Ninjas in our city: a study of the distribution and homing behaviour of short-nosed fruit bats

Team 1 Cheung Chuk Shan College

S5 Chan Mung Ni, Monica

S5 Cheung Ka Wing, Fransisca

S5 Chung Ka Ying, Cuby

S5 Go Ho Ching, Charlotte

S5 Zhang Shenglan, Ann

Content

1 Abstract

Short-nosed fruit bat (*Cynopterus sphinx*) is a common bat species found in urban areas. It is the only species that construct their tent roosts by biting marks on the fronds the Chinese Fan-palm (*Livistona chinensis*), which is commonly seen in urban areas. Due to its nocturnality, short-nosed fruit bats are not easily noticed by human, just like ninjas.

In this study, we are going to disclose the secrets of short-nosed fruit bats. Our objectives are to study the distribution and abundance of short-nosed fruit bats, the homing pattern and its relation to colony size, the time of the bats flying out from tent roosts and its relation to time of sunset and lastly, their feeding and foraging habits.

The key methods are field observation and roost censuses at some large parks like Victoria Park and Hong Kong Park, as well as some small parks in urban areas. The short-nosed fruit bats, Chinese Fan-palm and the surroundings of their tent roosts are recorded by photo and video taking.

As for the conclusion, by comparing with the study by AFCD in 2006, the percentages of palms with tent roosts increased in 4 out of 5 venues we surveyed, while the average percentage of palms with tent roosts (10.5%) decreased slightly by 0.7%. The average percentage of palms with bat colonies is 2.88%. Besides, the following behaviours of short-nosed fruit bat were observed. Withered fronds may not affect their preferences to live. The bats tended to construct and use roosts on the same palm or palms near to the location of original roosts and the bats tended to stay at 1 to 2 frequently used roosts only, though extra roosts were constructed nearby. Furthermore, it is found that the bats start flying out only after the time of sunset and the food sources can usually be found near their roosts

However, no concrete conclusion can be drawn about the following observations. Fluctuations of homing patterns of both small and large bat colonies are recorded in both short-term and long-term observation. There is no conclusion on the reasons and patterns for such fluctuations. Besides, the colony at Ocean Shores is observed to have consistent pattern of time lapses between the time of sunset and the time of 1st bat flying out, but the colony at Victoria Park does not. Moreover, it is suggested that there may be leading bats inspecting the areas before all bats fly out one by one. These could be the possible further studies about short-nosed fruit bat.

2 Introduction

Few months ago, a short-nosed fruit bat visited our campus and left some food remains and faeces on the ground. Inspired by our advising teacher, Mr. Tong, our interests towards short-nosed fruit bats aroused and we decided to set them as our investigation focus.

Fig 1. The short-nosed fruit bat visited our campus

In our field trips to Victoria Park, Hong Kong Park and other small parks in the urban areas, we observed the tent roosts and the surroundings and raised some questions concerning the homing behaviours of short-nosed fruit bats. Eventually, we grouped the research questions into four main objectives.

Objectives

1. Survey the distribution and abundance of short-nosed fruit bat
2. Study the homing pattern of short-nosed fruit bat and its relation to colony size
3. Study of the time of the bats flying out from tent roosts and study its relation to time of sunset
4. Study short-nosed fruit bat's feeding and foraging habits

Research Questions

1. How do the surrounding environment and fronds condition affect their preferences to live?
2. What is the bats' frequency of changing their roosts?
3. Are the roosts located at the outer part or inner part of the parks?
4. Is there any relation between the time of sunset and the time of bats flying out?
5. Is there any difference in the time of bats flying out in different districts?
6. Is there any pattern in the duration of flying out?
7. What does short-nosed fruit bat eat?
8. Would they construct roosts near to their food sources?

Background information of Short-nosed fruit bat

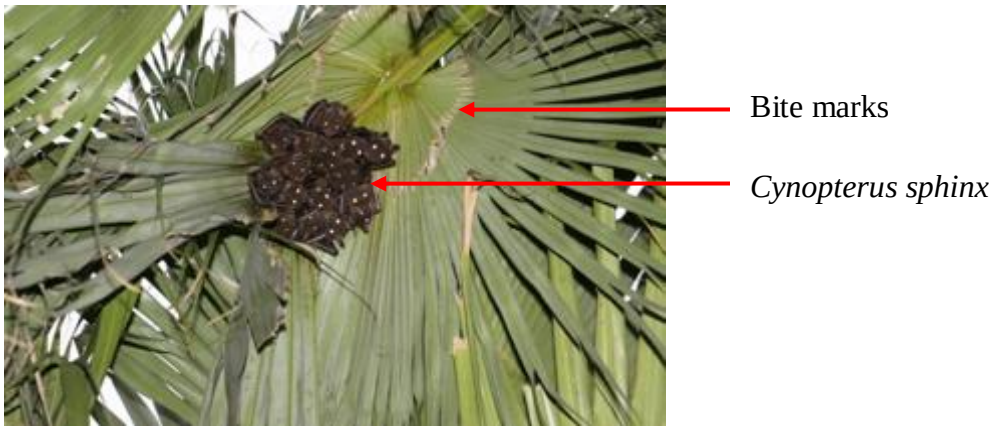

Fig 2.Short-nosed fruit bat (*Cynopterus sphinx*)

Short-nosed fruit bat (*Cynopterus sphinx*) has a short muzzle, conspicuous eyes and dark brown fur with white border on the ears and rims of fingers. The collar is orange tinted in males and yellowish brown in females. (Shek, 2006)

In Hong Kong, it is commonly found in urban areas where human disturbance is omnipresent. It is the only bat species in Hong Kong that constructs its own roosts by chewing the veins of the fronds of Chinese Fan-palm (*Livistona chinensis*) and Petticoat Palm (*Washingtonia robusta),* making the fronds collapsed along the circular bite marks. (Chan and Shek, 2006)

C. sphinx roosts in a harem-polygynous system. Generally, a single dominant male roosts alone or associated with one to 24 reproductive females and their dependent young. (Storz and Kunz, 1999; Chan and Shek, 2006) .Males constructs roosts and defends them against intrusions from other males for the purpose of gaining exclusive reproductive access to tent-roosting females (Bhat and Kunz, 1994; Storz and Kunz, 1999; Chan and Shek, 2006).

3 Materials and methods

3.1 Surveying the distribution and abundance of short-nosed fruit bat

1. Chinese Fan-palm were observed to look for fronds with bite marks (tent roosts) and potential bat colonies at Victoria Park, Hong Kong Park, Hong Kong Zoological and Botanical Gardens, Admiralty Garden and Ocean Shores (Tiu Keng Leng).
2. The positions of Chinese Fan-palm were marked on the map.
3. The number of tent roosts of each palm was counted and recorded.
4. The presence of bat colonies was determined by observing under the tent roosts with a pair of binoculars and a torch.
5. If bat colonies were present, the number of bats in each colony was counted by photo recording and recorded in the log sheets.
6. The tent roosts in use were observed to study whether withered fronds influence the bats' preferences to live.
7. The percentage of palms with tent roosts, average percentage of palms with tent roosts , average percentage of palms with bat colonies and the percentage of tent roosts occupied by bat colonies were calculated by the following formulae.

   Percentage of palms with tent roosts = $\frac{\text{No. of palms with tent roosts}}{\text{No. of palms}} \times 100\%$

   Average percentage of palms with tent roosts= $\frac{\text{Total no. of palms with tent roosts}}{\text{Total no. of palms}} \times 100\%$

   Average percentage of palms with bat colonies = $\frac{\text{Total no.of bat colonies}}{\text{Total no.of palms}} \times 100\%$

   Percentage of tent roosts occupied by bat colonies =$\frac{\text{No. of bat colonies}}{\text{No. of tent roosts}} \times 100\%$

3.2 Continuous observation of selected colonies to study the homing pattern and its relation to colony size

1. 2 bat colonies were selected, each from small size colonies (1 to 4 bats present) and large size colonies (more than 4 bats present) at Victoria Park and Ocean Shores.
2. Group members were divided into groups to observe the colonies at different locations for 7 consecutive days.
3. The homing patterns of large size and small size bat colonies were recorded and compared in terms of number of bats and frequency of changing their tent roosts.

4. The large and small colonies at Ocean Shores were observed for a long-term period.

3.3 Record of the time of the bats flying out from tent roosts and study its relation to time of sunset

1. Group members were divided into groups to record the time of bats flying out of similar size bat colonies simultaneously at Victoria Park and Ocean Shores.
2. The time of the first bat flying out from tent roosts was recorded with a watch.
3. The time lapses of bats flying out one by one were recorded with stopwatch function in smartphone.
4. The process was recorded by video taking for double checking.
5. The relation between the time of flying out and the time of sunset which was obtained from the Hong Kong Observatory was studied.

3.4 Continuous observation of bats' faeces and fruit remains to study their feeding and foraging habits

1. Faeces and fruit remains of bats at school and under tent roosts were recorded.
2. The fruit remains and seeds in the faeces were identified.
3. The trees around which grow fruits that bats eat were searched to study whether the bats would construct roosts near to their food sources.

3.5 Working Schedule

Date	Time	Venue	Event
15-2-2013	10:00-15:00	Hong Kong Park, Hong Kong Zoological and Botanical Gardens, Admiralty Garden	Distribution and abundance study
14-4-2013	12:00-15:30	Victoria Park	
27-4-2013	09:30-10:00	Ocean Shores	
12-3-2013 to 18-3-2013, 24-11-2012 to 27-4-2013	17:30-19:00	Ocean Shores, Victoria Park	Continuous observation of selected colonies
31-1-2013, 2-2-2013, 14-3-2013, 16-3-2013, 18-3-2013, 13-4-2013	17:30-19:00	Ocean Shores Victoria Park	Record of the time of the bats flying out from tent roosts
18-1-2013 to 30-4-2013	N/A	Ocean Shores, Siu Sai Wan Cheung Chuk Shan College	Continuous observation of bats' faeces and fruit remains

4 Results

4.1 Distribution and abundance of short-nosed fruit bat

Table 1. A table showing the data collected in distribution and abundance surveys

Venue	Hong Kong Park	Victoria Park	Hong Kong Zoological and Botanical Gardens	Admiralty Garden	Ocean Shores
No. of palms	45	218	29	7	14
No. of palms with tent roosts	7	11	6	1	8
No. of tent roosts	19	24	12	8	31
No. of bat colonies	2	4	0	1	2
Percentage of palms with tent roosts (%)	15.6	5.05	20.7	14.3	57.1
Average percentage of palms with tent roosts (%)	10.5				
Average percentage of palms with bat colonies (%)	2.88				
Percentage of tent roosts occupied by bat colonies (%)	10.5	16.7	0	12.5	6.45

Remarks:

- For all the formulae, refer to the section 3.1.
- All figures are corrected to 3 significant figures.

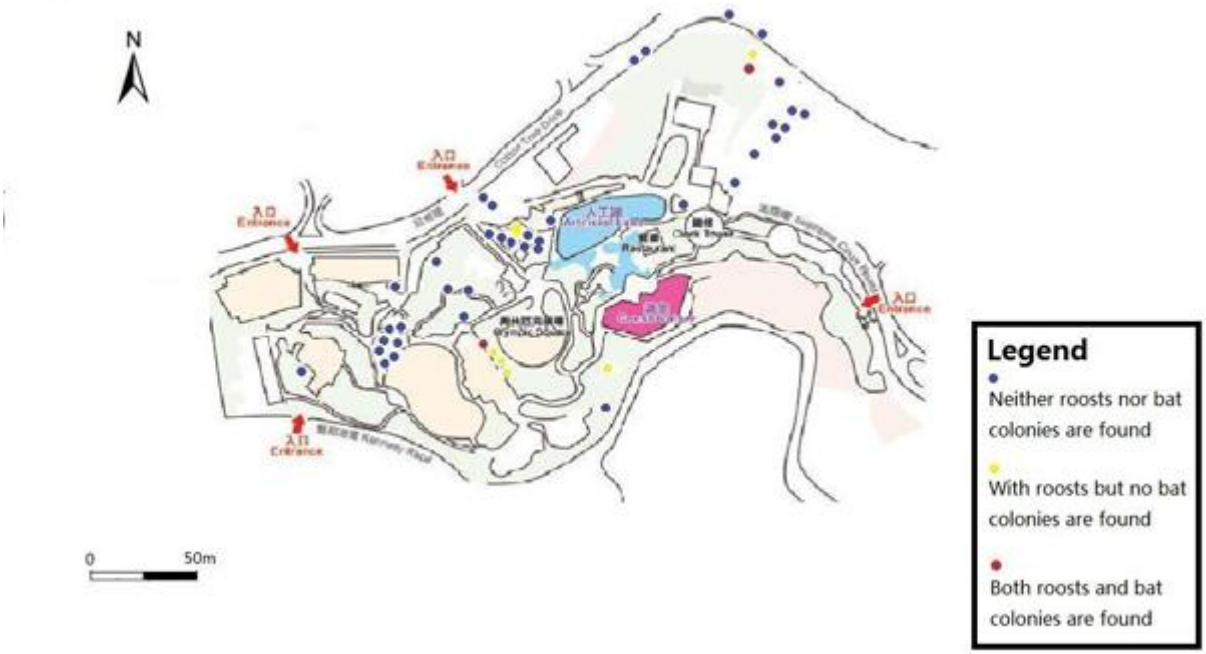

Fig 3. Hong Kong Park

Fig 4. Victoria Park

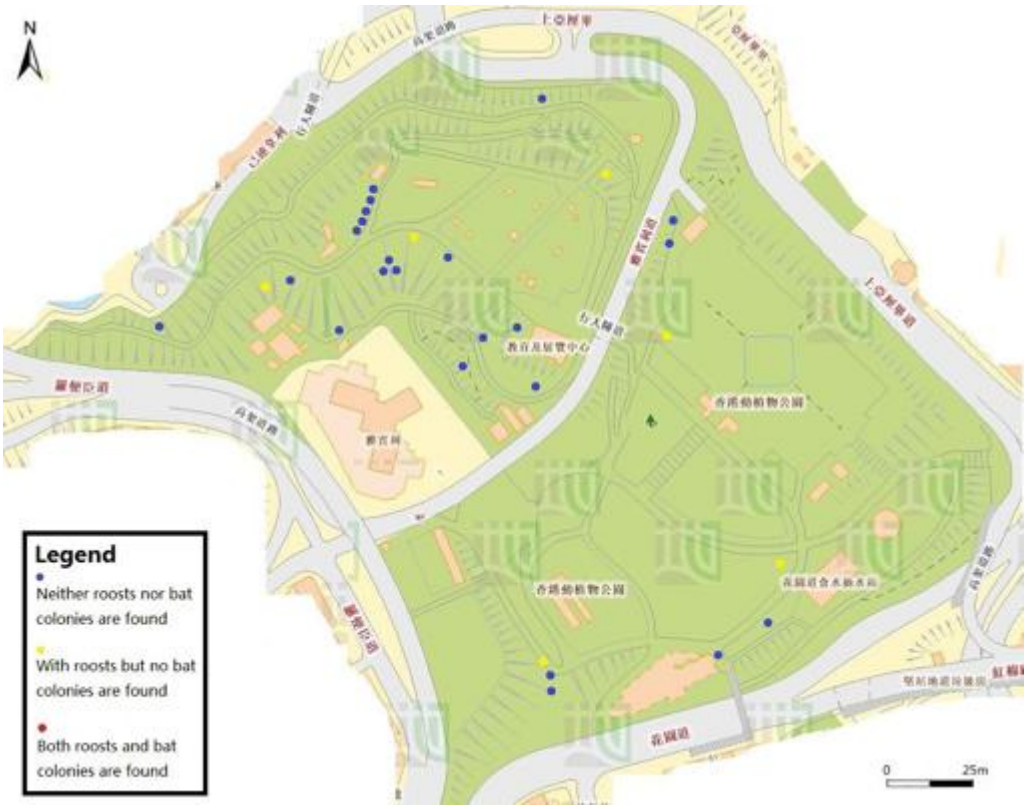

Fig 5. Hong Kong Zoological and Botanical Garden

From Table 1, the percentages of palms with tent roosts ranged from 5.05% to 57.1% in the five venues we surveyed. The percentages of tent roosts occupied by bat colonies ranged from 0% to 16.7%. Only tent roosts were found in Hong Kong Zoological and Botanical Gardens but no bat colonies were found. From fig 3,4 and 5, roosts were distributed at both outer and inner parts of the parks. Usually, roosts were found on palms close to each other.

4.2 Homing pattern and its relation to colony size

According to short-term observation (i.e.7 days) recorded in Table 2 and 3, the number of bats in both large and small size colonies varied by at most 2 bats. Comparatively, in the long-term observation (i.e. about 5 months) recorded in Fig 8 and 9, the numbers of bats of both large and small size colonies were observed to have ups and downs and fluctuated by a larger extent than that of short term observation.

For both short and long-term observations, the tent roosts in use were rather consistent. It was noticed that the roosts they changed to were close to each other (Fig 6,10,11).

4.2.1 Ocean Shores

Fig 6. Roosts A and B used by the large bat colony

Fig 7. Roost C used by the small bat colony

Table 2. Homing pattern of small and large size bat colony at Ocean Shores

Colony size / Date	No. of bats present		Tent roost in use	
	Small	Large	Small	Large
12-3-2013	2	13	C	A
13-3-2013	1	11	C	A
14-3-2013	1	12	C	B
15-3-2013	1	12	C	A
16-3-2013	1	12	C	A
17-3-2013	1	12	C	A
18-3-2013	1	12	C	A

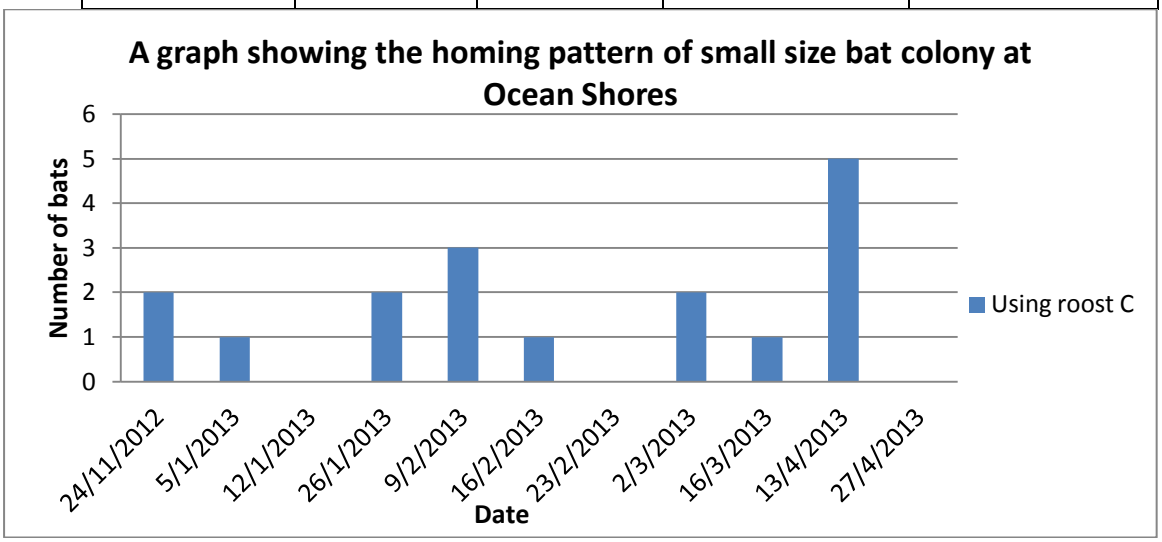

Fig 8. Long-term record of the homing pattern of small size colony at Ocean Shores

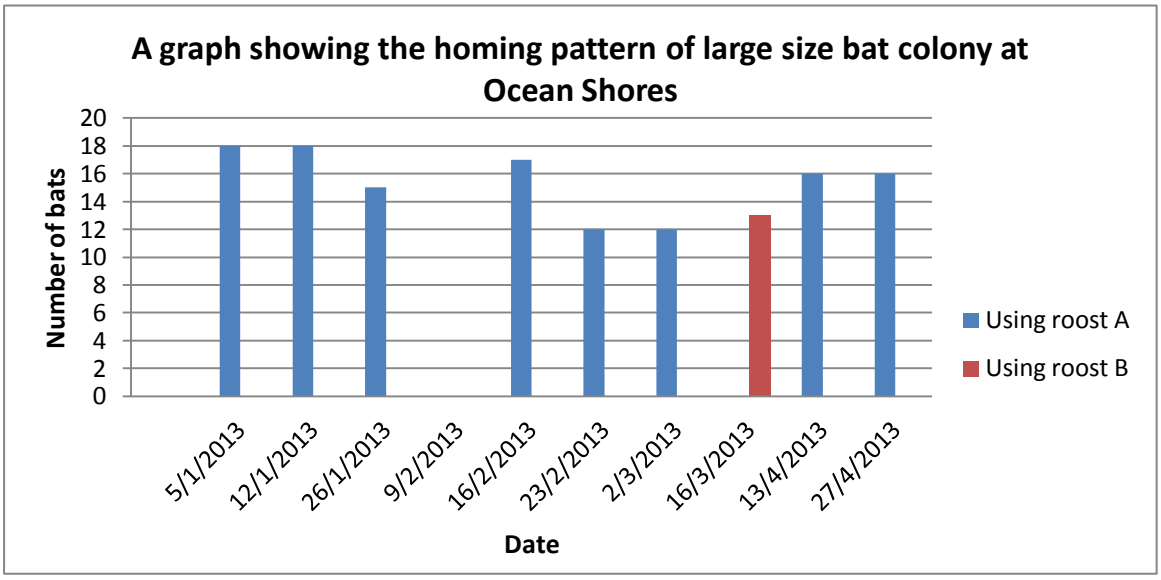

Fig 9. Long-term record of the homing pattern of large size colony at Ocean Shores

Remarks: For fig 8 and 9, the number of bats is zero if the bat colony was not found on that date.

4.2.2 Victoria Park

Fig 10. Roost D and E used by the small bat colony

Fig 11. Roosts F and G used by the large colony

Table 3. Homing pattern of small and large size bat colony at Victoria Park

Colony size / Date	No. of bats present		Tent roost in use	
	Small	Large	Small	Large
12-3-2013	3	13	D	F
13-3-2013	2	13	D	F
14-3-2013	1	13	E	F
15-3-2013	2	15	E	F
16-3-2013	2	14	E	F
17-3-2013	3	14	E	F
18-3-2013	3	15	E	G

4.3 Time of the bats flying out from tent roosts and its relation to time of sunset

Table 4. Time lapses between the time of sunset and the time of 1st bat flying out at Ocean Shores and Victoria Park

Date	Time lapse between the time of sunset and the time of 1st bat flying out (m:s)	
	Ocean Shores	Victoria Park
31-1-2013	13:00	
2-2-2013	10:00	
14-3-2013	10:00	
16-3-2013	08:53	16:24
18-3-2013	09:27	04:04
13-4-2013	07:42	00:00

Table 5. The time of the bats of large colony size flying out from tent roosts at Ocean Shores

Date	14-3-2013	16-3-2013	18-3-2013	13-4-2013
Time of sunset	18:32	18:33	18:34	18:43
No. of bats	Time of flying out (h:m:s)			
1	18:42:00	18:41:53	18:43:27	18:50:42
2	18:42:16	18:43:44	18:45:21	18:50:44
3	18:42:19	18:45:45	18:45:22	18:53:54
4	18:42:26	18:47:23	18:45:26	18:54:00
5	18:42:29	18:47:39	18:45:28	18:54:05
6	18:42:32	18:47:54	18:45:28	18:54:07
7	18:42:34	18:48:02	18:45:30	18:54:20
8	18:42:35	18:49:22	18:45:32	18:54:22
9	18:42:36	18:49:52	18:45:32	18:54:24
10	18:42:42	18:49:56	18:45:33	18:54:28
11	18:42:54	18:49:57	18:45:34	18:54:30
12	18:42:55	18:52:58	18:45:37	18:54:31
13				18:54:34
14				18:54:35
15				18:54:37
16				18:54:38
Duration(m:s)	00:55	11:05	02:10	03:56

Table 6. The time of the bats of large colony size flying out from tent roosts at Victoria Park

Date	14-3-2013*	16-3-2013	18-3-2013#	13-4-2013^
Time of sunset	18:32	18:33	18:34	18:43
No. of bats	Time of flying out (h:m:s)			
1	18:33	18:49.24	18:38.04	18:43:00
2	19:10	18:49.35	18:38.15	18:50:12
3	19:11	18:50.01	18:38.17	18:50:52
4	19:11	18:50.05	18:39.45	18:50:53
5	19:11	18:50.47	18:39.57	18:51:19
6	19:12	18:50.58	18:41.00	18:51:20
7	19:12	18:51.04	18:41.02	18:53:11
8	19:12	18:51.11	18:41.34	18:53:12
9	19:13	18:51.38	18:42.09	18:53:12
10	19:14	18:51.41	18:45.44	18:53:44
11	19:15	18:51.42	18:46.03	18:53:58
12	19:15	18:51.43	18:46.10	18:53:59
13	19:15	18:52.37	18:46.14	18:53:59
14				18:53:59
15				18:55:03
16				18:55:29
Duration(m:s)	42:00	03:13	08:10	12:29

* This data is discarded as the disturbance to the bats by torch illumination might be significant

\# Two bats flew out at 18:33 and 18:44 respectively, for one to two minutes. It is suggested that they were inspecting the area. A bat flew out and stayed at another roost for 10 minutes.

^ A bat was left behind after others flew out. It is suggested that it was a newborn.

4.4 Feeding and foraging habits

4.4.1 Ocean Shores (Tiu Keng Leng)

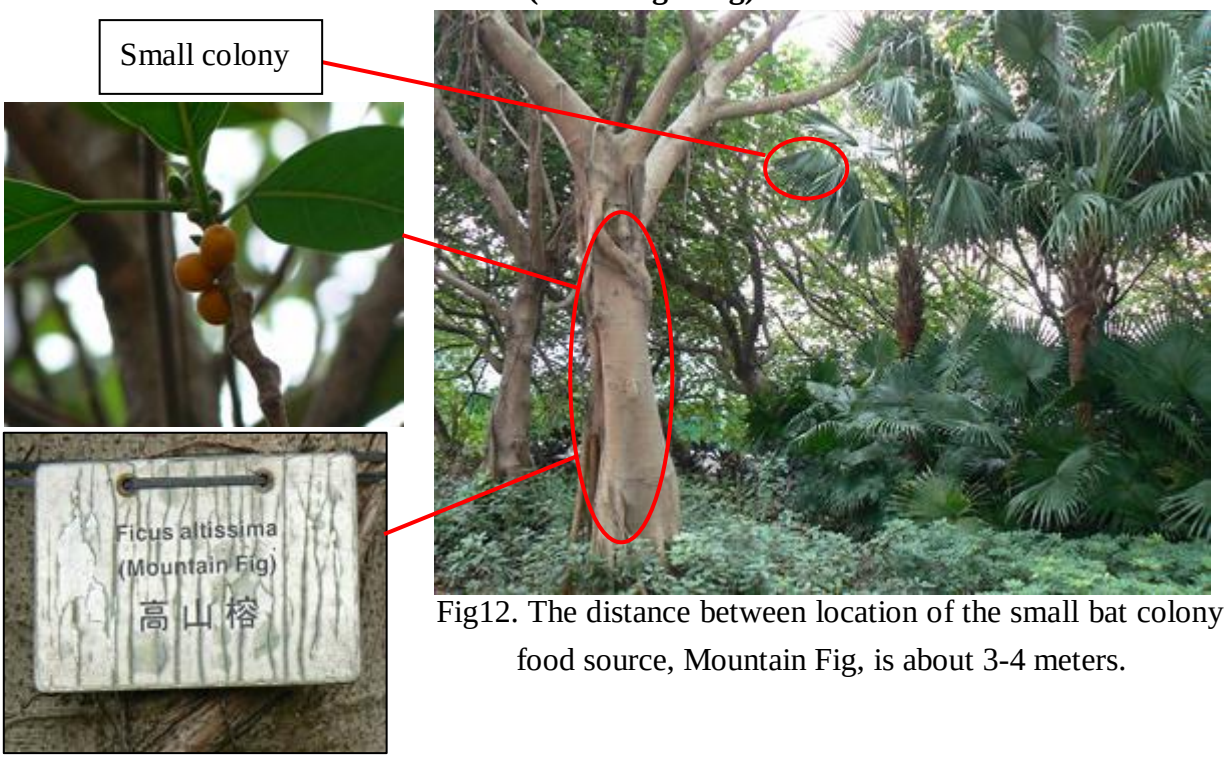

Fig12. The distance between location of the small bat colony and its possible food source, Mountain Fig, is about 3-4 meters.

Fig 13 & Fig 14. Fruits of Mountain Fig

Fig 15. Faeces under large bat colony Fig 16. Food remains under large bat colony

From Fig 13 & 15, the seeds in the bat's faeces are most likely the seeds of Mountain Fig. From Fig 16, the food remains found under large bat colony is most likely the fruit of Mountain Fig.

4.4.2 Siu Sai Wan

Fig 17. The distance between the location of the small bat colony and its possible food source, Common Red-stem Fig, is about 17 meters.

Fig 18 & 19. Common Red-stem Fig (*Ficus variegate*)

4.4.3 Cheung Chuk Shan College

The faeces and food remains recorded (Fig 20&21) are fruits of Common Red-stem Fig (*Ficus variegate*) and Cone Pepper (*Capsicum annuum*), which can be found in our school campus at a distance of about 10 m from the place we found the bat and its food remains (5/F stairs).

Fig 20 & 21. Faeces and food remains recorded

5 Discussion

5.1 Interpretation of results

5.1.1 Distribution and abundance of short-nosed fruit bat

The variation in the percentages of palms with tent roosts of the five venues surveyed is quite large as the range is about 52%. It is suggested that such variation is due to the different level of human disturbance in different venues. Ocean shores has a relatively low human disturbance as very few people pass by there, except those walking the dogs. Conversely, human disturbance in Victoria Park is relatively high. Besides, the difference in areas of venues may affect their percentages of palms with tent roosts.

According to a survey on the Short-nosed Fruit Bat by AFCD in 2006, the percentage of Chinese Fan-palm with tent roosts was 11.2% in urban areas in Hong Kong (Chan and Shek, 2006). By comparing our results with figures in previous study, the percentages of palms with tent roosts have risen except for that of Victoria Park (10.5%). It is suggested that the decrease is due to high level of human disturbance affecting the bats' preferences to construct roosts in Victoria Park. The average percentage of palms with tent roosts (10.5%) decreased slightly by 0.7% compared to the figure in previous study. Furthermore, the percentage of Chinese Fan-palm with bat colonies published by AFCD in 2006 was 6.1%, while that of the five venues we surveyed is 2.88%. There may be underestimation because the total number of Chinese Fan-palm surveyed by AFCD was over 3000, but we surveyed only 313 Chinese Fan-palm.

Fig 22. Bat colony found in the Admiralty Garden

Concerning the abundance, the percentage of tent roosts occupied by bat colonies varies from 0% to 16.7%. There is no conclusion on why tent roosts are found but no bat colonies are found in Hong Kong Zoological and Botanical Gardens.

In addition, withered fronds may not affect their preferences to live. A bat colony found in the Admiralty Garden used the withered fronds as its roost (Fig 22).

5.1.2 Homing pattern and its relation to colony size

During the 7-days continuous observation at Ocean Shores and Victoria Park, both the number of bats in small colonies and large colonies varied by 1 to 2 bats (Table 2&3). As for the frequency of moving out from the original roosts, both the small colonies and large colonies changed the roosts in use by at most 1 time and the roosts they changed to can be found near the original roosts used. These shows the homing pattern of the short-nosed fruit bats is rather stable. Also, there is no distinct difference in homing patterns between small and large colonies.

On the other hand, long-term observation of the homing patterns of small (Fig 8) and large colony (Fig 9) in Ocean Shores shows that the number of bats in the colonies fluctuates a lot. On some particular days, the small colony or large colony was not found. We cannot find the reason why there were bats missing some days, why the bats change their tent roosts and how frequent the bats change their tent roosts.

Apart from the homing pattern, we have discovered two interesting roost-changing behaviours of the bats. Firstly, the bats tended to construct and use roosts on the same palm or palms near to the location of original roosts (Fig 6,10,11). The same phenomenon can also be observed in Fig 3&4, which show tent roosts are found on palms close to each other. Secondly, the bats tended to stay in the 1 to 2 frequently used roosts only even though a number of roosts were constructed on the same palm and the palms around. The reason for constructing extra tent roosts could be further studied.

5.1.3 Time of the bats flying out from tent roosts and its relation to time of sunset

According to Table 4, the bats start flying out only after the time of sunset. Moreover, bat colony in Ocean Shores shows a rather consistent pattern of time lapses between the time of sunset and the time of 1st bat flying out, which is about 8 to 13 minutes. But for the bat colony in Victoria Park, there is no clear pattern seen. It is suspected that difference in patterns is resulted from the level of human disturbance of the venues that has already been mentioned in 5.1.1.

Besides, from our observation at Victoria Park, two members of the bat colony flew out and returned before the bats flew out one by one. Similar observation is recorded in Ocean Shores. It is suggested that they were inspecting the area.

5.1.4 Feeding and foraging habits

Judging from the faeces and food remains found below the roosts and our school, the short-nosed fruit bat mainly eat fruits of fig such as Common Red-stem Fig and Mountain Fig. According to earlier studies, short-nosed fruit bats also feed on flower nectar like banana plantation.(Shek, 2006)

According to earlier studies, fruit bats have important roles as seed dispersers at least for three species of local figs, the Common Yellow Stem-fig, the Opposite-leaved Fig, and the Common Red-stem Fig. The ripe figs of these species are green or yellow, do not attract birds and are available year-round (Shek, 2006).

The food sources can be found near their roosts (Fig 12 & 17) at a distance of about 3 to 17 m. Living near to the food sources may help reducing energy spent for foraging.

5.2 Significance of results

As one of the most abundant bats in Hong Kong, the roost-constructing behaviour of *C. sphinx* allows them to construct roosts on Chinese Fan-palm and stay at a stable environment in crowded urban areas in Hong Kong. Our results show that *C. sphinx* colonies are faithful to their roosting areas, which may be explained by its feeding and foraging habits.

Our study also raised a number of questions worth further studying, including:

1. Why only tent roosts were found but no bat colonies were found in Hong Kong Zoological and Botanical Gardens?
2. When the colony sizes decrease during the continuous observation of the same colonies, where were the missing bats?
3. What determines the bat colonies to change to another roost?
4. How frequent do the bat colonies change their tent roosts?
5. Why do the bats construct extra tent roosts on the same palm as and the palms around the frequently used roosts?
6. Why were there different patterns in the time lapses between the time of sunset and the time of 1st bat flying out in different districts?
7. What is the foraging distance of bats?

5.3 Limitations

1. We were not able to identify the sex of the *C. sphinx*. Hence, we cannot tell whether the missing bats during the continuous observation were male or female.
2. We were not able to track where the missing bats fly to.

3. There may be underestimation of the distribution and abundance of short-nosed fruit bat because we did not survey all Chinese Fan-palms in Hong Kong. Some Chinese Fan-palms are too high or located too far away. It was difficult to observe the fronds and search for the presence of bats.
4. We were not able to estimate the distance of foraging of the bats because we did not track where the bats fly to after they fly out from roosts.
5. We were not able to tell why bat colonies change the roosts.
6. It was difficult to search and identify all the trees around bat colonies and find their possible food sources.

5.4 Further studies

1. Outdoor infrared automatic camera can be set up to study whether there is leading bat in changing roosts and the pattern of time of bats flying out from tent roosts.
2. Outdoor infrared automatic camera can be set up under the roosts to study the activities of bats before they start flying out from roosts and if there are leading bats to determine time of flying out.
3. Long-term observation is conducted to study whether the extra roosts around the frequently used roosts are used.
4. Bats are tracked to study where do the missing bats fly to, whether the bats in the colonies are the same as last night, whether the new bats in the colonies are the missing bats
5. Bats are tracked to study their foraging distance.
6. The life expectancies and characteristics of fronds of Chinese Fan-palm are studied to find out why short-nosed fruit bat use them to construct roosts and the effect of bats chewing bite marks on the fronds.

6 Conclusion

By comparing with the previous study by AFCD in 2006, the percentages of palms with tent roosts increased in 4 out of 5 venues we surveyed, while the average percentage of palms with tent roosts (10.5%) decreased slightly by 0.7%. The average percentage of palms with bat colonies is 2.88%.

Besides, the following behaviours of short-nosed fruit bat were observed. Withered fronds may not affect their preferences to live. The bats tended to construct and use roosts on the same palm or palms near to the location of original roosts and the bats tended to stay at 1 to 2 frequently used roosts only even though extra roosts were constructed nearby. Furthermore, we found that the bats start flying out only after the time of sunset and the food sources can usually be found near their roosts.

However, no concrete conclusion can be drawn about the following observations. Fluctuations of homing patterns of both small and large bat colonies are recorded in both short-term and long-term observation. There is no conclusion on the reason and pattern for such fluctuations. Besides, the colony at Ocean Shores is observed to have consistent pattern of time lapses between the time of sunset and the time of 1st bat flying out, but the colony at Victoria Park does not. Moreover, it is suggested that there may be leading bats inspecting the areas before all bats fly out one by one. These could be the possible further studies about short-nosed fruit bat.

7 Bibliography

Bhat, H.R. and Kunz, T.H., (1994). Altered flower/fruit clusters of the kitul palm used as roosts by the short-nosed fruit bat, *Cynopterus sphinx* http://www.batconservancy.org/siteRoot/pdf/Lubee/Publications/8-%20Altered%20Flower%20Fruit%20Clusters%20of%20the%20Kitul%20Palm%20Used%20as%20Roosts%20by%20the%20Short-nosed%20fruit%20bat,%20Cynopterus%20sphinx.pdf. Retrieved on 16th,April, 2013.

Shek, C.T., (2006). A *Field Guide to the Terrestrial Mammals of Hong Kong*. Friends of the Country Parks and Cosmos Books Ltd. Press.

Shek, C.T and Chan, S.M., (2006).Mist Net Survey of Bats with Three New Bat Species Records for Hong Kong http://www.afcd.gov.hk/english/conservation/hkbiodiversity/newsletters/files/hkbonewsletter11.pdf. Retrieved on 16th,April, 2013.

Storz, J. F. and Kunz, T.H., (1999).Mammal Species *Cynopterus sphinx*. http://www.science.smith.edu/msi/pdf/i0076-3519-613-01-0001.pdf. Retrieved on 16th,April, 2013.