

Winter aggregation of Danaine Butterflies in Hong Kong (1999 - 2009) Ten years records and a brief account



Abstract

Winter aggregation of danaine butterflies (sub-family Danainae) in Hong Kong involves 7 species out of the 12 known species in Hong Kong. Species composition, population size and the physical environment of 21 local aggregation sites are described and discussed. Mortality, feeding behaviour, reproductive activities, form of aggregation and selection of plant species for aggregation in the winter aggregation sites are also described and discussed. A hypothesis of the effect of aggregation pheromones on danaine butterflies' aggregation and dismissal is proposed.

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Introduction

Aggregation behaviour of non-social insects have been reported in all major insect orders – Coleoptera, Lepidoptera, Diptera, Hemiptera, Homoptera and Orthoptera. Insect aggregations are formed and maintained for a number of reasons, and by a number of mechanisms (J. Bengtsson, 2008).

Aggregation of local danaine butterflies can be seen in all seasons. 4 different purposes of aggregation of local danaine butterflies were noticed :

1. Concentration of male danaine butterflies on certain plants presumably for acquisition of pyrrolizidine alkaloids for synthesis of pheromones.
2. Concentration of danaine butterflies for overnight.
3. Mass movement of danaine butterflies over an area.
4. Concentration of danaine butterflies on trees or shrubs growing in sheltered river valley during winter.

The first formal report on aggregation of danaine butterflies in Hong Kong seems to be in 1938, by Konyil Chan : " ...Lying close to the northern of Lai Chi Kok, Kowloon, with a mountain stream running down from top of the range, the "Butterfly Valley" furnishes a wonderful outing ground....On December 10, 1938... We reached the valley at about 10 a.m. and to my surprise thousands of butterflies were seen swarming on the twigs and branches of pine tree and other bushes. In certain corners of the Valley the *Schefflera octophylla* (Lour.) Harms; known to local Chinese as Aap Keurk Shu (鴨腳樹) was seen to have attracted at almost incredible numbers of butterflies. The majority of the

butterflies seems on that day were *Euploea* (*Isamia*) *midamus* Linn., *Euploea* (*Crastia*) *amymone* Godart., *Danaus* (*Salatura*) *plexippus* Linn., *Danaus* (*Radena*) *similis* Linn., and a few *Cupha erymanthis* Drury, ". The former two species being comparatively the most numerous."

Marsh (1968) also very briefly mentioned the congregation of hundreds of *Danaus genutia* at the flowers of "Ivy Tree". He also stated that *Euploea core* "often swarms in the Autumn".

Johnston & Johnston (1980) provided a little more details under their description of family Danaidae: "As winter draws near in Hong Kong, the butterflies of this family have a tendency to congregate in certain in places - the wooded areas around Tai Lam Reservoir is one – as if preparing for a move to warmer climes. But instead of doing so they seem to cluster in bunches on the trees for warmth. Most, however, seem to die at this time, falling to the ground where, poisonous or not, ants devour them leaving thousands of bodyless wings blowing forlornly about the breeze."

Bascombe, Johnston & Bascombe(1999) reported the observation of 50 males of *Euploea midamus* and *Euploea core* being attracted to *Heliotropium indicum*, congregation of danaines at *Lantana*, *Ruellia repens*, *Zanthoxylum avicennae*, *Schefflera octophylla* and other flowering trees and shrubs for nectar, congregation of large numbers "(several thousands in good years)" on or in the vicinity of *Schefflera octophylla* or *Melaleuca leucadendron* trees. They also reported that "the great majority of those taking part are *E. midamus* and *E. core*, small number of *Parantica aglea*, *Ideopsis similis*, *Tirumala limniace* and *Danaus genutia* usually also present." Moreover, they gave a brief description of "a steady southward stream of *E. midamus* crossed a garden on a hillside above the high-rise buildings on the north shore of Hong Kong Island."

Three years after the accidental discovery of the danaine butterflies aggregation site in Siu Lang Shui, Tuen Mun, by V. Yiu and J. J. Young. J. J. Young gave a brief report uploaded to the web site of the Hong Kong Lepidopterists' Society in 2001.

A booklet, "The Winter Butterfly Valleys of Hong Kong" (Written in Chinese) authored by V. Yiu was published in December, 2002. History of the discovery of the 2 winter aggregation sites (Siu Lang Shui, Tuen Mun and Fan Lau, Lantau Island), species density and composition, daily activities, the physical environment were briefly described in the booklet.

In December, 2003, Henry Tang of the Hong Kong Lepidopterists' Society discovered the aggregation site in Deep Water Bay river valley, Hong Kong Island. A detailed species list was written by him. Dr. P. C. Lee also provided description of the discovery. Both reports were posted on the web site of the Hong Kong Lepidopterists' Society in 2004.

Eric Wong *et al.* (2004) used capture-mark-recapture experiment to study the species composition, sex ratios and population dynamics of the winter aggregating danaine butterflies in Siu Lang Shui. Migration of the butterflies from Shing Mun Country Park to Siu Lang Shui was also proved, which are 20 kilometers apart.

No study of aggregation of danaine butterflies have been reported in mainland China. Only oral reports of aggregations in Shenzhen and Guongzhou were heard. Wang & Emmel (1990) gave a detailed report on the autumn migration of nine species of danaine butterflies

from northern Taiwan to southern Taiwan for overwintering. The nine species are: *Euploea sylvester*, *E. eunice*, *E. mulciber*, *E. tulliolus*, *Parantica aglea*, *Ideopsis similis*, *Tirumala limniace*, *T. septentrionis* and *Danaus genutia*. Kitching & Zalucki (1981) reported the overwintering aggregation of *Euploea core corinna* in Australia. Orr (1992) and Ishii (1993) reported the aggregation of *Euploea tulliolus*, *E. sylvester* and *E. modesta* in tropical Malaysia.

Hong Kong is located in eastern Asia, on the southeast coast of China and adjacent to the Pearl River estuary, facing the South China sea, belongs to the Indomalaya ecozone. Hong Kong's climate is sub-tropical, tending towards temperate for nearly half the year. Coolest in January and February, with occasional cold fronts followed by dry northerly winds, it is not uncommon for temperature to drop below 10°C in urban areas, usually a few degree lower in rural areas. Warmer and humid in March and April. May to August are hot and humid with occasional showers and thunderstorms. During November and December, there are plenty of sunshine and warm temperatures.

There are 12 species of danaine butterflies known in Hong Kong (*Tirumala hamata*, *Danaus plexippus* and *Euploea eunice* are considered as vagrant because their local records are too old and their distribution ranges do not cover Hong Kong (Bascombe, Johnston & Bascombe, 1999)), status of each are list in Table 1. Adult rarity follows Walthew (1997). Breeding status follows Young, Yiu & Yau (2007a, 2007b, 2008).

Table 1: List of 12 species of Danaine butterflies of Hong Kong

Species	Adult rarity	Breeding status
<i>Parantica aglea</i> 絹斑蝶	Common	Breeding locally
<i>Parantica melaneus</i> 黑絹斑蝶	Very rare	Not known
<i>Parantica sita</i> 大絹斑蝶	Rare	Breeding locally
<i>Ideopsis similis</i> 擬旖斑蝶	Very common	Breeding locally
<i>Tirumala limniace</i> 青斑蝶	Common	Breeding locally
<i>Tirumala septentrionis</i> 齋青斑蝶	Very rare	Not known
<i>Danaus chrysippus</i> 金斑蝶	Uncommon	Breeding locally
<i>Danaus genutia</i> 虎斑蝶	Very common	Breeding locally
<i>Euploea midamus</i> 藍點紫斑蝶	Very common	Breeding locally
<i>Euploea sylvester</i> 雙標紫斑蝶	Very rare	Not known
<i>Euploea mulciber</i> 異型紫斑蝶	Uncommon	Breeding locally
<i>Euploea core</i> 幻紫斑蝶	Very common	Breeding locally

Materials and methods

From 1999 January to 2009 March, danaines aggregation sites were visited and studied. More accessible sites were visited more frequently, approximately 5-10 times in winter. Species composition, spatial distribution, activities were checked on site. Abundance of aggregating butterflies were estimated by direct count. For large population size, 100 was used as the counting unit. This was usually done in low temperature when butterflies were less active and more clustered together. Photos were taken by a Single Lens Reflect camera equipped with a lens of 100 mm - 400 mm focal length. Approximately 2,000 photos were taken. Photos are examined to check for rare species and for estimation of relative species density. Aggregation of danaine butterflies in other seasons were also examined for comparison.

Results and discussion

Aggregation sites, population size and species composition

Totally, 21 sites with records of aggregating danaine butterflies can be identified (Map 1). According to the timing of aggregation, they can be classified into 3 categories:

- Winter aggregation site – aggregating butterflies can be seen in December, January and February, sometimes also in Early March. Aggregating butterflies may or may not stay over winter.
- Pre-winter aggregation site – aggregating butterflies can be seen in October and November, and sometimes in Early December. Butterflies do not stay till mid-December.
- Spring/summer aggregation site – aggregating butterflies can be seen from March to September.

The 3 categories may not be mutually exclusive, a site could be a whole-year aggregation site.

Map 1: Locations of *Danaine* Butterflies Aggregation sites in Hong Kong



Winter Aggregation sites

1. Siu Lang Shui, Tuen Mun (Photo 1)



Photo 1 Siu Lang Shui

This site is a southwest facing river valley located at the southwest extreme of the New Territories. Northeast to the river valley is Castle Peak which is 760 meters high. The site had been used as a landfill, 1.2 million tons of solid waste had been dumped on an area of 12 hectares. The landfill was closed on 1983. Then, the landfill was covered by a layer of soil and introduced tree species were planted on the land. Main tree species are *Eucalyptus torelliana* 毛葉桉, *Acacia confusa* 台灣相思 and *Leucaena leucocephala* 銀合歡。Small amount of *Acacia auriculiformis* 耳果相思 and *Casuarina equisetifolia* 木麻黃 were also planted. The site is comprised of 3 woodlands which are separated by a 2-meter wide concrete road. Largest woodland is situated at the east side. Since the first discovery in early January, 1999 by members of the Hong Kong Lepidopterists' Society (J. J. Young and V. Yiu), aggregating butterflies have been recorded in every winters in the northern part of this woodland. Concerning the population size of aggregating butterflies involved, this is the largest danaine butterflies aggregation site ever known in Hong Kong. Variation of population size over the past 10 years is shown in Table 2. Species composition in Jan - Feb, 1999 was studied in more detail and results are : *Euploea midamus* 85%, *Euploea core* 9%, *Euploea mulciber* <1%, *Danaus genutia* 3%, *Ideopsis similis* < 1%, *Tirumala limniace* < 1%, *Tirumala septentrionis* <1%. Study by Wong et al. in 2002/2003 in this site shows similar results. Few individuals of *Parantica aglea* and *Parantica sita* were also recorded in the later years. However, study in December, 2004 shows a different ratio of *Euploea midamus* to *Euploea core*, which was 3:1.

2. Deep Water Bay Valley (Photo 2a, Photo2b)

The site is located at the southern side of Hong Kong Island, which is a well vegetated southwest facing river valley with little human intervention. 800 meters south

to the valley is the sea. Between the sea and the valley is a golf court sized 8 hectares approximately. The site is surrounded by Shouson Hill, Mount Nicholson and Violet Hill, leaving only the southwest outlet. Danaine butterflies aggregating in this area was first discovered in December, 2003 by Henry Tang of the Hong Kong Lepidopterists' Society. Variation of the population over the past 10 years is shown in Table 2. In 2001 and 2002, concentration of hundreds of danaine butterflies in later afternoon in summer had been observed. More or less, it could be classified as spring/summer aggregation site as well. No visit has been made in October and November, existence of pre-winter aggregation is not clear. Species composition shows obvious fluctuation on the ratio between *Euploea midamus*, *Euploea core*, *Tirumala limniace* and *Ideopsis similis* in different years. Overall results are : *Euploea midamus* (50-80%), *Euploea core* (15-50%), *Tirumala limniace* (1-10%), *Ideopsis similis* (10-20%), *Tirumala septentrionis* (<1%), *Danaus genutia* (1-2%), *Parantica aglea* (1-2%), *Parantica melaneus* (<1%), *Parantica sita* (<1%) *Euploea mulciber* (<1%). In Jan 18, 2004 and Jan 14, 2008, the aggregating population size did not significantly drop. this suggests that the site may have been used for over-wintering, at least for some years. A more frequent visits to the site in Jan and Feb of 2009 also indicate that hundreds of *Ideopsis similis* and small number of various species stay there until early March without significant drop in the population size.

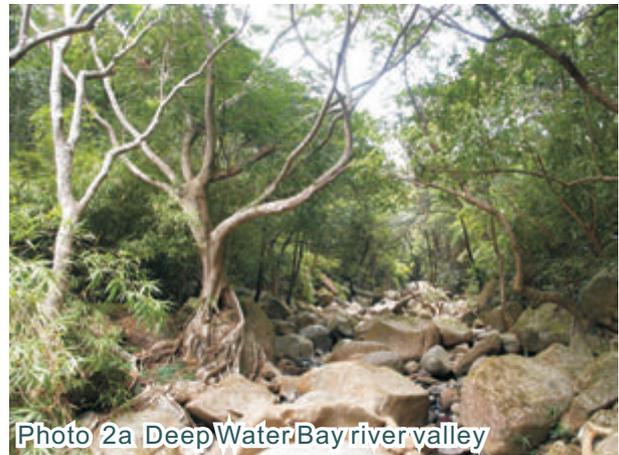


Photo 2a Deep Water Bay river valley



Photo 2b Deep Water Bay river valley

Table 2: Variation of population size in 4 major aggregation sites from 1998 to 2009

Year	Siu Lang Shui	Deep Water Bay	Shek Pik	Shui Hau	Fan Lau
1998 - 1999	30,000 1999Jan09				10,000 1998Dec13
	15,000 1999Jan16	No record	No record	No record	400 1998Dec27
	30,000 1999Feb12				
1999 - 2000	5,000 1999Dec??	No record	No record	No record	5,000 1999Nov128 5,000 1999Dec05
2000 - 2001	40,000 2000Dec09	No record	No record	No record	No record
	40,000 2000Dec29				
	40,000 2001Jan16				
	0 2000Feb15				
2001 - 2002	2,000 2001Nov17	No record	No record	No record	3,000 2001Dec15 0 2002Jan02
	10,000 2001dec08				
	20,000 2001Dec22				
2002 - 2003	No record	No record	No record	No record	4,000 2002Dec12
2003 - 2004	2,000 2003Nov22	10,000 2003Dec30		No record	
	2,000 2003Dec20	10,000 2004Jan18	10,000 2003Dec25		200 2003Dec07
2004 - 2005		4,000 2004Dec15		10,000 2004Dec03	7,000 2004Dec05
	15,000 2004Dec27	4,000 2004Dec18	3,000 2004Dec19	400 2004Dec27	7,000 2004Dec11
	4,000 2005Jan01	3,000 2005Jan09			
2005 - 2006	1,000 2005Nov05	1,000 2005Nov21	No record	2,000 2005Nov07	No record
	1,000 2005Nov21				
	7,000 2005Dec04				
	3,000 2005Dec15	3,500 2006Jan07			
2006 - 2007	200 2006Nov04	4,000 2006Dec10 500 2006Dec31 10 2007Jan07	200 2006Dec02	8,000 2006Nov11	100 2006Dec02
	20,000 2006Nov12				
	10,000 2006Dec06				
	15,000 2006Dec10				
	10,000 2006Dec16				
	5,000 2007Jan01				
	5,000 2007Jan07 0 2007Jan77				
2007 - 2008	1,200 2007Nov21	5,000 2007Dec30 2,500 2008Jan07 2,500 2008Jan14	No record	No record	No record
	40,000 2007Nov24				
	40,000 2007Dec09				
	40,000 2007Dec30				
	500 2008Jan13				
2008 - 2009	50 2008Nov13	0 2008Nov22	0 2008Nov22	20 2008Nov22	50 2008Nov22
	50 2008Nov19	50 2008Nov29			50 2008Dec09
	8,000 2008Nov29	100 2008Dec10			
	100 2008Dec19	300 2008Dec21			
		300 2009Jan01			
		150 2009Jan25			
		300 2009Feb01			
		300 2009Feb15			
		200 2009Feb22			

3. Shek Pik (Photo 3)

The site is a plantation woodland situated as the base of the southwest slope of Lantau Peak. 300 meters west to the site is the Shek Pik Reservoir, 800 meters southwest to the site is the sea. A water channel runs across the southwest side of the woodland. *Acacia confusa* 台灣相思 and *Lophostemon confertus* 紅膠木 are the main introduced tree species planted there. Aggregation in this site was orally reported by hikers for years since late 90's and the first formally reported was in December, 2003. Only 3-year data has been collected, the status of this site is not really certain. Species composition in 2003 were : *Euploea midamus* (88%), *Euploea core* (11%), *Tirumala limniace* (1%), *Tirumala septentrionis* (1 individual). Ratio of *Euploea midamus* to *Euploea core* reversed in a study on Dec 19, 2004, the ratio was 1:5.



Photo 3 ShekPik

Pre-winter aggregation sites

4. Fan Lau (Photo 4a, Photo 4b)

The site is a headland located at the southwest extreme of the Lantau Island. Southern part of the area is a more or less abandoned village and abandoned farmland. Northern part of the area is a mixture of natural woodland and Fung Shui Wood (A woodland situated behind the a village, which is comprised of local plant species and maintained or protected by the villagers for the interests of the village). Eastern side and western side of the area are sea coast which are 500 meters apart. Aggregating butterflies were usually seen at the small river valley leading to the east coast. The site was first discovered by the members of the Hong Kong Lepidopterists' Society in Early December, 1998. Butterfly aggregation was observed in late November and early December of each years since then. Not aggregation was observed in any visit made after mid-December. Status in spring and summer is not known. It should also be noticed that a small colony of *Crotalaria retusa* 吊裙草 (Fabaceae) form strong attraction to the danaines throughout the aggregation period (Photo 4b). The plant is also a well-known source of pyrrolizidine alkaloids (PAs). Although varies in different years, the aggregating butterfly population is obviously dominated by *Danaus genutia* which constitute about 60% of the total number of individuals. Ratio of other members are as follows: *Euploea core* (67%), *Euploea midamus* (22%), *Tirumala limniace* (8%), *Tirumala septentrionis* (<1%), *Ideopsis similis* (1%), *Parantica aglea* (1%), *Parantica sita* (<1%), *Danaus chrysippus* (<1%).



Photo 4a FanLau



Photo 4b Danaines attracted to *Crotalaria retusa*

5. Kau Ling Chung

This is a southwest facing bay which is about 1.5 km east to Fan Lau. In Dec. 5, 2004, hundreds of danaine butterflies was observed aggregating in the woodland behind the beach. The aggregating butterflies disappeared in the visit on Dec. 11, 2004. On Dec 2, 2006, about 300 danaine butterflies were seen. Species composition is similar to that in Fan Lau. Status in other seasons is not known.

6. Shui Hau (Photo 5a, Photo 5b)

It is a east facing sheltered bay in Lantau Island. Behind the coast is a large marsh which had been used for cultivation many years ago. It was first reported in December 2003 that large amount of danaine butterflies were seen from mid-October to late November. A visit was made on mid-December of the same year but no aggregating danaine butterflies was found. Around 10,000 danaine butterflies were recorded in a visit on Dec. 3, 2004. Hundreds to thousands of the butterflies were gathering on the flowering herb - *Adenostemma lavenia* (Asteraceae) 下田菊 which was quite densely growing in the area. As the amount of nectar available from this flowers is minimal, but the visiting duration is long and involved large number of individuals, it is possible that this plant provides pyrrolizidine alkaloids (PAs) from which some pheromones of the danaine butterflies derive. It has been reported that this plant genus contains PAs (Erhard Roeder, 1999). Small amount of the butterflies (both males and females) can also be seen on the dense flowers of *Mikania micrantha* 薇甘菊. A small woodland predominantly occupied by a large shrub *Paliurus ramosissimus* 馬甲子 is situated near the coast. Inside the woodland is the place where assemblage of danaine butterflies was found. On Nov 11, 2006, 2000 danaine butterflies were found aggregating in the orchard (Lychee 荔枝 and Longan 龍眼) near the junction of South Lantau Road and Lantau Trail Stage 9. Although aggregating butterflies generally dismissed before early December, about 400 danaine butterflies (mostly *Danaus genutia*) were still recorded in Dec 27, 2004. The status of this site is marginal. To certain extent, it may play the role of winter aggregation site as well. About half of the individuals were *Danaus genutia*, most of the remaining half are *Euploea midamus* and *Euploea core*, ratio of the former to the latter is about 3:1. Other recorded members includes *Euploea mulciber*, *Tirumala limniace*, *Ideopsis similis*, *Parantica aglea* and *Danaus chrysippus*. A colony of *Asclepias curassavica* 連生桂子花 were growing in the area and immature stages of *D. Chrysippus* could be found on the plant in winter months.



Photo 5a Shui Hau



Photo 5b Danaines on *Adenostemma lavenia* in Shui Hau

7. Mui Tze Lam Road

There has been only one record, at the dusk of Nov. 19, 2005, 600 *Tirumala limniace* densely aggregated into 2 separate groups (Photo 6). Male to female ratio is about 1:6.7 individuals of *Danaus genutia* mixed with the population. The aggregation disappeared on the next day.



Photo 6 Aggregating *Tirumala limniace* in Mui Tze Lam

8. Tsuen Kam Au

It is a small wetland located at 480 meter above sea level, the site is surrounded by plantation woodland. A small population of *Adenostemma lavenia* (Asteraceae) 下田菊 growing in the site which attract the danaine butterflies. Aggregation of about 100 butterflies was recorded on Oct. 21, 2005 and Sep. 23, 2004 respectively.

9. Kap Lung

The record was taken on Oct. 30, 2005. About 200 danaine butterflies were seen aggregating in the plantation woodland situated at the lower end of the Kap Lung Ancient Trail.

10. Sam A Tsuen

It is a large marsh with densely growing *Adenostemma lavenia* (Asteraceae). Aggregation of danaine butterflies was first seen

on late September, 2002. About 500 individuals were recorded in the site on Oct. 10 of the same year, most of them were gathering on the *Adenostemma lavenia*. Small portion of them were hanging on the small tree of the adjacent woodland. Similar scene was observed again on October, 2004. The danaine butterflies were mainly *Euploea midamus*, *Euploea core*, *Tirumala limniace* and *Ideopsis similis*, ratio were 6:2:1:1. Nearly all male. Other recorded species were *Euploea mulciber* and *Parantica aglea*.

Spring/Summer aggregation site

11. Tong Fuk

In May 11, 2002. Hundreds of various species of danaine butterflies were found crowded around the well known PAs source plant - *Heliotropium indicum* (Boraginaceae) 大尾搖 (Photo 7) which was densely growing on the large abandoned farmland in front of the village. The site was visited again on May 26, 2002, the scene was the same. Since then, most *Heliotropium indicum* was cleared leaving a small colony growing near the road. Although frequently disturbed, the small colony of *Heliotropium indicum* kept attracting 50-100 danaine butterflies at most of the time during its flowering period. Most of the danaine butterflies were *Tirumala limniace*, *Danaus genutia* and *Danaus chrysippus*, a few *Euploea midamus*, *Euploea core*, *Euploea mulciber*, *Tirumala septentrionis* and *Parantica aglea* were also seen. No female recorded.



Photo 7 Danaines on *Heliotropium indicum*

12. Lead Mine Pass



Photo 8 Danaines on *Ageratum conyzoides*

On Feb. 24, 2001. 50 - 100 *Parantica aglea* and *Parantica sita* were seen attracted to the well known PAs source - *Ageratum conyzoides* 藿香薊 (Asteraceae)(Photo 8) growing in the place. Few *Euploea midamus* were also seen. The situation remained unchanged on another visit on March 4 of the year.

13. Kat O

After the news of the first local record of *Euploea sylvester* in Kat O, a visit was organized by the Hong Kong Lepidopterists' Society on June 12-13, 1999. Hundreds of danaine butterflies of various species were seen crowded on the dense colony of *Heliotropium indicum* growing around a small pond in an abandoned field. Recorded species includes *Parantica aglea*, *Ideopsis similis*, *Tirumala limniace*, *Tirumala septentrionis*, *Danaus genutia*, *Euploea midamus*, *Euploea sylvester* and *Euploea core*.

Other Aggregation Sites

14. Chi Ma Wan Reservoir.

It was reported by a butterfly watcher on December, 2003 that thousands of *Euploea* spp., mainly *Euploea midamus* were aggregating near the Chi Ma Wan Reservoir.

15. Nam Fung Road

As mentioned by Wong et al. (2004): "The migration of Danaids in Hong Kong usually starts from November and small aggregates of butterflies would be seen in areas such as Nam Fung Road Site of Special Scientific Interest (SSSI)." The place is a well vegetated Fung Shui Wood which is 1 km away from the Deep Water Bay river valley.

16. Lai Chi Kwok

As mentioned above, the site was first documented by Chan in 1938. The place is also called "Wu Tip Kuk". The Chinese meaning is "Butterfly Valley". People may already know the swarming of butterflies in the valley for a long time. It was orally reported by a naturalist that aggregation of butterflies in the place was still seen in 1970s'. Although the valley was still densely vegetated in 1990s', it may already become unsuitable for winter aggregation of butterflies as the area around the valley had been rapidly developed in the 1980s'. All vegetation was removed to give way to a highway in 2000s'. In the past few years, small south westward stream of *Euploea* spp. could still be seen crossing the area in late November and early December.

17. Shing Mun Reservoir.

It is situated in the central New Territories. The place around the reservoir is a mixture of plantation woodland and natural vegetation. Paul Aston (1998) reported 3 aggregation sites around Shing Mun in winter of 1997. Wong et al. (2004) reported butterfly aggregates greater than 300 individuals observed in Shing Mun on Nov. 7, 2002 and Nov. 14, 2002. In April of some years, when the water level of the reservoir was low, around a hundred of danaine butterflies of various species were attracted to the densely growing *Ageratum conyzoides* and *Heliotropium indicum* on the north east shore of the reservoir. Comparatively, *Heliotropium indicum* is more attractive to the butterflies than *Ageratum conyzoides*.

18. Chuen Lung

It is a large river valley situated on the southern slope Tai Mo Shan. It was mentioned by Wong et al. (2004), but no details was given.

19. Tai Lam Reservoir

Wong et al. (2004) said: "The migration of *Danaïde*s in Hong Kong usually starts from November and small aggregates of butterflies would be seen in areas such as ... Tai Lam Country Park." Tai Lam Country Park covers an area of 5370 hectares, but it can be inferred from the given map in the paper that the site is somewhere near the Tai Lam Reservoir.

20. Lam Tsuen

A bird watcher reported that "over 200 *Danaus genutia* holding on two dead tree trunks" in a small Fung Shui Wood in Lam Tsuen, on late December, 2008.

21. Cheung Sheung

It was reported by a hiker on Dec. 16, 2004 that large group of danaine butterflies were found near Cheung Sheung (a flat land 400 meters above sea level situated in Sai Kung District). A few days after, Dr. P. C. Lee went there to check and estimated that there were about 400 individuals of *Danaus genutia* aggregating there.

From the above information, a few points can be noticed:

1. Spring/summer aggregation is formed by the strong attraction to PAs source plants namely *Adenostemma laevnia* 下田菊 (Asteraceae) (Flowering period May - Dec), *Heliotropium indicum* 大尾搖 (Boraginaceae) (Flowering period April - Oct), *Crotalaria retusa* 吊裙草 (Fabaceae) (Flowering period Jan - Dec) and *Ageratum conyzoides* 藿香薊 (Asteraceae). (Flowering period June? - Oct). Species so far recorded on these plants are all known species of the local *Danaïde* sub-family. After checking hundreds of photo records of danaine butterflies on these plants, unlike other nectar source plants, no female butterfly is found on this plants except 2 incidents involving a female *Euploea mulciber* and a female *Parantica aplea* respectively on *Ageratum conyzoides*. This may be explained by the fact that the plant also provides nectar as members of other butterfly families can also be found visiting its flowers. Whenever available, the PAs source plants are also strong cohesive force in pre-winter and winter aggregation sites. Danaine butterflies do not stop collecting PAs in winter.

2. It should be pointed out that only very small amount or none of the host plants (Table 3) of the local danaine butterflies can be found within or around all the aggregating sites. Although most of the host plants are locally common, they never occur in high density. In fact, no specific site have been reported as a significant breeding ground of any species of the danaine butterflies. It is quite certain that aggregation of danaine butterflies in the sites are not connected with the distribution of host plants.

Table 3: List of host plants for Hong Kong
Danaïde Butterflies

Host Plant	Known Hong Kong danaine butterflies feeding on
<i>Strophanthus divaricatus</i> 羊角拗	<i>E. midamus</i>
<i>Nerium oleander</i> 夾竹桃	<i>E. core</i>
<i>Urceola rosea</i> 酸葉膠藤	<i>E. core</i> , <i>E. mulciber</i>
<i>Asclepias curassavica</i> 連生貴子花	<i>P. aplea</i> , <i>I. similis</i> , <i>T. limniace</i> , <i>D. chrysippus</i>
<i>Graphistemma pictum</i> 天星藤	<i>D. chrysippus</i> , <i>D. genutia</i>
<i>Dregea volubilis</i> 南山藤	<i>T. limniace</i>
<i>Tylophora ovata</i> 娃兒藤	<i>P. aplea</i> , <i>P. sita</i> , <i>I. similis</i>
<i>Gymnema sylvestre</i> 匙羹藤	<i>E. core</i> , <i>E. mulciber</i>
<i>Cryptolepis sinensis</i> 白葉藤	<i>E. mulciber</i>
<i>Toxicarpus wightianus</i> 弓果藤	<i>E. core</i> , <i>E. mulciber</i>
<i>Hoya carnosa</i> 球蘭	<i>P. sita</i>
<i>Ficus microcarpa</i> 細葉榕	<i>E. core</i>

3. Pre-winter sites generally have wind-shielded woodland (plantation woodland or naturally developed woodland). It may be located at any elevation up to 500 meters above sea level.

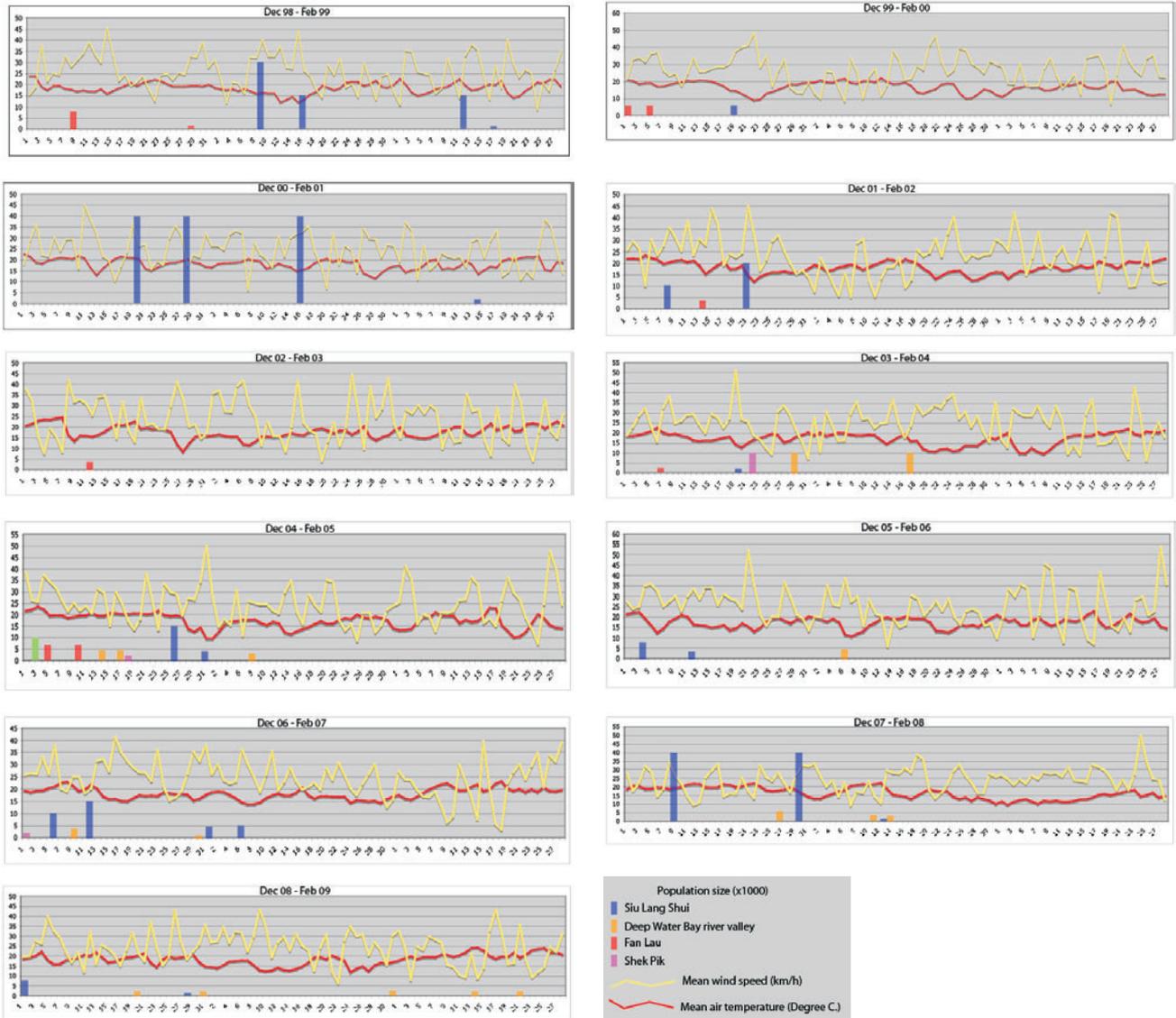
4. Winter aggregation sites are all located at southern or south western extremes of the territory or Islands. They are all dense woodland (plantation woodland or naturally developed woodland) located in south western facing river valley no further than 1 kilometer away from the sea. 2 kilometer east to the Siu Lang Shui Site is the Butterfly Beach (Wu Tip Wan). 700 meters north west to the beach is the Mong Hau Shek (Pillar Point) valley. The geography of the site is very similar to that of Siu Lang Shui. 38 hectare of the Mong Hau Shek valley was used as landfill site which was closed in 1996. So far no information is found about the origin of the name of the place "Butterfly Beach".

5. Table 1 shows that aggregating butterflies in Siu Lang Shui appear at early to mid November and the population size continue to grow until early December. It takes about 3 weeks for the population to increase to maximum. Segregation of arrival timing suggests that the butterflies may come from different origins. The aggregating butterflies disappear in late December to early January, but no latter than mid January. There have been only 2 exceptions : The 1998/1999 aggregation which dismissed at late February, and the 2000/2001 aggregation which dismissed before mid February. That is to say, over the 10 years, only 2 years, Siu Lang Shui was used as an over-wintering site. One would definitely ask : What made the difference in timing of dismissal? Were the dismissal induced by arrival of strong cold front? Changes of population size are plotted against changes of temperature and wind speed over the time period of December to February in chart 1. Neither the temperature nor the frequency and strength of cold fronts were exceptional in 1998/1999 and 2000/2001. In the 2 year sessions. Although low temperature and strong cold fronts still prevail in January and early February, the daniane butterflies chose to stay until the end of winter. Furthermore, if it is the result of sudden change of weather factors, it would be difficult to explain why the butterflies left Siu Lang Shui no latter than mid January in all of the other 8 years.

"Aggregation pheromones are important semiochemicals in insects that play a key role in mating and other social behaviour" (Jiang, Lei & Zhang, 2002. Written in Chinese). Chemistry of the aggregation pheromones in a number of insects are already known. Hick, Luszniak and Pickett (1999) stated that "*The hair pencil pheromones produced by male Lepidoptera have usually*

only close range aphrodisiac-like activity, but those male butterflies from the genus Euploea also display their hair pencils during patrolling flights, suggesting other possible activities". Jiang et al. (2002) studied the chemical signals originating from the ovaries of gravid females of *Musca domestica* (Diptera: Cyclorrhapha: Muscidae) attract ovipositing females to common egg-laying sites and found dose-dependent aggregation of gravid females in oviposition bioassays. Aggregation pheromone in danaine butterflies is yet to be reported. Suppose dose dependency mechanism also apply to the dispersal and aggregation behaviour in danaine butterflies and dose is related to the number of aggregating individuals, then the exceptional over-wintering behaviour of the aggregating danaines in 1998/1999 and 2000/2001 could be the results of the exceptional large population size. Also suppose the aggregation hormone is mediated by the length of daylight, like the diapause mechanism in many insects. The whole process of annual aggregation and dismissal in winter and spring respectively may then be logically explained: When daylight length decreases in autumn, aggregation hormone develops, individual danaine butterflies begin to aggregate to form small groups, and small groups to form larger groups. South westward migration is driven by the north easterlies and the desire to move away from low temperature. More danaine butterflies aggregate results in high concentration or dosage of the aggregation pheromones. When the dosage is high enough, danaine butterflies form stable aggregates. In South China, shortest daylight in the year is on Dec 22 or Dec 23. After that day, daylight length increases, synthesis of aggregation pheromones begins to be suppressed or weakened. If the population size is large enough, stable aggregates can still be kept. When daylight length continues to increase, the bonding becomes weaker and weaker. At the same time, diapause ends and the butterflies become active and finally dismiss at mid Feb or late Feb. However, if the population size is still "marginal" at late December, under the effect of increasing daylight length and weakening of aggregation pheromones, the aggregates choose to leave in January and continue the south westward migration until they meet other groups and form larger aggregate in the journey. Finally, the butterflies may settle on places like Hainan Island to stay a few more weeks until spring comes. (Map 2)

Chart 1: Variation of winter aggregation population, mean air temperature and mean wind speed from Dec to Feb



6. Winter and pre-winter aggregation sites on Lantau Island are dominated by *Danaus genutia*. However, neither the spring/summer aggregation site (Tong Fuk), nor other butterfly watching sites on Lantau Island visited in spring and summer shows similar species composition. Whether there be a tendency of the *Danaus genutia* moving south westward to the Island in autumn and winter is not known.

7. Population size and species composition ratio of *Ideopsis imilis* in the winter aggregation site on Hong Kong Island (Deep Water Bay river valley) is exceptionally high (Photo 9). Butterfly watching sites in all places of Hong Kong territory visited in other seasons does not show similar high ratio of *Ideopsis similis*. Whether there be a tendency of this butterfly moving to and gathering in Deep Water Bay river valley in winter is not known. More frequent visits to Deep Bay Valley in 2008-09 revealed that *Ideopsis similis* starts aggregating late (around mid-December) in comparing with *Euploea* spp. in Siu Lang Shui (around mid-November). In this



Photo 9 Aggregation of *Ideopsis similis* in Deep Water Bay river valley

winter, only small amount of *Euploea* spp. appeared in Deep Water Bay river valley, but the number of *I. similis* remain fairly constant (~300) when compared with those in the previous years in the same site. No significant change in population size was observed in the weekly visits in the period of Jan. to early March. This suggests that the *I. similis* may have used Deep Water Bay river valley as an over-wintering site.

8. No strict site specification is found. *Euploea midamus*, *Euploea core*, *Ideopsis similis*, *Danaus genutia* and *Tirumala limniace* were recorded in almost all aggregation sites although in different ratio. Nevertheless, preference of the former 4 species on selecting pre-winter and winter aggregation sites is clear and consistent over the years. A significant larger proportion of *Danaus genutis* chooses to aggregate in sites of Lantau Island except in Shek Pik. A significant larger proportion of *Ideopsis similis* chooses to aggregate in Deep Water Bay river valley of Hong Kong Island. A significant larger proportion of *Euploea midamus* and *Euploea core* chooses to aggregate in Siu Lang Shui of the New Territories. Is it a reflection of the

uneven local distribution of the 4 species and they simply choose a proximate site? Or it reflects that they are migrating on different routes and stop at different sites? Study by Wong *et al.* indicates that among the 189 marked individuals, a male *E. midamus* and a male *E. core*, both marked on Nov. 7, 2002 at Shing Mun Country Park, were recaptured in Siu Lang Shui on Dec 6 and Dec 12, 2002 respectively. The study shows that a south-western movement of the aggregating butterflies among different sites did occur. Does this apply to all other sites and all other involved danaine butterflies are yet to be studied.

Activities in the winter aggregation site

Mortality

It is generally agreed that larvae of the Danainae derive toxic cardiac glycosides, often referred to as cardenolides, from their larval food plants. Cardenolides are toxic to vertebrates. Among the 12 known local larval food plants (Table 3), 11 species belong to the family Asclepiadaceae 蘿藦科 and family Apocynaceae 夾竹桃科. Members of both families are generally believed to contain toxins (Tsiang & Li, 1977. Written in Chinese). One host plant species, *Ficus microcarpa*, fed by *Euploea core*, belongs to the plant family



Photo 10 *Euploea* spp. dropped onto the ground under low temperature

Moraceae. Moraceae is generally not regarded as toxic plants. However, the cytotoxin, Phenanthroindolizidine alkaloids had already been isolated from *Ficus septica*. Whether *Ficus microcarpa* has similar substances is yet to be studied. It is reasonable to expect that predation by vertebrates such as birds and reptiles would not be an important factor causing mortality of danaines. Over tens of hours of on-site observation, only 2 incidents of a *Euploea midamus* being attacked were observed: the first was by a Chinese Bulbul, *Pycnonotus sinensis* 白頭鸚, in Feb. 2002; the second was by a Great Tit, *Parus major* 大山雀, in Dec. 2007. In both cases, the butterfly was released and no further attack by the same bird was observed.

A visit to Siu Lang Shui on Jan. 16, 1999 found that large amount of the danaine butterflies fell on the ground, almost motionless. Affected by a strong north easterly, the minimum temperature recorded in Hong Kong Observatory Station dropped to about 10°C on Jan. 12, until Jan. 17. A measurement on Jan. 16 in Siu Lang Shui showed that the air temperature was 7°C at 11 am. Moreover, as there was trace amount of rainfall, a large portion of the butterflies on the ground had their wings adhered to the wet surface. Many butterflies on the ground had their abdomen been freshly removed, cause unknown. It was estimated that about half of the population dropped onto the ground. Another significant event of mortality occurred in late Dec. 2004, in Siu Lang Shui (Photo 10). The estimated number of individuals on Dec. 27, 2004 was 15,000. A visit on Jan 1, 2005 revealed that only 3,000 were still alive, thousands of dead bodies were found on the ground. According to the weather information records of Hong Kong Observatory, the minimum temperature dropped sharply from 13.8°C on Dec. 27 to 8.0°C on Dec. 28 (air temperature in Siu Lang Shui is usually a few degrees lower), low temperature lasts until Jan. 3, 2005. No rainfall was recorded during these days. Apparently, no matter there is rainfall or not, air temperature below 10°C could be fatal to the danaine butterflies, or at least to the *Euploea* spp.. This is probably the most obvious ecological reason for southern migration of the danaines in the winter. Similar results were shown in the study by Wang & Emmel (1990). They reported that the air temperature in the winter aggregation sites normally remains above 10°C, and if an extraordinary strong cold front arrives and causes the temperature drop below 4°C, disastrous losses occur in the colonies.

Such high proportion of mortality has not been recorded in Deep Water Bay river valley on Hong Kong Island. Whether it could be attributed to the more natural and sheltered physical environment in Deep Water Bay river valley is yet to be studied.

Feeding behaviour

Scheffera heptaphylla, being one of the few widely distributed plants blossoming in December, becomes exceptionally attractive to all nectar-feeding insects. When weather is fine, danaine butterflies can always be found collecting nectar on the *Scheffera heptaphylla* inflorescence (Photo 11). Other nectar plants attracting the danaine butterflies in winter are *Bidens alba* (Photo 12), *Mikania micrantha* (Photo 13), *Asclepias curassavica* and *Eucalyptus torelliana* (Photo 14). Both males and females could be found on the flowers, this behaviour is probably not sex linked. In pre-winter aggregation site as Fan Lau and Shui Hau, most of the danaine butterflies present were seen visiting the nectar plants in warmer days. In wintering aggregation sites, however, only a small portion of the aggregating population could be seen visiting the flowers for nectar, no matter how fine is the weather conditions. It is doubtful that the presence of certain amount of nectar plants is essential to the formation of a winter aggregation site.

When it is warm and bright, certain amount of danaine butterflies could be found sucking water on wet soil or on wet rock surfaces near the streams (Photo 15, Photo 16), this behaviour is common in most butterfly families and is commonly called mud-puddling. It is generally agreed that the purpose is to collect sodium ion from the water (Arms, Feeny & Lederhouse 1974, Beck, Mühlenberg & Fiedler 1999, Boggs & Dau 2004). This behaviour is often restricted to male butterflies. Launer *et al.* (1993) reported that considerable number of female *Euphydryas editha bayensis* (Nymphalinae) were also seen drawing moisture from mud, sand and gravel, along a seasonal creek in California. Although mud-puddling behaviour was observed a number of times in Fan Lau, Shek Pik, Deep Water Bay river valley and Siu Lang Shui, it had not been studied in detail. As most *Euploea* spp. close their wings during mud-puddling, it is not possible to distinguish the sex of individual butterflies. By reviewing limited amount of *Euploea* spp. with wings open during mud-puddling as well as limited amount of *T. limniace* from tens of photo records, it seems that most were male but not exclusive, few individuals of female were also found. It should also be emphasize that only a small portion (usually no more than 1,000) of the aggregating butterflies flied to water each times. How important of a water source in a winter aggregation site is yet to be studied.



Photo 11 *E. midamus* on *Scheffera heptaphylla*



Photo 12 *Euploea* spp. on *Bidens alba*



Photo 13 *D. genutia* on *Mikania micrantha*



Photo 14 Various danaines on *Eucalyptus torelliana*



Photo 15 *Euploea* spp. mud-puddling on wet concrete surface



Photo 16 *Euploea midamus* mud-puddling on wet soil

Reproductive activities

The over-wintering monarch butterflies in North American remain reproductive inactive during the over-wintering period (Urquhart 1960, Brower 1977). This is also called reproductive diapause. Reproductive diapause is characterized by depressed growth of reproductive organs (Herman, 1981) and much prolonged adult longevity (Herman & Tater, 2001). It is also found to be regulated by juvenile hormone (Herman & Tater, 2001). Studies of the over-wintering *Euploea* spp. in Taiwan by Lee & Wang (1997) shows that mating behaviour could be seen even in early stage and became more frequent towards the end of the over-wintering period. In the contrary, no mating behaviour had been observed earlier than mid-February in the winter aggregation sites of Hong Kong. Courtship behaviour as patrolling flights and extruding hair pencils in the air have not been seen in December and January, and only begin to appear around mid-February. Frequency of mating activity increases towards late February. It is not clear what proportion of the over-wintering population mate in the aggregation site before they left. In 1999 and 2001, aggregating danaine butterflies stayed in Siu Lang Shui until late February. The larval host plants near the site were thoroughly checked, but neither eggs nor larvae were found. In 2009, a portion of the aggregating danaine butterflies stay in Deep Water Bay river valley until early March, larval host plants were also thoroughly searched, neither eggs nor larvae were found. The over-wintering population may have probably moved to somewhere else to find their larval host plants. Among the members of winter aggregating danaine butterflies, only *Parantica aglea* has its eggs and larvae been found in December and January. This indicates that *Parantica aglea* probably keeps breeding locally in winter. Earliest records of immature stages of other members of the family in the year is in late March and early April. It should be noticed that *Danaus chrysippus* is also breeding locally in winter. It is recorded in Shui Hau, but not other winter aggregation sites is simply because the presence of large amount of its larval host plant - *Asclepias curassavica*, in Shui Hau.

Form of aggregation

It is quite obvious that the winter aggregating danaine butterflies have an inclination to form aggregates of the same species, so long as they have enough number of individuals to form aggregate. This is true to all recorded species. This may be a result of differentiation of aggregation pheromones chemistry between different species. However, the phenomenon is not exclusive. For very large aggregates containing thousands of individuals, usually 3-6 different species can be found

(Photo 17, Photo 18). For species with very small population size, they would choose to joint aggregates formed by other species, rather than staying along. How does a particular species find the aggregates formed by different species? Does it imply the aggregation pheromones of a particular species also has effect to different species?



Photo 17 Mixed species on *Garcinia oblongifolia*
Deep Water Bay river valley

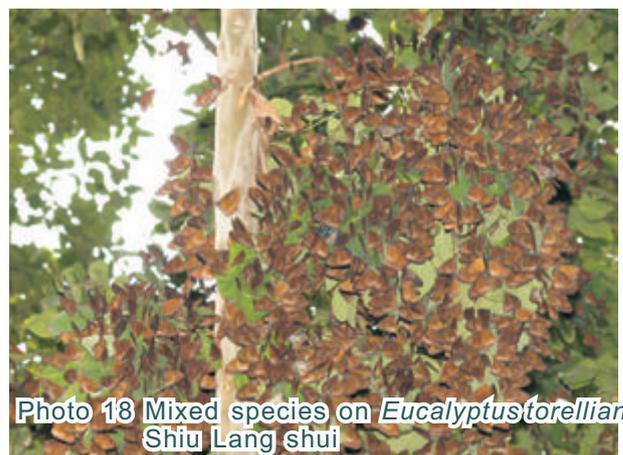


Photo 18 Mixed species on *Eucalyptus orelliana*
Siu Lang shui

Another interesting phenomenon is that several mimic of the *Euploea* spp. - *Hypolimnias bolina*, both male and female, has been recorded every years in Siu Lang Shui and Deep Water Bay river valley. They sometimes even joint the *Euploea* spp. aggregates.

The butterflies tend to form aggregates on leaves and small branches. Most exposed and highest positions of the woodland are avoided. They also stay away from vegetation too close to the ground. The aggregating butterflies may hold the upper or lower surface of the leaves, or the leaf stalks. In warmer afternoon with sunlight, butterflies show strong preference to stay on surfaces facing the sun, no matter they are leaves, tree trunks or rocks.

Activity of the butterflies are highly affected by air temperature. In general, when the temperature is above 16°C, the butterflies are very responsive to any disturbance and will quickly dismiss and fly away from



Photo 19 A sparse aggregate on *Acacia confusa*

the aggregate. Aggregates are also small and sparse (Photo 19). Between 10°C to 16°C, although they are responsive but are more reluctant to fly. They only fly away under stronger disturbance and quickly form new aggregate again. When temperature drops below 10°C, butterflies are immobile, cannot fly even touched. The aggregates become larger and may consist of more than 5,000 individuals. The aggregates are also formed at lower positions, either on shrubs, small trees, lower side branches of large trees, or on tree trunks. When the temperature drops below 7°C, a significant portion of the butterflies become incapable to hold firmly and drop onto the ground.

Selection of plant species for aggregation

Winter aggregation have been recorded on various large trees, small trees, shrubs, bamboos and vines including: *Acacia confusa* 台灣相思、*Acacia auriculiformis* 耳果相思、*Eucalyptus torelliana* 毛葉桉、*Lophostemon confertus* 紅膠木、*Ficus microcarpa* 細葉榕、*Neolitsea* sp. 新木薑子、*Litsea glutinosa* 潺槁樹、*Mallotus paniculatus* 白楸、*Sterculia lanceolata* 假蘋婆、*Garcinia oblongifolia* 黃牙果、*Dimocarpus longan* 龍眼、*Litchi chinensis* 荔枝、*Schefflera heptaphylla* 鴨腳木、*Bridelia tomentosa* 逼迫仔、*Cerbera manghas* 海芒果、*Microcos paniculata* 布渣葉、*Psychotria asiatica* 九節、*Zanthoxylum avicennae* 筍欖、*Paliurus ramosissimus* 馬甲子、*Aporosa dioica* 銀柴、*Bambusa* sp. 竹、*Arundinaria* sp. 托竹、*Byttneria aspera* 刺果藤、*Toxocarpus wightianus* 弓果藤 and *Lygodium* sp. 海金沙。 No strong preference on any specific plant(s) can be seen.



Photo 20 *Ideopsis similis* on dead twig and rock surface

It is the availability, position and general form of the plants which determine the choice of danaine aggregates. In general, most available plants are chosen so long as the plant is located at sheltered positions, has dense foliage and the leaf size of which is not too small. Sometimes, dead twigs and bare rock surfaces were also chosen (Photo 20). In Siu Lang Shui, *Leucaena leucocephala* 銀合歡 and *Casuarina equisetifolia* 木麻黃 are quite abundant, but they have never been chosen for aggregation. Their foliage units are both exceptionally small, thin and sparse. It should also be noticed that the *Eucalyptus torelliana* in Siu Lang Shui are becoming less attractive to the danaines. In the past 3 years, most winter aggregating danaines in Siu Lang Shui chose to stay on the *Acacia confusa* instead. This may be attributable to the fact that the *Eucalyptus torelliana* (an introduced plant from Australia) is growing exceptionally fast. Most of the *Eucalyptus torelliana* in Siu Lang Shui are now 20-25 meters high and the canopy becomes more exposed to the wind. At the same time, lower side branches of *Eucalyptus torelliana* are becoming more limited for the butterflies to stay on.

Origin of the winter aggregating danaine butterflies

Euploea midamus and *Euploea core*, being the largest component of the overall pre-winter aggregates and winter aggregates, are more worth discussing. Although they are both classified as "very common" locally. Whether we have a comparable local population size in spring/summer is doubtful. Highest records in Siu Lang Shui were around 40000 individuals of danaine butterflies. Total area of Hong Kong is approximately 1000 square kilometers. It means in average there should be 40 individuals of *E. midamus* / *E. core* in 1 square kilometer of land. This is apparently not consistent with the general observations in the field during spring and summer. Would some of the *E. midamus* and/or *E. core* originate from places outside Hong Kong? According to C. L. Chan (詹家龍) (2008. Written in Chinese), since 2000, there have been several cases of *Parantica sita* marked in Taiwan being recaptured in Japan and *Parantica sita* marked in Japan being recaptured in Taiwan. The longest travelling distance recorded was 2035 Kilometers. Sin (2007) (申慧媛) reported a case of travelling 1500 kilometers in 16 days, which means the travelling speed is about 100 kilometers per day. After years of extensive capture-mark-recapture experiment done in Taiwan, Chan (2008) reported that the longest

recorded travelling distance of *Euploea sylvester* is 255 km, that of *Euploea eunice* is 291 km, that of *Euploea mulciber* is 299 km, that of *Euploea tulliolus* is 125 km. 299 km north east to Hong Kong is the boundary between Guangdong and Fujian and 299 Km north to Hong Kong is the boundary between Guangdong and Hunan. Aston (1999) stated that "Numbers of *Euploea* are regularly seen flying across Mirs Bay" and reported a record on Nov 1998 that over 150 *Euploea* congregated outside the border fence at Mai Po and trying to move in a southerly direction. On Nov. 6, 2005, a stream of danaine butterflies was seen crossing a peak (702 m above sea level) of Tai Mo Shan situated in the central New Territories, and moving steadily to south west at the level of about 2 m above the ground surface. They were mainly *E. midamus*, some *E. core* and *T. limniace*, and a few *D. genutia*. The speed was assessed by measuring the numbers of seconds taken (by a stop watch) to travel across a distance of 10 meters. Measured speed of travelling was approximately 3m/s (~11km/h). Use this speed, it only takes about 3.5 hours to travel from the north border to the south border of Hong Kong. Suppose the butterflies fly 5 hours a day, it only takes 6 days to travel from Fujian to Hong Kong. Not to mention the speed of flying could be significantly accelerated by strong north easterlies occasionally blowing in that season. Although not proved yet, it is highly possible that *E. midamus* and *E. core* do have the ability to travel from other area of the Guangdong province or even from other provinces to Hong Kong. According to Chou (1999), there is only one sub-species namely *Euploea midamus midamus* known in China and it is only recorded in the 6 provinces located at the south China - Zhejiang, Fujian, Guangdong (including Hong Kong), Guangxi, Yunan and Hainan. It is also recorded in vietnam and Thailand. The sub-species *Euploea core amymone* of Hong Kong is only known in Guangdong (including Hong Kong), Guangxi and Hainan. Aggregation of *Euploea midamus* at Kinmen Island (an Island 10 km east to Xiamen) in October (private conversation with C. L. Chan), tens of thousands of various danaines on Hebao Island in late December and January, *Euploea* spp. at Hainan in February (private conversation with C. L. Chan) have been noticed. It is not difficult to imagine a large scale annual autumn/winter migration of at least some *Euploea* spp. all the way from Zhejiang, Fujian, Guangdong, to Hainan for over-wintering, and Hong Kong is one of the transitional stop of this large scale and long distance migration. (Map 2)

However. Kitching & Zalucki (1981) studied the over-wintering population of *Euploea core corinna* in Australia, and suggested that the butterfly is not migratory. The over-wintering aggregation represent contractions in its distribution in response to unfavourable seasonal conditions and not the end-points of some regular directional mass movement. To what extent is this applicable to different species of danaine butterflies in Hong Kong, needs further studies.

Conclusion

Studying the winter aggregation of danaine butterflies in Hong Kong is indeed inducing more questions rather than providing answers. We do not know the origin of the winter aggregates. We do not know the destination of the winter aggregates. We do not know the routes(s) of travelling. We do not know the mechanism of aggregation and dismissal. We do not know how do they re-colonize their breeding sites after winter. We do not know the correlation of the weather conditions with the migration and cannot predict the effect of global warming to it.

This study only represents a beginning in this field of study in Hong Kong and probably only represents the tip of the iceberg. There may be a large scale annual migration of danaine butterflies in South China. Experience in North American and Taiwan tells us that the most direct method to find out the timing and routes of the migration is through years of large scale mark-release-recapture work. With the rapid advancements in genetics and chemical ecology, the issue could be studied by very different approaches.

Map 2 Possible winter migration routes of *E. midamus* & *E. core* in south China



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