中華人民共和國香港特別行政區政府總部食物及衞生局
Food and Health Bureau, Government Secretariat
The Government of the Hong Kong Special Administrative Region
The People's Republic of China

[English Translation]

14 February 2019

Clerk to Panel on Food Safety and Environmental Hygiene
Legislative Council Complex
1 Legislative Council Road
Central
Hong Kong
(Attention: Miss Josephine SO)

Dear Miss SO,

Follow-up to the Panel on Food Safety and Environmental Hygiene Survey Results and Control Strategy Against Biting Midges

Regarding the captioned subject at the Panel meeting on 8 January 2019, our response is as follows:

(1) The Technical Guideline on Prevention and Control of Biting Midges (English only) and the biting midges survey report conducted by the Food and Environmental Hygiene Department (FEHD) between July 2017 and July 2018 (English only) are at **Annex 1** and **Annex 2** respectively.

(2) According to the results of the survey, the main breeding sites of the blood sucking midges that cause nuisances are parks. The survey results have been conveyed to the Leisure and Cultural Services Department (LCSD)

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and the Housing Department (HD) for reference to facilitate targeted control work in parks and open spaces with vegetation. Relevant departments will closely monitor the biting midges situation in venues under their purview. Apart from regular plant pruning and clearance of decaying and broken branches, they will enhance control of biting midges where necessary, including the engagement of professional pest control contractors to carry out fogging and apply residual insecticides in places where biting midges are prevalent, and install insect trapping devices in outdoor venues where biting midges are frequently found.

FEHD will continue to provide technical assistance to the management staff of such venues, including conducting site inspections and offering advice on prevention and control measures. It will also monitor the biting midges situation in public places through routine inspections by frontline staff, district feedbacks and complaints follow-up, thereby facilitating timely adjustment of the response strategy.

Furthermore, FEHD has formulated the Technical Guideline on Prevention and Control of Biting Midges for relevant departments' reference, with a view to tackling the issue at source by reducing potential breeding sites. It will continue to organise training and talks on the prevention and control of biting midges for the relevant departments, including LCSD and HD. FEHD also stands ready to provide technical advice on measures against biting midges to owners or management staff of private premises infested with biting midges.

(3) The insect trapping devices available in the market which generally use carbon dioxide and light as lures have been effective to a certain extent in trapping blood sucking midges. If trapping devices are placed near the breeding places of blood sucking midges and at locations with high density of people, nuisance caused by biting midges can be minimised. FEHD has recommended relevant departments to install trapping devices in venues under their purview where necessary. As at October 2018, LCSD installed some 1 300 insect trapping devices in its venues.

(4) FEHD, in collaboration with the Centre for Health Protection of the Department of Health (DH), has formulated guidelines on the proper use of insect repellents, which have been uploaded to the websites of FEHD

and DH for reference by the public. These guidelines are at **Annex 3**.

(5) The Pest Control Steering Committee (Steering Committee) met on 24 January 2019 to plan ahead for the overall deployment of pest control work throughout the year. It set objectives in three areas: strengthening prevention, co-ordination and surveillance. Under the co-ordination of the Steering Committee, some departments have been allocated additional resources to enhance pest control work. For FEHD, a total of about 700 staff are deployed to carry out pest control work.

To abate the nuisance caused by biting midges, departments have been requested by the Steering Committee to formulate targeted prevention and control measures against biting midges, taking into account their habitual behaviours as well as their seasonal and localised activity patterns. Departments are also reminded to start prevention and control work before the breeding season of biting midges (i.e. May), targeting at places where biting midges are active to tackle the issue at source by reducing sites suitable for breeding of biting midges supplemented by the adoption of direct control measures (e.g. application of larvicides and fogging operation). FEHD will continue to provide technical support to relevant departments.

Yours sincerely,

[Signed]

(Gilford LAW)
for Secretary for Food and Health

c.c.: Director of Food and Environmental Hygiene
Director of Leisure and Cultural Services
Director of Housing

附件一
Annex 1

Technical Guideline on Prevention and Control of Biting Midges

Biting midges are fly belonging to the family Ceratopogonidae. Adults are about 1-4 mm long, dark-coloured with female possessing piercing and sucking mouthparts.

2. Larvae are aquatic or semi-aquatic, being found in damp places or in mud. Adults can usually hatch in about 40 days but cooler weather will lengthen the process to about several months. Adults rest in dense vegetation and sometimes shady places. They fly in zigzag patterns and seldom fly more than 100 meter from their breeding grounds; however, dispersal by wind is possible. Nevertheless, wind over 5.6 kilometers/hour and temperatures below 10°C inhibit flying. In fact they are so fragile that cool and dry weather will shorten their longevity. Only female bite but they rarely do it indoors. Since they have short mouthparts, they cannot bite through clothing and so exposed body parts are more often attacked.

3. Irritation caused by bites of these midges can last for days, or even weeks. Scratching aggravates the pruritus and may lead to bacterial infection and slow-healing sores. However, biting midges are not considered important vectors of human diseases locally.

4. Different genera of Ceratopogonidae vary in their habits and biology. The control methodology for different genera should be tailor-made so as to enhance the effectiveness of the control measures. Almost all *Culicoides* (庫蠓屬) tend to be crepuscular or nocturnal feeders while *Lasiohelea* (蠛蠓屬) are diurnal and bite human at daytime. As these two genera of biting midges breed in different habitats, larval control measures for a particular genus should be carried out at the right places. The following prevention and control methods can be considered as appropriate:

A) Larval control for *Lasiohelea taiwana* (台灣蠛蠓)

Source reduction could be achieved by the following:

a) keeping moisture content of soil surface low by techniques like ploughing or draining;
b) removing refuse, fallen leaves and other decaying vegetation as well as muddy soil in sand-traps and surface drainage channels;
c) using barks or wood chips as covering mulch should be avoided as

these materials not only make the top soil suitable for larval development, the materials themselves could be favourable breeding grounds as well;

Using wood chips as covering mulch should be avoided

d) trimming vegetation on a regular basis to increase the exposure of soil surface to sunlight and air;
e) covering the soil surface with a few centimeter depth of round, non-water absorbency small pebbles may help to discourage larval growth;
f) leaking pipes, especially those in flower bed, should be repaired promptly to prevent the propagation of biting midges;

Moistures from leaking pipes often support biting midges infestation

g) removing the top surface soil for 1 to 2 cm to get rid of a great proportion of the developing larvae when the infestation is serious, as most *Lasiohelea* larvae live in the top layer of soil; and

h) applying insecticide at breeding places. Temephos in sand granules

formulation or *Bacillus thuringiensis israelensis* may help to arrest adults from hatching.

B) Larval control for *Culicoides*

As the breeding places of *Culicoides* are somewhat similar to those for *Aedes albopictus*, operators should target on aquatic environment. If the breeding sources or potential breeding grounds are unable to be eliminated, larviciding should be carried out whenever possible and practical. Temephos in sand granules formulation or *Bacillus thuringiensis israelensis* are possible choice of chemicals for use. Studies indicate that the effect in suppressing larval growth last for 3 to 6 weeks after each application of larvicide.

Under certain circumstances, fish can be used as a tool for larval control.

C) Timing of control

It was observed that the activities were generally low from December to April and started to be significantly active in May and reached its peak in June. To allow environmental control measures to take effect, actions should be taken well before the biting midges become active in May, particularly breeding places for *Lasiohelea taiwana* that caused major nuisance to human. Specific measures suggested in A) should be closely observed and actions should be taken to deplete potential breeding places before the onset of moist and wet season.

D) Adult control

Suppressing adult biting midges with insecticides only provide limited and short term effect. However, suppressing the density of adult biting midges by ULV treatment is still used under special circumstances to provide temporary relief when needed. In cases when pesticide treatment is warranted, recent systematic assessments suggested that cypermethrin could be a suitable choice. If the targeted midges are a daytime biter (i.e. *Lasiohelea* species), studies have demonstrated that they have a peak of activity at around 10 a.m. Should ULV treatment be conducted to knock down the adult insects, it would be more effective to carry out the insecticidal treatment say at around 8 a.m., when most of the ceratopogonids are still hiding in their resting places.

Installation of Carbon dioxide releasing traps (or with other attractants

such as Octene-3-ol) at strategic points with insect net of 60 x 60 mesh per square inch can be considered as a complementary control measure. The traps should be kept operating during the day to contain the population of daytime biting midges. Operating the traps at night could combat the crepuscular biting midges.

Pest Control Advisory Section
Food and Environmental Hygiene Department
September 2018

附件二
Annex 2

Report on Biting Midges Survey in Hong Kong

Mr M.L. CHAN, Advisor (Pest Control)

Pest Control Advisory Section

Food and Environmental Hygiene Department

Content

Introduction

The family Ceratopogonidae is a large and diverse group of insects belonging to the order Diptera. Although this family consists of more than 110 genera and 6,090 living species, only four genera are considered as blood-sucking flies, namely *Culicoides*, *Leptoconops*, *Lasiohelea* and *Austroconops* (the genus *Austroconops* includes just two living species and their distribution is limited to Western Australia only[1]).

2. Although the blood-sucking species may potentially act as a vector in transmitting certain diseases to human, comprehensive studies on this group of insects in Hong Kong is lacking and we know little on their biology in our local fauna. In May 2006, the Pest Control Advisory Section (PCAS) invited Professor YU Yi-Xin (虞以新)[2] to study the biting midges in Hong Kong. During his two weeks' visit, entomological surveys were conducted to get a rough picture of the insect bionomic in the territory. In his visiting report (香港地區吸血蠓初記)[3], Professor Yu pointed out that there are 24 species of blood-sucking ceratopogonids known to occur in Hong Kong. They are namely:

Genus *Culicoides*

1. *Culicoides anopheles*, Edwards1900 嗜蚊庫蠓
2. *Culicoides arakawai*, Arakawa 1910 荒川庫蠓
3. *Culicoides circumbasalis*, Tokunaga 1959 環基庫蠓
4. *Culicoides circumscriptus*, Kieffer 1918 環斑庫蠓
5. *Culicoides fulvus*, Sen et Das Gupta 1959 微黃庫蠓
6. *Culicoides hewitti*, Causey 1938 何微庫蠓
7. *Culicoides lanshangensis*, Howarth 1985 南山庫蠓
8. *Culicoides mcdonaldi*, Wirth et Hubert, 1989 麥氏庫蠓
9. *Culicoides orientalis*, Macfie 1932 東方庫蠓
10. *Culicoides palpifer*, Das Gupta et Ghosh 1956 撫鬚庫蠓
11. *Culicoides paraflavescens*, Wiyth et Hubert 1959 趨黃庫蠓

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1 *Austroconops*, a Lower Cretaceous Genus of Biting Midges Yet Living in Western Australia: a New Species, First Description of the Immatures and Discussion of Their Biology and Phylogeny; by Art Borkent & Douglas A. Craig; The American Museum of Natural History, Number 3449, August 23, 2004

2 Beijing Institute of Microbiology and Epidemiology, State Key Laboratory of Pathogen and Biosecurity

3 寄生蟲與醫學昆蟲學報 Vol. 14, No.3, Sept 2007

12. *Culicoides peregrinus,* Kiffer 1910 異域庫蠓
13. *Culicoides shortti,* Smith et Swanminath 1932 肖特庫蠓
14. *Culicoides toshiokai,* Kitaoka 1975 岡庫蠓
15. *Culicoides zhuhaiensis,* Yu et Hao 1988 珠海庫蠓
16. *Culicoides actoni,* Smith 1959 琉球庫蠓

Genus *Leptoconops*

17. *Leptoconops hongkongensis,* Yu 2006 香港細蠓

Genus *Lasiohelea*

18. *Lasiohelea divergena,* Yu et Wen 1982 擴散蠛蠓
19. *Lasiohelea humilavolita,* Yu et Liu, 1982 低飛蠛蠓
20. *Lasiohelea hygroecia,* Yu, Liang et Chen 潮濕蠛蠓
21. *Lasiohelea mixta,* Yu et Liu, 1982 混雜蠛蠓
22. *Lasiohelea taiwana,* Shiraki 1913 台灣蠛蠓
23. *Lasiohelea thyesta,* Yu, Chen et He 扭曲蠛蠓
24. *Lasiohelea wuyiensis,* Shen et Yu, 1990 武夷蠛蠓

3. The 24 species fall mainly under the two genera, namely *Lasiohelea* (7 species) and *Culicoides* (16 species). *Leptoconops* was only sampled on one occasion with two adults being collected. In the subsequent visit made by Professor YU, he also found two more species of *Lasiohelea* species in Hong Kong, they are namely *Lasiohelea phototropia* (趨光蠛蠓) and *Lasiohelea danxianensis* (儋縣蠛蠓).

4. As Professor Yu visited Hong Kong only for a very short duration and a limited number of places, his findings were by no means representative enough to reflect the whole picture of the local Ceratopogonidae fauna nor did we have sufficient sampling data to draw a conclusion confirming that vectors of important diseases species do not exist in Hong Kong. To further enhance the control of biting midges, FEHD invited Professor Yu to visit Hong Kong in June 2016 with a view to providing expert advice and recommendations for us to study the local fauna of biting midges in the territory and review our control methodology.

5. Acting on the advice of Professor Yu, PCAS has embarked on a one-year territory-wide survey since mid-July 2017 to investigate the distribution and species diversity of the blood-sucking midges with a view to confirming the presence of any disease carrying biting midges, and to study

the seasonal variation of their activities for providing a scientific basis for updating and fine-tuning the current biting midges prevention and control strategies. Building on the model of survey devised by Professor Yu during his visit to Hong Kong in 2016, this project aims to study, inter alia, the public health importance of this insect in local situation and establish a milestone for future study. To tap on his expertise, Professor Yu was invited to visit Hong Kong again in March 2018 to provide technical advice on the methodology and taxonomy deployed for the survey.

Objectives

6. The objectives of this study are:

a) to find out the prevalent species of blood-sucking biting midges in Hong Kong and their geographic distribution;
b) to update our species diversity record and look for the presence of any new species that has not been recorded before;
c) to study the seasonal variation in biting midges activity;
d) to search whether vector species occur locally;
e) to review the health implication with our findings;
f) to provide insight into control methodology;
g) to establish an identification key on blood-sucking midges for Hong Kong; and
h) to provide scientific fundamental background for future study.

Methods

7. A total of 257 sampling exercises were conducted at various locations over the territory. Biting midges were sampled by three different methods as listed below:

a) Light trapping:
The traps deployed for the surveys were fabricated by PCAS with reference to Professor Yu's recommendations[4]. The ultra-violet (UV) light source was produced by a 12V light bulb which could emit UV light with wavelength of around 300 nm. An electric fan with about 3,000 revolution per minute was used to draw the insect into a collection net. During trapping, octene-3-ol was used to enhance the attractiveness in enticing adult ceratopogonids to approach the traps. The traps were set up at selected locations and operated overnight from dusk till dawn.

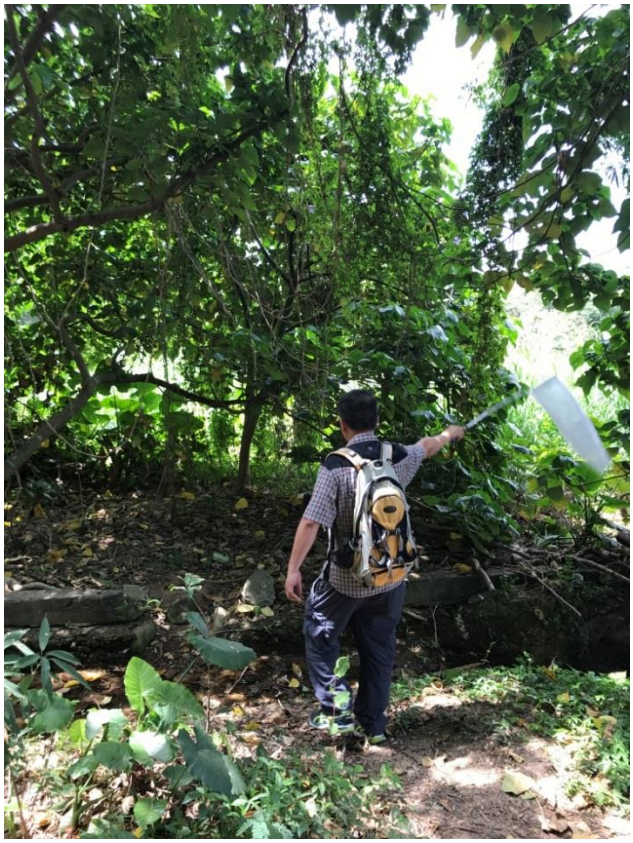
Light trap

4 中國蠓科昆蟲 第二卷；虞以新，軍事醫學科學出版社；2006

b) Netting:

Biting midges were also collected by specially designed nets with a diameter of 20 cm and mesh size of less than 0.75 mm. During the sampling, collectors walked slowly at the sites under study and swiped the net in air to collect the flying adults.

Net for biting midges collection



Collecting flying biting midges

c) Baiting:

In this sampling method, collectors rolled up their trousers and exposed their legs to attract biting midges to land on their skin for blood. The insects were hand-collected by vials/test tubes before they bit. This method allows collection of blood-sucking biting midges which attempt to prey on human. By counting the number of biting midges land on skin per man per hour, the man landing rate of biting midges was enumerated. The man landing rate reflects the relative activities of blood-sucking midges in an area. Four locations with records of repeated complaints on biting midges infestations were selected for the study. Each site was visited monthly by the same team of collectors. Data collected was used to enumerate the average monthly landing rate.

Human baiting / Man Landing Rate

8. Biting midges collected by all the above mentioned methods were knocked down by chloroform and the insects digested in 10% potassium hydroxide for 6 to 8 hours to unveil their internal anatomy. The digested specimens were then filtered and washed twice with distilled water. Each washing included a 15-minute soaking with water. Cleared ceratopogonids

were passed through graded concentration of alcohol (for 15 minutes in each grade) beginning from the lowest in this order: 70%, 80%, 90% and 100%. Finally, the midges were washed twice with distilled water again before they were dissected under microscope to separate the head, thorax, wing and abdomen. Each dissected insect was then mounted on a microscopic glass slide. The insects were identified under high power magnification after the mounting agent was fully dried.

9. Various morphological features of the mounted specimens were examined, including the wing pigmentation pattern, presence or absence of macrotrichia, shape of third palpal segment, antennal segments ratio, distribution of sensilla coeloconic, morphology of male genitalia, features of spermathecae, etc. The identification work was carried out with reference to several identification keys. Selected microscopic glass slides were sent to Professor Yu to certify our identification results. Pictures of the insect were taken under various magnifications for future reference and preparation of a pictorial identification key for the collected species.

Results

10. Throughout the year, 257 sampling exercises had been conducted by the following sampling methods: (i) 48 of them were sampled by human baiting; (ii) 142 sampling exercises were by netting; and (iii) 67 were by light traps. The total number of ceratopogonids so collected was 1,362, among which 247 belonged to the genus *Lasiohelea*, 605 were *Culicoides* and the remaining 510 were non-biting ceratopogonids (including the genera *Atrichopogon*, *Forcipomyia* and *Dasyhelea*). The non-biting midges are considered as beneficial insects in agriculture and horticulture as they play an important role in pollination. The table below summarized the species and the number of biting midges collected throughout the study.

Sampling method	**No. of sampling exercises taken**	**No. of ceratopogonids collected**			
		Lasiohelea	***Culicoides***	**Non-blood sucking species**	**Sub-total**
Netting	142 (in 93 different locations)	86	3	266	355
Light trap	67 (in 67 different locations)	7	602	244	853
Human baiting	48 (in 4 different locations)	154	0	0	154
Total	257 (in 133 different locations*)	247	605	510	1,362

Table 1: Number and types of ceratopogonids collected by different methods
(*Some locations were sampled more than once whilst some were studied by more than one sampling methods.)

Newly found species

11. Apart from the 16 *Culicoides* species previously reported by Professor Yu, seven *Culicoides* species which are not previously collected

locally were found in our surveys. They are:

Culicoides bedfordi 派附庫蠓,
Culicoides huffi 霍飛庫蠓,
Culicoides hui 屏東庫蠓,
Culicoides japonicas 大和庫蠓 ,
Culicoides liukueiensis 近緣庫蠓,
Culicoides okinawensis 沖繩庫蠓, and
Culicoides subfascipennis 亞單帶庫蠓.

12. No new species was found for the genera *Leptoconops* and *Lasiohelea* throughout our surveys.

Sampling by netting

13. A total of 142 collection exercises by netting were conducted at 93 locations over the territory. The species of blood-sucking ceratopogonids collected are summarized below:

Location	Blood-sucking Species Found
1. Ah Kung Kok, Ma On Sha	*Lasiohelea taiwana*
2. Ap Lei Chau Park	*Lasiohelea taiwana*
3. Areas around Inspiration Lake	Nil
4. Big Wave Bay Picnic Area	*Lasiohelea taiwana*
5. Chai Wan North Service Reservoir Playground	Nil
6. Chai Wan Park	*Lasiohelea taiwana*
7. Cherry Street Park	Nil
8. Chik Tai Lane Garden, Tai Wan	*Lasiohelea taiwana*
9. Ching Wah Garden & Ching Wah Playground	*Lasiohelea danxianensis* *Lasiohelea taiwana*
10. Clear Water Bay Country Park	Nil
11. Fa Hui Park	*Lasiohelea taiwana*
12. Fu Shan Public Mortuary Tai Wai	Nil
13. Fung Shek Street & Fung Shing Court	Nil
14. Fung Tak Playground	*Lasiohelea humilavolita*; *Lasiohelea taiwana*
15. Hammer Hill Park	*Lasiohelea taiwana*

Location	Blood-sucking Species Found
16. Han Garden, Lei Cheng Uk Han Tomb Museum	Nil
17. HK Zoological & Botanical Gardens	*Lasiohelea taiwana*
18. Hoi Ha, Sai Kung	*Lasiohelea mixta*
19. Hong Kong Park	*Lasiohelea mixta; Lasiohelea taiwana*
20. Hong Kong Velodrome Park, Tseung Kwan O	Nil
21. Hong Kong Victoria Park	*Lasiohelea taiwana*
22. Hong Ning Road Park	Nil
23. Hong Tak House, Tsz Wan Shan	Nil
24. Jordan Valley Park	*Lasiohelea danxianensis*
25. Kai Kuk Shue Ha, Luk Keng	Nil
26. Kai Tak Cruises Terminal Park	Nil
27. King Lam Estate	Nil
28. King's Park	Nil
29. Kowloon Reservoir Barbecue Area	Nil
30. Kowloon Tong (Cornwall Street Park)	Nil
31. Kowloon Tsai Park	Nil
32. Kowloon Walled City Park	Nil
33. Kwai Fong Street Playground	*Lasiohelea taiwana*
34. Lai Chi Kok Park	Nil
35. Lai Chi Wo	Nil
36. Lam Tin Park	*Lasiohelea taiwana*
37. Lam Tin, hillslope along Sin Fat Rd	Nil
38. Lion Rock Park	*Lasiohelea taiwana*
39. Lok Lo Ha Village, Fo Tan	Nil
40. Lok Wah Street Playground and Tsz Wan Shan Estate Service Reservoir Playground	Nil
41. Lower Shing Mun Reservoir	Nil
42. Luk Keng (near 56K minus bus terminal)	Nil
43. Ma Hang Park, Stanley	*Lasiohelea taiwana*
44. Ma Pui Tsuen, Lei Yue Mun	Nil
45. Mong Tseng Wai, Lau Fau Shab	Nil
46. Morse Park	Nil

Location	Blood-sucking Species Found
47. Mount Parker (near Sir Cecil's Ride)	Nil
48. Mount Parker Road Green Trail	*Lasiohelea taiwana*
49. Muk Min Ha Garden, Tsuen Wan	*Lasiohelea taiwana*
50. Nam Cheong Park	*Lasiohelea taiwana*
51. Pak Sha O	Nil
52. Pak Tam Chung, Sai Kung	Nil
53. Po Tsui Park, Tseung Kwan O	Nil
54. Pok Fu Lam Reservoir	Nil
55. Sam A Tsuen, North District	Nil
56. Sha Tin Park, Sha Tin	*Lasiohelea taiwana*
57. Shau Kei Wan Service Reservoir Playground	Nil
58. Shek O Beach	Nil
59. Shek O Road (near Shek O Country Club)	Nil
60. Shek Pai Street Park Kwai Chung	Nil
61. Shing Mun Reservior	*Lasiohelea taiwana*
62. Shing Mun Valley Park	*Lasiohelea taiwana*
63. Tai Hang Tung Recreation Ground	*Lasiohelea taiwana*
64. Tai Mong Tsai Campsite	Nil
65. Tai Po Road 7½ Mile-Stone Rest Garden	Nil
66. Tai Po Waterfront Park	*Lasiohelea humilavolita; Lasiohelea taiwana*
67. Tai Tam Reservoir	Nil
68. Tai Wong Ha Playground	Nil
69. Tin Hau Temple Road Garden No.2	Nil
70. Tin Shui Wai Park	*Lasiohelea taiwana*
71. Tin Shui Wai Tin Yuet Road (near Wetland Park)	Nil
72. Tin Shui Wai, Tin Heng Estate	Nil
73. Tin Shui Wai, Tin Shui Estate	Nil
74. To Yuen Street Playground	Nil
75. Tseung Kwan O Jockey Club Clinic	*Lasiohelea mixta*
76. Tseung Kwan O Waterfront Park	Nil
77. Tsim Bei Tsui, Deep Bay	*Lasiohelea taiwana*
78. Tsing Lung Garden, Tuen Mun	Nil
79. Tsing Yi Park	Nil

Location	Blood-sucking Species Found
80. Tsing Yi Pier and Tsing Yi Promenade	Nil
81. Tsing Yu Street Garden	*Lasiohelea taiwana*
82. Tsung Tsai Yuen, Tai Po Au	Nil
83. Tuen Mun Park	*Lasiohelea taiwana*
84. Wan Chai Gap Park, Wan Chai	*Lasiohelea taiwana*
85. West End Park, Central & Western District	Nil
86. Wong Yi Chau Village, Sai Kung	*Lasiohelea taiwana*
87. Wu Kau Tang, Tai Po	*Lasiohelea taiwana*
88. Yau Yue Wan Children's Playground, Tseung Kwan O	*Lasiohelea taiwana*
89. Yuen Chau Kok Park (Lowland), Sha Tin	*Lasiohelea taiwana* *Lasiohelea mixta*
90. Yuen Chau Kok Park (Upland), Sha Tin	*Lasiohelea taiwana* *Lasiohelea mixta*
91. Yung Shue O, Sai Kung	*Lasiohelea mixta* *Culicoides bedfordi*
92. Yung Shue Wan, Lamma Island	*Lasiohelea taiwana*
93. Yuen Long Park	*Lasiohelea taiwana*

Table 2: Types of bood-sucking ceratopogonids collected by netting

Sampling by light trapping

14. Throughout the survey, 67 sampling exercises by light traps had been conducted at 67 locations over the territory. The results are summarized below:

Location	Blood-sucking species found
1. Ap Lei Chau Park, Southern District	Nil
2. Big Wave Bay Picnic Area, Southern District	Nil
3. Deep Water Bay, Southern District	*Culicoides huffi*
4. Fa Hui Park, Sham Shui Po	Nil
5. Fu Shan (near Public Mortuary), Tai Wai	Nil
6. Fu Yung Shan, Tsuen Wan	*Culicoides lansangensis*
7. Ha Pak Nai, Yuen Long	*Culicoides paraflavescens*

Location	Blood-sucking species found
	Culicoides lansangensis *Culicoides actoni*
8. Heung Yuen Wai, Sha Tau Kok	*Culicoides liukueiensis*
9. Hoi Ha, Sai Kung	*Culicoides arakawai,* *Culicoides zhuhaiensis*
10. Hok Tau Wai, Fanling	*Culicoides liukueiensis,* *Culicoides actoni,* *Culicoides fulvus*
11. Inspiration Lake, Lantau	Nil
12. Kai Kuk Shue Ha, Luk Keng, Sha Tau Kok	Nil
13. Kau Tam Tso, Tai Po	*Culicoides bedfordi*
14. Kowloon Walled City Park, Kowloon City	Nil
15. Kuk Po (near Luk Keng), North District	*Culicoides mcdonaldi*
16. Lai Chi Wo, North District	*Lasiohelea mixta*
17. Lai Chi Yuen, Mui Wo, Lantau	*Culicoides lansangensis*
18. Lai Tau Shek, Tai Po	*Culicoides okinawensi*
19. Lam Tin Park, Kwun Tong	Nil
20. Ling To Monastery, Ha Tsuen, Yuen Long	Nil
21. Lo Kei Wan, Ngo Mei CHAU, North District	*Culicoides mcdonaldi*
22. Lo Sha Tin, Wong Wan Chau, North District	*Culicoides hewitti* *Culicoides circumbasalis* *Culicoides mcdonaldi*
23. Luk Keng Chan Uk, North District	*Culicoides lansangensis* *Culicodes subfcipennis*
24. Luk Keng Lo Uk, North District	*Culicoides paraflavescens* *Culicoides lansangensis* *Culicoides hewitti* *Culicoides japonicas* *Culicoides hui*
25. Luk Keng Nam Hang Mei, North District	*Culicoides mcdonaldi* *Culicoides orientalis*
26. Luk Tei Tong, Mui Wo, Lantau	*Culicoides huffi* *Culicoides actoni*
27. Lung Mei Hang, Mui Wo, Lantau	Nil
28. Ma On Shan (near A Kung Kok), Sha Tin	Nil

Location	Blood-sucking species found
29. Man Uk Pin, Sha Tau Kok	*Culicoides liukueiensis* *Culicoides fulvus*
30. Mirror Pool, Tai Po	Nil
31. Mong Tseng Wai Lau Fau Shan, Yuen Long	*Culicoides lansangensis* *Culicoides zhuhaiensis*
32. Mount Parker Road Green Trail, Eastern District	*Culicoides circumbasalis*
33. Pak Mong, Tung Chung, Lantau	*Culicoides lansangensis*
34. Pak Sha O, Sai Kung	*Culicoides arakawai* *Culicoides circumbasalis* *Culicoides palpifer*
35. Pak Tam Au, Sai Kung	*Culicoides liukueiensis* *Culicoides lansangensis*
36. Pak Tam Chung, Sai Kung	*Culicoides arakawai*
37. Pok To Yan (薄刀刃), slope behind Tung Chung Eastern Interchange, Tung Chung	Nil
38. Sam A Tsuen (near Lai Chi Wo), North District	*Culicoides bedfordi* *Culicoides mcdonaldi* *Culicoides okinawensis* *Culicoides arakawai* *Culicoides huffi* *Culicoides hewitti* *Culicoides orientalis*
39. Sam Tam Lo (烏蛟騰抗日英烈紀念碑), Tai Po	Nil
40. San Tau, Tung Chung, Lantau Island	*Culicoides circumbasalis* *Culicoides orientalis*
41. San Uk Ha, Tai Po	*Culicoides hewitti* *Culicoides mcdonaldi*
42. Sha Tin Park, Sha Tin	Nil
43. Sham Chung Pier, Sai Kung	*Culicoides huffi*
44. Shek O Beach	*Culicoides huffi*
45. Shek O Road (near Country Club)	Nil
46. Sheung Mui Tin (Wu Kau Tang), Tai Po	*Culicoides hui*
47. Siu Tan (near Lai Chi Wo), North District	*Culicoides arakawai* *Culicoides okinawensis* *Culicoides zhuhaiensis*

Location	Blood-sucking species found
	Culicoides huffi
48. So Lo Pun (near Luk Keng), North District	*Culicoides circumbasalis* *Culicoides bedfordi*
49. Stream near Luk Keng Chan Uk, North District	*Culicoides actoni* *Culicoides circumbasalis* *Culicoides mcdonaldi* *Culicoides orientalis* *Culicoides paraflavescens* *Culicoides shortti* *Culicoides zhuhaiensis*
50. Sunny Bay (near Disneyland) , Lantau Island	*Lasiohelea taiwana*
51. Tseng Tsai Yuen, Tai Po Au, Tai Po	*Culicoides huffi*
52. Tai Po Road 7½ Mile-Stone Rest Garden, Tai Wai	Nil
53. Tai Tam Reservoir, Southern District	Nil
54. Tai Tong Lai Chee Orchard, Yuen Long	*Culicoides lansangensis*
55. Tong To, Sha Tau Kok	Nil
56. Tsim Bei Tsui, Deep Bay, Yuen Long	*Culicoides lansangensis*
57. Tung O, Crooked Island, North District	*Culicoides okinawensis* *Culicoides bedfordi* *Culicoides hewitti* *Culicoides huffi*
58. Wang Tong, Mui Wo, Lantau	Nil
59. Wong Chuk Kok, Tai Po	*Culicoides zhuhaiensis* *Culicoides bedfordi* *Culicoides mcdonaldi* *Culicoides arakawai* *Culicoides actoni*
60. Wong Lung Hung, Tung Chung, Lantau	*Culicoides lansangensis*
61. Wu Chau Tong, North District (大水灣)	*Culicoides hewitti*
62. Wu Kau Tang, Tai Po	*Culicoides bedfordi* *Culicoides lansangensis*
63. Yau Yu Wan Playground, Tseung Kwan O	Nil
64. Yuen Chau Kok Park (Lowland), Sha Tin	Nil
65. Yuen Chau Kok Park (Upland), Sha Tin	Nil

Location	Blood-sucking species found
66. Yung Shue Au, Sha Tau Kok	*Lasiohelea mixta*
67. Yung Shue O, Sai Kung	*Culicoides zhuhaiensis* *Culicoides circumbasalis* *Culicoides huffi*

Table 3: Types of bood-sucking ceratopogonids collected by light traps

Sampling by human baiting

15. Four locations had been selected for samplings by human baiting, which were Shing Mun Valley Park (Tsuen Wan), Lok Wah Street Playground and Tsz Wan Shan Estate Service Reservoir Playground (Tsz Wan Shan), Hong Kong Park (Central District) and Yau Yue Wan Children's Playground (Tseung Kwan O). Each location was visited once a month and a total of 48 sampling exercises were conducted throughout the year. The man landing rate for each site was calculated and expressed as the number of biting midges landed on exposed skin per man per hour. The figures obtained may reflect the relative abundance of biting midges. By taking the monthly average man landing rate for the sites during the year, we can better understand the relative seasonal variation in biting midges nuisance. The results are tabulated in Table 4.

Month	Average Monthly Man Landing Rate	Species Involved
July 2017	17.0	*Lasiohelea taiwana* (100%)
August 2017	19.4	*Lasiohelea taiwana* (98%) *Lasiohelea mixta* (2%)
September 2017	17.8	*Lasiohelea taiwana* (83%) *Lasiohelea mixta* (6%) *Lasiohelea humilavolita* (11%)
October 2017	13.3	*Lasiohelea taiwana* (69%) *Lasiohelea mixta* (6%) *Lasiohelea humilavolita* (25%)
November 2017	8.0	*Lasiohelea taiwana* (69.2%) *Lasiohelea mixta* (15.4%) *Lasiohelea humilavolita* (15.4%)
December 2017	0.5	*Lasiohelea taiwana* (100%)

Month	Average Monthly Man Landing Rate	Species Involved
January 2018	1.5	*Lasiohelea taiwana* (100%)
February 2018	0	-
March 2018	1.6	*Lasiohelea taiwana* (100%)
April 2018	1.8	*Lasiohelea taiwana* (100%)
May 2018	6.7	*Lasiohelea taiwana* (63%) *Lasiohelea humilavolita* (25%) *Lasiohelea phototropia* (12%)
June 2018	25.5	*Lasiohelea taiwana* (100%)

Table 4: Average Monthly Man Landing Rate from July 2017 to June 2018

Findings in LCSD's venues

16. A great majority of our surveys were conducted at parks under LCSD's management. Over the year, a total of 56 sites under the jurisdiction of LCSD were surveyed. The findings in LCSD's venues are summarized in Tables 5, 6 and 7 below:

Hong Kong Island:

Location	Blood-sucking species found
1. Ap Lei Chau Park, Southern District	*Lasiohelea taiwana*
2. Big Wave Bay Picnic Area, Southern District	*Lasiohelea taiwana*
3. Chai Wan North Service Reservoir Playground, Eastern District	Nil
4. Chai Wan Park, Eastern District	*Lasiohelea taiwana*
5. HK Zoological & Botanical Gardens, Central	*Lasiohelea taiwana*
6. Hong Kong Park, Central	*Lasiohelea humilavolita;* *Lasiohelea mixta;* *Lasiohelea taiwana*
7. Hong Kong Victoria Park, Wan Chai	*Lasiohelea taiwana*
8. Kwai Fong Street Playground, Happy Valley	*Lasiohelea taiwana*
9. Ma Hang Park, Stanley	*Lasiohelea taiwana*
10. Shau Kei Wan Service Reservoir	Nil

Location	Blood-sucking species found
Playground	
11. Shek O Beach, around barbecue site	Nil
12. Tin Hau Temple Road Garden No.2, Eastern	Nil
13. Wan Chai Gap Park	*Lasiohelea taiwana*
14. West End Park, Western	Nil

Table 5: Types of blood-sucking ceratopogonids found in LCSD venues (Hong Kong)

Kowloon:

Location	Blood-sucking Species Found
1. Cherry Street Park, Sham Shui Po	Nil
2. Cornwall Street Park, Kowloon Tong	Nil
3. Fa Hui Park, Sham Shui Po	*Lasiohelea taiwana*
4. Fung Tak Playground, Wong Tai Sin	*Lasiohelea humilavolita*; *Lasiohelea taiwana*
5. Hammer Hill Park, Wong Tai Sin	*Lasiohelea taiwana*
6. Han Garden, Lei Cheng Uk Han Tomb Museum, Sham Shui Po	Nil
7. Hong Ning Road Park, Kwun Tong	Nil
8. Jordan Valley Park, Kwun Tong	*Lasiohelea danxianensis*
9. Kai Tak Cruises Terminal Park, Kowloon City	Nil
10. King's Park, Yau Tsim	Nil
11. Kowloon Tsai Park, Kowloon City	Nil
12. Kowloon Walled City Park, Kowloon City	Nil
13. Lai Chi Kok Park, Sham Shui Po	Nil
14. Lam Tin Park, Kwun Tong	*Lasiohelea taiwana*
15. Lion Rock Park, Kowloon City	*Lasiohelea sp*
16. Lok Wah Street Playground and Tsz Wan Shan Estate Service Reservoir Playground	*Lasiohelea mixta* *Lasiohelea taiwana*
17. Morse Park, Kowloon City	Nil
18. Nam Cheong Park, Sham Shui Po	*Lasiohelea taiwana*
19. Tai Hang Tung Recreation Ground,	*Lasiohelea taiwana*

Location	Blood-sucking Species Found
Sham Shui Po	
20. To Yuen Street Playground, Sham Shui Po	Nil

Table 6: Types of blood-sucking ceratopogonids found in LCSD venues (Kowloon)

New Territories

Location	Blood-sucking Species Found
1. Chik Tai Lane Garden, Tai Wai	*Lasiohelea taiwana*
2. Ching Wah Garden & Ching Wah Playground, Tsing Yi	*Lasiohelea danxianensis*
3. Hong Kong Velodrome Park, Tseung Kwan O	Nil
4. Muk Min Ha Garden, Tsuen Wan	*Lasiohelea taiwana*
5. Po Tsui Park, Tseung Kwan O	Nil
6. Sha Tin Park, Sha Tin	*Lasiohelea taiwana*
7. Shek Pai Street Park, Kwai Chung	Nil
8. Shing Mun Valley Park	*Lasiohelea taiwana* *Lasiohelea phototropia*
9. Tai Po Road 7½ Mile-Stone Rest Garden, Sha Tin	Nil
10. Tai Po Waterfront Park	*Lasiohelea humilavolita;* *Lasiohelea taiwana*
11. Tai Wong Ha Playground, Kwai Tsing	Nil
12. Tin Shui Wai Park, Yuen Long	*Lasiohelea taiwana*
13. Tseung Kwan O Waterfront Park	Nil
14. Tsing Lung Garden, Tuen Mun	Nil
15. Tsing Yi Park, Kwai Tsing	Nil
16. Tsing Yi Pier and Tsing Yi Promenade	Nil
17. Tsing Yu Street Garden, Kwai Tsing	*Lasiohelea taiwana*
18. Tuen Mun Park	*Lasiohelea taiwana*
19. Yau Yue Wan Children's Playground, Tseung Kwan O	*Lasiohelea taiwana*
20. Yuen Chau Kok Park (Lowland), Sha Tin	*Lasiohelea taiwana* *Lasiohelea mixta*
21. Yuen Chau Kok Park (Upland), Sha Tin	*Lasiohelea taiwana*

Location	Blood-sucking Species Found
	Lasiohelea mixta
22. Yuen Long Park	*Lasiohelea taiwana*

Table 7: Types of blood-sucking ceratopogonids found in LCSD venues (New Territories)

Discussion

Daily activity patterns of biting midges

17. Almost all *Culicoides* species are crepuscular feeders and *Lasiohelea* are active and prey at daytime. In our surveys, *Culicoides* species were mainly collected by light trapping (conducted from evening to early next morning) whereas netting and human baiting (conducted at daytime) yielded mainly *Lasiohelea* species. The results agreed with their known respective feeding and activity patterns.

Species new to Hong Kong

18. In 2007, Professor YU Yi-Xin published a paper (香港地區吸血蠓初記[5]) in the Journal of Parasitology and Medical Entomology after his visit to Hong Kong. In the paper, Professor Yu concluded that there are 24 species of blood-sucking biting midges known to be found in Hong Kong. Among the 24 species, one is *Leptoconops* (*Leptoconops hongkongensis*), seven are *Lasiohelea* species and 16 are *Culicoides* species.

19. Although our current surveys do not reveal new species of *Lasiohelea* and *Leptoconops*, we found seven species of *Culicoides* which are not previously recorded in Hong Kong. They are *Culicoides bedfordi*, *Culicoides huffi, Culicoides hui, Culicoides japonicas, Culicoides liukueiensis, Culicoides okinawensis* and *Culicoides subfascipennis.*

20. It is worth mentioning that *Culicoides bedfordi,* a potential vector of bluetongue virus[6] that mainly affects sheep but less frequently affects cattle, goats, deers, etc., is a fairly common species in the southern part of Africa though it has never been recorded in China. In our surveys, this species is found quite abundant in Luk Keng, Plover Cove Country Park, Sam A Tsuen and islands in Yan Chau Tong Marine Park. The areas are in close proximity to Yantian Harbour (鹽田港), a busy international container terminal. The

[5] 寄生蟲與醫學昆蟲學報 Vol. 14, No.3, Sept 2007

[6] Culicoides spp. (Diptera: Ceratopogonidae) as vectors of bluetongue virus in South Africa – a review, Gert Johannes Vente; Veterinaria italiana 51(4):325-333 · January 2016; https://www.researchgate.net/publication/289535470_Culicoides_spp_Diptera_Ceratopogonidae_as_vectors_of_bluetongue_virus_in_South_Africa_-_a_review

possibility of introduction of the ceratopogonid via international commodities transportation into Hong Kong could not be completely ruled out.

21. *Culicoides liukueiensis* is another species which has never been reported in the Mainland. This species was formerly recorded only in a single occasion at the southern part of Taiwan. Our surveys in Sai Kung Peninsula revealed that *Culicoides liukueiensis* is rather common in this area.

22. The above two examples suggest that Hong Kong, as an international port, is vulnerable to the importation of foreign species which may have impact on public health if the introduced species is a disease vector.

23. Together with those species found in 2006, the updated record of local *Culicoides* is listed below:

1. *Culicoides actoni* (subgenus *Avaritia* 二囊亞屬) Smith 1929 琉球庫蠓
2. *Culicoides anophelis* (subgenus *Trithecoides* 三囊亞屬) Edwards 1922 嗜蚊庫蠓
3. *Culicoides arakawai* (subgenus *Beltranmyia* 帶紋亞屬) Arakawa 1910 荒川庫蠓
4. *Culicoides bedfordi* Ingram and Macfie,1923 派附庫蠓
5. *Culicoides circumbasalis* Tokunaga (subgenus unplaced) 環基庫蠓
6. *Culicoides circumscriptus* (subgenus *Beltranmyia* 帶紋亞屬) Kieffer 1918 環斑庫蠓
7. *Culicoides fulvus* (subgenus *Avaritia* 二囊亞屬) Sen and Das Gupta 1959 微黃庫蠓
8. *Culicoides hewitti* Causey 1938 (subgenus unplaced) 何微庫蠓
9. *Culicoides huffi* Causey (subgenus *Oecacta* 屋室亞屬) 1938 霍飛庫蠓
10. *Culicoides hui* (subgenus *Avaritia* 二囊亞屬) Wirth et Hubert, 1961 屏東庫蠓
11. *Culicoides japonicus* (subgenus *Beltranmyia* 帶紋亞屬) Arnaud 1956 大和庫蠓
12. *Culicoides lansangensis* (subgenus *Avaritia* 二囊亞屬) Howarth 1985 南山庫蠓
13. *Culicoides liukueiensis* (subgenus *Oecacta* 屋室亞屬) *Kitaoka* 1985 近緣庫蠓
14. *Culicoides mcdonaldi* (subgenus *Cuilcoides* 庫蠓亞屬) Wirth et Hubert 1989 麥氏庫蠓

15. *Culicoides okinawensis* (subgenus *Oecacta* 屋室亞屬) Arnaud 1956 沖繩庫蠓
16. *Culicoides orientalis* (subgenus *Avaritia* 二囊亞屬) Macfie 1932 東方庫蠓
17. *Culicoides palpifer* (subgenus *Trithecoides* 三囊亞屬) Das Gupta et Ghosh 1956 撫鬚庫蠓
18. *Culicoides paraflavescens* (subgenus *Trithecoides* 三囊亞屬) Wirth et Hubert 1959 趨黃庫蠓
19. *Culicoides peregrinus* (subgenus *Avaritia* 二囊亞屬) Kieffer 1910 異域庫蠓
20. *Culicoides shortti* (subgenus *Oecacta* 屋室亞屬) Smith et Swaminath 1932 肖特庫蠓
21. *Culicoides subfascipennis* (subgenus *Oecacta* 屋室亞屬) Kieffer 1919 亞單帶庫蠓
22. *Culicoides toshiokai* (subgenus *Oecacta* 屋室亞屬) Kitaoka 1975 岡庫蠓
23. *Culicoides zhuhaiensis* (subgenus *Oecacta* 屋室亞屬) Yu et Hao 1988 珠海庫蠓

Prevalent species

24. Samplings by netting and human baiting were conducted at daytime and the total number of daytime collections conducted throughout the year was 190. A total of 243 blood-sucking biting midges were collected by netting and human baiting. Among the 243 blood-sucking ceratopogonids collected, 240 of them were *Lasiohelea* species and the remaining three were *Culicoides bedfordi*. Regarding the 240 *Lasiohelea* species collected, 207 were *Lasiohelea taiwana* and 33 of them were other species of *Lasiohelea.* In other words, about 86% of the *Lasiohelea* collected at daytime throughout the year was *Lasiohelea taiwana*. This species was not only the most abundant *Lasiohelea* species found, but also a widely distributed species. They had been collected in all the 18 districts under survey. *Lasiohelea taiwana* is a viscous biter at daytime. It is believed that most of the complaints lodged against biting midges infestation were caused by this species. Our collection revealed that areas with *Lasiohelea taiwana* were most commonly found in environment with moist soil covered by decaying leaves/wood chips, lower part of vegetated slopes (where moisture accumulated) and surfaces covered with mosses and algae.

Soils covered by decaying leaves are favourable breeding places for Lasiohelea species

Moist soils covered by wood chips support breeding of L. taiwana

Surfaces with moist mosses/algae are ideal places for larvae development of L. taiwana

Larvae of Lasiohelea also prefer living on surface channels with decaying vegetative materials

This flower bed, with fallen leaves and moisture collected from the slope behind, provides favourable breeding ground for Lasiohelea

25. The light trap collection exercises were conducted in the evening till early morning of the following day. Almost all the blood-sucking midges collected by light traps were *Culicoides,* species that were active at nighttime. Among the 609 blood-sucking midges collected, 602 belonged to the genus *Culicoides* (99%) and the remaining seven were *Lasiohelea* species. The most predominant *Culicodes* species collected was *Culicoides mcdonaldi* (161; 27%)**.** Other common species were *Culicoides lanshangensis* (99; 16%) and *Culicoides circumbasalis* (81; 13.5%). Although the total number of *Culicoides* collected by light trap is higher than the number of *Lasiohelea* collected by netting and human baiting, it did not necessarily mean that *Culicoides* are more abundant than *Lasiohelea* due to the difference in collection method and the duration of collection.

Distribution of Culicoides species

26. Although *Culicoides mcdonaldi* was the mostly collected species, it was mainly found in the north eastern part of the New Territories. In fact, *Culicoides lanshangensis* was the most often encountered species. Out of the 67 light trap samplings, *Culicoides lanshangensis* was collected in 12 locations over different parts of our territories. The sites with *Culicoides lanshangensis* infestation were widely distributed which included:

1. Fu Yung Shan, Tsuen Wan
2. Ha Pak Nai, Yuen Long
3. Lau Fau Shan, Yuen Long
4. Luk Keng Chan Uk, North District
5. Luk Keng Lo Uk, North District

6. Mui Wo, Lantau Island
7. Pak Mong, Tung Chung, Lantau Island
8. Pak Tam Au, Sai Kung
9. Tai Tong, Yuen Long
10. Tsim Bei Tsui, Yuen Long
11. Wong Lung Hung, Tung Chung, Lantau Island
12. Wu Kau Tang, Tai Po

27. Almost all of the *Culicoides* midges were collected in rural areas. Surveys conducted in urban areas did not yield any *Culicoides* midges. We had conducted light trap sampling exercises at some selected parks in urban areas/developed towns in the New Territories (including Sha Tin Park (Sha Tin), Tai Po Road 7½ Mile-Stone Rest Garden (Tai Wai), Yau Yue Wan Children's Playground (Tseung Kwan O), Yuen Chau Kok Park (Lowland), Yuen Chau Kok Park (Upland) (Sha Tin), Ap Lei Chau Park (Southern District), Big Wave Bay Picnic Area (Southern District), Fa Hui Park (Sham Shui Po), Kowloon Walled City Park (Kowloon City) and Lam Tin Park (Kwun Tong). Although *Lasiohelea taiwana* infestation was discovered in almost all these sites during our daytime collections, no *Culicoides* midges could be found in these parks. Our findings suggested that *Culicoides* midges might only adapt to a more rural natural environment and would probably not pose a serious nuisance in urban areas. Nevertheless, this inference needs further studies to justify.

Seasonal population change

28. The results of sampling by human bait not only reflect the relative abundance of blood-sucking midges in an area under study, they also allow the assessment of the seasonal variation in biting midges activities. Professor CHUANG Yi-yuan [7] who studied the seasonal variation in population density of *Lasiohelea taiwana* in Nantou county of Taiwan[8], pointed

[7] Assistant Professor, Faculty of Entomology, National Chung Hsing University

[8] The life cycle of the biting midge, Forcipomyia (Lasiohelea) taiwana (Shiraki) and their seasonal occurrence at Nontou area, Yi-yuan Chuang; 1994
https://ndltd.ncl.edu.tw/cgi-bin/gs32/gsweb.cgi?o=dnclcdr&s=id=%22083NCHU0185001%22.&searchmode=basic
https://www.researchgate.net/publication/47480428_The_life_cycle_of_the_biting_midge_Forcipomyia_Lasiohelea_taiwana_Shiraki_DipteraCeratopogonidae_and_their_seasonal_occurrence_at_Nontou_area

out that the population density reached its lowest point during November to March. It then gradually climbed up from late March and early April, arrived at the peak during June and July, and then declined again. We deployed the same methodology to study our local situation. The results are summarized in Table 8 and Chart 1:

Month	Man Landing Rate (per man per hour)
July 2017	17.0
August 2017	19.4
September 2017	17.8
October 2017	13.3
November 2017	8.0
December 2017	0.5
January 2018	1.5
February 2018	0
March 2018	1.6
April 2018	1.8
May 2018	6.7
June 2018	25.5

Table 8: Man Landing Rate Result from July 2017 to June 2018

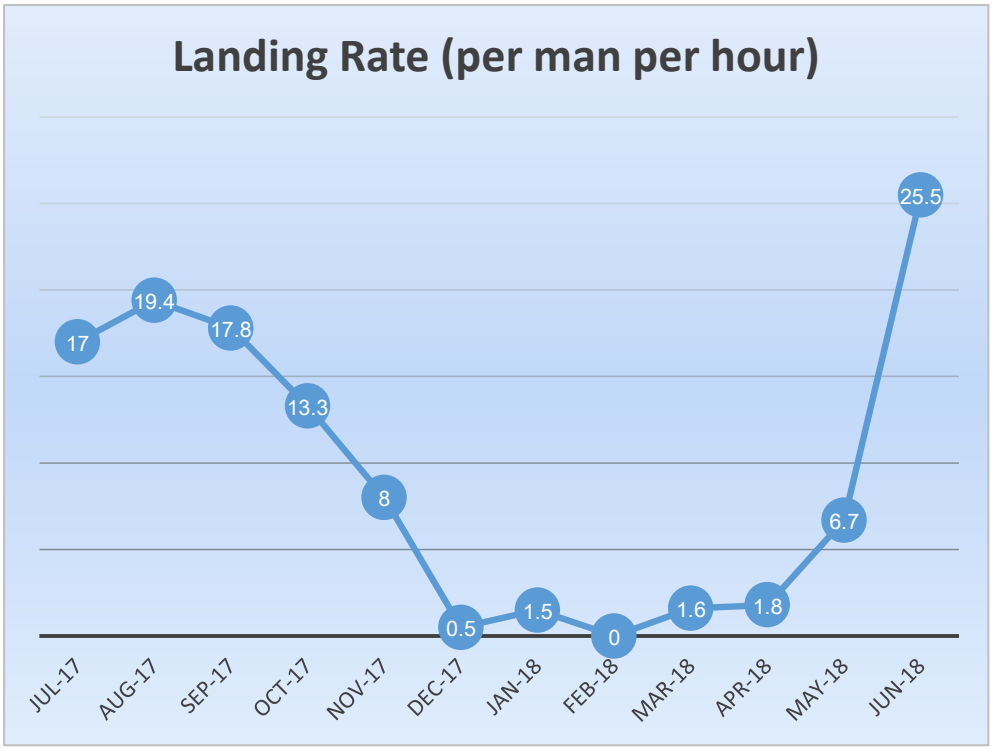


Chart 1: Monthly variation in Man Landing Rate

29. We found that our local *Lasiohelea* activities also showed a similar pattern with Nantou, Taiwan. The man landing rate was the highest in summer months (i.e. June to August). It then declined gradually and we had a biting midge free period in February.

30. The methodology for man landing rate study allows collection of specimens landing on human skin for blood. The man landing rate or man biting rate is sometimes deployed as a tool to estimate the relative population density. However, it is not considered feasible to be used as an indicator for reflecting the territory-wide level of biting midges activity for regular monitoring purpose. It is because this method requires the same collectors visit various localities regularly (as different persons are vulnerable to biting midges attack differently), expose their skin and prepare to be bitten by the insects everyday with potential risks of cutaneous pruritic wheal-and-flare responses or even permanent scarring and probably some unknown health concerns. This issue has been discussed with Professor Yu and he considered that no practical indicator is available for monitoring biting midges infestation rate over the territory on a regular basis.

Public health considerations

31. Although biting midges are known to cause biting nuisance and being carriers of internationally important arboviruses of livestock, the insects are in general not considered as major human disease vectors. By far the most recognized role of biting midges in public health issue is their ability to transmit Oropouche fever in human.

Oropouche fever

32. The most well-known pathogen that is transmitted by blood-sucking midges to human is the Oropouche virus, the aetiological agent of Oropouche fever. Oropouche fever is a febrile illness with symptoms similar to those of dengue fever which include high fever, chills, headache, myalgia, generalized arthralgia, anorexia, joint pains and vomiting. In rare cases, it can cause clinical symptoms of aseptic meningitis in some patients. Oropouche fever cases are widely distributed across a geographic range that is thought to include Brazil, Peru, Panama and Colombia. Major epidemic outbreaks largely took place in Brazil, where thousands of clinical cases can occur and yearly incidence in humans may be reported. Investigations in Brazil

revealed that the virus has adapted to an urban cycle and transmitted from human to human by the species *Culicoides paraensis* [9,10].

33. *Culicoides paraensis* is a widespread species in the world. Taxonomically, it is classified under the subgenus *Haematomyidium*. The external morphology of *Culicoides paraensis* looks a little bit similar to certain local *Culicoides* under the subgenus *Avaritia*.

Culicoides paraensis

34. Upon detailed examination of the biting midges collected throughout the year, neither the vector species nor the other member of the subgenus *Haematomyidium* is found in our surveys. In the absence of insect vector, the risk of local outbreak of Oropouche fever is believed to be minimal.

35. On taxonomic identification of *C. paraensis*, Maria and Abraham had provided detailed information for the identification of this vector species[11]. Maria Luiza Felippe-Bauer also compared the morphology and behavior of *C. paraensis* with some closely related species[12]. .

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[9] Oropouche fever, an emergent disease from the Americas, by Romero-Alvarez D; Microbes and Infection,Vol. 20, Issue 3, March 2018 p.135-146

[10] Oropouche virus disease – Peru, Emergencies preparedness, response, WHO; http://www.who.int/csr/don/03-june-2016-oropouche-peru/en/

[11] Two new *Culicoides* of the *paraensis* species group (Diptera:Ceratopogonidae) from the Amazonian region of Peru; by Maria and Abraham; Mem Inst Oswaldo Cruz, Rio de Janeiro, Vol. 98(8): p. 1051-1058, Dec 2003; http://www.scielo.br/scielo.php?script=sci_arttext&pid=S0074-02762003000800014

[12] Morphological alterations in Neotropical Ceratopogonidae(Diptera), Revista Brasileira de Zoologia 23(3), September 2006; by Maria Luiza Felippe-Bauer; online available: https://www.researchgate.net/publication/250037749_Morphological_alterations_in_Neotropical_Ceratopogonidae_Diptera

Mansonellosis

36. Filarial nematodes of *Mansonella ozzardi*, *M. perstans* and *M. streptocerca* could also be transmitted by biting midges to human. These parasites could infect human through the biting midges and cause dermatitis. However, the diseases are mainly reported in Central and South America, western and central Africa, and some Caribbean islands. Since the clinical manifestation of mansonellosis is usually either mild or entirely asymptomatic, examinations of the epidemiology of transmission by *Culicoides* are relatively rare. *C. furens, C. phlebotomus*, *C. austeni, C. grahami and C. inornatipennis* are the recognised vector species. In our surveys, we have not found these vector species locally and we have never been notified by the Department of Health or Hospital Authority of any infection case involving *Mansonella* worms.

Bluetongue Disease

37. In our surveys, *Culicoides fulvus, Culicoides orientalis* and *Culicoides actoni* were found. These three species of *Culicoides* play a role in the transmission of bluetongue viruses. Although the virus can be spread by these locally found *Culicoides* species, this viral disease mainly affects ruminants, particularly sheep but less frequently affects cattle[13, 14] and is not considered as a threat to human health.. Since Hong Kong does not have large scale sheep husbandry, the risk of bluetongue virus transmission should be rare.

Identification key for local species

38. The taxonomical work for biting midges identification is extremely difficult, especially for workers without profound training in entomology. To facilitate future survey work for all officers in the PCAS, an identification key with detailed morphological description on local blood-sucking biting midges is prepared based both on the current findings as well as our previous records. In addition to textual descriptions on their diagnostic features, drawings and photographs with annotations are incorporated in the key for

[13] Bluetongue Fast Fact http://www.cfsph.iastate.edu/FastFacts/pdfs/bluetongue_F.pdf

[14] The taxonomy of Culicoides vector complexes – unfinished business http://ela-europe.org/ELA%20teksten/library/bluetongue/The%20taxonomy%20of%20Culicoides%20vector%20complexes%20%20unfi.pdf

easy reference and avoid misinterpretation. This pictorial key has been proofread by Professor Yu who considered that the compiled information is a convenient guide for local biting midges identification.

Control measures

39. The PCAS has compiled technical guidelines for the control of biting midges. The control measures proposed below are additional recommendations based on the results of this survey. Theoretically, breeding source elimination is the best approach to alleviate the nuisance but on many occasions complete destruction of their breeding grounds is impractical because the breeding sites are widely dispersed and often inaccessible (the breeding places could be as small as a tiny tree hole with water or an animal foot print on muddy surface which collected small amount of water). Nevertheless, some suggestions on control measures are made based on the findings of our surveys.

A) <u>Different control strategy for different groups of biting midges</u>

Different genera of Ceratopogonidae vary in their habits and biology. The control methodology for different genera should be tailor-made so as to enhance the effectiveness of the control measures. Almost all *Culicoides* tend to be crepuscular or nocturnal feeders while *Lasiohelea* are diurnal and bite human at daytime. As these two genera of biting midges breed in different habitats, larval control measures for a particular genus should be carried out at the right places. The most prevalent daytime biter in Hong Kong is *Lasiohelea taiwana*. Like most *Lasiohelea* species, larvae of *Lasiohelea taiwana* live in a semi-aquatic environment. *Lasiohelea taiwana* prefer laying eggs on moist soil with high organic content, on surfaces covered by mosses, in damp rotten wood and in decaying vegetative materials with high moisture content. Elimination of the above-mentioned habitats is an effective approach to control daytime biting ceratopogonids.

Culicoides larvae breed in aquatic environment. These range from banks of small pools, ponds or streams with vegetation, rock pools, tree holes, bamboo stumps, decaying water found in epiphytic plants, etc. Small puddles or "pockets" of water can sometimes be a major breeding source. In general, the breeding places of *Culicoides* are

somewhat similar to those for *Aedes albopictus*. To control breeding of the evening biters, operators are invited to give special attention to aquatic environment.

It is very important to identify the ceratopogonids at least up to the genera level so that responsible parties can implement different appropriate control measures to tackle the infestation. Besides, a tailor-made control strategy not only save labour and effort, but also avoid applications of pesticides indiscriminately. The management of relevant parties with biting midges infestation should therefore identify the biology of the nuisance, locate the corresponding breeding sources and evaluate different applicable control measures which suit their individual conditions and restrictions.

B) Larval control for *Lasiohelea taiwana*

Our surveys revealed that *Lasiohelea taiwana* is the most commonly encountered species in the territory. Complete larval disinfestations could be difficult because of the extensive breeding sources (the breeding places could be as small as a tiny patch of moist mosses on rock surface). However, reduction of major breeding sites could help to lower the degree of infestation. Source reduction could be achieved by the following:

a) keeping moisture content of soil surface low by techniques like ploughing or draining;
b) removing refuse, fallen leaves and other decaying vegetation as well as muddy soil in sand-traps and surface drainage channels;
c) using barks or wood chips as covering mulch should be avoided as these materials not only make the top soil suitable for larval development, the materials themselves could be favourable breeding grounds as well;

Using wood chips as covering mulch should be avoided

d) trimming vegetation on a regular basis to increase the exposure of soil surface to sunlight and air;
e) covering the soil surface with a few centimeter depth of round, non-water absorbency small pebbles may help to discourage larval growth;
f) leaking pipes, especially those in flower bed, should be repaired promptly to prevent the propagation of biting midges;

Moistures from leaking pipes often support biting midges infestation

g) removing the top surface soil for 1 to 2 cm to get rid of a great proportion of the developing larvae when the infestation is serious, as most *Lasiohelea* larvae live in the top layer of soil; and

h) applying insecticide at breeding places. Temephos in sand granules formulation or *Bacillus thuringiensis israelensis* may help to arrest adults from hatching[15,16] .

C) <u>Larval control for *Culicoides*</u>

As the breeding places of *Culicoides* are somewhat similar to those for *Aedes albopictus*, operators should target on aquatic environment. If the breeding sources or potential breeding grounds are unable to be eliminated, larviciding should be carried out whenever possible and practical. Temephos in sand granules formulation or *Bacillus thuringiensis israelensis* are possible choice of chemicals for use. Studies indicate that the effect in suppressing larval growth last for 3 to 6 weeks after each application of larvicide[17].

Under certain circumstances, fish can be used as a tool for larval

[15] https://www.npsr.qld.gov.au/licences-permits/pdf/op-pk-nrm-mosquito-biting-midge-control.pdf

[16] https://pdfs.semanticscholar.org/a35a/c0d2937bbe24dd696dd5cdf0dd863ec4886c.pdf

[17] Field trials of pesticides to control larval Culicoides variipennis (Ceratopogonidae). By Holbrook, F. R. and S. K. Agun; Mosquito News, June 1984, vol. 44, p. 233-235 https://www.biodiversitylibrary.org/part/131887#/summary

control[18, 19].

D) Timing of control

The study of man landing rate indicated the seasonal changes in the activities of blood-sucking biting midges in Hong Kong. It was observed that the activities were generally low from December to April and started to be significantly active in May and reached its peak in June. To allow environmental control measures to take effect, actions should be taken well before the biting midges become active in May, particularly breeding places for *Lasiohelea taiwana* that caused major nuisance to human. Specific measures suggested in para. 39(B) should be closely observed and actions should be taken to deplete potential breeding places before the onset of moist and wet season.

E) Locations that required special attention

The study had covered 133 locations where various collection methods were conducted to better understand the biting midges infestation at the sites. These locations were selected from the list of locations with complaint of biting midges received by various departments from the public. Among these locations, 56 of them were park areas under the purview of the LCSD. The presence of blood-sucking species was recorded in 55.4% (31 out of 56) of park areas. Locations other than park areas had a lower rate of biting midges infestation. Only 11 out of 43 (25.6%) locations where net collection was conducted yielded positive findings of biting midges. The results indicated that park areas are prone to infestation of blood-sucking biting midges with *Lasiohelea taiwana* being the dominant species. Management of parks should be advised to closely observe the recommendations, particularly on control of *Lasiohelea taiwana* and take prompt actions to eliminate potential breeding grounds in parks before biting midges become active.

[18] Operational policy, Mosquito and biting midge control, Department of National Parks, Sport and Racing, Queensland Government https://www.npsr.qld.gov.au/licences-permits/pdf/op-pk-nrm-mosquito-biting-midge-control.pdf

[19] Midges, The Clemson University Cooperative Extension Service https://www.clemson.edu/extension/publications/entomology/household-structural/midges-hs43.html

F) Adult control by Ultra Low Volume (ULV) applications

Suppressing adult biting midges with insecticides only provide limited and short term effect[20]. However, suppressing the density of adult biting midges by ULV treatment is still used under special circumstances to provide temporary relief when needed. In cases when pesticide treatment is warranted, recent systematic assessments suggested that cypermethrin could be a suitable choice[21]. If the targeted midges are a daytime biter (i.e. *Lasiohelea* species), studies have demonstrated that they have a peak of activity at around 10 a.m. Should ULV treatment be conducted to knock down the adult insects, it would be more effective to carry out the insecticidal treatment say at around 8 a.m., when most of the ceratopogonids are still hiding in their resting places.

[20] Biting Midges: Biology and Public Health Risk, Purdue University https://extension.entm.purdue.edu/publichealth/insects/bitingmidge.html

[21] Advance of research on control of blood-sucking midges, by Wang Fei-peng; p.467- 471, 2015, 31(5), Chinese Journal of Zoonoses

Way Forward

Port surveillance

40. *Culicoides bedfordi*, a vector of bluetongue viruses[22], is a common blood-sucking species in the southern part of Africa. This species has not been recorded in Hong Kong and China previously. However, our surveys revealed that *Culicoides bedfordi* is in fact quite commonly found in the north-eastern part of the territory (e.g. Luk Keng, Sha Tau Kok and Plover Cove Country Park). As mentioned before, these areas are not far away from the Yantian Harbour (鹽田港). The findings illustrated that Hong Kong and our neighbouring areas, being busy in international cargo and passengers movements, are prone to the introduction of exotic species. Review at regular intervals at strategic locations, such as major port areas, may allow us to identify our risks and take early preventive measures before any exotic vector species could establish its foothold in our territories.

Indicator for monitoring the level of infestation in community

41. The methodology for landing rate study allows collection of specimens landing on human skin for blood. The landing rate/man biting rate is sometimes deployed as a tool to estimate the relative population density. However, using this method to monitor the level of biting midges infestation in the territory on a regular basis is not feasible. This subject matter has been discussed with Professor Yu who reiterated that no practical indicator is available for the time being to monitor biting midges infestation level over the territory on a regular basis. As there is increasing public concern about biting midges in recent years, it is advised to keep in view the technology development and investigate any emergent method for monitoring the insect's population dynamics.

Investigations on new control methods

42. PCAS to investigate whether some new approaches in controlling biting midges population could be practically and effectively applied in local

[22] Bluetongue virus is a virus that causes disease in livestock. Transmission potential of South African *Culicoides* species for live-attenuated bluetongue virus, by G.J. Venter & G.H. Gerdes; Veterinaria Italiana, 40 (3), 198-203, 2004; http://www.izs.it/vet_italiana/2004/40_3/39.pdf

situation. Two newly suggested methods could be considered:

A) Adult control by baiting

Research has suggested that using poisoned bait for biting midges (by mixing an insecticide with sugar solution) may be useful in reducing adult populations. It is worth examining its effectiveness and feasibility in local situation[23].

B) Adult control by light trap

It has been suggested by some entomologists that specially designed light traps may be used to lower the population of *Culicoides*[24]. It is also worthy to keep in view the development of such method and conduct field trial whenever necessary to assess the effectiveness.

[23] Insecticidal sugar baits for adult biting midges; by D. SNYDER; Medical and Veterinary Entomology, vol 30; June 2016.; https://onlinelibrary.wiley.com/doi/abs/10.1111/mve.12158

[24] Investigation of Methods for Protection of Horses in Jet Stalls Against Culicoides Biting Midges; Patrick Collin Page, University of Pretoria, South Africa, November 2015 https://repository.up.ac.za/bitstream/handle/2263/53307/Page_Investigation_2016.pdf?sequence=1&isAllowed=y

PROPER USE OF INSECT REPELLENTS

衛生署
Department of Health

衞生防護中心
Centre for Health Protection

食物環境衞生署
Food and Environmental Hygiene Department

How to choose insect repellents in the market?

Public can choose insect repellents containing active ingredient **diethyltoluamide** (DEET). World Health Organization also recommends insect repellents with IR3535 and Icaridin (also known as Picaridin) for preventing mosquito bites.

Does formulation with higher concentration provide better protection?

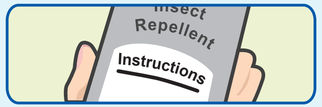
Formulation with concentration of 20% or more of DEET can provide the best and longer protection against *Aedes* mosquitoes. Products with higher concentration mainly provide longer-lasting protection but do not offer other additional protection against mosquito bites. The protection from plant-derived repellents, in general, is shorter.

Are there any side effects of using insect repellents containing DEET?

Using insect repellents containing DEET should not be harmful if label instructions are followed and the product is used safely. Some persons who used products containing a high concentration of DEET or who were exposed to excessive amounts of DEET have experienced skin rashes, blisters, and skin and mucous membrane irritation.

Are there any special precautions when using insect repellents?

- Read and follow the label instructions strictly before use



- Apply only to exposed skin and clothing

- Do not apply near eyes and mouth, and apply sparingly around ears
- Do not spray directly to face; spray on hands and then apply to face by hand
- Apply in a thin and even layer, just enough to cover clothing and exposed skin
- When used with a sunscreen, apply sunscreen first, followed by insect repellent

- Reapply only whenever needed and follow the instructions of the products

Is it safe for children, pregnant and nursing women to use insect repellents?

Yes. Pregnant or nursing women and children of 6 months or older* can use DEET-containing insect repellents.

Children

- Use lower concentration of DEET of up to 10%*
- Do not allow children to apply repellents by themselves. Adults should apply it to their own hands and then put it on children
- Limit application to the skin and reinforce application to clothing
- Roll-on preparations are preferable to sprays

* For children who travel to countries or areas where mosquito-borne diseases are endemic or epidemic and where exposure is likely, children aged 2 months or above can use DEET-containing insect repellents with a concentration of DEET up to 30%.

Pregnant and nursing women

- Use concentration of DEET of up to 30% for pregnant women
- Nursing mothers have to wash insect repellent off their hands and body before breastfeeding their infants

When is the appropriate time to apply the insect repellents?

DEET-containing insect repellents take immediate effect upon application, therefore it should be applied right before entering an area with risk of mosquito bites.

DO's

- Read and follow the label instructions strictly before use
- After returning indoors, wash treated skin with soap and water, change and wash the clothes which have been treated with insect repellent
- For the first time of application, apply to a small area of skin, if any reaction is found, stop using the insect repellent, wash it off with mild soap and water, and seek medical advice if needed
- Store insect repellents safely out of the reach of children

DON'Ts

- Do not apply insect repellent over cuts, wounds, sun burned or irritated skin
- Do not apply insect repellent near food or spraying in enclosed areas
- Do not apply insect repellent near naked flames or lit cigarettes

Public should also take other preventive measures when engaging in outdoor activities to avoid mosquito bites:

- Wear loose, light-coloured, long-sleeve tops and trousers
- Avoid using fragrant cosmetics or skin care products
- Avoid taking rest in the close proximity of densely vegetated areas

Revised in March 2018