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Feature Article

Fiddler Crabs in Hong Kong – An Overview

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Coastal Community Working Group

漁農自然護理署海岸生態工作小組於2002-2005年期間進行了全港性的紅樹林調查，蒐集招潮蟹在本港紅樹林的分佈情況，並更新紅樹林及其他動植物群落的資料。本文介紹以顏色豐富及巨大螯足見稱的招潮蟹的分類特徵及其生境，以及牠們一些有趣的覓食習性及穴居行為。本小組在香港39個紅樹林內找到6種招潮蟹，其中較常見的包括北方呼喚招潮蟹 (*Uca borealis*) 及色彩斑斕的粗腿綠眼招潮蟹 (*Uca crassipes*)。

General Introduction

Fiddler crabs are known from all continents except Antarctica (Crane, 1975). They are widely distributed throughout the tropics and subtropics, between 35° north and south.

Systematics

Fiddler crabs belong to the Family Ocypodidae (沙蟹科) (Ortmann 1894), subfamily Ocypodinae (Dana 1851) and Genus *Uca* (Leach 1814). They are represented by crabs with carapaces quadrate or subquadrilateral, broad in the front and without anterolateral tooth. Their orbits are deep and large, with the eyes on slender stalks and buccal cavities completely closed by the third maxillipeds. They are characterized by very unequal cheliped sizes in males (Dai & Yang, 1991) (Fig. 1). There are about 97 species or subspecies in the world (Rosenber, 2005).

Fig 1. The unequal cheliped sizes in male (*Uca paradussumieri*).

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Habitat

Fiddler crabs are not found on exposed shores like rocky coasts or coral reefs. Almost all live in intertidal zones of sheltered bays and estuaries, feeding and digging burrows in the inshore muddy or sandy substratums. Their habitats are closely related to mangroves. However, fiddler crabs do not depend entirely on mangroves for shelter or food, but rotting mangrove leaves enrich the muddy substratum providing the primary food to sustain the crabs.

Cheliped Dimorphism

The most remarkable characteristic of male fiddler crabs is the striking contrast in size between the two chelipeds; no other groups of crabs show such a disparity. The large cheliped can weigh up to half of the body mass, and grow up to three times the carapce length. The large cheliped is used mainly in waving display, during combat with other males; while some fiddler crabs use it for making sounds. Its vibrations against the ground can indicate threat or courtship (Crane, 1975).

As for the minor chelipeds, they are also specialized like their major counterparts – but in the opposite sense, of size reduction. In fact, their size is far smaller than in other members of the family Ocypodidae except for some spider crabs (Crane, 1975). Apart from cleaning the carapace, the primarily function of the minor cheliped is for feeding. The tips of the chela are spoon-shaped, and have numerous serrations and bristles for bringing mud and sticky substrate to the mouthpart. The name 'fiddler' comes from the crab's appearance which, when it is feeding, resembles a violin player.

An interesting finding of dimorphism of the major cheliped was reported by Yamaguchi (2001), who described this phenomenon. After the major cheliped of the male fiddler crab was lost, a new one would regenerate at the same place with no changes in handedness; however, the regenerated cheliped was more slender in shape than the originals. Yamaguchi (2001) explained his finding observing that males have to drop (for the first time) one of the chelipeds when they are young, to provide the opportunity to regenerate a specialized cheliped for feeding, leaving the other one to get enlarged to form the major cheliped. The regenerated one is slender and suitable to be inserted into the substratum, or to scratch the surface for feeding. Yamaguchi hypothesized that there was a special morphogenetic mechanism, existing in fiddler crabs, which works when the crab looses the cheliped accidentally (no matter which side). The one regenerated is thus 'defaulted' as the feeding cheliped, so appearing more slender – with the actual size depending on the handedness.

Body

Apart from the large cheliped, other general features of fiddler crabs resemble those of other shore crabs. Their carapaces are usually smooth, always convex and wider than long, their eyes protrude on long stalks, and there are eight walking legs. Most fiddler crabs are colourful, their colour varying with the tide and time. Their carapace turns dark in the daytime and pale at night. During the low tide period, their carapaces turn dark and turn pale during high tide period (Shih, 2001). Therefore, their body colour is unreliable for identification.

Feeding habitats

Fiddler crabs are detritus feeders, feeding on the microheterotrophs (bacteria and protozoa) or meiofauna (nematodes) that exist on the surface of sand or mud particles. During low tide periods, the crabs sit on the shore and repeatedly scrape up morsels of the substrate by the minor cheliped, placing the substrate to the mouth part – thus giving the appearance of eating mud. In fact the maxillipeds of the mouthpart function in a complex manner, separating out the edible matter from inorganic particles. Their maxillipeds are well-developed, with spoon-tipped setae adapted for sorting sand particles. After a few clawfuls of substrate, the inorganic matter is ejected onto the ground in a form of pellet. As the crabs usually move slowly ahead as they feed, lines of feeding pellets are left behind radiating from their burrows.

As male fiddler crabs have only one small feeding chela, in some species the males have to spend twice as long as females to complete their feeding (Valeila, *et al*, 1974). Feeding faster, and having a minor chela with a wider dactyl width (Caravello & Cameron 1987a,b), is seen as a compensatory mechanism. Montague (1982) suggested that fiddler crabs have the potential to enhance the production and decomposition of organic carbon in temperate salt marsh ecosystems. Their feeding activities can thus increase the nutrient flow in salt marshes.

Crane (1941) first suggested that there might be a relationship between the form of the feeding apparatus of fiddler crabs and their habitats. There are also studies on the relationship concerning (a) the distribution of different fiddler crabs; (b) the habitat sediment characteristics (c) the form of the feeding apparatus (Jones & Morton, 1994; Shin *et al*, 2004; Lim, 2004). As mentioned, setae present in the mouthparts are adopted for scouring nutrients from the sediment. It was shown by Shin *et al* (2004) that although it was common to see *U. lactea* and *U. borealis* co-existing on the shore, it was found that the ratio of the size of the third maxilliped to the body is higher in *U. lactea*. While *U. borealis* has needle-like setae on the second maxillipeds, *U. lactea* has needle-like and brushy setae. This suggested that *U. lactea* was more efficient in sorting sand particles for feeding purposes and would prefer sediment with a higher proportion of sand particles. As for *U. borealis*, with fewer spoon-tipped setae and thus a reduced sorting ability, they prefer to feed on finer sediments on the lower shore. This finding was in agreement with Jone & Morton's suggestion that *U. borealis* inhabited the lower shore more than *U. lactea*. Lim (2004) also reported similar results for fiddler crabs in Singapore. There, species inhabiting sandy substrates generally have more spoon-tipped setae than those living in muddy substratum.

Burrowing

Burrows are important to fiddler crabs, as they serve various useful functions. Apart from providing water for the crabs' physiological needs, and providing a refuge from environmental extremes and predators, they are sites for moulting and reproduction (Crane, 1975). The ecological significance of burrowing activities, such as increasing drainage and oxidation of the substrate, increasing the rate of decomposition of plant debris and enhancing growth of micro-organisms, have been widely reported. The structures of burrows are species specific and related to habitat type. *U. borealis*, *U. crassipes* and *U. arcuata*, which inhabit muddy areas, excavate deeper more complex burrows than *U. lactea*, which inhabit sandy areas (Bones, 1983). The burrow structures are built so that crabs can retreat hastily when threatened. This is why fiddler crabs commonly stay close to their burrows.

Species found in Hong Kong

Descriptions of the morphological characteristics of the carapace and the male major cheliped of *Uca* spp. found in HK (Jones & Morton, 1994) are listed in Table 1.

The nomenclature of the Hong Kong fiddler crab species was established by Jones & Morton (1994), who described six species of fiddler crabs that occurred in Hong Kong, representing 60% of the *Uca* species in China. They are *Uca acuta* (Stimpson, 1858) (Fig. 2 & Fig. 3), *U. arcuata* (de Haan, 1835) (Fig. 4 & Fig. 5), *U. borealis* (Crane, 1975) (Fig. 6 & 7), *U. crassipes* (Adams and White, 1848) (Fig. 8 & 9), *U. lactea* (de Hann, 1835) (Fig. 10 & 11) and *U. paradussumieri* (Bott, 1973) (Fig. 12 & 13). In this article, the nomenclature of *Uca* spp. suggested by Jones & Morton (1994) has been adopted.

Fig 2. ***U. acuta*** **♂ (front view)**

Fig 3. ***U. acuta*** **♂ (back view)**

Fig 4. ***U. arcuata*** **弧邊招潮蟹♂ (front view)**

Fig 5. ***U. arcuata*** **弧邊招潮蟹♂(back view)**

Scientific Name	Chinese name	Carapace	Major chelipad	Distribution in Asia
Uca acuta		• The inter-orbital region is narrow, ratio of the frontal width to fronto-orbital width is 1:18 to 1:12 • Not strongly arched, postero-lateral stria present • Usually small in size in about CW to 2 cm	• Manus covered with tubercles • Ratio of movable finger to manus is about 1:1	• South China coast only • Hong Kong is near the southmost limit for this species
Uca arcuata	弧邊招潮蟹	• The inter-orbital region is narrow, ratio of the frontal width to fronto-orbital width is 1:18 to 1:12 • Eye-stalks slender • Usually larger in size, CW ~3.7 cm • Red to orange-red colour, sometimes with black patches present	• Manus covered with tubercles • Movable finger is 1.3 times as long as manus	• China coast, Taiwan, west coast of Korea, Japan, Australia, Singapore, Borneo and Philippines
Uca borealis	北方呼喚招潮蟹	• The inter-orbital region is narrow, ratio of the frontal width to fronto-orbital width is 1:18 to 1:12 • Muddy or gray colour	• Manus covered with tubercles • Immovable finger with 'W-shaped', concave on its inner border. A 'C' shaped groove at the base • Movable finger 1.4-1.6 times as long as manus	• Guangdong, Taiwan • Hong Kong is near the southmost limit for this species
Uca crassipes	粗腿綠眼招潮蟹	• The inter-orbital region is board, ratio of the frontal width to fronto-orbital width is 1:4 to 1:3 • Mainly black and red with blue blotches	• Outer-lateral surface smooth without tubercles. • Movable finger 1.3 times as long as manus • Inner border with 5-6 teeth	• Guangdong, central and west Pacific, Philippines, Malaysia, Indonesia and Australia
Uca lactea	清白招潮蟹	• The inter-orbital region is board, ratio of the frontal width to fronto-orbital width is 1:4 to 1:3 • Surface smooth without grooves • Mainly white to milky colour	• Outer-lateral surface smooth without tubercles • Movable finger 1.8 times as long as manus • Inner border of both fingers are granulated toothed • A tooth is sometimes present in the middle on both fingers	• Taiwan, China coast, Korea, Japan • Hong Kong is near the southmost limit for this species
Uca paradussumieri	拟屠氏招潮蟹	• The inter-orbital region is narrow, ratio of the frontal width to fronto-orbital width is 1:18 to 1:12 • Yellow colour	• Manus covered with tubercles • Movable finger more than twice as long as manus • Fingers with a small gap, movable finger with a larger granular tooth near the base and at the middle • Immovable finger with a longitudinal groove on its outer groove, a larger tooth is found at in the middle.	• South china sea, Malaysia peninsular and Singapore

Table 1 . Description of the morphological characteristics and distribution in the world.

Jones & Morton (1994) described the vertical 'zonation' of the *Uca* species found in Hong Kong. The most important factor influencing the distribution of *Uca* species is the substrate type (Bones, 1983; Choi, 1991). Among the six species, *U. crassipes* are regarded as the highest-zone species, inhabiting salt meadows. *U. lactea* occupies in high intertidal zone, inhabiting exposed open sandflats. *U. borealis* is the middle-of-the-shore species, and can coexist with *U. lactea* although *U. borealis* are more likely to use the lower zones that have softer mud. The burrows with hoods at the entrances are built by *U. lactea*. As for *U. acuta* and *U. arcuata*, they are the 'mangrove species', commonly found in intertidal mangrove mudflats in Hong Kong. The last species, *U. paradussumieri*, favours the soft, low-zone area like the mudflat at the entrance of drainage channels in the northwestern New Territories.

As described by Jones & Morton (1994), Hong Kong is spatially heterogeneous with regard to its soft shores, and thus presents a varied assemblage of habitats for *Uca* communities. As explained above, the degree of speciality of the feeding apparatus likely determine the habitat range. Therefore the diversity of soft shores in Hong Kong offers more habitats, and do supports more *Uca* species.

Fig 6. *U. borealis* 北方呼喚招潮蟹♂ (front view)

Fig. 7. *U. borealis* 北方呼喚招潮蟹♂ (back view)

Fig 8. *U. crassipes* 粗腿綠眼招潮蟹♂ (front view)

Fig 9. *U. crassipes* 粗腿綠眼招潮蟹♂ (back view)

Fig 10. *U. lactea* 清白招潮蟹♂ (front view)

Fig 11. *U. lactea* 清白招潮蟹♂ (back view)

Fig 12. *U. paradussumieri* 拟屠氏招潮蟹♂ (front view)

Fig 13. *U. paradussumieri* 拟屠氏招潮蟹♂ (back view)

Apart from the comprehensive study of the distribution of *Uca* species in Hong Kong by Jones & Morton (1994), no study on *Uca* species was made for the past ten years. This survey, conducted by the Coastal Community Working Group, is intended to fill that gap.

Compared with the results from Jones & Morton (1994), who reported *Uca* species in only 18 Hong Kong locations, this survey of *Uca* species has found fiddler crabs in 39 different locations here (Table 2).

As shown in Table 2, *U. borealis* is the most widely distributed species occurring in 31 of the 39 sites. *U. paradussumieri* has the most restricted distribution in Hong Kong. The only record was from the Yuen Long Creek in Deep Bay (Jones & Morton, 1994), which was described as 'dangerous and rarely visited by scientists'. From our survey, this species is more widely distributed than before thought. *U. paradussumieri* was found in three mangroves

Mangrove Sites	*Uca* species					
	U. acuta	*U. arcuata*	*U. borealis*	*U. crassipes*	*U. lactea*	*U. paradussumieri*
Chek Keng			✓	✓		
Chi Ma Wan	✓	✓	✓	✓	✓	
Ho Chung		✓	✓	✓		
Kei Ling Ha Hoi			✓	✓		
Kei Ling Ha Lo Wai			✓	✓		
Lai Chi Chong			✓			
Lai Chi Wo			✓	✓	✓	
Lo Fu Wat			✓			
Ma Wan	✓	✓	✓	✓	✓	
Mai Po	✓	✓	✓	✓	✓	✓
Nam Chung Yeung Uk		✓	✓			
Pak Sha Wan		✓	✓			
Pui O Wan	✓	✓	✓	✓	✓	
Sai Keng		✓	✓			
Sam A Chung				✓		
Sam Mun Tsai			✓			
San Tau		✓		✓	✓	
Sham Wat					✓	
Sheung Pak Nai		✓	✓		✓	✓
Shuen Wan		✓	✓	✓		
Shui Hau	✓	✓	✓		✓	
Siu Tan	✓			✓		
Tai Ho Wan	✓	✓	✓	✓	✓	
Tai O	✓	✓	✓	✓	✓	
Tai Sham Chung		✓	✓	✓	✓	
Tai Tam	✓	✓	✓	✓	✓	
Tai Tan			✓	✓		
Tai Wan		✓	✓	✓	✓	
Ting Kok			✓	✓		
To Kwa Peng			✓		✓	
Tolo Pond				✓		
Tsim Bei Tsui	✓	✓				✓
Tung Chung	✓	✓	✓	✓	✓	
Tung Wan				✓		
Wetland Park		✓				
Wong Yi Chau			✓	✓		
Wu Shek Kok		✓	✓			
Yam O			✓			
Yi O			✓	✓	✓	
Total no. of locations found	11	21	31	25	17	3

Table 2. Distribution of fiddler crabs in Hong Kong (2002-2005)

sites (Mai Po, Tsim Bei Tsui and Sheung Pak Nai), situated in the Deep Bay area and dominated by very soft and fine sediments. In view of the difference in habitat requirements between species, only those sites with a high diversity of microhabitats, like Mai Po, can accommodate all the *Uca* species. As for the sites where five species were found (Chi Ma Wan, Pui O Wan, Tai Ho Wan, Tai O, Tai Tam and Tung Chung) these are considered spatially heterogeneous with regard to soft shores, important habitats for *Uca* species.

Threats to fiddler crabs in Hong Kong

Members of Genus *Uca* were found in most Hong Kong mangrove areas. Since many of these areas are substantially polluted, pollution may not be the greatest threat to fiddler crabs. From our field observation, *Uca* spp. have a quite high tolerance of human settlement. For example, the mudflats at Tung Chung and Ma Wan support a large population of *U. arcuata*, *U. borealis* and *U. lactea* – even though these sites are close to human settlement and pollution. Choi (1991) stated that the pollution level in Mai Po Nature Reserve had not reached a serious level, likely to affect *Uca* speices adversely; indeed, the *Uca* populations in the more polluted channels had better overall reproduction. This might be due to the increase in organic matter, leading to an increase in food availability for the fiddler crabs.

The greatest threat to *Uca* spp. may be the loss of suitable habitats. Jones & Morton (1994) suggested that Pui O, Tam Tam and Tung Chung might not be able to hold all five species of *Uca*, due to the development threat in Hong Kong. They suggested that Tung Chung's mangroves was susceptible to the development of the International Airport. However, after over ten years, we found the five *Uca* species are still present at these sites. Pui O Wan, relatively remote, free from development, has no immediate threat. At Tai Tam, the only mangrove site on Hong Kong Island, there is a high diversity of microhabitats including sandy and muddy mudflats that support a high diversity of fiddler crabs. It is protected from development through the designation as a Site of Special Scientific Interest (SSSI). The conversion of Tai O's old salt pans to a mangrove habitat, to compensate the loss of mangrove habitat from construction of Hong Kong International Airport, also provided additional habitats for the crabs. From the field visit in 2005, a total of 5 species of *Uca* were found in the Tai O salt pan area, including the uncommon species *U. acuta*. This suggested that recreated mangrove habitats could provide a diversity of microhabitats for the crabs.

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Working Group Column

Effectiveness of Animal Crossing at Route 3 by Camera Trapping

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漁農自然護理署於2002年9月至2003年3月之間，於三號幹線汀九段的生物通道進行了一項哺乳動物調查，以了解其哺乳動物的使用率。本文闡述調查的主要結果及建造生物通道所需考慮的因素。

Introduction

Highway impacts wildlife through various ways, such as loss of habitat and vehicle-caused injury or mortality (Ruediger, 1996). It also divides landscape into smaller pieces, taking away some of the habitat and results in habitat fragmentation. It leaves wildlife population isolated from one another and, over the long term, renders populations less healthy by limiting their home range (Devlin, 1998).

Animal crossings are tunnels, culverts or other structures that often include fencing and strategically placed vegetation to funnel animals to the safe crossing points which help to keep them off the road. It makes highways more permeable to animals by giving them a way through or over or under the pavement. Underpasses are the most common animal crossings in Europe and North America. It is known to provide passages for amphibians, crustaceans, small or even large mammals (Foster and Humphrey, 1995).

Route 3 is one of the major roads in the New Territories. It is a dual three-lane carriageway connecting Yuen Long down to Tsing Yi through the Au Tau, Tai Lam Tunnel, Ting Kau, Tsing Long Highway and Ting Kau Bridge. To avoid habitat fragmentation, an underpass passage was built to serve as an animal crossing at the Ting Kau end of Tai Lam Tunnel (Fig. 14 & 15).

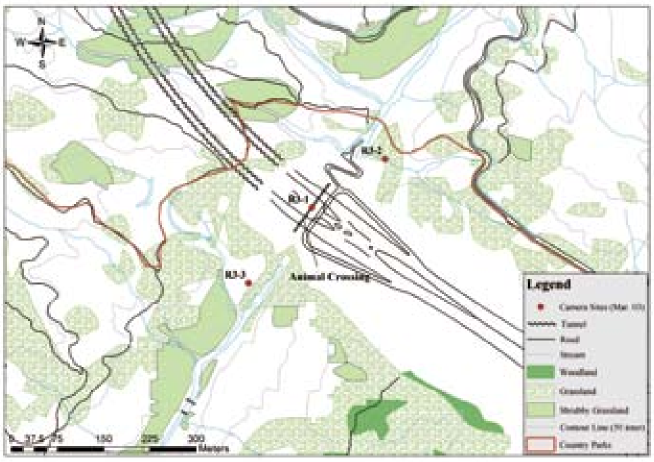

Fig 14. Location of the animal crossing at Route 3.

Fig 15. Location of the entrance (red arrow) of the animal crossing.

The Animal Crossing

The animal crossing is a concrete pipe of about 70 m long with an internal diameter of 1.8 m. One entrance of the animal crossing is about 3 m above ground, connected by stairs (Fig. 16) and the other entrance is on a slope with a plantation of Taiwan Acacia (*Acacia confusa* 臺灣相思).

Fig 16. The entrance of the animal crossing connected by stairs.

The objectives of this study were to identify the species of non-flying terrestrial mammal that uses the animal crossing as a passage across the road by camera trapping and to evaluate the effectiveness of the animal crossing by determining how many and what types of non-flying terrestrial mammals exist in the nearby environment.

Materials and Methods

Three sets of auto-trigger cameras (Model: Wildlife II by Wildlife Conservation Foundation Hong Kong Limited) were installed at the animal crossing at the Ting Kau Section of Route 3 and its nearby environment (Fig. 14). The details of the camera traps setup and data analysis followed Shek (2003). For the camera inside the animal crossing, it was mounted on the roof of the animal crossing.

Results

A total of 124 photos of 11 mammalian species were recorded by the three auto-trigger cameras (R3-1, 2 and 3) from September 2002 to March 2003 (Table 3). The Occurrence Index (OI) of larger mammals recorded by the cameras (R3-2 and 3) outside the tunnel was similar to the OI recorded in Tai Lam Country Park in AFCD baseline camera trapping survey (Table 3).

Table 3. Occurrence Index (OI) of recorded mammalian species in Route 3 area

Species	R3-1 OI (count)	R3-2 OI (count)	R3-3 OI (count)	Overall
Rattus sp.	-	4.179 (15)	12.645 (34)	5.325 (49)
Chestnut Spiny Rat (*Niviventer fulvescens*)	-	-	0.372 (1)	0.109 (1)
East Asian Porcupine (*Hystrix brachyura*)	-	0.836 (3)	8.554 (23)	2.825 (26)
Small-toothed Ferret Badger (*Melogale moschata*)	-	-	0.372 (1)	0.109 (1)
Masked Palm Civet (*Paguma larvata*)	0.864 (2)	0.836 (3)	0.744 (2)	0.761 (7)
Small Indian Civet (*Viverricula indica*)	-	0.557 (2)	0.372 (1)	0.326 (3)
Small Asian Mongoose (*Herpestes javanicus*)	-	0.557 (2)	-	0.217 (2)
Leopard Cat (*Prionailurus bengalensis*)	-	0.279 (1)	0.372 (1)	0.217 (2)
Domestic Dog (*Canis familiaris*)	-	0.279 (1)	2.232 (6)	0.761 (7)
Eurasian Wild Pig (*Sus scrofa*)	-	3.065 (11)	0.372 (1)	1.304 (12)
Red Muntjac (*Muntiacus muntjak*)	-	1.950 (7)	2.603 (7)	1.521 (14)
Overall	**0.864 (2)**	**12.537 (45)**	**28.638 (77)**	**13.475 (124)**

During the survey, only two Masked Palm Civets (*Paguma larvata* 果子狸) were recorded using the animal crossing (Fig. 17). The OI of these two Palm Masked Civets were 0.864, similar to the OI of the species recorded in the nearby environment (Table 3).

Fig 17. Masked Palm Civet recorded inside the animal crossing.

Discussion

Species Specific

The design of animal crossing such as size and substrate are very important to some species but irrelevant to others (Jackson and Curtice, 1998). Each species has different needs, and the design should be species specific. Therefore, it is necessary to understand the wildlife in the nearby environment and to design a suitable animal crossing for the target species. However , the general approach should be multi-species design in which the crossing should make highways permeable for as many species as possible.

Placement

Proper placement of the animal crossing is the most important feature in determining success (Jackson and Curtice, 1998; Rodriguez *et al.*, 1996). Most studies indicated that placing the animal crossing near the traditional migration or natural path of wildlife will increase effectiveness. For long highway, it should be built at regular intervals. The location should be chosen taking into account the geography of nearby environment. It should be located around the identified habitat connectivity areas. For example, the animal crossing at Route 3 should be further away from the entrance of the tunnel as the mountain area above the tunnel opening already serves as a natural overpass for wildlife to cross the highways. It is also recommended to place the animal crossing away from areas disturbed by humans (Clevenger, 1998).

Size

It is important to build animal crossings of different sizes, i.e. width and height, for different target wildlife. Most studies showed that the larger the animal crossing is the better it will accommodate a wide range of species (De Santo and Smith, 1993; Jackson and Curtice, 1998). For example, small amphibians or badgers need only small tunnels to accommodate their temporal and spatial concerns, but larger mammals like Red Muntjac (*Muntiacus muntjak* 赤麂), require larger ones. The suitable size of a tunnel can be estimated by calculating its relative openness. It is a parameter of a passage structure related to the ability of an animal to see through the structure and not feeling confined while within the structure. It is calculated as "height" times "width", then divided by "length" of the structure. Different species of wildlife have different preferences of the relative openness, ranging from 0.5 to 2. The relative openness of 0.055 (=1.8*1.8/58) for the Route 3 animal crossing is lower than the preferred relative openness of most of the larger species (Table 4).

Species	Relative openness	Reference
Rats	0.04 – 4.0	Mata *et al*, 2003
Badgers	0.05 – 4.0	Mata *et al*, 2003
Small mustelids	< 0.2	Mata *et al*, 2003
Canids	>0.4	Mata *et al*, 2003
Deer	>0.6	Reed and Woodward, 1979

Table 4. Preferred relative openness of mammalian species.

Floor Materials

It is important to use natural bottoms for the animal crossings. "Floor" materials should be chosen with respect to the adjacent natural environment. For aquatic or semi-aquatic species, e.g. Eurasian Otter (*Lutra Lutra* 水獺), a stream with appropriate water depth is recommended. For most species, natural materials such as soil and leaf litter may accumulate with time, though it is less possible for an elevated animal crossing like the one at Route 3.

Guiding Fence or Vegetation

The animal crossing will not be effective unless it is accompanied by fencing on both sides of the road. Fencing should be built around the crossing structure to guide or funnel animals to the passageway, and thus keeps the wildlife off the highway, and makes the animal crossings more "visible" to wildlife (Jackson and Curtice, 1998). At Route 3, the existing security fence surrounding the plantation areas limits the movement of wildlife and reduces the possibility of mammals approaching the entrance of animal crossing.

Overpasses vs. Underpasses

Many studies demonstrated that overpasses were relative more effective than underpasses, as they are less confining, quieter, maintain ambient light and temperature conditions, and can serve both as passage for wildlife and intermediate habitat for small animals, such as amphibians (Jackson and Curtice, 1998). Ideally, overpasses should be utilized whenever possible. However, they are more expensive than underpasses and underpasses are more often used as a promising mitigation measure. If adopted underpasses should be placed as frequently as possible, and the dimensions should vary to accommodate animals of various sizes (Clevenger, 1998).

In conclusion, wildlife crossing structures have had great success in some overseas cases, and it have been useful in decreasing roadkill and have been successful in enhancing habitat connectivity. For building a crossing structure, it is important to understand the distribution, abundance, and ecological and behavioral needs of the species in the area. The crossing should be placed at know migration routes or possible path of wildlife, and away from human disturbance. Fencing should be carefully designed to guide the targeted wildlife to the crossing, and finally, intensive monitoring should be carried out before and after the construction of the crossing structure.

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Rare Species Highlight: Northern Reed Snake (鈍尾兩頭蛇)

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About the Species

The Northern Reed Snake (*Calamaria septentrionalis*, 鈍尾兩頭蛇) is a small, non-venomous snake up to 45 cm in length (Fig. 18). The dorsal side of the body is black, grey or dark brown in colour, while the ventral side is orange red in colour (Fig. 19). Its head and tail are difficult to be distinguished as both ends are blunt and bear a similar pair of orange blotches, hence its Chinese name"鈍尾兩頭蛇", which literally means "blunt-tail two-headed snake". This burrowing species lives underneath forest floor and leads a strongly subterranean life. It only comes out from burrow at night or after heavy rains and thus is rather secretive in nature. Due to the limited past records, little is known about its habits. Some information about this species is summarized in the table below:

Family	Colubridae 游蛇科
Sub-family	Colubrinae 游蛇亞科
Genus	*Calamaria* 兩頭蛇屬
Scientific name	*Calamaria septentrionalis*
Common name	Northern Reed Snake
Chinese name	鈍尾兩頭蛇
Features	Body small. Head indistinct from neck. Head and tail blunt, with a pair of orange blotches at both ends. Back black, grey or dark-brown in colour; ventral orange-red. Tail short, ending with a spine; ventral side with a black line in the middle.
Diet	Earthworms; probably also feed on small soil arthropods and their larvae.
Reproduction	Oviparous.
Distribution	Widely distributed in central and southern China, including Henan, Guizhou, Anhui, Jiangsu, Zhejiang, Jiangxi, Hunan, Guangdong, Hainan and Guangxi. Also found in northern Vietnam.
Status in Hong Kong	Rare. Past records from Ng Fai Tin of Clear Water Bay only.

Fig 18. Northern Reed Snake (*Calamaria septentrionalis*)

Fig 19. Ventral view showing the orange-red underside

Fig 20. Tail mimicking the head's motion

Field Notes

The Northern Reed Snake is a rare snake in Hong Kong. Past records were limited to Clear Water Bay peninsula only.

On the sunny morning of 5 July 2006, Leung Wo-kwai of AFCD found a live Northern Reed Snake prowling across a road near Gilwell Scout Campsite in Ma On Shan Country Park. This represents the first local record of the species outside Clear Water Bay peninsula. The individual was a healthy adult of about 22 cm long. It was temporarily kept for observation and photo taking and eventually released back to where it was found. This species is known to feed on earthworms but the captured individual did not take any prey while in captivity. It was not an offensive snake and seldom attempted to bite, but became very agile when disturbed. When it was harassed, the anterior part of the body would coil up and the tail would mimic the head's motion to distract the enemy (Fig. 20). It might also sting by using the spine on its tail.

In view of the very limited number of records of this species in the wild, further surveys will be required to ascertain its distribution and status in Hong Kong.

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Rediscovery of White Cloud Mountain Minnow (*Tanichthys albonubes*) in the Wild

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Introduction

White Cloud Mountain Minnow (WCMM, 白雲山魚 *Tanichthys albonubes*) is native to southeast China. It was reported in mountain brooks in the vicinity of Guangzhou, including Baiyunshan (白雲山) and Huaxian (花縣), and in some small streams in Fanling, Hong Kong. It is a second-class state protected animal in China and classified as "extinct in nature" in the China Red Data Book (Yue and Chen, 1998).

WCMM is famous among aquarists for its attractive body colour. Aquarium stocks are maintained by aquarists and tropical fish farms all over the world. The aquarium stocks have at least two colour forms – the pale coloured "White Cloud Mountain Form" (Fig. 21) and the brightly coloured "Hong Kong Colour Form" (Fig. 22). It has been reported by aquarists that these two colour forms easily hybridize and produce morphologically intermediary offspring. It is noteworthy that none of the aquarium progenies has white-tipped dorsal fin.

Fig 21. Aquarium type (White Cloud Mountain Form)

No wild population of WCMM has been reported for more than 20 years. However in September 2003, a wild population was discovered by Chinese ichthyologists in a mountain puddle at the Qiuling region (丘陵地帶), Guangdong Province (Fig. 23). The site is an agricultural area fed by waters from mountain streams. One of the distinctive features of this population is the possession of a white band at tip of the dorsal fin, which matches with the descriptions of specimens from White Cloud Mountain by Weitzman and Chan (1966). The announcement comes less than a year after the mass release of captive bred WCMM into various wetlands in Baiyun District (白雲區), Huangpu (黃埔), Huadu (花都), Panyu (番禺), Zengcheng (增城) and Conghua (從化) by the mainland authority.

Fig 22. Aquarium type (Hong Kong Colour Form)

Fig 23. Habitat of wild White Cloud Mountain Minnow in Gaungdong

Yi *et al*. (2004) found that specimens from the Qiuling region were morphologically different in many aspects from those of the aquarium types (Table 5) and concluded that the population is the wild type (Fig. 24). They plan to support their morphological findings by molecular evidence.

Fig 24. Wild type

Table 5. Comparisons of the wild type with two colour forms of the aquarium type (source: Yi *et al*., 2004)

Characters	**White Cloud Mountain Form** (Aquarium type) (Fig. 21)	**Hong Kong Colour Form** (Aquarium type) (Fig. 22)	**Wild type** (Fig. 24)
Standard length (mm)	32.0-33.1	18.0 – 23.2	19.5-26.3
Dorsal fin	II,6 Fin pale red with yellow band at tip	II, 6 Basal part is yellow while the upper half is red	III, 6 Fin greenish yellow with some black dots, red in basal part with white band at tip
Anal fin	III,8 Fin pale red with yellow band at tip	III, 8 Fin yellow, with red band at tip	III, 7-8 Fin greenish yellow, red in basal part with white band at tip
Pectoral fin	I, 10	I, 9	I, 9-11
Caudal fin	A red round blotch constituted about 1/3 to 1/2 of caudal fin	A bright red blotch (usually elliptical) constituted about half to 1/2 to 2/3 of caudal fin; the blotch may sometimes runs from caudal fin base	A red round blotch constituted about 1/3 to 1/2 of caudal fin
Body colour and feature	Body yellowish to brownish; a narrow yellow to golden and a bold black stripe runs from the lower jar along the lateral side of the body to caudal fin base	Body reddish purple; a narrow yellow to golden and a bold black stripe begins from eye and extends along the mid-side almost to caudal fin base	Body silvery to yellowish; a narrow reddish purple and sparkling blue stripe runs along the lateral side of the body from eye to caudal fin base

Conservation issues

It is not sure why wild WCMM populations have been diminishing as aquarium specimens are hardy and are easily kept and bred in a wide variety of temperature and water conditions. However, it is believed the species existed in small isolated populations in hilly upland streams. It is likely that the fish cannot maintain self-supporting populations in the wild due to habitat alteration, human disturbance and / or destruction of hill streams. For instance, a public housing estate now sits at the site in Fanling where WCMM was found in the past.

The rediscovery of wild WCMM arouse great interest in its conservation as it may still be at the fringe of extinction. Mainland ichthyologists continue to search for any remnant populations and urge the relevant authority to consider designating the Qiuling region as a protected area. They are now putting more research effort on the species with a view to increasing wild populations e.g. releasing captive bred wild type individuals to the wild.

With the assistance of the mainland authority, we have visited and collected live specimens of the wild type WCMM from the Quiling region in 2005. Captive populations of the wild type and the Hong Kong colour form (obtained from specimens purchased from the aquarium market) of WCMM are now being kept in AFCD. New broods have successfully been bred in captivity in April 2006 and September 2006 respectively.

Reintroduction as a conservation tool requires several considerations. The source population should preferable be the same subspecies or race. The release site should be within the historic range of the species and have assured long-term protection. It should require minimal long-term post-release management. We also need to understand the effects the re-introduced species may have on the ecosystem (IUCN, 1998).

Hong Kong, being within the species' former range and has many hill streams in our country parks that are suitable for WCMM, seems to be a suitable place for the reintroduction of WMCC to enhance its long term survival in the wild. Remaining issues which need further deliberation are the possible impacts reintroduced WCMM may have on local freshwater ecosystem and which type(s) or form(s) should be released to the wild in Hong Kong. Bear in mind the final goal of reintroduction is the establishment of a viable, free-ranging population in the wild in its former range, of a species, subspecies or race, which has become globally or locally extinct, or extirpated (IUCN, 1998).

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Division Column

A Hong Kong Endemic Plant, *Croton hancei* - its Rediscovery and Conservation

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Background and Recent Studies

Further to the re-discovery of *Croton hancei* Bentham (1861), reported in Issue No. 3 of this newsletter (Yip, 2002), we can now report measures being implemented by the Agriculture, Fisheries and Conservation Department (AFCD) for the conservation of this endemic plant.

The re-discovery of *Croton hancei* (Fig. 25) has provided new material and information, shedding further light on the study of the genus *Croton*. For instance, Chinese plant taxonomists Chang and Qiu (2003) examined the rediscovered specimens taken from Tsing Yi Island, and compared these with other specimens from Guangxi Autonomous Region, which previously had been determined as *C. hancei*. They noticed differences in male and female flower morphology, and the native habitats and therefore described the Guangxi specimen as a new variety, *C. hancei* var. *tsoi* H. S. Qiu. This thus indicates that *C. hancei* is unique to the Hong Kong SAR, and is of scientific interest.

Fig 25. *Croton hancei* in its natural habitat.

One of the present authors (Yip) recently visited the Herbarium of the Botany Department (BM) of the Natural History Museum in London, where the type specimen of *C. hancei* was deposited with the collections of H. F. Hance (No. 10163) (Fig. 26). The specimen shows similar morphological features as those from Tsing Yi. However, there were no further details besides a brief label which reads "*Croton hancei*, Benth. Euphorbiaceae. Hong Kong". The lack of precise locality on the label is not surprising, since it is one of the earliest plant collections from Hong Kong Island (made around 1850 when the territory was only very roughly mapped).

Fig 26. The type specimen of *Croton hancei* deposited at the Natural History Museum, London.

Site Condition

Topography

To date, while the precise type locality of *C. hancei* is unknown, the only known site with living individuals of *C. hancei* is situated in South Tsing Yi, just below the island's highest peak (Fig. 27). The site is on a steep, northeast-facing slope which is primarily vegetated with native woodland. The woodland comprising the *C. hancei* population is isolated from the surrounding grassland by boulders and the ridge.

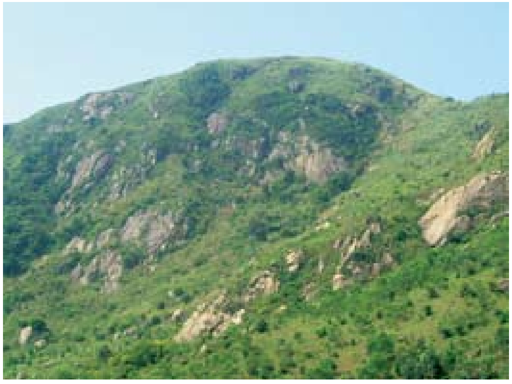

Fig 27. Natural habitat of *Croton hancei* on Tsing Yi Island, HKSAR.

Habitat and Other Plant Species Present at the Site

As indicated by field observations and analyses of the floristic composition, the existing woodland is probably remnants preserved from common hill fires, kept intact through the shelter of the boulders. There is no immediate threat of development to the site, given the difficult terrain. Field observations showed that all *C. hancei* individuals in the site are confined to the woodland's shaded understorey. The habitat also supports a variety of plant species, including another locally rare shrub *Ardisia faberii* Hemsl. (月月紅) and orchids such as *Tainia hongkongensis* (Rolfe) Tang & Wang (香港帶唇蘭) and *Cymbidium ensifolium* (L.) Sw. (建蘭).

Being a newly rediscovered endemic species, the biology of *C. hancei* is hardly explored – and so deserves investigation. Further studies on the vegetation of the site may reveal more details of the floristic composition and diversity of the natural vegetation on Tsing Yi, and by generalization of Hong Kong in general.

Population Size

Method

A field survey of the species was carried out in December 2005 in order to estimate the population size of *C. hancei* at the site. Since no *C. hancei* has been recorded outside this particular site, the woodland on the slope can be considered the entire habitat of the species. Three frame quadrats of approx. 25 sq. m. (5m x 5m) were randomly selected within the woodland to define the sample area of the population size estimation. Within each quadrat, locations and conditions, such as height and the presence of flowers or fruits of individuals of *C. hancei* occurring, were recorded.

Results

A total of 36 individuals of *C. hancei* were recorded in the quadrats. Their height ranged from 20 cm to 150 cm (mean = 82 cm), 19 (53%) and 5 (14%) of them were in the flowering or fruiting periods respectively. Young seedlings were observed, which indicate that the population remains in a healthy condition. The species has an average density of 0.48 individual per sq. m. Based on the assumption that the average density of the sampling area is representative to that of the entire woodland, which is of about 3,600 sq. m., the population size of *C. hancei* at the site is estimated to be 1,728 individuals.

Conservation

In-situ Conservation

Being the only site of this endemic species in the wild, the site was listed as a Site of Special Scientific Interest (SSSI) on 13 April 2005.

The SSSI is about 1.1 ha in size, covering all of the woodland which has the *C. hancei* population, the surrounding grassland and the boulders which act as a buffer to protect the population. The site is located entirely on government land. The population and growth conditions of *C. hancei* in the SSSI will be monitored. Conservation management will be carried out by AFCD on need basis.

By listing the site as a SSSI, the government departments concerned have been made aware of the special scientific value of the site. When developments in or near the site are proposed, AFCD will be consulted about the potential impacts on the SSSI. The site is also zoned as SSSI on the Tsing Yi Outline Zoning Plan and has statutory protection under the Town Planning Ordinance, Cap. 131, with no new development permitted within the SSSI zone unless it is necessary for conservation of the site. Moreover, for any major projects to be carried out in or in the proximity of the SSSI, the project would potentially be a designated project (DP) under the Environmental Impact Assessment Ordinance (EIAO), Cap. 499, and the statutory requirements of the Ordinance would be followed. Under the EIAO, no DP shall be constructed or operated without an environmental permit, which is issued to the project proponent only if it is demonstrated that the project will have acceptable environmental impacts through avoidance or implementation of mitigation measures.

Ex-situ Conservation and Reintroduction

The Field Investigation Unit of AFCD has attempted to propagate *C. hancei* since its rediscovery. Because the site is not conveniently accessible and only a small number of individuals were known, only limited materials were collected. Of these, 10 juvenile plants were raised under nursery conditions, with an 80% survival rate after the first year. Ten cuttings from the site were raised under nursery conditions, also resulting in 80% survival after the first year. Some of the propagated plants were kept in the greenhouse at Tai Tong nursery under similar shade as in the Tsing Yi site. These individuals produced flowers and fruits with viable seeds, with a germination rate of 65%. Other propagated plants were planted in the Shing Mun Arboretum and other localities in the Country Parks for *ex-situ* conservation, and they survive well also in more exposed environment.

Conclusion

Owing to its conservation importance, *C. hancei* is recorded in *Rare and Precious Plants of Hong Kong* (Hu, 2003). Using the 2001 IUCN Red List Categories and Criteria, the status of *C. hancei* in China is “Critically Endangered (CR)” because of its very restricted distribution with only a few small populations. Besides the listing of the site as a SSSI, the listing of *C. hancei* as a flagship species in *Rare and Precious Plants of Hong Kong* and its display in an arboretum aims to educate the general public and raise awareness and appreciation of precious plants in Hong Kong. It is hoped that the *in-situ* and *ex-situ* conservation measures and the re-introduction will guarantee the species’ continued existence in nature.

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17th International Symposium of Odonatology at Hong Kong Wetland Park

Tze-wai Tam and Virginia L.F. Lee

第十七屆國際蜻蜓研討會於本月初在濕地公園舉行，超過八十五位來自十三個國家的蜻蜓專家出席是次會議。有關活動的詳情及圖片請瀏覽www.hkbiodiversity.net。

The 17th International Symposium of Odonatology was held at the Hong Kong Wetland Park from 31 July to 4 August 2006, with a special theme on 'Dragonflies of South East Asia'. It was the first time the symposium had been held in the region. Over 85 participants from 13 different countries attended the Symposium (Fig. 28).

Fig 28. Group photo taken in front of the Hong Kong Wetland Park.

The symposium provided a valuable platform for odonate experts to share their experience and research findings. Keynote speakers talked about the uses and values of dragonflies for monitoring freshwater ecosystem health, dragonfly biodiversity in South East Asia and dragonfly conservation in Africa. Other participants presented papers on dragonfly biology, morphology, ecology, conservation, taxonomy, reproduction and habitat enhancement.

The symposium included a field trip to Sha Lo Tung for participants to appreciate the 'winged jewels' and the Hong Kong countryside (Fig. 29). There was also a five - day tour to Nankanshan mountain ranges, in mainland China, after the symposium (Fig. 30). Nearly half of the participants joined the tour. They found it to be a great opportunity to examine this unexplored insect group, making a few new records (e.g. *Aciagrion tillyardi* and *Philosina* sp.) for the area. A Japanese odonatologist even suspected finding a dragonfly species new to science!

Fig 29. Field trip to Sha Lo Tung.

Organization of the symposium, which was held at the Hong Kong Wetland Park, was described by the president of the International Odonatological Foundation as the 'Best Symposium' ever held. This reinforced Hong Kong's international image in nature conservation and promoted Wetland Park to the international community. It also helped local ondonatologists to establish connections with dragonfly organizations and experts worldwide.

We greatly appreciated the chance to organize this meaningful event and would like to thank all symposium participants, colleagues from the Wetland Park and Biodiversity Conservation Divisions, members of the Dragonfly Working Group and many other generous helping hands. Their contributions and dedicated work were indispensable to the success of the symposium. And we sincerely hope that all participants will leave with unforgettable memories.

For more photos and reminiscences of the symposium, please visit the website at www.hkbiodiversity.net.

Fig 30. The symposium tour to Nankanshan.