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行政院衛生署疾病管制局 98 年度科技研究發展計畫

台灣地區登革熱病媒蚊分布調查與屈公病發生的可能性探討

研究報告

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目　　錄

摘要

此計畫更新台灣地區登革熱病媒蚊分布，含高度、經度及緯度，預定三年，完成25個縣市，368個鄉鎮市區，7,826個村里，每個村里至少鑑定100隻斑蚊幼蟲（含蛹），並於實驗室進行屈公病毒感染試驗，瞭解台灣地區常見蚊蟲種類對屈公病毒的感染能力，以釐清台灣地區屈公病毒發生的可能性。今年截至10月止，全國7,826個村里中，已執行3,095個村里，完成100隻斑蚊幼蟲送驗村里，共2,066個村里。埃及斑蚊分布仍侷限於高雄市、台南市、高雄縣、屏東縣、台東縣及澎湖縣，此次調查與77-85年及92-93年調查資料比較，新增的鄉鎮市區包括屏東縣大樹鄉、台南縣南化鎮及澎湖縣望安鄉。白線斑玟則普遍分布台灣各地區，海拔高度可達1,760公尺。經以屈公病毒非洲株感染台灣地區常見蚊蟲種類埃及斑蚊、白線斑蚊、熱帶家蚊及白腹叢蚊，發現埃及斑蚊於第3-5天，約30-40%雌蚊體內病毒有明顯增殖現象，白線斑蚊於第6天有20%雌蚊有複製現象，而熱帶家蚊及白腹叢蚊體內病毒則未有複製現象。

中文關鍵詞：埃及斑蚊、白線斑蚊、屈公病毒、台灣

Abstracts

This 3-year project updates the distribution of dengue vectors and understands laboratory infection of chikungunya virus on common mosquito species in Taiwan. One hundred of *Aedes* larvae (including pupae) will be collected in 7,826 wards in 368 townships, 25 Counties/Cities from 2009 to 2011. Update to October, 2009, a total of 3,095 wards submitted collection of *Aedes* larvae and 2,066 wards compledted submition of 100 *Aedes* larvae. *Aedes aegypt* still confined in Kaohsiung City, Tainan City, Kaohsiung County, Pingtung County, Tainan County, Taitung County, and Pinghu County. Comparing with surveys in 1988-1996 and 2003-2004, new additions were Gaoshu Township, Pingtung County, Nanhua Township, Tainan County, and Wang-an Township, Penghu County. *Aedes albopictu*s was commonly found island wide below the sea level of 1,760 m. Laboratory infection of chikungunya virus (African strain) on common mosquito species in Taiwan was conducted. Virus replication was found in 30-40% *Ae. aegypti* females 3-5 days after feeding blood contianig virus, and in 20% *Ae. albopictus* 6 days after feeding. No virus replication was found in *Culex quinquefasciatus* and *Armigeres subalbatus* females.

Keywords：*Aedes aegypti*, *Aedes albopictus*, Chikungunya virus, Taiwan

前言

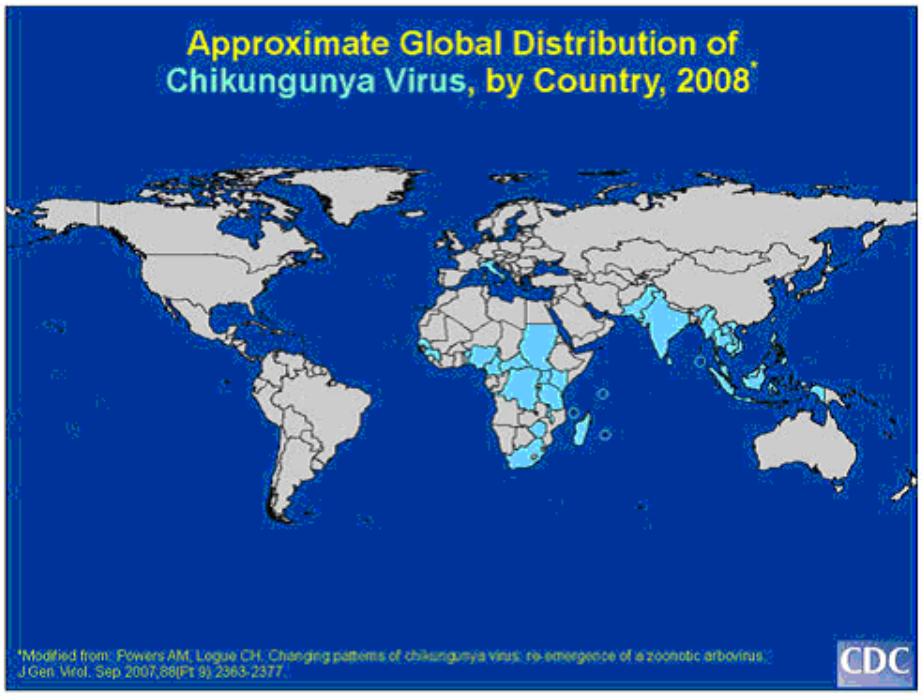
傳播登革熱病媒蚊屬於斑蚊屬室蚊亞屬，在台灣共有 9 種，包括埃及斑蚊 *Aedes aegypti* L.、白線斑蚊 *Ae. albopictus* Skuse、阿氏斑蚊 *Ae. alcasidi* Huang、安氏斑蚊 *Ae. annadalei* Theobald、帶紋斑蚊 *Ae. desmotes* Giles、加氏斑蚊 *Ae. gardnerii imitator* Leicester、馬氏斑蚊 *Ae. malikuli* Huang、巴氏斑蚊 *Ae. patriciae* Mattingly 及偽白線斑蚊 *Ae. pseudalbopictus* Borel（連日清 2004）。其中埃及斑蚊與白線斑蚊因為與人居住的地方息息相關，而列為主要的病媒蚊。前者分布於台灣本島南部及台東市(Lien 1978, Lien et al. 1992, Teng et al. 1996)，主導南部地區登革熱傳播，而後者分布於全台灣擔任無埃及斑蚊地區的登革熱傳播（Teng et al. 1999)。早期黃及陳（1986）利用衛生署預防醫學研究所的數據發表埃及斑蚊及白線斑蚊分布圖。自 86 年因為需增加各縣市調查村里數，所以將埃及斑蚊與白線斑蚊幼蟲指數合併，不再鑑定種類，計算幼蟲指數。南部地區後因 2002 年登革熱大流行後，增加成蟲調查，南部縣市衛生局鑑定種類，並依據 2003-5 年數據更新埃及斑蚊分布圖。其他地區則因為無埃及斑蚊所以沒有跟進。雖然目前有各縣市登革熱病媒蚊調查，但僅能知道密度，無法監測病媒蚊種類的擴散。

全球暖化日趨嚴重，平均每百年可增加 1-2℃（Hansen et al. 2006)，對病媒性疾病，特別是蚊蟲傳播的疾病有很嚴重的影響。其影響的範圍在縮短蚊蟲繁殖時間、蚊蟲種類擴散或縮短病原繁殖的時間。例如埃及斑蚊分布於台灣南部地區，雖然北部的溫度會限制此蚊種的擴散，但並非絕對因子（Chang et al. 2007)。在過去的調查中也曾在新竹、台東縣成功鎮等地發現埃及斑蚊幼蟲，但並沒有建立族群，所以隨著氣候的暖化，埃及斑蚊有可能會北移，例如埃及斑蚊是

否有往外擴散或像白線斑蚊經廢輪胎（Hawley et al.1987）、富貴竹（Madon et al.2002）、交通工具等北移的現象，而分布全台灣。登革熱病媒蚊調查依生活史期別的不同，而有不同的方法。卵期使用誘卵器，幼蟲直接調查孳生斑蚊幼蟲的積水容器，而成蟲可以直接掃網、人工誘引、背負式吸蟲機或誘蟲器（Meeraus et al. 2008, Krockel et al. 2006, Williams et al. 2007），其中又以誘卵器是低密度時最敏感的偵測方法。經常使用的誘卵器樣式有三種(1)新加坡使用的誘卵器（Ooi et al. 2006），(2)台灣使用的誘卵器，及(3)澳洲使用的粘紙誘卵器。其中又以澳洲使用的誘卵器功能最多（Ritchie et al. 2004, Facchinelli et al. 2008, Kittayapong et al. 2008），可同時採集卵粒及前來產卵的雌蚊，雌蚊又可進行病毒檢測及評估防治效果用，有效時間常達 9 個月。

屈公病病毒在 1953 年首先自坦薩尼亞屈公病流行時的病人身上分離出來，在非洲及亞洲地區流行（圖二）。非洲流行地區包括西非（塞內加爾至喀麥隆）、中非、東非（中非共合國、安哥拉、剛果共合國、尚比亞、辛巴威、坦尚尼亞、馬拉威、莫三鼻克、波札那東部）及南非北部。亞洲流行地區包括印度、斯里蘭卡、泰國、緬甸、馬來西亞、印尼、及東普賽。同時也曾在沙烏地阿拉伯及新幾內亞流行。最近（2005-2007 年）在印度洋西邊小島（包括科摩洛 Comoros、馬達加斯加 Madagascar、留尼旺島 Réunion、馬約特島 Mayotte、模尼西斯島 Mauritius 與塞席爾島 the Seychelles）流行，病例數超過 288,000 例(WHO 2007)。2007 年在義大利流行，病例數超過 200 例(deLambalerie et al. 2008, WHO 2007)。今年（2008 年）更在新加坡流行，截至 98 年 9 月 4 日為止，共有 178 個病例，其中境外移入病例 86 例（馬來西亞 77 例、印尼 4 例、斯里蘭卡 2 例、印度 2 例及馬爾地夫島 1 例），

本土病例 92 例，可能來自 19 個不同感染地區（新家坡衛生部 2008 年 9 月 5 日新聞稿）。

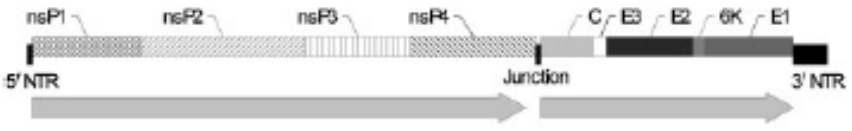


圖二、屈公病的全球分布圖（摘自美國疾病管制局網站 http://www.cdc.gov）

傳播屈公病的病媒蚊屬於斑蚊屬，在非洲屬於叢林型蚊蟲，包括 *Ae. furcifer* (Edwards), *Ae. taylori* Edwards, *Ae. luteocephalus* Newstead, *Ae. africanus* (Theobald), *Ae. neoafricanus* Cornet, Valade & Dieng，在亞洲則屬於都市蚊種－埃及斑蚊(Powers and Louge 2007, WHO 2007)，近 2 年在義大利、留尼旺島及模尼西斯島流行時的病媒蚊則為白線斑蚊，其他在實驗室證實也具有傳播能力的包括 *Ae. caspius* Pallas、*Ae. detritus* Hal.、*Ae. vittatus* Bigot、及 *Anopheles stephensi* Liston (Mourya and Banerjee 1987, Yadav et al. 2002, WHO 2007)。病毒在病媒蚊體內複製的時間僅需 3-5 天，就具有傳播的能力，而登革病毒在蚊蟲體內需要 8-12 天複製才具有傳播

的能力（Mourya and Yadav 2006）。依據實驗室的感染數據，病媒蚊媒介的能力受到蚊蟲地區品系及屈公病病毒株的影響，也有所不同（Turell et al. 1992）。依據留尼旺島所分離的病毒株在實驗室感染的結果，白線斑蚊的感染率在吸血後 12-14 天為 77%（WHO 2007），相較於白線斑蚊感染登革熱 14 日的感染率 3%高 （Chen et al. 1993）。

屈公病毒屬於批蓋病毒科(Togaviridae)α病毒屬(Alphavirus)，為線性單股 RNA，重量 11.8kb（圖三），有兩株病毒株（非洲株及亞洲株）。在印度洋的小島及義大利所分離出的病毒株（亞洲株）在 E1 基因 226 位置上均有一個單點突變（Alanine→Valine），而此突變使得屈公病病毒在白線斑蚊體內複製加速及傳播效率增加（Tsetsarkin et al. 2007,de Lamballerie et al. 2008）。此突變可能係因病毒由埃及斑蚊轉而適應白線斑蚊所致。義大利的白線斑蚊是由日本輸入可以越冬的品系，而台灣的白線斑蚊是屬於另一種不越冬的品系(Hawley et al. 1987)。此研究結果為台灣地區北部的白線斑蚊對光週期沒有反應，而光週期為啟動越冬的機制，所以白線斑蚊在台灣不越冬，而此實驗為 21 年前的實驗，且僅使用北部的品系。台灣地區白線斑蚊的品系，值得近一步探討。



圖三、屈公病病毒的基因體結構（摘自 Powers and Logue 2007）

此計畫的目的為調查台灣地區登革熱病媒蚊的分布，含高度、經度及緯度，並利用實驗室感染屈公病毒，以瞭解台灣地區蚊蟲種類對屈公病毒的感染能力，以釐清台灣地區屈公病毒發生的可能性。

材料與方法

一、　登革熱病媒蚊分布調查

1.蚊蟲幼蟲蒐集

請北部、中部、東部及南部縣市衛生局，將平常調查的斑蚊幼蟲，裝在 70%的酒精塑膠瓶，寄回昆陽辦公室，每里 100 隻幼蟲左右，預定於三年內（98-100 年）完成北部、中部及南部 25 縣市 368 個鄉鎮 7,826 個村里。

地區	縣市	土地面積	鄉鎮市區數	村里數
中	臺中縣	2,051.47	21	411
中	彰化縣	1,074.40	26	589
中	南投縣	4,106.44	13	261
中	雲林縣	1,290.83	20	387
中	台中市	163.43	8	214
中	苗栗縣	1,820.31	18	271
北	台北縣	2,052.57	29	1,016
北	宜蘭縣	2,143.63	12	235
北	桃園縣	1,220.95	13	471
北	新竹縣	1,427.54	13	182
北	基隆市	132.76	7	157
北	新竹市	104.15	3	120
北	台北市	271.80	12	449
北	金門縣	151.66	6	37
北	連江縣	28.80	4	22

東	台東縣	3,515.25	16	147
東	花蓮縣	4,628.57	13	177
南	嘉義縣	1,901.68	18	357
南	台南縣	2,016.01	31	521
南	高雄縣	2,792.67	27	441
南	屏東縣	2,775.60	33	464
南	澎湖縣	126.86	6	97
南	嘉義市	60.03	2	108
南	台南市	175.65	6	233
南	高雄市	153.59	11	459
總計	合計	36186.64	368	7,826

2.休閒地區調查

因為山區或空曠休閒地區會有其他種類斑蚊，所以在北部、中部、東部及南部，每年選 2 個人口流動頻繁的觀光休閒地區，至少 1 個為高海拔地區，以人工調查積水容器採集幼蟲及人工掃網採集斑蚊成蟲，並放置 2 個斑蚊成蟲誘蟲器(BG-sentineltraps)24 小時，內含乳酸、氨水、caproicacid 等誘引劑，上面放乾冰，增強誘引效果。所捕獲的成蟲帶回實驗室，鑑定蚊蟲種類。預定三年內（98-100 年），完成 24 個點。

3.埃及斑蚊分布地區確認

針對原來無埃及斑蚊分布的地區（北部、中部、及除台東市外的東部）所送驗樣本檢測出埃及斑蚊時，再次前往該村里抽查 100 戶，搜尋幼蟲及成蟲，並系統性放置黏紙誘卵器 50 個於戶外一個禮拜及 2-3 個斑蚊成蟲誘蟲器(BG-sentineltraps)一天（24 個小時），內含乳

酸、氨水、caproicacid 等誘引劑，上面放乾冰，增強誘引效果。

二、 台灣發生屈公病之可能性探討

1.蚊蟲品系及飼養

台灣地區住家常見的蚊蟲種類包括白線斑蚊、熱帶家蚊 *Culex quinquefasciatus* Say、白腹叢蚊 *Armigeres subalbatus* (Coquillett)及埃及斑蚊，在實驗室飼養多年，幼蟲以足量的酵母粉放置於 W40.5×D29.5×H7.5 水盤飼養，蛹羽化為成蚊，將調製好 10%糖水於燒瓶內，上面放置棉花棒後，放入成蚊飼養箱內，作為雌蚊及雄蚊的食物化蛹後檢出放置於蚊籠，以 10%糖水飼養，並吸老鼠血產卵。另外並於野外採集埃及斑蚊及白線斑蚊，進行感染試驗。

2.感染使用的病毒株

病毒株來源為疾病管制局歷年來以細胞培養方法分離所得者。實驗所使用的病毒株有兩株，一為 CHK/Singapore/0611aTw/2006，為自新加坡移入之境外病毒株，屬於 East/Central/SouthAfricagenotype，另一為 CHK/Indonesia/0706aTw/2007，為自印尼移入之境外病毒株，屬於 East/Central/SouthAfricagenotype（Shu et al.2008)。

3.感染試驗

將 2-5 日齡蚊蟲雌蚊 5-10 隻，放置於紙杯，(紙杯上裝置紗網，橡皮圈先固定後，再以膠帶密封，紙杯中間作一活動開口)，活動開口以膠帶密封，放在養蚊籠內，置於 28℃的生長箱，禁食 1 天後，將屈公病病毒、人血及糖水 1:1 混合均勻，滴在網上，供蚊蟲吸血 1 小時，第二天放於網上放入吸水棉花，每隔 2 日更換一次。處理時間包括吸血後 0 小時、1 日、2 日、3 日、4 日、5 日、6 日、12 日、18 日、24 日、30 日、36 日…，直至雌蚊死亡。蚊蟲處理完畢，即放入-20℃的

冷凍箱內保存，以作後續感染檢驗。共重複 2-3 次。

4.蚊蟲感染檢驗

蚊蟲感染檢驗方法為 TagMan®RT-PCR 檢驗方法（Pastorino et al. 2004, Rezza et al.2007）。

(1)病媒蚊體內病毒 RNA 的萃取方法

a.將單隻蚊子放入 1.5ml 微量試管中，加入 0.5mL BA-1 溶液，並放入 1 顆滅菌過的 3mm 玻璃珠。

BA-1 溶液 1 X medium 199 with Hanks' balanced salt solution,
0.05 M Tris Buffer (PH7.6)
1% bovine serum albumin
0.35 g sodium bicarbonate/L
100 U streptomycin/L
100 U penicillin
25 ug amphotericin B (Fungizone)/mL

b.以 tissue lyser 震盪 1 分鐘打碎蚊蟲細胞組織。

c.將均質液，以 14000rpm 離心 10 分鐘除去懸浮固體。

d.取 100μl 上清液至新的 1.5ml 微量離心管中，並加入 150μL BA-1 溶液，混和均勻。

e.吸取 560μL 含有 carrier RNA 的 AVL 溶液至 1.5mL 微量離心管中，並加入 140μL 步驟 4 的液體，vortex 1 分鐘混合均勻。

f.室溫(15~25℃)下作用 10 分鐘。

g.加入純酒精 560μL，震盪約一分鐘以終止反應。

h.利用小烏龜離心機離心數秒，將蓋子上的殘留液離下。

i.將上述混合液 630μL 分兩次加至 QIAampspin column(放置於 2 mL collection tube 上)，蓋上蓋子，以 14000rpm 轉速離心 2 分鐘，

將 QIAampspin column 放置新的 2 mL collection tube 上。

j. 小心打開 QIAampspin column 的蓋子，加入 500μL AW1 溶液，蓋上蓋子，以 14000rpm 轉速離心 2 分鐘，將 QIAampspin column 放置新的 2mL collection tube 上。

k. 小心打開 QIAampspin column 的蓋子，加入 500μL AW 2 溶液，蓋上蓋子，以 14000rpm 轉速離心 2 分鐘，倒去下層液，再以

l. 將 QIAampspin column 放置新的 1.5ml 微量離心管上，以 14000rpm 轉速離心 3 分鐘後，開蓋放置室溫中 5 分鐘除去多餘的酒精。

m. 將 QIAampspin column 放置新的 1.5ml 微量離心管上，加入 AVE 70 μL 溶液，靜置於室溫下 10 分鐘，以 14000rpm 轉速離心 2 分鐘。

n. 保存於-20℃或-80℃，進行後續病毒檢測用。

(2)TaqMan®real-timeRT-PCR 檢驗方法

TaqMan®real-timeRT-PCR 檢驗方法的配方如下：

Component	Volumn/reaction	
	Pastorino et al.（2004）	Edwards et al.（2007）
2 X Reaction Mix buffer（Invitrogen）	10μl	10μl
Forward primer	Variable（9pmole）	0.9μM
Reverse primer	Variable（9pmole）	0.9μM
Probe primer	Variable（2pmole）	1.25μM
Rnase Inhibitor（Rnasin, Promega）	Variable（8U）	---
MgSO4	---	6.75mM
RT/Taq（Invitrogen）	0.8μL	0.8μL

Extracted RNA	2.5μL	5μL
Distilledwater	6.7μL	4.2μL
Total	20μL	20μL

屈公病檢驗使用的兩組引子序列及位置如下：

引用文獻	引子 Primer	序列 5’-3’	基因體位置
Pastorino et al.（2004）	F-CHIK	AAGCTYCGCGTCCTTTACCAAG	10366-10387
	R-CHIK	CCAAATTGTCCYGGTCTTCCT	10554-10574
	P-CHIK	CCAATGTCYTCMGCCTGGACACCTTT	10465-10490
Edwards et al.（2007）	CHIKE1F	TCGACGCGCCCTCTTTAA	10865-10882
	CHIKE1R	ATCGAATGCACCGCACACT	10973-10991
	CHIKE1P	ACCAGCCTGCACCCATTCCTCAGAC	10902-10926

陽性對照組：屈公病病毒 RNA 稀釋 10 倍

陰性對照組：NTC（Non-Template Control），RNase-freewater

進行 real-time RT-PCR 反應及分析結果。參考溫度程式如下，但仍需要找到最佳狀況。

Step	Cycles	Pastorino et al.（2004）		Edwards et al.（2007）	
		Time	Temperature	Time	Temperature
Reverse Transcription	1	20min	50℃	30min	50℃
PCR Initial Activation	1	2min	95℃	15min	95℃
Denaturation、Annealing、Extension	45	5sec	95℃	15sec	95℃
	45	1min	60℃	0.5min	58℃

檢驗結果若 Ct 值低於 35，則以電泳跑膠比對產物大小（Edward et al.2004 的 PCR 產物 127bp)。若產物大小與陽性對照組相同，則將產物定序後，進入 NCBI 資料庫比對。

(4)病毒序列分析

每個處理選擇陽性檢體數個，利用以下兩組引子（Edwards et al. 2007)，放大萃取的病毒 RNA，產物大小為 570bp，然後定序，並利用相關網站（例如 NCBI）進行比對。

引子 Primer	序列 5’-3’	基因體位置
CHIK10264F	GGCGCCTACTGCTTCTG	10264-10280
CHIK11300R	CGACACGCATAGCACCAC	11281-11298
CHIK10564F	CCCTTTGGCGCAGGAAGAC	10564-10582
CHIK11081R	GACTTGTACGCGGAATTCGG	11081-11100

(5)屈公病病毒培養分離

選擇 RT-PCR 陽性的蚊蟲及經卵傳播試驗數個，進行病毒培養。

1.將約 1-50 隻蚊子放入 1.5ml 微量試管中，加入 0.5mlBA-1 溶液，並放入 1 顆滅菌過的 3mm 玻璃珠。

BA-1 溶液 1X medium 199 with Hanks’ balanced salt solution,0.05M Tris Buffer (PH7.6)

1% bovine serum albumin

0.35 g sodium bicarbonate/L

100 U streptomycin/L

100 U penicillin

25 ug amphotericin B (Fungizone)/ml

2.以 tissue lyser 震盪 1 分鐘打碎蚊蟲細胞組織。

3.將白線斑蚊 C6/36 細胞株在生長液中 2 天，直到在培養管內形成一層細胞。100μL 蚊蟲均質液通過 0.2μM 的過濾器，種入上面的

培養管。培養管震盪後,靜置室溫下2小時以利吸收。加入2% fetal calf serum (FCS)維持液後，在28℃下培養7天。

4.抹片(Smear)配置

培養七天後的培養管震盪及離心。取出沉澱物至teflon-coated12well的玻片，此玻片含有7個測試，4個陽性對照組及1個陰性對照組。此玻片放在有氣流的laminar flow在28℃下靜置3-4小時。此玻片用冷丙酮固定20分鐘。細胞陪養管存放於-20℃，以備後續細胞培養第二次或第三次(假使初步反應為陽性)。

5.PAP(Peroxidase-antiperoxidase)染色

(1)以丙酮固定的玻片，在室溫下與登革病毒的單株抗體(1:1000)反應40分鐘。

(2)細胞以PBS洗滌，與rabbit anti-mouseIgG (1:1000)反應40分鐘。

(3)細胞以PBS洗滌，與peroxidase-rabbit anti-peroxidase complex (1:1000)反應40分鐘。

(4)使用0.2mg/mL diaminobenzidine (DAB) 及0.2%雙氧水。

(5)細胞在光學顯微鏡下檢查。若為陽性，再重複一次確認。

結果

一、 登革熱病媒蚊分布調查

白線斑蚊在目前調查之所有鄉鎮中，均有採集（圖一及表一），除高雄市前金區，但送驗隻數僅24隻，其分布之高度可達海拔1,760公尺（台中清境農場)。埃及斑蚊分布則沒有太大變化，仍侷限於高雄市、台南市、高雄縣、屏東縣、台東縣及澎湖縣（圖二)。其中高雄市11個行政區均有採集到埃及斑蚊，埃及斑蚊為優勢種，佔登革熱病媒蚊百分比例為53.0-100.0%，台南市6個行政區均有採集到埃及斑蚊，在中西

區、北區、東 及南區為優勢種，佔 50.9-73.0%，在安平區及安南區則非優勢種，佔 23.0-34.1%。高雄縣 27 個鄉鎮市區，埃及斑蚊分布百分比例為 0.0-72.1%，其中有 14 個鄉鎮市區（51.8%）有發現埃及斑蚊（鳳山市、大社鄉及茄萣鄉等 3 個鄉鎮埃及斑蚊為優勢種），屏東縣 33 個鄉鎮市區埃及斑蚊分布百分比例為 0.0-59.9%，其中有 20 個鄉鎮市區（60.6%）有發現埃及斑蚊（僅東港鎮埃及斑蚊為優勢種），1 個鄉鎮無數據（3.0%），台南縣 31 個鄉鎮市區埃及斑蚊分布百分比例為 0.0-19.0%，其中有 6 個鄉鎮市區（19.4%）有發現埃及斑蚊，15 個鄉鎮無數據(48.4%)，台東縣 16 個鄉鎮市區，埃及斑蚊分布比例為 0.0-2.2%，其中僅台東市有埃及斑蚊， 2 個鄉鎮沒有數據，澎湖縣 6 個鄉鎮為 0.0-16.8%。此次調查與 77-85 年及 92-93 年調查資料比較，新增的地區包括屏東縣大樹鄉、台南縣南化鎮及澎湖縣望安鄉。

截至 10 月止，全國 7,826 個村里中，已執行 3,095 個村里，完成 100 隻斑蚊幼蟲送驗村里，共 2,066 個村里（表二）。送驗之斑蚊幼蟲及蛹數，以白線斑蚊最多，共 215,654 隻、埃及斑蚊次之，53,014 隻，接者為家蚊屬（含熱帶家蚊、黃尾家蚊 *Cx. fuscanus* Wiedemann、雙角家蚊 *Cx. bicornutus* Theobald、三斑家蚊 *Cx. tritaeniorhynchus* Giles、灰胸家蚊 *Cx. pallidothorax* Theobald、海氏家蚊 *Cx. halifaxii* Theobald、莫氏家蚊 *Cx. murrelli* Lien、花翅家蚊 *Cx. neomimulus* Lien 等 8 種）22,127 隻、搖蚊科 Chironomidae 2,516 隻、叢蚊屬（白腹叢蚊）1,075 隻、蝶蠅 146 隻、翠蚊屬（竹生翠蚊 *Tripteroides bambusa*(Yamada)）52 隻、瘧蚊屬（斑腳瘧蚊 *Anopheles maculatus* Theobald）32 隻及黃蚊屬（日本黃蚊 *Ochlerotatus japonicus shintienensis* (Tsi and Lien)及艾氏黃蚊 *Oc. Elsiae vicarious*(Lien)）11 隻。各縣市病媒蚊調查人員現場調查鑑定斑蚊幼

蟲及蛹正確率為 91.2%（=268,679/294,627*100%），並函送「台灣地區積水容器常見蚊蟲幼蟲特徵一覽表」（附錄二）予各縣市衛生局以供參考。

休閒地區預定完成北區、中區、南區與東區，目前完成北區（野柳及太平山休閒地區）與中區（清境農場及九族文化村）各 2 個點，東區及南區分別預定於 11 月及 12 月前往調查。白線斑蚊幼蟲與成蟲均分別發現於海拔 600 公尺之野柳、海拔 600~700 公尺之九族文化村及海拔 1,760 公尺之清靜農場（表三），但海拔 1,900 公尺之太平山僅發現哈氏黃蚊 *Oc. Harveyi*（Barraud）10 隻與日本黃蚊 10 隻。東鄉黃蚊 *Oc. Togoi*（Theobald）則發現於台北縣野柳海邊，其他採集之種類包括花翅家蚊、熱帶家蚊、雙角家蚊、黃尾家蚊、灰胸家蚊、佐佐家蚊 *Cx. sasai* Kano, Nitahara and Awaya、鹹水家蚊 *Cx. sitiens* Wiedemann、斑翅家蚊 *Cx. mimeticus* Noe、白腹叢蚊等 9 種。

二、 台灣發生屈公病之可能性探討

經以屈公病毒非洲株感染台灣地區常見蚊蟲種類埃及斑蚊、白線斑蚊、熱帶家蚊及白腹叢蚊，感染結果詳列於表四至表七。埃及斑蚊雌蚊吸血率為90%（表三），白線斑蚊吸血率為100%（表四）。埃及斑蚊完成兩次感染試驗，第一次重覆，僅於第三天及第五天。有10-20%雌蚊明顯增殖（Ct值小於0天所測之最小Ct值29.8），而第二次重覆，則於第一天及第二天即有10%雌蚊體內病毒開始增殖（Ct值小於0天所測之最小Ct值26.5）。於第三至五天約30-40%雌蚊病毒明顯增殖，而後於6天及18天有20%均有增殖。白線斑蚊第一次重覆試驗，於吸血後第6天有40%有複製（Ct值小於0天所測之最小Ct值29.8），而第二次重覆，則於第一天及第二天即有10%雌蚊體內病毒開始增殖（Ct值小於0天所測之最小Ct值28.0），12天、18天及24天則有20%雌蚊有複製，第

二次感染試驗，僅於第6天有20%雌蚊有複製現象（Ct值小於0天所測之最小Ct值26.7)。熱帶家蚊吸血率為100%，但病毒並未複製（Ct值大於0天所測之最小Ct值28.6)，僅於第6天及第有10%雌蚊仍可測到病毒。而白複叢蚊吸血率較差。為50%（表六)，，但病毒並未複製（Ct值大於0天所測之最小Ct值27.0）於12天至24天，仍可檢測到病毒。

討論

台灣地區埃及斑蚊的分布仍侷限於舊有分布區塊，並未北移或東移，但區塊內仍有變動，此次調查與前 20 年調查發現新增屏東縣高樹鄉、台南縣南化鎮、澎湖縣望安鄉，且白線斑蚊分布普遍，海拔可高達 1760 公尺。全球暖化日趨嚴重，平均可增加 1-2℃，對病媒性疾病，特別是蚊蟲傳播的疾病有很嚴重的影響。埃及斑蚊雖仍侷限於台灣南部地區，但北部的溫度會限制此蚊種的擴散，但並非絕對因子（Chang et al.2007)，所以隨著氣候的暖化，埃及斑蚊有可能藉著廢輪胎（Hawley et al.1987)、富貴竹（Madon et al.2002)、交通工具等擴散至其他地區，而此次台灣地區全面性調查建立了一個完整的登革熱病媒蚊基礎分布資料，可提供後續埃及斑蚊擴散的基準及登革熱防治政策擬定的參考。

病媒蚊的鑑定，在蚊蟲監測中佔很重要的角色，此次送來之斑蚊檢體中，現場鑑定正確率平均為91.2%，錯誤率為8.8%，種類包括叢蚊屬、家蚊屬、瘧蚊屬、翠蚊屬、搖蚊及蝶蠅等，各縣市衛生局於病媒蚊調查時，宜1組3人，內含經驗豐富有鑑定能力的人至少1人，以經驗傳承的方式，進行實務訓練。

此次感染試驗證實屈公病毒非洲株可於台灣地區埃及斑蚊族群第一天開始即有複製現象，且於第3-5日有明顯增殖，在白線斑蚊有少量複製現象，但在熱代家蚊及白腹叢蚊則沒有複製現象。但帚體而

言，兩次重複並不一致，有可能係因蚊蟲最初感染濃渡過低，建議進行最初濃度感染試驗或直接提高濃度至10^6或10^7 PFU/mL。另外白線斑蚊、白腹叢蚊及熱帶家蚊在試驗期間，0天後雌蚊均有陸續死亡情形發生，將再進行檢討生長箱飼養狀態，並增加對照組（直接將實驗室雌蚊放入紙杯）以釐清原因。

結論與建議

一、 台灣地區埃及斑蚊仍分侷限分布於高雄市全市、台南市全市、台南縣部份鄉鎮、高雄線部份鄉鎮、屏東縣部份鄉鎮、台東縣台東市、澎湖縣馬公市及望安鄉。

二、 屈公病毒非洲株可在台灣埃及斑蚊體內吸病毒血後3-5天內，繁殖複製，所以於吸完病毒血，完成產卵，應可於下次吸血（約吸病毒血後5天）就具有感染力，所以需進行病媒蚊傳播屈公病毒試驗。

三、病媒蚊的鑑定，在監測中佔很重要的角色，此次送來之斑蚊檢體中，現場鑑定正確率為91.2%，錯誤率為8.8%，種類包括叢蚊屬、家蚊屬、瘧蚊屬、翠蚊屬、搖蚊及蝶蠅等，應加強現場調查人員編組及實務訓練。

計畫重要研究成果及具體建議

屈公病毒非洲株在台灣埃及斑蚊體內吸病毒血後3-5天內明顯增殖，再加上最近五年來每年均發生登革熱疫情，而埃及斑蚊仍侷限於南部地區，應擬定埃及斑蚊逐年撲滅計畫。

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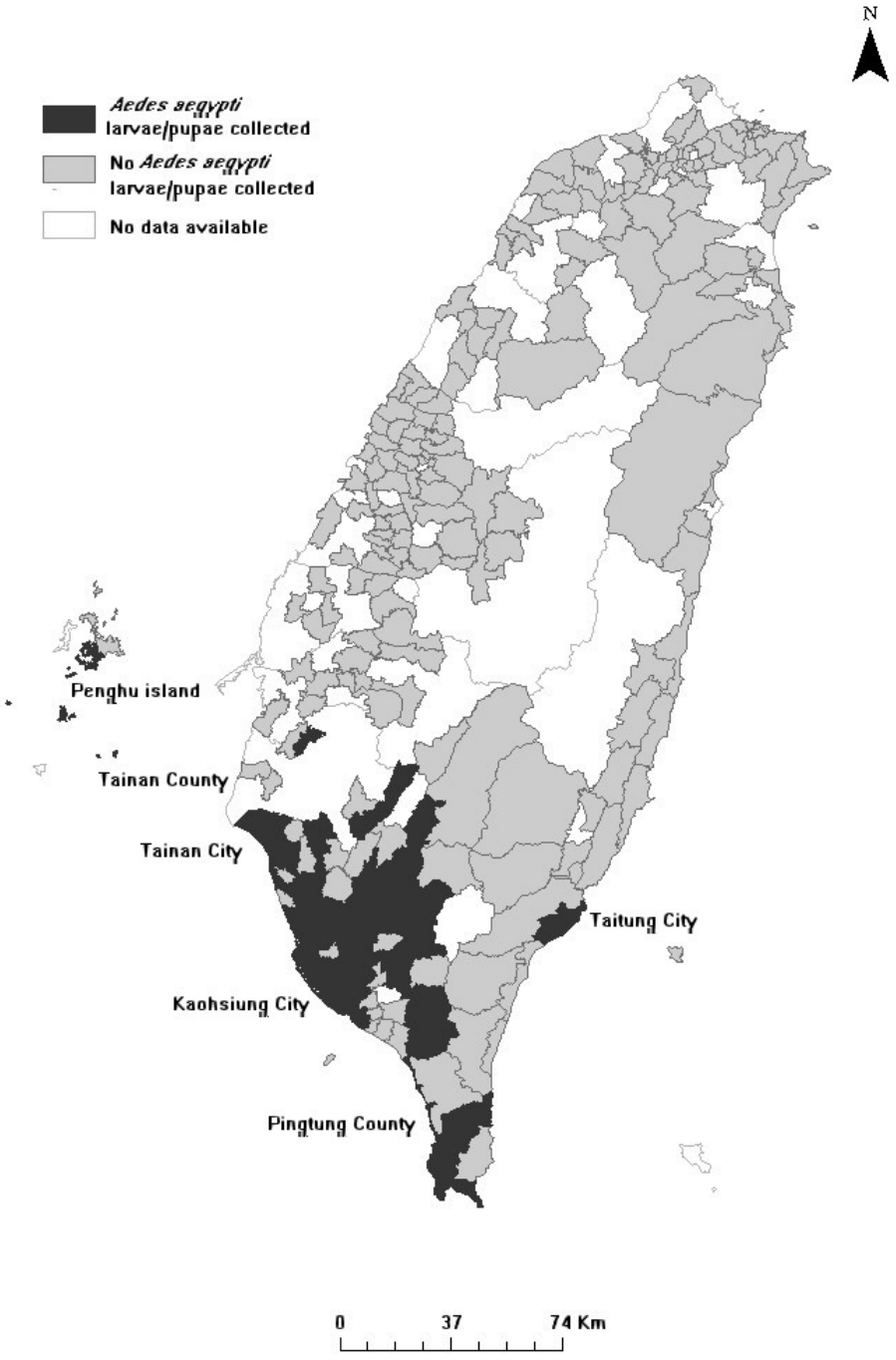
N
Aedes aegypti
larvae/pupae collected
No Aedes aegypti
larvae/pupae collected
No data available
Penghu island
Tainan County
Tainan City
Taitung City
Kaohsiung City
Pingtung County
0
37
74 Km

圖一、埃及斑蚊分布圖。


N
Aedes albopictus
larvae/pupae collected
No Aedes albopictus
larvae/pupae collected
No data available
0
37
74 Km

圖二、白線斑蚊分布圖。

表一、登革熱埃及斑蚊分布鄉鎮。

分布縣市	分布鄉鎮	77-85年	92-93年	98年			
				白線斑蚊	埃及斑蚊	合計	埃及斑蚊百分比
高雄市	前金區	√	√	0	24	24	100.0%
	前鎮區	√	√	317	4,194	4,511	93.0%
	三民區	√	√	286	2,933	3,219	91.1%
	新興區	√	√	190	1,635	1,825	89.6%
	鹽埕區	√	√	167	1,295	1,462	88.6%
	小港區	√	√	1,476	2,455	1,462	88.6%
	苓雅區	√	√	642	4,809	5,451	88.2%
	左營區	√	√	728	2,976	3,704	80.3%
	旗津區	√	√	246	943	1,189	79.3%
	鼓山區	√	√	830	2,718	3,548	76.6%
	楠梓區	√	√	1,215	1,401	2,616	53.6%
合計	11	11	11	10	11		
台南市	中西區	√	√	1,041	2,813	3,854	73.0%
	北　區	√	√	1,563	2,650	4,213	62.9%
	東　區	√	√	1,703	2,635	4,338	60.7%
	南　區	√	√	1,982	2,057	4,039	50.9%
	安平區	√	√	948	491	1,439	34.1%
	安南區	√	√	3,979	1,190	5,169	23.0%
合計	6	6	6	6	6		
高雄縣	鳳山市	√	√	2,058	5,310	7,368	72.1%
	大社鄉	√	√	284	431	715	60.3%
	茄萣鄉	√	√	512	721	1,233	58.5%
	大寮鄉	√	√	1,578	624	2,202	28.3%
	岡山鎮	√	√	2,002	535	2,537	21.1%
	仁武鄉	√	√	1,080	225	1,305	17.2%
	彌陀鄉	√	√	937	176	1,113	15.8%
	路竹鄉	√	√	1,376	249	1,625	15.3%
	梓官鄉	√	√	1,116	184	1,300	14.2%
	阿蓮鄉	√	√	978	156	1,134	13.8%
	燕巢鄉	√	√	1,039	117	1,156	10.1%
	旗山鎮	√	√	1,100	100	1,200	8.3%
	林園鄉	√	√	1,125	75	1,200	6.3%
	六龜鄉	√	√	893	8	901	0.9%
	美濃鎮	√	√	1,200	0	1,200	0.0%
	大樹鄉	√	√	1,400	0	1,400	0.0%
	鳥松鄉	√	√	600	0	600	0.0%
	橋頭鄉	√	√	1,100	0	1,100	0.0%
	田寮鄉	√	√	1,000	0	1,000	0.0%
	湖內鄉	√	√	1,000	0	1,000	0.0%
	永安鄉	√	√	500	0	500	0.0%

	甲仙鄉	√	√	100	0	100	0.0%
	杉林鄉	√	√	300	0	300	0.0%
	內門鄉	√	√	1,200	0	1,200	0.0%
	茂林鄉		√	300	0	300	0.0%
	桃源鄉		√	100	0	100	0.0%
	那瑪夏鄉	√	√	100	0	100	0.0%
合計	27	25	27	27	14		
屏東縣	東港鎮	√	√	838	1,253	2,091	59.9%
	春日鄉	√	√	218	193	411	47.0%
	屏東市	√	√	4,121	2,424	6,545	37.0%
	枋山鄉	√		99	55	154	35.7%
	車城鄉	√	√	481	126	607	20.8%
	瑪家鄉	√		345	88	433	20.3%
	恆春鎮	√	√	1,039	213	1,252	17.0%
	潮州鎮		√	1,620	280	1,900	14.7%
	來義鄉	√	√	532	67	599	11.2%
	牡丹鄉	√		226	28	254	11.0%
	麟洛鄉	√	√	633	60	693	8.7%
	三地門鄉	√	√	637	59	696	8.5%
	里港鄉	√	√	1,301	113	1,414	8.0%
	萬丹鄉		√	2,455	152	2,607	5.8%
	萬巒鄉	√		1,126	55	1,181	4.7%
	新園鄉	√		1,146	54	1,200	4.5%
	高樹鄉			1,718	76	1,794	4.2%
	九如鄉	√		789	25	814	3.1%
	內埔鄉	√	√	1,814	22	1,836	1.2%
	鹽埔鄉		√	1,029	10	1,039	1.0%
	長治鄉	√	√	1,400	0	1,400	0.0%
	竹田鄉			1,323	0	1,323	0.0%
	新埤鄉		√	389	0	389	0.0%
	枋寮鄉		√	1,207	0	1,207	0.0%
	崁頂鄉	√		735	0	735	0.0%
	林邊鄉	√	√	766	0	766	0.0%
	南州鄉		√	785	0	785	0.0%
	佳冬鄉	√		1,165	0	1,165	0.0%
	滿州鄉	√		407	0	407	0.0%
	泰武鄉		√	500	0	500	0.0%
	獅子鄉	√	√	106	0	106	0.0%
	琉球鄉	√	√	531	0	531	0.0%
	霧臺鄉						
合計	33	23	21	33	20		
台南縣	南化鄉			81	19	100	19.0%
	新化鎮		√	1,551	353	1,904	18.5%
	關廟鄉	√	√	1,422	278	1,700	16.4%

	永康市		√	3,363	440	3,803	11.6%
	仁德鄉	√	√	1,610	90	1,700	5.3%
	新營市	√	√	2,695	5	2,700	0.2%
	鹽水鎮			2,500	0	2,500	0.0%
	麻豆鎮		√	1,099	0	1,099	0.0%
	佳里鎮	√	√	2,130	0	2,130	0.0%
	柳營鄉			1,365	0	1,365	0.0%
	後壁鄉			735	0	735	0.0%
	下營鄉	√		1,500	0	1,500	0.0%
	六甲鄉			1,260	0	1,260	0.0%
	七股鄉		√	2,305	0	2,305	0.0%
	將軍鄉	√		200	0	200	0.0%
	龍崎鄉	√		800	0	800	0.0%
	白河鎮						
	善化鎮		√				
	學甲鎮	√	√				
	東山鄉						
	官田鄉		√				
	大內鄉						
	西港鄉	√					
	北門鄉	√					
	新市鄉						
	安定鄉	√					
	山上鄉		√				
	玉井鄉	√	√				
	楠西鄉						
	左鎮鄉		√				
	歸仁鄉	√	√				
合計	31	13	15	16	6		
台東縣	臺東市	√	√	4,984	113	5,097	2.2%
	成功鎮	√		771	0	771	0.0%
	博愛里			123	0	123	0.0%
	卑南鄉			1,300	0	1,300	0.0%
	大武鄉	√		449	0	449	0.0%
	太麻里鄉			971	0	971	0.0%
	東河鄉			677	0	677	0.0%
	長濱鄉			600	0	600	0.0%
	鹿野鄉			700	0	700	0.0%
	池上鄉			325	0	325	0.0%
	綠島鄉			35	0	35	0.0%
	延平鄉			33	0	33	0.0%
	海端鄉			300	0	300	0.0%
	達仁鄉			894	0	894	0.0%
	金峰鄉			201	0	201	0.0%

	關山鎮 蘭嶼鄉						
合計	17	3	1	15	1		
澎湖縣	望安鄉			232	47	279	16.8%
	馬公市		√	1,222	112	1,334	8.4%
	湖西鄉			1,493	0	1,493	0.0%
	白沙鄉			1,328	0	1,328	0.0%
	西嶼鄉 七美鄉						
嘉義縣	布袋鎮	√		2,401	0	2,401	0.0%
花蓮縣	卓溪鄉	√					

表二、登革熱病媒蚊幼蟲採集及鑑定現況。

縣市別	總村里數	已執行村里數	完成村里數	白線斑蚊	埃及斑蚊	黃蚊屬	叢蚊屬	家蚊屬	瘧蚊屬	翠蚊屬	搖蚊	蝶蠅
台北市	449	131	60	10,683	0	0	0	0	0	18	0	0
高雄市	459	407	257	6,157	25,418	0	0	0	0	0	0	0
台北縣	1,017	91	9	2,540	0	0	108	0	0	0	44	0
宜蘭縣	235	56	25	3,958	0	0	0	0	0	2	334	0
桃園縣	471	128	22	5,001	0	6	5	0	0	0	672	145
新竹縣	182	35	6	1,628	0	0	0	0	0	0	91	1
苗栗縣	271	39	12	2,177	0	0	0	0	0	24	14	0
台中縣	411	233	160	26,570	0	0	83	0	0	0	223	0
彰化縣	589	125	62	9,737	0	0	0	1,501	0	0	53	0
南投縣	261	36	9	2,036	0	0	0	201	0	0	28	0
雲林縣	387	62	30	4,556	0	0	0	441	0	0	316	0
嘉義縣	357	108	78	10,925	0	0	0	1,596	0	0	353	0

台南縣	521	253	253	24,616	1,185	0	0	2	0	0	0	0
台東縣	147	126	113	12,463	113	5	513	1,553	32	3	19	0
高雄縣	441	316	316	24,778	8,911	0	0	0	0	0	0	0
屏東縣	464	397	308	31,481	5,392	0	131	92	0	0	0	0
花蓮縣	177	46	13	2,196	0	0	219	1,417	0	3	65	0
澎湖縣	97	35	24	4,275	159	0	0	283	0	0	25	0
基隆市	157	72	13	3,282	0	0	16	402	0	2	14	0
新竹市	120	80	26	5,352	0	0	0	1,614	0	0	228	0
台中市	214	50	19	3,531	0	0	0	756	0	0	16	0
嘉義市	108	63	45	6,488	0	0	0	1,145	0	0	21	0
台南市	233	206	206	11,224	11,836	0	0	0	0	0	0	0
金門縣	37	0										
連江縣	22	0										
合計	7,827	3,095	2,066	215,654	53,014	11	1,075	22,127	32	52	2,516	146

表三、98年北區及中區休閒地區蚊蟲調查現況。

蚊蟲種類	野柳休閒區 海拔600公尺			太平山休閒區 海拔1900公尺			清靜休閒農場 海拔1760公尺			九族文化村 海拔600~700公尺			總計
	幼蟲調查	掛誘蚊燈	人工掃網	幼蟲調查	掛誘蚊燈	人工掃網	幼蟲調查	掛誘蚊燈	人工掃網	幼蟲調查	掛誘蚊燈	人工掃網	
白線斑蚊	47	59	10	0	0	0	15	0	13	35	5	33	217
哈氏黃蚊	0	0	0	10	0	0	0	0	0	0	0	0	10
日本黃蚊	0	0	0	2	0	2	0	0	0	0	0	0	4
東鄉黃蚊	85	87	0	0	0	0	0	0	0	0	0	0	172
花翅家蚊	0	0	0	0	0	0	7	0	4	0	0	0	11
熱帶家蚊	0	35	0	31	0	1	63	4	21	0	0	0	155
雙角家蚊	0	0	0	0	0	0	0	0	0	7	0	0	7
黃尾家蚊	0	0	0	0	0	0	0	0	0	4	0	0	4
灰胸家蚊	0	0	0	0	0	0	0	0	0	10	0	0	10
佐佐家蚊	0	0	0	1	0	6	0	0	0	0	0	0	7

鹹水家蚊	67	83	0	0	0	0	0	0	0	0	0	0	150
斑翅家蚊	0	0	0	0	0	0	0	0	1	0	0	0	1
白腹叢蚊	0	0	0	0	0	0	0	0	0	0	1	4	5

表四、埃及斑蚊雌蚊感染屈公病毒非洲株狀況（$1x10^5$PFU/mL）。

重覆數	蚊蟲編號	吸血後天數									
		0 天	1 天	2 天	3 天	4 天	5 天	6 天	12 天	18 天	24 天
I	1	29.8	30.7	31.3	22.8	33.0	28.1	33.5	31.6	32.6	33.6
	2	29.8	31.2	33.0	31.6	ND	28.5	34.4	32.7	32.7	33.6
	3	30.1	31.6	33.3	33.0	ND	33.3	34.9	35.2	33.1	35.1
	4	31.2	31.8	33.9	34.8	ND	33.8	35.1	ND	33.4	39.2
	5	31.2	32.0	34.3	ND	ND	35.0	36.2	ND	34.0	ND
	6	31.5	32.0	35.9	ND	ND	ND	ND	ND	39.2	ND
	7	31.5	33.2	36.0	ND	ND	ND	ND	ND	ND	ND
	8	31.6	33.7	ND	ND	ND	ND	ND	ND	ND	ND
	9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
	10	死亡	ND	ND	死亡	ND	ND	ND	死亡	ND	ND
II	1	26.5	24.9	25.2	15.5	16.7	13.8	14.2	33.6	15.6	30.8
	2	27.9	28.8	26.9	20.2	19.3	15.2	16.5	ND	29.8	32.2
	3	27.9	30.1	30.9	21.8	21.3	15.9	31.3	ND	30.7	32.5

4	28.0	30.1	40.0	31.6	22.9	31.7	31.6	ND	31.8	ND
5	28.2	30.8	ND	33.5	31.2	32.3	31.8	ND	32.0	ND
6	29.3	31.2	ND	34.0	33.8	33.9	32.1	ND	34.2	ND
7	29.4	31.2	ND	ND	ND	34.8	33.1	ND	ND	ND
8	29.8	31.7	ND	ND	ND	36.1	35.4	ND	ND	ND
9	30.6	34.1	ND	ND	ND	ND	ND	ND	ND	ND
10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
平均±SD	29.7±1.5	31.1±2.1	32.8±4.2	27.9 ±7.0	25.5 ±7.0	28.6 ±8.1	30.8 ±7.0	33.2 ±1.5	31.6 ±5.5	33.9±2.7
Ct>40%	10%	15%	45%	45%	65%	35%	35%	75%	40%	65%
死亡率	5%	0%	0%	5%	0%	0%	0%	5%	0%	0%

表五、白線斑蚊雌蚊感染屈公病毒非洲株狀況（$1x10^5$PFU/mL）。

重覆數	蚊蟲編號	吸血後天數									
		0 天	1 天	2 天	3 天	4 天	5 天	6 天	12 天	18 天	24 天
I	1	28.0	27.5	---	33.0	32.3	32.1	20.8	22.1	19.1	26.5
	2	28.8	29.0	---	33.6	32.8	33.6	27.2	31.7	32.6	30.1
	3	29.7	30.6	---	33.8	ND	33.7	32.0	ND	33.9	31.9
	4	29.7	31.0	---	33.8	ND	33.8	32.7	ND	ND	34.1
	5	30.1	31.7	---	33.9	ND	33.9	33.7	死亡	死亡	34.4
II	1	26.7	28.2	31.0	32.5	31.6	ND	21.3	32.6	32.8	33.8
	2	27.1	28.6	31.3	33.1	32.1	ND	28.0	37.7	33.6	34.4
	3	27.7	29.0	32.5	33.8	33.4	ND	31.8	40.0	33.7	35.4
	4	28.5	30.3	32.6	33.8	34.7	ND	33.7	ND	33.9	35.6
	5	28.5	30.7	32.8	36.3	40.0	ND	ND	ND	34.1	ND
	6	28.8	30.9	32.8	40.0	ND	ND	ND	ND	34.4	ND
	7	29.0	31.5	ND	ND	ND	ND	ND	ND	36.9	死亡
	8	29.5	40.0	死亡	ND	ND	ND	ND	死亡	ND	死亡

9	29.8	ND	死亡	死亡	死亡	死亡	死亡	死亡	ND	死亡
10	29.9	死亡	死亡	死亡	死亡	死亡	死亡	死亡	死亡	死亡
平均	28.8	30.7	32.1	34.3	33.8	33.4	29.6	32.7	33.0	34.5
±SD	±1.1	±3.1	±0.8	±2.1	±2.9	±0.8	±5.1	±7.3	±2.6	±1.0
Ct>40%	0.0%	6.7%	10.0%	13.3%	40.0%	53.3%	25.0%	33.3%	13.3%	20.0%
死亡率	0.0%	6.7%	30.0%	13.3%	13.3%	13.3%	12.5%	26.7%	6.7%	46.7%

表六、熱帶家蚊雌蚊感染屈公病毒非洲株狀況（$1x10^5$PFU/mL）。

蚊蟲	吸血後天數									
編號	0 天	1 天	2 天	3 天	4 天	5 天	6 天	12 天	18 天	24 天
1	28.6	40.0	32.9	---	33.5	ND	29.6	ND	32.7	ND
2	28.7	ND	ND	---	34.3	ND	31.8	ND	33.0	ND
3	28.8	ND	ND	---	ND	ND	ND	ND	33.1	ND
4	28.9	ND	ND	---	ND	ND	ND	ND	34.0	死亡
5	29.0	ND	ND	---	ND	ND	ND	ND	ND	死亡
6	29.0	ND	ND	---	ND	ND	ND	ND	ND	死亡
7	30.5	ND	ND	---	ND	ND	ND	ND	ND	死亡
8	31.1	ND	ND	---	ND	死亡	ND	ND	ND	死亡
9	31.7	ND	ND	---	ND	死亡	ND	死亡	死亡	死亡
10	32.8	ND	ND	---	ND	死亡	死亡	死亡	死亡	死亡
平均 ±SD	29.9±1.5	40	32.9	---	33.9 ±0.5		30.7 ±1.5		33.2±0.6	

Ct>40%	0%	90%	90%	---	80%	70%	70%	80%	40%	30%
死亡率	0%	0%	0%	---	0%	30%	10%	20%	20%	70%

表七、白腹叢蚊雌蚊感染屈公病毒非洲株狀況（1x10^{5}PFU/mL）。

蚊蟲	吸血後天數									
編號	0 天	1 天	2 天	3 天	4 天	5 天	6 天	12 天	18 天	24 天
1	27.0	---	33.5	33.9	33.0	33.5	ND	31.8	33.1	32.4
2	30.0	---	34.6	ND	ND	40.0	ND	31.9	33.3	ND
3	30.1	---	ND	ND	ND	ND	ND	32.9	33.8	ND
4	30.5	---	ND	ND	ND	ND	ND	33.1	34.1	ND
5	40.0	---	ND	ND	ND	ND	ND	ND	35.0	死亡
6	ND	---	ND	死亡	ND	ND	ND	ND	ND	死亡
7	ND	---	ND	死亡	ND	ND	ND	ND	ND	死亡
8	ND	---	ND	死亡	ND	死亡	ND	ND	死亡	死亡
9	死亡	---	死亡	死亡	死亡	死亡	死亡	死亡	死亡	死亡
10	死亡	---	死亡	死亡	死亡	死亡	死亡	死亡	死亡	死亡
平均 ±SD	31.5 ±5.0	---	34.1 ±0.8	33.9	33.0	36.8 ±4.6		32.5 ±0.7	33.8 ±0.7	32.4

Ct>40%	30%	---	60%	40%	70%	50%	80%	40%	20%	30%
死亡率	20%	---	20%	50%	20%	30%	20%	20%	30%	60%

附錄一

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Recent distribution of vector mosquitoes and epidemiology of the diseases they transmitted in Taiwan.

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Abstract: In Taiwan, the important mosquito-borne diseases include Japanese encephalitis (JE), dengue, and malaria, in which only JE is known as an endemic disease at present. This paper updates the current status of these disease vectors and pathogen activities to evaluate the disease risk. Since 2004, small to medium dengue outbreaks (202–2000 cases) have occurred annually, mostly in southern Taiwan where *Aedes aegypti* (L.) distributes. Occasionally, small outbreaks (smaller than 20) occurred in other areas without the presence of *Ae. aegypti*. Dengue virus infection in local vector population was detected sympatrically with the human cases in the same outbreak. JE cases have occurred sporadically after the introduction of vaccination program since 1968. The predominant species was *Culex tritaeniorhynchus* Giles (93.9%), followed by *Cx. fuscocephala* Theobald (3.4%), and *Cx. vishnui* Theobald (2.6%). Overall population densities were high, with the highest number of 37,440 per trap-night. JE virus was active in mosquito populations during May and June. The distribution of *Anopheles minimus* Theobald was limited to a few villages at the foothills of southern and eastern Taiwan. The highest numbers of *An. minimus* adults trapped per trap-night were between 23 and 206 in 6 villages. Chikungunya infection has been found in the travelers from endemic countries since 2007. In conclusion, the threat of these mosquito-borne diseases is increasing because of the frequent introductions of pathogens and the high densities of disease vectors in Taiwan.

Key words: Japanese encephalitis, dengue, malaria, vectors, Taiwan

Introduction

In Taiwan, the important mosquito-borne diseases include Japanese encephalitis (JE), dengue, and malaria, of which only JE at present is known as an endemic disease. Routine surveillance on these diseases, including human cases and mosquito vectors, has been conducted. Since 1968, vaccination of children has become an annual nationwide campaign in Taiwan to prevent human JE infections. After that, only sporadic JE human cases are reported each year. Dengue fever in Taiwan is a travel-related disease because travelers carry dengue virus from endemic areas into the island (Shu et al. 2009). Later, this virus will pass to *Aedes* mosquitoes, and cause small or medium local outbreaks of dengue (Huang et al. 2007). Since 1973, a small number (<84) of imported cases were detected for malaria every year (DOH 1991, Taiwan CDC 1992–2009). Additionally, 2 imported chikungunya cases were detected in 2007 (Shu et al. 2008).

Among 9 species of *Stegomyia* in Taiwan, *Aedes aegypti* L. and *Ae. albopictus* Skuse, associated with human dwellings, are the principal vectors of dengue. The former species

geographically distributed to areas south of the North Tropic of Cancer (Lien 1978, Huang and Chen 1986, Teng et al.1996). This species is more important in the epidemiology of dengue in southern Taiwan. The population of *Ae. aegypti* was identified as a mixed abdominal-scaling-pattern form of *Aedes aegypti aegypti* (Su et al. 2003). *Aedes albopictus* is distributed throughout the island, below an elevation of 1,500 m above the sea level. This mosquito is responsible for epidemics of dengue in those areas without *Ae. aegypti*, such as the small outbreaks in Taipei County (1995), Taichung City (1995), and Taipei City (1996) (DOH 1996, Wu 1996).

In Taiwan, *Culex tritaeniorhynchus* Giles, *Cx. vishnui* Theobald (previously known as *Cx. annulus* Theobald), and *Cx. fuscocephala* Theobald are the main vectors of Japanese encephalitis (Rosen et al. 1989, Cates and Detels 1969, Wang et al. 1962). Pigs served as the amplifier host in the transmission cycle of the JE virus (Hurlbut 1964), with a rather high infection rate (over 50%) across the island each summer. In 1958–1959, *Cx. tritaeniorhynchus* (98.9% and 83.4%) was predominant species in northern and central Taiwan while *Cx. fuscocephala* (69.2%) was predominant in southern Taiwan by the light-trap data (Hu and Grayston 1962). The percentages of *Cx. vishnui* were between 0.0–12.1%. In a 1962–63 survey, *Cx. vishinui* was the predominance species ilandwide followed by *Cx. tritaeniorhynchus* (Lien 1978). Later, the species composition varied in surveys, depending on site, methods and mosquito stages (Mitchell and Chen 1973, Rosen et al. 1989, Lin and Lu 1995). *Culex tritaeniorhynchus* larvae seemed to have a very high resistance to the insecticide, temephos, in central Taiwan (Teng et al. 2005). Among the 15 Anopheline species that are found in Taiwan, *Anopheles minimus* Theobald is regarded as the principal (perhaps the only) malaria vector (Lien 1991). The distribution of this species covered the entire island in surveys from 1955–1957, but is now confined to southern and eastern Taiwan (DOH 1991, Teng et al. 1998). Based on recent surveys, this species could be characterized as a *An. minimus* species A (Chen et al. 2002, Somboon et al. 2005), outdoor-resting, a slow-moving stream breeder, and an opportunist blood-feeder which fed on cattle, dogs, hogs, pigs, and non-chicken birds (Teng et al. 1998, Chang et al. 2008). Other mosquito species, listed as the vectors of diseases in other countries, are *An. sinensis* Wiedemann, *An. maculatus* Theobald, and *An. tessellatus* Theobald, *Ae. vexans* (Meigen), *Cx. quinquefasciatus* Say and *Mansonia uniformis* Theobald.

Mosquito-borne diseases are emerging and re-emerging in many areas of the world, especially in tropical and subtropical areas (Gubler 1998). Without human vaccines or effective mosquito control, these mosquito-borne diseases have increased extensively in numbers and territory. For example, the chikungunya virus, originally transmitted by *Ae. aegypti*, has mutated and adapted to *Ae. albopictus* (Tsetsarkin et al. 2007, de Lamballerie et al. 2008). The information on the current status of vector species and pathogen activities to evaluate the disease risk is important for evidence-based control policy-making. Therefore, the objective of this paper was to update the information of vector mosquitoes and the epidemiology of the diseases they transmitted in Taiwan.

Materials and Methods

Disease surveillance and laboratory diagnosis

Mosquito-borne diseases, including JE, dengue, malaria, chikungunya, West Nile fever, Rift Valley fever and yellow fever are classified as notifiable diseases in Taiwan. They require physicians to report the infection within 24 hours of clinical diagnosis, except for JE (within 7 days). Additionally, fever screening at airports in Taiwan was launched as part of

active surveillance for a panel of notifiable infectious diseases, including dengue, malaria, yellow fever, and chikungunya (Shu et al. 2005). The arriving passengers are screened for fever by infrared thermal scanners. Later, the airport clinicians evaluate the passengers with fever for further diagnostic testing decision. All serum specimens collected from suspected cases are tested by capture IgM and IgG ELISA. If specimens are collected within 7 days of on-set, RT-PCR and virus isolation are also carried out.

A confirmed case of mosquito-borne viral diseases (JE, dengue, chikungunya, yellow fever, and Rift Valley fever) is defined as one of the follows: (1) positive for virus isolation; (2) positive real-time one-step RT-PCR test; (3) positive seroconversion or ≧four-fold increase in the amount of disease-specific IgM or IgG antibody from appropriately timed paired serum; or (4) high-titer disease-specific IgM and IgG antibodies in a single serum specimen in which cross-reaction to other related diseases had been excluded, for example JE to dengue or dengue to JE. The detailed protocol of each method for dengue was described in the papers of Shu et al. (2003, 2004). For malaria, a confirmed case is defined when malarial parasites are identified in blood smear slides by microscopy and/or a positive PCR test.

Scout surveys for dengue vectors

In routine dengue vector surveillance, the wards were randomly selected using a stratified random sampling scheme by county/city if there were no reported cases. At each visit, the first floors, basements, and surroundings of a cluster of 50–100 houses were surveyed. The first house was either selected randomly or the location of the reported case. Traditional larval indexes, Breteau index and premise index, are calculated as the positive containers and the positive premises per 100 premises.

Since 1987, small sweeping nets have been used to collect *Aedes* mosquitoes in outbreak and high-risk areas in order to detect dengue viruses. The high-risk areas were selected on the basis of historic dengue incidence, high *Aedes* density, and frequent human activity. In 1995–1996 and 2003–2008, *Aedes* mosquitoes were collected extensively from high-risk areas island-wide and in southern Taiwan, respectively. Collected adults were brought back to the laboratory either alive in small paper cups or frozen in dry ice or icepacks. Live mosquitoes were kept 4–5 days under room temperature for blood digestion and virus replication. A 10% sucrose solution was provided. All mosquitoes were identified, pooled according to species, sex, and location, and then stored at −20°C or −80°C until tested. The detailed protocols of virus isolation, RNA extraction and a real-time RT-PCR method were described in the papers of Chen et al. (2009).

Light traps for JE and malaria vectors

In the period of 2004 and 2008, Pest-O-Lite light traps (Local manufactory, Taiwan) were hung in villages in the foothills to study the distribution of *An. minimus*. These light traps also were appropriate for surveillance of JE vectors. They were hung outside houses with animals and rivers nearby for 1–2 nights. Later, mosquito samples were sent to a CDC laboratory for species identification. Additionally, mosquitoes were collected at pig farms or natural parks, by human collection or CDC updraft black-light traps baited with carbon dioxide (Model 1312, John W. Hock, Gainesville, FL). These traps were hung downward overnight. Collected mosquitoes were transported to the laboratory for species identification and JE virus detection. Details of the specimen treatment and assay were described as mentioned in dengue vectors.

Results

Epidemiology of mosquito-borne diseases

After 40 years of silence on mainland

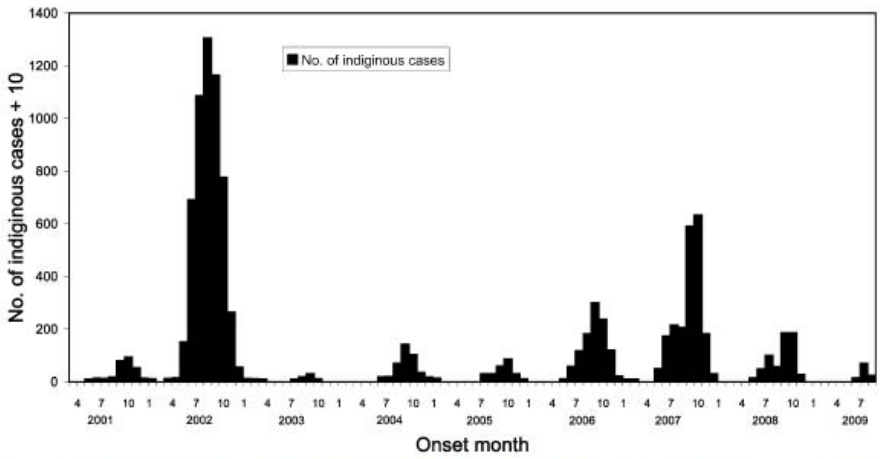

Fig. 1. The monthly dengue indigenous cases in Taiwan from 2001 to Sep. 2009 (In order to show the interepidemic periods between outbreaks, 10 was added to the number of dengue cases per month except for 0).

Table 1. The mosquito-borne diseases occurred in Taiwan from 1987 to September 2009.

Year	Dengue cases			Indigenous JE cases	Malaria cases	
	Indigenous DHF, Death)	Major seroty pes	Imported		Introduced	Imported
1987	527	DENV-1	—	—	0	35
1988	4,389	DENV-1	—	—	0	46
1989	16	DENV-1	19	15	0	45
1990	0	—	10	33	0	35
1991	149	DENV-1	26	20	0	26
1992	4	DENV-1, 3	19	10	0	42
1993	0	—	13	11	0	36
1994	222 (11, 1)	DENV-3	22	13	0	34
1995	329 (5, 0)	DENV-1	40	27	0	38
1996	20 (3, 0)	DENV-3	35	21	0	38
1997	19	DENV-1, 2	57	5	0	47
1998	238 (14, 1)	DENV-3	110	22	0	49
1999	40 (4, 0)	DENV-3	29	24	0	30
2000	113 (1, 0)	DENV-4	27	13	0	43
2001	215 (11, 0)	DENV-2	55	33	0	28
2002	5,336 (242, 21)	DENV-2	52	19	0	27
2003	86 (2, 1)	DENV-2	59	25	2	32
2004	336 (7, 0)	DENV-1	91	32	0	18
2005	202 (5, 0)	DENV-3	104	35	0	26
2006	965 (19, 5)	DENV-1	109	29	0	26
2007	2,000 (11, 0)	DENV-1	179	37	0	13
2008	488 (4, 0)	DENV-3	226	17	0	18
2009/9	101 (1, 0)	DENV-3	153	16	0	6
Total	15,795 (340, 29)	—	1435	457	2	738

Taiwan, a dengue outbreak was detected in southern Taiwan in 1987. Since then, the characteristics of dengue epidemiology from 1987 to 2002 cycled with small outbreaks (i.e. 100–250 cases) almost every 3 years and large epidemics (i.e. over 4,000 cases) nearly every decade. After 2004, outbreaks with a case range of 202–2,000 occurred each year in areas with the presence of *Ae. aegypti*. Only limited dengue hemorrhagic fever cases (up to 19) were detected each year except for 2002, in which 242 cases were found with a mortality rate of 8.7%. For the past 10 years except for 2002 (Fig. 1), the epidemics started from June to August and stopped in January or February. In that year, cases were detected all year round until April of the next year. Clusters of dengue cases smaller than 20 were detected from time to time in areas without the distribution of *Ae. aegypti*, for example, Taipei City (2008), Taipei County (2008, 2009), and Changhwa County (2009), where *Ae. albopictus* was prevalent.

Since 1987, the numbers of indigenous JE cases were between 5 and 37 cases per year (Table 1), distributed evenly in counties with agriculture production. The cases occurred mostly in the summer season (May-August) but sporadically in other seasons. In addition to the imported malaria (13–49 cases per year) found in Taiwan, two introduced cases occurred in August 2003 (Table 1), since the eradication of malaria in Taiwan. One case infected with *Plasmodium falciparum* and the other case co-infected with *P. falciparum* and *P. vivax*. The two cases of locally transmitted malaria occurred in a rural area of Taitung County, where 3 malaria-risk behaviors (working frequently in a malaria-endemic country, sleeping outdoors during night and raising hogs around the house in Taiwan) were identified. Additionally, 21 cases of imported chikungunya were detected by airport fever surveillance from 2007- to Sep 2009. No other monitored mosquito-borne diseases, including yellow fever, West Nile

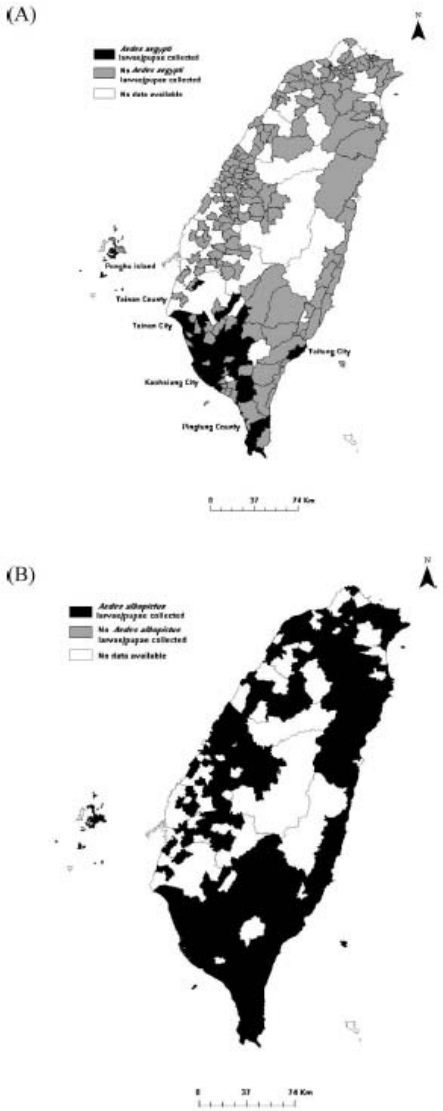

Fig. 2. The preliminary data on the distribution map of *Aedes aegypti* (A) and *Aedes albopictus* (B) in Taiwan in 2009. (areas in black color indicated larvae or/and pupae collected, areas in gray color indicated no larvae or/and pupae collected, and areas in white indicated no data available)

Table 2. Composition of dengue vectors collected in residential areas, southern Taiwan in 2003

Collection site	*Aedes aegypti*						*Aedes albopictus*					
	Female		Male		Total		Female		Male		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Indoor	1,338	27.8	2,401	49.9	3,739	77.7	25	1.4	7	0.4	32	1.8
Outdoor	349	7.2	725	15.1	1,074	22.3	1,057	60.7	654	37.5	1,711	98.2
Total	1,687	35.0	3,126	65.0	4,813	100.0	1,082	62.1	661	37.9	1,743	100.0

fever, and Rift Valley fever were detected.

Dengue vectors and dengue virus detection

The distribution of *Ae. aegypti* according to 2009 larval surveys was still limited to southern Taiwan, Taitung City in eastern Taiwan, and Penghu island (Fig. 2A). Inside southern Taiwan, this species was collected in all areas in Kaohsiung City and Tainan City and parts of Kaohsiung County, Tainan County and Pingtung County. *Aedes albopictus* larvae/pupae were collected throughout Taiwan (Fig. 2B). For 2008, in a total of 1,449 wards with 14,614 visits in southern Taiwan, mean (±SD) Breteau and premise indices of *Aedes* immatures were 4.25 (±6.52) and 2.72 (±3.74), respectively. Among 643,767 water-filled containers, 5.7% (36,910) of the containers were found to be positive with *Aedes* immatures. Most breeding containers were water buckets (37.5%), pottery pot (7.4%), flower vase (5.8%), plant saucers (5.5%), used tires (4.6%), polyester containers (4.4%) and plastic containers (3.2%). Most positive containers (90.6%) were found outdoors. In a 2003 survey, 77.7% (3,739) of *Ae. aegypti* adults were collected indoors (Table 2). However, almost all *Ae. albopictus* adults (98.2%) were collected outdoors. More *Ae. aegypti* males (65.0%) were collected than females (35.0%) both indoors and outdoors but vice versa for *Ae. albopictus* (37.9% vs. 62.1%).

From 1987 to 2008, dengue virus infections were detected in field-caught *Ae. aegypti* females (25 pools), males (1 pool), and *Ae. albopictus* females (2 pools) (Table 3). Mosquitoes of RT-PCR positive pools were collected sympatrically with human cases in the same dengue outbreaks. All four virus serotypes were detected in mosquitoes with DENV-1 (46.4%), DENV-2 (17.9%) and DENV-3 (32.1%), and DENV-4 (3.6%).

JE vectors and JE virus detection

From 2004 to 2008, the 3 vector mosquitoes of JE, *Cx. tritaeniorhynchus*, *Cx. vishnui*, and *Cx. fuscocephala*, were collected all over the island. The predominant species for all 10-survey counties was *Cx. tritaeniorhynchus* (mean=93.9%, range=64.1–100.0%) followed by *Cx. fuscocephala* (mean=3.4%, range=0–30%) and *Cx. vishnui* (mean=2.6%, range=0–5.9%). The highest number (37,440 per trap-night) of *Cx. tritaeniorhynchus* adults collected per trap-night was found on September 2008 in Chaiyi County, southern Taiwan; other traps attracted over 5,000 adults per night in all surveyed counties.

Among 31,146 adults collected from 2006–2008 for the virus infection study, JE virus infections were found in females of *Cx. tritaeniorhynchus* (25 pools) and *Cx. fuscocephalus* (1 pool) collected in Taipei City and Ilan County in northern Taiwan, Hwalien County in eastern Taiwan, and Kaohsiung County in southern Taiwan (Table 4). JE viruses were isolated from half of the positive pools. The genotype of JE virus isolated was type III, except for 2 virus isolates in 2008 (Type I)(data submitting).

Malaria vectors

The distribution of *An. minimus* was limited to a few location at the foothills of

Table 3. Dengue virus infection in field-caught vector mosquito species during 1987–2008.

	Aedes aegypti females			*Aedes aegypti* males			*Aedes albopictus* females			*Aedes albopictus* males		
	Pool no.	Mosquitoes tested	Positive pool no.	Pool no.	Mosquitoes tested	Positive pool no.	Pool no.	Mosquitoes tested	Positive pool no.	Pool no.	Mosquitoes tested	Positive pool no.
Jan	256	936	0	231	1,087	0	199	681	0	102	266	0
Feb	215	488	0	206	794	0	228	1,140	0	103	352	0
Mar	516	2,726	0	504	4,130	0	509	2,681	0	265	1,158	0
Apr	525	2,543	0	420	3,754	0	823	4,878	0	417	2,127	0
May	995	4,981	0	848	7,170	0	1,194	7,887	0	591	3,515	0
Jun	987	5,818	1	797	7,196	0	1,504	12,615	0	702	7,212	0
Jul	1,020	5,591	3	799	6,992	0	1,098	8,469	0	447	3,647	0
Aug	785	5,957	2	587	7,847	0	1,144	7,810	2	425	2,737	0
Sep	1,036	7,497	4	733	8,098	0	1,330	11,972	1	412	3,737	0
Oct	1,007	5,917	7	597	6,031	1	984	7,622	0	338	2,286	0
Nov	1,092	5,604	5	702	6,289	0	769	4,622	0	252	1,418	0
Dec	549	2,465	2	374	2,250	0	365	2,095	0	127	766	0
Total	8,983	50,523	24	6,798	61,638	1	10,147	72,472	3	4,181	29,221	0

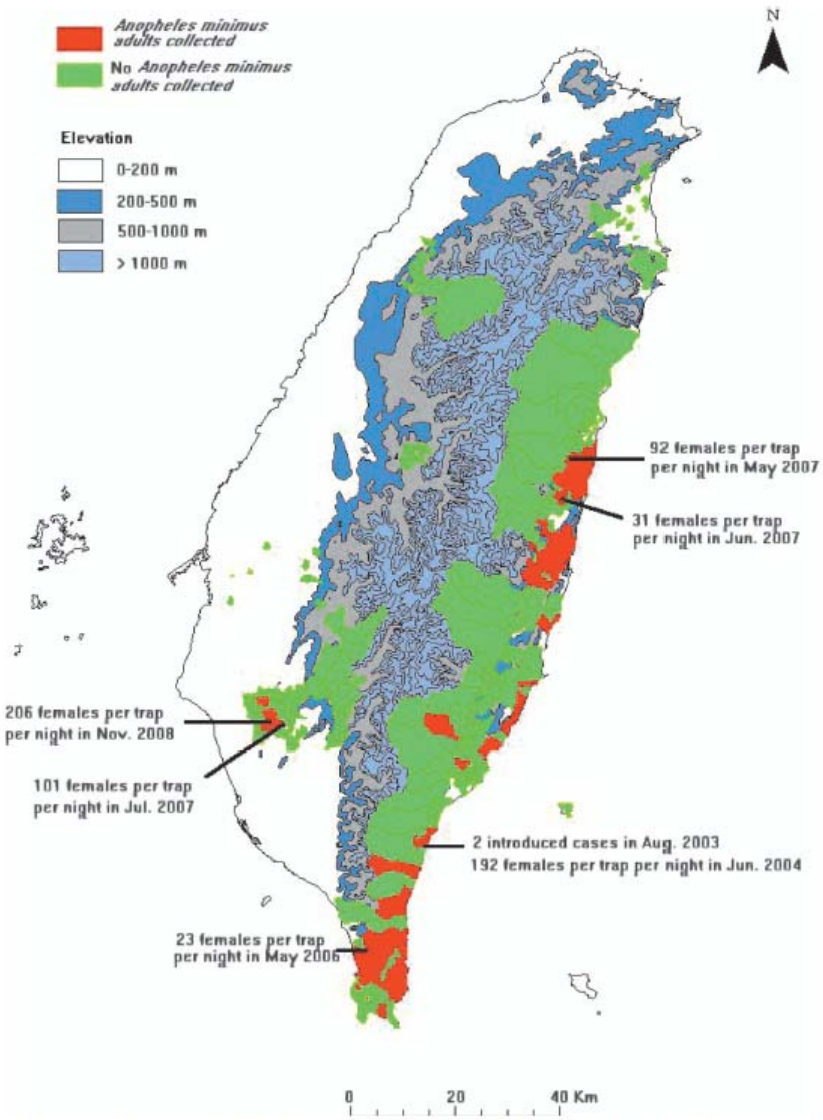

Fig. 3. The distribution map of *Anopheles minimus* in Taiwan, from 2004 to 2008 where areas with red colors indicated that *An. minimus* adult were collected at least one time and areas with gray colors indicated that no *An. minimus* were collected.

Southern and Eastern Taiwan (Fig. 3). Since 2004, a total of 413 villages in 9 Counties have been surveyed but relative high densities (23–206 females per trap-night) of *An. minimus* found in 1 village of Taitung County (June, 2004), 1 village of Pingtung County (May 2006), 2 villages of Hwa-lien County (May and June, 2007),

Table 4. Japanese encephalitis virus infection in field-caught vector mosquito species during 2006–2008.

Month	*Culex tritaeniorhynchus*			*Culex fuscocephala*			*Cx. vishnui*		
	Pool no.	Females tested	Positive pool no.	Pool no.	Females tested	Positive pool no.	Pool no.	Females tested	Positive pool no.
Jan	9	101	0	0	0	0	0	0	0
Feb	6	93	0	0	0	0	0	0	0
Mar	21	765	0	1	3	0	1	50	0
April	9	215	0	0	0	0	3	3	0
May	129	4,459	6	5	77	1	7	58	0
Jun	134	4,659	17	2	51	0	21	311	0
Jul	45	1,391	1	0	0	0	17	117	0
Aug	113	4,592	0	7	70	0	24	135	0
Sep	259	11,939	1	10	193	0	36	1,042	0
Oct	15	232	0	0	0	0	3	3	0
Nov	17	283	0	0	0	0	4	4	0
Dec	19	289	0	0	0	0	6	11	0
Total	776	29,018	25	25	394	1	122	1,734	0

and 2 villages of Tainan County (July 2007 and November 2008). The numbers of *An. minimus* adults trapped per trap-night were below 12 in 64 villages (15.5%) and 0 in 343 villages (83.0%).

Discussion

The frequency of dengue outbreak occurred has increased for the past 5 years and the high number of JE vectors and malaria vectors were found in Taiwan. Additionally, new introductions of chikungunya virus cases occurred through travelers from endemic countries to this island. Therefore, the threat of these mosquito-borne diseases is increasing. The control strategy for each disease varies. For example, introductions of dengue virus cases occurred so frequently each year that lower vector densities should be prioritized. The pathogen introductions for malaria are less frequent and their vectors have limited distributions and unstable populations; therefore, this disease should focus on patient diagnosis and management.

The distribution of *Ae. aegypti* has been documented in southern Taiwan since 1978 (Lien 1978), while *Ae. albopictus* is distributed throughout the island. Factors affecting the distribution difference of these 2 species are temperature (Chang et al. 2007), interspecific competition among larvae (Juliano 1998, Barrera 1996, Ho et al. 1989, Black *et al.* 1989), larva-induced egg hatch inhibition (Edgerly et al. 1993), mortality induced by a gregarine parasite (Munstermann and Wesson 1990, Blackmore *et al.* 1995, Yeh et al. 1994), mating interference (Nasci et al. 1989) and the greater reproductive efficiency of *Ae. albopictus* females (Klowden and Chambers 1992). Only temperature and gregarine parasite were demonstrated in Taiwan (Chang et al. 2007, Yeh et al. 1994). However, these factors are not lethal and could not stop the spread of this species into other areas of Taiwan (Chang et al. 2007).

The extremely high numbers of the JE vector, *Cx. tritaeniorhynchus*, which were commonly collected island-wide, deserve special attention. Although there is a good national vaccination policy for JE, sporadic cases still occurred each year. The detection of the new genotype of JE virus in the field raises some questions and should be monitored further to clear the impact of this new event. Moreover, this mosquito species can also transmit Rift Valley fever virus as seen in the Kingdom of Saudi Arabia (Miller et al. 2002), as well as serve as a potential vector of West

Nile virus. Therefore, a prevention strategy of environmental management through larval habitats of *Cx. tritaeniorhynchus* should be launched to decrease transmission in high-risk areas. This control effectiveness on the same larval habitats (drains and rice fields) of malaria vectors was demonstrated in malaria control (Castro et al. 2009, Klinkenberg et al. 2003).

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附錄二

台灣地區積水容器常見蚊蟲幼蟲特徵一覽表

疾病管制局 98 年 6 月 29 日製訂

屬名	鑑定特徵
斑蚊屬/黃蚊屬	1. 肉眼： （1） 呼吸管短且深色，身體常垂懸於水中，呈 90°。 （2） 腹節明顯。 （3） 幼蟲游動時，呈”S”字形狀。 （4） 蟲體背腹顏色一致。 2. 顯微鏡：具呼吸管，中間後段有 1 對呼吸管毛且有管櫛;第八腹節有側櫛齒;肛節至少 3 對腹方毛;頭部四號毛不顯著;管櫛不具小齒。  
家蚊屬	1. 肉眼： （1）呼吸管長，身體與水平面成一角度。 （2）因胸、腹毛多，腹節看起來不明顯。 （3）幼蟲受驚動時，擺動敏捷，向兩側或上方迅速游動。 （4）蟲體背腹顏色一致。 2. 顯微鏡： （1） 呼吸管且有 3 對呼吸管毛。 （2） 肛節至少 3 （3） 第八腹節有側櫛齒且具 12-P 毛。  
瘧蚊屬	1.肉眼：無呼吸管，幼蟲停息時，蟲體與水平面平行。 2.顯微鏡：無呼吸管、腹部各節有掌狀毛。  

屬名	鑑定特徵
叢蚊屬	1. 肉眼： (1) 蟲體背面呈褐紅色，腹面呈青綠色(即背腹顏色不一致)。 (2) 頭小、呼吸管短且為深色。 (3) 幼蟲受驚動而游動時，初為淺”S”形狀，接著尾部擺動激烈，很像土虱的動作。 2. 顯微鏡： (1) 呼吸管中間後段一對毛，但不具管櫛。 (2) 觸角柄之亞末端毛細小，長在靠末端處。 (3) 第八腹節有側櫛齒。 (4) 肛節至少 3 對腹方毛。  
翠蚊屬	1. 肉眼：身體有刺，感覺毛茸茸。 2. 顯微鏡： (1) 胸及腹部具長刺。 (2) 具呼吸管。 (3) 第八腹節有側櫛齒(一列)。 (4) 肛節僅具 1 對腹方毛。  (右側圖片 2009/6/28 摘自 http://www.arbovirus.health.nsw.gov.au網站，有版權，僅供參考)
搖蚊科	肉眼：身體紅色，無呼吸管，不會浮上水面換氣。