香港物種多樣性
Hong Kong Biodiversity
Agriculture, Fisheries and Conservation Department Newsletter

Issue No. 16 December 2008

www.hkbiodiversity.net

Feature Article

Current Status of Dragonflies (Odonata) and Their Representation in Protected Areas of Hong Kong

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Dragonfly Working Group

漁農自然護理署蜻蜓工作小組於2002年開始長期進行全港性的蜻蜓調查，從而全面收集有關香港蜻蜓的地理基線資料。直至2008年，工作小組共調查了207個地點及檢閱了可提供179個蜻蜓紀錄地點的現存資料。本文描述了工作小組這六年來調查香港蜻蜓的結果，列出經數據分析而選出的具代表性蜻蜓地點，以及介紹這些地點和在保護區內具保育價值的蜻蜓品種的情況。

Introduction

Records of dragonflies in Hong Kong were made as early as the 1850s but more extensive studies started only in the 1960s. Asahina (1965) made the first comprehensive documentation of Hong Kong's dragonflies which detailed 55 species. New species have been continuously added to the records by the efforts of various researchers (Asahina and Dudgeon,1987; Hämäläinen, 1991; Wilson, 1993), and Wilson (1997) compiled and updated the records with an annotated checklist of 107 dragonfly species from Hong Kong.

Fig 1. *Fukienogomphus choifongae* (Hong Kong Tusktail) ♀

Contents

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Studies in the past 40 years enhanced our understanding of the dragonfly diversity in Hong Kong. However, significant knowledge gaps still exist. For example, many dragonfly species have precise habitat requirements and are non-dispersive - with the majority of mature adults returning faithfully to their sites of emergence to breed (Wilson, 1997). This implies that they have very restricted distribution. Precise location of their breeding habitats and protection of representative sites of such habitats are therefore important to safeguard their population in Hong Kong. However, locality records of dragonflies in Hong Kong were very limited, often out of date (records up to 1997) or not detailed enough for precise site location.

In view of the above, the Agriculture, Fisheries and Conservation Department (AFCD) has carried out a long-term study on the dragonflies of Hong Kong since 2002 to obtain a more comprehensive and updated knowledge of the status and localities of members of this insect group. We document here the results of the first six-year (2002 - 2008) field survey and a review of the available information. These represent the first detailed geographical information, with analysis of spatial pattern, of the dragonflies in Hong Kong.

Study Site

Hong Kong lies on the south-eastern coast of China and the northern margin of the Asian tropics (22°09' - 22°37' N, 113°52' - 114°30' E).The total land area is 1,104 km^2 and the topography is rugged with the highest point, Tai Mo Shan, at 957 m. The mean daily temperature ranges from 16.1°C in January to 28.7°C in July, and the mean annual rainfall is 2,382.7 mm, with nearly 77% falling between May and September (30 year average: 1,971 - 2,000 mm; Hong Kong Observatory, 2008). Zoogeographically, Hong Kong is classified as tropical and is situated adjacent to the eastern extremity of the Indo-Chinese subregion of the Oriental region together with southern Guangxi, southern Fujian, southern Guangdong and Taiwan (Wilson, 1997).

Materials and Methods

Survey and monitoring

The study included baseline survey and monitoring of representative sites. The baseline survey was carried out from April 2002 to October 2004, covering all wetland habitats, including lowland natural or partly modified stream courses, upland streams, marshes, open water areas (pools / ponds / reservoirs) and abandoned / active wet agricultural fields, throughout the territory. A total of 207 sites was covered in the survey. Subsequent monitoring of the representative sites identified in the survey was commenced in 2005.

Both the baseline survey and monitoring of dragonfly representative sites focused on adults. Surveys were carried out by two surveyors on sunny / fine and windless days between 0900 and 1500 from April to October of each survey year. Transect count method was adopted in stream courses, around open water areas and along trails crossing stream courses. In marshes, the surveyors walked across the marshes following a systematic routing. All the dragonflies observed were identified visually, with the aid of a pair of close-focus binoculars or caught with a sweep net when necessary, to species level according to Wilson *et al*. (2004).

Data Analysis

Data obtained from the biodiversity survey of Hong Kong conducted by Dudgeon and Corlett (2001) in 1996 and 1997 and from the other available materials with geographical information about the dragonflies in Hong Kong (e.g. Wilson, 1997) were reviewed. Locality records in unsuitable habitats were corrected or discarded after confirmation by personal communication with the data / record providers. Records made before 1990, except those of species with only one locality record, were considered outdated and discarded. Existing records of 179 dragonfly sites were reviewed, in which 93 sites were not covered by the baseline survey.

The local status of each dragonfly species follows Wilson *et al.* (2004) and is based on the number of sites at which each species was recorded in Hong Kong. “Rare” species are restricted to one or two sites only, while “uncommon” species are found at 3 - 10 sites (inclusive). “Common” species are recorded from 11 - 100 sites and “abundant” species recorded from more than 100 sites.

Representation of each dragonfly species in the protected areas of Hong Kong was also analyzed. Any species that has all of its locality records or has any site with a breeding population within the protected areas system is considered well protected in Hong Kong. Protected areas include Restricted Areas, Country Parks, Special Areas and Sites of Special Scientific Interest (SSSI).

Spatial analysis using distributional data from 1 x 1 km grid squares was carried out to select dragonfly representative sites. The analysis was as follows. The number of dragonfly species found in each grid was calculated. Frequency distribution and dot plot of number of dragonfly species per grid were then made to assess if there was any grid outside the expected range of distribution. Any grid with the number of dragonfly species greater than the third interquartile range of the distribution was considered as an extreme outlier and has an exceptionally high number of dragonfly species. Any site covered by this kind of grid or providing a typical habitat for a species of conservation interest was selected as a representative sites of dragonflies in Hong Kong. Species of conservation interest are endemic and locally rare species or endangered / vulnerable species listed by IUCN.

Results and Discussion

Five new species, *Aethriamanta brevipennis brevipennis* (Elusive Adjutant), *Anax nigrofasciatus nigrofasciatus* (Blue-spotted Emperor), *Cephalaeschna klotsi* (Yellow-spotted Dusk-hawker), *Fukienogomphus choifongae* (Hong Kong Tusktail) and *Pseudagrion pruinosum frasei* (Ferruginous-faced Sprite) (Fig. 1 - 5) were recorded during our survey / monitoring between 2003 and 2008. In addition, *Trithemis pallidinervis* (Dancing Dropwing) was discovered by Mr. Graham Reels in Kam Tin in May 2003 and subsequently also recorded by AFCD at the Hong Kong Wetland Park (Fig. 6) in July 2003, and a new species, *Planaeschna* sp., was also recorded by Wilson (2006) in 2005. Furthermore, So and Wong (2008) recorded another new species, *Sieboldius deflexus*, in 2007. The total number of dragonfly species recorded in Hong Kong therefore increased from 107 in 1997 to 115 in 2008 (Table 1). Among the eight new species recorded, *F. choifongae* is new to science (Wilson & Tam 2006).

The local status of each dragonfly species was updated by analyzing a total of 300 site records pooled from the survey / monitoring and the review. The analysis revealed that there were 14 rare, 32 uncommon, 57 common and 12 abundant dragonfly species in Hong Kong.

Fig 2. *Aethriamanta brevipennis brevipennis* (Elusive Adjutant) ♂

Fig 6. *Trithemis pallidinervis* (Dancing Dropwing) ♂

Fig 3. *Pseudagrion pruinosum frasei* (Ferruginous-faced Sprite) ♂

Fig 4. *Anax nigrofasciatus nigrofasciatus* (Blue-spotted Emperor) ♂

Fig 5. *Cephalaeschna klotsi* (Yellow-spotted Dusk-hawker) ♀

Table 1. List of the new dragonfly species recorded in Hong Kong from 1997 to 2008.

Family	Species	Year of the first record
Coenagrionidae	*Pseudagrion pruinosum frasei*[1]	2003
Aeshnidae	*Anax nigrofasciatus nigrofasciatus*[1]	2003
	Cephalaeschna klotsi[1]	2003
	Planaeschna sp.[2]	2005
Gomphidae	*Fukienogomphus choifongae*[1]	2004
	Sieboldius deflexus[4]	2007
Libellulidae	*Aethriamanta brevipennis brevipennis*[1]	2008
	Trithemis pallidinervis[3,1]	2003

[1] Recorded by AFCD
[2] Recorded by Wilson (2006)
[3] Recorded by Reels (Pers. Comm. to Wilson, 2003)
[4] Recorded by So and Wong (2008)

Table 2. List of rare, uncommon and endemic dragonfly species or vulnerable species listed by IUCN and their representation in protected areas (Restricted Areas, Country Parks, Special Areas and Sites of Special Scientific Interest) of Hong Kong.

Family	Species	Local status [1]	No. of sites within protected areas / total no. of sites recorded
Euphaeidae	*Euphaea opaca*	R	1/1
Lestidae	*Lestes nodalis*	R	2/2
	Lestes praemorsus praemorsus	R	2/2
Megapodagrionidae	*Rhipidolestes janetae*	UC	4/5
Coenagrionidae	*Aciagrion tillyardi*	R	1/2
	Agriocnemis lacteola	UC	2/3
	Ischnura asiatica	R	NA[2]
	Ischnura sp. (*rufostigma* group)	R	0/1
	Mortonagrion hirosei	UC & Vu	3/8
	Paracercion hieroglyphicum	R	NA
	Paracerion calamorum dyeri	UC	4/10
	Paracerion melanotum	UC	1/9
	Pseudagrion microcephalum	UC	4/10
	Pseudagrion pruinosum fraseri	UC	1/6
	Pseudagrion spencei	R	1/2
Platycnemididae	*Calicnemia sinensis*	UC	9/10
Platystictidae	*Protosticta beaumonti*	UC	8/8
	Sinosticta ogatai	UC	6/7
Aeshnidae	*Anax nigrofasciatus nigrofasciatus*	UC	2/5
	Cephalaeschna klotsi	R	1/1
	Gynacantha saltatrix	UC	1/5
	Gynacantha subinterrupta	UC	4/7
Gomphidae	*Anisogomphus koxingai*	UC	4/7
	Burmagomphus vermicularis	UC	5/10
	Fukienogomphus choifongae	R & Ed	1/1
	Gomphidia kelloggi	UC	5/6
	Labrogomphus torvus	UC	4/7
	Lamelligomphus hainanensis	UC	4/4
	Leptogomphus elegans hongkongensis	C & Ed	15/25
	Paragomphus capricornis	UC	5/6
	Planaeschna sp.	R	1/1
	Sieboldius alexanderi	R	2/2
	Sieboldius deflexus	R	1/1
Corduliidae	*Idionyx claudia*	UC	2/3
	Macromia berlandi	UC	4/7
	Macromia katae	UC	5/6
	Macromia urania	C	10/18
	Macromidia ellenae	UC	4/7
Libellulidae	*Aethriamanta brevipennis brevipennis*	R	1/1
	Diplacodes nebulosa	UC	1/4
	Macrodiplax cora	UC	1/10
	Nannophya pygmaea	UC	5/10
	Nannophyopsis clara	UC	6/8
	Onychothemis testacea tonkinensis	UC	2/4
	Orthetrum poecilops poecilops	UC & Vu	2/6
	Tramea transmarina euryale	UC	1/3
	Trithemis pallidinervis	UC	1/3
	Zygonyx asahinai	UC	7/9

[1] R – rare, UC – uncommon, C – common, Ed – endemic, Vu – vulnerable as listed by IUCN
[2] No geographical information is provided in the available materials describing the species. The representation of the species in the protected areas therefore cannot be confirmed.

The analysis of the representation of dragonfly species of conservation interest in the protected areas system showed that all but three rare species were well protected in Hong Kong (Table 2). The three rare species (*Ischnura asiatica*, *Ischnura* sp. (*rufostigma* group) and *Paracercion hieroglyphicum*) had only one locality record each, which was made before 1965 and were considered as historical.

The frequency distribution and the dot plot of number of dragonfly species per grid showed that the grids with the number of dragonfly species equal to or greater than 60 were the outliers of the distribution and were considered to have an exceptionally high number of dragonfly species recorded (Fig. 7). These grids were found covering Sha Lo Tung and Luk Keng (including Kai Kuk Shue Ha) in the northeastern New Territories (Fig. 8 & Table 3). In addition, eight other sites i.e. Bride's Pool, Double Island, Hong Kong Wetland Park, Ng Tung Chai, Pat Sin Leng marsh, Tai Po Kau Nature Reserve, Tan Shan River and Wu Kau Tang were identified as the typical localities of species of conservation interest (Table 3). These ten sites were considered as the representative sites of Hong Kong's dragonflies. All these sites are either exclusively or partially within the protected areas system or under appropriate conservation measures (e.g. registered as Ecologically Important Stream or within "Conservation Area" on the relevant Outline Zoning Plan) in Hong Kong.

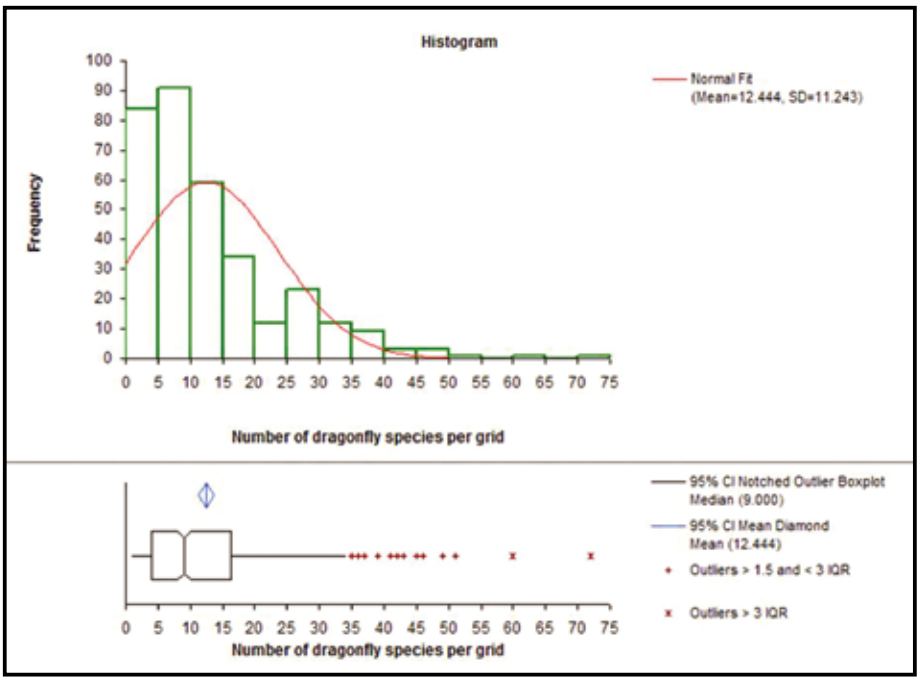

Fig 7. Frequency distribution and dot plot for the number of dragonfly species per 1 x 1 km grid.

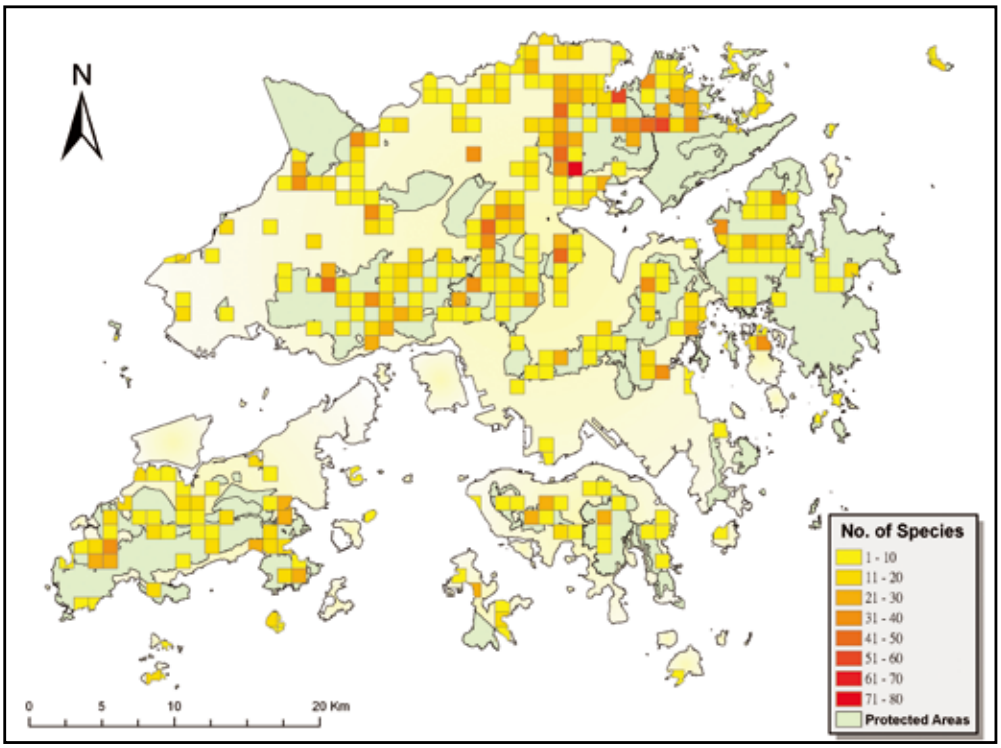

Fig 8. Map of Hong Kong covered by the grid squares showing the number of dragonfly species found inside each grid.

All the extant 112 species (after excluding the three historical records that were made over 40 – 110 years ago) were well represented in the protected areas and are considered to be well protected. In addition, the dragonfly species of conservation interest and the dragonfly representative sites were also well protected by the protected areas system or appropriate conservation measures in Hong Kong. Nevertheless, monitoring of the dragonfly representative sites and up-keeping of the existing management measures of the protected areas system will be continued so as to safeguard the habitats and local populations of the dragonflies of conservation interest in Hong Kong.

Table 3. List of the representative sites of Hong Kong's dragonflies.

Site	Conservation Interest	Protection status [1]
Bride's Pool	A typical locality for the rare *Sieboldius deflexus*	Within Plover Cove Country Park
Double Island	A typical locality for *Mortonagrion hirosei* and *Orthetrum poecilops poecilops* listed as vulnerable by IUCN	Within Plover Cove Country Park
Hong Kong Wetland Park	A typical locality for the rare *Aethriamanta brevipennis brevipennis* High number (43) of dragonfly species recorded including 8 uncommon species: *Diplacodes nebulosa*, *Gynacantha subinterrupta*, *Mortonagrion hirosei* (listed as vulnerable by IUCN), *Macrodiplax cora*, *Nannophya pygmaea*, *Paracercion melanotum*, *Pseudagrion microcephalum* and *Trithemis pallidinervis*	Designated as Special Area in 2005
Luk Keng (including Kai Kuk Shue Ha)	Exceptionally high number (61) of dragonfly species recorded including 1 rare species, *Aciagrion tillyardi*, and 12 uncommon species: *Diplacodes nebulosa*, *Gomphidia kelloggi*, *Macrodiplax cora*, the endemic *Macromidia ellenae*, *Macromia berlandi*, *Mortonagrion hirosei* (listed as vulnerable by IUCN), *Nannophya pygmaea*, *Nannophyopsis clara*, *Paracercion calamorum dyeri*, *Paracercion melanotum*, *Pseudagrion microcephalum* and *Pseudagrion pruniosum frasei*	Within the zoning of CA on Luk Keng & Wo Hang OZP Main part of the stream course at Kai Kuk Shue Ha is registered as EIS under ETWB TC No. 5/2005
Ng Tung Chai	A typical locality for the rare *Cephalaeschna klotsi*	Listed as SSSI Within Tai Mo Shan Country Park
Pat Sin Leng marsh	A typical locality for three rare species: *Aciagrion tillyardi*, *Lestes nodalis* and *Lestes praemorsus praemorsus*	Within Pat Sin Leng Country Park
Sha Lo Tung	The highest number (72) of dragonfly species recorded including 1 rare species, *Sieboldius alexanderi*, and 9 uncommon: *Anisogomphus koxingai*, *Burmagomphus vermicularis*, *Gomphidia kelloggi*, *Gynacantha subinterrupta*, *Lamelligomphus hainanensis*, *Macromia berlandi*, *Macromia katae*, the endemic *Macromidia ellenae* and *Zygonyx asahinai*	Within the zonings of CA and SSSI on Sha Lo Tung OZP
Tai Po Kau Nature Reserve	A typical locality for the endemic *Leptogomphus elegans hongkongensis* Very high number (51) of dragonfly species recorded including 4 uncommon: *Anax nigrofasciatus nigrofasciatus*, *Gynacantha saltatrix*, *Tramea transmarina euryale* and *Zygonyx asahinai*	Within Tai Po Kau Special Area
Tai Shan River (River Jhelum)	A typical locality for the rare *Pseudagrion spencei* Very high number (53) of dragonfly species recorded including 6 uncommon: *Burmagomphus vermicularis*, *Labrogomphus torvus*, *Nannophyopsis clara*, *Paracercion calamorum dyeri*, *Pseudagrion microcephalum* and *Pseudagrion pruniosum frasei*	Within the zoning of AGR on Man Uk Pin OZP Main part of the stream course is registered as EIS under ETWB TC No. 5/2005
Wu Kau Tang	A typical locality and the type locality for the rare and endemic *Fukienogomphus choifongae* Very high number (54) of dragonfly species recorded including 1 *Planaeschna* sp. and 6 uncommon: *Burmagomphus vermicularis*, *Macromia berlandi*, *Macromia katae*, the endemic *Macromidia ellenae* and *Paracercion calamorum dyeri*	Within the zoning of CA on Wu Kau Tang OZP Part of woodland is within the Plover Cove Country Park Main part of the stream course is registered as EIS under ETWB TC No. 5/2005

[1] CA – Conservation Area, OZP – Outline Zoning Plan, EIS – Ecologically Important Stream, ETWB TC – Environment, Transport and Works Bureau Technical Circular

Acknowledgements

We would like to thank Keith D.P. Wilson for his assistance in the identification of some dragonfly specimens. We would also like to thank W.L. Hui, Kenneth K.K. Leung and W.Y. Yam of AFCD for providing their recent locality records of some rare and uncommon dragonfly species in Hong Kong.

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蘇毅雄及黃志俊. 2008. 折尾施春蜓 *Sieboldius* (*Pseudohagenius*) *deflexus* (Chao, 1955) - 香港新種蜻蜓. 郊野探索 17:35.

Special Feature

The Frosting Impact on *Sonneratia* in Hong Kong

Winnie P. W. Kwok, Wing-sze Tang and Sau-wah Wong

Introduction

In late February 2008, a shocking, massive die-back of tall trees along Kam Tin Main Drainage Channel was observed. Similar phenomena were also evident along the fringe of the mangrove in Shan Pui River, Tsim Bei Tsui and Shenzhen River (Fig. 9). The trees had turned brown, with all the leaves and flower buds withered, and most of the leaves shed, leaving only bare branches (Fig. 10 & 11). A closer examination of the trees revealed that they were the exotic mangrove, *Sonneratia caseolaris* (海桑) (Fig. 12). It is estimated that about 80% of the *S. caseolaris* found in Inner Deep Bay withered that winter. Strangely, less than 10% of another exotic mangrove which is found in Hong Kong, *Sonneratia apetala* (無瓣海桑), was withered (Fig. 13). On the other hand, all native mangroves in Hong Kong remain in good condition without any sign of withering.

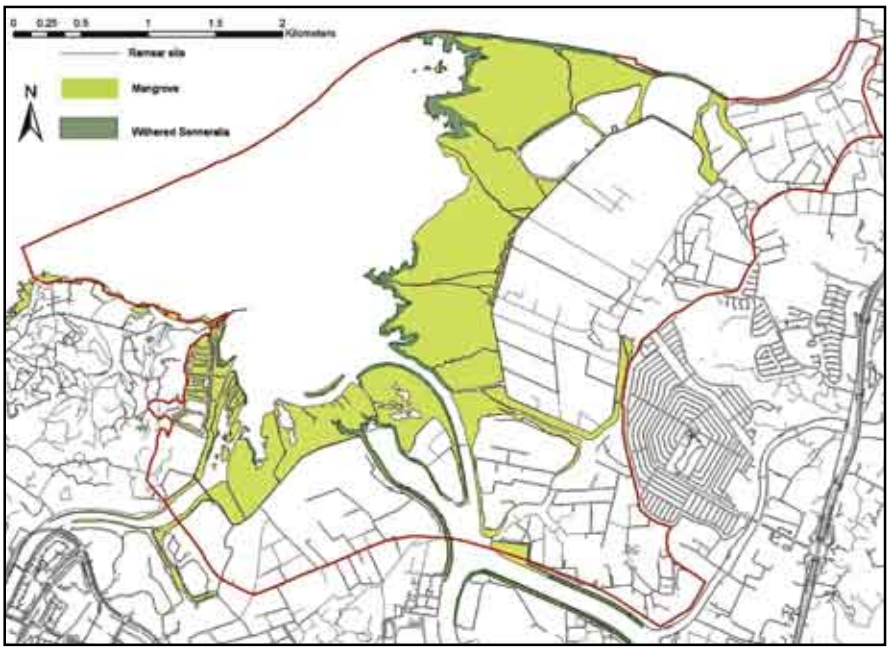

Fig 9. Map showing the distribution of withered *Sonneratia* in Inner Deep Bay in March 2008.

Fig 10. Withered *Sonneratia* found along water channel.

Fig 11. Withered *Sonneratia* found in Inner Deep Bay.

Fig 12. Withered leaves and flower buds of *S. caseolaris*.

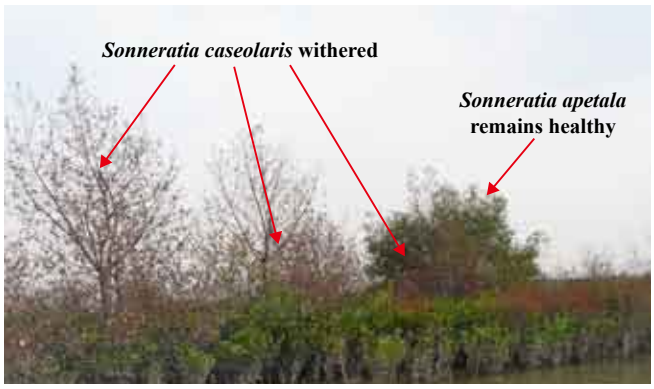

Fig 13. *S. apetala* was not affected by the cold spell.

The Frosting Impact on Mangroves in Southern China

According to the Hong Kong Observatory's records, February 2008 was much colder than usual, with a mean temperature of 13.3°C - the lowest for February in the past 40 years. Under the influence of an intense northeast monsoon, the cold spell persisted for 24 days from 24 January to 16 February. This was also the longest cold spell recorded in 40 years.

Liao (2008) reported that because of the unusual cold winter this year, more than 1,000 ha of planted mangrove had died in Guangdong (including Shenzhen, Zhuhai, Guangzhou, Fujian, Shantou, Yangjiang and Jiangmen) and Guangxi. The most seriously affected mangroves were the introduced species including *Sonneratia caseolaris* (海桑), *Thespesia populnea* (楊葉肖槿) and *Rhizophora stylosa* (紅海欖). More than 3 million seedlings in mangrove nurseries were also affected. According to a report by 'Daily Sunshine' (深圳晶報) on 11 March 2008, some 10 hectares of the planted Sonneratia within or close to the Futian National Nature Reserve, Shenzhen had withered due to the unusually long cold spell, but native mangroves were not affected.

As reported by Anon (2008), the cold spell also caused damage to another mangrove reserve at Qi'ao Island, Zhuhai, which has a size of 678 hectares. The affected mangroves were mainly *S. caseolaris* and *S. apetala* and comprised about 30% of the *Sonneratia* planted for re-forestation in 1999 by the government. Some remedial work including pruning and cutting away the trunks to prevent the cold damage injury from spreading to the whole plant had been carried out.

The Frosting Effect on Sonneratia

S. caseolaris is native to Dongzhaigang in Hainan Island, while *S. apetala* originates from Surdarban, in southwest Bangladesh. Zan *et al*. (2003) analyzed the response of *S. caseolaris* in Futian to winter cold waves and found that a sudden drop in temperature did cause obvious damage to *S. caseolaris*, with the damage being more severe on the fringe of the forest. All leaves of *S. caseolaris* in Futian shed in January to March in 1998 when the temperature remained below 8°C for more than 72 hours. However, further observation found that *S. caseolaris* was not fatally affected when the lowest temperature was above 5°C for less than 4 days. The trees were found to suffer only partial die-off of buds and stems, with dry shoots and foliage shed. In fact, as suggested by Zan *et al*. (2003), *S. caseolaris* becomes more and more tolerant of cold temperature as it grows.

On the other hand, *S. apetala*, originating from Surdarban, which has a colder winter, showed a better adaptation to the low temperature and cold waves in Futian. As observed by Zan *et al*. (2003), even when there was a sudden drop in temperature from 27°C to 10°C in February of 2000 while the cold temperature was maintained for 3 days, less than 10% of leaves were shed in *S. apetala*, indicating that they were much more tolerant of cold conditions.

The response of *Sonneratia* in Hong Kong to the cold spell matches with the findings of Zan *et al*. About 80% of the *S. caseolaris* was found withered, and most of these were on the fringe of the forest, while less than 10% of *S. apetala* was affected. We also found that the cold spell may not have a fatal effect on *S. caseolaris* as the stems of the withered trees were found to be vital (Fig. 14). In May this year, we carried out a site visit to check the condition of the withered *Sonneratia*, and some new sprouts were found (Fig. 15a&b). Another site visit was conducted in June, when it was found that about 30% of the withered *Sonneratia* were re-spouting (Fig. 16a&b). Further site visits carried out in August this year confirmed that nearly all withered *Sonneratia* had recovered to produce flowers and fruits.

Fig 14. The stem of withered *S. caseolaris* was still vital.

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Fig 15a&b. New sprouts found in withered *S. caseolaris* in May 2008.

Fig 16a&b. New sprouts found in withered *S. caseolaris* in June 2008.

Mass Dieback of Reed (*Phragmites australis*) Caused by *Dimorphopterus spinolae* (高粱長蝽蛛)

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Abstract

In the summer of 2007, over 1 ha of reedbeds in the Yuen Long Bypass Floodway Engineered Wetland suffered rapid dieback caused by *Dimorphopterus spinolae* – an insect pest of a number of economic plants. This paper briefly reports on the infestation and discusses its implications in establishing and managing of artificial reedbeds.

Introduction

A 7-hectare artificial wetland was established in 2006 by the Drainage Services Department (DSD) at Nam Sang Wai to compensate the wetland loss caused by construction of the Yuen Long Bypass Floodway (YLBF). Various wetland habitats were created to provide foraging, roosting and breeding habitats for wildlife. These included a one-hectare reedbed (divided into 4 cells by bunds / water channels) which serves the dual functions of water cleansing and wildlife habitat. Planting of reeds was completed in July 2005 and the reedbed was fully established when DSD handed over the whole wetland to this department for management in December 2006 (Fig. 17).

Fig 17. The reedbeds at Yuen Long Bypass Floodway Engineered Wetland.

The Insect Pest

We first noticed wilting of some new reed shoots in May 2007. Closer examination revealed the presence of bugs on sheaths and inside stems of the dying reeds (Fig. 18). The bugs were collected and later identified at the Tai Lung Experimental Farm as follows:

Order	Hemiptera	半翅目
Family	Lygaeidae	長蝽科
Subfamily	Blissinae	杆長蝽亞科
Genus	*Dimorphopterus*	狹長蝽屬
Species	*Dimorphopterus spinolae* (Signoret, 1857)	高粱長蝽蛛

Fig 18. *Dimorphoterus spinolae* on infested reed.

D. spinolae is a notorious pest of a number of economically important crops in the family Poaceae, including sorghum, rice, maize, millet, wheat, wild rye, reed and elephant grass (Slater, 1976; Nengnai & Li, 2005). It occurs throughout Eurasia, including China, Korea, Japan, Russia and some European countries such as Hungary, Germany, Italy and Slovenia (Viskens, 1995; Nengnai & Li, 2005; Gogala, 2007).

The bugs feed by sucking the sap from the stems, leaves, and roots of their host plants. They have an elongate, slender and dorso-ventrally flattened body, an adaptation to living on the stems of plants with an elongate and narrow growth form. Their compressed body allows them to hide inside leaf sheaths, where they are protected from predators and desiccation (Slater, 1976). Adult females are 3.5 - 6.0 mm long, while males are 4.5 - 5.0 mm in length (Cheng & Tsou, 1982; Li, 1982). The body is black and hairy. There are two forms of *D. spinolae* – the long-winged and the short-winged. Both forms move by crawling rather than flying and thus have limited dispersal ability (Li, 1982).

D. spinolae is known to cause mass dieback of reeds in mainland China. New shoots of reeds (about 1 m in height) are the most susceptible to attack. The bugs are most active at or below 25°C but become inactive above 34°C or in adverse weather (Li, 1982).

In northern China, *D. spinolae* has two generations a year. They over-winter as adults in the underground rhizomes, leaf litter, surface soil or wilted leaf sheaths. The survival rate of over-wintering adults is very high. As the temperature rises in April, adults emerge and start laying eggs inside leaf sheaths. A mature female lays 188 eggs during its lifetime on average (Hao *et al.*, 1992). Nymphs have black, yellow and orange bands but otherwise resemble a miniature adult. They grow rapidly and the second generation starts breeding in June (Li, 1982).

The number of breeding cycles locally is unknown but it was observed that nymphs were seen throughout the wet season, suggesting a multivoltine reproductive pattern in Hong Kong.

Infestation in YLBF Reedbed

In response to the discovery of the infestation, we stepped up inspection of the reedbed according to the YLBF's Ecological Habitat Management Plan. Many adults and nymphs (with over 50 individuals per shoot) were found inside leaf sheaths and the hollow parts of the stems of infested reeds (Fig. 19), seriously retarding plant growth. The terminal leaves and the young shoots of the infested reeds turned yellow at first, followed by wilting of the whole plant. Dissection of the reed stems showed that the vascular bundles were damaged as a result of the infestation.

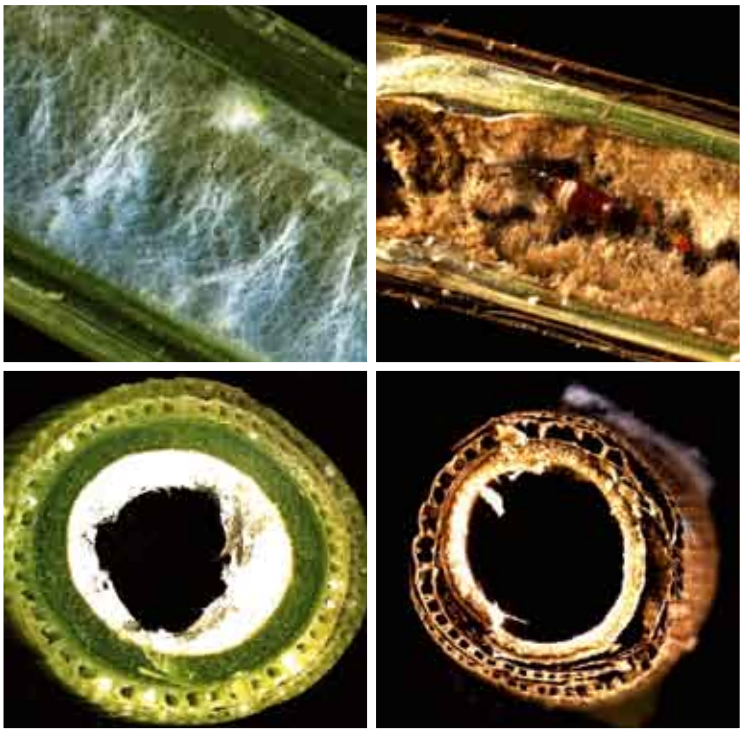

Fig 19. Healthy and infested stems of reed (top/bottom left: healthy stem; top/ bottom right: infested stem). Note the presence of the orange/white-coloured juveniles of *D. spinolae* inside the stem.

This infestation by a large number of bugs caused a rapid wilting of the reeds in late May. Conditions of the infested reeds improved slightly in mid June, probably due to more active plant growth in the warmer period and the reduced activity of the bugs at higher ambient temperature. However, more reeds wilted as the pest population increased. Infestation also spread to all four cells of the reedbed, causing mass dieback of nearly all of the reeds by July i.e. in a period of two months (Fig. 20).

Incidentally, it is interesting to note that one small patch of reeds some 50 m away from the reedbed remained healthy until the complete removal of the reeds in the reedbed in late July, indicating that the bugs have limited dispersal ability. This patch of reeds was eventually infested by the bugs and suffered dieback within three weeks of the infestation.

Fig 20. One of the infested cells of reedbed showing near complete wilting of the reeds after infestation with *D. spinolae* for two months.

Infestation in Other Local Reedbeds

The rapid dieback of the reedbed caused by *D. spinolae* poses a management problem for newly established artificial wetlands. To investigate the situation of the bugs in local mature reedbeds, we collected and examined over 50 reed stems from the gei wai of Mai Po for the presence of *D. spinolae*. All but one of the reed stems were free of the pest, and only five nymphs were found inside the leaf sheath of the infected stem. Unlike the infested reedbed at YLBF, the population density of the pest at Mai Po seems very low. In the natural environment or mature reedbeds, *D. spinolae* has many natural enemies including birds, frogs, reptiles, spiders, ants and ladybirds. Their eggs are known to be preyed upon by ants and over 90% of the adults are killed by predators (Li, 1982). It is likely that the presence of predators in the natural or mature ecosystem prevents any exponential growth of the pest.

Newly established artificial wetlands, on the other hand, do not enjoy the services of natural predators and thus are susceptible to pests, as in the present case of mass dieback of reeds caused by *D. spinolae*. The pest is also known to have infested other newly established reedbeds in Hong Kong, including those at the Hong Kong Wetland Park from June to September 2004 (Y. Yip, per. comm.) and Lok Ma Chau Spur Line Wetland Compensation Area in June 2007 (Y.W. Wong, per. comm.). These infested reeds were removed manually and the reedbeds were allowed to regenerate naturally afterwards.

Control Measures

Wetland habitats are ecologically sensitive and the use of chemical insecticides there should be avoided as far as possible due to the potential adverse impacts they may have on other wildlife. Nevertheless, we conducted a trial using a horticultural oil (Caltex's D-C-Tron®Plus) of very low ecotoxicity in a small area of the infested reeds to test its effectiveness in controlling the pest.

Infested reeds in the trial plot (about 40 m^2) were sprayed with the horticultural oil at a dilution ratio of 1:100 on a fine sunny day (6 July 2007) and examined two weeks later. It appeared that the horticultural oil was not effective in eradicating this pest. This is possibly because the oil kills by blocking the respiratory systems of target pests through direct physical contact. However, any bugs inside the infested reed stems would be left unharmed and could safely emerge once the oil had worn off.

As the horticultural oil was not effective in controlling *D. spinolae*, we explored the possibility of mechanical control measures. Removal by blower or vacuum would not be practicable for a large area of reeds. Burning might be an effective control method (Fan, 2005) but it was deemed not feasible due to the fire risk to a high-voltage pylon situated in the reedbed. As such, we decided to cut and remove all infested reeds manually.

We completed removal of all aerial parts of the reeds in the first infested cell on 15 June 2007. The cut reeds were sprayed with D-C-Tron®Plus and left on site for two days before disposal to minimize the possible spreading of any *D. spinolae* to other areas. Reeds in the remaining three cells appeared in good condition at first. However, some young shoots started to wilt in late June and finally all remaining reeds suffered rapid dieback by July.

In view of the seriousness of the infestation, it was decided to remove the reeds completely. All the aerial parts of the reeds in the reedbed were cut, sprayed with the horticultural oil and removed on 26 July 2007. Only the rhizomes were left in the wetland. The cleared reedbed was subsequently submerged with 1 m of water with a view to suffocating any bugs hiding in the rhizomes.

New reed shoots emerged from the rhizomes after two to three weeks. They were examined and initially found to be free from infestation . Unfortunately, when the new shoots grew to a height of about 1 m, they started wilting, with the bugs sucking sap from them (Fig. 21). The bugs were probably hiding in the soil or grasses nearby and colonized the new reed shoots once they emerged. To eliminate any chance of bugs aestivating in any remaining parts of the reeds, or even under the soil of the reedbed (mostly at 2-3 cm under the soil surface), the reedbed was plowed to destroy all the remaining rhizomes and the soil was exposed to direct sunlight so as to kill any resident pests.

Fig 21. Re-infestation of the new shoots of reed by *D. spinolae* after removal of the infested reeds. Note the presence of orange white-coloured juveniles which confirmed that breeding of the second generation of *D. spinolae* in the infested reedbeds.

Reed replanting was not carried out immediately. Instead, we adopted a "crop rotation" practice and planted water cress (*Nasturtium officinale*) in the reedbed. This serves to temporarily remove susceptible host plants (i.e. reeds) of *D. spinolae* while providing a suitable habitat for wildlife. Water cress grows well in the cooler months and provides suitable vegetation cover and food sources for migratory waterbirds and other wildlife (Fig. 22). Preliminary monitoring indicated that the Water Cress habitat was frequented by waterbirds such as Northern Pintail, Common Teal, Grey Heron, Little Egret, Great Egret, Cattle Egret, Chinese Pond Heron, Black-crowned Night Heron, Green Sandpiper, Common Sandpiper, Wood Sandpiper, Common Greenshank, Little Ringed Plover, Common Snipe and Common Moorhen.

Fig 22. The cleared reedbed has been replanted with water-cress to provide a vegetated habitat for wildlife in the dry season.

Latest observations, in January 2008, indicated that there was still some regeneration of reeds in the reedbed, in particular along the bunds. No *D. spinolae* were found. However, as a precautionary measure, all new reed shoots would be removed to avoid harbouring any remnant pest population.

Conclusion

The mass dieback of reeds in the YLBF wetland indicated that newly-established habitats with a simple structure are ecologically unstable and are particularly susceptible to attack by pests or invasive species. In the present case, the monotypic stand of reeds was completely infested by *D. spinolae* within a short time, causing a complete failure of the reedbed to function as a wildlife habitat and a water cleansing system. Thus, it appears that monocultures should be avoided in newly-established habitats as far as possible. Perhaps, different plants should be established in the wetland to minimize the potential risk of large-scale infestation or mass die-off of a single species plant community. This would also increase the diversity of flora and fauna in the wetland.

On the other hand, the experience gained in the control of *D. spinolae* in the YLBF reedbed gives cause for consideration of the implications for the management of newly established artificial wetlands. It would appear that newly established wetland habitats should be left for "maturation" with minimal management interventions, thus avoiding disturbing the process of natural succession and establishment of the fine balance of the ecosystem. Needless to say, essential management measures such as pest control or removal of aggressive weeds are still required for the proper management of the habitats for fulfilling the conservation objectives of the artificial wetland.

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Working Group Column

A Note on the Captive Breeding of the White Cloud Mountain Minnow

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Freshwater Fish Working Group

Introduction

The White Cloud Mountain Minnow (WCMM 白雲山魚, *Tanichthys albonubes*) is a small cyprinid endemic to China. It is a popular aquarium fish species due to its attractive colour and hardiness. Aquarium stocks are kept by many aquarists and tropical fish farms all over the world. It was once found in the wild in Hong Kong and the White Cloud Mountain area in Guangzhou, but no wild populations had been reported for more than 20 years until the rediscovery of a wild population in Guangdong Province in 2003 (Yue & Chen, 2004).

The WCMM has two colour forms – the Hong Kong colour form (with a red upper half to the dorsal fin) and the wild form (in which the dorsal fin is red at the base with a white band at the tip).

The species is listed as a freshwater fish of conservation concern by the Agriculture, Fisheries and Conservation Department (AFCD). The Freshwater Fish Working Group of AFCD has been exploring the possibility of reintroducing this fish back to the wild in Hong Kong since its rediscovery, and is maintaining captive populations of both colour forms (Lee, 2006).

Fig 23. Male WCMM displaying (the upper two individuals are of the Wild Form; the lower one is the Hong Kong Form).

Fig 24. WCMM spawning in Java Moss.

Methods

The WCMM is a hardy fish – tolerant of a wide range of pH (pH 4 - 9) and temperature (8°C - 28°C), and has a non-selective diet. It breeds easily in captivity from April to November at room temperature ranging from 20°C to 25°C. There are a few points to note for successful breeding of a large brood of the WCMM in captivity. They are applicable to both colour forms.

1. Fatten up the fish before breeding by increasing the feeding frequency and the ratio of flesh food (such as blood worms and water fleas) in the diet.

2. Sudden changes in environmental conditions stimulate spawning. This can be done by transferring the parent fish into a breeding tank, altering water parameters such as water flow, pH and salinity, providing new spawning substrates / aquatic plants, or rearranging tank setup. The males will start displaying (Fig. 23) and chasing females after a short period of adjustment to the new environment. Once paired up, the couples will spawn in the spawning substrates / aquatic plants.

3. Select suitable spawning substrates. Wool, polyester, or aquatic plants such as Java Moss are suitable as spawning substrates (Fig. 24). The WCMM spawns inside patches of substrates. They prefer substrates of moderate density where

Fig 25. Fertilized egg (~1mm).

Fig 26. Embryo at day 2.

Fig 27. Fish fry at day 3.

Fig 28. Free swimming fry at day 6.

Fig 29. 2-week-old juvenile.

Fig 30. 1-month-old juvenile, with development of bright neon colour.

spaces in between are just large enough for the fish to pass through. Fertilized eggs either adhere onto the substrates or sink to the bottom. Substrates at an appropriate density offer suitable protection against predators.

4. Low fish density brings high productivity. The ratio of males to females should be 1:1, 1:2 or 2:3, depending on the tank size. Increasing the number of fish in the tank increases the chance of disturbance and cannibalism, leading to lower hatching rate.

5. Protect the fry against cannibalism. The WCMM usually has several broods within a short period of time. Eggs hatch within 2 to 3 days and the fry will search for and adhere to substrates near the water surface. At this stage, floating plants such as duckweed can be provided as a shelter for the fry. Fry are free swimming 1 to 2 days after hatching and will remain near the water surface. Parent fish should be removed from the breeding tank once the fish fry are observed, in order to avoid cannibalism (Fig. 25 - 30).

6. Add snails to keep the tank clean. Snails are great cleaners and crucial in rearing fry in indoor tanks despite the fact that they may prey on eggs. They consume uneaten food provided for the fry and maintain water quality.

Information obtained from our trials provides clues for mass production of the WCMM in captivity. Although the species reaches sexual maturity and breeds at the age of 2.5 months under captive condition (personal observation), other factors have to be taken into consideration in preparing a reintroduction programme. For example, our polyculture trials showed that the species was less competitive than other native freshwater fish such as *Macropodus opercularis*, *Oryzias curvinotus* and *Puntius semifasciolatus* due to its inferior performance, foraging efficiency, cannibalism and the high predation pressure on fish fry by other fishes. Further studies are required for a better understanding of its habitat requirements, and interaction with the environment and other fish species, which are prerequisites for a successful reintroduction of the species back to the wild in Hong Kong.

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Division Column

Pteridophytes New to Hong Kong

Joseph K. L. Yip & Patrick C. C. Lai
The Hong Kong Herbarium

The study of Hong Kong flora is one of the earliest in China (Yip, Lai & Xia, 2007). The first authentic plant specimen collection in Hong Kong was that made in 1841 by R. B. Hinds, who collected among others 18 species of pteridophytes (Hinds & Bentham, 1842). Between 1847 and 1850, J. G. Champion collected 97 species of pteridophytes on Hong Kong Island. G. Bentham (1861) recorded 81 species and H. F. Hance (1872) added 15 species.

C. G. Matthew collected pteridophytes in Hong Kong in 1900s and deposited some 50 duplicate specimens in the Hong Kong Herbarium. Dunn & Tutcher (1912) included 177 pteridophyte species in his *Flora of Kwangung and Hong Kong*. Later, Gibbs (1927) published a booklet entitled *Common Hong Kong Ferns*. Ching (1936) described two new fern species based on Hong Kong specimens, namely *Hymenophyllum autrosinicum* Ching and *Diplazium maonense* Ching.

With the assistance of R. E. Holttum of the Kew Herbarium, Edie (1978) reported 175 Hong Kong fern species. So (1994) documented 140 species in the first colour photo guide to local pteriodophytes, which not only presenting them systematically according to Kramer (in Kubilzki, 1990), but also revealing their spores using scanning electron microscopy – the first of its kind for Chinese ferns. Based on re-examinations of specimens deposited in various herbaria in Hong Kong, the pteridophyte flora by Lee *et al*. (2003) recorded 239 species.

New Records

Further to the previous discoveries of ferns and fern-allies in Hong Kong described above, this paper provides two new records based on recent surveys as well as examination of herbarium specimens.

(1) ***Selaginella scabrifolia*** Ching & C. H. Wang 糙葉卷柏 (Fig. 31)

This species of clubmoss is characterised by rows of parallel leaves on both sides of the stem and branches. The stem is prostrate and creeping, producing rhizophores for support. It has two types of leaves arrangements on the dorsal surface: two rows of small oval leaves near the centre and two rows of flattened parallel leaves on the sides. All leaves have pointed tips. This species is closely related to *S. doederleinii* Hieron (深綠卷柏). They share a similar growth habit, and leaves are arranged in almost the same plane resulting in a somewhat flattened appearance. However, *S. scabrifolia* differs in having roughly papillate central leaves. This species was first discovered in Chim Fung Ling and Tia-lo Shan, Hainan Island in the 1950s. This first record in Hong Kong was also made at high altitude.

Voucher specimen: CHINA. Hong Kong: Victoria Peak *(HK sheet 39159)*

Fig. 31 Specimen of *Selaginella scabrifolia*

(2) ***Bolbitis x laxireticulata*** K. Iwats. 網脈實蕨 (Fig. 32)

This species features bipinnatifid fronds and the anastomosing veins especially along costae and crenate pinnae clearly distinguish it as *B. x laxireticulata*. It resembles *Egenolfia sinensis* (Bak.) Maxon, a species first reported by So (1995). However, the latter bears free veins throughout and pinnatifid lateral pinnae. *B. x laxireticulata* was previously known in China from Nantou in Taiwan and Mount Limushan on Hainan Island. Dong and Zhang (2005) considered that it might have originated from *B. appendiculata* and *B. subcordata* by hybridization, as the latter two share a similar range of distribution with *B. x laxireticulata*. Indeed, both putative parental species are known from Hong Kong, and thus supporting that hypothesis.

Voucher specimen: CHINA. Hong Kong: Lantau Island, Sunset Peak *(HK sheet 38836)*

Fig. 32 Specimen of *Bolbitis x laxireticulata*

Acknowledgements

Thanks are due to Prof. Simon Owens (K), Dr. Tim Utteridge (K), Dr. N. H. Xia, Dr. S. Y. Dong, Mr. Y. G. Ye (all of IBSC) and Dr. M. L. So (Biology Department, Hong Kong Baptist University), who provided assistance and helpful information.

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