Moving houses: distribution patterns and homing patterns of local and exotic species of snails in Hong Kong


Team 2 Cheung Chuk Shan College
Leader: Lor Cheuk Wai (S5)
Members: Yip Hung Mui, Wu Gabriel Tze Chung, Yeung Choi Yan,
Ng Rosemary Hiu Ching (S5)

1. Abstract

The focus of our investigation was laid on showing you how snails are distributed in different habitats, as well as their homing patterns in the habitats respectively. Major methods include field inspection at both flower beds at our school entrance, along with natural habitats including the Tai Tam Country Park. Quadrat sampling was adopted for population estimation. Concerning the homing patterns, capture-mark-recapture method and a laboratory terrarium was set-up for a more accurate view of the snails' behavior.

For population density, *Criptosoma imperiator* is most abundant, with 6.52 m^{-2}. The mean population density *of Achatina fulica* is 0.8 m^{-2}, that of *Bradybaena similaris* is 3.23 m^{-2}, and that of *Cyclophorus punctatus* is 0.54 m^{-2}. The least abundant snail is *Camaena cicatoricosa* with 0.00728 m^{-2}.

In brief, artificially maintained flower beds are more favourable to snails than natural habitats. No *Achatina fulica* (exotic species) can be found in investigated natural habitat. They do not stay at specific spots, but most tend to reside beneath leaves. The plant species may be the main consideration in choosing a habitat. Yet, no explanation could be made on the choice of plants and a direction for further investigation arises. Two snail species, *Cyclophorus punctatus* and *Bradybaena similaris* choose to dig deeper into the soil. Lastly, snails tend to stay together in a small area, while few distribute themselves sparsely.

Content

2. Introduction

As researchers, we seek answers to questions of great interest to us. Biology involves unraveling many secrets of nature. There are two flower beds at the entrance of our school, where snails are frequently seen. That is why we have chosen to initiate the research on this seemingly tiny but fascinating creature, snails, to know more about their behaviour.

Questions of investigation

1. Are there any differences in the distribution pattern of the Giant African Snail (*Achatina fulica*) and the local species?

2. Do the snails show any preference to artificially maintained flower beds or natural habitats?

3. Do the snails show recognizable homing behavior, i.e. do they tend to go back to the same resting place/spots with similar features day by day?

4. Do different species of snails tend to stay sparsely apart or closely together, regardless of their species?

3. Methodology

To investigate on the population density and the homing pattern of the snails, our investigation has been segmented into three parts.

3.1 Investigation on population density

The population density of snails was ascertained by quadrat sampling, with 0.5m x 0.5m quadrats. Sampling was carried out at night to minimize bias, as snails were more active and easily sighted then later in the day. Population density of a certain species of snail was determined from the snails found. The following investigations were carried out. 0.5m x 0.5m quadrats were placed randomly at sites with gentle slope with adequate soil profile, leaf litter and moisture. The number of the quadrats thrown was restricted due to time limitation. Once quadrats were thrown, weed and leaf litter was removed to avoid snails being hidden from observation. Flashlights were used to provide light source in dark environment. Both moving and hibernating snails were counted. The number and species of snails found in each quadrat was recorded immediately.

Density = (total count of snails / number of quadrats) / area covered by one quadrat

Date/time	Site	Weather condition	Quadrat

			(0.25m²)
16/2/2014 7:00-9:10pm	A hillside slope close to a cycling path in Tseung Kwan O	Temperature: 13-15°C Humidity: 84-92% Light drizzle, foggy, chilly	25
17/2/2014 Starting from 7:35pm	Small flower bed in entrance of CCSC	Temperature: 16°C humidity: 84-99% foggy	4
	Large flower bed in entrance of CCSC		8
	Hillside slope near CCSC		11
25/2/2014 8:30-10:10 pm	Tai Tam Country Park in Quarry Bay	Temperature: 18°C Humidity: 77-95% Very foggy Low visibility	20

3.2 Investigation on homing pattern

a) Large flower bed at school entrance [Artificial environment]

The snails were marked on 9th February, at 9:00pm. Shells of moving snails were marked using a black marker as the ink was easy to apply and dried rapidly. The code was assigned by the first letter of the snails' species name followed by a number representing order of discovery. Snails were marked and put back to the original spot. The two flower beds were thoroughly searched on the next day at 4:00pm to locate their initial positions. The snails were recaptured on 10th February, 17th February, 28th February and 3rd March to determine if they had change their resting place or not. Snails were immediately replaced to the site of discovery after recording.

b) Artificial terrarium at Biology laboratory [Artificial environment]

To obtain more comprehensive data on the homing patterns of snails, an artificial terrarium made with the following components was set up:

i. Plastic storage box, dimensions 53.2cm x 34.3 cm [Width x Length], locked and pinned air holes after snails escaping

ii. Soil, from Biology laboratory

iii. Decaying plants, as food source and shelter, including the following:

a. *Rhoeo discolor*, added on the first and after three days
b. *Oxalis corymbosa*, replenished after three days to provide food to snails
c. *Bauhinia variegata* leaves
d. Unidentified leaves from flower bed

iv. 16 snails, including species as follows:

a. *Achatina fulica,* 6 snails
b. *Bradybaena similaris,* 3 snails
c. *Criptosoma imperiator,* 3 snails
d. *Cyclophorus punctatus,* 2 snails
e. *Camaena cicatoricosa,* 2 snails

These snails were all marked with black marker, with coding including their species code and an assigned number, e.g. CC2 represents a *Camaena cicatoricosa* snail.

v. 3 Slugs (found in their original living environment)

vi. Water, added daily to keep soil moist

The snails were allowed a week to adapt to the new habitat before their positions were recorded. The investigation was carried out through a week, in which the snails' positions were checked daily. After inspection, the spots where the snails were found were marked immediately on a sketch map, with reference from the grids of the lid of the box sketched for better comparison. Leaves have also been flipped for searching hidden snails, and the box was lifted to ensure that snails digging into the soil would not be missed. For snails not locating on the surface of the soil (e.g. adhering onto the lid or the inner walls of the box), their locations had been recorded. The following coding was adopted for recording the location of snails on the sketch map:

4. Snail profile

The snail information is based on 《香港動物原色圖鑑》 and dissertation of Ho, Wai-hoong.

Archatina fulica (Giant African Snail) [Code assigned: A]

It possesses shell which are quite large, with length of 6 to 8 cm. It is originated in Africa and is transferred to Hong Kong. It has a pyramidal shell with alternating yellow and brown stripes.


Bradybaena similaris (Small Banded Snail) [Code assigned: B]
It has smooth shell and is small, with shell length of 1 to 2 cm. It is usually found beneath flowerpots, in flower beds as well as some woodland.


Cyclophorus punctatus (Leopard Snail) [Code assigned: P]
It is a terrestrial species with operculum and gills, and is usually distributed in humid woodland. It possesses flat conical and broad shells with length of about 2.5 cm. It has thick and flared peristome.


Criptosoma imperiator (Arboreal Snail) [Code assigned: C]
It possesses globular shell. The whirl expands rapidly, with almost circular aperture. It is olive-green in colour. The spiral part of its shell is short and small, while the shell is about 3 cm long. It was recorded in literature to be usually found under banana trees. It has a layer of mantle to cover the shell.


Camaena cicatoricosa (Large Striped Snail) [Code assigned: CC]
It is conical in shape with spiral bands. It is terrestrial. Its shell is sinistral and large with width of about 4 cm. Its peristome is almost circular. It is widely distributed in some woodland in the Hong Kong Island.

5. Result

5.1 Distribution

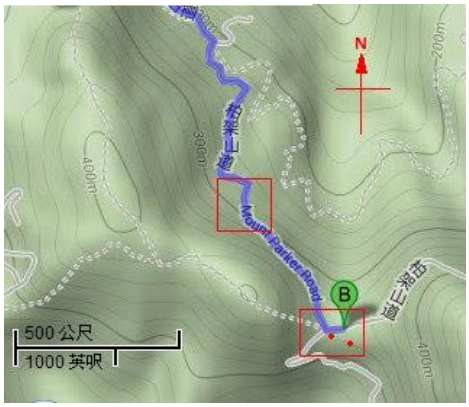
We inspected five sites for investigation in different dates: hillside slope in Tseung Kwan O, two flower beds, small flower, hillside slope near school and Tai Tam Country Park.

Date/time	Site	Weather condition	Quadrat ($0.25m^2$)	Vegetation
16/2/2014 7:00-9:10pm	A hillside slope close to a cycling path in Tseung Kwan O	Temperature: 13-15°C Humidity: 84-92% Light drizzle Foggy, chilly	25	dry leaves found on the surface; dense vegetation of arbor
17/2/2014 Starting from 7:35pm	Small flower bed in entrance of CCSC	Temperature: 16°C humidity: 84-99% foggy	4	*Epipremnum aureum* and *Setcreaesea purpurea*
	Large flower bed in entrance of CCSC		8	*Oxalis corymbosa*, *Aglaia odorata, Rhoeo discolour*
	Hillside slope near CCSC		11	*Alocasia macrorrhiza*
25/2/2014 8:30-10:10 pm	Tai Tam Country Park in Quarry Bay	Temperature: 18°C Humidity: 77-95% Very foggy Low visibility	20	much leaf litter found on the ground

Large flower bed

Rhoeo discolor and *Oxalis corymbosa*

Small flower bed



Map of Tai Tam Country Park in Quarry Bay

Staircase near school

Table 1. List of snail species found in different location inspected

Locations inspected	**Snail species found**
Tseung Kwan O	*Bradybaena similaris*
Large flower bed in CCSC	*Achatina fulica* *Bradybaena similaris* *Cyclophorus punctatus*
Small flower bed in CCSC	*Bradybaena similaris*
Hillside slope near CCSC	*Bradybaena similaris* *Criptosoma imperiator* *Camaena cicatoricosa*
Tai Tam Country Park in Quarry Bay	*Bradybaena similaris* *Cyclophorus punctatus* *Criptosoma imperiator*

It was found that proximal locations can have vastly different variety of species. The large flower bed, small flower bed and hillside are only around 10 m away from each other, but *Criptosoma imperiator* can be found in hillside but not the flower bed, the *Achatina fulica* and *Cyclophorus punctatus* can be found in the large flower bed, but not in the small flower bed and hillside. The reason why these species do not migrate to such proximal locations remains unknown.

During the observation, it was discovered that *Criptosoma imperiator were* feeding on dog's faeces.

Key:
A: *Achatina fulica* B: *Bradybaena similaris* P: *Cyclophorus punctatus*
C: *Criptosoma imperiator* CC: *Camaena cicatoricosa*

Table2: Number of different species of snails in Tseung Kwan O(artificial environment)

0.25 m^2 Quadrat no.	No. of different species of snails				
	A	B	P	C	CC
Q1	0	2	0	0	0
Q2	0	0	0	0	0
Q3	0	2	0	0	0
Q4	0	0	0	0	0
Q5	0	0	0	0	0
Q6	0	3	0	0	0
Q7	0	3	0	0	0
Q8~25	0	0	0	0	0

Table3: Number of different species of snails in Small flower bed in CCSC

0.25 m^2 Quadrat no.	No. of different species of snails				
	A	B	P	C	CC
Q1	0	1	0	0	0
Q2	0	1	0	0	0
Q3	0	0	0	0	0
Q4	0	5	0	0	0

Table4: Number of different species of snails in Large flower bed in CCSC

0.25 m^2 Quadrat no.	No. of different species of snails				
	A	B	P	C	CC
Q1	8	2	4	0	0
Q2	0	2	0	0	0
Q3	0	1	0	0	0
Q4	0	1	0	0	0
Q5	0	1	0	0	0
Q6	0	3	0	0	0
Q7	0	1	0	0	0
Q8	0	1	1	0	0

Table5: Number of different species of snails in Hillside near CCSC

0.25 m^2 Quadrat no.	No. of different species of snails				
	A	B	P	C	CC
Q1	0	0	0	4	0
Q2	0	0	0	10	0
Q3	0	0	0	4	0
Q4	0	0	0	2	0
Q5	0	0	0	13	0
Q6	0	0	0	9	0
Q7	0	0	0	10	0
Q8	0	0	0	15	0
Q9	0	0	0	3	0
Q10	0	0	0	7	0
Q11	0	1	0	12	1

Table6: Number of different species of snails in Tai Tam Country Park in Quarry Bay

0.25 m^2 Quadrat no.	No. of different species of snails				
	A	B	P	C	CC
Q1	0	1	0	0	0
Q2	0	0	1	0	0
Q3	0	1	0	0	0
Q4	0	1	0	0	0
Q5	0	1	0	0	0
Q6	0	0	0	1	0
Q7	0	2	0	0	0
Q8~20	0	0	0	0	0

Table7. Population densities of five species of snails at 5 sites

Site	Population densities of 5 species of snails (no. of snail per m^2)				
	A	B	P	C	CC
Tseung Kwan O	0	1.6	0	0	0
Large flower bed	4	6	2.5	0	0
Small flower bed	0	7	0	0	0
Hillside	0	0.364	0	32.4	0.364

Tai Tam Country Park in Quarry Bay	0	1.2	0.2	0.2	0
Mean population density	0.8	3.23	0.54	6.52	0.00728

Table8. Population densities of five species of snails in different type of area

Mean population densities in:	Population densities of 5 species of snails (no. of snail per m^2)				
	A	B	P	C	CC
Artificial area	1	3.741	0.625	8.1	0.091
Natural	0	1.2	0.2	0.2	0

With reference to Table 7, the most abundant species is *Criptosoma imperiator,* having 6.52 m^{-2} density. However, most of them are found at the same site, the hillside. Its density in hillside is very high, with 32.4 m^{-2}. Their population is evenly distributed in hillside. However they are absent in both flower beds and Tseung Kwan O. The least abundant snail is *Camaena cicatoricosa,* we can only find one in the hillside. And its density is only 0.00728 m^{-2}, which is far less than the other species.

Achatina fulica, which is an exotic species, can only be found in the large flower bed, which is one of the artificial habitats. So, their mean population is only 0.8 m^{-2}. According to Table 4, their distribution in large flower bed is also very patchy. They are concentrated at the section where *Rhoeo discolour* is planted.

Bradybaena similaris is found in all sites we investigated, with a second highest mean population density 3.23 m^{-2} . Most of them are found in flower beds. They are the most abundant in gardens. Their population density in both flower beds are high with 6 m^{-2} and 7 m^{-2} respectively, but the population density in hillside, where are only around 10 m away from large flower bed, is low with only 0.364 $m^{-2.}$

Cyclophorus punctatus can be found in both artificial and natural habitat, but with a rather low density, 2.5 m^{-2} in large flower bed and 0.2 m^{-2} in Quarry Bay. The mean population density is low. According to Table 4, their distribution in large flower bed is also very patchy, same as *Achatina fulica,* they are concentrated at the section where *Rhoeo discolour* is planted.

According to Table 8, the density of all species in artificial area is higher than that of natural habitat.

5.2 Homing pattern of snails in experimental habitat

Table9. A continuous record of the location of the snails in the experimental habitat

Grid	Time of observation					
	27/2, 1630	28/2, 1445	3/3, 1620	4/3, 1620	5/3, 1450	6/3, 1050
AA0				C2		
AA1		C1				
AA2				**A1**		
AA3					**C2**, B3, CC1	A1, B3
AA5						B2
AA6		C3				
A0				C3	B2	
A1						A5
A2						C1
A3						A2
A4			P1		A5	CC1, CC2
A5	P1	P1		P1		
B1		CC2, A3	C2			*A6*
B2		A5		A6		
B3	B2			A5		
B4	A6		A5	B3	CC2	C2, A3
B5				B2	A4	

B6	C1					
C1			*A6*		A3, A6	
C2	B1, C2		A1	A2		
C3		A4	A3			
C4	A5, CC1					
C5	CC2			A4		
D1			CC2, B3	A3, CC1		
D2		A1		CC2		
D3		A2			B1	
D4	A4					
D5	C3					
E1				B1		
E2	A1	B1	CC1			**C3**
E4	A3					
E6			A2			
F1	P2	P2, C2	C1	**P2**	A3	
F3						A4
F4				C1		
F5		B2			A1	B1, *P1*
G1			C3			
G5	A2		**B1**			**P2**
G6			A4			
GG3					C1	
Total no.	15	13	14	16	13	16

Key:

Different species of snails

A: *Achatina fulica* B: *Bradybaena similaris* P: *Cyclophorus punctatus*

C: *Criptosoma imperiator* CC: *Camaena cicatoricosa*

Position:

a. Only code: on surface of soil/leaf or attaching onto the inner wall of the box

b. Underlined code: beneath leaf

c. **Bolded code**: attaching onto the lid

d. *Code in italic*: beneath soil

Points of interest:

1. Not all snails could be recovered during the observation.
2. Most of the snails did not show any homing behavior.
3. Some snails move a lot and rested at very different locations, e.g. C1 (B6→AA1→F1→F4→GG3→A2)

(In the following, snails are quoted by their assigned codes, while the species code remains the same for one species of snails)

Almost all snails do not have specific homing patterns.

P1 *(Cyclophorus punctatus)* stayed at Grid A5 from Day 1 to Day 4, probably because of egg-laying. P2 stayed in Grid F1 and under the *Bauhinia variegate* leaf from Day 1 to Day 2. For Day 4 and 6, it was found on the cover of the box. But for Day 3 and 5, it couldn't be found.

Both B1 (*Bradybaena similaris*) and B2 didn't stay at any fixed spot.

CC1 (*Camaena cicatoricosa)* also do not have any homing pattern. CC2 stayed under leaves for five days. It stayed at proximal spots, Grids A4 and B4 on Day 5 & 6 and stayed at proximal spots, Grids D1 and D2 on Day 3 & 4. It seems that CC tend to be under leaves.

C (*Criptosoma imperiator)* also do not have any homing pattern. However, they usually slithered to the wall and cover, unlike the other species. C1 hid beneath the leaves on Day 1, attached to different spots on wall for two days. It spent another two days on the ground and a day on the cover. C2 was found under leaves for two days, on the ground for three days and on the cover for one day. C3 was found on the ground for four days, on the wall and on the cover for the other two days.

A (*Achatina fulica*) mainly slithered on the ground or under leaves. All A don't have specific homing pattern. For Day 1 and 2, A1 stayed at proximal spots, Grids E2 and D2. For three days it stayed on the ground, two days on the cover and a day attached on the wall. A2 was found under leaves for three days, two days on the ground. A3 was found on the ground for three days, two days under the leaves. A4 slithered on the ground for four days and under the leaf for one day. A5 was found under the leaves and on the ground for three days each. A6 slithered on the ground for four days and under the leaf for one day, but it moved within four grids.

5.3 The homing pattern of the snail in the large flower bed

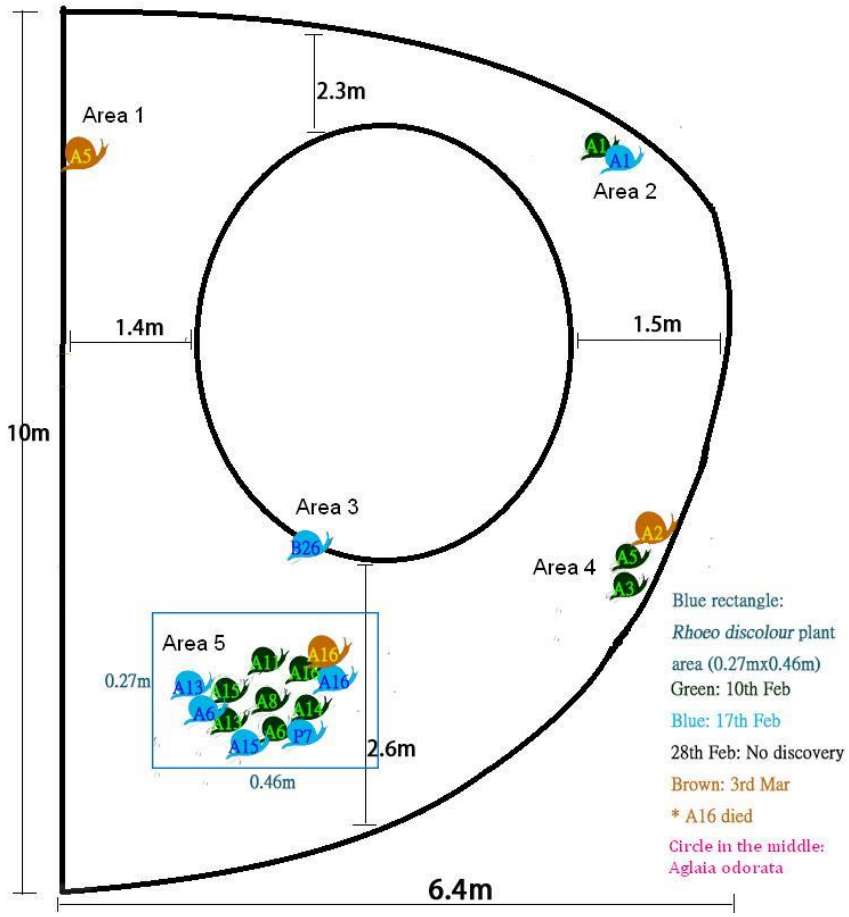


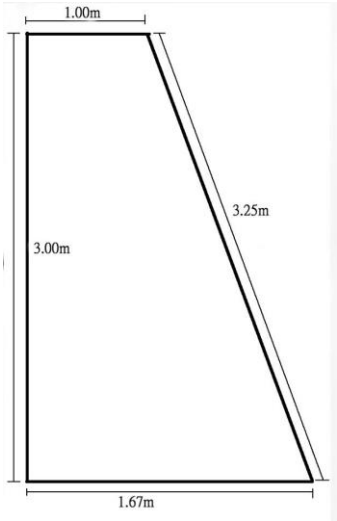
Table10. The location of marked snails recovered at different date of observation

Location	Dates of observation			
	10/2	17/2	28/2	3/3
1				A5
2	A1	A1		
3		B26		
4	A3,5			A2
5	A6,8,11,13,14,15,16	A6,13,15,16		A16

If the location of a snail deviated no more than 0.25m from that of the previous day, it was assumed to be staying at the same spot.

A16, A15, A13, A6 and A1 stay in Area 5 as day one. A16, A15, A13, A6 stay in the *Rhoeo discolour* plant area and A1 stay on the upper side of the flower bed under some scrubs .A5 move from the right bottom side to the left upper side of the flower bed.

Where A11, A8, A2, A3, P7 and B26 only showed up one day, and no homing pattern could be identified. No snail could be found on 28th February.



Sketch map of small flower bed: (on the right)
All snails marked here are *Bradybaena similaris.*
No snail found in the small flower bed could be recaptured.

6. Discussion

6.1 General comment on accuracy/reliability of data

In determining the population of snails by quadrat sampling, the number of quadrats placed in a location vary from 4 to 25, while displays a large degree of deviation in representativeness. For the flower beds, only a few quadrats were placed considering the small area, which was reasonable. However, for the investigation at Tai Tam Country Park 20 quadrats were thrown for sampling. A greater count of quadrats may seem to give more reliable results, yet the area of the country park was way greater than other locations and a mere 20 quadrats may not be reflective of the actual population. In quadrat sampling, the data was considered to be not accurate enough as only the surface of the area enclosed by the quadrat was inspected whereas the soil beneath has been neglected.
Meanwhile, considering the homing pattern investigation, the reliability of the data obtained from the flower beds are not considered to be reliable. In the small flower bed no snail could be recaptured and only a few was found in the larger flower bed. Though the data were not conclusive, about half of the *Achatina fulica* recovered tended to stay in the same place for more than 1 week. However, one of the snails travelled to extreme locations during the study.
Regarding the laboratory terrarium, the data collected is considered to be reliable and accurate enough as a supporting evidence to the findings in artificial habitats as no biased methods have been adopted and greatest effort has been made to minimize interference to the habitat after established. However, it is not reflective of the natural environment of Hong Kong as the density of snails is exceptionally high.

6.2 Population density/distribution of snails

All types of snails refer to the mean population density was found more in artificial than the natural habitat.
Firstly, we think that the difference in plants in the artificial area and natural environment may affect the population density. In the artificial areas, *Aglaia odorata* and *Rhoeo discolour* and *Alocasia macrorrhizos* are planted. However, it can't be found in Tai Tam Country Park. In

the natural habitat, *Acacia confusa* and *Pinus elliottii* are planted. Plants in the artificial habitats may be more favorable to snails than those in the natural habitat, so that the population density in the artificial habitats is higher than the natural habitat.

Secondly, the regular irrigation in the artificial areas maybe one of the reasons why the population density was found higher in artificial areas is than the natural habitat. In the artificial areas, in order to water the plants there is regular irrigation. It provides a moisten environment to maintain a higher humidity environment in dry seasons. High humidity favors the growth of snails. The natural habitat cannot provide this kind of favorable environment for snails, so that the snails tended to stay in the artificial areas instead of natural habitat.

In the case of *Criptosoma imperiator*, they were more abundant in the hillside slope beside road. There may be more their favorable trees and *Alocasia macrorrhizos*. They don't appear in the small or large flower bed may be because of the small amount of tree plant there. Snails like eating decadent food like rotten *Ficus carica*. And we discover *Criptosoma imperiator* feeding on dog's faeces. Both foods can be found in hillside, but not in the flower bed, so food may also one of the reasons of this strange distribution. Our finding contradict with the description in the book 《香港動物原色圖鑑》. It states that *Criptosoma imperiator* can only be found near banana trees and *Kaempferia galinga* forest. However, the place that we found more than 80 *Criptosoma imperiator* is without any banana trees or *Kaempferia galinga*. It suggested that *Criptosoma imperiator* also prefer *Alocasia macrorrhizos*.

The other reasons suggested is the thick canopy cover by trees compared to that of flower bed. The retention of moisture is preferred, so the population of *Criptosoma imperiator* is higher.

In the case of *Camaena cicatoricosa*, it matches the description from Ho, Wai-hoong where it can be found in woodland in Hong Kong Island. With reference to the dissertation, the population density of *Camaena cicatoricosa* is $0.4m^{-2}$ at hill above Belcher and $0.3m^{-2}$ at Nam Fung Road Woodland. Our results are much smaller than that. They are not easily found beside the staircase, it may be because there are more disturbances from the footsteps and cars. Base on our findings, *Camaena cicatoricosa* can only be found in the upper part of hillside which is artificial areas. They cannot be found in the natural habitat we investigated.

For *Achatina fulica*, they are mainly found in the *Rhoeo discolour* plant area of the large flower bed. But we found that the actual size of *Achatina fulica* found there didn't match the description on the book《香港動物原色圖鑑》. Instead of 6 to 8 cm, only 1 to 3 cm *Achatina fulica* can be found.

Achatina fulica is not found in the natural habitat. It tend to live in artificial area which having more favourable environment to them, for example more humid environment in flower bed due to irrigation. *Rhoeo discolour* cannot be found in the natural may also be one of the reasons.

For *Bradybaena similaris*, the size of them is small so they are more likely to sustain. They are small in size so that they require fewer resources. They can easily survive and adapt to the environment. We don't prefer the method to scoop the soil and dig out the snails because this may cause serious disturbance and destruction of the living environment for the snails. The places where they found match the information from the book and the dissertation. It is stated in the dissertation that it is the most widespread snail in gardens and nurseries. Our results matched with it. *Bradybaena similaris* are the most abundant species in gardens.

As for *Cyclophorus punctatus*, there is a great difference in population with the result of the dissertation. It stated that *Cyclophorus punctatus* was the most abundant snail in the two sites (hill above Belcher's and Nam Pung Road on Hong Kong Island) that she investigated, with $0.7m^{-2}$ and $4.4m^{-2}$. However, the population density obtained in this investigation was quite low, only $0.54\ m^{-2}$. It may be it is not evenly distributed in different sites. According to Table 4, their distribution in large flower bed is also very patchy. Same as *Achatina fulica,* they are concentrated at the section where *Rhoeo discolour* is planted. If the sites she investigated was planted with *Rhoeo discolour* or other favorable plants, the population density might be greater.

6.3 Homing pattern of snails in laboratory terrarium and flowerbeds

From the results, most snails won't stay at the same spot in terrarium but they seem to have a pattern of staying under leaves, under soil or slithering to the cover and wall. For the flower bed, most snails can't be recaptured, so they are most likely under soil. Those can be recaptured are found in the region of *Rhoeo discolour.* So the plants planted may be a factor affecting their homing pattern instead.

In the following, the homing patterns of snails will be analyzed and compared on a species-to-species basis. *Achatina fulica* snails mainly stay beneath leaves or soil. They tend to stay at flat and broad areas, instead of attaching to walls of the box, in the laboratory terrarium. In the larger flower bed, most were located at the spot with *Rhoeo discolour* planted. It is assumed that *Rhoeo discolour* is a favourable plant species to them as it provides much shelter. This is interpreted with reference from Table 10.

Bradybaena similaris and *Cyclophorus punctatus* snails stay beneath the soil to hide from their potential predators. Meanwhile, the underground environment was safer to them due to their small size. In the smaller flower bed, no *Bradybaena similaris* snail could be recaptured. These two species both have small sizes, and thus less resources are required for their survival. Therefore, they are considered to have better adapted to the new laboratory environment. In the laboratory terrarium, a *Cyclophorus punctatus* even laid eggs and stayed at the same spot to protect the eggs.

Criptosoma imperiator tend to climb trees according to past literature. However, in the laboratory no tree trunk was present, these snails exhibited a general pattern of climbing up the inner walls of the box, which to a certain extent matches the recorded charcteristics. *Camaena cicatoricosa* snails tend to stay together beneath leaves. A possible explanation to this is hiding against predators. This phenomenon was also found in other snail species except *Criptosoma imperiator.*

6.4 Limitations of research methods

In the investigation, there were a few limitations caused by the methodology adopted, including:

1. In tracking the homing behaviour of the snails, no soil was dug or scooped up from the schools' flower beds to minimize human disturbance. Snails resting beneath the soil were far less likely to be found.
2. In collecting data about the homing patterns of the snails at the large flower bed, an assumption[1] was put forward that if a snail moves less than 0.25m it is considered not to have moved. Nevertheless, this assumption was due to the restrictions on our ability to track the movement of the snails. As the school forbids students to make marks on the flower bed, we could not place marks on the soil to locate the position of the snails. Thus, the location of snails in the flower bed were not accurate.

6.5 Further investigations

Considering the unexplained phenomena as well as the sources of error in the investigation, it is suggested that the following further investigations be made to obtain more information about the behaviour of the snails:

1. During the investigation, both the artificial flower beds in the school and the soil next to the staircase a few meters away from the flower bed had been inspected. However, the population of snails differed vastly, and the species of snails did not overlap each other. Investigation on the conditions of the two habitats should be carried out to find out why different species stay at the same habitat but do not migrate to nearby habitats.

2. The homing patterns of snails in the laboratory habitat generally varied from species to species, but each species' individual homing patterns could not be identified due to the fact that correlation between species in homing patterns had neither been identified nor proven to be absent. It is suggested that new laboratory habitats include only one species of snails per set-up should be created in order to compare the homing patterns of different species.

[1] See p15.

7. Conclusion

The overall snail density in artificially maintained flower bed was higher than that in natural habitat. However, different species showed different preference to the habitats. No *Achatina fulica* (exotic species) could be found in natural habitat. Thus, they may not be a serious threat to the local species of snails in the wild.

The snails don't have a specific staying spot, but most of them tend to stay under leaves. The plants are the main consideration when they choose their habitat. *Cyclophorus punctatus* and *Bradybaena similaris* will dig into the soil.

8. Reflection

Unceasing researches allow us to continue to pursue our interests on snails, to learn new knowledge, to hone our problem-solving skills and to challenge ourselves by new means. Working on a project gives us the opportunity to work closely with nature. With this self-initiated research, we have come up with a product that represents the distillation of our interests and studies, and hopefully, a real contribution to knowledge.

Biology will always be a part of our life, as we are all parts of the nature. Biological advancements is essential to the advancement of the modern society. Even if this is the first scientific research we ever conduct, we will continue to make decisions rooted in biology from time to time. This research will provide us with the knowledge and skills necessary to understand scientific issues, to be able to make educated decisions.

We appreciate science as a "process" by which we develop a better understanding of our world. We need to understand the fundamentals and significance of individual discoveries to understand and appreciate the changes, advances and improvements in science and technology. To this end, we can proudly say that, our mission has been accomplished.

9. Bibliography

Ho, Wai-hoong, (1994). The taxonomy and ecology of land snails in Hong Kong, with particular reference to factors affecting their distribution and population dynamics http://hdl.handle.net/10722/32448 Retrieved on 20th March, 2014.

許狄思 費嘉倫編著 何迪媛譯, (1989). 香港動物原色圖鑑, 香港政府印務局印行