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Feature Article

The Geckos of Hong Kong

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Herpetofauna Working Group

本署兩棲及爬行動物工作小組的基線調查結果顯示，香港的壁虎科蜥蜴共有八種，即截趾虎、壁虎、大壁虎、原尾蜥虎、密疣蜥虎、鋸尾蜥虎、半葉趾虎及疣尾蜥虎，當中以壁虎及原尾蜥虎的分布最廣及數量最多。至於密疣蜥虎、半葉趾虎及疣尾蜥虎等，由於過往記錄甚少，其狀況還需進一步確認。在保育方面，所有本地的壁虎均可見於郊野公園等保護區內，當中包括較稀有的大壁虎及半葉趾虎； 而一些常見於村落四周的品種， 雖然面對發展帶來的威脅，牠們高度的適應性及廣泛的分布確保了種群的穩定。

Introduction

Geckos are small to moderately large lizards with a depressed, soft-skinned body and a large flattened head. They vary widely in body size, from 5 cm to about 40 cm at most. Geckos are considered primitive animals due to their vertebral structure, hyoid (horse-shoe like) bone, fleshy tongue and scale patterns. Their first appearance can be dated back to the Eocene (i.e. 38 – 54 million years ago).

Like most other lizards (except burrowing species of which eyes are highly reduced), geckos have good eyesight. Most geckos have large, protruding eyes to adapt to their nocturnal habits. They have no eyelids and their eyes are covered by a transparent membrane which they lick to clean. They usually prey on insects, arachnids and other small invertebrates. Large members such as the Tokay Gecko (Fig. 1) also prey on other lizards, as well as snakes, birds and even small mammals.

Fig 1. Tokay Gecko (dark form).

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Geckos are able to change the colour of their skin despite their usual dull colours and subdued patterns. However, unlike chameleons which can present abrupt changes in skin colour, geckos can only do so by going darker or paler. Some species can change color to blend in with their surroundings or with temperature differences.

Geckos are unique among lizards in their vocalization. Most species have a well-developed larnyx and vocal cord, and they are able to make chirping sounds or even loud barks during social interactions with other individuals.

Many gecko species also possess the special ability to climb. They have specialized toe pads which allow them to climb on smooth vertical surfaces and even cross indoor ceilings with ease. Their tails are easily broken off upon pressure, which will regenerate in time. This tactic has in fact allowed geckos to distract their predators and run for their lives when they are preyed upon.

Most geckos are oviparous, laying eggs (mostly two at a time) with hard, calcareous shells several times a year. Usually, the eggs will hatch after 2 to 6 months. Some species are parthenogenetic, that is, the females are capable of reproducing clonally without fertilization. This reproductive strategy has greatly enhanced their ability to spread to and colonise new habitats. A few genera are ovoviviparous, producing eggs which are hatched inside the body of the females and youngs are born alive.

There are over 900 species of geckos worldwide but they are most abundant and diverse in the tropics. They are found in a wide variety of habitats including forests, shrublands, grasslands, marshes and deserts, and some are even closely associated with human habitations. China has a total of about 30 species of geckos. In Hong Kong, eight species have been recorded to date. They are all nocturnal. Except the Garnot's Gecko which is parthenogenetic, the other seven species are oviparous.

Classification

Reptilia (爬行綱) – Lacertiformes (蜥蜴目) – Gekkonidae (壁虎科)

Species of Geckos Found in Hong Kong

Four-clawed Gecko (*Gehyra mutilata* 截趾虎) (Fig. 2)

Fig 2. Four-clawed Gecko

Fig 3. Gehyra's lamellae and claws.

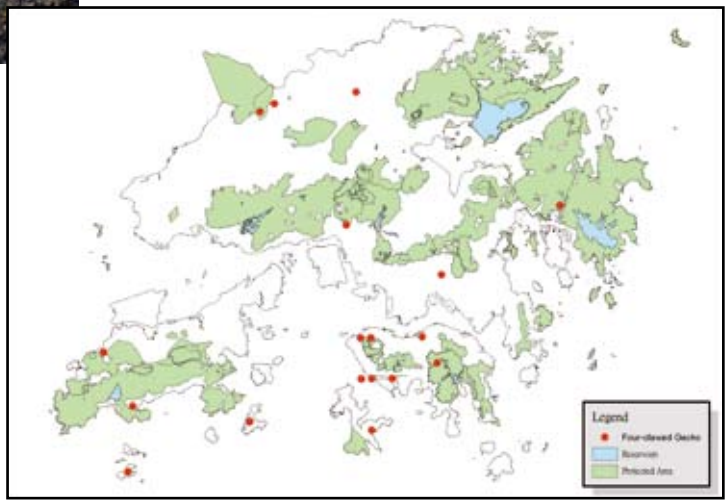

Fig 4. Distribution of Four-clawed Gecko in Hong Kong.

Geckos of the genus *Gehyra* are commonly known as web-toed geckos. They are distributed in the Philippines, Sri Lanka, IndoChina, and many of the Pacific Islands. In mainland China, Four-clawed Gecko is found in Yunnan, Guangdong and Hainan.

Four-clawed Gecko has delicate skin, which is usually colored a soft purplish/pinkish grey with golden spots on younger individuals; these spots eventually fade with age. This species is moderate in size, reaching up to 12 cm. It is characterised by an enlarged tail base. Its tail can reach almost

the entire length of the body. Usually, only 4 out of the 5 digits have claws and their digits have divided lamellae (Fig. 3).

The species is widely distributed in Hong Kong and is rather common inside buidlings (Fig. 4). Like many other geckos, it is highly adaptable to its surroundings and can be found in woodlands, rocky areas or human dwellings, although it usually prefers foraging around houses or inside other illuminated man-made structures where many night-flying insects are attracted by light. Being nocturnal and spend much of their time high up on walls and ceilings, they are quite unobtrusive, and they prey on household insect pests, including mosquitoes, flies, cockroaches, moths and termites.

Four-clawed Gecko is oviparous, laying two eggs at a time in holes inside buildings or in crevices. It is able to vocalize, making chirping sound which resembles that of a cricket.

Chinese Gecko (*Gekko chinensis* 壁虎) (Fig. 5)

Fig 5. Chinese Gecko

Fig 6. Undivided lamellae

The Chinese Gecko is a very common gecko in Hong Kong, widely distributed throughout the territory. This species is often found hiding in crevices in forested areas, caves and on the outside walls of old, abandoned buildings. This species is only found in central and southern China, and northern Vietnam. In mainland China, it is distributed in Fujian, Guangdong, Hainan and Guangxi.

This is a fairly large gecko, growing up to about 18 cm in total length. Its body is greyish in colour, with faint dark bandings on the back but distinct brown or black bands on the tail. The head is large and flattened. Genus Gekko is characterized by digits with undivided lamellae (Fig. 6).

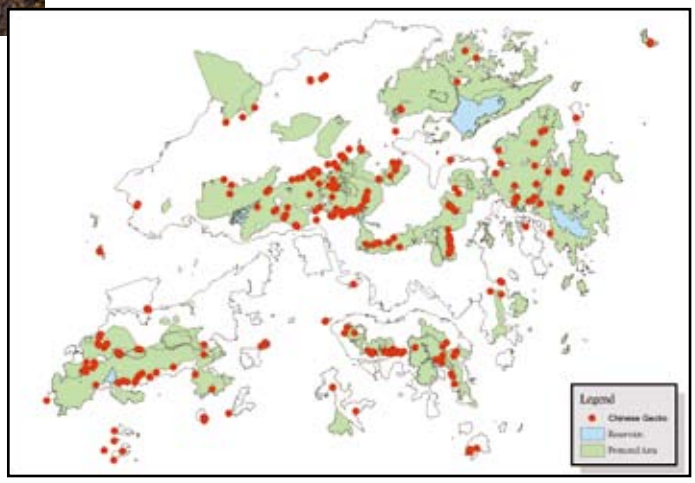

Fig 7. Distribution of Chinese Gecko in Hong Kong.

Chinese Gecko is nocturnal and occurs from sea level to the summit of Tai Mo Shan in Hong Kong (Fig. 7). It feeds on insects such as crickets, moths and mosquitoes. This species is oviparous and its eggs can often be seen inside holes of retaining walls and catchwaters. Some females aggregate and lay eggs at the same spot.

The Chinese Gecko may squeak and bite if caught or disturbed.

Tokay Gecko (*Gekko gecko* 大壁虎 / 蛤蚧) (Fig. 8)

The Tokay Gecko is a nocturnal gecko native to Southeast Asia and the Indo-Australian Archipelago. They are abundant in their range, from northeast India and Bangladesh, throughout Southeast Asia, to Indonesia and western New Guinea. In mainland China, this species is found in Yunnan, Guangdong and Guangxi. Their native habitat is rainforest trees and cliffs, but they are also adapted to human habitations, often seen roaming on walls and ceilings at night in search of insect prey.

Fig 8. Tokay Gecko (pale form).

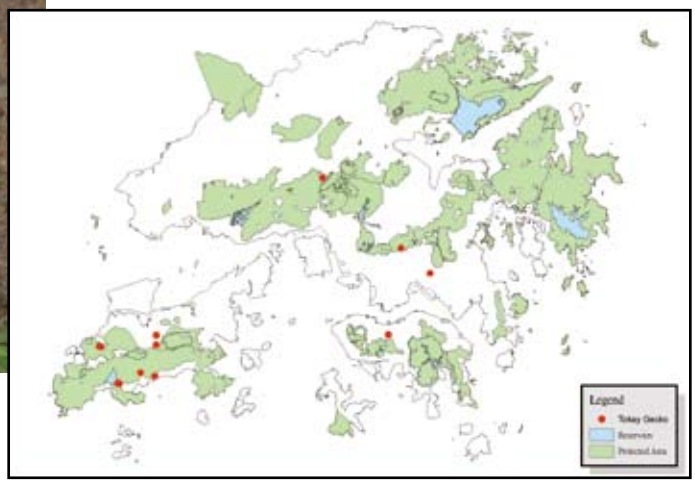

Fig 9. Distribution of Tokay Gecko in Hong Kong.

Tokay Gecko is locally uncommon but sighting records have been reported from several localities across the territory, though most were obtained from Lantau Island (Fig. 9). As this species is widely sold in snake shops, the populations in the suburban areas are probably escapees.

This species is arboreal, living on cliffs and trees. Some may live in group, herd of 8 has been recorded. Tokay Geckos are aggressive carnivores which consume a variety of insects and even small mammals and birds. Their aggressive behaviour can lead to attacks on other males.

Tokay Gecko is the second largest gecko species in the world, attaining lengths of about 30-40 cm for males, 20-30 cm for females and weights of 150-300 g. They are distinctive in appearance by having a bluish (Fig. 8) or greyish body (Fig. 1) covered with orange or red spots, with a few transverse rows of white spots. The ventral side is white and scattered with orange spots. Their tail is dorsolaterally flattened with distinct white bandings. The digits have undivided lamellae.

The species is oviparous, laying two eggs at a time which is the largest among local gecko species. Eggs are often found attached onto vertical surfaces in rock crevices and catchwater tunnels. Hatchlings can be seen living together with adults.

Tokay Geckos are nocturnal. They will come out of their hiding/resting places in the evening to look for food. They have a distinctive call, from which comes the name "tokay" - the call is said to sound like "to-kay" or variations thereof. Calls can be heard during the day and at night. Both sexes are able to make calls.

Dried specimens of Tokays have long been used in traditional Chinese medicine.

Brook's Gecko (*Hemidactylus brookii* 密疣蜥虎) (Fig. 10)

Fig 10. Brook's Gecko

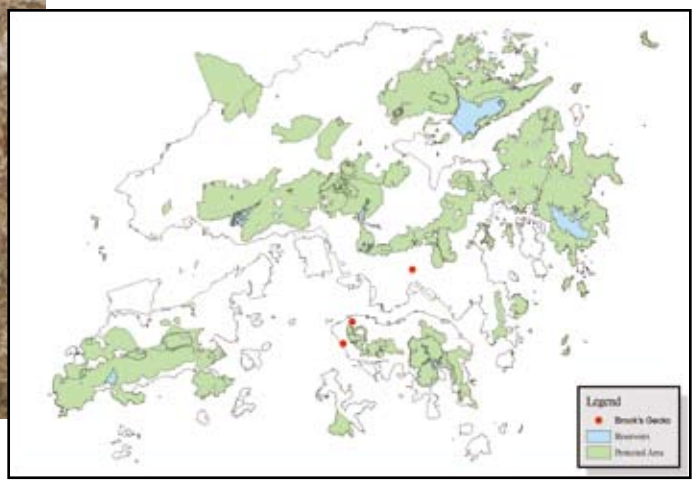

Fig 11. Distribution of Brook's Gecko in Hong Kong.

Brook's Gecko is readily distinguished from other similar-sized geckos by its rough warty appearance formed by the presence of numerous prominent tubercles on the dorsal surface of its body and tail. The tail is also covered with rows of spikes. This species is moderate in size, adults grow up to 15cm in total length. The body is slender and predominantly tan in colour, ventral can be white or light yellow. Digits have divided lamellae.

This species occurs in South and Southeast Asia, Indo-Australian Archipelago, West Indies and tropical Africa. In mainland China, it is found in Zhejiang, and it also appears to be quite common in Macau. In Hong Kong, Brook's Gecko has a very limited distribution and past records were obtained from only two localities in the Western District (Fig. 11). Recently, a well-established population has been found in Ngau Chi Wan. The actual status of this species in Hong Kong awaits further investigation.

This species is oviparous.

Bowring's Gecko (*Hemidactylus bowringii* 原尾蜥虎/鹽蛇) (Fig. 12)

Fig 12. Bowring's Gecko

Fig 13. Divided lamellae

Hemidactylus is the second most diverse genus in the family Gekkonidae, with some 78 species recorded to date. This genus is characterized by the divided lamellae on the toes (Fig. 13).

Also known as the Oriental Leaf-toed Gecko, the Bowring's Gecko is the most commonly seen gecko locally. It occurs throughout Hong Kong, often found around human habitations and suburb areas (Fig. 14). It is distributed from India across Southeast Asia and southern China to the Ryukyus. In mainland China, it is found in Sichuan, Yunnan, Fujian, Guangdong, Hainan and Guangxi. It also occurs in Taiwan.

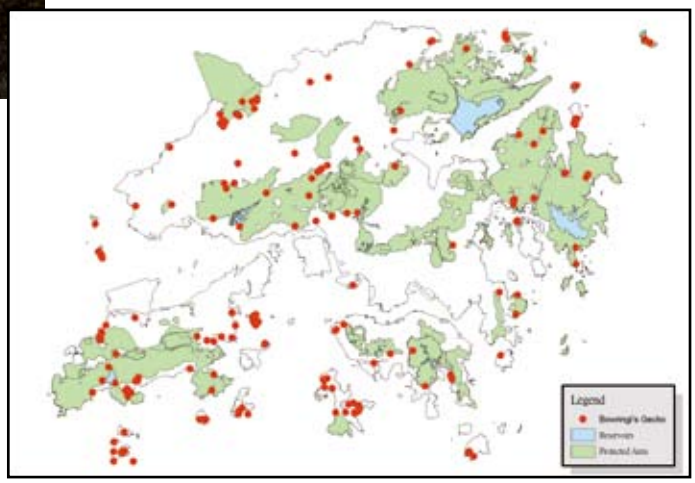

Fig 14. Distribution of Bowring's Gecko in Hong Kong.

The species is moderate in size, reaching up to 14 cm in total length. Its tail can reach almost the entire length of the body. Its body is slender and light tan in colour. It can change colour according to the surroundings and temperature. A brown line runs longtudinally from the snout through the eye until the ear opening. There are 5 to 6 light brown, transverse markings on the dorsal side. About 10 light crosslines are present on the dorsal side of the tail. The ventral side is white.

This species is oviparous, laying two eggs at a time. The eggs are white and oval in shape.

Garnot's Gecko (*Hemidactylus garnotii* 鋸尾蜥虎) (Fig. 15)

Also known as the Indo-Pacific Gecko, Garnot's Gecko is rather uncommon in Hong Kong, though it is known to occur in a number of localities across the territory. As its name implies, this gecko is native to Southeast Asia, and its range of distribution includes southern China, India, the Philippines, Indo-Australian Archipelagos and Oceania. It has also been introduced to many tropical areas worldwide, including the United States where it is well established. In mainland China, it is found in Yunnan and Hainan, and it also occurs in Taiwan. This species inhabits mostly hilly or low mountainous areas, and typically lives in shrublands and grasslands.

Fig 15. Garnot's Gecko

Fig 16. Underside of Garnot's Gecko.

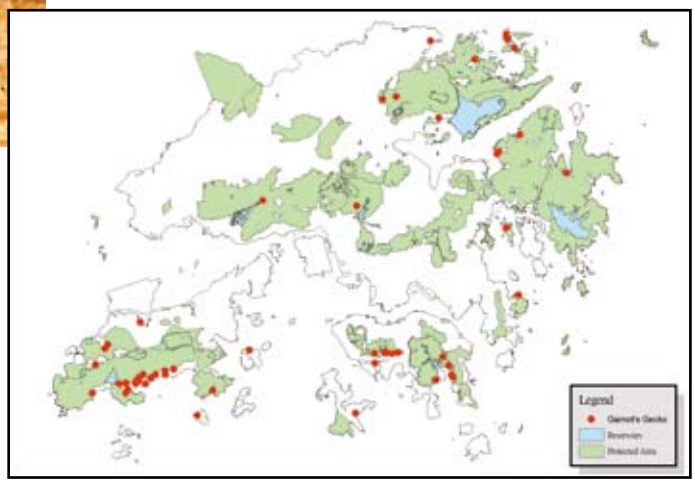

Fig 17. Distribution of Garnot's Gecko in Hong Kong.

The Garnot's Gecko has a pair of large eyes and a pointed snout. It is generally grey to brown in colour. The skin is smooth but not shiny. Five dark lines extend from the head to the anterior part of the tail, interspersed with grey spots. The belly is yellowish with two white patches on the throat; the underside of the tail can be grey or orange (Fig. 16). This species is most easily distinguished by the presence of prominent saw-like yellow spikes along the lateral sides of its tail. The size of the spikes diminishes down the tail. However, regenerated tail lacks the spikes. Digits have divided lamellae.

This species is unisexual. Reproduction occurs by parthenogenesis, that is, unfertilized eggs will develop into embryos directly. Eggs are laid in pair under bark, in crevices, or in moist soil.

This species' adaptability and unisexual mode of reproduction has made it a very successful invader in other parts of the world. Garnot's Gecko is more abundant on Lantau Island and Hong Kong Island. Its distribution is sporadic in the New Territories where it has been recorded from Shing Mun, Sai Kung, Plover Cove and Pat Sin Leng Country Parks. It also occurs on small islands such as Shek Kwu Chau and Kau Sai Chau (Fig. 17).

House Gecko (*Hemidactylus frenatus* 疣尾蜥虎) (Fig. 18)

Fig 18. House Gecko

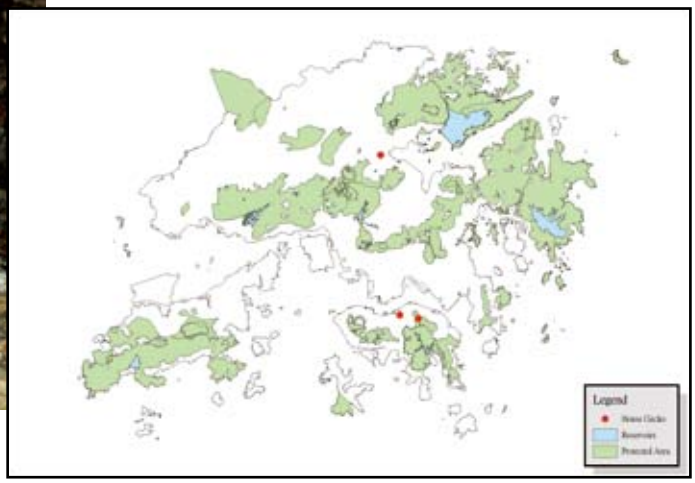

Fig 19. Distribution of House Gecko in Hong Kong.

This nocturnal gecko is closely tied to human habitations. During daytime, it hides in crevices inside houses, or in sheltered artificial hideaways, such as electrical installations, air conditioners and lamps. At night, the upper surface of the body appears light gray, tan or brown with scattered small spots, but the overall colour becomes darker during the day. The tail is encircled by whorls of enlarged pointed tubercles and the limbs are relatively short and stout. Both sexes are able to vocalize, producing a loud chirping sound, which is usually uttered during aggressive interactions. The digits have divided lamellae.

House Gecko is widely distributed and native to Southern Asia, the Pacific Islands, tropical Africa, Australia and Polynesia. It was introduced by human to other areas including mainland China, where it is found in Yunnan, Guangdong and Hainan. The species is only known to occur at three localities in Hong Kong (Fig. 19). On Hong Kong Island, it was reported from North Point and Mount Parker. More recently, it was found in Tai Po market.

This species is oviparous, producing two eggs per clutch.

Tree Gecko (*Hemiphyllodactylus* sp. 半葉趾虎) (Fig. 20)

Fig 20. Tree Gecko

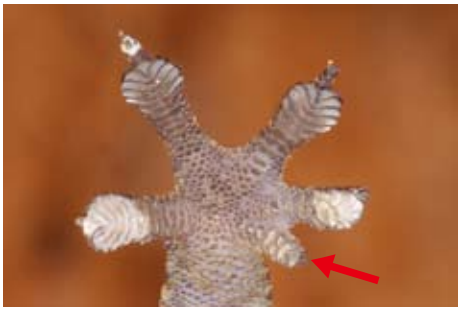

Fig 21. Reduced inner digit without claw

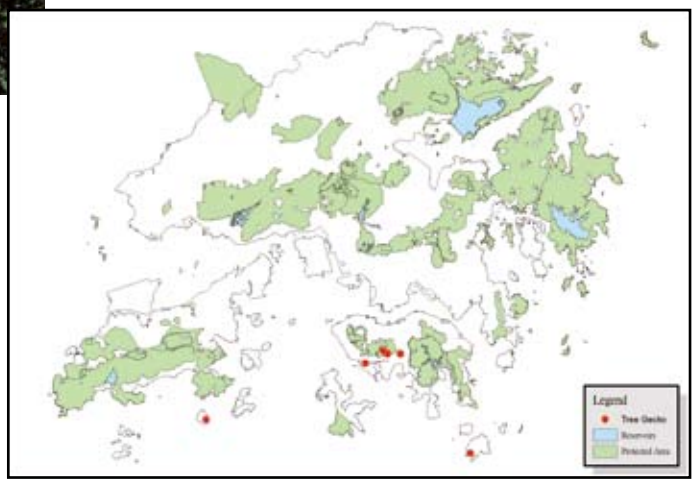

Fig 22. Distribution of Tree Gecko in Hong Kong.

Tree Gecko is a very rare gecko species in Hong Kong. This is a forest dwelling species which can be found among the bark of large trees and abandoned buildings. It has only been recorded from Po Toi, Aberdeen and Shek Kwu Chau in Hong Kong (Fig. 22). This species has not been reported in mainland China. Further investigation is necessary to confirm the species and local status of Tree Gecko in Hong Kong.

This is a small gecko with slender body, of less than 10 cm in total length. The tail is shorter than the body, the tail tip always form a hook. Its body is pale brown in colour, with fine dark wavy lines on the head and body. Limbs short. There is a pale stripe behind each eye. Lamellae divided, inner digits reduced and without claw (Fig. 21).

This species is oviparous but its breeding habits are poorly known due to its rarity. It can be found living inside tree barks, abandoned houses and rock crevices.

Conservation

Many geckos across the world have been popular pets among herp lovers and some species are regarded as delicacy or used in traditional medicine. In some parts of the world, it is considered good luck to have geckos in the house. But in some other places, they are consumed as food and are also used in some Chinese medicinal preparations. While certain species survive well in captivity and sustainable stocks can be maintained through captive breeding, other more rare species suffer population decline due to over-exploitation through hunting and trapping from the wild. Species that have been victims of worldwide pet and food trade include the Tokay Geckos, one of the largest gecko species in the world, whose wild populations have declined considerably in mainland China. At present, Tokay Gecko is considered as endangered in the China Red Data Book and it is listed as a “Class II State Key Protected Animal”.

In Hong Kong, all the local gecko species can be found in the protected areas such as the Country Parks, which offer protection to the natural habitats of gecko species including the rare ones, such as the Tokay Gecko and Tree Gecko. On the other hand, household species that used to be frequently seen inside village houses have become less common due to rapid urbanization. Nevertheless, the high adaptability and wide distribution of these species still render their population status rather stable.

A Summary of Geckos of Hong Kong

Species	*Gehyra mutilata*	*Gekko chinensis*	*Gekko gecko*	*Hemidactylus bowringii*
中文名	截趾虎	壁虎	大壁虎/蛤蚧	原尾蜥虎/鹽蛇
Common Name	Four-clawed Gecko	Chinese Gecko	Tokay Gecko	Bowring's Gecko
Maximum Length	12 cm	18 cm	40 cm (males) 30 cm (females)	14 cm
Habitat	Underneath roof and in crevices of houses and buildings	Usually high up on walls outside buildings	Always hiding in rocky cliffs or boulder piles in thick bush or forests	Around houses, also found in catchwaters, shrublands and grasslands
Diet	Small insects	Small insects	Insects and probably smaller geckos	Small insects
Reproduction	Oviparous	Oviparous	Oviparous	Oviparous
Distribution	Native. Occurs throughout Hong Kong	Native. Occurs throughout Hong Kong	Native. Found in Lantau, Lion Rock and Mid-Levels	Native. Occurs throughout Hong Kong
Identification	Up to 12 cm. Soft purplish/ pinkish grey body with golden spots which fade with age. Tail with enlarged base.	Up to 18 cm. Body grayish. Faint dark bandings on back. Tail with brown/ black bands. Head large and flattened. Digits with undivided lamellae.	Large, attaining 30-40 cm for males, 20-30 cm for females. Body bluish or greyish, with orange/ red spots and a few transverse rows of white spots. Tail dorsolaterally flattened with distinct white bandings. Digits with undivided lamellae.	Up to 14 cm. Body slender, light tan. A brown line running longtudinally from snout through eye til ear opening. Five to six light brown, transverse markings on dorsal side. Ten light crosslines on dorsal side of tail.

Species	*Hemidactylus brookii*	*Hemidactylus garnotii*	*Hemidactylus frenatus*	*Hemiphyllodactylus* sp.
中文名	密疣蜥虎	鋸尾蜥虎	疣尾蜥虎	半葉趾虎
Common Name	Brook's Gecko	Garnot's Gecko	House Gecko	Tree Gecko
Maximum Length	15 cm	15 cm	12 cm	< 10 cm
Habitat	Around buildings and man-made structures	Shrublands and grasslands, also around villages	Hide in crevices and dark places inside houses and buildings	Forest species found on large tree trunks and buildings near forests
Diet	Small insects	Small insects	Small insects	Small insects
Reproduction	Oviparous	Oviparious (Parthenogenetic)	Oviparous	Oviparous
Distribution	Introduced. Only known from 3 localities: Western District , Sandy Bay and Ngau Chi Wan.	Native. Uncommon but widely distributed throughout Hong Kong especially on Hong Kong Island and Lantau Island.	Local status uncertain. Rare, only known from North Point and Mount Parker on Hong Kong Island and Tai Po Market.	Local status uncertain. Rare, only known from Po Toi, Aberdeen and Shek Kwu Chau
Identification	Up to 15 cm. Body slender, tan in colour; ventral white or light yellow. Dorsal surface of body and tail covered by numerous prominent tubercles. Tail covered with rows of spikes.	Prominent saw-like yellow spikes along lateral sides of tail. Body grey to brown, with 5 dark lines extending from head to tail, interspersed with grey spots. Belly yellowish with 2 white patches on the throat.	Upper surface of body light gray/ tan/ brown with scattered small spots at night, becomes darker during the day. Tail encircled by whorls of enlarged pointed tubercles. Limbs relatively short and stout.	Less than 10 cm. Body slender, tail short, with tip forming a hook. Body pale brown, with fine dark wavy lines on head and body. A pale stripe behind each eye. Inner digits reduced, without claws.

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Acknowledgement

We would like to thank Mr. Tony Ngai and Mr. Samson So for providing information on the new sighting records of *Hemidactylus frenatus* and *H. brookii* respectively.

Working Group Column

Echolocation Calls of Five Horseshoe Bats of Hong Kong

Chung-tong Shek and Clement T.Y. Lau

Mammal Working Group

漁農自然護理署哺乳動物工作小組正進行一項有關本地蝙蝠回聲定位聲波的研究，目的為建立一個香港蝙蝠聲紋資料庫作日後調查參考之用。除了一些蝙蝠回聲定位聲波的基本資料之外，本文更介紹了本港五種菊頭蝠回聲定位聲波，及其聲紋辨認索引作品種鑒別之用。

Introduction

Bats contribute more than half of the native mammalian diversity of Hong Kong. Among the 26 species recorded (Shek and Chan, 2005), 24 are Microchiroptera which emit signals of high frequency (mostly ultrasonic, i.e. >20 kHz) and analyze the echoes to detect, characterize and locate obstacles or preys (Fig. 23). Such echolocation ultrasounds can be detected or recorded by using specialized bat detectors (Fig. 24 a&b), and the use of bat detectors in conjunction with traditional studying methods for creating inventories of bats' biodiversity is becoming increasingly widespread.

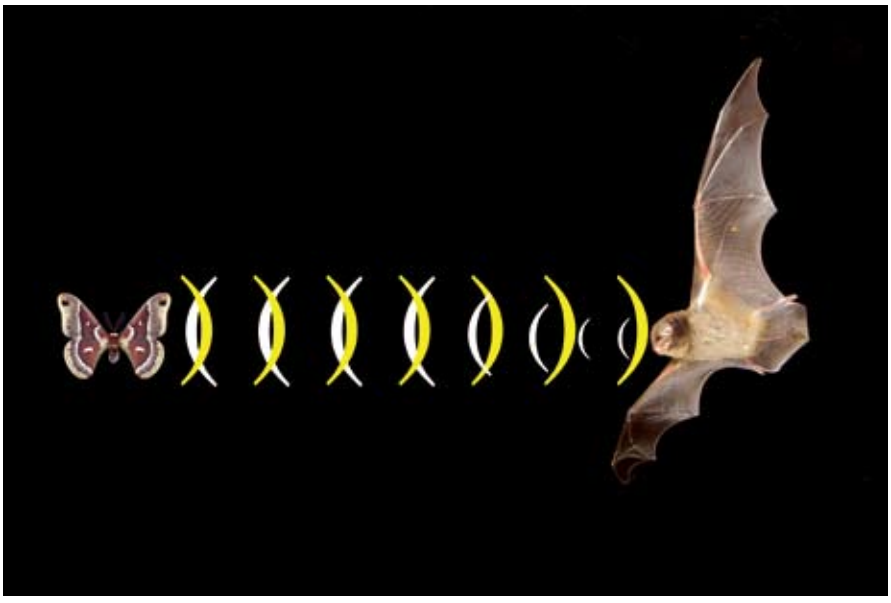

Fig 23. Echolocation of bats: sound emitted from the bat (white ripple) travel away. Upon contact with an object (moth) in the environment, the sound waves bounce back to the bat's ears in the form of echoes (yellow ripple).

Bat echolocation ultrasounds, or bat's calls, of different species vary widely in both duration (0.2 - 50 ms) and frequency (10 - 200 kHz), according to species and purpose of the calls, and may contain frequency modulated (FM) or constant frequency (CF) components. For example, the Japanese Pipistrelle (*Pipistrellus abramus* 東亞家蝠) uses multiple harmonic sounds with relatively broad FM sweeps and a large overall bandwidth (45 – 90 kHz) which gives high resolution information about the targets in complex habitats (Fig. 25).

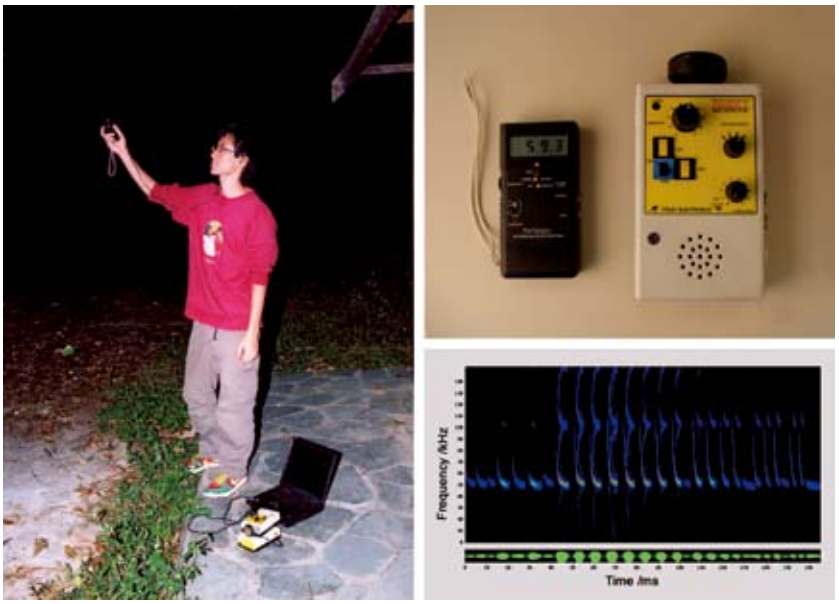

Fig 24. Bat acoustic monitoring by using bat detectors. a) Pettersson D240X and Anabat II bat detectors; b) Sonogram by Sonobat v.2.6.2.

Echolocation calls of a species also vary considerably and influenced by many factors, such as sex, age, acoustic clutter and foraging strategy (Bogdanowicz *et al*., 1999). Bats phase the call speed differently in order to conserve energy while foraging. When searching for food, the pulse rate of calls is slowest. The rate doubles upon approaching a potential food source and only when a target is imminent, the rate increases by more than 10 folds. These three basic phases are known as “searching”, “approaching” and “terminating or feeding buzz”. An example of these three phases of the Japanese Pipistrelle is shown in Fig. 25.

The Mammal Working Group is now developing acoustic monitoring methods for studying local bats, which aims at establishing a complete call library of all known bat species of Hong Kong. As bat calls are species specific, establishment of a call library would allow noninvasive identification of bat species in the field. We selected the horseshoe bats in this pilot study, as the calls of these bats are relatively conserved. A typical call (Fig. 26) comprises CF components, followed and/or preceded by a short frequency modulated FM components under different background conditions (Schnitzler, 1987). These bats specialize in hunting insects in complex habitats (e.g. in and near vegetation), relying on the apparent changes in frequency caused by the Doppler shift effect (i.e. the relative movement of a sound source and the receiver) for the purpose.

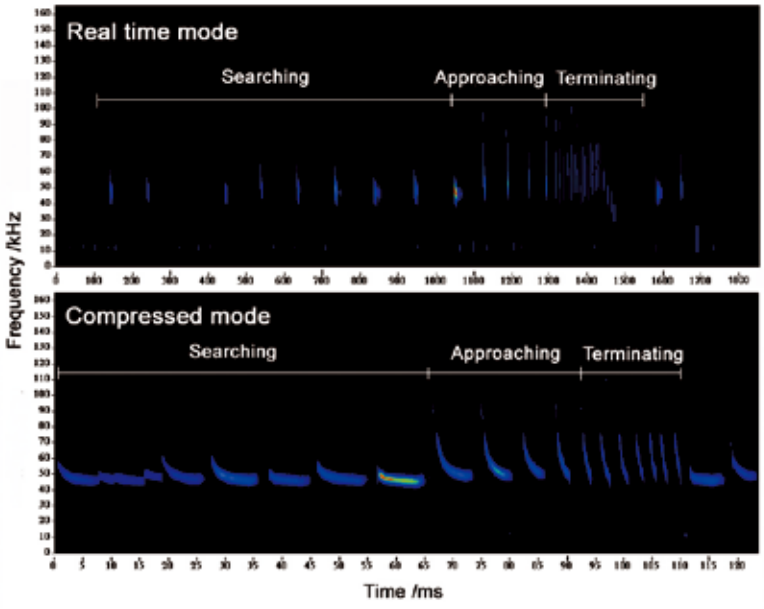

Fig 25. Sonogram (in both real time and compressed mode) of the Japanese Pipistrelle by Pettersson D240X bat detectors and Sonobat v.2.6.2.

Methodologies

We captured bats outside known roosts (i.e. the water tunnels in Tai Lam Chung, Lau Shui Hang, Sai Kung and Tung Tse) by using mist nets and recorded calls in the search phase (as defined by Griffin, 1958) on release from hand after capture. Calls were also recorded at foraging sites where species and individual bats could be identified unambiguously. The bat detectors were set at about 3 - 5 m from the roost entrance, the release point or the foraging sites.

We used a Pettersson Ultrasound Detector D240X bat detector wired to a MP3 player (iriver IFP-790) as a recording device. The calls were sampled at 307 kHz with 1/10 time expansion factor. All recorded sequences were analyzed by the software Sonobat v.2.6.2 and the maximum frequency, minimum frequency, call duration and call interval were extracted of representative calls for comparison.

Results & Discussion

Rhinolophids produced FM-CF-FM calls: a CF component followed and preceded by short FM components while hipposiderids produced CF-FM calls: a CF component followed by a short FM component (Fig. 27). The minimum frequency and call intervals were also variable and only the maximum frequency was highly conserved within species. Furthermore, among the five species, the Chinese Horseshoe Bat and the Himalayan Leaf-nosed Bat showed a certain degree of variations in their dominated frequency, which may due to the greater variation of their body sizes, see Table 1.

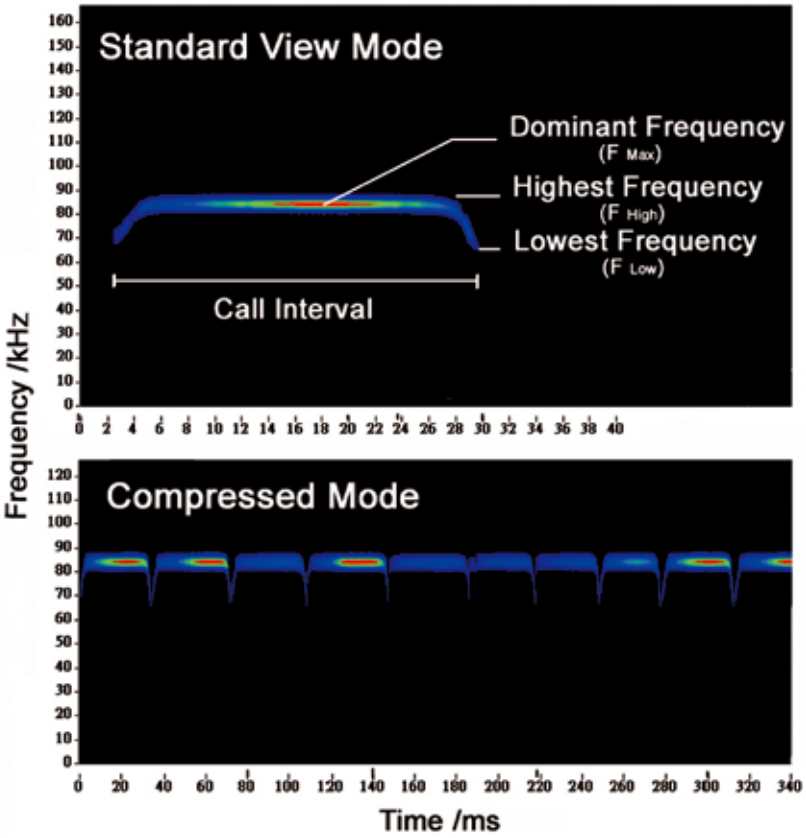

Fig 26. Sonogram (in compressed mode and standard view) of the Chinese Horseshoe Bat by Pettersson D240X bat detectors and Sonobat v.2.6.2. F_{max} is dominant frequency with highest energy distributed from a power spectrum (red color); F_{high} is highest frequency of the extract call; F_{low} is the lowest frequency of the extracted call; INT is the call interval between extracted calls.

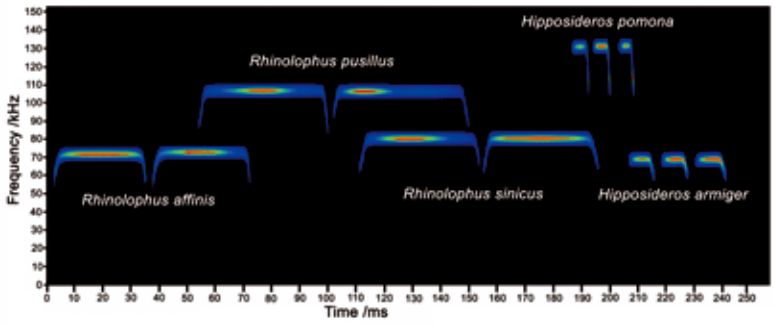

Fig 27. Sonogram of five local horseshoe bats by Pettersson D240X bat detectors and Sonobat v.2.6.2.

The maximum frequency of echolocation calls of horseshoe bats negatively correlated with their body sizes (Francis and Habersetzer, 1998). Such correlation may link to the sizes of the larynx, and their preys of interest, as larger species have larger larynx which produce lower frequency calls for detecting larger prey.

An acoustic identification key to five horseshoe bats of Hong Kong is provided in Fig. 28. The key will be updated and expanded regularly following findings of further acoustic studies on other bat species of Hong Kong.

Other Limitations

The identification of individual bats to species or genus level from their echolocation calls is difficult because of the technological and analytical limitations and the ability to obtain reliable calls under different conditions (Stuart and Gareth, 2000). First, not all calls were identifiable. It is important to record high quality calls under known conditions, such as clutter and non-clutter background, to establish a representative call library. Some species produce high frequency calls which attenuate quickly in air. For example, Pomona Leaf-nosed Bat produces calls with very short range, which is difficult to detect in the field. Some bats, so-called "Whispered bats", produce calls with low intensity that is only detectable in a short distance. Also, some species may emit calls with overlapping ranges of frequency. Therefore, it is important to study the calls of each species under different conditions and to create a reliable call library for bat acoustic monitoring.

Family	Species	Forearm / mm	n	Type	F_{max} / kHz	F_{low} / kHz	DUR / ms	INT / ms
Rhinolophidae 菊頭蝠科	Least Horseshoe Bat (*Rhinolophus pusillus* 小菊頭蝠)	37.4 (35.6 – 39.0)	31	FM-CF-FM	105.4 (100.5-107.8)	81.7 (79.6-89.6)	32.3 (12.4-55))	58.6 (24.5-88.3)
	Chinese Horseshoe Bat (*R. sinicus* 中華菊頭幅)	47.0 (43.1 – 52.8)	50	FM-CF-FM	82.9 (79.2 – 85.5)	63.4 (55.7-72.8)	39.1 (21.4-59.6)	70.6 (35.5-95.3)
	Intermediate Horseshoe Bat (*R. affinus* 中菊頭幅)	52.3 (50.2 – 55.0)	40	FM-CF-FM	72.0 (70.1 – 73.9)	52.6 (39.0-61.9)	38.3 (12.3-61.3)	73.6 (22.3-98.7)
Hipposideridae 蹄蝠科	Pomona Leaf-nosed Bat (*Hipposideros pomona* 小蹄蝠)	42.7 (40.4 – 47.1)	30	CF- FM	129.6 (125.7 – 132.5)	103.1 (98.3-111.2)	6.3 (5.4-7.8)	23.2 (18-33.3)
	Himalayan Leaf-nosed Bat (*H. armiger* 大蹄蝠)	89.6 (80.9 – 99.0)	30	CF-FM	70.1 (66.7 – 73.0)	56.9 (53.2-60.6)	11.9 (9.7-15.3)	44.3 (31.8-57.8)

Table 1. Maximum frequency (F_{max}), lowest frequency (F_{low}), call duration (DUR), and call intervals (INT) of five rhinolophids and hipposiderids recorded in Hong Kong (n = number of individuals recorded). All values are shown in mean (range).

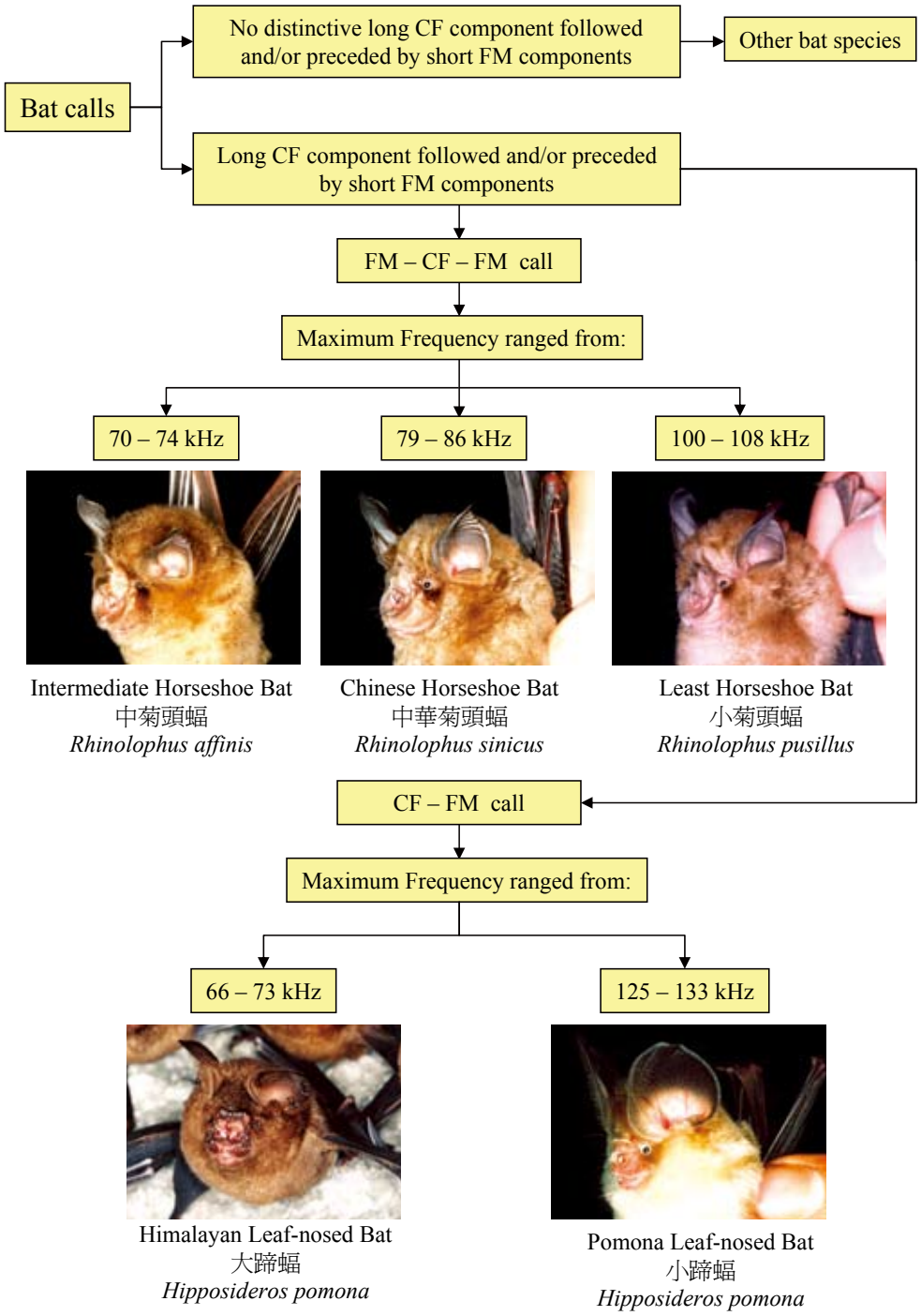

Fig 28. Identification keys of echolocation calls of five horseshoe bats in Hong Kong: CF = Constant Frequency and FM = Frequency Modulated.

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Preliminary Results of Bat-box Trial Project in the Hong Kong Wetland Park

Cynthia S.M. Chan
Mammal Working Group

為了解香港蝙蝠對棲所的需要，及提高本港市民對蝙蝠的保育意識，漁農自然護理署哺乳動物工作小組與濕地公園科於2005年8月始，合作進行了一項蝙蝠巢箱試驗計劃，成功於濕地公園內為東亞家蝠提供合適的棲所。

Fig 29. Bat-boxes of different designs, 2-chambered (on left) and 4-chambered (on right), installed in the HKWP.

Background

Wetlands are key habitats in the conservation of biodiversity and are suitable habitats for foraging insectivorous bats, possibly because of the abundance of insects and drinking places there. Nevertheless, the availability of natural roosts in most wetlands is very low (Flaguer *et al.*, 2006; Kunz and Lumsden, 2003). Bat-boxes may thus provide alternative roosts for bats in wetlands.

Any bat species known to use artificial structures like buildings or bridge crevices as diurnal roost could potentially be a bat-box user. Among the 26 Hong Kong bat species (Shek and Chan, 2006), the Japanese Pipistrelle (*Pipistrellus abramus* 東亞家蝠), the Daubenton's Bat (*Myotis daubentonii* 水鼠耳蝠) and the Brown Noctule (*Nyctalus noctula* 褐山蝠) have been found using bat-boxes (Ades, 2004; Dahmer, 2002; Pliquett, 2001). Jointed with the Wetland Park Division, a bat-box trial project, which was designed to study the preferred bat-box designs and to enhance community awareness of bat conservation, was initiated in 2005 in the Hong Kong Wetland Park (HKWP).

Study Method

On 31 August 2005, 20 bat-boxes of 2 types (2-chambered & 4-chambered, Fig. 29 & 30) were installed in the HKWP. Both type of boxes had similar structural design to the open bottomed, Bat Conservation International model bat house (Tuttle *et al.*, 2005).

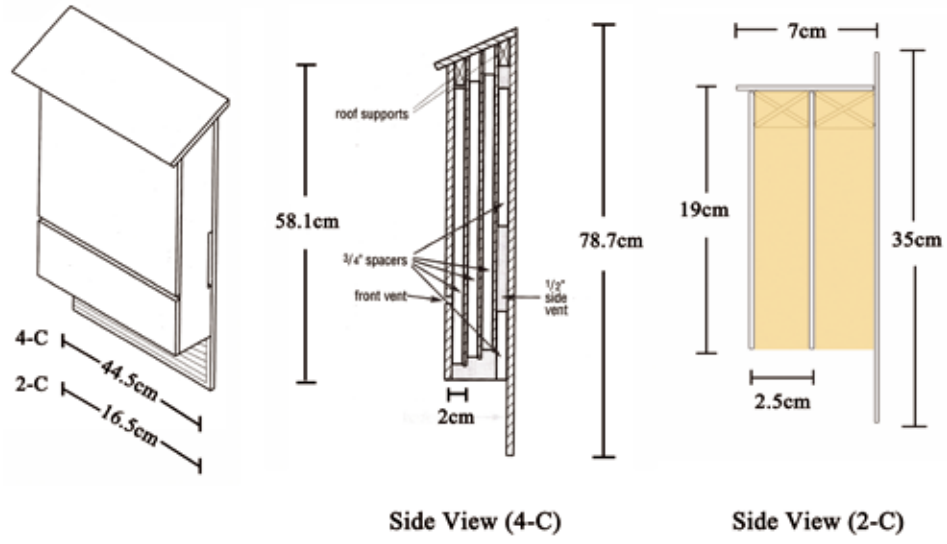

Fig 30. Designs & dimensions of the 2-chambered (2-C) and the 4-chambered (4-C) bat-boxes. (Reprinted with permission from Tuttle *et al.* (2005), Bat Conservation International, for the 4-chambered bat-box.)

Roost chambers were of height 19.0 cm & 58.1 cm and of width 16.5 cm & 44.5 cm in the 2-chambered and 4-chambered bat-boxes respectively. In hope of getting a higher occupancy, modifications were made on the 4-chambered bat-boxes. These include: a) to provide bats with footholds by stapling fiberglass insect screening on the roosting partitions; b) to increase the durability of the boxes, and to ensure the box chamber stay dry during wet seasons, by covering the box roof with water-proof plastic clothes.

Boxes were mounted on poles 2.5 m above ground, located near water sources and along natural bat flyways. Inspections on boxes were made on 26 April 2006 at 1400-1700 and 18 September 2006 at 1500-1800. During each inspection, the number of bats per box and box occupancy were recorded. The box-occupancy was expressed as the percentage of boxes occupied by bats among the boxes checked.

Results & Discussion

Bats were attracted before the first summer after box installation. This indicated the initial success of the project. Boxes were occupied by the Japanese Pipistrelle (Fig. 31) – a species commonly found foraging in wetlands like the HKWP and the Mai Po Inner Deep Bay Ramsar Site (Shek and Chan, 2006). The occupancies of the 2-chambered & 4-chambered bat-boxes were 62.5 % & 57.0 % respectively after one year of the installation.

Fig 31. The Japanese Pipistrelle (*Pipistrellus abramus* 東亞家蝠) roosting in a 4-chambered bat-box.

Sixteen bats were found occupying the boxes in the box-check of April 2006. The number of bats further increased to 37 in the box-check of September 2006. The number of roosting bats in each occupied box ranged from one to 17 (mean = 4.6 ± 2.1). The two largest colonies with 10 and 17 bats (82 % of the total number of bats recorded) recorded in September were found roosting in the 4-chambered bat-boxes. In addition to its relatively larger size, the 4-chambered bat-boxes also provided bats with a wider range of internal temperature that could in turn results in considerable energy savings (Lourenço and Palmeirim, 2004) as bats move to the part with the most favourable temperature. This may account for the higher number of bats found in the 4-chambered box. Apart from the Japanese Pipistrelle, bat-boxes were also found occupied by other animals during the first inspection, like frogs, geckos, spiders and ants. Invader guard and Vaseline have been applied to the mounting poles, which were found working effectively in deterring some of these animals during the second inspection.

Conclusion & Recommendation

This study highlights the role of bat-boxes as a valuable management tools to conserve bat populations in highly productive wetland habitats where few natural roost sites are available. Bats are natural predators of many night-flying insects, such as mosquitoes. Installation of bat-boxes in attracting bats could thus serve as mosquito control measure and practical preventative measures against mosquito-bounded diseases (IFCNR, 2003). However, it should be noted that not all bat species, especially the cave-dwelling bat species would roost in bat-boxes. It is thus not applicable to propose bat-boxes as ecological mitigation measures / habitat replacement tool for all the 26 local bat species.

The Mammal Working Group plans to further investigate the best designs and installation methods of bat-boxes for our local bat species. More bat-boxes will be installed in the HKWP, the country parks and the protected areas in Hong Kong. Monitoring and maintenance of the bat-boxes will be done in a regular basis.

Acknowledgment

We would like to thank Mrs. L.P.S. Chan, Mr. W.M. Yam and Mr. K.L. Cheung of the HKWP and Mr. Y.L. Chan of the Tai Tong Country Park Management Centre for their technical support and coordination of the field work. Thanks were also given to Mr. Bob Locke & Miss Mary Boyer of the Bat Conservation International for arranging the reprint permission of the figure 30.

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Division Column

A Note on the Use of Nest Boxes by Owls and other Birds in the Hong Kong Wetland Park

Jackie Y. Yip
Wetland Park Division

Introduction

Ten artificial bird nests were installed in the woodland of the Hong Kong Wetland Park in March 2004, to provide artificial habitats for woodland birds. The woodlands are well established and free of human disturbance, and hence considered suitable sites for setting up the nest boxes.

Previous work in the Country Parks found that three species of birds have been attracted to artificial nests of different dimensions: Great Tits (大山雀 *Parus major*), Magpie Robins (鵲鴝 *Copsychus saularis*) and Collared Scops Owls (領角鴞 *Otus bakkamoena*) (Lock, 2001). In this study we have installed nest boxes to attract owls especially the common Collared Scops Owls because Lock (2001) suggested there are not enough natural nesting sites for them in Hong Kong.

Collared Scops Owl is a nocturnal species recorded in many places around Hong Kong. Breeding season is from March to May (Cary *et al.*, 2001). This species utilizes a variety of wooded habitats including forests, shrubs with large trees, gardens and urban parks, and is not particularly shy. They have been found nesting in tree holes and disused Magpie nests. It is considered the most common owl in Hong Kong. The species has occasionally been recorded in the Wetland Park since 2003.

Methods

a) Design and material

Ten nest boxes (internal dimension: 16 x 21 x 44.5 cm) were installed. Design follows the L Type boxes in Lock (2001) with the following improvements (Fig. 32):

Fig 32. CCTV in nest box.

- Seal the top joints with waterproof glue, and face the entrance slightly downwards to prevent rain from entering.
- Apply a thick layer of Vaseline onto the tree trunks below and above the boxes to deter ants and predators such as snakes.

A pin-hole camera with infrared LEDs was attached to the bottom of the roof, with power and AV cables hanging down tree trunks. These cables, properly wrapped in plastic bags for water-proofing, can be connected to hand-held power supply and AV output devices (such as a digital video recorder) to check the inside of the boxes. This will enable regular video-taking without disturbing the inhabitants. This also provides a safe way to check the boxes that are placed high above ground.

b) Installation

We have considered the following principles in theinstallation of nest boxes (Lock, 2001; du Feu, 2003):

- Fix the nest boxes to tree trunks at 4 m or over above ground, preferably with leaves and branches around them to make them less conspicuous to predators.
- Place them away from direct sunlight.
- Not to place them towards the east as east-facing boxes are least likely to be inhabited (Lock, 2001).
- Not to place them too close to each other (i.e. at least 50 m apart).

c) Data collection

Data were collected between 2 April 2004 and 24 August 2006. Systematic surveys were not carried out in 2005 due to faulty cameras but we were able to make casual observations at some boxes. There was a data gap from mid-April to early June 2006 due to lack of manpower.

During each survey, the number of eggs, chicks and adults were recorded using the cameras installed, with any observations of interest such as the presence of any birds nearby and the presence of nesting material. If animals other than birds (e.g. rodents, wasps) were found inside the nests in the early breeding season, they would be removed at the earliest instance. Nesting materials left over from the previous breeding season were not removed.

Results and Discussion

The nest boxes were used by at least four species of birds from March to July, during 2004 and 2006 (Table 2, detailed sighting information can be downloaded from the web at http://www.afcd.gov.hk/english/conservation/hkbiodiversity/leaflets/leaflets_doc.html). All of the nest boxes except WP-04 have been used at least once by breeding birds. The occupancy rate of nest boxes is 80% in the first year and 60% in the third year (but two boxes were re-located in mid-April). Half of the boxes have been used twice in the breeding season of 2004 (i.e. first year), and the inhabitants were Magpie Robin and Crested Myna (八哥 *Acridotheres cristatellus*). In the second year Collared Scops Owl (Fig. 33) and Asian Barred Owlet (斑頭鴷 *Glaucidium cuculoides*) (Fig. 34) started to use the nest boxes, as observed by casual observation. In the third year, five out of the ten nest boxes have been used by owls for breeding, followed by other species of birds including Crested Myna and Magpie Robin later in the season. It has been observed that Collared Scops Owl laid 2 to 4 eggs, and Asian Barred Owl laid 2 to 6 eggs each time in the nest boxes.

Fig 33. Collared Scops Owl in nest box.

Fig 34. Asian Barred Owlet nestlings in a box.

Many of the nest boxes have been used twice by same species or different species of birds in one breeding season. In the first year, we have recorded the breeding of Magpie Robin twice in three boxes, but we do not know if these were the same pairs. In the third year, at least half of the boxes were used by owls from March to May, and by other species of birds from June to July.

The nest boxes have provided nesting habitats for the two commonest species of owls in Hong Kong. We observed that the owls did not use the nest boxes for breeding until the second year. This could be due to the fact that the nest boxes were installed in mid-March 2004, after the start of owl's breeding season. The rapid colonization and high occupancy of nest boxes by owls in the Hong Kong Wetland Park indicated the lack of natural breeding habitats nearby. The installation of artificial nest boxes is likely to increase their breeding success.

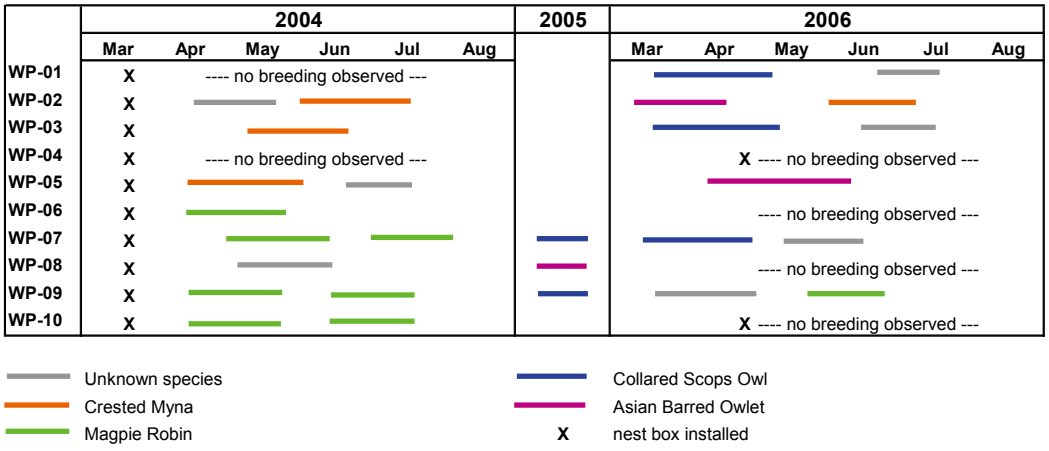

Table 2 Usage of nest boxes in the Hong Kong Wetland Park by breeding birds from 2004 to 2006.

Acknowledgements

I wish to thank all colleagues of the Hong Kong Wetland Park who have taken part in the nest box project, especially Stanley Chow who designed and installed the pin-hole cameras, and Yam Wing Yiu who conducted most of the surveys.

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