Annotated checklist and review of the mosquito species (Diptera: Culicidae) in Sri Lanka

Article *in* Journal of Insect Biodiversity · October 2018

DOI: 10.12976/jib/2018.07.3.1

1 author:

Hasantha Nayana Gunathilaka
University of Kelaniya
127 PUBLICATIONS **109** CITATIONS

SEE PROFILE

J. Insect Biodiversity 007 (3): 038–050
http://www.mapress.com/j/jib

Article

ISSN 2538-1318 (print edition)
J. Insect Biodiversity
ISSN 2147-7612 (online edition)

http://dx.doi.org/10.12976/jib/2018.07.3.1
http://zoobank.org/urn:lsid:zoobank.org:pub:4C72286D-80C1-4BA9-BAEE-38D1D41B0AED

Annotated checklist and review of the mosquito species (Diptera: Culicidae) in Sri Lanka

NAYANA GUNATHILAKA
Department of Parasitology, Faculty of Medicine, University of Kelaniya, Sri Lanka. E-mail: n.gunathilaka@kln.ac.lk

Abstract

Mosquito borne diseases remains as an importance source of morbidity and mortality in Sri Lanka. To better control vectors which transmit the diseases, updated list of the species present in the county is imperative. It is also vital in documenting the diversity of the family Culicidae. Original records were collected from a literature review to compile a list of the species recorded in Sri Lanka. This work illustrates the updated list of mosquito species in Sri Lanka and their current taxonomic status based on previous studies from 1901 to date. A total of 159 species belonging to 19 genera including sibling species, have been included in the revised mosquito checklist in Sri Lanka. The present work includes 13 species, two genera (*Lutzia*, *Verrallina*) and 9 subgenera in subfamily Culicinae, tribe Aedini of genus *Aedes* (*Bruceharrisonius, Collessius, Danielsia, Dendroskusea, Downsiomyia, Fredwardsius, Hulecoeteomyia, Neomelaniconion, Phagomyia*) in to the checklist which were not included in the previous mosquito checklist published nearly 26 years ago. However, further work is essential to refine this list and to explore the abundance of new species within the country. Improved morphological and molecular identification methods will sanction the refinement of the mosquito catalog in years to come.

Key words: Species, mosquitoes, Sri Lanka

Introduction

Mosquitoes belong to the family Culicidae, order Diptera, class Insecta (Hexapoda), phylum Arthropoda. There are two recognized subfamilies namely; Anophelinae and Culicinae. Subfamily Culicinae has 10 tribes: Aedeomyiini (*Aedeomyia*), Aedini (*Aedes, Armigeres, Eretmapodites, Haemagogus, Heizmannia, Opifex, Psorophora, Udaya, Verrallina, Zeugnomyia*), Culicini (*Culex, Deinocerites, Galindomyia, Lutzia),* Culisetini (*Culiseta*), Ficalbiini (*Ficalbia, Mimomyia*), Hodgesiini (*Hodgesia*), Mansoniini (*Coquillettidia, Mansonia*), Orthopodomyiini (*Orthopodomyia*), Sabethini (*Isostomyia, Johnbelkinia, Limatus, Malaya, Maorigoeldia, Onirion, Runchomyia, Sabethes, Shannoniana, Topomyia, Trichoprosopon, Tripteroides, Wyeomyia*, *Kimia*, Toxorhynchitini (*Toxorhynchites*), and Uranotaeniini (*Uranotaenia*) (Wilkerson *et al.* 2015).

According to available records, more than 3,601 species have been identified worldwide under 140 subgenera in 41 mosquito genera (Wilkerson *et al.* 2015). The number seems to be increasing due to advancement in taxonomy and molecular based approaches. However, only a minority transmit medically important diseases such as malaria, dengue, Japanese encephalitis, yellow fever, west nile, lymphatic filariasis, chikungunya and zika. These vectors vary geographically in their medical importance. Therefore, update of vector and non-vector species at different geographical locations is important in order to plan vector control approaches based on vector density indices.

Sri Lanka is a tropical island located in the Indian Ocean off the southern tip of the Indian peninsula. The island has an area of approximately 65,610 km^2 and has diverse habitats with a complex topography and variable rainfall patterns (De Zoysa *et al.* 2016). Sri Lanka is home to a rich diversity of fauna and flora with high endemicity. However, fewer data are available on the invertebrates due to the low number of Sri Lankan researchers who work on insects (De Zoysa *et al*. 2016).

The first list of mosquitoes in Sri Lanka (Ceylon) was published in 1901 by Green including 20 species of which 18 are valid taxa to date (Green 1901). Subsequently Chalmers (1905) indicated ten anopheline species based on the investigations made in various parts of the Island during the dry season and records of previous observers (Carter 1950b).

 Accepted by Levent Gültekin: 12 Sept. 2018; published: 4 Oct. 2018

During the period 1905-1910, Theobald described many mosquitoes, listing 54 species (Theobald 1901). Christophers (1933) and Barraud (1934) expanded list to 92 mosquito species from the studies conducted under anophelines and culicines, respectively. A comprehensive catalog of mosquito species was produced by Carter (1950b) including 125 species under 14 genera. This list was subsequently updated by Chow *et al.* (1954) and Jayasekera & Chelliah (1981). Latter, Amerasinghe (1991) updated the mosquito catalogue including 140 species under 16 genera. In Sri Lanka, diseases caused by mosquito-borne pathogens remain an important source of morbidity and mortality. Therefore, up-to-date list of the species present is the country is impressive in order to ascertain the presence of vectors and thereby control the vectors that transmit the agents of disease. It is also vital in documenting the diversity of the family Culicidae. Hence, understanding mosquito distribution is important to gather high quality taxonomic and geographical information about mosquito occurrence (White & Grodhaus 1972; Faran *et al.* 1984).

There have been many changes in the mosquito taxonomy in the world. For instance, abbreviations for genera and subgenera of Culicidae (Diptera) and list of abbreviations for currently valid generic-level taxa in family Culicidae (Diptera) have been revised (Reinert 2009). Several generic-level taxa in tribe Culicini have been recognized and include the following: genus *Lutzia* Theobald (= Lt.), raised from subgeneric status in *Culex* Linnaeus (Tanaka 2003). On the other hand, there are many recent changes in the list of mosquitoes under different subgenera in genus *Aedes* (Wilkerson *et al.* 2015). In addition, there have been few new species described in Sri Lanka during recent past. Therefore, there is a paramount importance of updating the mosquito catalog of Sri Lanka based on the new information and accepted taxonomic classifications.

Materials and methods

The catalogue was compiled by reviewing the literature from 1901 to date. Articles only citing another article's collections (second-hand accounts) were not included. All articles were entered in to a spreadsheet in order to facilitate enumeration of the number of species and the number of records for each species.

Abbreviations for the generic and subgeneric names follow Reinert (2009). The information incorporated in this checklist includes the synonyms of each species with each author(s), year. Subfamilies, genera, subgenera and species are listed in alphabetical order. Appropriate citations for each species are given if they provide original records for Sri Lanka, and/or affect the taxonomy of the species, and/or provide important geographical records of the species.

Results

The literature review reveals 159 species of mosquitoes (including sibling species) under 19 genera (Diptera: Culicidae) namely; *Anopheles* Meigen, *Aedeomiya* Theobald, *Aedes* Meigen, *Verrallina* Theobald, *Armigeres* Theobald, *Heizmannia* Ludlow, *Culex* Linnaeus, *Lutzia* Theobald, *Ficalbia* Theobald, *Mimomyia* Theobald, *Hodgesia* Theobald, *Coquillettidia* Dyar, *Mansonia* Blanchard, *Orthopodomyia* Theobald, *Malaya* Leicester, *Topomyia* Leicester, *Tripteroides* Giles, *Toxorhynchites* Theobald, and *Uranotaenia* Lynch Arribalzaga. The records ranged in date from 1901 to 2016 (Table 1). Of the 159 species, 23 could be considered as endemic species.

The inclusion of *Topomyia* is based on a study conducted during 1986–1990 in Sri Lanka (Kamimura 1996) and reported collections in the Kalutara district, by a research team from Medical Research Institute (MRI) of Sri Lanka in December 2012 (Ranasinghe *et al.* 2014). The species name is not yet finalized.

The present work includes 13 new species namely; *Anopheles* (*Cellia*) *jeyporiensis*, *Anopheles* (*Cellia*) *mirans*, *Anopheles* (*Cellia*) *stephensi*, *Aedes* (*Bruceharrisonius*) *greenii*, *Aedes* (*Paraedes*) *ostentation*, *Aedes* (*Stegomyia*) *scutellaris*, *Armigeres* (*Armigeres*) *obturbans*, *Culex (Culex) perplexus*, *Culex* (*Eumelanomyia*) *foliates*, *Heizmannia carteri*, *Lutzia vorax*, *Toxorhynchites amboinensis*, and *Uranotaenia novobscura* which have been found in Sri Lanka but were not listed in previously published mosquito checklist 1981 and 1991.

The mosquito species are listed below, alphabetically by genus, subgenus, and species. In accordance with the International Code of Zoological Nomenclature (ICZN), the authorship and date of species names enclosed indicating that the species was originally described as a member of a genus other than the one in which it is currently placed (Table 2).

Table 1. Systematic arrangement of subfamilies, genera and subgenera of mosquitoes recorded from Sri Lanka

Subfamily	Tribe	Genera	Subgenera
Anophelinae	-	1. *Anopheles*	*Anopheles*
			Cellia
Culicinae	Aedeomyiini	2. *Aedeomyia*	*Aedeomyia*
		3. *Aedes*	*Aedimorphus*
			Bruceharrisonius
			Cancraedes
			Chritophersiomyia
			Collessius
			Danielsia
	Aedini		*Dendroskusea*
			Diceromyia
			Downsiomyia
			Finlaya
			Fredwardsius
			Hulecoeteomyia
			Mucidus
			Neomelaniconion
			Paraedes
			Phagomyia
			Rhinoskusea
			Stegomyia
		5. *Armigeres (6)*	*Armigeres*
			Leicesteria
		6. *Heizmannia*	*Heizmannia*
		4. Verrallina (11)	-
		7. *Culex*	*Culex*
			Culiciomyia
	Culicini		*Eumelanomyia*
			Lophoceraomyia
			Oculeomyia
		8. *Lutzia*	*Metalutzia*
		9. *Ficalbia*	-
	Ficalbiini	10. *Mimomyia*	*Etorleptiomyia*
			Mimomyia
	Hodgesiini	11. *Hodgesia*	
	Mansoniini	12. *Coquillettidia*	*Coquillettidia*
		13. *Mansonia*	*Mansonioides*
	Orthopodomyiini	14. *Orthopodomyia*	-
	Sabethini	15. *Malaya*	-
		16. *Topomyia*	*Topomyia*
			Suaymyia
		17. *Tripteroides*	*Rachionotomyia*
	Toxorhynchitini	18 *Toxorhynchites*	*Toxorhynchites*
	Uranotaeniini	19. *Uranotaenia*	*Pseudoficalbia*
			Uranotaenia

Table 2. Catalogue for mosquitoes in Sri Lanka

Subfamily: Anophelinae		
Genus: *Anopheles* Meigen		
Subgenus *Anopheles* Meigen		
1	*aitkenii* James, 1903	Harrison & Scanlon 1975; Reid 1965
2	*barbirostris* Van der Wulp, 1884 Sibling species: A, B, C, D (WHO, 2007)	Harrison & Scanlon 1975
3	*barbumbrosus* Strickland & Choudhury, 1927	Harrison and Scanlon 1975
4	*gigas refutans** Alcock, 1913 (Udawattekele [Central Province], Sri Lanka)	Christophers 1911; Reid 1968
5	*interruptus* Puri, 1929	Harrison & Scanlon 1975
6	*nigerrimus* Giles, 1900	Harrison & Scanlon 1975
7	*peditaeniatus* Leicester, 1908	Harrison & Scanlon 1975
8	*peytoni* Kulasekera, Harrison & Amerasinghe, 1988	Kulasekera *et al.* 1988
9	*reidi* Harrison, 1973* (Peradeniya Botanical Gardens, Kandy District [Central Province], Sri Lanka)	Harrison 1973
Subgenus *Cellia* Theobald		
10	*aconitus* Donitz, 1902	Harrison 1980
11	*annularis* Van der Wulp, 1884 Sibling species: A, B (WHO, 2007)	Reid 1968
12	*culicifacies* Giles, 1901 Sibling species: B, E (WHO, 2007)	Harrison 1980; Green & Miles 1980
13	*elegans* James, 1903	Reid 1968; Mendis *et al.* 1983
14	*jamesii* Theobald, 1903	Reid 1968
15	*jeyporiensis* James, 1902.	Gunathilaka *et al.* 2015
16	*karwari* James, 1902	Reid 1968
17	*maculatus* Theobald, 1901 Sibling species: B (WHO, 2007)	Reid 1968
18	*mirans* Sallum & Peyton, 2005* (Kalatuara, Morapitiya, Sinharaja, western Sri Lanka)	Sallum *et al.* 2005
19	*pallidus* Theobald, 1901	Christophers 1933; Reid 1968
20	*pseudojamesi* Strickland & Chowdhury, 1927.	Reid 1968; Huda *et al.* 1985
21	*subpictus* Grassi, 1899 Sibling species: A, B (WHO, 2007)	Reid 1968
22	*stephensi* Liston, 1901	Dharmasiri *et al.* 2017
23	*tessellatus* Theobald, 1901	Reid 1968
24	*vagus* Donitz, 1902	Reid 1968
25	*varuna* Iyengar, 192	Harrison 1980
Subfamily: Culicinae		
Genus: *Aedes* Meigen		
Subgenus *Aedimorphus* Theobald		
26	*alboscutellatus* Theobald, 1905	Reinert 1973
27	*argenteoscutellatus* Carter & Wijesundera, 1948* (Ceylon [Sri Lanka])	Carter & Wijesundara 1948
28	*jamesi* Edwards, 1914	Barraud 1934
29	*pallidostriatus* Theobald, 1907	Carter & Wijesundara 1948
30	*pipersalatus* Giles, 1902	Carter & Wijesundara 1948
31	*stenoetrus* Theobald, 1907	Carter & Wijesundara 1948
32	*taeniorhynchoides* Christophers, 1911	Carter & Wijesundara 1948
33	*vexans* Meigen, 1830	Carter & Wijesundara 1948

...continued on next page

Table 2. (Continued)

Subgenus *Bruceharrisonius* Theobald		
34	*greenii* Theobald, 1903* (Peradeniya [Central Province], Sri Lanka)	Barraud 1934
Subgenus *Cancraedes* Edwards		
35	*simplex* Theobald, 1903* (Kurunegala, [North-Western Province], Sri Lanka)	Mattingly 1957
Subgenus *Christophersiomyia* Barraud		
36	*annulirostris* Theobald, 1905	Abercrombie 1977
37	*thomsoni* Theobald, 1905	Abercrombie 1977
Subgenus *Collessius* Reinert, Harbach & Kitching		
38	*macdougalli* Edwards, 1922* (Diyatalawa [Uva Province], Sri Lanka)	Barraud 1934
39	*pseudotaeniatus* Giles, 1901	Barraud 1934
Subgenus *Danielsia* Theobald		
40	*albotaeniatus* Leicester, 1904	Barraud 1934; Chow 1951
Subgenus *Dendroskusea* Edwards		
41	*ramachandrai* Reuben, 1967.	Reuben 1967
42	*reginae* Edwards, 1922* (Colombo [Western Province], Sri Lanka)	Reinert 1970
Subgenus *Diceromyia* Theobald		
43	*periskelatus* (Giles, 1902)	Khorhart & Tariq 1966; Amerasignhe *et al.* 1987
Subgenus *Downsiomyia* Vargas		
44	*albolateralis* Theobald, 1908	Colless 1959
45	*mohani* Knight, 1969	Knight 1969
Subgenus *Finlaya* Theobald		
46	*aureostriatus* Doleschall, 1857	Kamimura 1996
47	*niveus* Ludlow, 1903	Knight & Hull 1951
Subgenus *Fredwardsius* Theobald		
48	*vittatus* Bigot, 1861	Huang 1977b
Subgenus *Hulecoeteomyia* Theobald		
49	*chrysolineatus* Theobald, 1907* (Pundabroya {Pundaluoya}, [Central Province], Sri Lanka)	Knight 1968
50	*harveyi* Barraud, 1923	Knight 1968
Subgenus *Mucidus* Theobald		
51	*quasiferinus* Mattingly, 1961	Tyson 1970b
52	*scatophagoides* Theobald, 1901	Tyson 1970b
Subgenus *Neomelaniconion* Newstead		
53	*lineatopennis* Ludlow, 1905	Mattingly 1958
Subgenus *Paraedes* Edwards		
54	*ostentatio* Leicester, 1908	Knight & Hull 1953
55	*chrysoscuta* Theobald, 1910	Reinert 1978
Subgenus *Phagomyia* Theobald		
56	*gubernatoris* Giles, 1901	Barraud 1934
Subgenus *Rhinoskusera* Edwards		
57	*wardi* Reinert, 1976	Reinert 1976
Subgenus *Stegomyia* Theobald		
58	*aegypti* Linnaeus, 1762	Belkin 1962
59	*albopictus* Skuse, 1894	Huang 1972
60	*krombeini* Huang, 1975* (Udawattekele [Central Province], Sri Lanka)	Huang 1975
61	*mediopunctatus* Theobald, 1905	Huang 1973

...continued on next page

Table 2. (Continued)

62	*novalbopictus* Barraud, 1931	Huang 1972; Amerasinghe 1983
63	*scutellaris* Walker, 1858	Walker 1858
64	*w-albus* Theobald, 1905	Huang 1977a; Amerasinghe & Alagoda 1982
Genus: *Aedeomyia* Theobald		
Subgenus *Aedeomyia* Theobald		
65	*catasticta* Knab, 1909	Tyson 1970a
Genus: *Armigeres* Theobald		
Subgenus *Armigeres* Theobald		
66	*aureolineatus* Leicester, 1908	Barraud 1934; Thurman 1959
67	*durhami* Edwards, 1917	Thurman 1959; Rajendram & Anthony 1985
68	*obturbans* Walker, 1859	Edwards 1932
69	*subalbatus* Coquillett, 1898	Bohart & Imgram 1946; Tanaka *et al.* 1979
Subgenus *Leicesteria* Theobald		
70	*mangus* Theobald, 1908	Barraud 1934; Delfinado 1966
71	*omissus* Edwards, 1914	Barraud 1934; Delfinado 1966
Genus: *Culex* Linnaeus		
Subgenus *Culex* Linnaeus		
72	*fuscocephala* Theobald, 1907	Sirivanakarn 1976
73	*gelidus* Theobald, 1901	Sirivanakarn 1976
74	*hatchinsoni* Barraud, 1924	Sirivanakarn 1976
75	*jacksoni* Edwards, 1934	Sirivanakarn 1976
76	*mimulus* Edwards, 1934	Sirivanakarn 1976
77	*perplexus* Leicester, 1908	Sirivanakarn 1976
78	*pseudovishnui* Colless, 1957	Sirivanakarn 1976
79	*quinquefasciatus* Say, 1823	Sirivanakarn 1976
80	*sitiens* Wiedemann, 1828	Sirivanakarn 1976
81	*tritaeniorhynchus* Giles, 1901	Sirivanakarn 1976
82	*vishnui* Theobald, 1901	Sirivanakarn 1976
83	*whitmorei* Giles, 1904	Sirivanakarn 1976
Subgenus *Culiciomyia* Theobald		
84	*bahri* Edwards, 1914* (Badulla, [Uwa Province], Sri Lanka)	Sirivanakarn 1977a
85	*bailyi* Barraud, 1934	Bram 1967
86	*fragilis* Ludlow, 1903	Bram 1967
87	*nigropunctatus* Edwards, 1926	Bram 1967
88	*pallidothorax* Theobald, 1905	Bram 1967
89	*scanloni* Bram, 1967	Bram 1967
90	*spathifurca* Edwards, 1915	Bram 1967
Subgenus *Eumelanomyia* Theobald		
91	*brevipalpis* Giles, 1902	Sirivanakarn 1972
92	*campilunati* Carter & Wijesundera, 1948* (Moon Plains at Nuwara Eliya [Central Province], Sri Lanka)	Sirivanakarn 1972
93	*castrensis* Edwards, 1922	Sirivanakarn 1972
94	*foliates* Brug, 1932	Sirivanakarn 1972
95	*malayi* Leicester, 1908	Sirivanakarn 1972
96	*pluvialis* Barraud, 1924	Sirivanakarn 1977b
Subgenus *Lophoceraomyia* Theobald.		
97	*bicornutus* Theobald, 1910	Sirivanakarn 1977c

...continued on next page

Table 2. (Continued)

98	*infantulus* Edwards, 1922	Sirivanakarn 1977c
99	*lasiopalpis* Sirivanakarn, 1977* (Matale, Matale District [Central Province], Sri Lanka)	Sirivanakarn 1977c
100	*mammilifer* Leicester, 1908	Sirivanakarn 1977c
101	*minutissimus* Theobald, 1907	Sirivanakarn 1977c
102	*quadripalpis* Edwards, 1914	Sirivanakarn 1977c
103	*rubithoracis* Leicester, 1908	Sirivanakarn 1977c
104	*uniformis* Theobald, 1905	Sirivanakarn 1977c
105	*wardi* Sirivanakarn, 1977* (Kanneliya, Galle District [Sabaragamuwa Province], Sri Lanka)	Sirivanakarn 1977c
Subgenus *Oculeomyia* Theobald		
106	*bitaeniorhynchus* Giles, 1901	Sirivanakarn 1976
107	*infula* Theobald, 1901	Sirivanakarn 1976
108	*sinensis* Theobald, 1903	Sirivanakarn 1976
Genus: *Coquillettidia* Dyar		
Subgenus *Coquillettidia* Dyar		
109	*crassipes* Van der Wulp, 1881	Wharton 1962
Genus: *Ficalbia* Theobald		
110	*minima* Theobald, 1901	Mattingly 1958
Genus: *Heizmannia* Ludlow		
Subgenus *Heizmannia* Ludlow		
111	*greenii* Theobald, 1905	Amerasinghe 1989
112	*carteri* Amerasinghe, 1993* (Udawattakele Forest [Central Province], Sri Lanka	Amerasinghe 1993
Genus: *Hodgesia* Theobald		
113	*bailyi* Barraud, 1929	Carter & Wijesundera 1948
114	*malayi* Leicester, 1908	Delfinado 1966
Genus: *Lutzia* Theobald		
Subgenus *Metalutzia* Tanaka		
115	*fuscanus* Wiedemann, 1820	Bram 1967
116	*halifaxii* Theobald, 1903	Bram 1967
117	*vorax* Edwards, 1921	Bram 1967
Genus: *Malaya* Leicester		
118	*genurostris* Leicester, 1908	Iyengar & Menon 1948; Tanaka *et al.* 1979
Genus: *Mansonia* Blanchard		
Subgenus *Mansonioides* Theobald		
119	*annulifera* Theobald, 1901	Carter 1950a
120	*indiana* Edwards, 1930	Carter 1950a
121	*uniformis* Theobald, 1901	Carter 1950a
Genus: *Mimomyia* Theobald		
Subgenus *Etorleptiomyia* Theobald		
122	*luzonensis* Ludlow, 1905	Mattingly 1957
Subgenus Mimomyia Theobald		
123	*chamberlaini* Ludlow, 1904	Mattingly 1957
124	*hybrid* Leicester, 1908	Mattingly 1957
125	*intermedia* Barraud, 1929	Mattingly 1957
Genus: *Orthopodomyia* Theobald		

...continued on next page

Table 2. (Continued)

126	*anopheloides* Giles, 1903	Zavortink 1968
127	*flavithorax* Barraud, 1927	Zavortink 1968
Genus: *Tripteroides* Giles		
Subgenus *Rachionotomyia* Theobald		
128	*affinis* Edwards, 1913	Mattingly 1981
129	*ceylonensis* Theobald, 1905* (Peradeniya, [Central Province], Sri Lanka)	Mattingly 1981
130	*dofleini* Gunther, 1913* (Near Udugama, [Southern Province], Sri Lanka)	Mattingly 1981
Genus: *Topomyia*		
**** Species name is not yet confirmed.**		
Genus: *Toxorhynchites* Theobald		
Subgenus *Toxorhynchites* Theobald		
131	*amboinensis* Doleschall, 1857	Barraud 1934
132	*minimus* Theobald, 1905	Barraud 1934
133	*splendens* Wiedmann, 1819	Barraud 1934
Genus: *Uranotaenia*		
Subgenus *Pseudoficalbia* Theobald		
134	*bicolor* Leicester, 1908	Peyton 1977
135	*gouldi* Peyton & Klein, 1970	Peyton 1977
136	*nivipleura* Leicestor, 1908	Peyton 1977
137	*obscura* Edwards, 1915	Peyton 1977
138	*novobscura* Barraud, 1934	Kamimura 1996
139	*srilankensis* Payton, 1974* (Wilpatti, Hunuwilagama, Anuradhapura District [North Central Province], Sri Lanka)	Peyton 1974
Subgenus *Uranotaenia* Lynch Arribalzaga		
140	*campestris* Leicester, 1908	Barraud 1934
141	*lateralis* Ludlow, 1905	Belkin 1962
142	*rutherfordi* Edwards, 1922* (Peradeniya, [Central Province], Sri Lanka)	Carter & Wijesundara 1948
Genus: *Verrallina* Theobald		
143	*butleri* Theobald, 1901	Reinert 1984
144	*indicus* Theobald, 1907	Reinert 1984
145	*lankaensis* Stone & Knight, 1958* (Ganemulla, Ratmalana, Attidiya, Negombo, Akaragama, Colombo [Western Province] Toppur [Eastern Province] Ambalangoda [Southern Province], Kegalle [Central Province] Sri Lanka)	Reinert 1984
146	*lugubris* Barraud, 1928	Reinert 1984
147	*pteroelephantus* Wijesundara, 1951* (Kurunegala [North Western Province], Sri Lanka)	Reinert 1984
148	*pseudomediofasciatus* Theobald, 1910	Reinert 1984
149	*secullatus* Menon, 1950	Reinert 1984
150	*spermathecus* Wijesundara, 1951* (Weligama [Southern Province], Sri Lanka)	Reinert 1984
151	*srilankensis* Reinert, 1977* (Vavuniya [Northern Province], Yakkala [Western Province], Sri Lanka)	Reinert 1984
152	*yerburyi* Edwads, 1917	Reinert 1984
153	*yasafi* Barraud, 1931	Reinert 1974; Amerasinghe *et al.* 1987

*Endemic species of Sri Lanka.

Discussion

Updated knowledge of the mosquito species abundance in Sri Lanka is important in the country, since the checklist of mosquitoes has not been restructured for last 27 years. There have been some changes in the taxonomic classification and nomenclature in recent years. On the other hand, the names of species have been changed or subspecies elevated to species status. In several cases, new collections have resulted in species representing new country records being added to the list.

Some entomological studies conducted later in the country have identified some species namely; *Culex perplexus*, *Cx. scanloni*, *Uranotaenia novobscura*, *Topomyia* spp. (Kamimura 1996; Ranasinghe *et al.* 2014) and *Anopheles jeyporiensis* (Gunathilaka *et al.* 2013, 2015). Some species in the subgenera *Culex* of the genus *Culex* namely; *Cx. barraudi, Cx. edwardsi* and *Cx. mimeticus* were excluded from the checklist since they were found as misidentification and doubtful records from Sri Lanka (Jayasekera & Chelliah 1981). The species formerly known as *Cx. fuscanus* and *Cx. halifaxii* are now included in the genus *Lutzia* as *Lt. fuscana* and *Lt. halifaxii* respectively. In addition, 3 species namely; *Cx. bitaeniorhynchus*, *Cx. infula* and *Cx. sinensis* were classified under the subgenus *Oculeomyia* of genus *Culex*.

The present study included 3 species in the genus *Aedes* namely; *Aedes* (*Bruceharrisonius*) *greenii*, *Ae.* (*Paraedes*) *ostentation*, *Ae.* (*Stegomyia*) *scutellaris* and *Armigeres* (*Armigeres*) *obturbans* of the genus *Armigeres, Heizmannia carteri* of genus *Heizmannia*, *Lutzia vorax* of genus *Lutzia* and *Toxorhynchites amboinensis* of genus *Toxorhynchites,* which were not updated in the previously published mosquito check list for Sri Lanka.

Some early field surveys which were conducted in Udawattakale forest; Kandy District, Central province of Sri Lanka during 1980-1981 had indicated the presence of *Tp. aranoides* (Amerasinghe, 1982). However, the mosquito checklist updated by Jayasekera & Chelliah (1981) specified this species as a misidentification and a doubtful record. Latter the mosquito checklist updated by Amerasinghe (1991) has not included the *Tp. aranoides* as an existing species in the country (Amerasinghe 1991).

Uranotaenia recondita has been firstly recoded as a species present in Sri Lanka by Carter in 1950. However, there is no solid record to confirm the presence of this species in the country. A previous study which was published in 1974 has indicated the presence of an *Ur. srilankensis* which is an endemic species. The same study has highlighted some similarities of *Ur. srilankensis* to *Ur. recondita* and with the absence of *Ur. pseudoficalbia* species (other than *nivipleura* Leicester). Therefore, the record of *Ur. recondita* by Carter (1950b) is doubtful and probably a misidentification with *Ur. srilankensis* (Peyton, 1974).

Morphological identification key to *Anopheles* species in Sri Lanka was revised in 2017 (Gunathilaka 2017). This is the most recent taxonomic study conducted in the country after more than 25 years. There are few species included in the present work viz; *An. jeyporiensis*, *An. mirans* and *An. stephensi,* which were not in the previous records. However, *An. fluviatilis*, *An. indefinitus* and *An. minimus* were excluded from the checklist since they were considered as some doubtful specimens from Sri Lanka by previous researchers (Jayasekera & Chelliah 1981). Some studies emphasize that samples collected from coastal areas in the Mannar District of Sri Lanka presented some morphological features similar to *An. sundicus*, *An. pseudosundicus* and *An. epiropticus* (Gunathilaka *et al.* 2011, 2014, 2017). There can be some slight differences between the specimens observed in different geographical locations and regions (Christophers 1933). A recent study conducted in Mannar District confirmed the presence of *An. stephensi* by both morphology and molecular methods as the first time in Sri Lanka (Dharmasiri *et al.* 2017).

However, the mosquito taxonomy studies are still not sufficient in Sri Lanka since there are no proper published morphological identification keys available for local mosquito species under each genera except the genus *Anopheles*. Therefore, entomological surveys do not consider the mosquito species other than the confirmed vectors in the country by disease surveillance programmers. Hence, the relative abundance of mosquito species and diversity of mosquito fauna receive very limited attention. This may ultimately hindrance the notice of new species or non-recoded species from the country. Hence, disease surveillance programmers should characterize the species encounter in collections and development of morphological identification keys to the locally available mosquitoes under each genus is a paramount importance.

Even though some online reference materials provide information on *Verrallina uniformis* by Harrison *et al.* (1974), *Verrallina ceylonica* and *An. willmori* as recorded species from Sri Lanka, there are no recent records available to affirm the presence of these species. Some studies conducted in 1984 has indicated *Verrallina uniformis* and *Verrallina ceylonica* (Harrison *et al.* 1974). However, the mosquito checklist published latter in 1991 was not taken above species in to consideration. This may be due to a misidentification or a doubtful record.

The current work constitutes the most complete list of mosquito species recorded from Sri Lanka, further work is needed to refine this list and understand the distributions of those species within the country. Improved morphological and molecular methods of identification will countenance the enhancement of this list in years to come.

The present study provides the most updated list of mosquito species in Sri Lanka after 26 years. This may serve as a basis for the development of identification keys for other mosquito genera and will act as a catalyst to study on bionomics of these species. Further work is essential to refine this list and to explore the abundance of new species within the country. Improved morphological and molecular identification methods will sanction the refinement of the mosquito catalog in years to come.

Acknowledgements

I would like to acknowledge the National Research Council, Sri Lanka Grant Number NRC 16-142.

References

Abercrombie J. 1977. Medical Entomology Studies - IX. The subgenus *Christophersiomyia* of the genus *Aedes* (Diptera: Culicidae). *Contributions of the American Entomological Institute* 14(2): 1–72.

Amerasinghe F. P. 1982. Observation on the mosquito (Diptera: Culicidae) of Udawattakele Forest, Sri Lanka. *Journal of National Science Council Sri Lanka* 10(1): 81–97.

Amerasinghe F. P. 1983. A note on *Aedes* (Steqomyia) *novalbopictus* Barraud from Sri Lanka, including first descriptions of the female and egg. *Journal of Natural History* 17: 203–212. https://doi.org/10.1080/00222938300770171

Amerasinghe F. P. 1989. Re description of *Heizmannia* (Heizmannia) *greenii* (Theobald) from Sri Lanka (Diptera: Culicidae). *Mosquito Systematics* 21(2): 83–99.

Amerasinghe F. P. & Alagoda T. S. B. 1982. Occurrence of *Aedes* (Stegomyia) *w-a1bus* in Sri Lanka. *Mosquito Systematics* 14: 86–87.

Amerasinghe F. P., Munasingha N. B. & Kulasekera V. L. 1987. Some new records of mosquitoes occurring in Sri Lanka. *Mosquito Systematics* 19(2): 162–166.

Amerasinghe F. P. 1991. A catalog of the mosquitoes in Sri Lanka. *Natural Resources, Energy and Science Authority of Sri Lanka* 1–23.

Amerasinghe F. P. 1993. A new species of *Heizmannia* from Sri Lanka (Diptera: Culicidae). *Mosquito Systematics* 25(2): 110–115.

Barraud P. J. 1934. *Family Culicidae. Tribes Megarhinini and Culicini. The Fauna of British India including Ceylon and Burma*. Diptera. Vol. 5. illus, London, 463 pp.

Belkin J. N. 1962. *The mosquitoes of the South Pacific (Diptera, Culicidae)*. Vol. 1, 608 pp.; Vol. 2, 412 pp. University of California Press.

Bohart R. M. & Ingram R. L. 1946. *Mosquitoes of Okinawa and Islands in the Central Pacific*. U.S. Navmed 1055, Washington, 110 pp.

Bram R. A. 1967. Contributions to the mosquito fauna of Southeast Asia (Diptera: Culicidae) II. The genus *Culex* in Thailand. *Contributions of the American Entomological Institute* 2(1): 1–296.

Carter H. F. 1950a. The genus *Taeniorhynchus* Lynch Arribalzaga (Diptera, Culicidae) with special reference to the bionomics and relation to disease of the species occurring in Ceylon. *Ceylon Journal of Science* 24(1): 1–26.

Carter H. F. 1950b. Ceylon mosquitoes: Lists of species and names of mosquitoes recorded from Ceylon. *Ceylon Journal of Science* 24(2): 85–115.

Carter H. F. & Wijesundera D. P. 1948. Notes on some Ceylon culicine mosquitoes. *Ceylon Journal of Science* 23: 135–151.

Chalmers A. J. 1905. Anophelinae found in Ceylon. *Spol Zey1* 2(B):165–178.

Chow C. Y. & Mattingly P. F. 1951. The male genitalia and early stages of *Aedes* (Fin1aya) *albocinctus* Barraud and *Aedes* (Fin1aya) *a1botaeniatus* var. *mikaranus* Edwards with some notes on related species. *Proceedings Entomological Society of London* 20(B): 80–90.

Chow C. Y., Thevasagayam E. S. & Tharumarajah K. 1954. Insects of public health importance in Ceylon. *Revista Ecuatoriana de Entomologia y Parasitologia* 2(1-2): 115–119.

Christophers S. R. 1911. Notes on mosquitoes III. A new culicine, *Les1ieomyia taeniorhynchoides*. nov. gen. et sp. *Paludism Simla* 2: 68–72, 3: 130.

Christophers S. R. 1933. The fauna of British India, including Ceylon and Burma. Diptera. In: Family Culicidae, Tribe Anophelini, Vol.

4. (Taylor & Francis), London, pp. 371–372.

Colless D. H. 1959. Notes on the culicine mosquitoes of Singapore. V. The *Aedes niveus* subgroup (Diptera Culicidae): Previously described species and keys to adults and Larvae. *Annals of Tropical Medicine and Parasitology* 53:166–179. https://doi.org/10.1080/00034983.1959.11685914

Delfinado M. D. 1966. The culicine mosquitoes of the Philippines, tribe Culicini (Diptera: Culicidae). *Memorie American Entomology Institute* 7: 1–252.

De Zoysa H. K. S., Nguyen A. N. H. D. & Wickramasinghe S. 2016. Annotated checklist of millipedes (Myriapoda: Diplopoda) of Sri Lanka. *Zootaxa* 4061(5): 451–482. https://doi.org/10.11646/zootaxa.4061.5.1

Dharmasiri A. G. G., Perera A. Y., Harishchandra J., Herath H., Aravindan K., Jayasooriya H. T. R., Ranawaka G. R. & Hewavitharane M. 2017. First record of *Anopheles stephensi* in Sri Lanka: a potential challenge for prevention of malaria reintroduction. *Malaria Journal* 16: 326. https://doi.org/10.1186/s12936-017-1977-7

Edwards F.W. 1917. Notes on Culicidae, with descriptions of new species. *Bulletin of Entomology Research* 5: 283–285. https://doi.org/10.1017/S0007485300030315

Faran M. E., Burnett C., Crockett J. J. & Lawson W. L. 1984. A computerized mosquito information and collection management system for systematic research and medical entomology (Diptera: Culicidae). *Mosquito Systematics* 16: 289–307.

Green E. E. 1901. Mosquitoes and malaria. *Circular of Royal Botanical Gardens, Ceylon* 1: 345–368.

Green C. A. & Miles S. J. 1980. Chromosomal evidence for sibling species of the malaria vector *Anopheles culicifacies* Giles. *Journal of Tropical Medicine and Hygiene* 83: 75–78.

Gunathilaka P. A. D. H. N., Fernando M. A. S. T., Premasiri D. S., Hapugoda M. D., Wijeyerathne P., Wickramasinghe A. R. & Abeyewickreme W. 2011. Morphological differences among *Anopheles subpictus* sibling species B breeding in wastewater habitats in Mannar District, Sri Lanka. *Annual Research Symposium, University of Kelaniya, Sri Lanka* 12: p. 50.

Gunathilaka P. A. D. H. N., Fernando M. A. S. T., Hapugoda M. D., Wijeyerathne P., Wickramasinghe A. R, & Abeyewickreme W. 2013. Appearance of *Anopheles jeyporiensis* (James) in Sri Lanka after 106 years. *Proceedings of the Sri Lanka Association of Advancement of Science, Colombo, Sri Lanka* 71: p. 202.

Gunathilaka P. A. D. H. N. 2014. Distribution of major and potential malaria vectors in Mannar and Trincomalee districts and systematics of anophelines in Sri Lanka. *Ph.D. Thesis, University of Kelaniya, Sri Lank*a.

Gunathilaka N., Hapugoda M., Wickremasingh R. & Abeyewickreme W. 2015. Appearance of *Anopheles jeyporiensis* James from Sri Lanka; a new species to the mosquito checklist. *Medical Entomology and Zoology* 66(3):1–5. https://doi.org/10.7601/mez.66.121

Gunathilaka N. 2017. Illustrated keys to the adult female Anopheles (Diptera; Culicidae) mosquitoes of Sri Lanka. *Applied Entomology and Zoology* 52: 69–77. https://doi.org/10.1007/s13355-016-0455-y

Harrison B. A. 1973. *Anopheles* (An.) *reidi*. a new species of the *barbirostris* species complex from Sri Lanka (Diptera : Culicidae). *Proceeding of Entomology Society of Washington* 75: 365–371.

Harrison B. A.1980. Medical Entomology Studies - XIII. The Myzomyia series of *Anophe1es* (CeIlia) in Thailand, with emphasis on intra-interspecific variations (Diptera:Culicidae). *Contributions of the American Entomological Institute* 17(4): 1–195.

Harrison B. A. & Scanlon J. E. 1975. The subgenus *Anopheles* in Thailand (Diptera:Culicidae). *Contributions of the American Entomological Institute* 12(1): 1–307.

Harrison B. A., Reinert J. F., Sirivanakarn S., Huang Y. M., Peyton E. L. & de Meillon B. 1974. Distributional and biological notes on mosquitoes from Sri Lanka (Ceylon) (Diptera: Culicidae). *Mosquito Systematics* 6(2): 142–162.

Huang V. M. 1972. Contributions to the mosquito fauna of Southeast Asia. XIV. The subgenus Stegomyia of *Aedes* in Southeast Asia. 1 - The Scutellaris group of species. *Contributions of the American Entomological Institute* 9(1): 1–108.

Huang Y. M. 1973. A new species of *Aedes* (Stegomyia) from Thailand and notes on the *mediopunctatus* subgroup (Diptera: Culicidae). *Proceeding of Entomology Society of Washington* 75: 224–232.

Huang Y. M. 1975. A new species of *Aedes* (Stegomyia) from Sri Lanka (Ceylon) (Diptera: Culicidae). *Mosquito Systematics* 7(4): 345–356.

Huang Y. M. 1977a. Medical Entomology Studies - VII. The subgenus *Stegomyia* of *Aedes* in Southeast Asia. II. The *edwardsi* group of species. III. The *w-a1bus* group of species (Diptera: Culicidae). *Contributions of the American Entomological Institute* 14(1): 1–111.

Huang Y. M. 1977b. Medical Entomology Studies - VIII. Notes on the taxonomic status of *Aedes vittatus* (Diptera : Culicidae). *Contributions of the American Entomological Institute* 14(1): 113–132.

Huda K. M. N. & Harrison B. A. 1985. Priority of the name *Anophe1es pseudojamesi* for the species previously called *An. ramsayi*

(Diptera: Culicidae). *Mosquito Systematics* 17(1): 49–51.

Iyengar M. O. T. & Menon M. A. U. 1948. Notes on *Harpagomyia oenurostris* Leicester (Diptera: Culicidae). *Proceeding of Entomology Society of Washington* (A) 23: 39–43.

Jayasekera N. & Chelliah R. V. 1981. An annotated checklist of mosquitoes of Sri Lanka. MAB-UNESCO-*Man and the Biosphere National Committee for Sri Lanka* 8: 1–16

Kamimura K. 1996. The mosquitoes (Diptera: Culicidae) collected from Sri Lanka. *Journal of Medical Entomology and Zoology* 47(2): 145–153.
https://doi.org/10.7601/mez.47.145

Khokhar R. R. & Tariq Z. K. 1966. A redescription of *Aedes* (Diceromyia) *periskeletus* (Giles, 1902) (Diptera: Culicidae). *Pakistan Journal of Science* 18: 117–123.

Knight K. L. 1968. Contributions to the mosquito fauna of Southeast Asia - IV. Species of the subgroup Chrysolineatus of group D, genus *Aedes*. subgenus *Finlaya* Theobald *Contributions of the American Entomological Institute* 2(5): 1–45.

Knight K. L. 1969. A new species of the genus *Aedes*. subgenus *Finlaya* Theobald, from India" (Diptera: Culicidae). *Journal Kansas Entomology Society* 42: 382–386.

Knight K. L. & Hull W. B. 1951. The *Aedes* mosquitoes of the Philippine Islands. I. Keys to species. Subgenera *Mucidus*, *Ochlerotatus* and *Finlaya* (Diptera: Culicidae). *Pacific Science* 5: 211–251.

Ku1asekera V. L., Harrison B. A. & Amerasinghe F. P. 1988. *Anopheles* (Anopheles) *peytoni* n.sp., the "*An. insulaeflorum*" auct. from Sri Lanka (Diptera:Culicidae). *Mosquito Systematics* 20(3): 302–316.

Mattingly P. F. 1957. The culicine mosquitoes of the Indomalayan Area. Part 1. Genus *Ficalbia* Theobald. *British Museum of Natural History, London,* 61 pp.

Mattingly P. F. 1958. The culicine mosquitoes of the Indomalayan area. Part III. Genus *Aedes* Meigen, subgenera *Paraedes* Edwards, *Rhinoskusea* Edwards and *Cancraedes* Edwards. *British Museum of Natural History, London*, 61 pp.

Mattingly P. F. 1981. Medical Entomology Studies - XIV. The subgenera *Rachionotomyia, Tricholeptomyia* and *Tripteroides* (Mabinii group) of genus *Tripteroides* in the Oriental region. *Contributions of the American Entomological Institute* 17(5): 1–147.

Mendis K. N., Ihalamulla R. L., Peyton E. L. & Nanayakkara S. 1983. Biology and descriptions of the larva and pupa of *Anopheles* (Cellia) *elegans* James (1903). *Mosquito Systematics* 15(4): 318–324.

Peyton E. L. 1974. *Uranotaenia srilankensis*. a new species of the subgenus *Pseudoficalbia* from Sri Lanka (Diptera:Culicidae). *Mosquito Systematics* 6(3): 222–227.

Peyton E. L. 1977. Medical Entomology Studies - X. A revision of the subgenus *Pseudoficalbia* of the genus *Uranoteania* in Southeast Asia (Diptera:Culicidae). *Contributions of the American Entomological Institute* 14(3): 1–273.

Rajendram G.F. & Anthony N.R. 1985. Mosquito sampling in several locations in Jaffna peninsula. *Proceedings of the Sri Lanka Association of Advancement of Science* 42: pp. 144–145.

Ranasinghe P., Sriyakanthi Y. & Premaratne N. W. G. 2014. Genus Topomyia (Leicester 1908) subgenus Suaymyia from Sri Lanka. *Scientific Sessions of the Medical Research Institute, Colombo, Sri Lanka*, 41 pp.

Reid J. A. 1965. A revision of the *Anopheles aitkenii* group in Malaya and Borneo. *Annals of Tropical Medicine and Parasitology,* 59: 106–125.
https://doi.org/10.1080/00034983.1965.11686289

Reid J. A. 1968. Anopheline mosquitoes of Malaya and Borneo. *Studies of Institute of Medical Research, Malaysia* 31: 520.

Reinert J. F. 1970. Contributions to the mosquito fauna of Southeast Asia - V. Genus *Aedes*. subgenus *Diceromyia* Theobald in Southeast Asia. *Contributions of the American Entomological Institute* 5(4): 1–43.

Reinert J. F. 1973. Contributions to the mosquito fauna of Southeast Asia. XVI. Genus *Aedes* Meigen, subgenus *Aedimorphus* Theobald in Southeast Asia. *Contributions of the American Entomological Institute* 9(5): 1–218.

Reinert J. F. 1974. Medical Entomology Studies - I. A new interpretation of the subgenus *Verrallina* of the genus *Aedes (*Diptera: Culicidae). *Contributions of the American Entomological Institute* 11(1): 1–249.

Reinert J. F. 1976. Medical Entomology Studies' V. The subgenus *Rhinoskusea* of the genus *Aedes* (Diptera:Culicidae). *Contributions of the American Entomological Institute* 13(2): 1–60.

Reinert J. F. 1978. First descriptions of the immature stages of *Aedes* (Verral1ina) *pseudomediofasciatus* and *Ae.* (Ver.) *yerburyi* (Diptera: Culicidae). *Mosquito Systematics* 10(2): 225–238.

Reinert J. F. 1984. Medical Entomology Studies - XVI. A review of the species of subgenus *Verrallina*. genus *Aedes* from Sri Lanka and a revised description of the subgenus (Diptera: Culicidae). *Mosquito Systematics* 16(1): 1–130.

Reinert J. F. 2009. List of abbreviations for currently valid generic-level taxa in family Culicidae (Diptera). *Journal of American Mosquito Control Association* 27: 68–76.

Reuben R. 1967. *Aedes* (Diceromyia) *ramachandrai*, n. sp. (Diptera: Culicidae) from southern. *Indian Journal of Medical Entomology* 4: 234–236.

https://doi.org/10.1093/jmedent/4.2.234

Sallum M. A. M., Peyton E. L. & Wilkerson R. C. 2005. Six new species of the *Anopheles leucosphyrus* group, reinterpretation of *An. elegans* and vector implications. *Medical and Veterinary Entomology* 19(2): 158–199. https://doi.org/10.1111/j.0269-283X.2005.00551.x

Sirivanakarn S. 1972. Contributions to the mosquito fauna of Southeast Asia.-XIII. The genus *Culex.* subgenus *Eumelanomyia* Theobald in Southeast Asia and adjacent areas. *Contributions of the American Entomological Institute* 8(6): 1–86.

Sirivanakarn S. 1976. Medical Entomology Studies - III. A revision of the subgenus *Culex* in the Oriental region. *Contributions of the American Entomological Institute* 12(2): 1–272.

Sirivanakarn S. 1977a. Re description of four Oriental species of *Culex* (Culiciomyia) and the description of a new species from Thailand (Diptera: Culicidae). *Mosquito Systematics* 9(2): 93–111.

Sirivanakarn S. 1977b. A new species of *Culex* (Eumelanomyia) from India with descriptions of pupae and larvae of *Cx. pluvial* is Barraud and *Cx. iphis* Barraud (Diptera: Culicidae). *Mosquito Systematics* 9(4): 537–547.

Sirivanakarn S. 1977c. Medical Entomology Studies - VI. A revision of the subgenus *Lophoceraomyia* of the genus *Culex* in the Oriental Region (Diptera :Culicidae). *Contributions of the American Entomological Institute* 13(4): 1–245.

Tanaka K., Mizusawa K. & Saugstad E. S. 1979. A revision of the adult and larval mosquitoes of Japan (Including the Ryukyu Archipelago, and the Ogasawara Island) and Korea (Diptera: Culicidae). *Contributions of the American Entomological Institute* 16: 1–987.

Tanaka K. 2003. Studies on the pupal mosquitoes of Japan (9) Genus Lutzia, with establishment of two new subgenera, Metalutzia and Insulalutzia (Diptera, Culicidae). *Japanese Journal of Systematic Entomology* 9: 159–169.

Theobald F. V. 1901. *A Monograph of the Culicidae or Mosquitoes*. Vol 1 (illus, London) 424 pp.

Thurman E. H. B. 1959. A contribution to a revision of the Culicidae of northern Thailand. *University of Maryland Agricultural Experiment Station, Bulletin* A-100: 186.

Tyson W. 1970a. Contributions to the mosquito fauna of Southeast Asia. VII. Genus *Aedeomyia* Theobald in Southeast Asia. *Contributions of the American Entomological Institute* 6(2): 1–27.

Tyson W. 1970b. Contributions to the mosquito fauna of Southeast Asia. VIII. Genus *Aedes*, subgenus *Mucidus* Theobald in Southeast Asia. *Contributions of the American Entomological Institute* 6(2): 20–80.

Walker 1958. Catalogue of the dipterous insects collected in the Aru Islands by Mr. A. R. Wallace, with descriptions of new species. *Journal of the Proceedings of the Linnean Society of London Zoology* 3(10-11): 77–131.

Wharton R. H. 1962. The biology of *Mansonia* mosquitoes in relation to the transmission of filariasis in Malaya. *Bulletin of the Institute for Medical Research in Malaya* 11: 1–114.

White K. E. & Grodhaus G. 1972. Computer information retrieval system for California mosquito collection records. *California Vector News* 19: 27–39.

Wilkerson R. C., Linton Y. M., Fonseca D. M., Schultz, T. R., Price D. C. & Strickman D. A. 2015. Making Mosquito Taxonomy Useful: A Stable Classification of Tribe Aedini that Balances Utility with Current Knowledge of Evolutionary Relationships. *Plos One* 2015. https://doi.org/10.1371/journal.pone.0133602

World Health Organization. 2007. Anopheline Species Complexes in South and South-East Asia. (ISBN 978-92-9022-294-1). 1–79.

Zavortink T. J. 1968. Mosquito Studies (Diptera : Culicidae). VIII. A prodrome of the genus *Orthopodomyia*. *Contributions of the American Entomological Institute* 3(2): 1–22.