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Title: **The Poisonous Predators: The Abundance and Feeding Habits of Asian Toad**

Team R02

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Content

1. Abstract

Duttaphrynus melanostictus is an amphibian prevalent in South Asia. In our project, we aim to investigate the abundance and active time of Asian toad of different stages in their lives in various habitats and weather conditions. We also aim to probe into the amount and preference of food Asian toads consume and their abundance of varied color patterns.

It is concluded that the emergence of Asian toads at all sites are noted to be affected by temperature but not relative humidity and they are more active at times of higher temperature. Adult Asian toads are not observed during daytime while juvenile Asian toads are observed in both daytime and nighttime. In comparison to other amphibians, Asian toads are more adapted to urban areas.

The amount of food consumed by an Asian toad per unit mass decreases with increasing body length. It is found that the main food source of all Asian toads is ant in both urban and rural area. Asian toads have a wider variation of prey when they grow bigger and the food variation of Asian toads living in rural area is larger.

Most of the Asian toads in Hong Kong were found to be in dark green color while brown colored toads only occupied a small proportion.

2. Introduction

2.1 Introduction to the research topic

Hong Kong has recorded 25 species of amphibians, the majority of which being frogs and toads. Asian toads are the most pervasive species in Hong Kong. Their glands secrete toxin that kills their predator[1] in which only Red-necked Keelback and Chinese cobra can feed on them[1]. Playing an important role in Hong Kong's ecosystem, Asian toads catch our eyes, so we would like to carry out an investigation on their abundance, active time, food consumption and preference, with reference to their sizes.

2.2 Objectives

i. Investigation on the abundance and active time of Asian toads of different stages in their lives in various habitats and weather conditions
ii. Investigation on the amount of food that Asian toads consumed
iii. Investigation on the food preference among different sizes of Asian toads
iv. Investigation on the abundance of Asian toads of different color patterns

2.3 Research questions

- What is the difference in active time between juvenile Asian toads and adult Asian toads?
- What is the effect of weather condition to the toads' activity?
- What is the difference of their abundance at rural and urban habitats?
- What prey will Asian toads of difference sizes hunt?
- How much food can they consume in one day?
- What is the difference of amount of food they consume at different stages of their live?
- What is their abundance corresponding to their color pattern?

2.4 Background information of Asian toad

Duttaphrynus melanostictus, also commonly called Asian common toad, Asian black-spined toad, and black-spectacled toad, occurs widely in South and Southeast Asia, from Northern Pakistan to Indonesia[2]. Being one of the most common toads in Southeast Asia, invasion of Asian toads to Australia and Madagascar is also observed. Asian toads occur in a variety of habitats, including both urban and rural areas[3]. They breed in still and slow-flowing rivers, temporary, permanent ponds and pools. Adults are terrestrial and may be found under ground covers such as rocks, leaf litter, and logs, and are also associated with human habitations. The larvae are found in still and slow-moving waterbodies. They are noted to feed on a wide range of invertebrates, including scorpions. They have toxin stored in their body to protect themselves against predators. They also have considerable color variation between Asian toads.

Classification:

Kingdom	Animalia
Phylum	Chordata
Class	Amphibia
Order	Anura
Family	Bufonidae
Genus	*Duttaphrynus*
Species	*D. melanostictus*

3. Methodology

3.1 Objective 1: Investigation on the abundance and active time of Asian toad of different stages in their lives in various habitats and weather conditions

3.1.1 Principle of Experimental design

To study the abundance and active time of Asian toads at different stages of life, estimated by their sizes, field studies were carried out. During the field studies, the abundance, together with their approximate sizes, which is estimated by their lengths, of Asian toads observed are recorded. With reference to the method of line transect, several paths were selected and a width of 1 metre span along the path was observed. Assuming that all toads within the 1 metre area were observed. By comparing the abundance of Asian toads of different lengths, their abundance at different stages of life can be found. Also, the influence of weather condition to Asian toads can be deduced by comparing their abundance in different weather conditions.

Their preferences of habitats like rural and urban areas, can be known by comparing the abundance of Asian toads at different sites. The duration of each field studies is set to be approximately 90 minutes and the route of study in each trip at the same site is identical to achieve fair comparison. Little Hawaii Trail, Lung Fu Shan and Kowloon Park were chosen to carry out the field trips because of their accessibility.

Table 1: summary of field trips

Sites	Dates of field trips
Kowloon Park	27/3, 9/5, 19/7(daytime), 29/7
Little Hawaii Trail	24/3, 18/7(daytime), 18/7
Lung Fu Shan	29/6, 10/7, 12/7(daytime)

*Unless specified, the field trips were carried out in nighttime as the majority of amphibians are nocturnal.

The details of fields studies are shown in appendix 1.

(Fig.1) Map of Kowloon Park

(Fig.2) Map of Little Hawaii Trail

(Fig.3) Map of Lung Fu Shan

*The black line above indicates the route of investigation carried out. A return journey in Lung Fu Shan is made, so the direction sign is not applicable.

3.2 Objective 2: Investigation on the Amount of Food Consumed by Asian Toads

3.2.1 Principle of Experimental Design

To find out the amount of food consumed by Asian toads, toads of different sizes were caught from different fields and fed artificially in laboratory. Every day, crickets of known weight and number were supplied to the Asian toads caught as their only food source. Each day, the weight of crickets left over is measured. The number of crickets eaten by the Asian toads can then be found in terms of weight by subtracting the weight of crickets left over from the weight of crickets supplied to the toad the day before.

Two graphs are plotted for every set of data: one graph is plotted to show the relationship between the average weight of the toads under investigation and their appetite while another graph is plotted to show the relationship between the food consumption per unit weight of the toad and the toads' age, which is assumed to be represented by the toads' body length. Measuring a toad's body length is prefered to measuring its weight when estimating its age as the fresh mass of a toad can vary greatly.

3.2.2 Procedures

1. Asian toads were caught and their body lengths were(from snout to vent) measured by vernier scale.
2. Each Asian toad caught was kept inside an aquarium.
3. Around 1g of crickets were measured by an electronic balance and fed to the toads every 24 hours. It is assumed that Asian toads eat crickets.
4. Uneaten crickets were taken out using a pair of forceps.
5. The number of uneaten crickets was counted.
6. The weight of the uneaten crickets was measured by electronic balance and was recorded.
7. The change in weight and number of the crickets was calculated by comparing the data with the recorded data the day before.
8. A control set-up was prepared by putting also around 1g of crickets, measured by an electronic balance, to a small plastic vial.
9. The weight of the crickets in the bottle was measured at the same time as the crickets left in the aquarium so that the weight loss of the crickets in the aquarium due to respiration can be deduced and the weight of crickets eaten can be more reliable.
10. Step 3-9 were repeated every 24 hours for 4 days. (Step 4-9 were skipped on the first day of the experiment since no crickets had been supplied to the toads the day before.)

(Fig.4) The method of measuring the toad size

(Fig.5) Man-made habitat for keeping toads

(Fig.6) Crickets fed

3.3 Objective 3: Investigation on the food preference among different sizes of Asian toad

3.3.1 Principle of Experimental design:

In order to find out the food preferences of Asian toads of different sizes, faeces of the Asian toads and their gut contents from two dead toads, which died accidentally, were also collected. The contents were examined under microscope. The undigested insect body parts in the faeces and in the gut show the food preferences. Assuming that the toads were healthy when captured. After the investigation, all toads were released back to their natural habitats.

Comparing the undigested parts with the pictures in “An Atlas of Invertebrate Structure”[4] and “A Photographic Guide to Hong Kong Insects”[5], the types of food the toads consumed can be identified. Thus, by comparing different samples collected from toads of different sizes, the change in food preference during the growth of Asian toads can be found. Besides, the Asian toads were caught in two different sites -- Little Hawaii Trail and Kowloon Park in which the two sites can be considered as rural and urban areas respectively. Any differences in food source between the toads living in different environment will be investigated too.

Dissection was done by professional study to find out the food preferences of amphibians. For example, in the study of greenhouse frog’s diet done by Utah State University, the research team had dissected a total of 427 greenhouse frogs in order to obtain a more reliable result[6]. However dissection is not the first priority in our study because damage to the ecosystem should be minimized. The toads should be released back to the wild and not be killed.

3.3.2 Procedure

1. 11 Asian toads were captured and their body lengths (from snout to vent) was measured by vernier scale.
2. The toads were kept separately in empty plastic vials. Holes were punctured on the covers of the vials to prevent suffocation of toads.
3. Defecation of the toads was waited and the faeces were collected by a pair of forceps.
4. The faeces were mixed with water.
5. The faeces were put on a slide and observed under microscope at 40X and 100X using both light microscope and dissecting microscope.
6. Two Asian toads, which died accidentally, were dissected to analyse their gut content under dissecting microscope.
7. The images in the microscope were captured to record the material found in faeces, with reference to the atlas.

3.4 Objective 4: Investigation on the abundance of Asian toad of different color pattern

3.4.1 Principle of Experiment design:

In order to find out the abundance of Asian toads of different color patterns, the number of Asian toads of different colors were recorded during the field studies. In addition, it is hypothesized that Asian toads would opt for habitats similar to their own color. An experiment was carried out in laboratory by allowing the toads to select to stay on substrata of different colors.

3.4.2 Procedure

1. A transparent aquarium was separated into two even parts. Each was covered by a colored paper, one was of yellow and another of brown. The sizes of the papers were identical so that only the color was different in the two habitat.
2. Three Asian toads were put inside the aquarium with adequate food and water supply. Two of them were yellow in colour and one was brown in colour.
3. Their location was marked every 8 hours for three days.

(Fig.7) The aquarium separated into two colours

4. Results

4.1 Result on Objective 1: Investigation on the abundance and active time of Asian toad of different stages in their lives in various habitats and weather conditions

Table 2: Abundance of Asian Toad of different sizes in Kowloon Park from 27/3 to 29/7

Date	Time	Average Temperature (°C)	Relative Humidity (%)	No. of Asian Toad observed	
				Adult*	Juvenile*
27/3	21:00	22.3	78	19	0
9/5	21:30	23.7	86	30	0
19/7	09:00	28.7	81	0	2
29/7	21:15	27.9	73	28	12

Table 3: Abundance of Asian Toad of different sizes in Little Hawaii Trail from 24/3 to 18/7

Date	Time	Average Temperature (°C)	Relative Humidity (%)	No. of Asian Toad observed	
				Adult*	Juvenile*
24/3	21:00	18.7	84	19	0
18/7	11:34	26.5	96	0	3
18/7	21:15	28.6	83	39	4

Table 4: Abundance of Asian Toad of different sizes in Lung Fu Shan from 29/6 to 12/7

Date	Time	Average Temperature (°C)	Relative Humidity (%)	No. of Asian Toad observed	
				Adult*	Juvenile*
29/6	23:30	29.2	80	13	1
10/7	22:30	27.2	86	10	0
12/7	09:00	28.8	80	0	2

*Toads with size 30mm or above are recognized as adult toads.
Toads with size 10mm to 29mm are recognized as juvenile toads.


(Fig.8) Adult Toad


(Fig.9) Juvenile Toad

Table 5: The number of different species of frogs other than Asian toads observed during trips in summer

Sites	Asian toads	Greenhouse frogs	Green Cascade frogs	Peak Spadefoot toads	Hong Kong Cascade frogs	Hong Kong Whipping frogs	Banded bullfrogs
Kowloon Park(9/5)	30	2	0	0	0	0	0
Lung Fu Shan(29/6)	14	4	5	3	2	2	1

*The percentage of Asian toads
= No. of Asian toads in a site/Total no. of frogs and toads observed in a site x100%

Percentage of Asian toads in Kowloon Park = 30/32 x100% = 93.8%
Percentage of Asian toads in Lung Fu Shan = 14/31 x100% = 45.2%

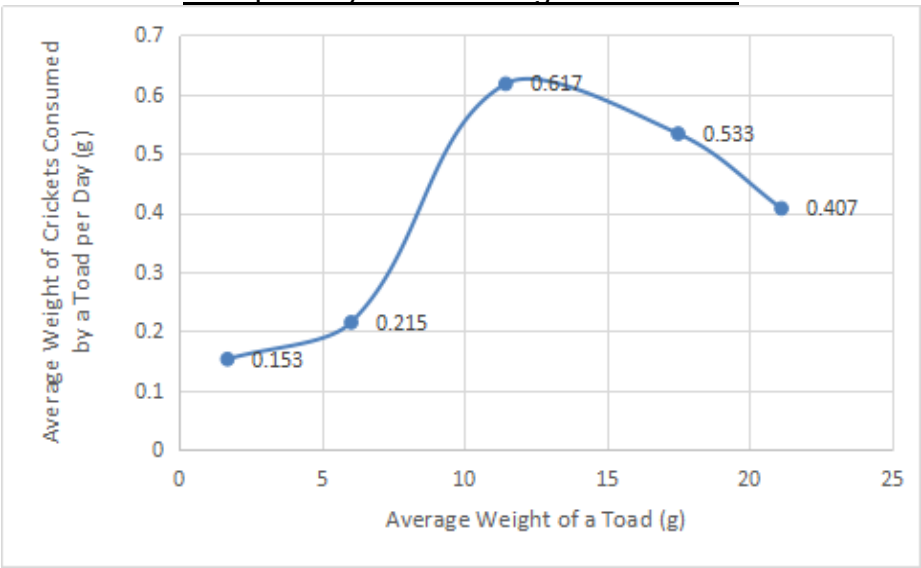
4.2 Result on Objective 2: Investigation on the Amount of Food Consumed by Asian Toads

The raw data of the amount of food consumed by Asian Toads caught in Kowloon Park can be found in appendix 2.

Table 6: The amount of food consumed by Asian Toads caught in Kowloon Park

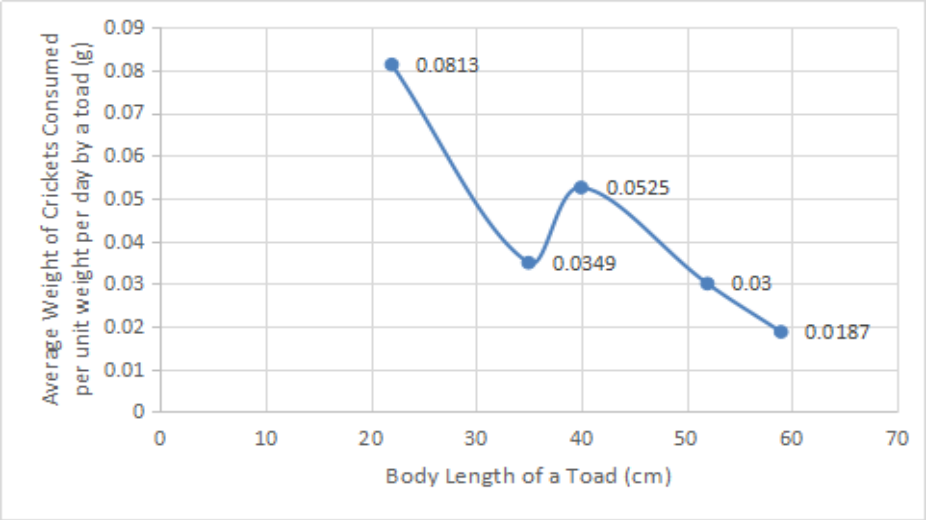
Toad of different size (mm)	Mean Data		
	Weight of the toad ± S.D. (g)	Cricket eaten ± S.D. (g)	Cricket eaten per unit weight of the toad ± S.D. (g/g)
22	1.89/ ± 0.358	0.153 ± 0.132	0.0810 ± 0.0730
35	6.03/ ± 0.419	0.215 ± 0.0500	0.0349 ± 0.00120
40	11.45/ ± 0.702	0.617 ± 0.0499	0.0518 ± 0.00599
52	17.5 ± 1.20	0.533 ± 0.0464	0.0300 ± 0.00467
59	21.1 ± 1.20	0.407 ± 0.132	0.0187 ± 0.00630

Graph 6.1: The relationship between the average amount of food consumed by a toad per day and the weight of the toad



The average weight of crickets consumed by a toad per day increase with the average weight of the toad when the weight of the toad is smaller than 12.3g. The daily food consumption for a toad decreases slightly with its weight when the weight is larger than 12.3g.

Graph 6.2: The relationship between amount of food consumed by an Asian toad caught in Kowloon Park per unit mass and its body length



The graph generally shows that the average weight of crickets consumed per unit weight per day by a toad decreases with the body length of the toad. A small-scale rebounce is observed when the body length is 35cm.

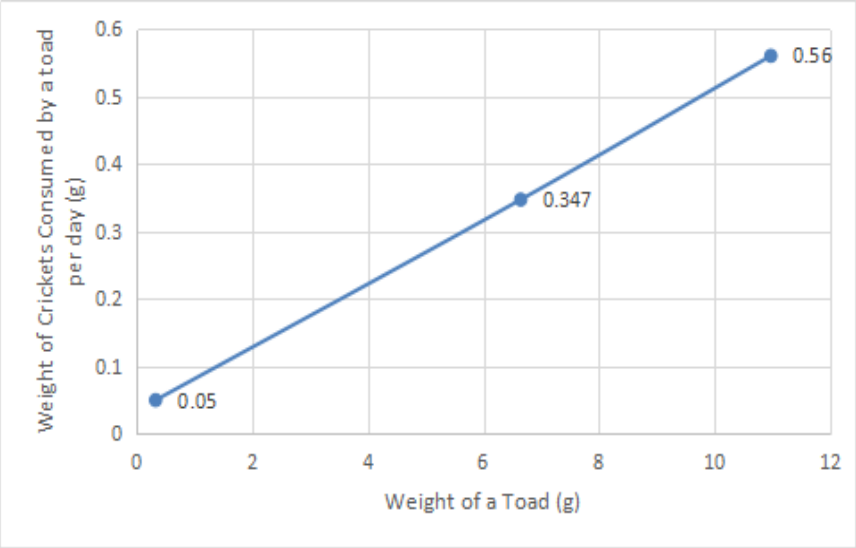
The raw data of the amount of food consumed by Asian Toads caught in Little Hawaii Trail can be found in appendix 2.

Table 7: The amount of food consumed by Asian Toads Caught in Little Hawaii Trail

Toad of different size (mm)	Mean Data		
	Weight of the toad ± S.D. (g)	Cricket eaten ± S.D. (g)	Cricket eaten per unit weight of the toad ± S.D. (g/g)
14	0.328 ± 0.0130	0.05 ± 0.0510	0.156 ± 0.159
36	6.65 ± 0.391	0.350 ± 0.261	0.052 ± 0.0407
41	11.0 ± 1.99	0.560 ± 0.190	0.0502 ± 0.0219
68	17.3 ± 1.23	0 ± 0	0 ± 0

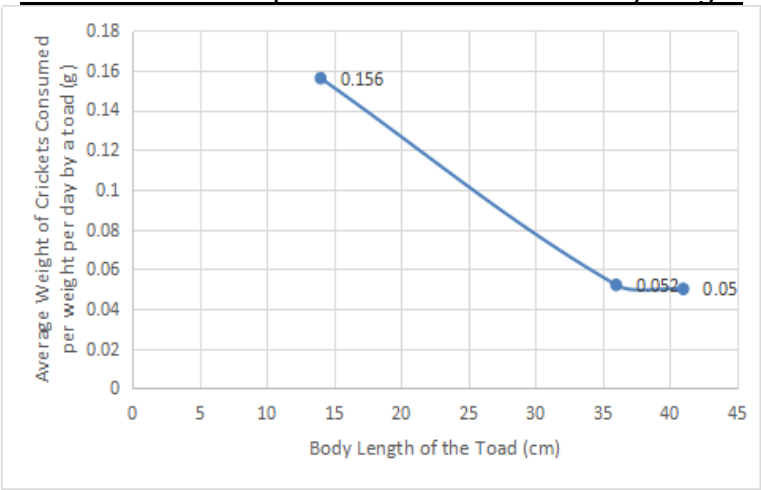
The set of data for the toad 68mm long is discarded when plotting graphs as it had not consumed any food during the 4 days.

Graph 7.1: The relationship between amount of food consumed by an Asian toad caught in Little Hawaii Trail and its weight



The average weight of crickets consumed by a toad per day increases uniformly with the weight of the toad.

Graph 7.2: The relationship between amount of food consumed by an Asian toad caught in Little Hawaii Trail per unit mass and its body length



The graph generally shows that the average weight of crickets consumed per unit weight per day by a toad decreases with the body length of the toad. The drop stops when the body length is around 36cm.

Results of the Control Set-up:

It is found that the weight of 15 crickets decrease 0.06g by themselves on average in 24 hours , with the standard deviation being 0.0453g.

The raw data of the results of the control set-up can be found in appendix 3.

4.3 Result on Objective 3: Investigation on the food preference among different sizes of Asian toad

Table 8: The items that were eaten by Asian toads caught in Little Hawaii Trail

samples of toads of difference sizes(mm)	number of items that can be identified by faecal analysis#				
	termite	ant	mite	beetle	snail
68	20	29	16	3	
40.5	1	17			
17		4			
14		6	1		
12		22		3	

#Each number represent one identifiable animal.

Table 9: The items eaten by Asian toads caught in Kowloon Park

samples of toads of difference sizes(mm)	number of items that can be identified by faecal analysis#				
	termite	ant	mite	beetle	snail
59	1	3			1
52		8			
42	1	7			
22		58			
14*		4	1		
11*		26			

*****The two toads were dead by accident so the content in the toads' guts were investigated.
#Each number represent one identifiable animal.


(Fig.9) termite




(Fig.10) ant


(Fig.11) mite


(Fig.12) beetles


(Fig.13) snail

4.4 Result of Objective 4: Investigation on the abundance of Asian toad of different color pattern

Table 10: The number of different colors of toads caught in Kowloon Park

Samples of toads of difference sizes(mm)	Yellow	Dark Green	Brown	Black
60	1	9	1	4
50	1	12	0	2
40	1	9	0	0
30	2	7	0	1
20	0	7	0	0

(Fig.14) Toad with relatively lighter green (right) and darker (right) green skin color
(Fig.15) Toad with brown (left) and yellow (right) skin color

Table 11: The result of the experiment of the habitat preference of different colored toads

Two yellow Asian toads named as y1 and y2
One brown Asian toad named as b

Time	toads in yellow region	toads in brown region
13/8 00:00	y1 b	y2
13/8 08:00	y1 b	y2
13/8 16:00	y1 y2	b
14/8 00:00	y2	y1 b
14/8 08:00	y2 b	y1
14/8 16:00	y1 b	y2

No apparent trend is seen from the results of the experiment. The locations of the toads in different colour regions does not show that they would opt for habitats similar to their own colour.

5. Discussion

5.1 Discussion on Objective 1: Investigation on the abundance and active time of Asian toad of different stages of their lives in various habitats and weather conditions

The emergence of Asian toads at all sites are noted to be affected by temperature but not relative humidity. This observation can be supported by all tables(2,3,4) showing the abundance of Asian toads in Little Hawaii Trail,Kowloon Park and Lung Fu Shan in March and July. It was most significantly observed in Kowloon Park that when the temperature had risen from 22.3℃ to 27.9℃, the number of Asian toads recorded increased from 19 to 40, as well as in Little Hawaii Trail, when the temperature had risen from 18.7℃ to 28.6℃, the number of Asian toads recorded increased from 19 to 43. This shows that the number of Asian toads observed increases with the surrounding temperature. Thus, it can be concluded that Asian toads are more active at times of higher temperature.

Furthermore, from the results in objective 1, in sites where Asian toads are recorded, adult Asian toads are not observed during daytime while juvenile Asian toads are observed in both daytime and nighttime, which can be deduced from all tables(2,3,4) showing the abundance of Asian toads. As most amphibian are active during night, it may be concluded that the prey of juvenile Asian toads may be active during both daytime and nighttime, causing them to hunt their preferred food at both times of the day.

In addition, from table 5 showing the number of different species of frogs other than Asian toads observed during trips in a specific day in summer, it was noted that the percentage of Asian toads in Kowloon Park(urban areas), 93.8%, was higher than that in Lung Fu Shan(rural areas), 45.2%. This may be due to other amphibians being less adaptive to urban areas and this leads to the high percentage of Asian toads in urban areas. To sum up, in comparison to other amphibians, Asian toads are more adapted to urban areas.

However, due to the limited view of field of our vision, the distance that can be observed was limited. Therefore, the estimated abundance of Asian toads was not accurate. Moreover, the data in daytime had a low reliability as there was only one trial in each sites.

5.2 Discussion on Objective 2: Investigation on the Amount of Food Consumed by Asian Toads

According to the graph 6.1, it can be concluded that the amount of food consumed by an Asian toad is generally higher if the weight and body length of the toad is larger and longer. However, the toads with around 40mm body length eat the most, whereas the larger toads consume not as much. A possible hypothesis is that toads around 40 mm are in their growing period so they need more energy thus more food to support their higher growth rate. However, no relevant information could be found upon data research.

The difference in appetite between the toads living in Kowloon Park and Little Hawaii Trail is not concluded. Among the 5 sets of data of Kowloon Park’s toads and 4 sets of data of Little Hawaii Trail’s toads, only two toads which come from different places have comparable weight (both 6.09 g). Therefore, the comparison is not reliable enough.

According to table 6.2 and 7.2, food consumption per unit mass by all the toads decrease with increasing body length. The reason may be that smaller and younger toads require more energy per unit weight to support growth. In addition, one set of the data rebound and the other set stops dropping

when the body lengths of the Asian toads are 35mm. The reason for the rebounce cannot be accounted for as no relevant data can be found.

It is found that all toads, with the 52 mm-long toad caught from Kowloon Park being the exception, consume less or even no food on the first day that they are supplied with crickets than they do on subsequent days. The reason may be that, firstly, the Asian toads are not acquainted with the new and artificial environment and feeding in laboratory, so they are alarmed by the sudden supply with crickets thus refuse to eat as much. Secondly, the reason may be that Asian toads do not get to eat as much as supplied in nature meaning that they may have been accustomed to consume smaller amount of food. Therefore, on the first day they are supplied with crickets, they have not yet adjusted themselves. Thirdly, the reason may be that, given that crickets are not included in the toads' diets according to findings in objective 3, they refuse to eat them the first day but are then forced to do so due to starvation.

A fact that stands out is that the toad caught from Lung Fu Shan which is 68 mm long has not eaten any food in 3 days and accidentally died the next day.

The finest calibration of the vernier scale is 0.05mm, meaning that the maximum error is 0.025mm. The largest percentage error is 0.179%, for the toad with body length 14mm. The finest calibration of the electronic balance is 0.01g, meaning that the maximum error is 0.005g. The largest percentage error is 1.56%, for the toad with weight 0.32g. Errors due to inaccuracy of apparatus is insignificant.

However, the reliability of Graph 6.1, 6.2 and especially Graph 7.1, 7.2 is low. As only 5 and 3 sets of data are collected for toads of Kowloon Park and Little Hawaii Trail respectively, the best-fit curve may not represent the real trend reliably. According to the result of the control set-up (shown in the appendix), the weight of crickets shows percentage change varying from -16.7% to +25.0%, which the loss in cricket weight may not equal the food consumed by the toad. In addition, according to table 6.1, the standard deviation of the average weight of cricket consumed per day by the toads with body length 22mm and 59mm is of large value(0.358 g and 1.2 g respectively). The data of average weight of cricket consumed per day per unit weight by the 22mm long toad also show large variation (0.132 g). Besides, concerning data obtained from toads in Little Hawaii Trail, both sets of data indicating average daily food consumption show large variation (0.261 g and 0.19 g respectively) for toads of 36mm and 41mm long. Together with the fact that only 3 sets of data are used for graph 7.1, it makes the trend insignificant.

According to Table 6 and 7, Asian Toads can eat in one day from 1.87% up to 15.7% of their own weight.

5.3 Discussion on Objective 3: Investigation on the food preference among different sizes of Asian toad

After the investigation, Asian toads' major food source, difference of food preferences of toads in different sizes, and variations of food in rural and urban areas were known.

According to table 8 and 9, ants take up the largest proportion in the leftover of the faeces. This tells that the main food source of all Asian toads is ant. In Little Hawaii Trail, in the adult toad's (68mm) faece, 29 ants were found, which takes up 43% of the insects that can be indicated. In juvenile toad's (17mm) faeces, there were 4 ants found, which takes up 100%. In Kowloon Park, in the adult toad's (52mm) faeces, 4 ants were found, which takes up 60%. In the juvenile's (14mm) gut, 4 ants were found, which takes up 80%. This shows that ants is the main food source of Asian toads in both rural

and urban areas. Thus, this shows that all Asian toads are mainly responsible for controlling the number of ants in the ecosystem. Two types of ant most commonly eaten by the toads which can be identified, is *Oecophylla smaragdina* and *Crematogaster ebenina.* Limited by our unprofessional classification knowledge, many of the undigested materials cannot be identified, including some undigested insect body parts. Thus, the actual species of ants that they eat should be more than what we investigated.

Also, larger Asian toads (body length longer than 22mm) also consume termite, while the juveniles cannot. This shows that larger Asian toads have a wider variation of prey. As termite are insects that are relatively big in size (~6-10mm), the small juvenile toads cannot feed on them. As a result, as the toads increase in size, the type of food that they can eat increases. This can be shown in the faece content of the toad (68mm) in Little Hawaii Trail. However, even if the toads grown up to 60mm, their main dish are still ants and sometimes with termite. For that of beetle, mite and snail or any other insects, they are consumed by the toads randomly in a small amount and will not affect the toad's main diet.

In addition, according to tables 8 and 9, the variation of prey in Little Hawaii Trail is much wider than that in Kowloon Park. In Kowloon Park, ants take up 95% of the total prey found (80 out of 84). While in Little Hawaii Trail, ants only take up 64% (78 out of 122), termites take up 17% (21 out of 122), mites take up 13 %(17 out of 122), and beetles take up 5 %(6 out of 122).Therefore, it shows that in Little Hawaii Trail (rural areas), the proportion of other preys except ant is larger.

Discussion on Objective 4: Investigation on the abundance of Asian toad of different color pattern

It is found that the colors of the toads have significant difference. The colors range from yellow, dark green, brown, to black. The comparisons can be seen in figure 14 and 15. This variation in color also can be seen in other countries such as Taiwan[7]. Most of the Asian toads were found to be in dark green color while brown or yellow colored toads only occupied a small proportion. Nonetheless, no qualitative methods can be used to test the darkness of skin color, so no concise conclusion is drawn. Darker Asian toads were more likely to be found in a larger abundance in soil of darker color while Asian toads of lighter color were more abundant in soil of lighter color in Kowloon Park. As a result, it is hypothesized that the toads will choose their habitats of similar color concerning their skin.

From the results of the experiment, one yellow toad was recorded to be staying in the yellow region for 4 times and brown for twice. The other yellow toad was founded to be staying in both area for the same period of time while the brown toad was recorded to be staying in the brown region for 2 times and yellow for 4 times. It is shown that Asian toads have no preference of habitats with reference to their own color. However, this experiment is quite artificial since no bedding is provided. It is unreliable too as only three toads were being investigated.

Extra findings

During the field study to Little Hawaii Trail on 18/7, Asian toads were found stacking together in those water pipes for water drainage at the hillside. At the previous field studies, although the appearance of Asian toads was also observed in water pipes, mostly one Asian toad was observed in a single drainage. A maximum of 2 Asian toads were located in the same water pipe. However, at that field study, a much larger number of Asian toads were found in the water pipes and many of them stacked together. A maximum of 5 toads had been observed in a single water pipe in Little Hawaii Trail.

Further investigations

After the research, it is deduced that the main food source of Asian toads, no matter from rural or urban areas, is ants. However, in the experiment on the amount of food consumption of Asian toads, the food provided to the toads were crickets. They may not be familiar with having crickets as their diet so the actual fresh mass of food consumed by the Asian toads in the wild may be higher. A juvenile Asian toad captured died after not willing to eat for 3 days. It is hypothesized to be due to their unusual diet.
A further investigation on the mass of food consumed by Asian toads can be carried out by the same procedure as the original one, but with ants as food supply to further simulate the situation in the wild.

The experiment investigating whether Asian toads' color pattern would affect their preference of habitat was very artificial. No soil was supplied and changing the color by colored paper is also unnatural. The environment was greatly differing from the habitat of Asian toads and this would greatly influence the experimental results. An improvement of the experiment is that substrata of different color can be collected from the field where the toads were captured to simulate the natural environment.

The phenomenon of Asian toads stacking together in a small water pipe was only discovered at the last field study. No further investigation was carried out to find out whether they have the tendency to live together or not.
A few more field studied to Little Hawaii Trail can be carried out to see under what circumstances would this situation occur and details like would factors like sex, weight, color affect their preferences of staying together.
An experiment can also be carried out in laboratory to find out whether Asian toads are prone to living together. A large transparent aquarium covering soil, with adequate water and food supply, can be prepared. A few Asian toads are put inside. Cut water pipes can be placed inside and investigate whether they tend to stay together.

6 Conclusion

It is concluded that the emergence of Asian toads at all sites are noted to be affected by temperature but not relative humidity and they are more active at times of higher temperature. Adult Asian toads are not observed during daytime while juvenile Asian toads are observed in both daytime and nighttime. In comparison to other amphibians, Asian toads are more adapted to urban areas.

The amount of food consumed by an Asian toad's food consumption per unit mass by all the toads decrease with increasing body length. The reason for the rebounce cannot be accounted for as no relevant data can be found. It is also found that an Asian toad is capable of consuming food as much as 1.87% to 15.7% of its weight in one day.

It is found that the main food source of all Asian toad is ant. Asian toads have a wider variation of prey when they grow bigger. Also, the variation of prey in rural area (Little Hawaii Trail) is much more than that in urban area (Kowloon Park).

Most of the Asian toads were found to be in dark green color while brown colored toads only occupied a small proportion.

It is also found that Asian toads may have a tendency to live together.

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Appendix 1

Table Details of field trips

Date	Time	Site	Event
24/3	2000-2100	Little Hawaii Trail	Estimation of abundance and distribution of toads
27/3	2200-2100	Kowloon Park	Estimation of abundance and distribution of toads
9/5	2030-2130	Kowloon Park	Estimation of abundance and distribution of toads
29/6	2230-2330	Lung Fu Shan	Estimation of abundance and distribution of toads
10/7	2130-2230	Lung Fu Shan	Estimation of abundance and distribution of toads
12/7	0800-0900	Lung Fu Shan	Estimation of abundance and distribution of toads
18/7	1030-1130	Little Hawaii Trail	Estimation of abundance and distribution of toads
18/7	2200-2300	Little Hawaii Trail	Estimation of abundance and distribution of toads Identification of color pattern of Asian toads Capture of Asian toads Measure of length and identification of sex of captured toads Brief estimation of length of toads that were not captured
19/7	0830-0930	Kowloon Park	Estimation of abundance and distribution of toads Identification of color pattern of Asian toads Capture of Asian toads Measure of length and identification of sex of captured toads Brief estimation of length of toads that were not captured
29/7	2015-2115	Kowloon Park	Estimation of abundance and distribution of toads Identification of color pattern of Asian toads Capture of Asian toads Measure of length and identification of sex of captured toads Brief estimation of length of toads that were not captured

Appendix 2

Detailed Results of the Experimental Set-up of Objective 2

The amount of food consumed by Asian Toads caught in Kowloon Park

Toad of different size (mm)	Day 1		Day 2		Day 3		Day 4	
	Weight of the toad(g)*	Cricket eaten (g)	Weight of the toad (g)	Cricket eaten (g)	Weight of the toad (g)	Cricket eaten (g)	Weight of the toad(g)	Cricket eaten (g)
22	1.09*	/	1.81	0.01	1.84	0.33	2.03	0.12
35	5.34	/	6.46	/	6.21	0.21	6.12	0.22
40	10.4	/	12.3	0.55	11.3	0.67	11.8	0.63
52	16.1	/	16.0	0.58	18.8	0.47	19.1	0.55
59	19.1	/	21.8	0.26	22.2	0.38	21.4	0.58

The amount of food consumed by Asian Toads caught in Little Hawaii Trail

Toad of different size (mm)	Day 1		Day 2		Day 3		Day 4	
	Weight of the toad(g)	Cricket eaten (g)	Weight of the toad (g)	Cricket eaten (g)	Weight of the toad(g)	Cricket eaten (g)	Weight of the toad (g)	Cricket eaten (g)
14	0.32	/	0.32	0.03	0.32	0.12	0.35	0
36	6.60	/	6.36	0	7.30	0.41	6.33	0.63
41	9.09	/	9.62	0.77	11.0	0.31	14.2	0.60
68	20.6	/	18.5	0	16.0	0	(Dead)	(Dead)

Appendix 3

Result of the Control Set-up of Objective 2

	Weight of Crickets Added (g)	Weight of Crickets Retrieved after 24 hours（g）	Change in the Weight of Crickets (g)
Day 1	0.60	0.58	-0.02
Day 2	0.58	0.51	-0.07
Day 3	0.64	0.51	-0.13
Day 4	0.67	0.65	-0.02