

SCIENTIFIC NOTE

NEW RECORD, HABITATS, AND UPDATED CHECKLIST OF THE MOSQUITOES OF HONG KONG¹

LEOPOLDO M. RUEDA,^{2,3} JAMES E. PECOR,² MING-CHI YUEN⁴ AND MING-WAI LEE⁴

ABSTRACT. Mosquito collections were carried out during April 2002 in Hong Kong. Twenty-six species of mosquitoes in 9 genera were collected, including 1 new record, *Culex (Culicomyia) nigropunctatus*. Characteristics of larval habitats of these species are described and an updated checklist is included.

KEY WORDS Mosquitoes, *Anopheles*, *Aedes*, *Culex*, Hong Kong, Culicidae

Hong Kong (1,092 km²) is at the northern edge of the tropics in eastern Asia and borders the South China Sea and China. Hong Kong is famous for its urban landscape and high human population density, with a total of about 6.8 million people. Outside the urban center, Hong Kong includes many large and small towns, villages, and rural communities. About 28% of its land area consists of forests, woodland, pastures, and crop fields with about 20 km² of irrigated land. Its climate is subtropical; the mean daily minimum temperature for January and February (the coolest months from 1961 to 1990) was 13.8°C, whereas the mean daily maximum temperature for July and August (1961-90) was 31.4°C. The mean yearly rainfall from 1947 to 2001 was 2,214.3 mm (Government of Hong Kong Special Administrative Region 2002).

The mosquitoes of Hong Kong have been documented by several workers (e.g., Jackson 1938, 1951; Mattingly 1949; Sirivanakarn 1972, 1976). Chau (1982) recorded 68 species in 12 genera, and 1 unidentified species in *Topomyia* and 1 in the *Ochlerotatus (Finlaya) niveus* group. To better understand the mosquito fauna of Hong Kong in relation to the types of habitats available, larval and adult collections were conducted from April 9 to 23, 2002. Adults were collected with a modified miniature Centers for Disease Control light trap (Department of Food and Environmental Hygiene, Hong Kong), baited with CO₂ and light, and hung from a tree branch about 1.5 m above the ground near larval breeding habitats. Larvae were collected from a variety of habitats with the primary intention of obtaining adults with associated larval and

pupal exuviae. Data from each collection site were recorded on a standard form (Faran et al. 1985, Pecor and Gaffigan 1997). Fourth-stage larvae and pupae were individually reared to adult stage and associated immature exuviae were preserved in 80% ethanol. Fourth-stage larvae also were preserved from as many species as possible. Most adult specimens were killed in ethyl acetate vapor and mounted on points on pins. Exuviae of larvae and pupae were subsequently mounted in euparal on microscope slides. Selected reared adults, particularly male specimens, were preserved in 100% ethanol to preserve their DNA. Male genitalia were dissected when necessary to assist identification. Specimens were identified to species by using keys and descriptions from pertinent literature (e.g., Bram 1967; Sirivanakarn 1972, 1976, 1977; Chau 1982; Rattanarithikul and Green 1986).

Twenty-six collections were made in April 2002, resulting in 359 pinned adults and 381 vials with exuviae of larvae and pupae and whole larvae (Table 1). The collections represented 26 species from 9 genera and 16 subgenera. One species, *Culex nigropunctatus* Edwards, is a new occurrence record for Hong Kong. Forty-three species not encountered during our surveys are recorded from Hong Kong, bringing the total number of species known to occur in Hong Kong to 69. We also collected topotypic specimens of 4 species (originally collected and described from Hong Kong), namely, *Anopheles maculatus* Theobald, *An. minimus* Theobald, *Culex annulus* Theobald, and *Ochlerotatus macfarlanei* Edwards. In this survey, we collected larvae of 21 species from a variety of open habitats. *Aedes lineatopennis* (Ludlow), *Coquillettidia crassipes* (Van der Wulp), *Culex nigropunctatus*, *Cx. vagans* Wiedemann, and *Mansonia uniformis* (Theobald) were only collected as adults with CO₂-baited light traps.

We initially targeted for larval collections those habitats where mosquitoes in the genus *Anopheles* were likely to be found. During our collections, we also encountered species from genera other than *Anopheles* from those habitats. Larval *Anopheles sinensis* Wiedemann were collected from a flood

¹ The views of the authors do not purport to reflect the views of the supporting agency.

² Department of Entomology, Walter Reed Army Institute of Research, Silver Spring, MD 20910-7500.

³ To whom correspondence should be addressed at Walter Reed Biosystematics Unit, Museum Support Center, Smithsonian Institution, 4210 Silver Hill Road, Suitland, MD 20746.

⁴ Department of Food and Hygiene, Hong Kong Government, South Wing, 11/f, Canton Road Government Offices, 393 Canton Road, Kowloon, Hong Kong.

Table 1. Mosquito species collected from various habitats in Hong Kong, April 2002.

Species	Larval habitat ¹	Locality	Coordinates
<i>Aedes (Aedimorphus) vexans</i> (Meigen)	GP, LT	Tai Hong Wei Kam Tin	22°27'N, 114°04'E 22°26'N, 114°04'E
<i>Ae. (Neomelaniconion) lineatopennis</i> (Ludlow)	LT	Kam Tin	22°21'N, 114°04'E
<i>Ae. (Stegomyia) albopictus</i> (Skuse)	AC, FL	Wu Mei Tai Tan	22°21'N, 114°15'E 22°26'N, 114°20'E
<i>Anopheles (Anopheles) bengalensis</i> Puri	SM	Wu Mei	22°21'N, 114°15'E
<i>An. (Ano.) sinensis</i> Wiedemann	FP, GP	Lamma Island Tai Hong Wei Tan Chuk Hang	22°12'N, 114°08'E 22°27'N, 114°04'E 22°31'N, 114°11'E
	ID, PP	Ting Kak Ying Pun Yuen Kong	22°28'N, 114°13'E 22°28'N, 114°07'E 22°26'N, 114°04'E
<i>An. (Cellia) maculatus</i> Theobald ²	GP, IP	Ham Hang Mei Ho Chun Lamma Island	22°31'N, 114°13'E 22°21'N, 114°15'E 22°12'N, 114°08'E
	RP, SM	Pak Mong Tai Tan Tai Shu Hang Wu Mei	22°18'N, 113°58'E 22°26'N, 114°20'E 22°24'N, 114°13'E 22°21'N, 114°15'E
<i>An. (Cel.) minimus</i> Theobald ²	SM	Ham Hang Mei	22°31'N, 114°13'E
<i>Armigeres (Armigeres) subalbatus</i> (Coquillett)	SM	Ham Hang Mei	22°31'N, 114°13'E
<i>Coquillettidia (Coquillettidia) crassipes</i> (Van der Wulp)	LT	Kam Tin	22°26'N, 114°04'E
<i>Culex (Culex) annulus</i> Theobald ²	FP, ID, SM	Ho Chu Lamma Island Ying Pun	22°21'N, 114°15'E 22°12'N, 114°08'E 22°28'N, 114°07'E
<i>Cx. (Cux.) bitaeniorhynchus</i> Giles	SM	Tai Shu Hang	22°24'N, 114°13'E
<i>Cx. (Cux.) mimeticus</i> Noe	RP	Tai Tan	22°26'N, 114°20'E
<i>Cx. (Cux.) quinquefasciatus</i> Say	AC, FP, ID, IP	Lamma Island Tai Tan Tan Chuk Hang Ying Pun	22°12'N, 114°08'E 22°26'N, 114°20'E 22°31'N, 114°11'E 22°28'N, 114°07'E
<i>Cx. (Cux.) sitiens</i> Wiedemann	LT, PP, RD	Kam Tin Ting Kak Yuen Kong	22°26'N, 114°04'E 22°26'N, 114°04'E 22°26'N, 114°04'E
<i>Cx. (Cux.) vagans</i> Wiedemann	LT	Kam Tin	22°26'N, 114°04'E
<i>Cx. (Culicomyia) nigropunctatus</i> Edwards ³	LT	Kam Tin Luk Kong	22°26'N, 114°04'E 22°20'N, 114°02'E
<i>Cx. (Cui.) pallidothorax</i> Theobald	AC, ID, SM	Tai Tan Tan Chuk Hang Yuen Kong	22°26'N, 114°20'E 22°31'N, 114°11'E 22°26'N, 114°04'E
<i>Cx. (Eumelanomyia) foliatus</i> Brug	SM	Wu Mei	22°21'N, 114°15'E
<i>Cx. (Eum.) malayi</i> (Leicester)	SM	Ham Hang Mei	22°31'N, 114°13'E
<i>Cx. (Lophoceratomyia) infantulus</i> Edwards	AC, IS, SM	Lamma Island Pak Mong Tai Shui Hang Wu Mei	22°12'N, 114°08'E 22°18'N, 113°58'E 22°25'N, 113°56'E 22°21'N, 114°15'E
<i>Cx. (Lutzia) fuscans</i> Wiedemann	AC, PP	Tai Tan Ting Kak	22°26'N, 114°20'E 22°26'N, 114°04'E
<i>Cx. (Lut.) halifaxii</i> Theobald	FP, RP	Tai Tan Ying Pun	22°26'N, 114°20'E 22°28'N, 114°07'E
<i>Mansonia (Mansonioides) uniformis</i> (Theobald)	LT	Kam Tin	22°26'N, 114°04'E
<i>Ochlerotatus (Finlaya) macfarlanei</i> Edwards ²	AC, RP	Tai Tan	22°26'N, 114°20'E
<i>Toxorhynchites (Toxorhynchites) splendens</i> (Wiedemann)	AC	Fo Tan	22°24'N, 114°12'E
<i>Uranotaenia (Uranotaenia) annandalei</i> Barraud	RD	Pak Mong	22°18'N, 113°58'E

¹ GP, garden or vegetable paddy; LT, adult light trap; AC, artificial container; FL, fallen leaf (palm); SM, stream margin; FP, flood pool; ID, irrigation ditch; PP, pasture pool; IP, irrigation pond; RP, rock pool; RD, road ditch.

² Topotypic material.

³ New record.

Table 2. Checklist of mosquito species from Hong Kong.

<i>Aedes</i> (<i>Aedimorphus</i>)
1. <i>vexans</i> (Meigen)
<i>Aedes</i> (<i>Neomelaniconion</i>)
2. <i>lineatopennis</i> (Ludlow)
<i>Aedes</i> (<i>Stegomyia</i>)
3. <i>aegypti</i> (Linnaeus)
4. <i>albopictus</i> (Skuse)
5. <i>gardnerii imitator</i> (Leicester)
<i>Anopheles</i> (<i>Anopheles</i>)
6. <i>bengalensis</i> Puri
7. <i>lesteri</i> Baisas and Hu
8. <i>sinensis</i> Wiedemann
<i>Anopheles</i> (<i>Cellia</i>)
9. <i>fluvialis</i> James
10. <i>jeyporiensis</i> James
11. <i>karwari</i> (James)
12. <i>maculatus</i> Theobald
13. <i>minus</i> Theobald
14. <i>splendidus</i> Koidzumi
15. <i>tessellatus</i> Theobald
16. <i>vagus</i> Doenitz
<i>Armigeres</i> (<i>Armigeres</i>)
17. <i>subalbatus</i> (Coquillett)
<i>Armigeres</i> (<i>Leicesteria</i>)
18. <i>magnus</i> (Theobald)
<i>Coquillettia</i> (<i>Coquillettia</i>)
19. <i>crassipes</i> (Van der Wulp)
<i>Culex</i> (<i>Culex</i>)
20. <i>annulus</i> Theobald
21. <i>barraudi</i> Edwards
22. <i>bitaeniorhynchus</i> Giles
23. <i>fuscocephala</i> Theobald
24. <i>gelidus</i> Theobald
25. <i>jacksoni</i> Edwards
26. <i>mimeticus</i> Noe
27. <i>mimulus</i> Edwards
28. <i>murrelli</i> Lien
29. <i>orientalis</i> Edwards
30. <i>pseudovishnui</i> Colless
31. <i>quinquefasciatus</i> Say
32. <i>sinensis</i> Theobald
33. <i>sitiens</i> Wiedemann
34. <i>tritaeniorhynchus</i> Giles
35. <i>vagans</i> Wiedemann
36. <i>whitmorei</i> (Giles)
<i>Culex</i> (<i>Culicomyia</i>)
37. <i>nigropunctatus</i> Edwards ¹
38. <i>pallidothorax</i> Theobald
39. <i>ryukyensis</i> Bohart
40. <i>shebbearei</i> Barraud
41. <i>spiculothorax</i> Bram
<i>Culex</i> (<i>Eumelanomyia</i>)
42. <i>foliatus</i> Brug
43. <i>malayi</i> (Leicester)
<i>Culex</i> (<i>Lophoceraomyia</i>)
44. <i>infantulus</i> Edwards
45. <i>rubithoracis</i> (Leicester)
46. <i>sumatranus</i> Brug
<i>Culex</i> (<i>Lutzia</i>)
47. <i>fuscans</i> Wiedemann
48. <i>halifaxii</i> Theobald
<i>Ficalbia</i>
49. <i>jacksoni</i> Mattingly
50. <i>minima</i> (Theobald)
Malaya

Table 2. Continued.

51. <i>genurostris</i> Leicester
<i>Mansonia</i> (<i>Mansonioides</i>)
52. <i>uniformis</i> (Theobald)
<i>Mimomyia</i> (<i>Etorleptomyia</i>)
53. <i>luzonensis</i> (Ludlow)
<i>Mimomyia</i> (<i>Mimomyia</i>)
54. <i>chamberlaini</i> (Ludlow)
<i>Ochlerotatus</i> (<i>Finlaya</i>)
55. <i>japonicus</i> (Theobald)
56. <i>macfarlanei</i> Edwards
57. <i>pulchriventer</i> (Giles)
58. <i>togoi</i> (Theobald)
<i>Ochlerotatus</i> (<i>Mucidus</i>)
59. <i>scatophagoides</i> (Theobald)
<i>Toxorhynchites</i> (<i>Toxorhynchites</i>)
60. <i>splendens</i> (Wiedemann)
<i>Tripteroides</i> (<i>Rachionotomyia</i>)
61. <i>aranoides</i> (Theobald)
<i>Uranotaenia</i> (<i>Pseudoficalbia</i>)
62. <i>bicolor</i> Leicester
63. <i>jacksoni</i> Edwards
64. <i>nivipleura</i> Leicester
65. <i>novobscura</i> Barraud
<i>Uranotaenia</i> (<i>Uranotaenia</i>)
66. <i>annandalei</i> Barraud
67. <i>edwardsi</i> Barraud
68. <i>macfarlanei</i> Edwards
<i>Verrallina</i> (<i>Verrallina</i>)
69. <i>dux</i> Dyar and Shannon

¹ New record.

pool, a garden and vegetable paddy, a grassy pasture pool, and irrigation ditches. Larval *An. maculatus* were retrieved from a stream margin, a garden and vegetable paddy, irrigation ponds, and rock pools. Larval *An. minimus* were only collected from stream margins. Larval *Oc. macfarlanei* were collected from rock pools and artificial containers. *Culex* had the greatest number of species (13); larvae of this genus were found in most habitats including artificial containers, flood pools, rock pools, irrigation ditches, and stream margins. The specific habitats of other species are listed in Table 1. Chau (1982) briefly noted the habitats of mosquitoes in Hong Kong.

Table 2 is an updated checklist of the mosquitoes of Hong Kong based on our collections, Hong Kong Department of Food and Environmental Hygiene reference collections, and available publications (e.g., Chen 1980, Chau 1982). Changes made to the generic and subgeneric classification of Culicidae since the publication of *A catalogue of the mosquitoes of the world* (Knight and Stone 1977), its supplements (Knight 1978; Ward 1984, 1992; Gaffigan and Ward 1985), and other sources (Reinert 1999, 2000; and online systematic catalog of Culicidae [Walter Reed Biosystematics Unit 2001]) that apply to the mosquito fauna of Hong Kong are followed here. This checklist has 69 species in 14 genera. Chau (1982) listed unknown species of *Topomyia* and *Ochlerotatus* (*Finlaya*) from Hong

Kong, which are not included in the present list. Chen (1980) noted that the distribution of *Culex vishnui* Theobald in China was doubtful, but he suggested the existence of *Cx. annulus* in the country instead. We collected *Cx. annulus* during our surveys in Hong Kong and we concur with Chen (1980) that the occurrence of *Cx. vishnui* in Hong Kong is unlikely. Our Hong Kong mosquito species checklist is a useful aid for further studies and a revision of this list should be done as new collection and taxonomic data become available in the near future.

This study was supported in part by a research project of Walter Reed Biosystematics Unit, Walter Reed Army Institute of Research (MIDRP U0019.03.WR). We would like to thank the staff of the Hong Kong Department of Food and Environmental Hygiene for their field and laboratory assistance, particularly W. H. Lee, K. K. Wan, C. K. Chong, T. F. L. Yau, M. Y. Cheng, C. Y. Tsang, Y. W. Lai, K. F. Yeung, and C. W. Leung. Special thanks to Y. Y. Ho for hospitality and technical support; to R. C. Wilkerson and D. Strickman for support and encouragement; and to R. C. Wilkerson, B. P. Rueda, and Y. M. Huang for reviewing the manuscript.

REFERENCES CITED

- Bram RA. 1967. Contributions to the mosquito fauna of southeast Asia.—II. The genus *Culex* in Thailand (Diptera: Culicidae). *Contrib Am Entomol Inst (Ann Arbor)* 2(1):1–296.
- Chau GW. 1982. *An illustrated guide to the identification of the mosquitoes of Hong Kong* Hong Kong: Urban Council.
- Chen HB. 1980. Study on the *Culex vishnui* subgroup in China with discussions on the taxonomic status of *C. neovishnui* Lien, *C. permixtus* Hsieh and Liao and *C. cheni* Ho. *Acta Entomol Sin* 23:434–440.
- Faran ME, Burnett C, Crockett JJ, Lawson WL. (1984) 1985. A computerized mosquito information and collection management system for systematics research and medical entomology (Diptera: Culicidae). *Mosq Syst* 16:289–307.
- Gaffigan TV, Ward RA. 1985. Index to the second supplement to “A catalog of the mosquitoes of the world”, with corrections and additions (Diptera: Culicidae). *Mosq Syst* 17:52–63.
- Government of Hong Kong Special Administrative Region. 2002. Hong Kong observatory: monthly meteorological normals and extremes of Hong Kong. <http://www.hko.gov.hk/climate/normals/htm>.
- Jackson RB. 1938. A guide to the identification of the anopheline larvae of the Colony of Hong Kong. *Chin Med J* 53:259–270.
- Jackson RB. 1951. A review of investigations of the habits and pathogenicities of the common anophelines of Hong Kong. *Trans R Soc Trop Med Hyg* 45(1):91–101.
- Knight KL. 1978. Supplement to *A catalog of the mosquitoes of the world (Diptera: Culicidae)*. *Thomas Say Found* 6(Suppl):1–107.
- Knight KL, Stone A. 1977. A catalog of the mosquitoes of the world (Diptera: Culicidae) 2nd edition. *Thomas Say Found* 6:1–611.
- Mattingly PF. 1949. *Ficalbia (Ficalbia) jacksoni* sp. n., a new species of mosquito (Diptera, Culicidae) in Hong Kong. *Proc R Entomol Soc Lond (B)* 18:9–11.
- Pecor J, Gaffigan T. 1997. Laboratory and field protocols. <http://wrbu.si.edu/www/labman/labman.html>.
- Rattanarithikul R, Green C. 1986. Formal recognition of the species of the *Anopheles maculatus* group (Diptera: Culicidae) occurring in Thailand, including the descriptions of the two new species and a preliminary key to females. *Mosq Syst* 18:246–278.
- Reinert JF. 1999. Restoration of *Verrallina* to generic rank in tribe Aedini (Diptera: Culicidae) and descriptions of the genus and three included subgenera. *Contrib Am Entomol Inst (Ann Arbor)* 31:1–83.
- Reinert JF. 2000. New classification for the composite genus *Aedes* (Diptera: Culicidae: Aedini), elevation of subgenus *Ochlerotatus* to generic rank, reclassification of the other subgenera and notes on certain subgenera and species. *J Am Mosq Control Assoc* 16:175–188.
- Sirivanakarn S. 1972. Contributions to the mosquito fauna of Southeast Asia. XIII. The genus *Culex*, subgenus *Eumelanomyia* Theobald in Southeast Asia and adjacent areas. *Contrib Am Entomol Inst (Ann Arbor)* 8(6):1–86.
- Sirivanakarn S. 1976. Medical entomology studies—III. A revision of the subgenus *Culex* in the Oriental Region (Diptera: Culicidae). *Contrib Am Entomol Inst (Ann Arbor)* 12(2):1–272.
- Sirivanakarn S. 1977. Medical entomology studies—VI. A revision of the subgenus *Lophoceraomyia* of the genus *Culex* in the Oriental Region (Diptera: Culicidae). *Contrib Am Entomol Inst (Ann Arbor)* 13(4):1–245.
- Walter Reed Biosystematics Unit. 2002. Systematic catalog of Culicidae. <http://www.mosquitocatalog.org/main.asp>.
- Ward RA. 1984. Second supplement to “A catalog of the mosquitoes of the world” (Diptera: Culicidae). *Mosq Syst* 16:227–270.
- Ward RA. 1992. Third supplement to “A catalog of the mosquitoes of the world” (Diptera: Culicidae). *Mosq Syst* 24:177–230.