Searching for nature story 2019

Title: **The silent hunter in the woods: Large woodland spider**

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Content

1. Abstract

Nephila pilipes is a common species of spider in Asia. In this study, we aimed at investigating the web-lasting time of the female spiders, the abundance of female spiders with different body size and the chance of finding symbiotic spiders and male spiders on their female's web. We also aimed at studying how *N. pilipes* respond to the man-made frequency, the web-cleaning behaviour and the male-seeking behaviour of *N. pilipes*.

It is concluded that medium-sized spiders stay on their webs for a longer time than small-sized spiders. Added to this, the abundance of large-sized spiders is the lowest. Also, the body size of the spiders increases as the chance of having symbiotic spiders and the male spiders on their webs increases. Moreover, the abundance of spiders with colour pattern of yellow and black is higher than that of black.

The frequency ranges from 3Hz to 8.5Hz would most likely trigger the spiders' predatory behaviour, where a decrease in the number of responses is observed as the trials proceed.

The surface area of rubbish on large woodland spiders' webs is not a factor at triggering their web-cleaning behaviour, while the average minimum mass of rubbish in triggering the spiders' web-cleaning behaviour is 1.46g.

According to our study, the male large woodland spiders do not have any female-seeking behaviour.

2. Introduction

2.1 Introduction to the research topic

There are currently about 220 species of spiders[1] in Hong Kong. The large woodland spider *Nephila pilipes* is not only one of the most common spiders but also the largest spider in Hong Kong. We are interested in its hunting, web cleaning and female seeking behavior. The spider gets its name owing to the reason that it produces sticky golden silk to catch its prey. It is also famous for its hunting skills, that there are lots of research showing that it can catch prey which is large in size, for instance, Chinese gecko and Japanese White-eye[2]. Therefore, we are attracted to this eye-catching spider and want to investigate it in detail.

2.2 Objectives

I. Investigation on the web-lasting time of *N. pilipes* of different sizes
II. Investigation on how *N. pilipes* responds to the vibration of different frequencies artificially induced on its web
III. Investigation on the web-cleaning behaviour of *N. pilipes*
IV. Investigation on the female seeking behaviour of male *N. pilipes*

2.3 Research questions

I. What is the web-lasting time of *N. pilipes* of different sizes?
II. What is the abundance of *N. pilipes* of different sizes?
III. What is the chance of symbiotic spiders and its male found on the webs of *N. pilipes* of different sizes?
IV. What is the abundance of *N. pilipes* of different colour patterns?

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[1] Dickson Wong, A Guide to the Spiders of Hong Kong (2016), Society of Hong Kong Nature Explorers - Cover Page

[2] Dickson Wong, A Guide to the Spiders of Hong Kong (2016), Society of Hong Kong Nature Explorers - P.45

V. Is there any specific range of vibrating frequency which triggers the predatory behaviour of *N. pilipes*?
VI. Will the surface area or the mass of the rubbish fall on the web determine the trigger point of web cleaning behaviour ?
VII. What does male *N. pilipes* rely on to find the female *N. pilipes*? Sight or chemical?

2.4 Background information of *Nephila pilipes*

Nephila pilipes, also known as large woodland spider or golden orb weaver, is indigenous to a host of Asian countries like China, India, and Japan, alongside the continent of Australia. *N. pilipes* occurs in a variety of habitats, including both urban and rural areas. The species produces golden silk for weaving their enormous webs, which are vertical and with irregular meshes. Their common prey includes flies, coleopterans, moths and cicadas, and their webs are strong enough to trap small birds, bats, and even snakes. Its web is found with the symbiotic spiders. This species is also characterized by its distinct difference between males and females. Most of the females are multi-coloured with bright yellow and black, whereas some may be just in a single black colour with white stripes. The males, however, are of uniform appearance. In addition, the females are able to reach a body length, the distance between the tip of its head and abdomen, of 5cm. On the contrary, body length of the males is much smaller, about 1 cm.


Fig.1 black female spider


Fig.2 Yellow female spider


Fig.3 Male spider

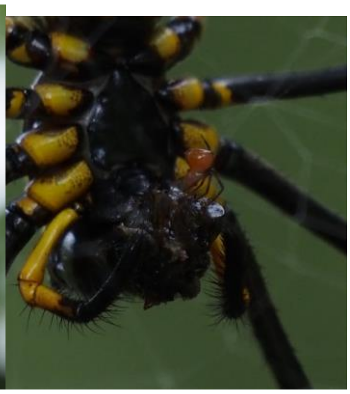
Fig.4 symbiotic spider stealing food from its female host

Classification:

Kingdom	Animalia
Phylum	Arthropoda
Class	Arachnida
Order	Araneae
Family	Nephilidae
Genus	Nephila
Species	*N. pilipes*

3. Materials and methods

3.1 Objective 1: Investigation on web-lasting time of *N. pilipes* of different sizes

3.1.1 Principle of Experimental design

In order to investigate web-lasting time of *N. pilipes* of different sizes, a continuous field studies for days were carried out. With reference to the method of line transect, a trail was selected and the spiders were found along the trail whose width is of about 1 metre. It was assumed that all the spiders within the investigating area were found.

During the field studies, when a spider of the species was spotted, its details such as colour pattern and size were recorded, and a label was marked near the spider for recognition. The spiders were traced for days with labels to understand the web-lasting time of each spider found. The web-lasting time of spider is defined as the time of a spider seen staying on the same web during field studies. With relevant data put into a table, web-lasting time of *N. pilipes* of different sizes could be found. At the same time, the data could be made use of to determine the abundance of *N. pilipes* of different sizes and colour pattern. Relationship of body sizes of the female spiders to presence of symbiotic spiders and the male spiders could be found incidentally.

The sizes of the spiders were estimated by its approximate body length. Also, unless specified, only data of the female spiders were put into tables because their sample size was larger and the difference in body size was more obvious than the males'. In an effort to maximize the number of spiders identified, field studies were carried out during their active period, July[3]. As for the duration of field studies, it is set to be around 180 minutes for proper identification of the spiders. With regard to the route, the trail (Fig.4) was chosen because of its accessibility, and it is noted that the route remained the same in each of the field studies to ensure a fair comparison.

Table 1: Details of the field studies

Date	Time	Site	Event
22 - 07 - 2019	14:30 – 17:30	Sir Cecil's Ride	1. Search and locate *N. pilipes* 2. Collection of spiders for lab experiments
23 - 07- 2019	15:30 – 18:30		1. Search and locate *N. pilipes*
24 - 07 - 2019	14:00 – 17:00		1. Search and locate *N. pilipes*
26 - 07 - 2019	13:00 – 15:30		1. Search and locate *N. pilipes*
30 – 07 – 2019	14:00 – 17:00		1. Search and locate *N. pilipes* 2. Collection of spiders for lab experiments
11 – 09 – 2019	16:30 – 18:00		1. Search for *N. pilipes*

[3] 人面蜘蛛 Nephila pilipes - iNaturalist. Retrieved September 18, 2019,from https://www.inaturalist.org/taxa/68390-Nephila-pilipes

Fig.5 Route of the field studies

* Red dots represent the starting and ending point, and the arrows represent the direction of the investigation.

3.2 Objective 2: Investigation on the predatory behaviour of *N. pilipes* on their web

3.2.1 Principle of Experimental design

When prey is enmeshed in the webs of *N. pilipes* and struggles, the spiders can detect its presence as sensory hairs on their legs can sense the vibration induced by the prey. However, it is noted that the vibration is not only induced by their prey, but also air current and leaves falling on the web. Therefore, it is suspected that there may be certain ranges of vibrating frequency from the prey which triggers the predatory behaviour of the spiders.

In this experiment, we would like to find out the effect of different vibrating frequency on the predatory behaviour of the spider on the web. Therefore, spiders of different sizes were caught from fields and experimented in the laboratory. A vibrating source was connected to the web in a bid to simulate vibration induced by the prey. With increasing frequency of vibration on the web on each trial, the frequency at which the spider reacts or attacks was recorded, and thus enabling us to determine certain ranges of vibrating frequency which is specific in triggering the spiders' predatory behaviour.

3.2.2 Procedures

1. Set up as below

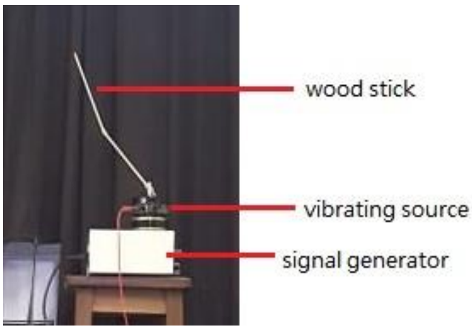

Fig.6 Setup for studying response of spiders to the vibration of different frequencies

2. The amplitude and frequency of the signal generator was set at 8mm and 1Hz respectively

3. The signal generator was turned on for 30 seconds
4. All attacking behaviour of the spider during the period was recorded down, which meant the action of biting the wooden stick. Once the spider attacked, the signal generator would be turned off in order to calm down the spider. The experiment would go on only when the spider went back to the position where she came from
5. The stick was pulled out if the web was damaged or was no longer attached to the stick.
6. Steps 3 to 5 were repeated after having the frequency increased by 0.5 Hz
7. Steps 2 to 6 were repeated five times after 10 Hz was reached.

3.3 Objection 3: Investigation on the web cleaning behaviour of *N. pilipes*

3.3.1 Introduction

During the field studies, it was observed that the spiders exhibited web cleaning behaviour when rubbish like leaves or branches fell on their webs as seen in Fig.6. The rubbish falling onto them might expose the presence and location of the spider web to its prey, or increase its resistance to wind and damage the web if the surface area of the piece was large. If the rubbish was of high mass, it might deform or even damage the spider web. To investigate the potential factors of triggering the web cleaning behaviour of *N. pilipes*, whether they were their fear of damaging the web by wind, by force, or the fear of exposing the presence of their web, hence the surface area or mass of rubbish on their web, two separate experiments were carried out in the school laboratory when the spider webs were still intact and not too damaged to minimize external factors, like varying wind speed or web conditions, on affecting experimental results.

Fig.7 A female large woodland spider cleaning a piece of leave off her web

3.3.2.1: 1. Determining the minimum surface area of rubbish which triggers the web cleaning behaviour of *N. pilipes*

Principle of experimental design

Tissue paper was used for studying the effect of surface area of the rubbish on triggering the web cleaning behaviour of *N. pilipes*. With the low mass to surface area ratio, the tissue paper could be placed onto the web of spider with little deformation of the web, just like a piece of leaf in the wild. We assumed the effect of mass of tissue paper was insignificant in triggering the web cleaning response. A folded piece of tissue paper was placed onto the web, where it would be carefully unfolded to increase its surface area in contact with the web while keeping the mass of the piece constant. The smallest surface area of the piece in contact with the web at which triggers the web cleaning behaviour of the spiders would be the minimum surface area of rubbish to trigger their web cleaning behaviour.

3.3.3.1 Procedures

1. large woodland spiders were caught from the wild.
2. Each large woodland spider was kept in mesh cages, or allowed to roam freely in the lab.
3. From a week to overnight was waited for the large woodland spiders to build their webs, when a cricket was fed around twice a week for each spider[4].
4. Tissue paper was cut into 8cmx8cm square pieces, which was folded till it was 1cmx1cm in surface area on one side.
5. The folded piece of tissue paper was placed onto the web of a large woodland spider.
6. 2 minutes, measured by a stopwatch, was the duration used to wait for the web cleaning behavior (if any) of the spider. The above web cleaning behaviour was defined as approaching the target rubbish piece and the removal of spider silk connected to the target rubbish piece. Any behaviour of the large woodland spider was recorded in the meantime.
7. The paper piece was gently unfolded into a 2cmx2cm square piece using a pair of forceps. It was to make sure that the folded part of paper is sticking to the web.
8. If the paper piece was cleaned off, repeat step 7 and place it back onto the unbroken part of the web
9. Steps 6-8 were repeated by unfolding the paper piece to 4cmx4cm, 6cmx6cm and 8cmx8cm in surface area
10. Steps 4-9 were repeated to 3 other large woodland spiders to reduce the effect of random variation of test subject on the experimental results
11. Steps 4-10 were repeated 3 times to increase the reliability of experimental results
12. The surface area of the paper piece on the web at which triggered the web cleaning behaviour of the large woodland spiders was recorded.

3.3.2.2: 2. Determining the minimum mass of rubbish which triggers the web cleaning behaviour of *N. pilipes*

Principle of experimental design

A piece of tissue paper of constant surface area was placed onto *N. pilipes* 's webs with a paperweight connected to the paper hanging below. Paper is used due to its low but still significant weight. By placing more small pieces of paper onto the paperweight, the overall weight of the rubbish would be increased slightly at a time. The smallest mass of the rubbish at which triggers the web cleaning behaviour of the spiders would be the required minimum mass of rubbish to trigger their web cleaning behaviour.

3.3.3.2 Procedures

1. Repeat steps 1-4 in 3.3.3.1, but the paper is folded to 4cmx4cm in surface area. 4cmx4cm was used for the surface area as it was not too large when compared to the surface area of the webs, while it was not too small so that the rubbish won't break the web under its own weight.
2. A piece of A4-sized paper was cut into 2cmx2cm square pieces with scissors.
3. Set up as shown in Figure 6, where the centre of tissue paper was connected to a paper cone by strings. The initial mass of the paperweight setup was weighed by an electronic balance
4. 10 seconds, measured by a stopwatch, was the duration used to wait for the web cleaning behavior (if any) of the spider. 10 seconds per interval was used instead of 2 minutes because the spiders in the field would clean off the fallen rubbish in less than 10 seconds if there was clear deformation of web as observed by us. The above web cleaning behaviour was defined as approaching the target rubbish piece

[4] Minibeast Wildlife,Care guide Golden Orb-weaver, Nephila pilipes. Retrieved 16 September 2019, from https://shop.minibeastwildlife.com.au/content/Minibeast%20Wildlife%20Care%20Guide%20-%20Nephila%20pilipes.pdf

and the removal of spider silk connected to the target rubbish piece. Any behaviour of the large woodland spider was recorded in the meantime.

5. 1 piece of 2cmx2cm paperweight was placed onto the paper funnel if the web cleaning behaviour of large woodland spider was not triggered
6. Steps 7-8 were repeated until the web cleaning behaviour of large woodland spider was triggered.
7. The no. of 2cmx2cm paperweights added to the paper funnel was recorded.
8. The final mass of the whole rubbish piece cleaned off was weighed by an electronic balance. We assumed the mass of spider silks connected to the rubbish piece, which was included in the required final mass, was insignificant to affect the experimental results.
9. Steps 6-11 were repeated to 3 other large woodland spiders.
10. Steps 6-12 were repeated 3 times.

Fig. 8 Setup for studying mentioned minimum mass of rubbish

3.4 Objective 4: Investigation on the female detecting behaviour of male *N. pilipes*

3.4.1 Principle of Experimental design

During the field studies, it was observed that some of the female spiders' webs were shared by one female spider and male spider each while some of the webs were only occupied with one female spider. The sharing of net allowed the mating behaviour of the female and the male. In order to carry out mating, it is essential for male spiders to detect the location of the female spiders and there are several possible methods for the male to detect the location of the female, which are sight and chemical (i.e. sex pheromone).

To investigate the female detecting behaviour of male *N. pilipes*, several female spiders and male spiders were caught from fields and experiments were done in the laboratory. Firstly, the experiment was carried out to prove that the male spiders could detect the location of the female. If a positive result was shown, the second experiment would be carried out in order to distinguish the method that the male spiders used.

3.4.2 Procedures

1. Three male spiders and one female spider which shared her net with male spiders in nature were caught from the field in order to ensure that the female spider we used in experiment has the ability to attract the male spiders.

2. Three concentric circles, with radii 20cm, 40cm and 60cm respectively, were drawn by a homemade compass, as shown in figure 3.2, on the paper. The circles were divided into four quadrants which were named with four directions N, S, W and E which were conducive to recording the walking routes of the male spider, as shown in figure 3.3.
3. One male spider was put on the center of the concentric circles.
4. The male spider was allowed to move freely inside the circles, each trial was ended when the male spiders move outside the circles.
5. The walking route of the male spiders were recorded.
6. Repeat step 5 and step 6 with female spiders, which has been put inside a hollow cage, placed at area S60.
7. Repeat step 3 to 6 with another male spider.
8. The trials which the male spider walk straight from S20 to S40 and S60 were considered as a positive result as we assumed that the male spiders walk towards the female spiders is a sign of female detecting behaviour .
9. The percentage of positive results among all the trials were calculated. The percentage of the spiders walked straight to any direction were calculated as another index to show the influence of female spiders towards the walking routes of the male spiders.

Fig.9 The homemade compasses

Fig.10 The setup with concentric circles

R4. Result

<u>4.1 Result on Objective 1: Investigation on the web-lasting time of *N. pilipes* of different sizes</u>

Table 1.1: Web-lasting time of *N. pilipes* of different sizes (From 22/7 to 30/7)

Size (cm)	Web-lasting time (day)					Total no. of spiders
	<1	1 – 2	2 – 4	4 – 6	>6	
<2	4	3	5	2	0	14
2-4	4	1	4	4	2	15
>4	0	0	1	1	0	2

* The spiders which were being traced were firstly found on either 22/7 or 23/7
* Data of spider >4 cm was discarded due to small sample size

Table 1.2: Abundance of *N.pilipes* of different sizes (from 22/7 to 26/7)

Date of field studies	No. of spiders observed		
	Length (cm)		
	<2	2-4	>4
22/7	8	14	4
23/7	13	14	2
24/7	11	15	3
26/7	8	14	2
average no. of spiders observed each day*	10	14.3	2.75

* The required average no. of spider observed each day=the required sum of valid no. of spider observed/ no. of date of field studies

Table 1.3: Probability of the male *N. pilipes* and symbiotic spiders being present on the web of the female *N. pilipes*

Size	No. of female	Chance of males being present on the females' webs		Chance of symbiotic spiders being present on the females' webs	
		No. of females with males found	Percentage (%)	No. of females with symbiotic spiders found	Percentage (%)
<2	17	2	11.7	10	58.8
2-4	25	2	8	20	80
>4	5	2	40	5	100

Table 1.4: Abundance of *N. pilipes* of different colour patterns (from 22/7 to 30/7)

Colour pattern	No. of spiders observed	Percentage (%)
Yellow and Black	44	93.6
Black	3	6.4

4.2 Result on Objective 2: Investigation on predatory behaviour of *N. pilipes* on the web

Table 2.1: Number of times of attack at each frequency range[5]

No.	Name	Frequency (Hz)	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Total
1	B1	1-2.5	0	0	1	0	0	5%
		3-4.5	4	1	0	0	0	25%
		5-6.5	3	1	1	0	0	25%
		7-8.5	1	4	1	1	1	40%
		9-10	0	0	0	0	0	0%
2	Y1	1-2.5	0	0	0	1	/	6.25%
		3-4.5	4	1	2	0	/	43.75%
		5-6.5	3	1	0	1	/	31.25%
		7-8.5	1	4	1	0	/	37.5%
		9-10	0	0	0	2	/	12.5%
3	B2	1-2.5	0	0	0	0	0	0%
		3-4.5	0	0	0	0	0	0%
		5-6.5	0	0	0	0	0	0%
		7-8.5	0	0	0	0	0	0%
		9-10	0	0	0	0	0	0%
4	Y2	1-2.5	0	0	0	0	/	0%
		3-4.5	0	0	0	0	/	0%
		5-6.5	0	0	0	0	/	0%
		7-8.5	0	0	0	0	/	0%
		9-10	0	0	0	0	/	0%

[5] Raw data is in appendix 1

5	Y3	1-2.5	0	0	0	/	/	0%
		3-4.5	0	0	0	/	/	0%
		5-6.5	0	0	0	/	/	0%
		7-8.5	0	0	0	/	/	0%
		9-10	0	0	0	/	/	0%

* Spider Y2 and Y3 has no trial 4 or 5 done owing to the reason of no response in the previous trials.

The trend shows that the frequency range will be at about 3 Hz to 8.5 Hz. Yet, not all spiders had given respond.

Table 2.2: Total number of attack at each trial

Spider No.	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5
1	8	6	3	1	1
2	8	6	3	4	/
3	0	0	0	0	0
4	0	0	0	0	/
5	0	0	0	/	/

The trend shows that the number of attacks will decrease when more trial is done

4.3 Result on Objective 3: Investigation on the web cleaning behaviour of *N. pilipes*

Table 3.1: The effect of surface area of tissue paper attached to large woodland spiders' webs on triggering of their web cleaning behaviour

Spider name	The surface area of rubbish which triggers web cleaning behaviour (cm^2)														
	1			4			16			36			64		
	Trial 1	Trail 2	Trail 3	Trial 1	Trial 2	Trial 3	Trial 1	Trial 2	Trial 3	Trial 1	Trial 2	Trial 3	Trial 1	Trial 2	Trial 3
Y2	no	no	no	no	no	no	no	no	no	no	no	no	no	no	**yes**
Y3	**yes**	no	no	no	no	no	no	no	no	no	no	**yes**	**yes**	no	no
Y4	no	no	/*	no	no	/*	no	no	/*	no	no	/*	no	no	/*
B2	no	no	no	no	no	no	no	no	no	no	no	no	no	no	no

*Trial 3 of above experiment was not carried out on Y4 spider as its web was severely damaged at the time.

Table 3.2: The minimum mass of the rubbish attached to large woodland spiders' webs on triggering their web cleaning behaviour

The triggering of web cleaning behaviour from spiders of different marked no.	The minimum mass of rubbish attached to the web which triggers web cleaning behaviour(g)					
	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	average
Y3	1.55	1.36	1.46	2.72*	3.70*	1.46

*Both data was discarded due to abnormal increasing trend which will be discussed later
The required average=sum of required valid datum /no of valid data

4.4 Result on Objective 4: Investigation on the mate detecting behaviour of male *N. pilipes*[6]

Table 4: The walking routes and the percentage of the male spiders walk straight or walked from S20 to S40 and S60 with or without female spider placed at S60

The male spider used	The presence of female spider	The number of trials that male spider walked straight to any direction out of total trials (highlighted in raw data)	Percentage that the male spiders walk straight to any direction (highlighted in raw data) (%)	The number of trials that male spider walked straight from S20 to S40 and S60 which shows the male spiders could detect the female spider out of total trials	Percentage that the male walked straight from S20 to S40 and S60(%)
male spider 1	Absent	5/12	35.7	0/12	0
	present at S60	14/29	48.3	3/29	10.3
male spider 2	absent	9/19	47.4	0/19	0
	present at S60	2/4	50	0/4	0
male spider 3	absent	15/27	55.6	2/27	7.41
	present at S60	11/22	50	3/22	13.6

No trend can be observed.

Calculation:
Percentage that the male spiders walk straight to any direction
=number of trials that the spiders walk straight to any direction / total number of trials ×100%

Percentage that the male spiders walked from S20 to S40 and S60 straight
=number of trials that the male spiders walked from S20 to S40 and S60 straight / total number of trails × 100%

[6] Raw data is in appendix 2

5. Discussion

5.1 Discussion on Objective 1: Investigation on the web-lasting time of *N. pilipes* of different sizes

In this investigation, the spiders were divided into three groups in respect to their body sizes. The spiders of body sizes “<2cm", "2-4cm" and “>4cm” were considered small-sized, medium-sized and large-sized spiders respectively.

In terms of web-lasting time of the spiders, first and foremost, data of large-sized spiders was discarded due to small sample size. With only two spiders in that group, the comparison of web-lasting time between them and the small-sized or medium-sized spiders would be unfair as both of the latter had a much larger sample size of fourteen and fifteen spiders. With reference to table 1.1, web-lasting time of the spiders was dependent on their sizes. The medium-sized spiders had the longest web-lasting time. There were a total number of six webs from medium-sized spiders lasting for four days or above, but only two webs from small-sized spiders sustaining for four days or above. Other than that, the number of small-sized and medium-sized spiders, which sustained their webs for less than one day, were the same.

In the investigation, since field studies were not carried out on 25/7, and from 27/7 to 29/7, the web-lasting time could only be predicted with ranges of days. In addition, other significant errors in the investigation would be the difficulties in tracing the labels and shift in the spider's web location.

As mentioned in section 3.1, a label would be marked near a spider once it had been observed. However, the labels were sometimes removed by the hikers as seen by the remains of torn labels along the trail. Therefore, tracing the particular spiders became very difficult and it might be possible for us to miss the spiders out. This contributed to the incorrect web-lasting time of spiders. Furthermore, it was discovered that some spiders tended to shift their web locations because the spider was founded to reappear on the same web after disappearing from the web for once. It is believed that the web was occupied by another spider. As the investigation was studying the web-lasting time spent by the spider on the same web, shifting the web locations indicated that the old web was discarded. So, the web-lasting time of the spider might be incorrectly estimated.

In terms of abundance of the spiders of different sizes, with reference to table 1.2, there were more than thirty spiders located on each day of the field studies from 22/7 to 26/7. Among all the spiders, the abundance of the medium-sized spiders was the highest, with an average number being 14.3. The number was slightly higher than that of small-sized spiders which was 10. Among all the spiders, abundance of the large-sized spiders was the smallest since an average number of 2.75 spiders were found. The number was much less than that of small-sized and medium-sized spiders. As a rule of thumb, the abundance of large-sized spiders is higher than that of the smaller ones due to the accumulation of the number of deaths in each of their stages of life. However, the number of small-sized spiders found was larger than that of medium-sized spiders. This implies that some small-sized spiders remain undiscovered in this investigation due to difficulties in spotting them and it was a source of error.

In terms of the chance of finding the symbiotic spiders on the females’ webs, with reference to table 1.3, the chance of the symbiotic spiders found on the webs of large-sized spiders is the highest, with it being 100% since all the five spiders are found together with the symbiotic spiders. The chance of the symbiotic spiders found on the webs of medium-sized spiders is 80%, coming into the second place. With 58.8% of the webs of small-sized spiders found with the symbiotic spiders, the chance is the lowest. This can be explained by difference in foraging success of spiders of different stages of life. The spiders of large-sized spiders build their webs with larger surface area which increases the number of prey captured. These explain a higher chance for the symbiotic spiders to stay on the webs of those spiders, because of more food available. The error of this investigation is relatively low. With binoculars used in spotting the symbiotic spiders, it is easy to identify the presence of the symbiotic spiders, avoiding mixing them up with scraps left on the webs.

In terms of the chance of finding the male spiders on the females' web, the large-sized female spiders have the highest chances of being found with the males, which is 40%. Two out of five female spiders are found with males. Small-sized spiders and medium-sized spiders came into second and third place respectively, each with two females' webs spotted with the males only. The highest chance of finding males with large-sized spiders can be explained by the maturity of the female spider. The large-sized spiders might be sexually mature and developed certain mechanisms which attract the males for mating to a larger extent. For the reason why the chance of male found on the small-sized spiders was higher than that on medium-sized spiders, it may be due to the scant sample size.

In terms of abundance of the spiders of different colour patterns, with reference to table Z, in a total number of 47 observed female spiders, the spiders with colour pattern of yellow and black share a very large proportion of 93.6%. On the other hand, the total number of spiders with black colour pattern is lower, with the number being only three, taking up 6.4% of the total. It shows that black and yellow is the dominant colour pattern of *N. pilipes* in natural environment. It can be explained by research article of *N. pilipes* in 2004[7]. This explained that brightly coloured body parts of the spider increase their foraging success so the spiders with colour pattern of yellow and black are allowed to gain food more easily and in turn have a higher survival rate and reproductive rate.

5.2 Discussion on Objective 2: Investigation on the predatory behavior of *N. pilipes* on the web

According to the table 2.1,discarding the data from spider B2, Y2, Y3 which gave no response at all, spider B1 and Y1 attack most frequently at the range of 3Hz to 8.5Hz, which the probability of triggering the spiders' predatory behaviour will be more than or equal to 25%, with an average of 30% for the former one and 37.5% for the latter one. While for the range of 1Hz to 2.5Hz and 9 Hz to 10Hz, the probability decreases to below 15%, and an average of 2.5% for B1 and 9.38% for Y1.

Yet, it was found that there is a great difference in the predatory behaviour between different individuals of *N. pilies.* For spider B1 and Y1, both of them gave response to the vibration source at different frequency ranges. But when it came to spider B2, Y2, Y3, none of them gave any response. It was also noticed that they might even escape from the web during the experiment, showing that they got scared easier than that of the previous ones. This might due to the reason that they were not well adapted to the man-made environment, during the field observation before they were being captured, it was observed that they usually gave response to anything falls onto their web when we were looking for their web cleaning behaviour. This would affect the accuracy of the data as we could not be sure that the result would be more or less the same when they were in natural environment. Not only the individual variation of adaptability would affect the result, but their health condition also. Even when all of them were fed at the same period of time twice a week after being captured, their level of hunger would not be the same owing to their different amount of energy used. The active one might spend more time on building web, which required a lot of protein and energy, while those hardly adapted to the environment would most likely just stay on their web and energy was saved. Their daily behaviour determined their requirements on the amount of food, and so as their predatory behaviour.

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[7] I-Min Tso, Chin-Wei Lin, En-Cheng Yang, (2004), Colourful orb-weaving spiders, Nephila pilipes, through a bee's eyes, Journal of Experimental Biology. Retrieved September 18, 2019, from https://jeb.biologists.org/content/207/15/2631

Furthermore, an extra finding of the learning behaviour of spiders also doubted the accuracy of the results. Referring to table 2.2, it was found that the number of responses from spider B1 and Y1 decreased when more trial was made. Both of the spiders gave 8 times of response in the first trial, but reduced to only 1 time for the former one in trial 5 and 4 times for the latter one, and 87.5% and 50% decrease. As the vibrating frequency was given out by a machine, its pattern should be the same every time, which was not supposed to happen in nature as the prey would not give constant vibration when it fell onto the web. So, at the first time, the spiders might still consider the vibrating wood stick as a prey as they never met such a situation before. After biting for so many times, finding the stick could not be eaten, the spiders might no longer see the stick as a meal, causing a decreasing trend of data. This means that they might have the ability to recognize the pattern of frequency and their reaction would not be as natural as when they are in the wild.

To conclude, the frequency ranges from 3Hz to 8.5Hz would most likely trigger the spiders' predatory behaviour. Nevertheless, their adaption to environment, health condition and learning behaviour might affect the accuracy of the results.

5.3 Discussion on Objective 3: Investigation on the web cleaning behavior of *N. pilipes*

Discarding the data from B2 and Y4 spiders as they had given no response during the study of the required minimum surface area of the rubbish, The spiders' web cleaning behaviour was triggered at trial 3 of 64 cm^2 for Mid Y, while at Trial 1 of 64cm^2, Trial 3 of 36cm^2 and Trial 1 of 1cm^2 the above behaviour of Y3 was triggered as shown in table 3.1. Their responses to surface area of rubbish were inconsistent as the behaviour, when it was triggered, were in random pattern as the spiders would still give no response even at other trials of the same surface area which they had responded before as shown in table 3.1. It might be due to limitations of the lack of wind in our lab, which failed at creating potential damage to the web to alert the spider for the triggering of web cleaning behaviour or the man-made environments of which they were not used to as discussed above. The set-up could be improved by blowing wind to the webs by a fan during the study. Still, with the inconsistent result shown in the above study, it was concluded that surface area was not a factor for the triggering of web-cleaning behaviour of large woodland spiders.

As shown in table 3.2, the required minimum mass of rubbish increased from 1.55 g at Trial 1 to 3.70 g at Trial 5, with only a slight decrease from 1.55g at Trial 1 to 1.36g at Trial 2 in the meantime. Thus, the required average minimum mass was 1.46g. The data of the first 3 trials were consistent, but the increase in the required mass of rubbish per trial showed that the results were inconsistent, which might be due to frequent repetition we had in the study. With the higher frequency of rubbish fallen onto their web compared to the wild, they might try to clean more rubbish at a time to preserve energy. After 3 trials, lots of energy had been lost but still there were rubbish fallen onto their webs. As the required mass of rubbish might still not reach the critical mass of which would destroy the webs, they waited out for more time until they had rested enough and could perform the web-cleaning behaviour. It can be improved by waiting for 20 minutes between each trial.

The other reason for the increase in required minimum mass per trial might be due to an extra finding of the potential learning behaviour of the large woodland spiders. As mass of the same rubbish increased in each trial, which was different from that of the nature where the mass of the same piece of rubbish stayed relatively the same, the spiders might learn that the mass of rubbish was just going to increase so there was no need of cleaning the rubbish early on if it still would not damage the webs. After each trial, they waited out longer for the increase in mass of rubbish to stop, which would not happen, before they clean the rubbish off as they thought the mentioned increase would soon stop. Further studies are still needed on the learning behaviour of large woodland spiders.

The data of the study on required minimum surface area is not reliable with the inconsistency as mentioned above, while the data of the study on the required minimum mass is also not reliable as only 1 spider was used, the result can be easily influenced by the independent variation of the 1 spider.

The data in the first study is not accurate with the various limitations mentioned above, as shown the minimum surface area at which triggers the web-cleaning behaviour of Y3 ranges from 1cm^2 to 64 cm^2. While the data in the second study is fairly accurate as with the limitations mentioned above, the data of the first 3 trials can still be taken as the required result as it was not much influenced by frequent repetition or learning behaviour as mentioned above.

5.4 Discussion on Objection 4 Investigation on the female detecting behaviour of male *N. pilipes*

According to the table 4, it showed that the percentage for both male spiders walked straightly to any direction and male spiders walked towards S60 did not show a significant change before and after the female spider being placed at s60. The percentage that the spider walked straight to any direction were all around 50% for both control and experimental set up, while the increase on the percentages that the male spiders walked from S20 towards S40 and S60 straightly after female spider was placed at s60 were only about 0% to 10.3%. As the result it did not give a significant change when the female spider was placed at S60, the hypothesis that the male spiders can be attracted by female could not be supported by this experimental setup. This result might be due to the reason that male spiders might be scared even if they were handled with care during the experiment and the unfamiliar environment (i.e. laboratory) for spiders. Thus no conclusion could be drawn and no further experiment for distinguishing the actual method that the male spiders were used to detect female spiders could be carried out.

For the reliability of the result, there were three male spiders used in this experiment to increase the reliability. Also, more than 12 replicates were carried out with each of the male spiders except male spider 2 which had died during the experiment and the experiment was monitored by two students to prevent the error caused by omittance in recording the result, thus increasing the reliability.

For the accuracy of the result, there were some sources of error in the experiment which were human disturbance and artificial environment. As the experiment was carried out in the laboratory, the female spiders and the male spiders might feel unaccustomed to the environment so the female spiders might not release the chemical which could attract the male spiders. The male spiders might even be scared during the experiment when students were handling them, which might lead to different mate seeking behaviour compared to that in nature. This leads to the decrease of reliability and the data would be varied. In order to reduce such error, the experiment could be carried out in nature or in the venue which has a similar environment with that the spiders live in the nature.

5.5 Extra findings

Origin of male spiders

Where would the male spiders be before they were attracted to their female for mating has been a fascinating topic that we would like to find out. During the field study on 30/7, two brown male spiders were found on the web of the two previously identified small female spiders with similar body size. Maybe the spiders had been male all along but they were not sexually mature enough to turn red when we first located them, thus we might have misidentified them as female in the first place. This gave us an insight that maybe male spiders could also build their own where they stayed and hunted before they mature. Further study is still needed on this topic.

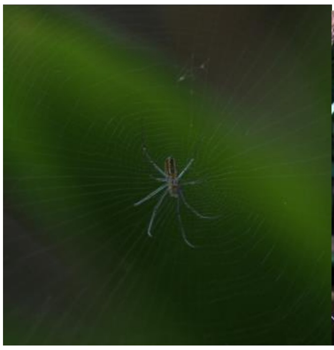

Fig.11 small spider on 22/7 Fig.12 male spider on the same web on 30/7

Web occupation behaviour

As B1 and B2 were kept in the same large mesh cage, B1 was found to have been eaten by B2 on 7/8/2019 as B2 climbed onto good b's web. On another day, Y3 was found to have climbed onto Y4's web, which forced Y4 to build another web at the opposite corner. The former was then repairing the latter's web and stayed on it until the study ends. Maybe female large woodland spiders can detect the presence of other near female spider and may then occupy the others' web for own use to preserve energy used in web building. Further study is needed on the topic.

Fig.13 B2 was consuming the remains of B1

5.6 Further investigation

To further investigate the foraging success of the spiders of different colour patterns, the female spiders of different colour patterns and similar size have to be caught. They should be divided into three groups which have normal black female spiders as a control, black female spiders painted with yellow colour, and a group of normal dominant yellow female spiders. All of them can be put in a greenhouse with nature environment provided for their daily life. After they have adapted to the new environment, flying insects like moths will be introduced into the greenhouse as a food source for the spiders during their active time. Then the number of prey caught by the spiders from each group can be counted and comparison can be made.

6. Conclusion

It is concluded that medium-sized spiders stay on their webs for a longer time than small-sized spiders. Added to this, the abundance of large-sized spiders is the lowest. Also, the body size of the spiders increases as the chance of having symbiotic spiders and the male spiders on their webs increases. Moreover, the abundance of spiders with colour pattern of yellow and black is higher than that of black.

The frequency ranges from 3Hz to 8.5Hz would most likely trigger the spiders' predatory behaviour, where a decrease in the number of responses is observed as the trials proceed.

The surface area of rubbish on large woodland spiders' webs is not a factor at triggering their web-cleaning behaviour, while the average minimum mass of rubbish in triggering the spiders' web-cleaning behaviour is 1.46g.

According to our study, the male large woodland spiders do not have any female-seeking behaviour.

7. Bibiography

1. Dickson Wong, A Guide to the Spiders of Hong Kong (2016), Society of Hong Kong Nature Explorers
2. 人面蜘蛛 Nephila pilipes - iNaturalist. Retrieved September 18, 2019, from https://www.inaturalist.org/taxa/68390-Nephila-pilipes
3. Minibeast Wildlife,Care guide Golden Orb-weaver, Nephila pilipes. Retrieved 16 September 2019, from https://shop.minibeastwildlife.com.au/content/Minibeast%20Wildlife%20Care%20Guide%20-%20Nephila%20pilipes.pdf
4. I-Min Tso, Chin-Wei Lin, En-Cheng Yang, (2004), Colourful orb-weaving spiders, *Nephila pilipes*, through a bee's eyes, Journal of Experimental Biology. Retrieved September 18, 2019, from https://jeb.biologists.org/content/207/15/2631

Appendix

Appendix 1: Raw data of vibrating experiment

Black spider No.1

	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5
1.00hz					
1.50hz					
2.00hz			Attack		
2.50hz					
3.00hz	Attack				
3.50hz	Attack				
4.00hz	Attack				
4.50hz	Attack	Attack			
5.00hz	Attack	Attack			
5.50hz	Attack				
6.00hz	Attack		Attack		
6.50hz					
7.00hz	Attack	Attack			
7.50hz		Attack			
8.00hz		Attack	Attack		Attack
8.50hz		Attack		Attack	
9.00hz					
9.50hz					

10.00hz					

Yellow spider No.2

	Trial 1	Trial 2	Trial 3	Trial 4	
1.00hz					
1.50hz				Attack	
2.00hz					
2.50hz					
3.00hz	Attack		Attack		
3.50hz	Attack		Attack		
4.00hz	Attack				
4.50hz	Attack	Attack			
5.00hz	Attack	Attack			
5.50hz	Attack				
6.00hz	Attack			Attack	
6.50hz					
7.00hz	Attack	Attack	Attack		
7.50hz		Attack			
8.00hz		Attack			
8.50hz		Attack			
9.00hz				Attack	
9.50hz				Attack	
10.00hz					

Black spider No. 3 + Yellow spider No. 4 + Yellow spider No. 5

	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5
1.00hz					
1.50hz					
2.00hz					
2.50hz					
3.00hz					
3.50hz					
4.00hz					
4.50hz					
5.00hz					
5.50hz					
6.00hz					
6.50hz					
7.00hz					
7.50hz					
8.00hz					
8.50hz					
9.00hz					
9.50hz					
10.00hz					

Appendix 2:The raw data of the walking routes of male spiders with or without female spider placed at S60

The male spider used	The male spiders' walking routes （withought female）	The male spiders' walking routes （female spider placed at S60）
male spider 1	Trial 1 ： N20 N40 W60 E60 Trial 2 ： W20 W40 W60 Trial 3 ： E20 S40 S60 Trail 4 ： E20 N20 W20 W40 W60 Trial 5 ： W20 W40 W60 Trial 6 ： E20 N40 W60 Trial 7 ： E20 E40 E60 Rest Trial 8 ： W20 S20 E20 W20 S20 N20 W20 W40 N60 Trial 9：E20 E40 E60 Trial 11 ： E20 E40 S20 S40 S60 Trial 12 ： W20 W40 W60 Trial 13 ：W20 W40 N20 N40 N60 Trial14 ：N20	Trial 1 ： S20 S40 W40 W60 Trial 2 ： W20 W40 W60 Trial 3 ： N20 N40 N60 Trial 4 ：S20 S40 W40 W60 Trial 5 ：S20 Trial 6 ： W20 W40 W60 Trial 7 ： E20 N40 N60 Trial 8 ； N20 N40 N60 Trial 9 ： E20 S40 S20 W40 W60 Trial 10 ： S20 W40 N40 N60 Trial 11 ： W20 N20 N40 N60 W60 Trial 12 ： W20 W40 W60 Trial 13 ： W20 W40 W60 Trial 14 ： N20 N40 W40 W60 Trial 15 ： N20 E20 E40 E60 Trial 16 ： N20 N40 N60 Trial 17 ： S20 S40 S20 E20 E40 E60 Trial 18 ： N20 N40 N60 Trial 19 ： N20 N40 N60 Trial 20 ； W20 W40 W60 Trial 21 ： S20 S40S60 Trial 22 ； N20 S20 S40 S60 Trial 23 ； E20 N20 N40 W40 W60 Trial 24 ： E20 E40 E60 S60 Trial 25 ： E20 N20 N40 N60 Trial 26 ： S20 S40 S60 Trial 27 ： W20 W40 W60 Trial 28 ： E20 N20 N40 N60 Trial 29 ： S20 S40 S60

male spider 2	Trial 1 ： W20 W40 W60 Trial 2 ： E20 S40 S60 Trial 3 ： E20 N20 W20 W40 W60 Trial 4 ： N20 N40 N60 W60 Trial 5 ： E20 N40 N60 Trial 6 ： E20 E40 E60 Trial 7 ： W20 W40 W60 Trial 8 ： W20 W40 W60 E60 Rest Trial 9 ： N20 W20 N40 N60 Trial 10 ：E20 W40 W60 Trial 11 ： W20 W40 W60 Trial 12 ： W20 W40 N40 N60 Trial 13 ： W20 W40 W60 Trial 14 ： N20 N40 N60 Trial 15 ： N20 N40 N60 Trial 16 ： S20 W20 W40 W60 Trial 17 ： W20 W40 W60 Trial 18 ： E20 E40 N60 Trial 19 ： E20 E40 E60	Trial 1 ： S20 W40 W60 Trial 2 ： W20 W40 W60 Trial 3 ： S20 S40 S60 E60 N60 Trial 4 ： E20 E40 E60
male spider 3	Trial 1 ：W20 W40 W60 Trial 2 ：S20 N20 N40 Trial 3 ： W20 W40 W60 Trial 4 ：W20 W40 W60 Trial 5 ：S20 E20 E40 E60 Trial 6 ：W20 N20 N40 N60 Trial 7 ：S20 S40 S60 Trial 8 ：S20 S40 S60 Trial 9 ：N20 N40 N60 Resting Trial 10 ：S20 W20 W40 W60 Trial 11 ：W20 N20 N40 N60 Trial 12 ：W20 W40 W60 Trial 13 ：W20 W40 W60 Trial 14 ：W20 W40 W60 Trial 15 ： E20 E40 E60	Male no 3 Trial 1 ： S20 S40 S60 Trial 2 ： S20 S40 S60 W60 Trial 3 ： S20 W20 W40 W60 Trial 4 ： N20 S20 S40 S60 Trial 5 ： W20 W40 N60 Trial 6 ： W20 W40 W60 Trial 7 ： W20 W40 W60 Trial 8 ： N20 E20 E40 E60 S60 Trial 9 ：S20 W20 W40 W60 Resting Trial 10 ：W20 W40 W60 Trial 11 ：E20 E40 E60 Trial 12 ： S20 S40 W20 W40 W60 Trial 13 ：S20 S40 S60 Trial 14 ：S20 S40 S60 W60 Trial 15 ：E20 E40 E60 N60

	Trial 16 ：S20 W20 W40 W60 Trial 17 ：E20 E40 E60 Trial 18 ：W20 W40 W60 Trial 19：S20 S40 W20 W40 W60 Rest Trial 20 ： S20 W20 W40 W60 Trial 21 ： W20 N20 N40 N60 Trial 22 ： W20 W40 W60 Trial 23 ： S20 S40 W40 W60 Trial 24 ： E20 E40 S40 S60 Trial 25 ： W20 W40 W60 Trial 26 ： N20 W20 W40 W60 Trial 27 ： E20 E40 E60	Trial 16 ：W20 W40 W60 Trial 17 ；E20 E40 E60 Trial 18 ：N20 N40 N60 Trial 19：E20 E40 E60 S60 Trial 20：N20 N40 N60 Trial 22：S20 S40 S60

Appendix 3 The raw data of web-lasting time of *N. pilies* with different body sizes.

spider no.	location	gender	size(body size in cm)	colour	found date	statement when return on 23/7	statement when return on 24/7
1	(22.283449,114.200550)	F	<1	yellow	7月22日	gone	gone
2	(22.284024,114.201846)	M	<1	white	7月22日	remain on same web	remain on the same web
3	(22.2826808, 114.2002959)	F	<1	yellow	7月23日	/	remain on the same web
4	(22.2836987, 114.2010885)	F	<1	yellow	7月23日	/	remain on the same web
5	(22.2836987, 114.2010885)	F	<1	yellow	7月23日	/	remain on the same web
6	(22.283787,114.201486)	F	1~2	yellow	7月22日	gone	gone
7	(22.283827,114.203606)	F	1~2	yellow	7月22日	remain on same web	remain on the same web
8	(22.284038,114.204775)	F	1~2	yellow	7月22日	remain on same web	remain on the same web
9	(22.284038,114.204775)	F	1~2	yellow	7月22日	remain on same web	remain on the same web
10	(22.283787,114.204674)	F	1~2	yellow	7月22日	remain on same web	gone
11	(22.283736,114.205039)	F	1~2	yellow	7月22日	gone	gone
12	(22.2825766, 114.2003237)	F	1~2	yellow	7月23日	/	remain on the same web
13	(22.2836987, 114.2010885)	F	1~2	yellow	7月23日	/	remain on the same web
14	(22.2841299, 114.2020557)	F	1~2	yellow	7月23日	/	gone
15	(22.2838594, 114.2036688)	F	1~2	yellow	7月23日	/	remain on the same web
16	(22.2840328, 114.2045442)	F	1~2	yellow	7月23日	/	gone
17	(22.2833255, 114.2036134)	F	1~2	yellow	7月24日	/	/
18	(22.284103,114.201967)	F	2~4	yellow	7月22日	remain on same web	remain on the same web
19	(22.284144,114.202026)	F	2~4	yellow	7月22日	gone	gone
20	(22.283386,114.203610)	F	2~4	yellow	7月22日	gone	gone
21	(22.284006,114.203598)	F	2~4	yellow	7月22日	remain on same web	remain on the same web
22	(22.284006,114.203598)	F	2~4	yellow	7月22日	remain on same web	gone
23	(22.284006,114.203598)	F	2~4	yellow	7月22日	gone	gone
24	(22.284104,114.203596)	F	2~4	yellow	7月22日	/	/
25	(22.284275,114.203744)	F	2~4	yellow	7月22日	gone	gone
26	(22.284442,114.203883)	F	2~4	yellow	7月22日	remain on same web	remain on the same web
27	(22.284385,114.203933)	F	2~4	yellow	7月22日	remain on same web	remain on the same web
28	(22.284426,114.203911)	F	2~4	yellow	7月22日	remain on same web	remain on the same web

statement when return on 26/7	statement when return on 30/7	web day lasting	number of sym on web on 22/7
return to the same web	gone	X	0
remain on the same web	turn into a male(gone, and a male take over the web)	X	0
remain on the same web	gone	3	0
remain on the same web	gone	3	0
gone	gone	1	0
gone	gone	0	0
remain on the same web	gone	4	1
remain on the same web	gone	4	5
gone	gone	3	2
gone	gone	1	0
gone	gone	0	/
remain on the same web	gone	3	0
remain on the same web	gone	3	0
gone	gone	0	0
gone	gone	1	0
gone	gone	0	0
remain on the same web	gone	X	0
gone	goen	2	1
gone	return to the same web	X	0
gone	gone	0	2
remain on the same web	gone	4	4
return to the same web	gone	1	4
gone	gone	0	0
/	/	X	4
gone	return to the same web	X	1
remain on the same web	remain on the same web	8	0
remain on the same web	gone	4	1
remain on the same web	gone	4	6

number of sym on web on 23/7	number of sym on web on 24/7	number of sym on web on 26/7	number of sym on web on 30/7
0	0	0	0
0	0	0	1
0	0	1	0
0	0	1	0
0	0	0	0
0	0	0	0
0	4	7	0
11	15	24	0
3	0	0	0
0	0	0	0
/	/	/	/
0	1	2	0
0	0	1	0
0	0	0	0
0	0	0	1
0	0	0	0
0	0	2	0
0	2	0	0
0	0	0	8
0	0	0	0
2	3	8	0
2	0	11	0
0	0	0	0
/	/	/	/
0	0	0	8
0	6	0	8
0	4	2	0
0	8	9	0

Ever have sym	date for discovering a male on the web	Remark
n	no male found	
y	no male found	
y	no male found	
y	no male found	
n	no male found	
n	1 male found on 22/7	
y	no male found	
y	no male found	
y	1 male found on 22/7	
n	no male found	
n	no male found	
y	no male found	
y	no male found	
n	no male found	
y	no male found	
n	no male found	
y	no male found	
y	no male found	
y	no male found	
y	no male found	
y	no male found	
y	no male found	
n	no male found	
/	no male found	Captured for lab study
y	no male found	
y	no male found	
y	no male found	
y	1 male found on 23/7, but gone on 24/7, and another male found riding on the back of the male on 26/7	

No.	Location	gender	size(cm)	Colour	Found date	Statement on 23/7
28	(22.284426,114.203911)	F	2~4	yellow	7月22日	remain on same web
29	(22.284416,114.203977)	F	2~4	yellow	7月22日	gone
30	(22.283941,114.204778)	F	2~4	yellow	7月22日	remain on same web
31	(22.283736,114.205039)	F	2~4	yellow	7月22日	gone
32	(22.2841110, 114.2020182)	F	2~4	black	7月23日	/
33	(22.2831111, 114.2030354)	F	2~4	yellow	7月23日	/
34	(22.2843183, 114.2037945)	F	2~4	yellow	7月23日	/
35	(22.2840288, 114.2047128)	F	2~4	yellow	7月23日	/
36	(22.2840524, 114.2036366)	F	2~4	yellow	7月23日	/
37	(22.2837269, 114.2050384)	F	2~4	yellow	7月23日	/
38	(22.2838138, 114.2051128)	F	2~4	yellow	7月23日	/
39	(22.2832101, 114.2034569)	F	2~4	yellow	7月24日	/
40	(22.2836249, 114.2035300)	F	2~4	yellow	7月24日	/
41	(22.2840719, 114.2045945)	F	2~4	yellow	7月24日	/
42	(22.2839407, 114.2054789)	F	2~4	black	7月24日	/
43	(22.2835588, 114.2044909)	F	2~4	yellow	7月26日	/
44	(22.283787,114.204674)	F	4~6	yellow	7月22日	remain on same web
45	(22.284426,114.203911)	F	4~6	yellow	7月22日	remain on same web
46	(22.2842717, 114.2023565)	F	4~6	yellow	7月23日	/
47	(22.283375,114.203590)	F	>6	black	7月22日	/
48	(22.284104,114.203596)	F	>6	yellow	7月22日	gone
49	(22.283787,114.201486)	M	<1	red	7月22日	/
50	(22.283375,114.203590)	M	<1	red	7月22日	/
51	(22.284038,114.204775)	M	<1	red	7月22日	/
52	(22.2838138, 114.205112)	M	<1	red	7月26日	/
53	(22.284426,114.203911)	M	<1	red	7月22日	remain on same web

Statement on 24/7 Statement on 26/7 Statement on 30/7

remain on the same web	remain on the same web	gone
gone	return to the same web	gone
remain on the same web	built a new web at location(22.2838814, 114.20	gone
gone	gone	gone
gone	gone	gone
remain on the same web	remain on the same web	gone
gone	gone	remain on the same web
remain on the same web	remain on the same web	gone
remain on the same web	remain on the same web	gone
remain on the same web	remain on the same web	gone
remain on the same web	remain on the same web	remain on the same web
/	remain on the same web	gone
/	gone	gone
/	remain on the same web	gone
/	gone	gone
/	/	moved her web to(22.2837344, 114.2035930)
remain on the same web	gone	gone
remain on the same web	remain on the same web	gone
built a new web at location(22.2842534, 114.2023106)	remain on the new web	gone
/	/	/
gone	gone	gone
/	/	/
/	/	/
/	/	/
/	/	/
gone	return to the same web	remain on the same web

Web day lasting	number of sym on 22/7	number of stm on 23/7	number of sym on 24/7	number of sym on 26/7
4	6	0	8	9
X	5	0	0	7
X	3	0	0	9
0	3	0	0	0
0	0	0	0	0
3	0	1	3	4
X	0	0	0	0
3	0	0	2	0
3	0	5	3	11
3	0	0	0	0
7	0	3	0	31
X	0	0	5	5
X	0	0	4	0
X	0	0	8	2
X	0	0	0	0
X	0	0	0	0
2	7	5	4	0
4	10	5	6	20
X	0	13	5	12
X	14	/	/	/
0	10	0	0	0
X	/	/	/	/
X	/	/	/	/
X	/	/	/	/
X	/	/	/	/
X	/	/	/	/

number of stm on 30/7   Ever have sym   date for discovering a male on a web   Remark

0	y	1 male found on 23/7, but gone on 24/7, and another male found riding on the back of the male on 26/7	
0	y	no male found	
0	y	no male found	
0	y	no male found	
0	n	no male found	
0	y	no male found	
4	n	no male found	
0	y	no male found	
0	y	no male found	
0	n	no male found	
6	y	1 male found on 26/7	
0	y	no male found	
0	y	no male found	
0	y	no male found	
0	n	no male found	
2	y	no male found	
0	y	no male found	
0	y	no male found	
0	y	1 male found on 26/7	
/	y	1 male found on 22/7	Captured for lab study
0	y	no male found	
/	/	/	On the same web with 06, captured for lab study
/	/	/	On the same web with 47, captured for lab study
/	/	/	On the same web with 09, captured for lab study
/	/	/	On the same web with 38
/	/	/	On the same web with 28