plastic tray	**8. Soldier crabs caught**

	
9. Saline preparation using table salt and distilled water	**10. Temperature measurement**
	
11. Set-up with small stones on one side and saline is poured into the tray.	**12. Counting the number of soldier crabs on shore in each trial.**

1. More than 15 soldier crabs were collected from the mangrove site by using a spade, a sieve and a bucket.

2. By using an electronic balance for measurement, 40 g table salt was added to a beaker with 1 L distilled water and stirred with a glass rod. The salinity of the resulting saline is 40 ppt (parts per thousand).
3. Step 3 was repeated using 80 g, 120 g and 160 g table salt to produce saline with 80 ppt, 120 ppt and 160 ppt salinity respectively.
4. Another beaker was used to collect 1 L sea water from the habitat.

5. A plastic tray was filled with 1 L saline (salinity 40 ppt) and some stones were added to one side of the tray to form an on shore shelter as shown below. The stone surfaces were not submerged in the saline and exposed to the air.


6. The temperature of the saline and air temperature were measured.
7. 15 soldier crabs were placed to one side of the tray and a plastic partition was used to block the soldier crabs and acted as a set off line.


8. 2 minutes equilibration time was allowed for the soldier crabs to stabilize in the salinity of the saline.
9. After 2 minutes, the plastic partition was removed and the stopwatch was started.
10. The number of soldier crabs that stayed on the shore was recorded for every 15 second intervals for 2 minutes.
11. The counting was repeated for 3 times for taking the average.
12. Before starting with another saline, the previous saline was disposed and the set-up, the stones and the soldier crabs were rinsed with distilled water.
13. Steps 5 to 12 were repeated for other salinities (80 ppt, 120 ppt, 160 ppt) and sea water (35 ppt).

Precautions:

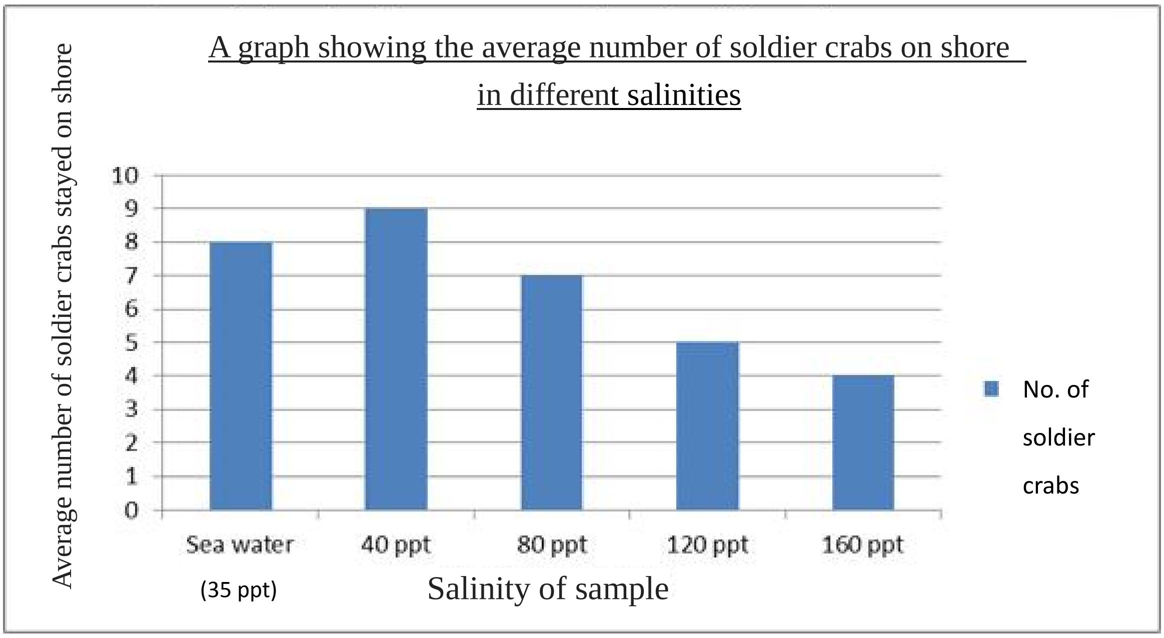
All apparatus, stones and soldier crabs used in the investigation should be rinsed with distilled water before a new saline is added to avoid contamination. After adding the salt to distilled water, thorough stirring is required to ensure an even salinity of saline. Before each trial, the soldier crabs should be carefully examined to ensure that they remain viable and active.

Moreover, the setting of the stones should be the same for all trials and the stones chosen should be of the same type, size and number and suitable for the soldier crabs to step on.

5. Results

A table showing the number of soldier crabs on shore at every15 s interval in different salinities

			Time (second)								Average number of soldier crabs on shore in a 2-min course	Average number of soldier crabs on shore in a 2-min course
			15	30	45	60	75	90	105	120		
Salinities of sample	40 ppt saline	Trial 1	9	9	8	10	7	7	7	6	7.9	9
		Trial 2	10	11	6	9	9	12	12	10	9.9	
		Trial 3	7	8	8	10	10	8	7	6	8	
	80 ppt saline	Trial 1	6	8	8	6	7	7	5	5	6.5	7
		Trial 2	6	7	7	7	8	8	7	5	6.9	
		Trial 3	7	8	7	7	6	8	6	6	6.9	
	120 ppt saline	Trial 1	4	6	5	4	6	6	4	3	4.8	5
		Trial 2	3	4	4	3	4	6	5	4	4.1	
		Trial 3	4	5	4	5	7	7	5	5	5.3	
	160 ppt saline	Trial 1	3	2	4	3	4	2	5	3	3.3	4
		Trial 2	4	3	4	5	4	3	4	4	3.9	
		Trial 3	5	3	3	3	5	4	3	3	3.6	
	Sea water (35 ppt)	Trial 1	10	12	8	8	7	8	9	10	9.0	8
		Trial 2	8	10	9	7	9	7	7	6	7.9	
		Trial 3	7	7	10	10	9	10	8	6	8.4	



A graph showing the average number of soldier crabs on shore in different salinities

6. Discussion

Interpretation of result

From the bar chart obtained, the number of soldier crabs that stay on shore decreases when the salinity of saline increases. Therefore, more soldier crabs would prefer to remain in aquatic environment when the salinity of saline increases.

Unlike most of the arthropods, soldier crabs depend on lungs for respiration. About 90% of oxygen intake is through their lungs. The lungs and gills are situated in a chamber in the thorax, with the upper part of the thoracic cavity occupied by the lungs. The oxygen enters the body through a hole in the forward part of the carapace. The animal can breathe in air both in and out of water. By careful observation we noticed that the crabs would try to lift up their carapace above the saline surface, especially for the young crabs with smaller body size and also shorter appendages. These young crabs tried to lift up their body vertically by extending their appendages to keep their carapace exposed to the atmosphere. Soldier crabs could also breathe in atmospheric air if they remained on shore. However, most of them preferred to stay in the saline when the salinity of saline increased. Hence, the availability of oxygen is not a determining factor for the crabs to choose between land or water environment as its shelter.

The amount of dissolved oxygen decreases in saline with increasing salinities. We assume that the soldier crabs mainly depend on gaseous oxygen for respiration but this decreased amount of dissolved oxygen in water will not cast a great influence on the crabs.

Further information reveals that the appendages of soldier crabs possess decalcified areas for them to absorb tiny amounts of oxygen. We suggest that when the crabs move on shore with the highly concentrated saline remaining on these decalcified areas, salt crystals will remain after water evaporation. These salt crystals will lead to loss of water from their body tissue by exosmosis. As a result they would rather stay in saline with their appendages submerged in water to reduce water evaporation.

An interesting observation was that there was no flocking instinct displayed by the soldier crabs in our investigation. Each crab seemed to move by its own to different shelter places. For those crabs that moved on shore, some gathered around the side of the tray and tended to "climb up the slippery hindrance" and sought for a better lodging site. Some even tried to burrow themselves among the smaller stones but failed. Therefore, crabs that remained in saline may protect themselves to confuse the predators and improve the chances of survival. Further investigation should be performed to collect more evidence to support this hypothesis.

Limitations

In order to protect the species, the sample size should not be too large. 15 soldier crabs were used in the investigation and all of them were released back to the nature after investigation. However, the accuracy was lowered.

For more accurate measurement, a refractometer should be used for measuring the salinity of saline.

As the size of the plastic tray used was only medium size, large number of soldier crabs was trapped in a small area. This might lead to the dispersal of the soldier crabs to avoid close encounter.

Not all components of the natural environment for the soldier crabs could be simulated. The soldier crabs in the nature face with tidal effects in muddy shore daily. Stones were used as substratum in this investigation instead of sand and mud as the latter were inhabited with different animal species that might affect the result. The lack of food supply for the soldier crabs might affect its choice of shelter place as they might migrate on shore to search for food. They also burrow in the muddy shore in the nature to escape from danger but the stones in the plastic tray did not allow them to burrow a cavity for themselves. The sea water sample might contain microorganisms and chemical substances which were not found in the saline solutions prepared. Therefore, the accuracy of result obtained might be affected.

Sources of error

The possible sources of error were mainly the abiotic factors that were difficult to be controlled. As we conducted the investigation on a cloudy and rainy day, the light intensity of the environment and temperature of different samples were not consistent during the investigation. Besides, the arrangements of rocks were slightly different in the plastic tray for different salinities. Also, as the soldier crabs were being investigated for many trials, they might be overloaded. This might make them become less active in the later investigations. 2 minutes were given to the soldier crabs to adapt to the new salinity, the equilibration time could be longer.

Suggestions for improvement / further investigation

There are several suggestions for improvement. The sample size of the soldier crabs could be increased to 30. A refractometer should be used to check the salinity of different saline solutions. A larger plastic tray should be used in order to minimize the overcrowding effect. The natural habitat of the soldier crabs should be simulated by using sterilized sands as the shore.

7. Conclusion

The higher the salinity of saline, the smaller number of the soldier crabs chose to stay on shore and the larger number of them chose to stay in saline. Therefore, we conclude that more soldier crabs would prefer to remain in aquatic environment when the salinity of saline increases. Moreover, the soldier crabs can survive in an extreme range of salinity and still retain certain degree of the freedom of movement.

8. Acknowledgement

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