香港物種探索
Hong Kong Biodiversity

Agriculture, Fisheries and Conservation Department Newsletter

Issue No. 27   June 2023

www.bih.gov.hk

From the Editor

The COVID pandemic has brought about unprecedented changes to our lives. While some might have stayed indoors, more people are looking for ways to enjoy the local countryside right on our doorstep, recognising nature's role in supporting our recreation and well-being. Since the last issue of this *Newsletter*, AFCD has been dedicating efforts to deepen our understanding of local biodiversity through surveys and studies. In addition to a photographic identification guide and a collaboration on updating Hong Kong's territory-wide habitat map, this issue also brings to you first discoveries and new sightings, a tracking study of cross-border journeys, decadal records of a planting initiative and insights into the habitations of our wild neighbours.

Other than staying tuned to this *Newsletter* for AFCD's new findings on local wildlife, you might find other stunning facets of our biodiversity by visiting the Hong Kong Biodiversity Information Hub (HKBIH). Launched in 2022, this web-based information hub shares a broad spectrum of information and knowledge on the local biodiversity contributed by experts, institutes and the AFCD, with aims to facilitate information sharing, support biodiversity mainstreaming and bring benefits from nature to people. The HKBIH will not be realised without staunch support from collaborators and the wider conservation community. While the HKBIH will evolve to bring about enriched contents and encompass spatial information in its next phase, we will count on your continued support to enhance together the knowledge base of local biodiversity.

Flora MOK

Contents

Feature Article

A Photographic Identification Guide to Lowland Amphibian Tadpoles

Ray L.H. So, Helen L.Y. Wong and Eric H.N. Ng
Herpetofauna Working Group

蛙類於蝌蚪階段的外貌相似，辨認上容易混淆，故本文先就普遍生活於香港低地的蝌蚪作出簡短介紹及提供辨認索引，方便研究人員於野外快速進行物種鑒別。

Introduction

While all the adult amphibians in Hong Kong can be easily identified with various field guides, identifying their tadpoles can be challenging, in part due to their similar appearance and lack of handy identification field guides. The publication most commonly referred to at present is a morphological key for Hong Kong tadpoles developed in the PhD study of Lau (1998). In light of Lau (1998) and other previous publications, this article seeks to aid quick and direct field identification of tadpoles found in Hong Kong's lowland habitats. The dichotomous key and photo collection prepared by the Herpetofauna Working Group present some habitat characteristics and key morphological features of each species for easy reference during field observation.

Breeding habitat characteristics

The amphibian species in Hong Kong can be broadly categorised into two groups by the elevation where they inhabit. One group of species occupies habitats in higher elevations, such as hill streams and surrounding forests. This article focuses on another group of species predominantly found in lowland habitats, including wetlands, agricultural fields, forests, etc.

Besides elevation, different amphibians have varying preferences on breeding water body which can be characterised by its water flow. Generally, there are two types of water flow: lotic and lentic. Lotic water bodies include flat and slow-flowing streams and concretised channels such as catchwaters. Lentic refers to standing water bodies that include agricultural fields, wetlands, ponds, pools as well as water stored in containers such as buckets and barrels. Table 1 summarises the habitat characteristics of the 13 lowland species described by Lau (1998). Based on our field observation, the species are broadly divided into two groups: benthic and nektonic, which are mostly found on the bottom of water bodies and in the water column, respectively.

Table 1. Habitat characteristics of lowland tadpoles in Hong Kong.		
Species	**Common name**	**Water flow type**
Benthic – found on the bottom of water bodies		
Duttaphrynus melanostictus	Asian Common Toad	Lotic or lentic
Fejervarya limnocharis	Paddy Frog	Mostly lentic; Rarely lotic
Hoplobatrachus rugulosus	Chinese Bullfrog	Mostly lentic; Rarely lotic
Hylarana macrodactyla	Three-striped Grass Frog	Mostly lentic; Rarely lotic
Hylarana taipehensis	Two-striped Grass Frog	Lentic
Liuixalus romeri	Romer's Tree Frog	Mostly lentic; Rarely lotic
Sylvirana guentheri	Günther's Frog	Mostly lentic; Rarely lotic
Nektonic – found in the water column		
Kalophrynus interlineatus	Spotted Narrow-mouthed Frog	Lentic
Kaloula pulchra	Asiatic Painted Frog	Lentic
Microhyla butleri	Butler's Pigmy Frog	Lentic
Microhyla fissipes	Ornate Pigmy Frog	Lentic
Microhyla pulchra	Marbled Pigmy Frog	Lentic
Polypedates megacephalus	Brown Tree Frog	Mostly lentic; Rarely lotic

Morphological features

Identification of tadpoles often makes reference to the parameters and shapes of head-body, tail, dorsal and ventral fin, and other features such as the positions of eyes, nostrils, oral disc, spiracle, and vent tube. In terms of oral disc morphology, the orientation, classification of marginal papillae and dental formula are also discriminative among species, but such microscopic structures would require thorough examination in a laboratory setting. In order to facilitate field identification, with reference to the morphological key by Lau (1998), shape variations by Dubeux et al. (2020), pattern descriptions by Altig et al. (1998) and *Microhyla fissipes* embryonic development figures by Wang et al. (2017), this article highlights the head-body and tail shape, colour and other distinctive features of the tadpoles. Figure 1 illustrates the major morphological features and measurements of tadpole. Figures 2 to 14 present the photos of the dorsal and lateral views of the tadpole of each species (with a 10 mm scale bar) and field condition. One should note that this photographic guide mainly serves as a supplementary reference as there may be differences in morphological characteristics between individuals as well as developmental stages of each species. Precise identification of tadpoles shall always take into account all available literature.

a)

b)
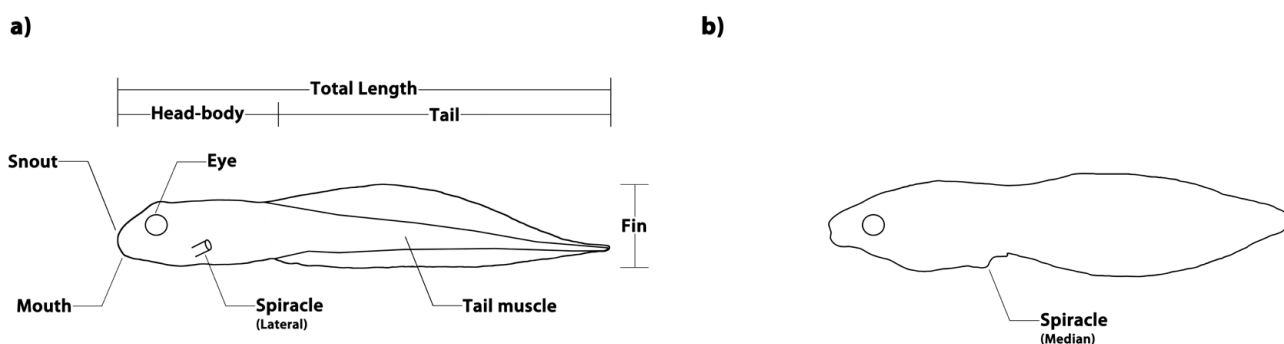
Figure 1. Major morphological features and measurements of a tadpole: lateral view of (a) *Fejervarya limnocharis* and (b) *Kaloula pulchra*.

Dichotomous key to lowland amphibian tadpoles

Information for this key was referenced from Lau's key and descriptions (1998), and gathered from the Working Group's field observation.

1a) Spiracle median 2

1b) Spiracle lateral...6

2a) Head-body fully pigmented...3

2b) Head-body mainly transparent 4

3a) Head-body dark brown to grey-brown, total length >20mm .... *Kaloula pulchra*

3b) Head-body brown to orange-brown,

    total length <15mm and tail length less than 1.5 times head-body length .... *Kalophrynus interlineatus*

4a) Tail partially pigmented red .... *Microhyla butleri*

4b) Tail mainly transparent 5

5a) Tail length at least twice as long as head-body length .... *Microhyla pulchra*

5b) Tail length more than 1.5 times but less than twice as long as head-body length .... *Microhyla fissipes*

6a) Tail tip rounded, head-body and tail muscle dark.. *Duttaphrynus melanostictus*

6b) Tail tip pointed 7

7a) Head-body rounded to elliptical in dorsal view, abdomen transparent... *Liuixalus romeri*

7b) Head-body not rounded in dorsal view, abdomen not transparent...8

8a) Snout with a white dot... *Polypedates megacephalus*

8b) Snout without a white dot 9

9a) Tail fin mainly transparent, dark mouth relatively remarkable.. *Hoplobatrachus rugulosus*

9b) Dark spotted or mottled tail fin...10

10a) Dark spotted tail fin .... *Fejervarya limnocharis*

10b) Dark mottled tail fin 11

11a) Dorsal head-body often with dark spots, a short black stripe on the side in front of the eyes........ *Sylvirana guentheri*

11b) Not as above 12

12a) Larger tadpole dorsal head-body with two light-coloured stripes extending to the tail .... *Hylarana taipehensis*

12b) Larger tadpole dorsal head-body with three stripes... *Hylarana macrodactyla*

Lowland tadpole photo collection and morphological description

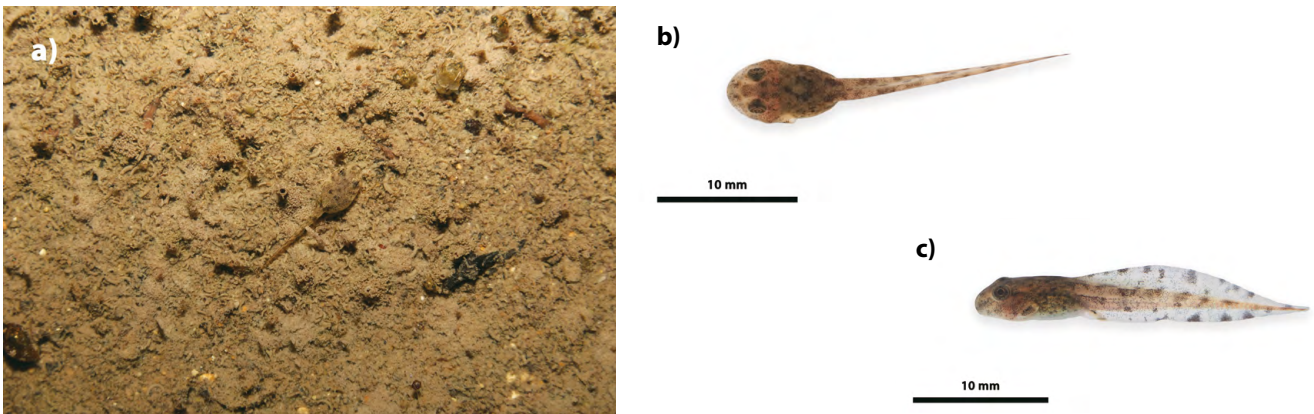## *Duttaphrynus melanostictus* (Asian Common Toad)
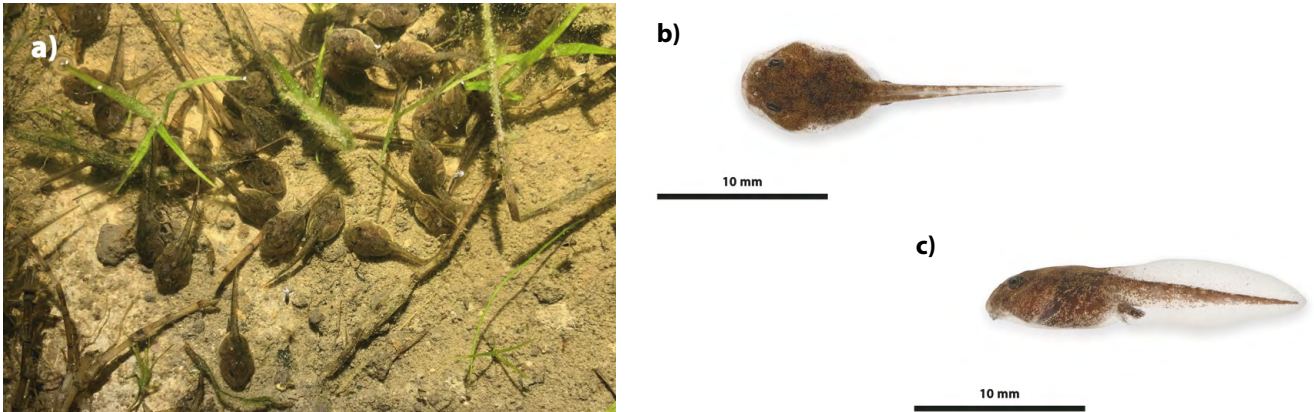
Figure 2. Tadpole of Asian Common Toad: (a) in the field (b) dorsal view (c) lateral view.
Morphological description:
Head-body elliptical in dorsal view; head-body and tail muscle dark, with light-coloured dense pigment; tail tip rounded.
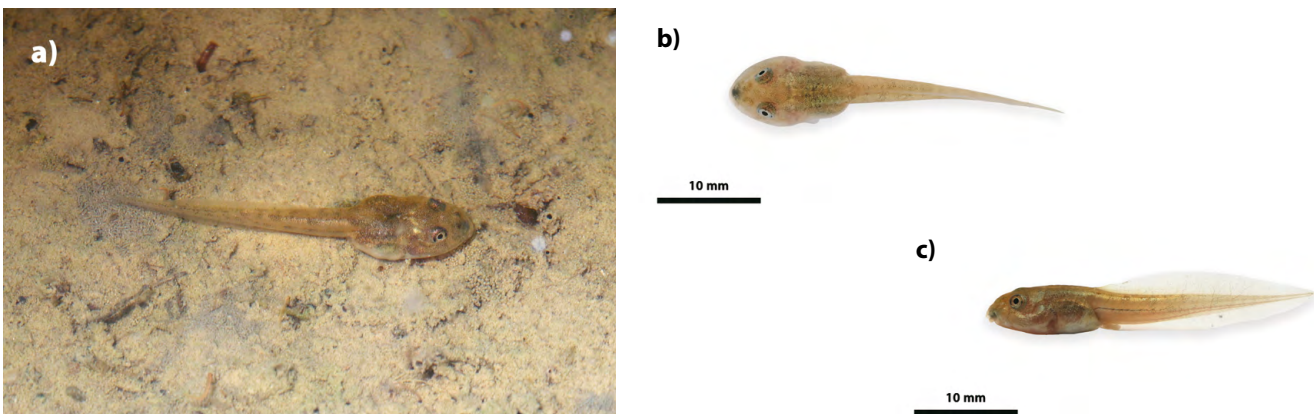
Fejervarya limnocharis (Paddy Frog)

Figure 3. Tadpole of Paddy Frog: (a) in the field (b) dorsal view (c) lateral view.
Morphological description:
Head-body ovoid to elliptical-elongated in dorsal view; head-body brown to pale brown; dark spotted tail fin.

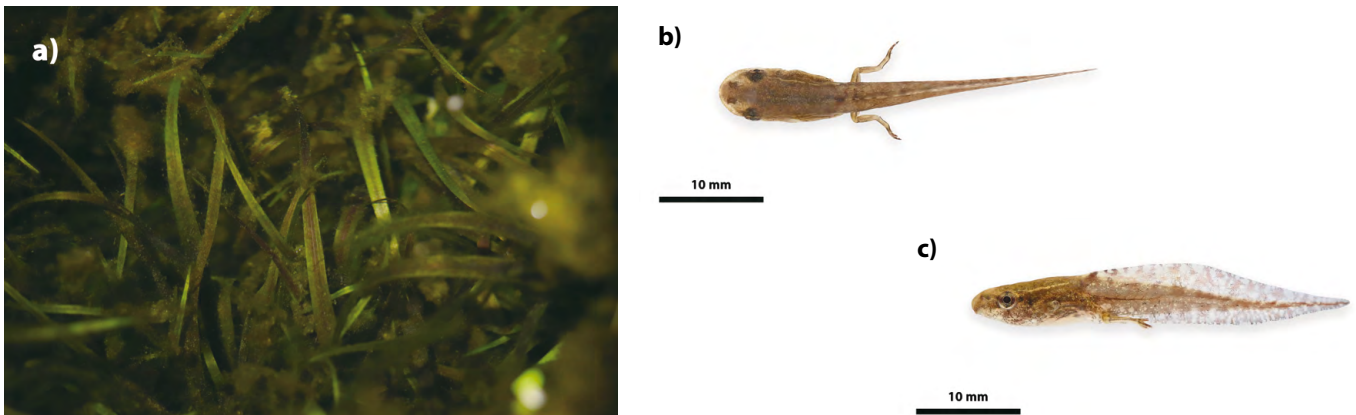## *Hoplobatrachus rugulosus* (Chinese Bullfrog)

Figure 4. Tadpole of Chinese Bullfrog: (a) in the field (b) dorsal view (c) lateral view.
Morphological description:
Head-body elliptical-elongated in dorsal view; head-body pale brown or lighter; dark mouth relatively remarkable.

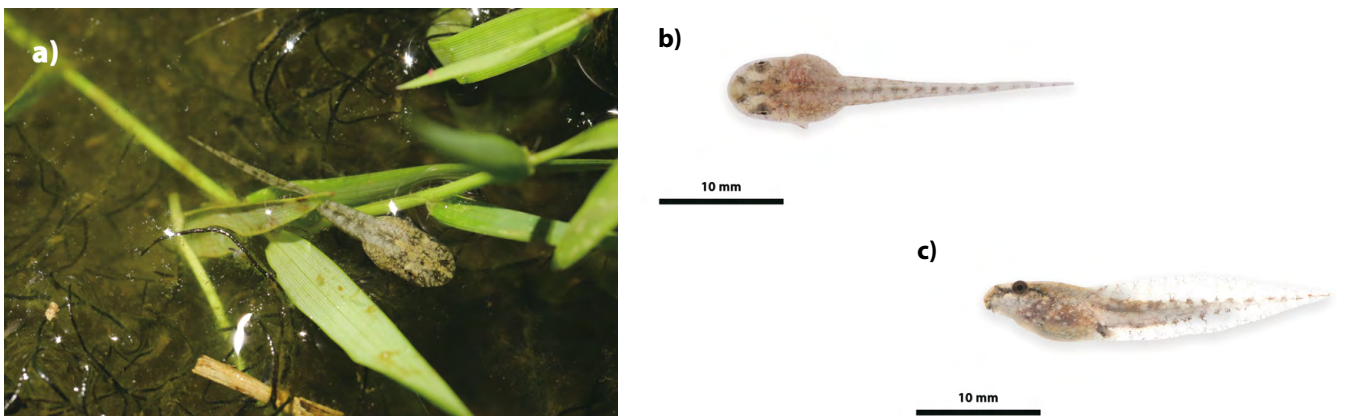## Hylarana macrodactyla (Three-striped Grass Frog)

Figure 5. Tadpole of Three-striped Grass Frog: (a) habitat photo (b) dorsal view (c) lateral view.
Morphological description:
Head-body elliptical-elongated in dorsal view; head-body brown to pale brown; larger tadpole dorsal head-body with three stripes.

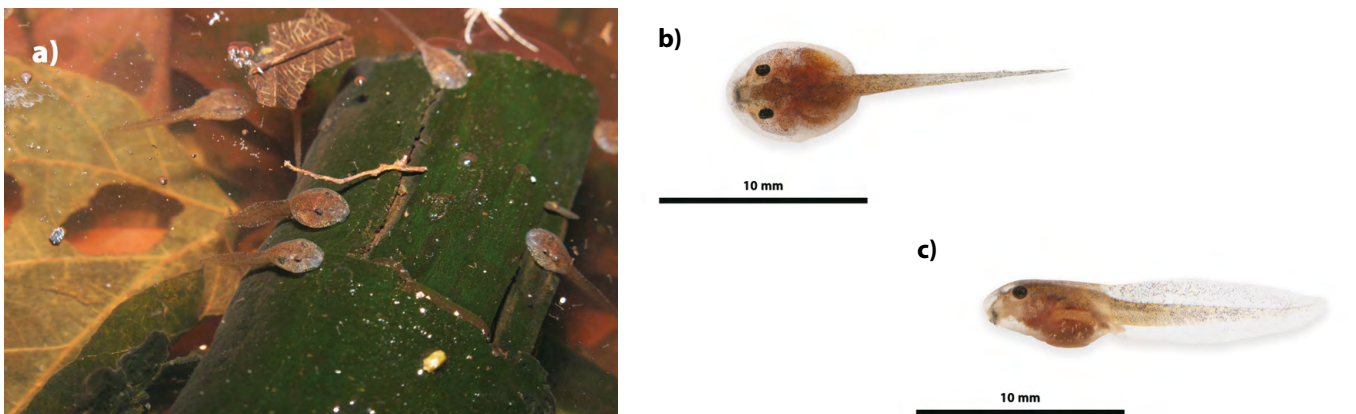## Hylarana taipehensis (Two-striped Grass Frog)

Figure 6. Tadpole of Two-striped Grass Frog: (a) in the field (b) dorsal view (c) lateral view.
Morphological description:
Head-body ovoid to elliptical in dorsal view; head-body brown to pale brown; larger tadpole dorsal head-body with two light-coloured stripes extending to the tail.

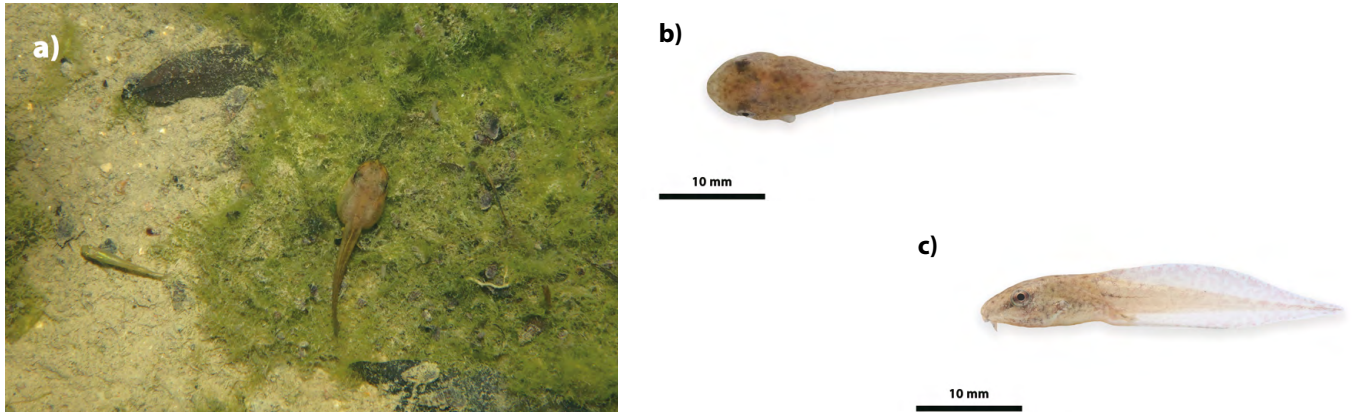## Liuixalus romeri (Romer's Tree Frog)

Figure 7. Tadpole of Romer's Tree Frog: (a) in the field (b) dorsal view (c) lateral view.
Morphological description:
Head-body rounded to elliptical in dorsal view; head-body brown to pale brown; abdomen transparent and the internal organs are clearly visible.
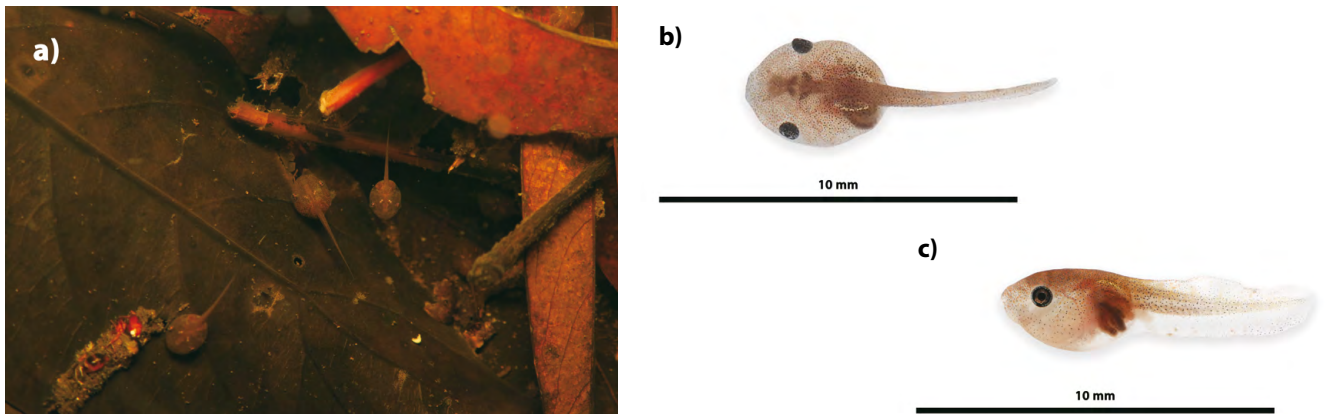
Sylvirana guentheri (Günther's Frog)

Figure 8. Tadpole of Günther's Frog: (a) in the field (b) dorsal view (c) lateral view.
Morphological description:
Head-body elliptical-elongated in dorsal view; head-body brown to pale brown; dorsal head-body often with dark spots; a short black stripe on the side in front of the eyes.

Kalophrynus interlineatus (Spotted Narrow-mouthed Frog)

Figure 9. Tadpole of Spotted Narrow-mouthed Frog: (a) in the field (b) dorsal view (c) lateral view.
Morphological description:
Head-body rounded to elliptical in dorsal view; dorsal head-body brown to orange-brown; tail length less than 1.5 times head-body length.

Kaloula pulchra (Asiatic Painted Frog)

Figure 10. Tadpole of Asiatic Painted Frog: (a) in the field (b) dorsal view (c) lateral view.
Morphological description:
Head-body rounded to elliptical-elongated in dorsal view; head-body dark brown to grey-brown.

Microhyla butleri (Butler's Pigmy Frog)

Figure 11. Tadpole of Butler's Pigmy Frog: (a) in the field (b) dorsal view (c) lateral view.
Morphological description:
Head-body rounded in dorsal view; head-body mainly transparent; tail partially pigmented red.

Microhyla fissipes (Ornate Pigmy Frog)
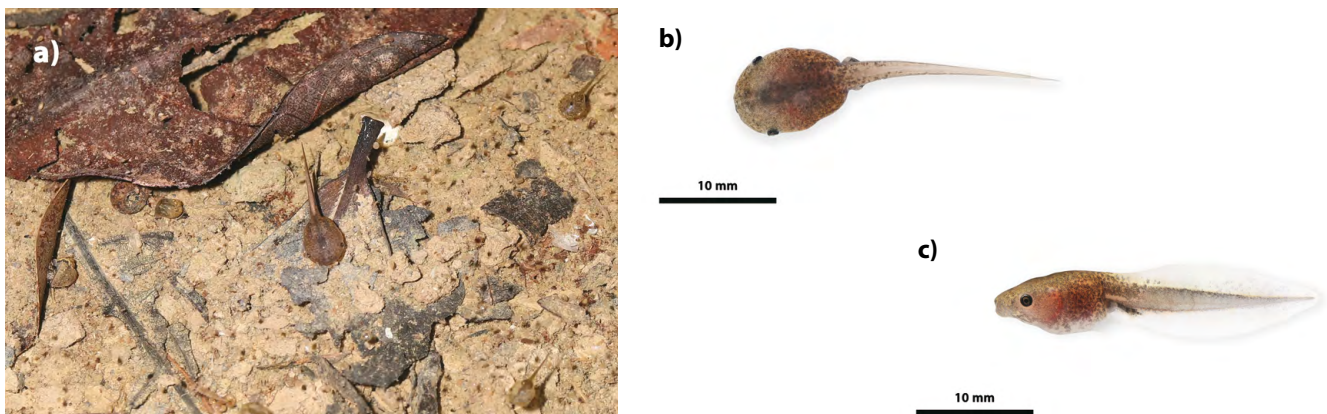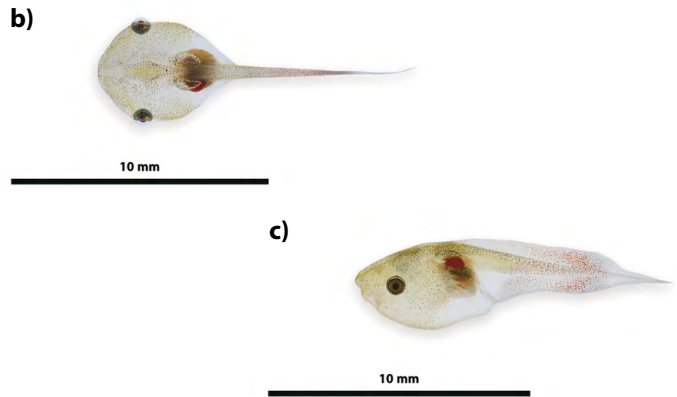

Figure 12. Tadpole of Ornate Pigmy Frog: (a) in the field (b) dorsal view (c) lateral view.
Morphological description:
Head-body rounded to kite-shaped in dorsal view; head-body mainly transparent; tail length more than 1.5 times but less than twice head-body length.

Microhyla pulchra (Marbled Pigmy Frog)

Figure 13. Tadpole of Marbled Pigmy Frog: (a) in the field (b) dorsal view (c) lateral view.
Morphological description:
Head-body kite-shaped in dorsal view; head-body mainly transparent; tail length at least twice as long as head-body length.

Polypedates megacephalus (Brown Tree Frog)

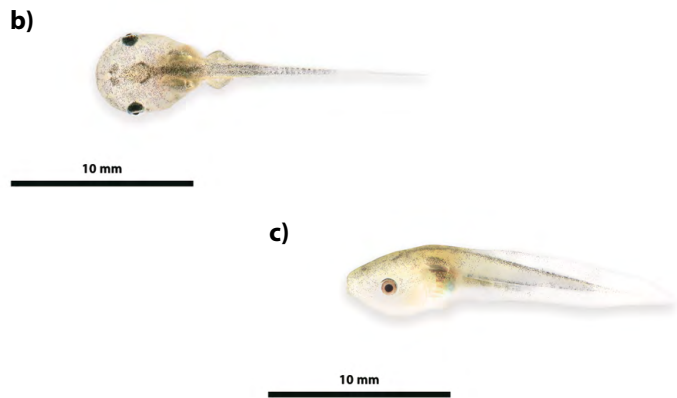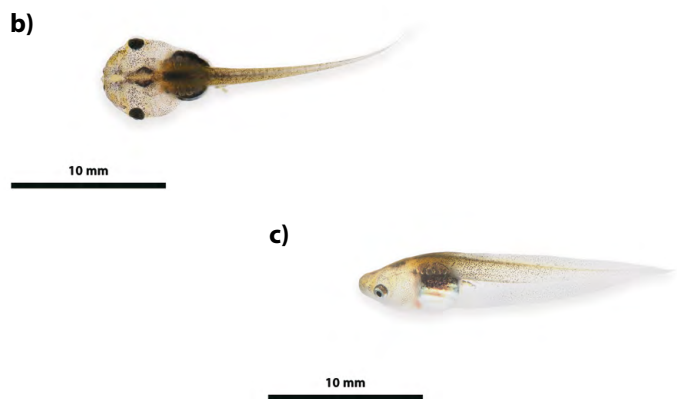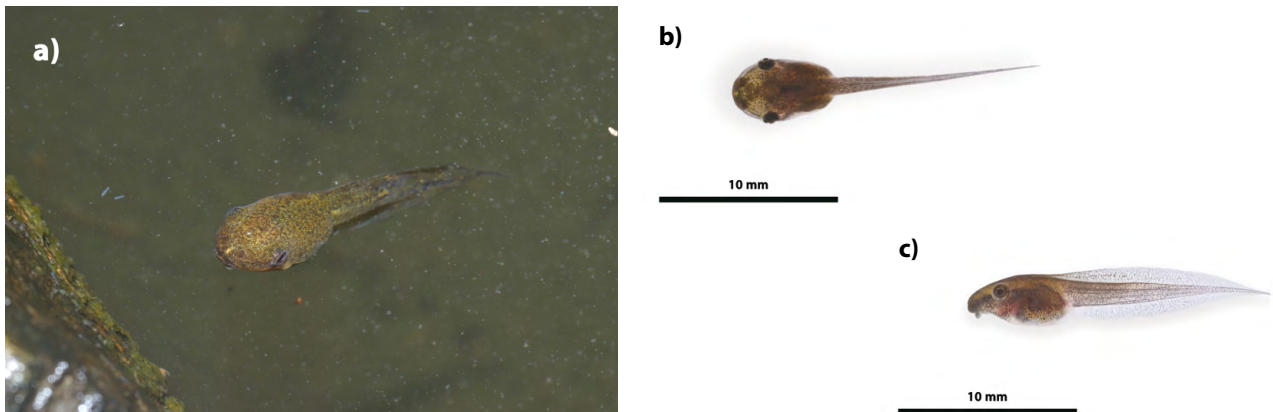**Figure 14. Tadpole of Brown Tree Frog: (a) in the field (b) dorsal view (c) lateral view.**
Morphological description:
Head-body elliptical-elongated in dorsal view; head-body brown to pale brown; snout with a white dot.

References

Altig R, McDiarmid RW, Nichols KA, Ustach PC. 1998. Tadpoles of the United States and Canada: A Tutorial and Key. Contemporary Herpetology Information Series. [Accessed 16 August 2022]. https://www.pwrc.usgs.gov/tadpole/default.htm.

Dubeux MJM, Nascimento FACD, Lima LR, Magalhães FDM, Silva IRSD, Gonçalves U, Almeida JPF, Correia LL, Garda AA, Mesquita DO, et al. 2020. Morphological characterization and taxonomic key of tadpoles (Amphibia: Anura) from the northern region of the Atlantic Forest. Biota Neotropica. [Accessed 16 August 2022]; 20(2). https://doi.org/10.1590/1676-0611-BN-2018-0718.

Lau MWN. 1998. Habitat use by Hong Kong amphibians, with special reference to the ecology and conservation of *Philautus romeri* [unpublished PhD thesis]. [Hong Kong]: The University of Hong Kong.

Wang SH, Zhao LY, Liu LS, Yang DW, Khatiwada JR, Wang B, Jiang JP. 2017. A Complete Embryonic Developmental Table of *Microhyla fissipes* (Amphibia, Anura, Microhylidae). Asian Herpetological Research. [Accessed 16 August 2022]; 8(2): 108–117. https://doi.org/10.16373/j.cnki.ahr.170006.

Working Group Column

First Discovery of *Orthetrum poecilops poecilops* Larva

Bill S.K. Ho and Tze-wai Tam
Dragonfly Working Group

漁農自然護理署蜻蜓工作小組於 2021 年 6 月在香港馬鞍山輋下觀察到斑灰蜻的稚蟲，乃指名亞種稚蟲的全球首次記錄。本文就其稚蟲的生境、特徵和生命週期等作簡短介紹。

Introduction

Classified as "Vulnerable" on the International Union for Conservation of Nature (IUCN) Red List (Wilson 2009), *Orthetrum poecilops* (Ris 1919) is one of the few extraordinary dragonfly species that tolerate high salinity. The nominate subspecies (*Orthetrum poecilops poecilops*) is restricted to coastal habitats in southern China, including Fujian, Guangdong (Hong Kong, Zhuhai) and Hainan (Zhang HM pers. comm.), whereas the subspecies *O. p. miyajimaense* (Yûki and Doi 1938; reinstated by Asahina 1970 principally by its smaller size) is only found at Miyajima Island, Japan. Wilson (2001) considered that the two taxa are probably synonyms. The adults of the two taxa appear to show no apparent differences in their morphology, ecology and genetic composition (Sawano et al. 1998; Ozono et al. 2013). As for the larva, the general structure, biology and habitats of the species have been described, nonetheless from the single population in Japan (Sawano 1966; Ishida et al. 1988), outside which the larva has not been documented. This article gives the first account of the larva and larval habitats of *O. p. poecilops* recorded in Hong Kong, China.

Orthetrum poecilops poecilops adult in Hong Kong

In Hong Kong, *O. p. poecilops* are found in mangroves along the northeast and west coast of New Territories, Kei Ling Ha Hoi and Tung Chung. Adults prefer mangroves within the landward zone where freshwater streams cascade into tidal mangroves (Tam et al. 2011; Zhang 2019). Males are easy to observe, often found perching on isolated, protruding branches of vegetation, whereas females are seen mostly in pairs with the males or laying eggs in isolation. For many years, we have observed females laying eggs onto substrates at the edge of or inside mangroves (AFCD unpublished data), it is therefore suspected that the larvae may inhabit mangrove habitats.

Habitat preference of *Orthetrum poecilops poecilops* larva

On 7 June 2021, the AFCD Dragonfly Working Group collected two *O. p. poecilops* larvae when surveying along the coast of Kei Ling Ha Hoi near Che Ha, Ma On Shan (Figure 15). A final instar larva (Figure 16a) was found under soft silty mud and detritus of a brackish marsh, which mostly supported sedges including *Cladium chinense* and *Fimbristylis subbispicata*, mangrove *Kandelia obovata*, as well as *Bacopa* species (Figure 16b). Fifteen individuals of *Mortonagrion hirosei* larvae were also found on the landward side of the marsh, where there was limited freshwater stream input and sedges and Pandanus species dominated. Immediately downstream to the brackish marsh was a mangrove, where a mid to late (n-3 or n-4) instar larva was recorded (Figure 17). This larva dwelled on substrates composed of mostly coarse sand and some silt, adjacent to the roots of *K. obovata*. The salinity was 0.12 ppt at the marsh where the final instar larva was found and 0.53 ppt at the mangrove where the mid to late instar larva was found.

Figure 15. Che Ha, Ma On Shan.

Figure 16. (a) A final instar larva of *O. p. poecilops* recorded at Che Ha on 7 June 2021 and (b) the brackish marsh where it was recorded.

Figure 17. (a) The mid to late instar (n-3 or n-4 instar) larva of *O. p. poecilops* recorded at Che Ha on 7 June 2021 and (b) the mangrove where it was recorded.

Figure 18. Lateral view of a final instar larva of *O. p. poecilops*, with prominent dorsal spines on abdominal segments II – IX.
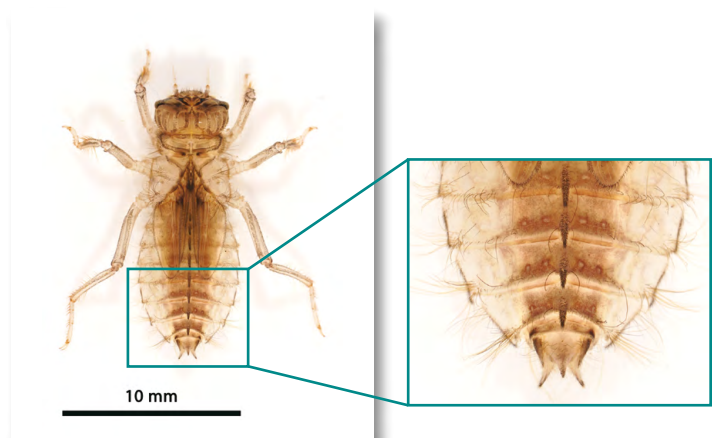

Figure 19. A newly shed final instar larva of *O. p. poecilops*, with four horizontally arranged pale spots on darker brown dorsum.

Wilson (2020) suggested that *O. p. poecilops* larvae might inhabit brackish streams below the mean high water springs, and that although they could tolerate fully saline marine water for some time, they would require at least some freshwater stream input when the tides are low. Our findings partially accord with his suggestion, but instead of brackish streams, the larvae were found in brackish marshes and mangroves with freshwater input. Furthermore, an *O. p. poecilops* exuvia was found at the landward zone of a mangrove at another site of Kei Ling Ha Hoi (Yung Shue O) in another survey, where the salinity could exceed 15 ppt during high tides (AFCD unpublished data). As such, it is considered that mangroves should serve as both the dwelling and emergence grounds for *O. p. poecilops* larvae.

In Japan, *O. p. miyajimaense* larvae are recorded hiding in ground-fed ponds among soft mud, decaying leaves and water plant roots, and marshes dominated by sedges (*Scirpus wichurae*) and reeds with probable seawater input during high tides (Sawano 1966; Wilson 2020). Situated beyond the northern limit of mangroves in Japan (31°22'N; Saenger 2002), the brackish marsh in Miyajima Island is connected to the sea through sandy shores instead of mangroves. Although *O. p. miyajimaense* larvae are not found on sandy shores, they are known to have high tolerance to salinity (Ugai S pers. comm.). Therefore, *O. p. poecilops* larvae have a similar habitat preference with *O. p. miyajimaense* – both use brackish marshes, but the former also utilises mangrove. Further investigation over the wider distributional range of *O. p. poecilops* larva will be required to fully comprehend its habitat requirements.

Morphology of *Orthetrum poecilops poecilops* larva

The *O. p. poecilops* larva is medium-sized (final-instar 16.5 – 20.0 mm long, n = 5), covered by dense hairs; head rectangular, wing pads extending to abdominal segments V – VI, abdomen elongated with long, pointed dorsal spines on abdominal segments II – IX (Figure 18) and relatively short lateral spines on VIII – IX. The larva is easily distinguished from its congeners in Hong Kong by its extra dorsal spine on abdominal segment IX. In addition, the central part of the dorsum is relatively dark brown tinted with four horizontally arranged pale spots (most apparent on S6 – 8; Figure 19). Both *O. p. poecilops* and *O. p. miyajimaense* are also distinct with three pairs of long palpal lateral setae and five to eight pairs of short outer premental setae at labium (Figure 20; Sawana 1966), in contrast to other *Orthetrum* species in Hong Kong which have five to eight pairs of long palpal setae and two to four long outer premental setae (Ng c2017 – 2022). The number of outer premental setae varies between five to eight pairs in *O. p. poecilops* and five pairs in *O. p. miyajimaense* (Sawana 1966).

Some *O. p. poecilops* eggs were also collected in Che Ha on the same survey day when an egg-laying female was captured (i.e. 7 June 2021). The eggs were pale yellow, oval-shaped, c. 0.78 mm x 0.48 mm in size while the first instar larva was c. 1.2 mm in length (Figure 21). Sawana (1966) reported smaller eggs (0.46 mm x 0.32 mm), first instar larvae (1.0 mm) and final instar larvae (15.8 – 19.0 mm, n = 6) in *O. p. miyajimaense*. However, significant intraspecific and even intra-population variation in egg size is not uncommon in dragonflies (Watanabe and Adachi 1987; Sahlén and Suhling 2002). In fact, including the larvae found in the field, the final instar larvae of *O. p. poecilops* are similar in size (16.5 – 20.0 mm) to *O. p. miyajimaense* (16.0 – 21.0 mm; Ozono et al. 2013; Ozono et al. 2019).
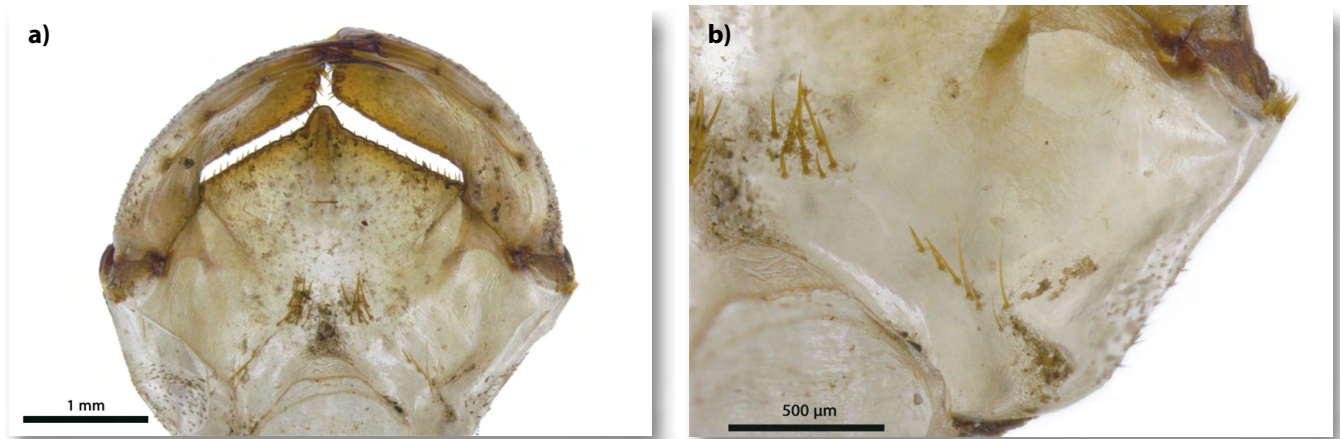
Figure 20. (a) Labium of *O. p. poecilops* with three pairs of long palpal lateral setae; (b) Labium of *O. p. poecilops* with seven short outer premental setae on the right side.
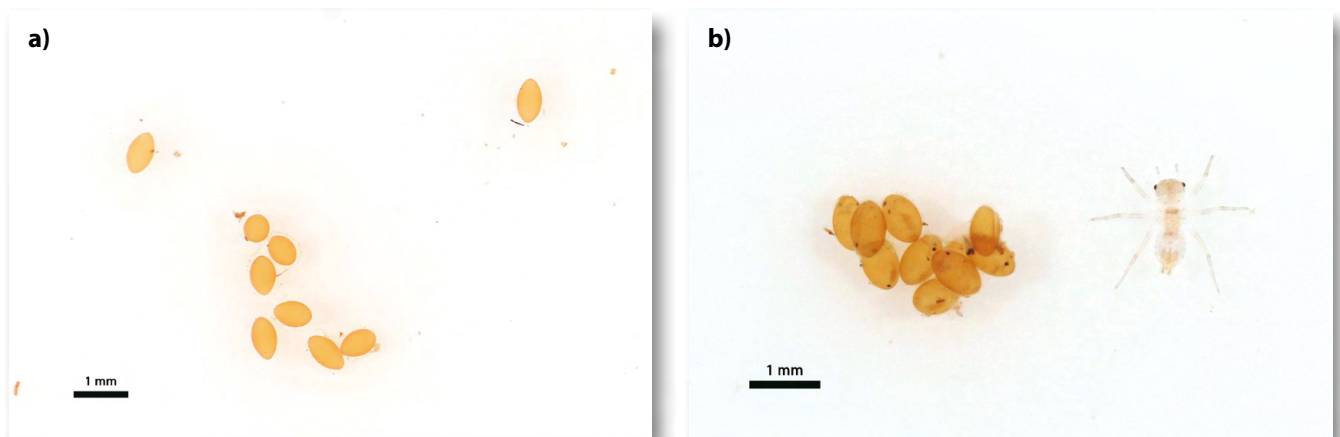

Figure 21. (a) Freshly laid eggs of *O. p. poecilops*; (b) Mature eggs (7th Day) and a first instar larva of *O. p. poecilops*.

Larval cycle and voltinism of *Orthetrum poecilops poecilops* larva

Literature about the larval cycle of *O. poecilops* is lacking, but its congener *O. sabina* has a mean larval cycle of 86 or 160 days when reared at 27 ± 1°C (Mathavan 1990; Corbet 1999), a temperature comparable to that in summer in Hong Kong. In Hong Kong, adults are on the wings between April and September. It is likely that eggs laid in spring (April) can complete their larval stage faster if they do not overwinter. Indeed, the mid to late instar (n-3 or n-4 instar) *O. p. poecilops* larva collected on 7 June 2021, which the egg was presumably laid in spring, reached the final instar on 22 August 2021 in captivity, suggesting it could emerge by the end of the same year for breeding. Therefore, it is likely that eggs laid from early emerged adults (April) could develop into adults in late summer (August) or autumn (September) of the same year, i.e. bivoltine.

On the other hand, larval development of dragonflies generally slows down with a decrease in temperature, and many species have very little or no growth at 8 – 12°C (Pickup and Thompson 1990; Suhling et al. 2015). Larvae which begin their larval period from summer (June) onwards generally need to overwinter and emerge on the following year, i.e. are univoltine. As in the case of *O. p. poecilops*, the species could take approximately 293 – 355 days (9 – 12 months) for an egg laid in early summer (June) to develop into an adult (AFCD unpublished data).

Accordingly, it seems that *O. p. poecilops* may complete at least one and perhaps two generations a year. In contrast, *O. p. miyajimaense* is univoltine in Japan (Ozono et al. 2013), likely due to the colder climate. Certainly, the generation length is also affected by numerous factors, such as abundance and type of prey, availability of permanent water, and even intraspecific genetic variation (Corbet 1999; Corbet et al. 2006; Flenner et al. 2010).

Conclusion

O. p. poecilops larva was first discovered in this study. We have briefly described its habitats, morphology and life cycle. The larva can easily be distinguished from its congener in Hong Kong by the additional dorsal spine on abdominal segment IX, and its distinct habitat preference for brackish marshes and mangroves with freshwater input. Both *O. p. poecilops* and *O. p. miyajimaense* larvae have very similar morphology and habitat preference, but the former may have a faster life cycle (univoltine or bivoltine) and also utilises mangrove habitat. Future investigation over the wider distributional range of *O. p. poecilops* larva with a larger sampling size would be needed to fully comprehend its biology and ecology.

Acknowledgements

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Planting of Mangroves at Tai Tam

Terence P.T. Ng and Nelson P.L. Wong
Wetland Specialist Working Group

位於大潭灣內的泥灘有著港島區唯一的一片紅樹林。為提高該泥灘的生態價值，漁農自然護理署於 2005 年在該處試行了一項紅樹種植計劃。本文旨在概述這計劃的發現及成果。

Introduction

Located on the southern coast of Hong Kong Island, the inner bay of Tai Tam Harbour is surrounded by steep hills on all sides. Within the inner bay, an area of around 16 ha covering the lower course of the Tai Tam Tuk Reservoir was designated as a Site of Special Scientific Interest (SSSI) in 1975. The SSSI hosts diverse habitats, including intertidal mudflat, sheltered sand flat and natural watercourse, which support a dazzling array of flora and fauna. In particular, the intertidal mudflat of the SSSI is known to support small patches of mangroves that are known as the only mangrove stand on Hong Kong Island. In 2005, AFCD initiated a mangrove planting programme at the intertidal mudflat of the SSSI with an aim to enhancing the ecological value of the site through extending the mangrove coverage. This article aims to provide an overview of the planting programme after more than a decade of monitoring.

The Planting Programme

The original mangrove patches (<0.1 ha) at the intertidal mudflat of the SSSI were once found to be completely missing in a survey conducted by Tam and Wong (1997). Yet, our surveys conducted in April 2005, right before the planting programme, revealed the presence of small patches of *Excoecaria agallocha* and *Kandelia obovata*. During the planting programme in 2005 and 2006, seedlings of six true mangroves species were planted near the existing mangrove patches, as detailed in Table 2 and Figure 22.

Quadrat counts in 2020 showed that *K. obovata* achieved the highest survival rate (>70%) among the other planted species. Figure 23 shows the condition of the planting area before the planting programme and its domination by *K. obovata* in 2020. Despite a large number (>1,000 individuals) of *Aegiceras corniculatum* being planted, their survival rate was very low. A small number of *Lumnitzera racemosa*, *Avicennia marina* and *Heritiera littoralis* were also planted, but none had survived more than three years. Encouragingly, two true mangrove species formerly absent at the site (i.e. *A. corniculatum* and *Bruguiera gymnorhiza*) have been established under the planting programme.

The average heights of the planted *K. obovata*, *A. corniculatum* and *B. gymnorhiza* were monitored from 2005 to 2020 under a series of surveys, and the results are presented in Figure 24. The established *K. obovata* and *B. gymnorhiza* showed a gradual increase in height, and both species were able to reproduce as indicated by the presence of flowers and propagules in their reproductive seasons. Recruits of *K. obovata* seedlings could also be observed at the edge of the planting areas during the survey period (Figure 25). The established *A. corniculatum*, however, only showed a slight increase in height and exhibited poor health with signs of attack by leaf-mining moths. No flower or propagule was recorded in the surveys. The overall increase in mangrove area, covering the planted and recruited mangroves, was estimated to be about 0.27 ha in November 2020 based on drone images (Figure 26).

Table 2. Heights and estimated survival rates of six planted mangrove species.

Species	Average height of seedlings when planted (cm)	No. of individuals planted in July 2005	No. of individuals planted in June 2006	Estimated no. of individuals survived in 2020	Estimated survival rate (%)	Average height of the established individuals in 2020 (cm)
Kandelia obovata	42	2,000	-	1,506	75.3	128
Aegiceras corniculatum	60	1,000	100	99	9.0	70
Bruguiera gymnorhiza	79	500	-	108	21.6	231
Avicennia marina	48	-	500	0	0	-
Lumnitzera racemosa	35	-	15	0	0	-
Heritiera littoralis	57	-	30	0	0	-

As mangroves are very slow growing plants, Tam and Wong (1997) suggested that mangrove seedlings should be planted in addition to droppers as this would shorten the establishment time to restore mangrove stands. While the use of well-established seedlings (>30 cm) in this programme may have facilitated the establishment of some species, it was not the case for all the others. The results suggest that the site condition seems to favour *K. obovata*, as supported by the prior existence of this species at the site before the planting programme.

Unfortunately, there is a lack of robust data on faunal diversity and abundance within the planting area before and after the planting programme. Nevertheless, a recent territory-wide mangrove survey has showed that, in terms of insects, Tai Tam stood out by its overall high species richness and the number of rare species amongst the mangrove stands in Hong Kong despite its small area (Cannicci 2019). This shows that the additional mangrove habitat created by this planting programme can potentially be conducive to preserving rare local fauna. All in all, this planting programme has successfully established a growing, species-rich mangrove stand in Hong Kong, and the lesson learnt can be valuable for similar programmes in the future.
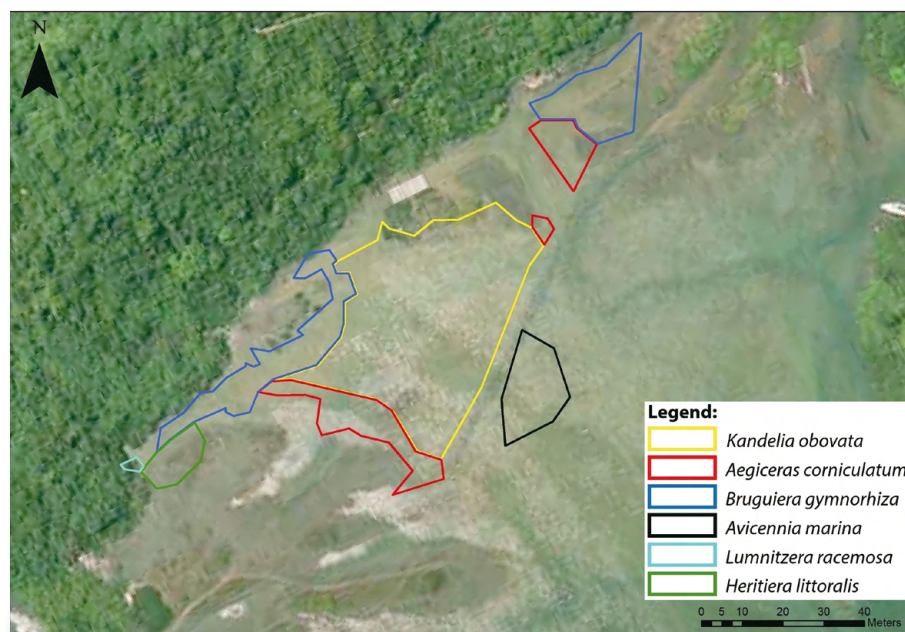
Figure 22. Overall planting plan of the Planting Programme in 2005 and 2006.

Figure 23. (a) View of the planting area (indicated by the red arrow) before the planting in April 2005; (b) View of the planting area in November 2020.
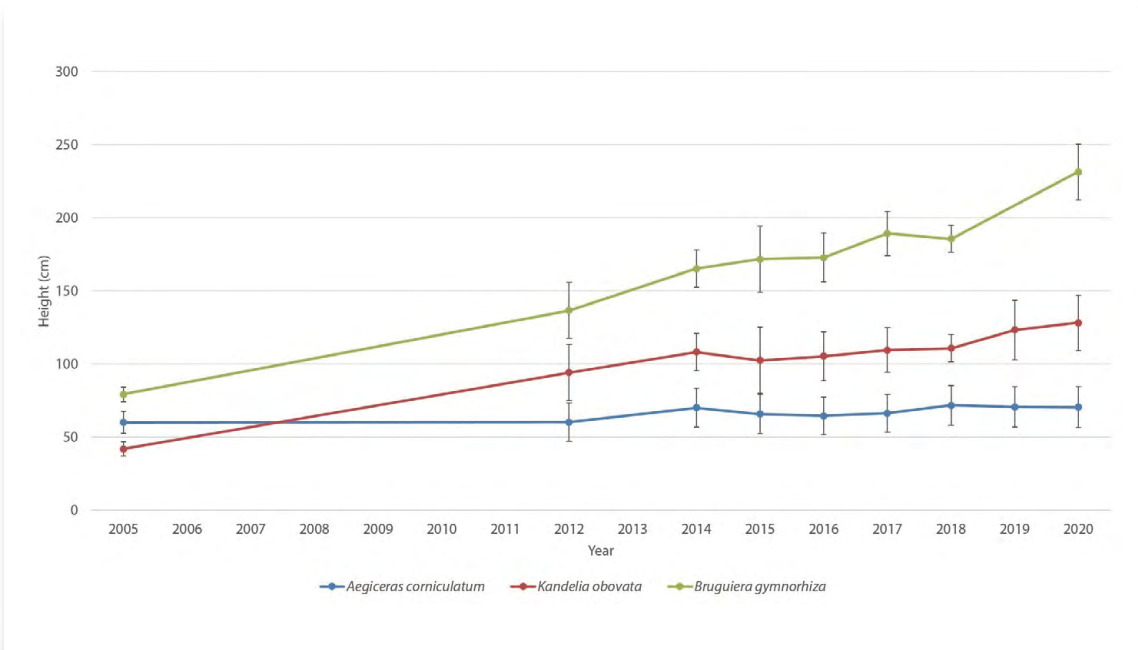

Figure 24. Changes in average heights of the three planted mangroves, *K. obovata*, *A. corniculatum* and *B. gymnorhiza* from 2005 to 2020 (Error bar: standard deviation).

Figure 25. New recruits of *K. obovata* (photo taken in November 2020).

Legend:
- *Kandelia obovata*
- *Aegiceras corniculatum*
- *Bruguiera gymnorhiza*
- *B. gymnorhiza* w/ new recruits of *K. obovata*
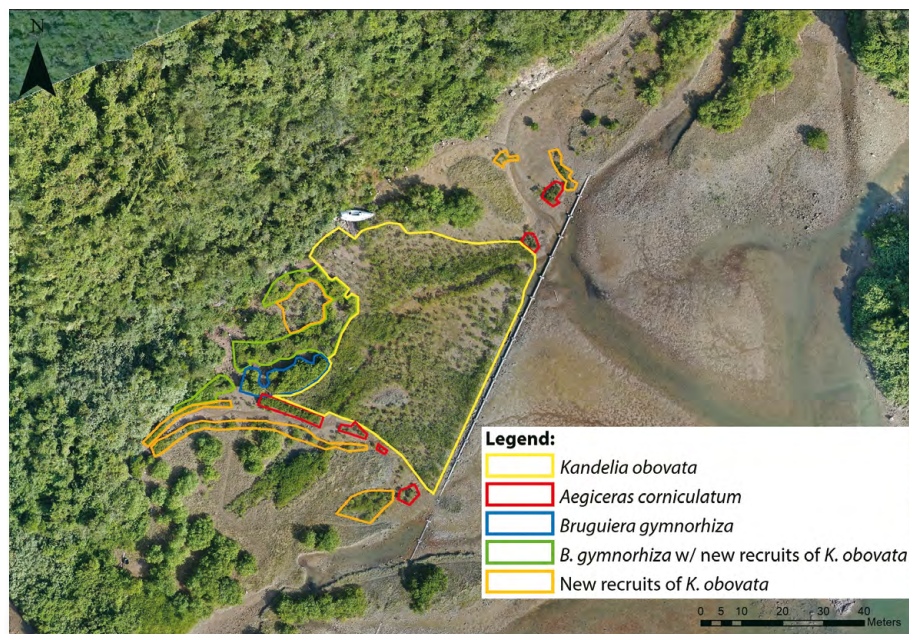- New recruits of *K. obovata*

Figure 26. Drone image of the planting site taken at 70 m above ground in November 2020. Areas of the planted and the recruited mangrove patches are indicated in different colours.

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An Overview on Short-nosed Fruit Bat (*Cynopterus sphinx*) and Its Roost Selection in Urban Parks of Hong Kong

Nick K.W. Chan, Alex W.K. Lo and Wing W.C. Tsui
Mammal Working Group

漁農自然護理署哺乳動物工作小組於 2021 年夏季進行了市區公園調查，觀察短吻果蝠利用市區公園棲息的情況。調查共錄得 212 個蝠巢、701 隻果蝠，結果顯示短吻果蝠廣泛分布於本港多個市區公園。本文描述和分析短吻果蝠利用市區公園築巢的現況，並與以往作比較，以了解果蝠的生境需求和所需的管理措施。

An overview of Short-nosed Fruit Bat and its status in Hong Kong

Cynopterus sphinx (Short-nosed Fruit Bat) is one of the two fruit bats recorded in Hong Kong. Belonging to the Pteropodidae family, *C. sphinx* is a medium-sized fruit bat characterised by large eyes, short muzzles and pale borders around ears and wing bones. The bat roosts in harems with usually one mature male, which can be distinguished by its larger size and orange-tinted collar, and a group of females (Marshall and Hechtel 1966; Storz and Kunz 1999).

Animal Profile

Scientific name: *Cynopterus sphinx*
Common name: Short-nosed Fruit Bat/ Greater Short-nosed Fruit Bat/ Dog-faced Fruit Bat
Weight: 38 – 70 g
Forearm length: 58 – 76 mm
Habitat: Woodlands, orchards, rural fringes, buildings
Breeding season: April and September

C. sphinx feeds predominantly on fruits (Storz and Kunz 1999). Leaves are another regular food item of the bat and are considered an important source of minerals and proteins to supplement its fruit-oriented diet (Kunz and Diaz 1995; Ruby et al. 2000). The species was recorded to feed on 15 families of fruits, flowers or leaves from a study in Guangzhou (Wu et al. 2008). Being frugivorous and nectivorous, *C. sphinx* plays an important role in seed dispersal and pollination of numerous wild and cultivated plant species.

C. sphinx's distribution ranges from Pakistan, India to southern China, and southwards to Southeast Asia up to Indonesian Archipelago (Storz and Kunz 1999; Bates et al. 2019). In Hong Kong, *C. sphinx* is a common and widespread species occurring in both urban and rural areas, as well as outlying islands, such as Cheung Chau and Soko Islands (Shek 2006; AFCD unpublished data). The bat frequently roosts under *Livistona chinensis* (Chinese Fan-palm) and *Washingtonia robusta* (Petticoat Palm), palm species commonly planted in parks and villages in Hong Kong. The male bat constructs roosts by chewing the veins of palm fronds, causing the distal leaflets to collapse and creating a tent-like space for shelter and breeding. Occasionally, the bat also roosts under *Ravenala madagascariensis* (Traveller's Palm), banana tree and eaves of houses (Ades 1994; AFCD unpublished data).

C. sphinx was first documented in Hong Kong in 1955 (Romers 1960; Marshall and Hechtel 1966). Locally, it is protected under the Wild Animals Protection Ordinance (Cap. 170) together with other bat species. It is currently listed as Least Concern by the IUCN Red List with an overall rising global population trend (Bates et al. 2019). Considering its common and widespread status, C. sphinx is not considered to be under any major threats in Hong Kong. However, it is subjected to occasional bycatch in mist-nets in orchards and fish farms (Ades 1994; KFBG 2019; AFCD unpublished data). Extreme weather condition, such as cold spell and heatwave, may also cause stress and affect the survival of some individuals. Due to its adaptiveness to human-modified landscapes, C. sphinx is unfortunately involved in human-wildlife conflicts in Hong Kong. Its versatile roosting ability in urban habitats has resulted in occasional public complaints about environmental hygiene and the general fear of spread of diseases. Besides, the bat's preference over fruits and figs for food also has led to conflicts with orchard farmers and owners.

The Mammal Working Group of AFCD conducted a pilot study on C. sphinx in 2004 – 2005 to learn about its distribution and habitat preference in the urban area of Hong Kong (Chan and Shek 2006). Fifteen years from our previous study, we were looking once again at C. sphinx in urban areas, this time focused on urban parks, and comparing our observations with the previous study to gain further understanding of the roosting preference of this charismatic species and insights into the management of its urban habitat.

Methodology

This study was conducted in 49 urban parks managed by the Leisure and Cultural Services Department (LCSD) over 41 days of the summer season in July and August 2021. The study sites were selected taking into consideration the planting of L. chinensis (Chinese Fan-palm) and W. robusta (Petticoat Palm) (Figures 27a and 27b), which are the two palm species well known to be used by C. sphinx as roosts, at the premises. In addition, the parks selected are spread out across Hong Kong to give representation to the populations from Hong Kong Island, Kowloon and the New Territories.

Surveys were conducted during daytime by direct observation with the aid of binoculars. All palms (L. chinensis, W. robusta and other species present) were surveyed in the parks. The height of each palm tree was measured from trunk base to top of crown. The GPS coordinates of each palm tree were also recorded using a GPS device (model: Garmin GPSMAP 64s). To observe the abundance and roosting pattern of C. sphinx, the number of individuals was counted; and each frond, either comprising single or multiple individuals, was counted as one roost (Figure 28). Once C. sphinx was observed, the roost size and height, as well as the maturity of individuals (infant, juvenile or adult) were recorded. The juveniles were distinguished from adults by their smaller size and more greyish pelage. For roosts that were partially masked by fronds and not fully visible to the surveyors, the roost size was counted by the number of visible individuals. Besides bats, bite mark (Figure 29) was counted and used as an indication of bat occupancy.

The data collected were analysed using the statistical computing package SPSS (version 28.0.1.1(15)). Independent Samples T-test was applied to compare the mean heights of palms with and without bat occupancy, with the aim to find out if the height of palms is related to bat occurrence. For the distribution of bat occupancy in urban parks, the data were analysed and presented in a 1 km^2 grid system on ArcGIS Desktop (ESRI).

Figure 27. (a) *L. chinensis* (Chinese Fan-palm); (b) *W. robusta* (Petticoat Palm).

Figure 28. Roost of *C. sphinx* under the frond of *L. chinensis*.

Figure 29. Bite mark made by *C. sphinx* on the frond of *L. chinensis*.

Results

Roost selection

A total of 2,936 palm trees were surveyed in 49 urban parks, comprising three species: *L. chinensis* (n = 2,746), *L. australis* (n = 3) and *W. robusta* (n = 187). Among the surveyed trees, 26.1% were found with bite marks and 6.7% recorded with the presence of *C. sphinx*. Bat roosts were found in palms of height between 3 m to 26 m (average height: 10.9 ± 3.7 m), with the majority (82.7%) falls within the range of 7 m to 14 m. The parameters measured for *L. chinensis* and *W. robusta* surveyed are illustrated in Table 3.

Table 3. Comparison of selected parameters of *Livistona chinensis* and *Washingtonia robusta* surveyed.

Parameters	*Livistona chinensis*	*Washingtonia robusta*
No. of palms surveyed	2,746	187
Height range (m)	1 – 25	2 – 26
No. of palms with bite marks (% of same palm species surveyed)	698 (25.4%)	66 (35.3%)
No. of palms with bats (% of same palm species surveyed)	182 (6.6%)	15 (8.0%)
Height range of palms with bat roost (m)	3 – 25 (Average: 10.3 ± 2.9)	10 – 26 (Average: 18.0 ± 5.1)

It was found that although lower in actual number, the percentage of bite marks and roosts of *C. sphinx* found in *W. robusta* was higher than that of *L. chinensis*. For palms observed with bite marks, most had more than one bite mark. Moreover, for *L. chinensis*, the mean height of palms with bat roosts (10.3 m) was significantly higher than that of palms without bat roosts (6.5 m; $p < 0.001$); whereas, no significant difference was observed in the case of *W. robusta*.

Roost size and height

This study recorded a total of 701 individuals of *C. sphinx* in 212 roosts (occupying 197 palm trees), of which 195 and 17 roosts were found in *L. chinensis* (182 nos.) and *W. robusta* (15 nos.) respectively. Although the coverage of this survey was much smaller than that in 2004 – 2005, the number of roosts was higher. All roosts were found in green fronds and none on withered fronds. The roost size ranged from 1 to 15 individuals in this study, with 72.6% of roosts comprising more than one individual. Following a similar pattern as the tree height, the roost height ranged from 2 m to 25 m (average height 9.8 ± 3.7 m) with 78.8% of roosts at 6 m to 12 m high. The largest roost size was recorded at Victoria Park with 15 individuals roosting in a *L. chinensis* at the height of 13 m. Figures about the bat roosts observed in *L. chinensis* and *W. robusta* are illustrated in Table 4, Figure 30 and Figure 31.

Table 4. Comparison of roost data between this study and the previous one conducted in 2004 – 2005.

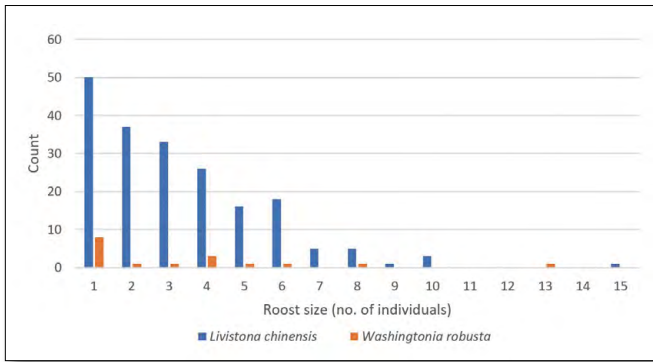| Parameters	Year of study	
	2004 – 2005	2021
No. of 1 km^2 grids surveyed	168	49
No. of bat individuals	819	701
No. of roosts	177	212
Range of roost sizes (no. of individuals)	1 – 28	1 – 15
Roost in harems (% of roosts with over one individual)	147 (83.1%)	154 (72.6%)
Height range of roost (m)	3.5 – 16 (Average: 6.0 ± 1.8)	2 – 25 (Average: 9.8 ± 3.7)

Figure 30. Distribution of roost size of *C. sphinx* in *L. chinensis* and *W. robusta*.
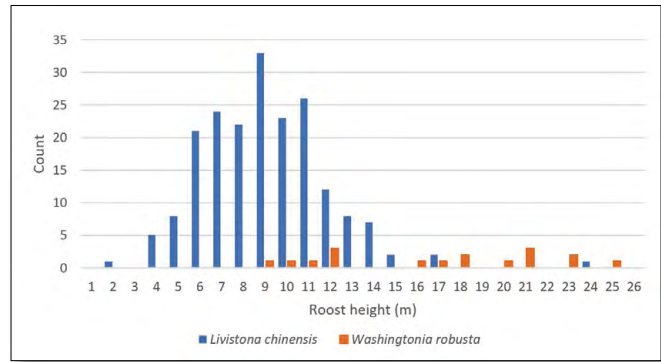

Figure 31. Distribution of roost height of *C. sphinx* in *L. chinensis* and *W. robusta*.

Distribution and abundance of *Cynopterus sphinx* found at urban parks

A total of 49 urban parks were visited in this study. The distribution and abundance of the bats surveyed are illustrated in 1 km^2 grids, where park area falls within, in Figure 32.
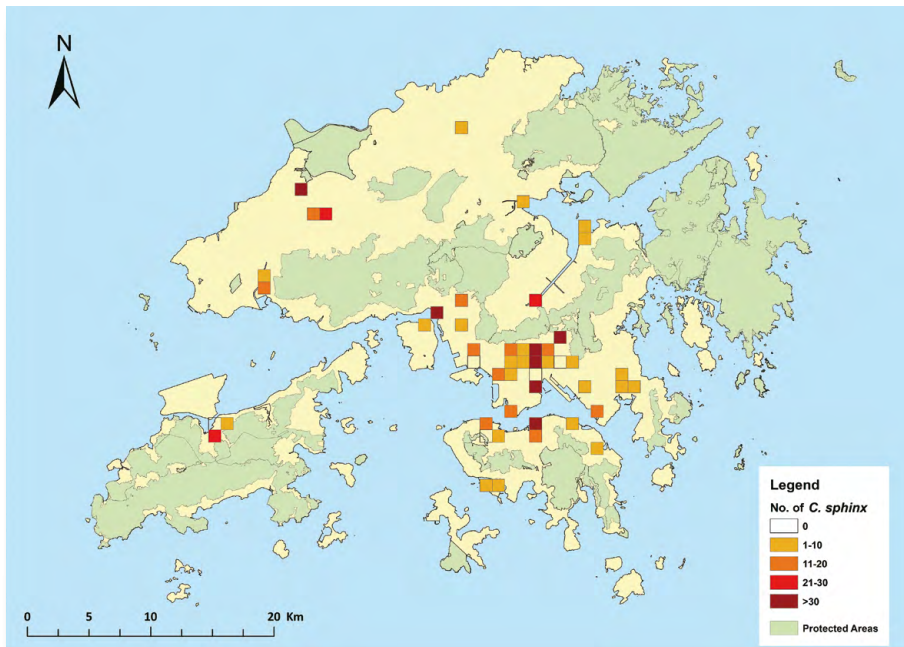

Figure 32. Locations of urban parks surveyed presented in 1 km^2 grids. Colour of grids indicates the number of *C. sphinx* recorded in each grid in this study. 44 out of 49 x 1 km^2 grids were recorded with roosting *C. sphinx*.

Discussions

C. sphinx is a habitat generalist well known for its high tolerance to anthropogenic disturbance and co-existence with humans (Campbell 2008; Campbell et al. 2006; Shek 2006). The occupancy patterns of bats in palms found in this study are consistent with our study from 2004 – 2005, with the majority of roosts found in *L. chinensis* and the overall occupancy rate above 6%. Roosts identified in this study served at least as day roosts in the form of tents constructed by the bats, with a few exceptions of single individuals inhabiting under unaltered leaves. While in total much fewer roosts were found in *W. robusta*, the percentage of bat occupancy was in fact higher than *L. chinensis*, suggesting that the fewer bat roosts found in *W. robusta* could be more due to the lower abundance of *W. robusta* planted in urban parks instead of the bat's lower preference over the species. It was also observed that while most occupied palms only carried one active bat roost, it was common to find multiple bite marks in one palm, suggesting bats would construct new tents in the same palm as their previous roosts or picked trees that have previously been inhabited by other individuals. The suspected roost site fidelity of *C. sphinx* was also observed in other studies (Balasingh et al. 1995; Seeburrun 2019).

Regarding roost characteristics and selection, roosts found in *L. chinensis* mainly fall within the height range of 6 m to 12 m while no special pattern was observed in *W. robusta*, whose average roost height (17.0 m) was nonetheless notably almost double that of *L. chinensis* (9.1 m). In the case of *L. chinensis*, tree height has a significant effect on the presence of roost and the results indicated a general absence of roosts in young palms less than 3 m tall and most roosts were observed in palms over 7 m tall. It is suspected that *C. sphinx* selects palms that have reached a certain height in order for it to stay further away from disturbance and threats, including natural predators, noise and traffic, and other anthropogenic disturbance; as well as for easy landing and take-off (Kumar and Elangovan 2019). This also echoes the local observation made by Seeburrun (2019) that *C. sphinx* appeared to prefer tall palm trees. In addition to disturbance, the lack of dense overhanging foliage (both fresh and withered) in young palms to provide sufficient shelter and protection for the bats could also be a deterring factor in roost selection. This may also explain why bat roosts were not observed in more mature palms (>7 m tall) with over-trimmed crowns in this study.

Although more roosts were recorded in this study compared to the one conducted in 2004 – 2005, fewer individuals were recorded in each roost with the maximum roost size (15 individuals) almost half of the number recorded in the previous study (28 individuals). While the difference in roost size could be related to the fluid harem social organisation of *C. sphinx* that individuals intermittently shift between roosts and resulting in different roost size recorded at different time of the year (Garg et al. 2018; Storz et al. 2000a; Storz et al. 2000b), it remains a challenge to determine the actual reason due to the limited observation made at each bat colony, which comprises a few roosts (harems) living in proximity. It is also worth bearing in mind that, since the survey season, locations (though overlapped) and effort were not entirely the same between the two studies, direct comparisons in certain parameters cannot be made and shall not be made to avoid misinterpretation.

In this study, juveniles or young individuals were observed in at least 31 roosts. However, the number reported is likely an underestimated figure due to the challenge in telling apart some young individuals from adults which were of similar body sizes. Based on the colouration and body size, the young bats observed are suspected to be born in early summer (April to June) of the year. The difference in the sizes and pelages of juveniles suggests non-synchronised parturition/breeding in this species, which is consistent with the observations by Storz and Kunz (1999).

C. sphinx is a versatile species and is observed to have a stable population in the urban areas of Hong Kong (AFCD field observation; public reports). With the increasing public awareness of wildlife and bats, understanding the roosting and foraging preferences and ecological needs of the bat is conducive to the management of urban parks and human-wildlife management. While there are many factors affecting roost selection, based on the observations from this study, it is recommended that as little crown trimming as practicable should be performed to palms over 3 m that are distant from public access to provide more favourable roosting space for the species, while balancing the need of public concern, other management goals of the premises, and reducing the chance of direct human-wildlife conflict.

To further improve the study, monitoring of locations known to have a high abundance of palms like urban resting areas and rural villages would provide information for better understanding the distribution and habitat usage of the species. Citizen science data and indirect information, such as rescue cases and public reports can also serve as useful information sources. Besides habitat management, it is also crucial to promote bat conservation and nurture the understanding and respect for bats among the mass public in order to strike a healthy and sustainable balance in human-wildlife co-existence in our city.

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Division Column

Tracking of Rehabilitated Wild Birds

Ivy W.Y. So[1] and Ricky K.M. Wong[2]
[1]Bird Working Group
[2]Fauna Conservation Division

漁農自然護理署於 2020 及 2021 年為十四隻受傷或生病後康復的水鳥及猛禽安裝追蹤儀器，以監察這些雀鳥於野放後的活動情況。本文簡短描述從其中九隻野鳥上收集到的定位數據。

Introduction

With the advancement of technology, the use of tracking devices to study the movement of wildlife has become increasingly popular. Tracking wild birds provide insight into their habitat usage, activity range, migratory route, etc. Such information is useful for the conservation of these species (Robinson et al. 2010), in particular species of conservation concern. Tracking rehabilitated birds can also provide information on the survival rate of the animals after release (Simonis et al. 2018). In 2020 and 2021, GPS tags were fitted on rehabilitated wild birds to collect their movement data after release. Tracking rehabilitated birds allows the study of species rarely captured by mist net, which is the most commonly used bird trapping method for scientific studies of avifauna in Hong Kong.

Methodology

Fourteen wild birds that had recovered from injuries and sickness and were assessed to be suitable for fitting with GPS tags were included in this study. The species tagged were Black-faced Spoonbill (*Platalea minor* 黑臉琵鷺), Eurasian Spoonbill (*Platalea leucorodia* 白琵鷺), Eastern Buzzard (*Buteo japonicus* 普通鵟), Black Kite (*Milvus migrans* 黑鳶) and Crested Goshawk (*Accipiter trivirgatus* 鳳頭鷹). The selection of species was based on the conservation status of the species and the availability of individuals among the rehabilitated birds that were suitable for carrying the tags. Four models of solar tags were used: KoEco WT-300 Ibis (36 g), KoEco WT-300 Harrier (24 g), Druid LEGO 3G with hive (21 g) and Druid OMNI 3G (10 g). The tags were fitted on the birds in a "backpack" style with wing harness (Thaxter et al. 2014). For the welfare of the birds, the weight of the specific tag with harness was less than 3% of the body weight of the bird fitted with the tag. After fitting the tags, the birds were observed for a minimum of one day before release to ensure their locomotion and behaviour were not affected by the tags. This article briefly describes the movement of the nine birds with data collected for at least two months.

Results and Discussions

Black-faced Spoonbill

Three rehabilitated Black-faced Spoonbills, with engraved leg ring numbers, A45, A48 and A49, were tracked for at least four months.

A45:

Four-month movement data were collected from A45. This bird was released on 16 January 2020 in Lok Ma Chau. After staying around the Lok Ma Chau and San Tin area for two days, it moved to the Mai Po Nature Reserve (MPNR) and the area nearby. This individual spent most of the time on the southern side of the MPNR, Tai Sang Wai and Nam Sang Wai (Kam Tin River and Shan Pui River) until the signal was lost from the tag it carried by the end of May 2020.

A48:

Eleven-month data were collected from A48 that was released on 30 March 2020 in the MPNR. A48 remained in

Hong Kong during this period and did not migrate. A48 made use of the habitats in the MPNR and the mudflat of Mai Po. It was sometimes recorded around Nam Sang Wai and the mudflat of Shenzhen opposite the MPNR.

A49:

A49 was released on 13 January 2021 in the MPNR and the signal was received until late April 2022 (Figures 33 and 34). When A49 was in Hong Kong, it spent most of its time at the Hong Kong Wetland Park (HKWP) and the area nearby, including the Tin Shui Wai Nullah. It started utilising the Mai Po and Lok Ma Chau area more often in April 2021.

It departed Hong Kong on 21 April 2021, taking a route along the coast and stopping over in Shanwei（汕尾）and Chongming, Shanghai（上海崇明）, and finally reaching Incheon, South Korea（南韓仁川）on 18 May 2021. It stayed in Incheon during the summer and started its southward movement on 13 November 2021. Passing by Yancheng（鹽城）, it stayed in Shanghai for about half a month and returned to the HKWP on 14 December 2021. Its most favourite site in winter 2021/22 was still the HKWP and the nearby area. On 29 April 2022, it started its northward migration along the coast again, but the signal from the GPS tag was lost on the same day A49 was around the coast of Chaozhou（潮州）.

Figure 33. Black-faced Spoonbill (A49) released in the Mai Po Nature Reserve on 13 January 2021.
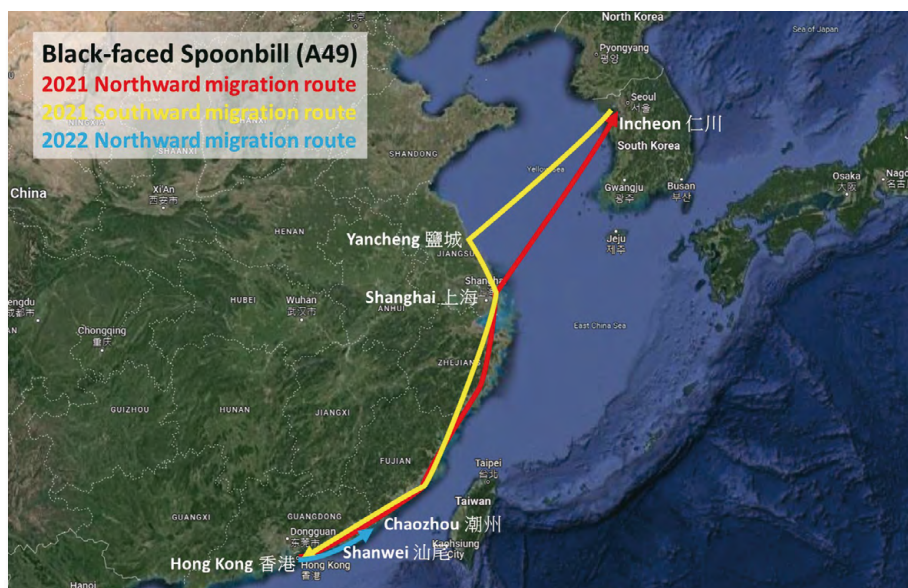
Figure 34. Migration routes of Black-faced Spoonbill (A49) in 2021 and 2022.

Eurasian Spoonbill

One rehabilitated Eurasian Spoonbill (A46) was released on 16 January 2020 in Lok Ma Chau. The tag it carried sent back signal until April 2021. However, the signal did not show any movement since late December 2020, suggesting that the tag might have detached from the bird or the bird might have died. Movement data were collected for eleven months from this individual. From January to March 2020, the Spoonbill mainly made use of the fishponds at Lok Ma Chau and Sam Po Shue and the gei wai of the MPNR. In April and May 2020, it also utilised the mudflat of Mai Po and was sometimes found in the Futian Mangrove Nature Reserve（福田紅樹林自然保護區）of Shenzhen.

It started its northward migration on 15 May 2020 with an inland route. It passed through Shaoguan（韶關）in mid-May, but the tag signal was then lost for a month. When the signal was being picked up again, it was at Wuning（武寧）. It reached Xianning（咸寧）the next day and stayed there until late September 2020. It then moved south slightly to Yueyang（岳陽）for October and November and then to Changsha（長沙）and Xiangtan（湘潭）in December 2020 until the signal became stationary (Figure 35).
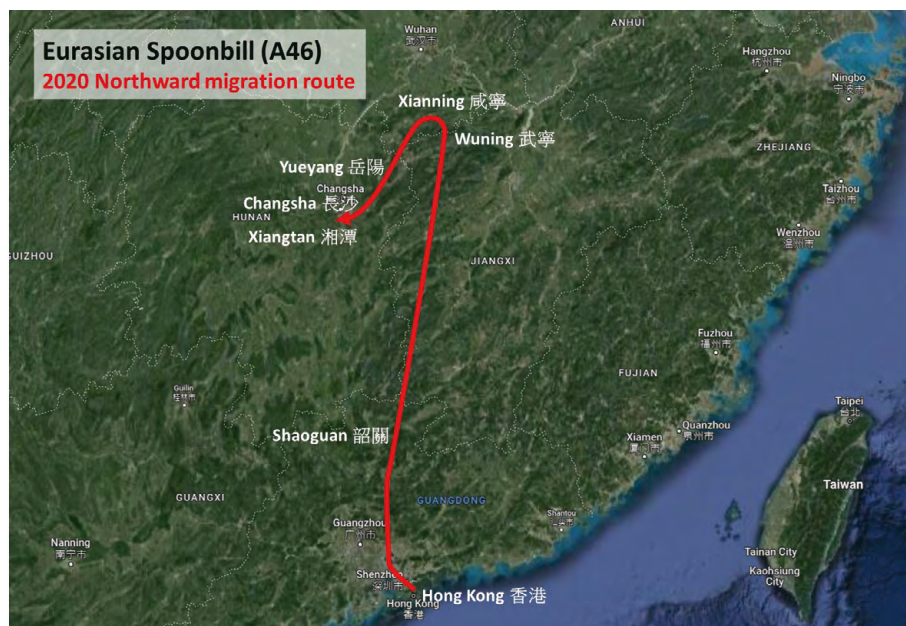

Figure 35. Migration route of Eurasian Spoonbill (A46) in 2020.

Eastern Buzzard

One rehabilitated Eastern Buzzard was tracked for almost 2 years. The Buzzard was released on 24 December 2020 from the Kadoorie Farm and Botanic Garden (KFBG). It wandered around Beacon Hill, Cheung Sha Wan, Tai Lam and Tai Wai for a few days after release and returned to the area around Central, where it was originally rescued from. Since then, it stayed mostly around Central. Its daily activity was quite regular, generally moving between the area around Central and Victoria Peak.

On 29 March 2021, it started its northward migration. Stopping over at Baizhang Peak Forest Park in Xinyu（新余百丈峰森林公園）for five days, it passed through Wuhan（武漢）, Tianjin（天津）and reached Chengde（承德）by the end of April. The signal from its tag was only collected occasionally from May to September 2021. The data collected showed that it stayed in Amur Oblast, Russia（俄羅斯阿穆爾州）during the summer. On 3 October 2021, it started its southward migration. Moving slowly past Harbin（哈爾濱）, Tianjin, Zhoukou（周口）and Jian（吉安）, it reached Hong Kong for the winter again on 18 November 2021. The activity of the Buzzard during its stay in Hong Kong was similar to that of the previous year, staying around Central (but the signal was lost quite frequently in January and February 2022).

It left for the north again on 31 March 2022. Its migration route passed through Hengyang（衡陽）, Wuhan, Xuchang（許昌）, Beijing（北京）, Chengde and Harbin. It reached Da Hinggan Range（大興安嶺）by the end of April and stayed there until mid-May 2022. Only limited signal was received from the tag since late May 2022 and the signals showed that the Buzzard stayed in Amur Oblast and later moved back to Da Hinggan Range until September 2022 (Figure 36). Signal was not received from the tag starting from early September 2022. When signal was picked up again in early October, the Buzzard was passing Harbin. It passed Jilin（吉林）, Tianjin, Xinyang（信陽）, Jian and returned once again to Hong Kong on 1 November 2022. The signals received occasionally indicated the Buzzard still favour the area around the Peak and Central.

Figure 36. Migration routes of Eastern Buzzard (GA00210) in 2021 and 2022.

Black Kite

Four Black Kites (ring numbers: GA00502, GA00504, GA00221 and GA00511) were fitted with tags and at least 2.5-month movement data were collected from them. All of the birds did not show any sign of migration.

GA00502:

The Kite was released on 19 August 2021 in Tai Tam Country Park. The activity range of this individual concentrated at the southern part of Hong Kong Island, e.g. Tai Tam, Shek O, Po Toi, Aberdeen and Lamma Island. The signal from the tag was lost since 8 November 2021 and a total of 2.5-month data were collected.

GA00504:

The signal from this Kite was still being received by the time this article was written in early December 2022, and about 14-month movement data were collected from this bird. The Kite was released in the KFBG on 29 September 2021. It stayed around Tai Mo Shan and Shing Mun Country Park for a few days and then returned to the area around southern Lantau, where it was rescued, and Cheung Chau. Its range was mostly restricted to this area until mid-December 2021, when it started to shift its range south and made use of the area around Cheung Chau and Wailingding Island of Zhuhai (珠海外伶仃島). From March to July 2022, most of the signals received came from the area around Wailingding Island. Since August 2022, it moved between Cheung Chau and Wailingding Island again. It appears that this individual often roosts on Cheung Chau at night.

GA00221:

Since the release of this Kite from the KFBG on 31 December 2021, most of the signals collected from the tag were near Mount Davis, close to where the Kite was rescued in Kennedy Town. Data indicated the bird made use of the night roosts in Aberdeen Country Park and Magazine Gap.

GA00511:

This individual was released back to the wild on 11 February 2022 from the KFBG and its tag was still sending out signal by the time this article was written in early December 2022 (Figure 37). The data collected showed that the activity range of this bird generally covered Kowloon, Sai Kung and Shatin. It roosted at Magazine Gap, Aberdeen Country Park and Yeung Chau (Sai Kung) at night.

Figure 37. Black Kite (GA00511) with a GPS tag deployed.

Conclusion

The tracking of rehabilitated birds provided information on the movement of species that are less easily captured by trapping methods commonly used in Hong Kong. The data collected, in particular, their local movement data, would enhance the understanding of their local ecology and facilitate the formulation of local conservation measures, if necessary. It is suggested that tracking suitable rehabilitated birds can be continued if opportunity arises.

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Terrestrial Habitat Map of Hong Kong 2021

Roger H. Lee, Terence P.T. Ng, and Eric K.Y. Liu
Technical Services Division

漁農自然護理署委託香港中文大學進行一項結合遙感及地理訊息技術的應用研究，辨認香港主要陸地生境。本文就研究背景及結果作簡短介紹。

Under the Biodiversity Strategy and Action Plan 2016-21, the Government has committed to reviewing and developing an updated territory-wide terrestrial habitat map of Hong Kong, with a standardised Terrestrial Habitat Classification Scheme (THCS), to facilitate long-term monitoring of Hong Kong's terrestrial habitats (and intertidal habitats). Such information will be conducive to biodiversity and ecosystem assessments, supporting environmental planning and guiding conservation actions.

To achieve this, AFCD worked with the Chinese University of Hong Kong to develop a standardised THCS and produce an updated habitat map through a commissioned study. The mapping exercise adopted the new generation of satellite imagery technology (i.e. using very high-resolution (VHR) satellite images), as well as incorporated field data in the machine learning process to improve mapping accuracy. The study successfully produced the standardised THCS (Table 5) and the Terrestrial Habitat Map of Hong Kong 2021 (Figure 38) through a three-stage mapping procedure – classifying the satellite images using machine learning-based classification algorithms, modifying the mapping results based on decision rules, and integrating multiple geographical information datasets. After the mapping process, 30-day field surveys were carried out to verify the habitat map. Readers may find more technical information regarding the mapping methodology at Kwong et al. (2022) and download the habitat map from the Hong Kong Biodiversity Information Hub at https://bih.gov.hk/en/feature-studies/index-id-7.html.

As a first step, it is hoped that this updated habitat map would set a rigorous baseline for quantifying natural habitats, and help facilitate sustainable development planning on the natural resources in Hong Kong at a strategic level. In particular, long-term monitoring of habitat changes can be achieved through regular updates of the map using the standardised method.
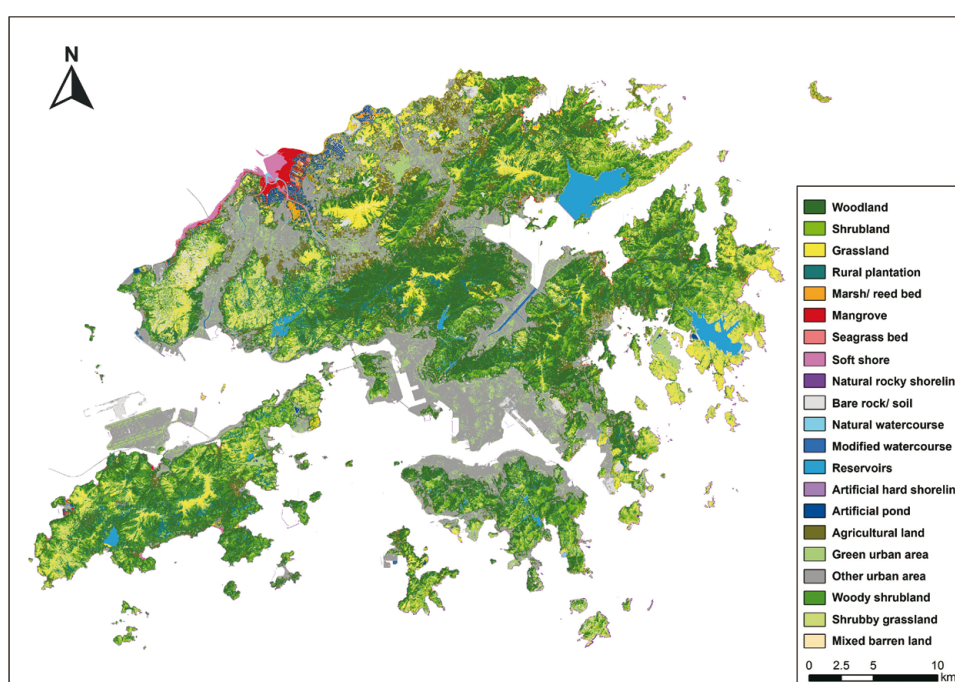

Figure 38. The terrestrial habitat map of Hong Kong 2021.

Table 5. Terrestrial Habitat Classification Scheme (THCS) of 21 habitat types in Hong Kong with estimated total area.

Habitat	Definition	Total Area (km²)	Percentage
Woodland	Rural lands mainly covered by tree species.	270.42	24.02%
Shrubland	Rural lands mainly covered by shrub species.	96.18	8.54%
Grassland	Rural lands mainly covered by grass species.	82.31	7.31%
Rural plantation	Rural lands mainly covered by woody plants and the top canopy is dominated by manually planted species in an organised and systematic way.	57.06	5.07%
Woody shrubland	Rural lands covered by mixture of wood and shrub species, which each of them occupies at least 1/3 of the coverage.	143.41	12.74%
Shrubby grassland	Rural lands covered by mixture of shrub and grass species, which each of them occupies at least 1/3 of the coverage.	87.80	7.80%
Mixed barren land	Rural lands covered by mixture of grass and bare rock/ soil, which each of them occupies at least 1/3 of the coverage.	9.86	0.88%
Marsh/reed bed	Lands, including abandoned agricultural land, covered with shallow waters and dominated by hydrophytes seasonally or all year round.	3.43	0.30%
Mangrove	Coastal lands covered by true mangrove plant species.	6.21	0.55%
Seagrass bed	Coastal lands covered by seagrass species.	0.38	0.03%
Soft shore	Coastal lands of fine-grained sediment (i.e. sand, silt or finer particles) between high and low tide marks.	8.02	0.71%
Natural rocky shoreline	Coastal lands of rocks between high and low tide marks.	9.71	0.86%
Bare rock/soil	Natural open rock faces or disturbed lands, or "badlands" denuded of vegetation.	35.57	3.16%
Natural watercourse	Rivers and streams experiencing natural flow patterns in unchanneled watercourse beds and banks.	1.66	0.15%
Modified watercourse	Channelised rivers and streams, which are often without natural banks and beds, and are not subject to natural flow patterns (e.g. drainage channels and nullahs).	1.93	0.17%
Reservoirs	Artificial lake used as a source of water supply.	22.37	1.99%
Artificial hard shoreline	Man-made intertidal hard shore habitats (e.g. seawalls, jetties, groins and piers).	1.64	0.15%
Artificial ponds	Small artificial water bodies constructed for the aquaculture purpose (e.g. gei wai and fishponds).	9.41	0.84%
Agricultural land	Lands currently under cultivation, and lands not currently under land cultivation and yet to transform into other habitats such as marsh/reed bed.	40.23	3.57%
Green urban area	Urban lands undergone artificial greening for various purposes (e.g. golf area courses, urban parks, and vegetation on the roadside).	41.27	3.67%
Other urban area	Lands occupied by urban, other highly modified habitats (e.g. quarry, landfill) or industrial storage/containers.	197.00	17.50%
Total		1,125.86	100.00%

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What's New

A Short Note on an Interesting Sighting of Himalayan Leaf-nosed Bat (*Hipposideros armiger*)

*Wing W.C. Tsui[1] and W.H. Chan[2]*
[1]Mammal Working Group
[2]Fauna Conservation Division

漁農自然護理署職員於 2022 年 10 月觀察到大蹄蝠咀嚼羽毛的情況，為香港首次記錄。本文就該發現記錄作簡單描述。

An interesting sighting was made on October 2022 during a visit to an ancestral hall located in the northern New Territories. Within a colony of *Hipposideros armiger* (Himalayan Leaf-nosed Bat 大蹄蝠) found roosting in the premise, one individual was observed to be doing something that has not been seen before – chewing bird feathers.

The visit took place on 12 October 2022, jointly in the company of the staff members from the Kadoorie Farm and Botanic Garden (KFBG). Upon the team's arrival at the ancestral hall, over 40 *H. armiger* were found hanging from the wooden beams at the ceiling in one of the main halls. Different from its counterparts, which were mainly resting or grooming, one bat was observed to be chewing a small bundle of feathers, which later dropped to the ground, amongst the bat guanos (Figure 39 and 40). A couple of feathers were also found scattered on the ground and they were suspected to have come from the same bird species based on the colour, size and shape. With the assistance of KFBG's Conservation Genetics Laboratory, the feathers were identified to belong to *Phylloscopus plumbeitarsus* (Two-barred Warbler 雙斑柳鶯), an uncommon but regular passage migrant and winter visitor of Hong Kong (HKBWS 2022).
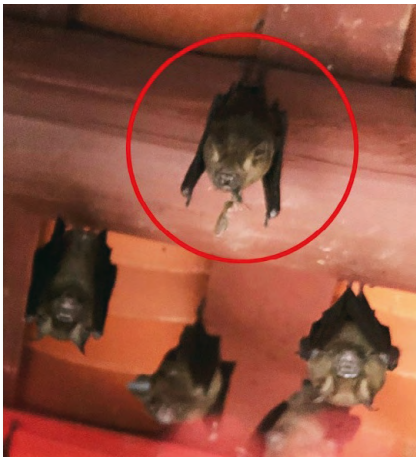
Figure 39. An individual of *H. armiger* found chewing bird feathers.

Figure 40. Feathers of *P. plumbeitarsus* found amongst bat guanos.

This is believed to be the first sighting record of *H. armiger*, or any local bat, chewing bird feathers in Hong Kong and this behaviour is also not known to be reported in *H. armiger* elsewhere. Even though it is not possible to confirm whether any predation or ingestion had occurred solely based on this single observation, this however provides an insight into the possibility of *H. armiger* preying on animals other than insects. *H. armiger* has always been known to be insectivorous with its diet mainly composed of Coleoptera (beetles), followed by Hymenoptera (sawflies, wasps, bees, etc.) (Wilson and Mittermeier 2019). While most *Hipposideros* spp. are known to be insectivorous, opportunistic carnivorous behaviour was observed in *Hipposideros diadema* (Diadem Leaf-nosed Bat), a close relative of *H. armiger*

distributed in Southeast Asia and northeast Australia (Pavey and Burwell 1997; Wilson and Mittermeier 2019). Considering the similar size and genetic similarities between *H. diadema* and *H. argmier* (Lim et al. 2017), it raised an interesting question if *H. armiger* could potentially exhibit similar behaviour. Further observation and studies, including faecal sample analysis would be required to confirm the dietary preference and predatory habit of this species.

In Hong Kong, *H. armiger* is widely distributed in countryside and rural areas and roosts in a wide variety of habitats, including water tunnels, abandoned mine caves, abandoned buildings and under bridges/buildings (Shek 2006) (Figure 41 and 42). The bat displays seasonal movement and roosting preference that some individuals switch to roosting in smaller roosts, such as this ancestral hall, to form breeding colonies during the breeding season (AFCD unpublished data).

Figure 41. *H. armiger* **roosting in a water tunnel.**

Figure 42. A roost of *H. armiger* **in an abandoned building.**

Acknowledgements

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