香港物種探索
Hong Kong Biodiversity
Agriculture,Fisheries and Conservation Department Newsletter

Issue No. 19 September 2010

www.hkbiodiversity.net

Feature Article

First Record in China of the Firefly Genus *Pteroptyx*（齊爍螢屬）

Josephine C.Y. Cheng, Rex C.H. Shih and Joseph K.H. Cheung
Beetle Working Group

漁護署甲蟲工作小組最近在香港濕地公園找到一種齊爍螢屬(*Pteroptyx*)的螢火蟲，這是首次在中國發現該屬的螢火蟲，而初步鑑定更顯示該螢火蟲是全球首次發現的品種。本文介紹該螢火蟲的鑑定特徵、生境和交配行爲特點。

Introduction

The Beetle Working Group of the Agriculture, Fisheries and Conservation Department (AFCD) was formed in July 2009. It aims to collect baseline information on beetles (Order Coleoptera 鞘翅目), including fireflies, in Hong Kong. The Working Group recently found an unidentified firefly species in Hong Kong Wetland Park (HKWP) (Fig. 1). Subsequent taxonomic studies revealed that this firefly species belongs to the genus *Pteroptyx* (齊爍螢屬), making it the first record of this genus in China.

Fig 1. Male *Pteroptyx* firefly found in HKWP, with the arrow showing the trilobed terminal abdominal ventrite.

Morphology and Taxonomy

This firefly species has a body length of about 8-10 mm. It has yellow pronotum (前胸背板) and elytra (鞘翅) with dark brown apices. It has a total of six visible sterna (腹板) (known as "ventrites" 節腹面) in the abdomen, and the light organ of the male is located at the last two ventrites in the abdomen (Fig. 1), indicating that this firefly species is a member of the subfamily Luciolinae (絲螢亞科) (Jeng et al., 2007). The female firefly resembles the male but it has only one single segment of light organ at the second last ventrite in the abdomen (Fig. 2).

Contents

Subscribing Hong Kong Biodiversity

If you would like to have a copy, or if you know anyone who is interested in receiving a copy of this newsletter, please send the name, organization, and email (soft copy) or postal addresses (hard copy) to the Article Editor.

Chief Editor : Simon K.F. CHAN
(kf_chan@afcd.gov.hk)

Article Editor : Aidia S.W. CHAN
(aidia_sw_chan@afcd.gov.hk)

Fig 2. Female *Pteroptyx* firefly found in HKWP, with the arrow showing only one segment of light organ compared with two in the male.

There are two key characteristics of this firefly species that lead to its identification as the genus *Pteroptyx*. The male has conspicuous deflexed elytral apices (Fig. 3), which is the most distinctive feature of the male members of the genus *Pteroptyx* (*Ptero* = wing, *ptyx* = fold) (Ballantyne & McLean, 1970; Wing et al., 1983; Ballantyne, 2001). These hooked wing covers serve as a clamp enabling the male to hold the female during mating, while at the same time keeping other males away from the receptive female. Another distinctive feature differentiating *Pteroptyx* from other genera of the subfamily Luciolinae is the presence of the trilobed terminal abdominal ventrite (Fig. 1).

Fig 3. The deflexed elytral apices (arrow) of the male *Pteroptyx* firefly.

Detailed identification of this *Pteroptyx* species, including microscopic examination of the species-specific male genitalia, against established taxonomy frameworks has revealed no matching with any known *Pteroptyx* species so far. While further studies and descriptions are needed to ascertain the identity of the firefly, it is believed that this firefly is a species new to science (Ballantyne and Fu, per. com.).

Habitat and Behaviour

The Genus *Pteroptyx* is primarily a mangrove-dependent firefly group, and members of the genus rely on different parts of the mangrove ecosystem throughout their life cycle (Nallakumar, 2002; Nada et al., 2008). Adults of the unidentified *Pteroptyx* species, including males and females, were first discovered in October 2009 in the mangroves at HKWP (Fig. 4). Thereafter, we regularly recorded it from March to August 2010. Penetrated by an intertidal channel with brackish muddy soil on its banks, its habitat is dominated by the mangrove plant species *Acanthus ilicifolius*, *Aegiceras corniculatum* and *Kandelia obovata*.

Fig 4. Habitat of the *Pteroptyx* firefly in HKWP.

Fireflies produce flashes as a mean of communication between males and females for courtship. We observed that shortly after dusk, males of this *Pteroptyx* species begin flashing and flying above the mangroves and nearby vegetation to search for a mate. The females usually perch on leaves and stems of the vegetation waiting for the males. During mating, the elytra of the male is positioned under those of the female (Fig. 5). After copulation, the females lay their eggs on moist mud or soil, where food source is available for the *Pteroptyx* larvae (Nada et al., 2008).

Fig 5. Mating pair of *Pteroptyx* fireflies.

Further Studies

We are now further examining the adult specimens to ascertain the taxonomic status of this firefly. Unidentified firefly larvae have also been collected from the mangroves in HKWP where the *Pteroptyx* species were found. These larvae were observed feeding on small gastropods (Fig. 6). Studies are now under way to investigate whether these larvae belong to the *Pteroptyx* species. A baseline survey of the *Pteroptyx* firefly in similar mangrove habitats in Hong Kong is being carried out. We have also found the larvae of an unidentified aquatic firefly species in a freshwater marsh (Fig. 7). The larvae live in water throughout the larval stage, breathe through eight pairs of bifurcate gills and feed on aquatic gastropods. Taxonomical and ecological studies of this aquatic firefly species are also being conducted.

Fig 6. Unidentified larva found underneath mangrove plants at HKWP.

Fig 7. Unidentified aquatic firefly larva found in a freshwater marsh.

Acknowledgements

We would like to express our gratitude to Dr. Lesley Ballantyne and Dr. Fu Xin-hua for their advice on the identification of this newly discovered *Pteroptyx* firefly. We are also grateful to Mr. Atwood Chiu, Mr. Alex Li, Mr. Michael Leung and Mr. Yeung Chak-ming of the AFCD for their assistance in field surveys, as well as other members of the Working Group for reviewing this article.

References

Ballantyne, L. A., and M. R. McLean. 1970. Revisional studies on the firefly genus *Pteroptyx* Olivier (Coleoptera: Lampyridae: Luciolinae: Luciolini). Transactions of the American Entomological Society 96: 305.

Ballantyne, L. A. 2001. The bent winged fireflies of Cambodia, Indonesia, Malaysia, Philippines and Thailand (Coleoptera: Lampyridae: Luciolinae: Luciolini). *Pteroptyx* spp. of the Polunin collection. Serangga 6 (1): 51-95.

Jeng, M. L., M. Engel, and P. S. Yang. 2007. Oculogryphus, A Remarkable New Genus of Fireflies from Asia (Coleoptera: Lampyridae). American Museum Novitates 1-19.

Nada, B., L. G. Kirton, and V. Khoo. 2008. Conservation efforts for the Synchronous Fireflies of the Selangor River in Malaysia. Proceedings of International Firefly Symposium, Chiang Mai, Thailand.

Nallakumar, K. 2002. Management and Conservation of Fireflies in Peninsular Malaysia. PhD Dissertation, University of London.

Wing, S., J. E. Lloyd. and T. Hongtrakul. 1983. Male competition in *Pteroptyx* fireflies: Wing-cover clamps, female anatomy, and mating plugs. Florida Entomologist 66:86-91.

Division Column

Population Survey and Contraceptive/Neutering Programme of Macaques in Hong Kong

C.T. Shek and William W. W. Cheng
Wetland and Fauna Conservation Division

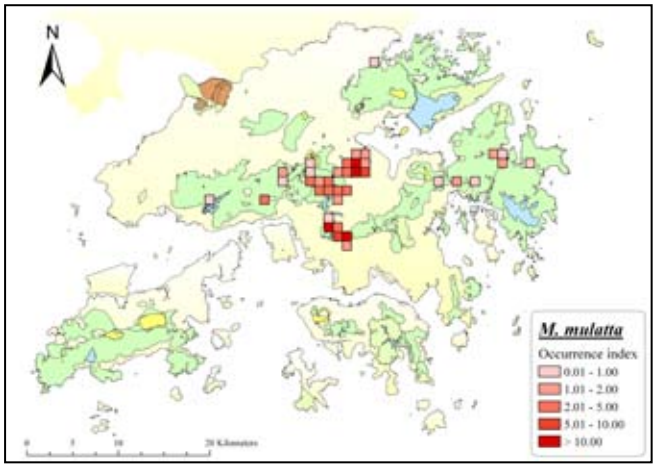
漁農自然護理署自2002年爲金山及獅子山郊野公園的野生猴群進行避孕及絕育計劃，至今已爲超過1,500頭彌猴進行避孕及絕育處理。從過去三年的群落監察發現，彌猴的總群落出生率有下調趨勢，幼猴比例更從2008年的23.6%下跌至2010年的11.9%，總群落數目亦於過去兩年錄得負增長，初步可見此計劃的成效。漁農自然護理署將繼續監察本地野生猴群群落的變化，並在有需要時爲更多本地彌猴進行避孕及絕育處理，從而長遠控制牠們的數目。

Background

In Hong Kong, Kam Shan (金山郊野公園) and Lion Rock Country Parks (獅子山郊野公園) are well known as the "Monkey Hills" (馬騮山) to local residents for the macaques that inhabit the area. According to a camera-trap survey conducted by the Agriculture, Fisheries and Conservation Department (AFCD) in 2002-06 (Shek et al, 2007), macaques are common, but have a fairly restricted distribution in Hong Kong. They are found mostly in Kam Shan, Lion Rock and Shing Mun Country Parks (城門郊野公園), as well as Tai Po Kau Nature Reserve (大埔滘自然護理區) (Fig. 8). Although Hong Kong falls within the range of natural distribution of Rhesus Macaques (*Macaca mulatta*, 彌猴／恆河猴), the original wild stock is believed to have become extirpated (Herlots, 1951). The existing macaque populations are believed to be the descendents of individuals introduced to the above areas in the 1910s. A few Long-tailed Macaques (*M. fascicularis*, 長尾彌猴) were also released in the same area in the 1950s, which led to crossbreeding between these two species. In addition to these two species, there have been sightings of Pig-tailed Macaques (*M. nemestrina*, 豚尾猴), Japanese Macaques (*M. fuscata*, 日本彌猴) and Tibetan Macaques (*M. thibetana*, 藏酋猴) in the Kowloon Hills (Southwick & Southwick, 1983; Fellowes, 1992; Wong & Ni, 2000), but none are likely to have survived. The most recent record of Tibetan Macaque was a female found in Kam Shan Country Park in October 2008.

Due to excessive human food provisioning, the number of macaques in Hong Kong has increased from just a few to over 2,000 in the past 100 years. Through frequent contact with humans over the years, some macaques have lost their natural fear of humans and have even become habituated to straying into nearby sub-urban residential areas to search for easy food. Their behavior, which is sometimes aggressive, is a nuisance, and has led to human-macaque conflicts in both Country Parks and residential areas in the urban fringes. Control of the unnatural growth of macaques is deemed necessary to reduce the nuisance and human-macaque conflicts caused by the increasing population of macaques.

Fig 8. Distribution of Rhesus Macaque (*M. mulatta*) in Hong Kong. The Occurrence Index refers to the number of photos of Rhesus Macaque taken per 100 days (Shek et al., 2007).



Contraceptive/Neutering Programme

In order to manage the growth of the macaque population in the long term, a contraceptive/neutering programme was initiated in 1999 for macaques in captivity. Females were injected with an immuno-contraceptive vaccine named SpayVac™, which induces the immune response of females to produce antibodies that adhere to the surface of their eggs and prevent sperm from binding, thus blocking fertilization. It has been proven that a single dose of SpayVac™ confers contraceptive protection for three to five years (Fraker et al, 2002; Hernandez, 2005). Males were given a chemical vasectomy (輸精管化學結紮), which is done by injecting scarring chemicals at the epipidymis (附睾), resulting in permanent blockage of the vas deferens (輸精管). In 2002, the contraceptive/neutering programme was extended to a field trial on wild macaque populations in the Country Parks, and a total of 124 macaques were successfully treated in the following five years. After the first field trial, field monitoring on the treated macaques was carried out and none of the treated females were found to be pregnant in the two years after the SpayVac™ treatment (Wong and Chow, 2004).

Following the success of the field trials, a large scale macaque contraceptive/neutering programme was launched in mid-2007. The programme, which also include catching/trapping, was commissioned to the Tai Wai Small Animals and Exotic Hospital, and the Ocean Park Conservation Foundation, Hong Kong, in the form of

a service contract starting in 2008. In each operation, 30-130 macaques were trapped, using a 28-foot long remote-controlled cage. The trapped macaques were sedated and suitable adults and sub-adults received contraceptive/neutering treatments. The programme has been running for over three years and up to June 2010, a total of 1,287 macaques had been treated. The total number of macaques that received contraceptive/neutering treatments from 2002-10 is shown in Table 1.

Table 1. Number of macaques treated in the contraceptive/neutering programme.

Year	Treated Males	Treated Females	Total
2002-07	63	202	265
2008	136	425	561
2009	179	360	539
2010 (up to Jun 10)	116	71	187
Total:	**494**	**1,058**	**1,552**

In late 2009, a new technique for permanent sterilization of females by means of endoscopic tubectomy (內視鏡輸卵管結紮) (Martelli, 2009) was introduced to the programme by the current service provider – the Ocean Park Conservation Foundation, Hong Kong (Fig. 9). This surgical operation involves the use of a pediatric endoscopic instrument of 3 mm in diameter to cauterize and remove a portion of the fallopian tubes (輸卵管). This sterilization method provides highly effective, lifetime protection against pregnancy for female macaques. It is anticipated that this technique will effectively control the population growth of local macaques in the long run.

Fig 9. Endoscopic tubectomy of wild female macaques.

Population Survey in 2008-10

Since the first contraceptive/neutering trial operation in 2002, the AFCD has also conducted regular field monitoring on population changes of macaques. An extensive population survey was carried out from 2008 to 2010, to determine the population structure of macaques in Hong Kong and at the same time to evaluate the effectiveness of the contraceptive/neutering programme implemented so far.

In macaque core areas, i.e. Kam Shan, Lion Rock and Shing Mun Country Parks, the population survey was carried out by direct counting along forest trails of all known macaque sites. For smaller troops in other areas, such as Tai Po Kau and Sai Kung, the population sizes were estimated by interviewing AFCD Country Park Rangers and Park Wardens who are familiar with the macaques in the areas.

During the survey, individuals from each heterosexual or multi-male multi-female troop were divided into four different age-groups: (1) "adults" – fully grown and sexually mature males and females which are typically over 6 years old; (2) "subadults" – typically males and females 4 to 6 years old, which are smaller than adults and are not fully developed sexually; (3) "juveniles" (grouped as unisex) – from 1 to 3 years old, weaned, small, and showing little sexual development; and (4) "infants" (grouped as unisex) – newborns or those up to one year old, usually carried by their mothers. The age structure of the smaller troops in other areas was not determined in the survey.

Population Dynamics

Up to February 2010 (i.e. before the birth season in 2010), the total number of macaques in Hong Kong was estimated at 2,163, distributed in 26 heterosexual troops, 29 male groups and 15 solitary males (Table 2). The majority of local macaques were found in Kam Shan and Lion Rock Country Parks, representing 83.7% of the total wild population in Hong Kong. In the survey, only 101 individuals (or 4.8% of the total population) were identified as hybrids between Rhesus Macaques and Longtailed Macaques, with 98 of them belonging to a single troop, nicknamed "Long Tail" (長尾), in Kam Shan and Lion Rock Country Parks. However, since the two species of *Macaca* have been hybridized for over 50 years in Hong Kong, it is possible that some hybrids have become "well-mixed" and are difficult to distinguish from the pure strain of Rhesus Macaque.

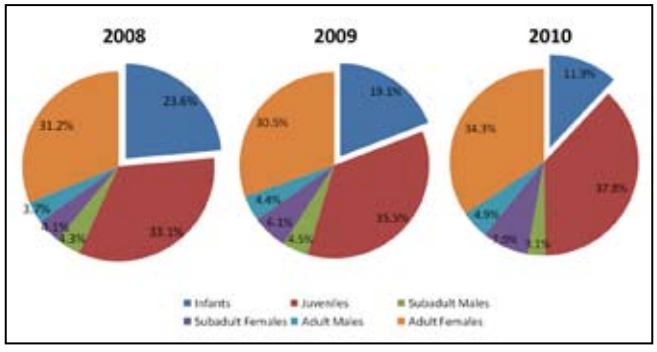
Table 2. Estimated population size of macaques in Hong Kong in February 2010.

Locations	Heterosexual Troops / Individuals	Peripheral Males Groups/Individuals (Solitary)
Kam Shan & Lion Rock	16 / 1,719	17 /92 (11)
Shing Mun	3 / 112	11 / 39 (4)
Tai Po Kau	3 / 80	1 / 3
Sai Kung	1 / 50	-
Lam Tsuen	1 / 40	-
Sha Tin Height	1 / 15	-
Hin Keng	1 / 13	-
Total:	**26 / 2,029**	**29 / 134 (15)**

In 2010, a total of 19 heterosexual troops were surveyed in Kam Shan, Lion Rock and Shing Mun Country Parks, with the troop size ranging from 22 to 272 individuals. Three large troops with over 200 members, which may have an advantage in competing for food sources from humans, were observed in Kam Shan and Lion Rock Country Parks. The overall sex ratio (male to female) for the adults and sub-adults was 1:3.5, including peripheral males, (or 1:5.3, excluding peripheral males) and the immature proportion (i.e. juveniles plus infants) was 49.7%. A low sex ratio was observed in big troops with over 100 members, as adult males within a troop usually consist of around only 10-11 individuals. The movement range of different troops showed great variation. The majority of the troops had limited movement range and were mostly found within Kam Shan and Lion Rock Country Parks. The largest movement range was observed in the "Swollen Eyes" (腫眼) troop, which is known to travel 4 km away from the Smuggler's Ridge Firing Range (孖指徑練靶場) in Kam Shan Country Park to the Tai Shing Stream (大城石澗) in Shing Mun Country Park.

The dominant age groups were female adults and juveniles (both sexes), which together constituted over 70% of all members in the troops surveyed. It is noted that there was a drop in the percentage of infants, from 23.6% in 2008 to 11.9% in 2010, while the percentage of most other age groups increased slightly (Fig. 10). The birth rate, which is defined as the total number of newborns per year divided by the total number of fertile females in a troop or in the total population, decreased steadily from 77.4% in 2008 to 63.2% in 2009 and 56.6% in 2010. The decreasing trend in birth rate was also reflected by a decrease in the proportion of infants in the composition of the age groups. From 2009 to 2010, we observed that the birth rate of the troops which had received contraceptive/neutering treatment before the mating season (i.e. late October to early March) in the previous year dropped from about 70-80% to around 30-40%.

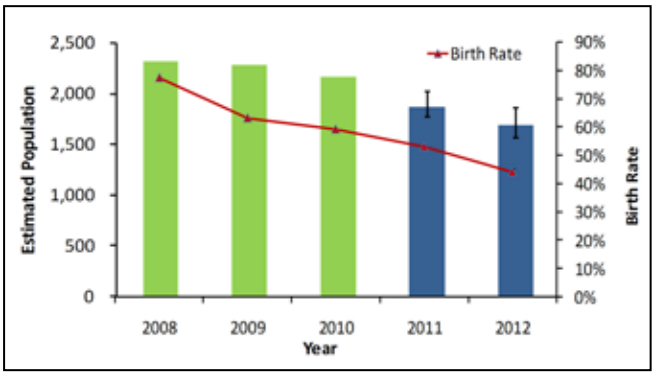
Fig 10. Age structure of heterosexual troops surveyed from 2008-2010.



The survival rate of different age groups, which is defined as the percentage of the individuals in a particular age group still alive after a year, was determined by tracing the change in the composition of different age groups from 2008 to 2010. According to the survey, females had a survival rate of 91% to 98%, followed by males, at 70% to 78%. The survival rates for infants and juveniles were 60% to 77% and 43% to 67% respectively. For subadults and adults, the mortality rate was high, possibly due to competition and fighting. However, the mortality rates of sub-adult and adult males were probably over-estimated, as some male individuals may have left their troops and become peripheral males. These peripheral males are difficult to survey owing to their high mobility and shifting associations with different troops (Fellowes, 1992). Taking into account the birth rates and survival rates of macaques, the population growth of macaques in Hong Kong is estimated to have experienced a downward trend, with a rate of -1.6% in 2009 and -6.9% in 2010.

The current contraceptive/neutering program on the majority of the troops of macaques in Kam Shan and Lion Rock Country Parks will be continued, with permanent endoscopic tubectomy to be performed on approximately 200 females per year. Assuming the environmental conditions and survival rates of macaques remain unchanged, the population of macaques in Hong Kong should continue to shrink at a rate of -11.5% in 2011 and -9.6% in 2012, as shown in Fig. 11. By 2013, the estimated population should drop to about 1,630 individuals, with an estimated birth rate of 48.3%.

Fig 11. Estimated macaque population from 2008 to 2012.

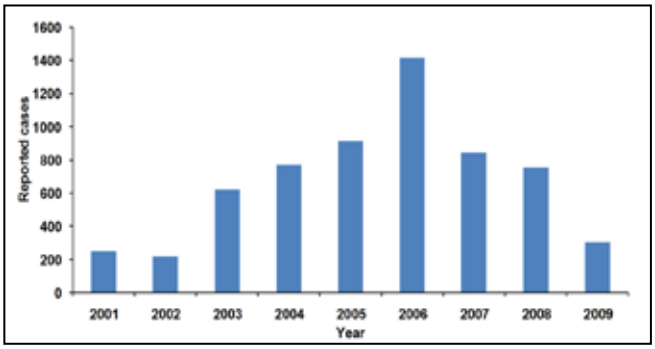


The green bars show the estimated population based on the survey results and the blue bars show the projected population. The error lines show the estimated population with the highest and lowest range of the survival rates of different age groups.

The Way Forward

Hong Kong is the first city in the world to carry out a contraceptive/neutering programme to control the wild macaque population. With the implementation of both a feeding ban and the contraceptive/neutering programme, it is observed that there has been a decreasing trend in the population of macaques, as well as in the number of macaque nuisance cases (Fig. 12), indicating the initial success of the programme.

Fig. 12. Total number of macaque nuisance cases received by the AFCD from 2001 to 2009.



The AFCD is planning to extend the neutering programme to other areas, such as Shing Mun and Sai Kung Country Parks (西貢郊野公園) to neuter the macaques that belong to other smaller peripheral troops which are habituated to, and have learnt to forage in, urban fringe residential areas, with a view to controlling their population size. Surveys on the various populations of macaques will be continued annually, thus providing an important tool for monitoring the changes in the population structure and the effectiveness of the macaque contraceptive/neutering programme. Subject to the results of the population surveys and the number of nuisance cases in nearby suburban residential areas, the scope and scale of the contraceptive/neutering program will be reviewed for possible improvements in its effectiveness and/or robustness.

Acknowledgements

We gratefully acknowledge the contribution of the Ocean Park Conservation Foundation, Hong Kong and the Tai Wai Small Animal and Exotic Hospital as the contractors of the contraceptive/neutering programme, and the Society for the Prevention of Cruelty to Animals (Hong Kong) for their support for the programme. Thanks are also due to Dr. Paolo Martelli, Dr. Karthi Martelli, and Dr. Gail Cochrane, who provided assistance and helpful information. Special thanks to Mr. C. L. Wong for his participation in the population survey in early 2010.

References

Fellowes, J. R. 1992. Hong Kong Macaques. World Wide Fund for Nature (WWF), Hong Kong.

Fraker, M. A., R. G. Brown, G. E. Grant, J. A. Kerr, and B. Pohajdak. 2002. Long-lasting, single-dose, immune-contraception of feral fallow deer in British Columbia. Journal of Wildlife Management 66:1141–1147.

Herlots, G. A. C. 1951. The Hong Kong Countryside. South China Morning Post, Hong Kong.

Hernandez, S. 2005. Effects of SpayVacH on urban white-tailed deer at Johnson Space Center. M.S. Thesis, Texas A&M University, College Station, Texas. 40 pp.

Martelli, P. 2009. Endoscopic tubectomy in Macaques (DVD). Karl Storz – Endoskope.

Shek, C. T., C. S. M. Chan, and Y. F. Wan. 2007. Camera Trap Survey of Hong Kong Terrestrial Mammals in 2002-06. Hong Kong Biodiversity 15:1-10.

Southwick, C. H., and K. L. Southwick. 1983. Polyspecific groups of Macaques on the Kowloon Peninsula, New Territories. Hong Kong American Journal of Primatology 5:17-24.

Wong, C. L., and K. L. Chow. 2004. Preliminary results of trial contraceptive treatment with SpayVacTM on Wild Monkeys in Hong Kong. Hong Kong Biodiversity 6:13-16.

Wong, C. L., and I. H. Ni. 2000. Population dynamics of the feral macaques in the Kowloon Hills of Hong Kong. American Journal of Primatology 50:53-66.

Working Group Column

A Floristic Survey of Marshes in Hong Kong

Jackie Y. Yip, Joseph K. L. Yip, Eric K. Y. Liu, Y. N. Ngar, Patrick C. C. Lai
Plant Working Group

本署植物工作小組於2003至2009年間，在全港26片淡水及鹹淡水沼澤濕地，進行植物調查。小組蒐集了植物種類、環境數據及植物親水性等資料。調查共錄得372種植物，其中191種（共46科）爲水生或濕生植物，本文根據其出現頻率分爲「十分常見」、「常見」、「不常見」和「稀有」。調查結果補充了文獻的不足，並爲沼澤濕地的保育建立數據基礎。

Introduction

The rapid decline of rice cultivation in Hong Kong in the 1960s and 1970s caused many paddy fields to be left fallow or converted for growing vegetables. Some of these abandoned fields, mostly located around villages, have gradually become marshes as a result of natural succession (自然演替).

Despite the growing interest in this unique wetland habitat, research on the vegetation of marshes in Hong Kong has been rather limited. A number of publications in the 1970s and 1980s gave an overview of wetland flora in Hong Kong during this period, including common aquatic plants (Hodgkiss, 1978), grasses and sedges (Griffiths, 1983), common

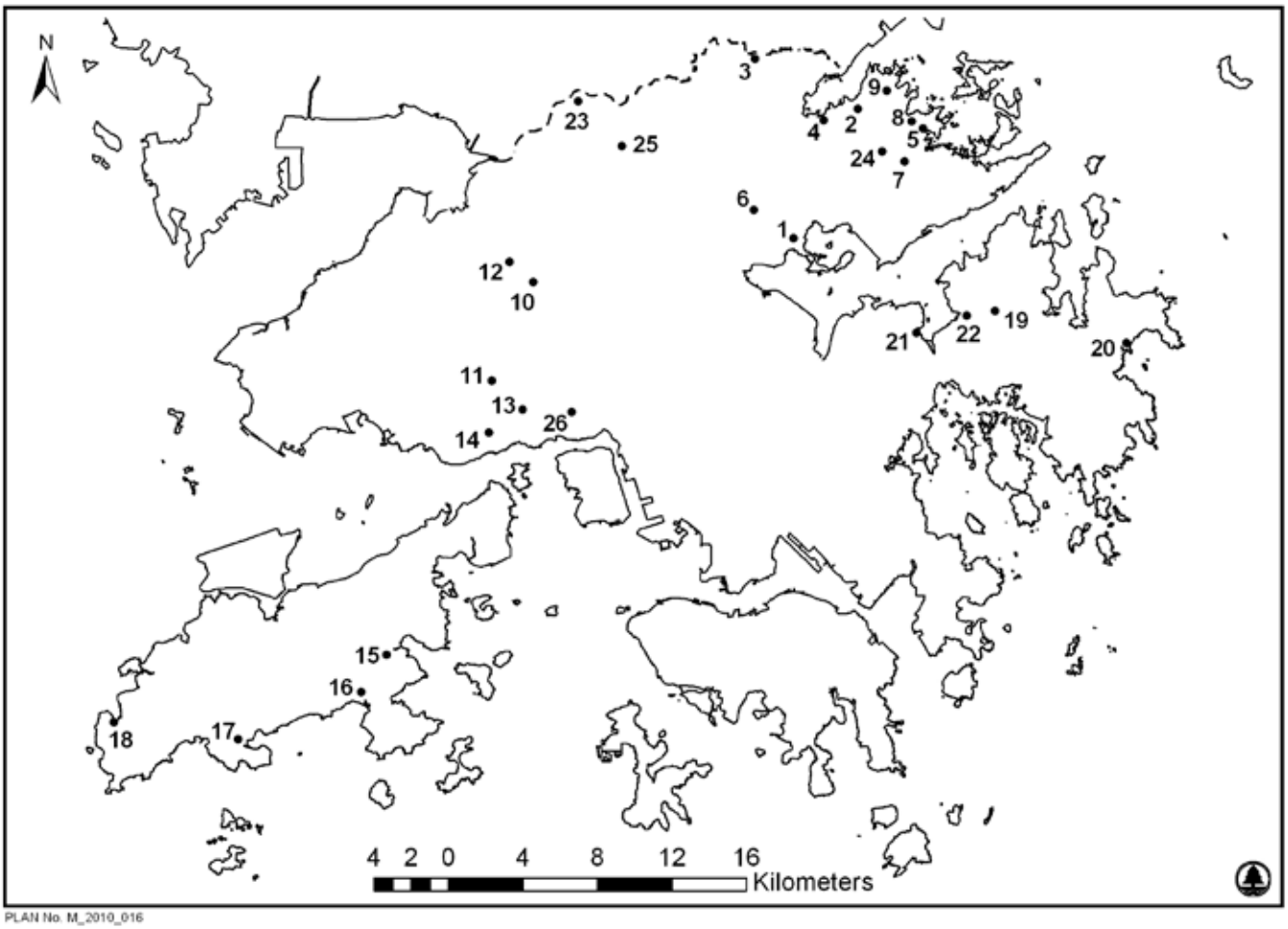
freshwater plants (Hill et al., 1978) and brackish water plants (Hu, 1974). As part of a territory-wide survey of freshwater wetlands, Dudgeon and Chan (1996) recorded 73 species of macrophytes (大型水生植物) in 33 freshwater wetlands. However, most wetland plants (except for Cyperaceae 莎草科) were identified to genus level only. Shaw (1998) conducted a taxonomic and ecological review of the family Cyperaceae, which consists of many wetland species. The Biodiversity Survey conducted by the University of Hong Kong (HKU) provided data on the distribution and commonness of vascular plants in Hong Kong (Corlett et al., 2000), but uncertainties still exist for many wetland plants which were either rare or unrecorded in the HKU survey. An unpublished consultancy report produced for the West Rail project (KCRC, 2001) also provided information on the local distribution of 80 species of plants associated with wetlands.

With the rapid succession of abandoned paddy fields to marshes as a result of hydrological changes and weed invasion, the available information is deemed insufficient to reflect the floral characteristics of this fast-changing habitat. A territory-wide vegetation survey of marshes was conducted by the Agriculture, Fisheries and Conservation Department (AFCD), with the aim of better understanding the floristic composition of marshes. The survey also provided an opportunity to update the current status and distribution of plant species, information that had not been collected for a long time.

Methods and Analysis

A survey of 26 marshes (Fig. 12) was conducted from 2003 to 2009 by the AFCD Plant Working Group and staff of the Hong Kong Herbarium. The sites were chosen based on previous studies (e.g. Dudgeon & Chan, 1996; KCRC, 2001) and a desktop review of aerial photos and vegetation maps. Most of the sites were freshwater marshes located on low-lying ground (Fig. 13). Aerial photos taken in the 1970s indicated that all of the sites surveyed were wet agricultural fields or fish ponds at the time, whereas active agricultural activities remained only in Long Valley during our survey.

Fig 12. Location of marshes surveyed (Date(s) of survey for each site are given).



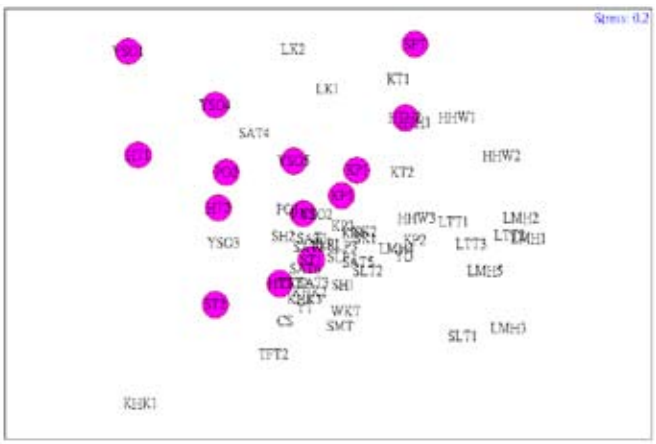
1 - Ha Tei Ha 蝦地下 10.IX.2003; 2 - Kuk Po 谷埔 9.VII.2003; 3 - Lin Ma Hang 蓮麻坑 26.VI.2003; 4 - Luk Keng 鹿頸 20.V.2003, 5.V.2009; 5 - Sam A Tsuen 三椏村 29.X.2009; 6 - Sha Lo Tung 沙螺洞 18.VI.2003, 12.IX.2008; 7 - Sheung Ha Miu Tin 上下苗田 26.IX.2003; 8 - Siu Tan 小灘 8.X.2003; 9 - So Lo Pun 鎖羅盆 21.VII.2003, 2.X.2003; 10 - Kam Tin 錦田 22.X.2003, 4.VII.2008; 11 - Kat Hing Bridge 吉慶橋 12.XI.2003; 12 - Sha Po 沙埔 16.VII.2003; 13 - Tsing Fai Tong 清快塘 5.XI.2003, 27.VIII.2008, 22.X.2008; 14 - Yuen Tun 圓墩 5.XI.2003; 15 - Luk Tei Tong 鹿地塘 12.VIII.2003; 16 - Pui O 貝澳 27.VIII.2003, 23.VI.2008; 17 - Shui Hau 水口 17.IX.2003; 17.VII.2009; 18 - Yi O 二澳 6.XI.2008; 19 - Cheung Sheung 塘上 26.XI.2003; 20 - Ham Tin & Tai Wan 鹹田及大灣 15.X.2003, 10.X.2008, 2.IX.2009; 21 - Sai Keng 西徑 3.VII.2003; 22 - Yung Shue O 榕樹澳 27.V.2003, 25.VII.2008, 1.IX.2009; 23 - Hoo Hok Wai 蠔殼圍 11.VIII.2008; 24 - Wu Kau Tang 烏蛟騰 30.X.2008, 15.VII.2009; 25 - Long Valley 塱原 12.II.2009; 26 – Shek Lung Kung 石龍拱 21.XI.2009

Fig 13. Luk Keng Marsh – freshwater marsh on low-lying ground.

The survey effort was not consistent across sites, as the sites varied in size and habitat complexity. While most of the sites were visited only once in 2003, a few sites were re-visited in 2008 and 2009 in order to capture the flowering or fruiting period of certain target species. In order to cover as many sites and species as possible, a walk-through survey was conducted, instead of a quantitative survey, such as quadrat and transect. Surveyors walked around the sites and recorded all species along the route until no more new species were encountered. Plants were identified on site or collected for further identification in the Hong Kong Herbarium. When significant variations in environmental conditions (such as water depth and tidal influence) were observed within a site, the site was further divided into different parcels (sub-site) with similar site conditions, and plant species were recorded for each sub-site. A total of 64 sub-sites within the 26 sites were recorded.

The frequency of occurrence of each species in the surveyed sites was calculated. In addition, analysis of species composition was conducted using Non-metric Multidimensional Scaling (NMDS) (PRIMER 5 for Windows, version 5.2.9, 2002). Species composition was analysed for sites at higher (≥100m) and lower (<100m) altitudes, as well as for sub-sites with and without tidal influence.

Fig 14. NMDS plot of wetland plant species composition in sub-sites with (circled sub-sites in pink) and without (not circled) tidal influence



Results

A total of 372 plant species were recorded in the 26 sites surveyed. These included wetland species and terrestrial species that colonise drying-up marshes. Excluding plant species that were widespread or commonly found in non-wetland habitats, a total of 191 wetland species in 46 families were recorded (Annex 1). Major plant families were Cyperaceae (51 species), Poaceae (禾本科, 32 species), Scrophulariaceae (玄參科, 16 species) and Polygonaceae (蓼科, 12 species).

Commonness of wetland plants

Annex 1 summarises the commonness of wetland plant species in Hong Kong, primarily based on the frequency of occurrence in the sites surveyed. It should be noted, however, that some species recorded in marshes were also present in other types of wetlands, such as mangroves, streams and constructed wetlands. The distribution of these species in other habitats was also taken into account when evaluating their frequency of occurrence in Hong Kong. Around 11% (21 species) of the 191 species shown in Annex 1 are exotic species. Annex 1 also indicates the life form of plant species (submerged, floating, floating-leaved, emergent, hygrophytic), as observed during the survey.

Species associated with brackish marshes

The NMDS plot in Fig. 14 shows a clear distinction between the species composition in freshwater marshes and marshes under tidal influence. A number of species, mostly Cyperaceae, were confined to sub-sites under tidal influence (Table 1), so they could be considered indicator species for brackish marshes. Mangroves and mangrove associates were also found at the fringe of brackish marshes, but they are not shown in Table 2, as the focus of this study was marsh species.

Table 1. Wetland plant species restricted to brackish marshes

Family	Species Name	Chinese Name
Cyperaceae 莎草科	*Cladium mariscus* subsp. *jamaicense*	華克拉莎
	Cyperus stoloniferus	粗根莖莎草
	Eleocharis geniculata	黑籽荸薺
	Eleocharis spiralis	螺旋鱗荸薺
	Fimbristylis ferruginea	銹鱗飄拂草
	Fimbristylis subbispicata	雙穗飄拂草
	Fimbristylis tetragona	四棱飄拂草
	Scirpus littoralis	鑽苞薰草
Poaceae 禾本科	*Paspalum vaginatum*	海雀稗
	Sporobolus virginicus	鹽地鼠尾粟
	Zoysia sinica	中華結縷草
Scrophulariaceae 玄參科	*Lindernia angustifolia*	狹葉母草

Species associated with disturbed or drying-up marshes

Table 2 shows the common terrestrial species of trees, shrubs, herbs and climbers recorded during the survey. These species were recorded mainly at the fringe of the marshes, or in the portion of the marshes that had started to dry up. The trees species recorded were tolerant of relatively wet soil, but the climbers and herbs were mainly weedy species ubiquitous in Hong Kong. The dominance of these species in a wetland indicates that the wetland has been disturbed or is in the process of drying up.

Some plants appeared to be associated with wetlands, but were usually found at the drier portion of marshes. Among them were some members of the Poaceae family, including *Ischaemum* spp.(鴨嘴草屬), *Microstegium ciliatum* (剛莠竹), and *Apluda mutica* (水蔗草), as well as members of various other families, including *Cyclosorus interruptus* (間斷毛蕨), *Ludwigia octovalvis* (毛草龍) and *Polygonum pubescens* (伏毛蓼). The dominance of these species also indicates that the wetlands were drying up.

Table 2. Terrestrial plants commonly recorded during the survey.

Habit	Family	Species Name	Chinese Name
Tree	Myrtaceae 桃金娘科	*Cleistocalyx operculatus*	水翁
	Moraceae 桑科	*Ficus hispida*	對葉榕
	Euphorbiaceae 大戟科	*Glochidion hirsutum*	厚葉算盤子
		Glochidion zeylanicum	香港算盤子
		Sapium sebiferum	烏桕
Shrub	Verbenaceae 馬鞭草科	*Clerodendrum inerme*	苦郎樹
	Melastomataceae 野牡丹科	*Melastoma candidum*	野牡丹
	Malvaceae 錦葵科	*Urena lobata*	肖梵天花
Climber	Cuscutaceae 菟絲子科	*Cuscuta australis*	南方菟絲子
	Convolvulaceae 旋花科	*Ipomoea cairica**	五爪金龍
	Lygodiaceae 海金沙科	*Lygodium scandens*	小葉海金沙
		Lygodium japonicum	海金沙
	Asteraceae 菊科	*Mikania micrantha**	薇甘菊
	Rubiaceae 茜草科	*Paederia scandens*	雞矢藤
	Polygonaceae 蓼科	*Polygonum perfoliatum*	杠板歸

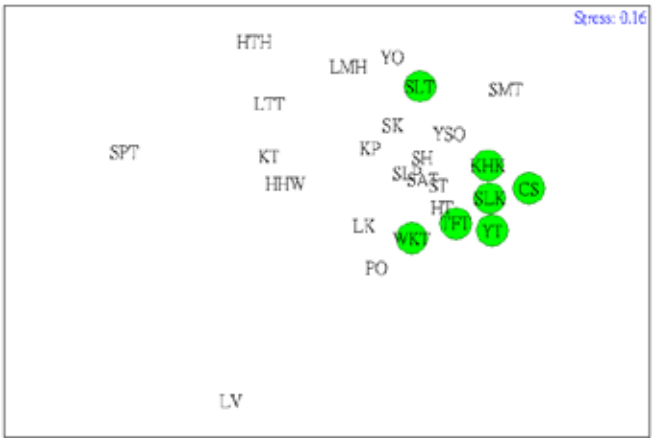
Habit	Family	Species Name	Chinese Name
Herb	Asteraceae 菊科	*Ageratum conyzoides**	藿香薊
		*Bidens alba**	白花鬼針草
		Wedelia chinensis	蟛蜞菊
		*Wedelia trilobata**	三裂葉蟛蜞菊
		*Conyza sumatrensis**	蘇門白酒草
		Crassocephalum crepidioides	野茼蒿
	Araceae 天南星科	*Alocasia macrorrhiza*	海芋
	Fabaceae 蝶形花科	*Desmodium heterophyllum*	異葉山蚂蟥
		Mimosa pudica	含羞草
	Poaceae 禾本科	*Digitaria* spp.	馬唐屬
		Eleusine indica	牛筋草
		Panicum maximum	大黍
		Paspalum conjugatum	兩耳草
		*Pennisetum alopecuroides**	狼尾草
		Sporobolus fertilis	鼠尾粟
	Polygonaceae 蓼科	*Polygonum chinense*	火炭母
	Solanaceae 茄科	*Solanum torvum**	水茄

*indicates exotic species

Species at higher and lower altitudes

The NMDS plot in Fig. 15 shows differentiation between species composition of sites at higher altitude (100m or above) and those at low altitudes. Notably absent from the higher-altitude sites were brackish species, including *Cyperus malaccensis* (茳芏) and *Acrostichum aureum* (鹵蕨), and common lowland weeds, such as *Brachiaria mutica* (巴拉草), *Alternanthera philoxeroides* (空心莧), *Aster subulatus* (鑽形紫菀), *Apluda mutica* (水蔗草) and *Eclipta prostrata* (鱧腸).

Fig 15. NMDS plot of wetland plant species composition in sites at higher altitudes of 100 m and above (circled sites in green) and lower altitudes (not circled).



Discussion

Rarity and conservation status

Most of the wetland plants in Hong Kong are small herbs that can be easily overlooked. Many are annuals with short flowering/fruiting periods, so their occurrence can be highly seasonal. The rarity of some species in the existing literature might reflect the lack of surveys. For example, some species considered "rare", e.g. *Eleocharis acutangula* (銳棱荸薺), *Fimbristylis acuminata* (披針穗飄拂草), in Corlett et al. (2000) were found in a number of sites during this study. On the other hand, some rare or uncommon species might have previously been recognised as "common" due to confusion in identification. For example, *Polygonum hydropiper* (水蓼), which is easily confused with *P. glabrum* (光蓼) or *P. lapathifolium* (大馬蓼) (Fig. 16), was found in only one site in this survey, and *Ludwigia perennis* (細花丁香蓼), which is easily confused with *L. hyssopifolia* (草龍), was not recorded in any of the surveyed sites.

Fig 16. Easily confused *Polygonum* species: (a) *P. hydropiper*; (b) *P. glabrum*; (c) *P. lapathifolium*.


(a)


(b)


(c)

In general, the wetland flora in Hong Kong consists mainly of cosmopolitan or pantropical species. Some paddy field weeds have become uncommon locally due to the decline of agricultural activities, but they are not considered to be of major conservation concern if they are widespread globally or regionally. However, the study results indicate that the population of many floating or submerged plants is seemingly in decline locally, probably as a result of the abandonment of paddy fields. For instance, species listed as "common" or "very common" in Hill et al. (1976), including *Vallisneria spiralis* (苦草), *Utricularia aurea* (黃花狸藻) and *Wolffia arrhiza* (微萍), could not be found in this survey. *Callitriche stagnalis* (now *C. palustris*) (水馬齒), *Marsilea quadrifolia* (田字草) and *Salvinia natans* (槐葉蘋) were previously considered "common" or "very common" (Hill et al., 1976), but were only recorded in one or two sites in this survey. Similarly, some of the plants previously classified as problematic "paddy weeds" are now listed as threatened in Japan as a result of the abandonment of paddy fields (Yamada et al., 2007). Some wetland species listed in the Red Data Book of Japan (Ministry of the Environment, 1997) are regarded as rare or becoming rare in Hong Kong. These include the Critically Endangered *Potamogeton* spp. (眼子菜屬), *Ruppia maritima* (川蔓藻), *Panicum paludosum* (水生黍), *Lobelia hancei* (假半邊蓮); the Endangered *Najas minor* (小茨藻), *Utricularia exoleta* (少花狸藻); the Vulnerable *Marsilea quadrifolia, Salvinia natans, Azolla imbricata* (滿江紅), *Utricularia uliginosa* (濕地挖耳草), and *Blyxa aubertii* (無尾水篩); and the Near Threatened *Veronica undulata* (水苦賈).

Generally speaking, studies of wetland plants are relatively limited. The *List of Plants under State Protection* in China (國家重點保護野生植物名錄, 1999) consists of few wetland species, among which only two species have been recorded in Hong Kong – *Ceratopteris thalictroides*

(水蕨, Fig. 17a) and *Liparis ferruginea* (銹色羊耳蒜). *C. thalictroides* is considered "Vulnerable" (VU) in the Mainland (Yu et al., 1998), but despite its declining population in the Mainland as a result of habitat destruction, this species is fairly widespread in Hong Kong. Another species listed as "VU" in the Mainland (Yu et al., 1998), *Blyxa aubertii* (無尾水篩, Fig. 17b), is now considered rare in Hong Kong, due to the disappearance of suitable habitat (that is, shallow pools with clear water).

(a)

(b)

Fig 17. Two nationally threatened species that have been recorded in Hong Kong: (a) *Blyxa aubertii*; (b) *Ceratopteris thalictroides*

The Red Data Book of Taiwan, now in preparation, includes many wetland plant species. The listed species that are also rare or uncommon in Hong Kong include *Utricularia uliginosa, Salvinia natans, Potamogeton* spp., *Ludwigia perennis*, and *Cladium jamaicense* (華克拉莎). On the other hand, the following Red Data Book listed species are fairly common and widespread in Hong Kong: *Utricularia bifida* (挖耳草), *Hygrophila lancea* (now *H. salicifolia*, 水簑衣) , *Floscopa scandens* (聚花草), *Eriocaulon sexangulare* (華南穀精草) and *Philydrum lanuginosum* (田薑).

Exotic species

Another observation from the current study is the rapid colonisation of exotic plants in the marshes of Hong Kong, especially in disturbed sites and constructed wetlands. A few exotic species first sighted in Hong Kong in the 1990s, including *Typha angustifolia* (水燭), *Lindernia rotundifolia* (圓葉母草), *Kyllinga aromatica* (香根水蜈蚣), *Cyperus imbricatus* (疊穗莎草) and *Aster subulatus* (鑽形紫菀), have become fairly common in abandoned fields and ponds in the New Territories. Some exotic species introduced by the aquarium or horticultural trade have also become naturalised: e.g. *Egeria densa* (水蘊草), *Cyperus flabelliformis* (風車草), *Lindernia rotundifolia* (圓葉母草) and *Hydrocotyle ranunculoides*. Some of the exotic species were observed to have proliferated in constructed wetlands. Managers of constructed wetlands are advised to remove the naturally colonising exotic species regularly, to avoid further expansion of these aggressive species.

Wetland Indicator Categories

The Wetland Indicator Categories defined by the US Fish and Wildlife Service (Reed, 1988) indicate the probability of a species occurring in wetlands versus non-wetlands. Wetland plants are divided into the following categories based on their affinity to wetlands: Obligate wetland (OBL), Facultative wetland (FACW), Facultative (FAC) and Facultative upland (FACU). In the US, these categories were decided based on consensus among experts. While the current study does not provide sufficient data for the determination of Wetland Indicator Categories for the species in Hong Kong, the life form of each species was recorded during the survey. The composition of species in a wetland, including the percentage cover of hygrophytes (濕生植物) and hydrophytes (水生植物) (i.e. submerged, floating, floating-leaved, emergent), could indicate the degree of "wetness" of wetlands. This information would be useful in evaluating the ecological value and monitoring the ecological function of natural and constructed wetlands.

Acknowledgements

We would like to thank the dedicated staff of the HK Herbarium (LAM Ying Wai and TAM Kai Yip) who assisted in the field work and species identification. LAM Ying Wai also provided invaluable comments on this paper. We are also grateful to NG Sai Chit for providing information on some rare species.

References

Corlett, R. T., F. Xing, S. C. Ng, K. C. Chau, and L. M. Y. Wong. 2000. Hong Kong vascular plants: distribution and status. Memoirs of the Hong Kong Natural History Society 23:1-148.

Dudgeon, D., and E. W. C. Chan. 1996. Ecological Study of Freshwater Wetland Habitats in Hong Kong. Unpublished report, Department of Ecology & Biodiversity, the University of Hong Kong.

Griffiths, D. A. 1983. Grasses and Sedges of Hong Kong. Urban Council, Hong Kong. 138 pp.

Hill, D., B. Gott, B. Morton, and J. Hodgkiss. 1978. Hong Kong Ecological Habitats: Flora & Fauna. Department of Zoology, University of Hong Kong. 189 pp.

Hodgkiss, I. J. 1978. Hong Kong Freshwater Plants. Urban Council, Hong Kong. 89 pp.

Hu, S.Y. 1974. Sea-shore Plants of Hong Kong. Journal of the Chinese University of Hong Kong, 2(2): 317-344.

Kowloon-Canton Railway Corporation (KCRC), 2001. Habitat Creation and Management Plan. Contract No. DD901, KCRC West Rail, Hong Kong.

Ministry of the Environment. 1997. Red List of Threatened Plants of Japan. Ministry of the Environment, Japan. Available from http://www.biodic.go.jp/english/rdb/rdb_f.html (accessed August 2010).

Reed, P. B. 1988. National List of Plant Species That Occur in Wetlands: National Summary. Biological Report 88 (24). U.S. Fish & Wildlife Service, Washington, D.C.

Shaw, J. 1998. Hong Kong Cyperaceae: Taxonomy, Ecology and Geography. M.Phil. Thesis, University of Hong Kong.

Yamada, S., S. Okubo, Y. Kitagawa, and K. Takeuchi. 2007. Restoration of weed communities in abandoned rice paddy fields in the Tama Hills, central Japan. Agriculture, Ecosystems & Environment, 119 (1-2): 88-102.

State Forestry Administration & Ministry of Agriculture. 1999. List of Wild Plants under State Protection (Part 1). The State Council, Beijing. (promulgated on 9 Sept. 1999).
[國家林業局和農業部。1999。《國家重點保護野生植物名錄(第一批)》。中國國務院，北京。(1999年9月9日頒佈)]

Yu, D., Y. X. Chong, M. H. Tu, X. Y. Wang, and X. H. Zhou. 1998. Study on the threatened aquatic higher plant species of China. Chinese Biodiversity, 6(1): 13-21 (In Chinese with English summary).
[于丹、鍾雲霄、涂芒輝、汪小炎、周曉華。1998。中國水生高等植物受危種的研究。生物多樣性，6(1):13-21。]

台灣植物分類學會。2008。台灣植物紅皮書第一階段名錄。台灣植物分類學會，台北。可瀏覽自http://www.tsps.org.tw/redbook.htm（存取於2010年8月）。(In Chinese only).

Annex1. List of wetland plants recorded at the 26 surveyed marshes.

Family	Species Name	Chinese Name	Exotic	Life Form[1]	Commonness[2]
Acanthaceae 爵床科	*Hygrophila salicifolia*	水簑衣		E	C
Acrostichaceae 鹵蕨科	*Acrostichum aureum*	鹵蕨		E	C*
Alismataceae 澤瀉科	*Sagittaria guayanensis subsp. lappula*	冠果草		FL	U
	Sagittaria sagittifolia subsp. leucopetala	慈姑		E	U*
Amaranthaceae 莧科	*Alternanthera philoxeroides*	空心莧	✓	E	C
	Alternanthera sessilis	蝦鉗菜		E/H	C
Apiaceae 傘形科	*Centella asiatica*	積雪草		H	C*
	Hydrocotyle ranunculoides		✓	FL/E	C*
	Hydrocotyle sibthorpioides	天胡荽		H	C
	Oenanthe javanica	水芹		E	U*
Araceae 天南星科	*Colocasia esculenta*	芋		E/H	C
	Pistia stratiotes	大薸	✓	F	C*
Asteraceae 菊科	*Adenostemma lavenia*	下田菊		E	C
	Aster subulatus	鑽形紫菀	✓	E/H	C*
	Eclipta prostrata	鱧腸		E/H	C
	Pluchea indica	闊苞菊		H	C*
	Spilanthes paniculata	金鈕扣		E/H	C
Athyriaceae 蹄蓋蕨科	*Callipteris esculenta*	菜蕨		H	U*
Azollaceae 滿江紅科	*Azolla imbricata*	滿江紅		F	U*
Balsaminaceae 鳳仙花科	*Impatiens chinensis*	華鳳仙		E	C
Brassicaceae 十字花科	*Cardamine flexuosa*	彎曲碎米薺		H	C*
	Rorippa cantoniensis	廣州蔊菜		H	R
Callitricheaceae 水馬齒科	*Callitriche palustris var. elegans*	東北水馬齒		E/H	R
Campanulaceae 桔梗科	*Lobelia hancei*	假半邊蓮		E	R
	Sphenoclea zeylanica	尖瓣花		E	U*
Caryophyllaceae 石竹科	*Drymaria diandra*	荷蓮豆		E/H	C*
	Myosoton aquaticum	鵝腸菜		H	C*
Clusiaceae 山竹子科	*Hypericum japonicum*	地耳草		E/H	C
Commelinaceae 鴨跖草科	*Commelina diffusa*	節節草		E/H	VC
	Commelina paludosa	大苞鴨跖草		H	R
	Floscopa scandens	聚花草		E	VC

Family	Species Name	Chinese Name	Exotic	Life Form[1]	Common-ness [2]
	Murdannia bracteata	大苞水竹葉		H	U*
	Murdannia loriformis	牛軛草		H	U*
	Murdannia nudiflora	裸花水竹葉		E/H	C*
	Murdannia vaginata	細柄水竹葉		E/H	U
Convolvulaceae 旋花科	*Ipomoea aquatica*	蕹菜	✓	FL/H	C*
Cyperaceae 莎草科	*Cladium mariscus* subsp. *jamaicense*	華克拉莎		E	R
	Cyperus difformis	異型莎草		E/H	C*
	Cyperus distans	疏穗莎草		H	C*
	Cyperus flabelliformis	風車草	✓	E/H	C*
	Cyperus haspan	畦畔莎草		E/H	C
	Cyperus imbricatus	疊穗莎草	✓	E	U*
	Cyperus iria	碎米莎草		E/H	C*
	Cyperus malaccensis	茳芏		E	U
	Cyperus malaccensis var. *brevifolius*	短葉茳芏		E	C
	Cyperus odoratus	斷節莎	✓	E	U*
	Cyperus pilosus	毛軸莎草		E	VC
	Cyperus rotundus	香附子		H	C*
	Cyperus stoloniferus	粗根莖莎草		H	C*
	Diplacrum caricinum	裂穎茅		H	R
	Eleocharis acutangula	銳棱荸薺		E	C
	Eleocharis congesta	密花荸薺		E	R
	Eleocharis dulcis	荸薺	✓	E	C
	Eleocharis equisetina	木賊荸薺		E/H	U
	Eleocharis geniculata	黑籽荸薺		E	R
	Eleocharis ochrostachys	假荸薺		E	U
	Eleocharis retroflexa	貝殼葉荸薺		H	U
	Eleocharis spiralis	螺旋鱗荸薺		E/H	U*
	Fimbristylis acuminata	披針穗飄拂草		E/H	C*
	Fimbristylis aestivalis	夏飄拂草		H	U*
	Fimbristylis complanata	扁鞘飄拂草		H	C*
	Fimbristylis cymosa	黑果飄拂草		H	C*
	Fimbristylis dichotoma	兩歧飄拂草		H	C
	Fimbristylis ferruginea	銹鱗飄拂草		E/H	C*
	Fimbristylis miliacea	日照飄拂草		H	C
	Fimbristylis nutans	垂穗飄拂草		E/H	R
	Fimbristylis schoenoides	少穗飄拂草		H	U
	Fimbristylis subbispicata	雙穗飄拂草		E/H	U*
	Fimbristylis tetragona	四棱飄拂草		E/H	R
	Fuirena ciliaris	毛芙蘭草		E	R
	Fuirena umbellata	芙蘭草		E	C
	Gahnia tristis	黑莎草		H	C*
	Kyllinga aromatica	香根水蜈蚣	✓	E/H	C*
	Kyllinga brevifolia	短葉水蜈蚣		H	C
	Kyllinga monocephala	單穗水蜈蚣		H	C*
	Lepidosperma chinense	鱗子莎		H	C*
	Lipocarpha chinensis	華湖瓜草		E/H	U
	Lipocarpha microcephala	湖瓜草		E/H	R
	Pycreus flavidus	球穗扁莎		H	C
	Pycreus polystachyus	多穗扁莎		H	VC
	Pycreus sanguinolentus	紅鱗扁莎		E/H	C
	Rhynchospora chinensis	華刺子莞		H	R
	Rhynchospora corymbosa	傘房刺子莞		H	U*
	Rhynchospora rugosa	皺果刺子莞		E/H	U*
	Scirpus juncoides	螢藺		E	U

Family	Species Name	Chinese Name	Exotic	Life Form[1]	Common-ness [2]
	Scirpus littoralis	鑽苞藨草		E/H	R
	Scirpus mucronatus	北水毛花		E	R
Equisetaceae 木賊科	*Equisetum debile*	筆管草		E/H	U*
Eriocaulaceae 穀精草科	*Eriocaulon merrillii*	菲律賓穀精草		E/H	C*
	Eriocaulon nantoense	南投穀精草		E/H	U*
	Eriocaulon sexangulare	華南穀精草		E/H	C*
Fabaceae 蝶形花科	*Geissapis cristata*	睫苞豆		E/H	R*
	Smithia conferta	密花坡油甘		E	C
Hydrocharitaceae 水鼈科	*Blyxa aubertii*	無尾水篩		S	R
	Egeria densa	水蘊草	✓	S	C*
	Hydrilla verticillata	黑藻	✓	S	U*
Juncaceae 燈心草科	*Juncus effusus*	燈心草		E	U*
	Juncus prismatocarpus	笄石菖		E/H	U
Lamiaceae 唇形科	*Mosla scabra*	石薺苧		H	C
	Pogostemon auricularius	水珍珠菜		E/H	C
Lemnaceae 浮萍科	*Lemna minor*	青萍		F	C*
	Spirodela polyrrhiza	紫萍		F	R
Lentibulariaceae 狸藻科	*Utricularia bifida*	挖耳草		H	U
	Utricularia caerulea	短梗挖耳草		H	R
	Utricularia gibba	少花貍藻		S	R*
	Utricularia uliginosa	濕地挖耳草		H	U
Lythraceae 千屈菜科	*Ammannia areneria*	耳基水苋		E	U*
	Rotala rotundifolia	圓葉節節菜		E	C*
Marsileaceae 蘋科	*Marsilea quadrifolia*	田字草		FL/E	R
Najadaceae 茨藻科	*Najas graminea*	草茨藻		S	R
Nymphaeaceae 睡蓮科	*Nymphaea* spp.	睡蓮	✓	FL	C*
Onagraceae 柳葉菜科	*Ludwigia adscendens*	水龍		FL/E	C*
	Ludwigia decurrens	翼莖水丁香	✓	E	R
	Ludwigia hyssopifolia	草龍		E/H	VC
	Ludwigia octovalvis	毛草龍		H	VC
Orchidaceae 蘭科	*Liparis ferruginea*	銹色羊耳蒜		E/H	R
Parkeriaceae 水蕨科	*Ceratopteris thalictroides*	水蕨		E	C
Philydraceae 田蔥科	*Philydrum lanuginosum*	田蔥		E/H	C
Poaceae 禾本科	*Alopecurus aequalis*	看麥娘		E/H	C*
	Apluda mutica	水蔗草		H	C
	Arthraxon hispidus	蓧草		H	C*
	Brachiaria mutica	巴拉草	✓	H	C*
	Coix lacryma-jobi	薏苡		H	C*
	Diplachne fusca	雙稃草		E	U*
	Echinochloa colona	光頭稗		H	C*
	Echinochloa crusgalli	稗		E/H	C*
	Echinochloa crusgalli var. *breviseta*	短芒稗		E/H	C*
	Echinochloa glabrescens	硬稃稗		E/H	C*
	Eragrostis atrovirens	鼠婦草		H	C*
	Hemarthria compressa	扁穗牛鞭草		E/H	U*
	Isachne globosa	柳葉箬		E/H	VC
	Ischaemum aristatum var. *glaucum*	鴨嘴草		H	U*
	Ischaemum barbatum	粗毛鴨嘴草		H	VC*
	Ischaemum indicum	細毛鴨嘴草		H	VC*
	Leersia hexandra	李氏禾		E	C
	Leptochloa chinensis	千金子		H	C*
	Microstegium ciliatum	剛莠竹		H	C
	Neyraudia reynaudiana	類蘆		H	C*
	Panicum bisulcatum	糠稷	✓	H	U

Family	Species Name	Chinese Name	Exotic	Life Form[1]	Commonness[2]
	Panicum brevifolium	短葉黍		H	C*
	Panicum paludosum	水生黍		E	U*
	Panicum repens	鋪地黍		E/H	VC
	Paspalum orbiculare	圓果雀稗		H	C
	Paspalum paspaloides	雙穗雀稗		E/H	C*
	Paspalum vaginatum	海雀稗		E/H	C*
	Phragmites australis	蘆葦		E/H	C
	Phragmites karka	卡開蘆		E/H	C
	Sacciolepis indica	囊穎草		E/H	VC
	Sphaerocaryum malaccense	稗蓋		H	C*
	Sporobolus virginicus	鹽地鼠尾粟		H	C*
Polygonaceae 蓼科	*Polygonum barbatum*	毛蓼		E/H	C
	Polygonum dichotomum	二歧蓼		H	U*
	Polygonum hastato-sagittatum	長葉箭蓼		H	R
	Polygonum hydropiper	水蓼		E	R
	Polygonum jucundum	愉悅蓼		H	U*
	Polygonum lapathifolium	大馬蓼		E	C*
	Polygonum muricatum	小花蓼		E/H	C*
	Polygonum orientale	紅蓼		E/H	R*
	Polygonum plebeium	腋花蓼		H	U*
	Polygonum pubescens	伏毛蓼		H	C
	Polygonum tenellum var. *micranthum*	柔莖蓼		E	C*
	Rumex trisetifer	長刺酸模		H	C*
Pontederiaceae雨久花科	*Eichhornia crassipes*	鳳眼藍	✓	F	C
	Monochoria vaginalis	鴨舌草		E	U
Ranunculaceae 毛茛科	*Ranunculus cantoniensis*	禺毛茛		E/H	R
	Ranunculus sceleratus	石龍芮		E	U*
Rubiaceae 茜草科	*Hedyotis diffusa*	白花蛇舌草		E/H	C
Salviniaceae 槐葉蘋科	*Salvinia cucullata*	勾葉槐葉蘋	✓	F	U*
	Salvinia natans	槐葉蘋		F	R
Saururaceae 三白草科	*Houttuynia cordata*	蕺菜		H	U*
	Saururus chinensis	三白草		E	R
Scrophulariaceae 玄參科	*Bacopa monnieri*	假馬齒莧		E/H	C
	Bacopa repens	田玄參		E	R
	Limnophila aromatica	紫蘇草		E	C
	Limnophila chinensis	中華石龍尾		E	C
	Limnophila rugosa	大葉石龍尾		H	R
	Lindernia anagallis	長蒴母草		E/H	VC
	Lindernia angustifolia	狹葉母草		H	R
	Lindernia antipoda	泥花草		E/H	C*
	Lindernia crustacea	母草		H	C*
	Lindernia procumbens	陌上菜		H	C
	Lindernia pusilla	細莖母草		H	U
	Lindernia rotundifolia	圓葉母草	✓	E/H	C
	Lindernia ruellioides	旱田草		H	C*
	Mazus pumilus	通泉草		H	C*
	Scoparia dulcis	野甘草		H	C
	Veronica undulata	水苦賈		E/H	R
Thelypteridaceae 金星蕨科	*Cyclosorus interruptus*	間斷毛蕨		E/H	VC
Typhaceae 香蒲科	*Typha angustifolia*	水燭	✓	E	C*
Xyridaceae 黃眼草科	*Xyris pauciflora*	蔥草		E/H	U*
Zingiberaceae 薑科	*Hedychium coronarium*	薑花	✓	E/H	C

Note 1 S - Submerged; F – Floating; FL – Floating-leaved; E – Emergent; H – Hygrophytic

Note 2 Commonness in Hong Kong: Rare (R): 1-2 site(s); Uncommon (U): 3-5 sites; Common (C): 6-15 sites; Very Common (VC): >15 sites.

* commonness evaluated based on data from surveyed sites and other known localities in Hong Kong.

A Note on the Cascade Frogs of Hong Kong

Wing-sze Tang
Biodiversity Conservation Division

本港湍蛙屬的湍蛙共有兩種，分別是香港湍蛙及近年才發現的華南湍蛙。由於兩種湍蛙外貌相似，辨認上容易混淆，故本文就兩種湍蛙的分佈、生態及特徵方面作出簡短的介紹，以助品種的鑒別。

Introduction

Amolops hongkongensis (Hong Kong Cascade Frog, 香港湍蛙) used to be considered the only *Amolops* species found in Hong Kong until recent years. In 2003, two herpetologists, Dr. Xie Feng (謝鋒博士) and Dr. Jiang Jian-ping (江建平博士), from the Chengdu Institute of Biology of the Chinese Academy of Sciences (中國科學院成都生物研究所) found four individuals of the *Amolops* species in a stream near Shek Pik Reservoir (石壁水塘) on Lantau Island. Based on the morphological features, they concluded that it could be *A. ricketti* (South China Cascade Frog, 華南湍蛙) or *A. daiyunensis* (Daiyun Cascade Frog, 戴雲湍蛙). A year later, Dr. Lau Wai-neng (劉惠寧博士) collected four of the frogs in streams near Tei Tong Tsai (地塘仔) on Lantau Island. More specimens were subsequently collected by the Agriculture, Fisheries and Conservation Department (AFCD) at Pak Kung Au (伯公坳). The species was later confirmed to be *A. ricketti*, increasing the total number of native amphibian species in Hong Kong to 24. As the two native cascade frogs resemble each other in external appearance and use of habitats, the purpose of this article is to provide an identification guide to distinguish between these two *Amolops* species.

The Genus *Amolops*

Amolops belongs to the large amphibian family Ranidae (蛙科). Members of this genus are commonly known as cascade or torrent frogs due to their adaptation to fast-flowing forest streams. They are characterized by the presence of dilated discs on their digits, absence of humeral glands (肱骨腺體), presence of gular pouches (喉囊) in males, dorsoventrally compressed bodies, and inconspicuous tympanum (鼓膜) (Fig. 18). The adults are strictly nocturnal and feed on small insects. The females lay their eggs in rock crevices or under boulders where water splashes over them and where they remain shaded from direct sunlight (Fig.19). The tadpoles have a well-developed sucker behind the mouth on the ventral side of the body (Fig. 20), which enables them to cling to rocks and stones on stream bottoms in swift water. They are bottom-feeders, grazing on algae that grows on boulders.

Fig 18. *A. hongkongensis* (left) and *A. ricketti* (right).

There are 48 *Amolops* species known in the world, distributed in China, the Philippines, Nepal, India, Southeast Asia and Greater Sunda Island. China alone has 25 species, which are found mainly in southern China.

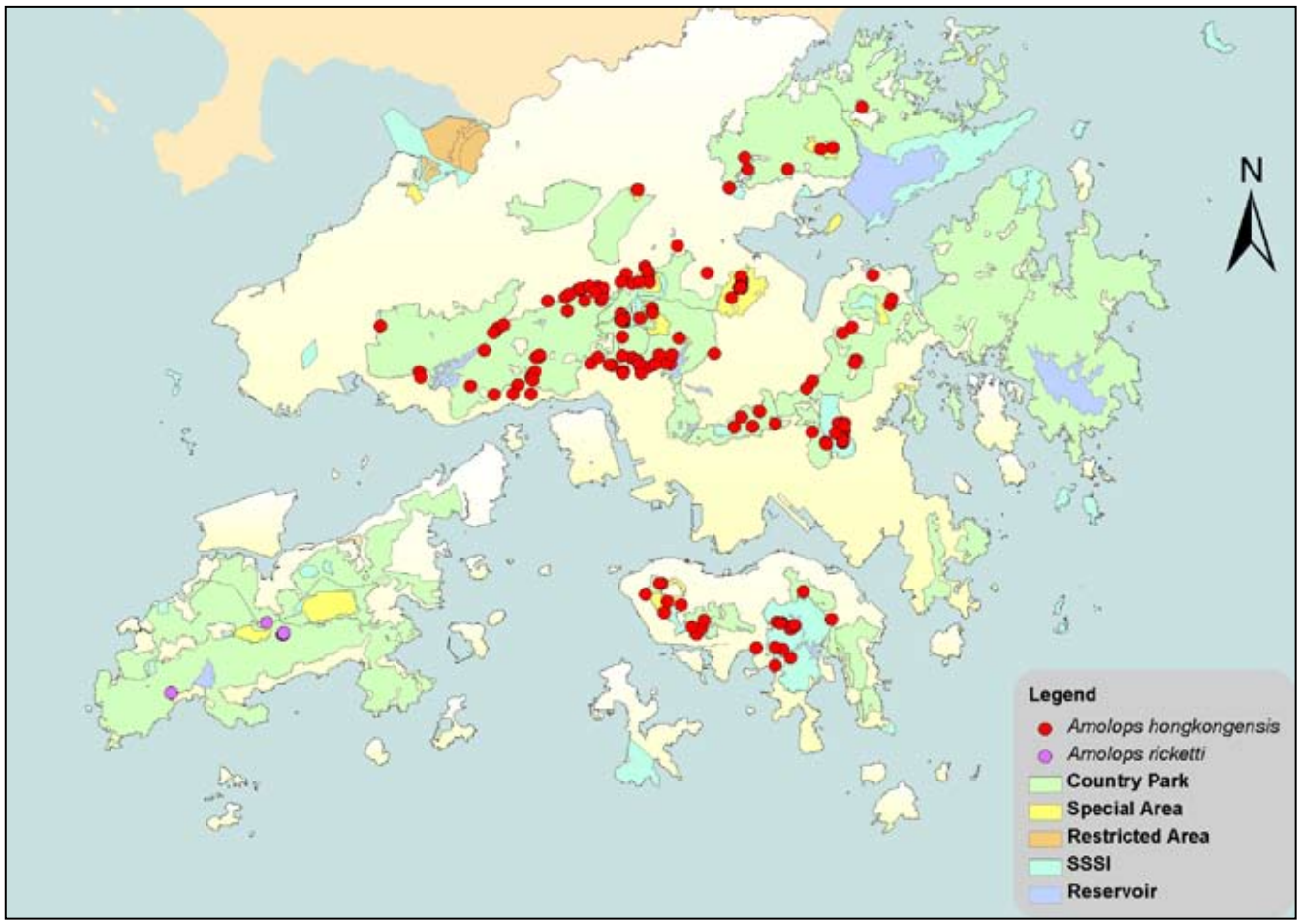
Fig 19. Eggs of *A. hongkongensis*.

Fig 20. Tadpole of *A. hongkongensis* (Upper: dorsal; Lower: ventral).

Cascade Frogs in Hong Kong

Two *Amolops* species are known to occur in Hong Kong: *A. hongkongensis* and *A. ricketti*. The former is more abundant and widespread. It is widely distributed in the New Territories and on Hong Kong Island, but has not been found on Lantau Island, whereas *A. ricketti* has been found on Lantau Island only (Fig. 21). Interestingly, *A. ricketti* occurs in Wutongshan (梧桐山), Shenzhen, just 2 km across the northern border of Hong Kong. Further studies are needed to understand the reasons for (1) the local distribution of the two *Amolops* species which do not overlap with one another, and (2) the apparent absence of *A. ricketti* in the New Territories.

Fig 21. Distribution map of the two *Amolops* species.



Amolops hongkongensis (Fig. 18, 22-23, 26)

A. hongkongensis is a medium-sized frog with a body length up to 6 cm. It has a depressed head, whose width is about the same as its length. It has a short round snout and a tooth-like projection on the lower jaw, but had no vomerine teeth (犁骨齒). It has large eyes and an inconspicuous tympanum. Its body is flat and tapered towards the rear. Its back is blackish-brown or greenish-brown, with distinct round, well-separated black spots. Its skin has small granules scattered over the entire surface. Its belly is grey, and it has dark spots on the throat. The width of the adhesive discs on the third and fourth digits is around 3-4 times of that of the respective digits. The female breeds in late spring and lays its eggs in rock crevices that are splashed over by water and remain shaded from direct sunlight. The eggs are creamy white, with 12-60 eggs per clutch. The tadpole is up to 4 cm long. The body is black, with black blotches on the tail.

This species was first discovered in 1950 in Tai Mo Shan (大帽山) by Pope and Romer. A specimen which was believed to be *A. hongkongensis* was subsequently found in Guangdong. However, close examination of the tympanum and skin structure of the specimen showed that it was different from *A. hongkongensis*. Further investigation is required to confirm the endemic status of this species.

Amolops ricketti (Fig. 18, 22-26)

Its body size is similar to *A. hongkongensis*, with a maximum length of 5.8 cm. Its head width is slightly greater than its head length. Its snout is round and blunt, its tympanum is small and inconspicuous, and vomerine teeth are present. Its back is yellowish-gray, with irregular dark markings and rusty mottling at the edge. Its skin is rough and warty, with numerous granules scattered on the back. Its belly is pale yellow with a rusty edge, while its chest has a marbled pattern. The limbs are barred and toes fully-webbed. The width of the adhesive discs on the third and

forth digits is around two times of that of the respective digits. It breeds in summer, in particular in May and June. The male has a milky white, spine-like nuptial pad. The female can lay up to 1,000 eggs at a time. The eggs attach to the underside of stones on the banks of streams. The total length of the tadpole is about 4 cm, and its body is black, with a golden line extending to the front of the tail, which is observable from the lateral side of the body.

A. ricketti is widely distributed in southern and western China, including Sichuan (四川), Chongqing (重慶), Yunnan (雲南), Guizhou (貴州), Hunan (湖南), Hubei (湖北), Jiangxi (江西), Zhejiang (浙江), Fujian (福建), Guangxi (廣西), Guangdong (廣東) and Hong Kong, as well as northern Vietnam.

Annex 1. Diagnostic features of the two *Amolops* species in Hong Kong

Scientific Name	*Amolops hongkongensis* (Pope and Romer, 1951)	*Amolops ricketti* (Boulenger, 1899)
English Common Name	Hong Kong Cascade Frog, Hong Kong Torrent Frog	South China Cascade Frog, South China Torrent Frog
Chinese Common Name	香港湍蛙	華南湍蛙
Body Shape(Fig. 22)	Flat and tapered towards the vent	Not tapered towards the vent
Back(Fig. 22)	Blackish-brown or greenish-brown, with distinct round and well-separated black spots; skin has small granules scattered over the body	Yellowish-grey, with irregular dark markings and rusty mottling at the edge; skin is rough and warty with numerous granules scattered over the body
Belly (Fig. 23)	Grey, with dark spots on the throat	Pale yellow with rusty edge; chest with marbled-like pattern
Width of Adhesive Disc in Relation to the 3rd and 4th Digits(Fig. 24)	Larger, width of the disc is around 3-4 times of that of the digit	Smaller, width of the disc is around 2 times of that of the digit
Tarsal Fold (跗褶)	Present	Absent
Nuptial Pad (婚墊) on the 1st Digit	White and granular	Milky white and spine-like (Fig. 25)
Vocal Sac (male) (聲囊)	Internal subgular	Absent
Vomerine Teeth (犁骨齒)	Absent	Present
Posture(Fig. 26)	Less upright	More upright
Habitat	Fast-flowing cascading water	Both pools and riffles
Local Distribution	New Territories and Hong Kong Island	Restricted to Lantau Island only
Global Distribution	Hong Kong	Southern and western China, as well as northern Vietnam

Fig 22. Dorsal view of the two *Amolops* species (Left: *A. hongkongensis*; Right: *A. ricketti*)

Fig 23. Bellies of the two *Amolops* species. (Left: *A. hongkongensis*; Right: *A. ricketti*)

Fig 24. Digits of the two *Amolops* species. (Left: *A. hongkongensis*; Right: *A. ricketti*)

Fig 25. Nuptial pad of *A. ricketti*.

References

Chan, S. K. F., K. S. Cheung, C. Y. Ho, F. N. Lam, W. S. Tang, M. W. N. Lau, and A. Bogadek. 2005. A Field Guide to the Amphibians of Hong Kong. Friends of the Country Parks and Cosmos Books Limited. P.126-133.

China Wildlife Conservation Association. 1999. Atlas of Amphibians of China. Henan Publishing House of Science and Technology, Zhengzhou, China. P.242-243. (In Chinese only)

[中國野生動物保護協會主編。1999。中國兩棲動物圖鑒 河南科學技術出版社。鄭州。242-243頁。]

Fei, L., S. Hu, C. Ye, and Y. Huang. 2009. Fauna Sinica, Amphibia Vol. 3. Science Press, Beijing, China. P.1506-1508, 1563-1570. (In Chinese only)

[費梁、胡淑琴、葉昌媛、黃永昭。2009。中國動物誌，兩棲綱（下卷）。科學出版社。北京。1506-1508頁、1563-1570頁。]

Fei, L., C. Ye, J. Jiang, F. Xie, and Y. Huang. 2005. An illustrated key to Chinese Amphibians. Sichuan Publishing Group, Sichuan Publishing House of Science and Technology, Sichuan, China. P.152-158. (In Chinese only)

[費梁、葉昌媛、江建平、謝鋒、黃永昭。2005。中國兩棲動物檢索及圖解。四川出版集團，四川科學技術出版社。四川。152-158頁。]

Jiang, J., and F. Xie. 2003. Biodiversity of Amphibians and Reptiles in Lantau Island with Comments on their Environment. The 3rd Conference on the Present Status and Conservation of Wild Animals and Plants in Hong Kong - New Information and Ecological Conservation Concerns for the Lantau Island. Hong Kong, China. P.21-37. (In Chinese only)

[江建平、謝鋒。2003。香港大嶼山離島兩棲動物多樣性及其生存環境狀態。第三次香港野生動植物現況與保育研討會-大嶼山離島的資料更新與生態保育論文集。中國香港。21-37頁。]

Fig 26. Lateral view of the two *Amolops* species. (Left: *A. hongkongensis*; Right: *A. ricketti*

Kadoorie Farm and Botanical Garden. 2002. Report of a Rapid Biodiversity Assessment at Wutongshan National Forest Park, Shenzhen Special Economic Zone, China, 16 to 17 May 2001. South China Biodiversity Survey Report Series: No. 11. KFBG, Hong Kong.

Karsen, S. J., M. W. N. Lau, and A. Bogadek. 1998. Hong Kong Amphibians and Reptiles 2nd Edition. Provisional Urban Council, Hong Kong. P.53.

Lau, M. W. N. 2005. The South China Cascade Frog, *Amolops ricketti*, found in Hong Kong. Porcupine! 32:8.

Pope, C. P., and J. D. Romer. 1951. A new ranid frog (*Staurois*) from the colony of Hong Kong. Fieldiana: Zoology 31: 609-612.

Rao, D., and J. A. Wilkinson. 2007. A new species of *Amolops* (Anura: Ranidae) from Southwest China. Copeia 4:913-917.

謝鋒。2010。香港原生兩棲動物的遺傳多樣性研究報告。中國科學院成都生物研究所兩棲爬行動物研究室。成都。51頁。(In Chinese only)