International Journal of Mosquito Research

ISSN: **2348-5906**
CODEN: **IJMRK2**
IJMR 2015; 2 (2): 50-97

Received: 28-08-2014
Accepted: 13-12-2014

B.K. Tyagi
Centre for Research in Medical Entomology (ICMR) 4, Sarojini street, Chinna Chokkikulam Madurai – 625 002 (TN), India

A. Munirathinam
Centre for Research in Medical Entomology (ICMR) 4, Sarojini street, Chinna Chokkikulam Madurai – 625 002 (TN), India

A. Venkatesh
Centre for Research in Medical Entomology (ICMR) 4, Sarojini street, Chinna Chokkikulam Madurai – 625 002 (TN), India

For Correspondence:
B.K. Tyagi
Centre for Research in Medical Entomology (ICMR) 4, Sarojini street, Chinna Chokkikulam Madurai – 625 002 (TN), India
Email: abktyagi@gmail.com

A catalogue of Indian mosquitoes

B.K. Tyagi, A. Munirathinam and A. Venkatesh

Abstract
An annotated catalogue for Indian mosquitoes has been prepared with a view to primarily enlist all the extant taxa, along with simplified field-friendly identification keys for the 4th instar larvae and adults of the major vector species of public health importance in India. This is by far the most complete and comprehensive inventory compiled post-independence in single volume of the entire mosquito faunal wealth in the country. The Catalogue offers many novelties; first, it has inventoried the largest ever number of 404 species and subspecies (which is >12% of the total number of taxa in the world, i.e., 3541), belonging to 50 genera and 2 subfamilies (12 tribes); secondly, it has organized all the taxa in a more modern and universally acceptable classificatory system proposed by Harbach [(2014). Mosquito taxonomic inventory, http://mosquito-taxonomic-inventory.info/node/11667; accessed 31st July, 2014)], with of course some consideration of the other popular systems earlier used by Christophers (1933) and Barraud (1934) in their respective *magnum opuses* 'Anophelini', and 'Culicini and Magarhirini' under CULICIDAE volumes of the internationally famous *The Fauna of British India* series; and thirdly, in order to facilitate field entomologists who urgently need a simple and practical identification keys for all the major vector species, a diagrammatic description aided with the most directly applicable dichotomous identification keys is offered.

Keywords: Catalogue, mosquitoes, vectors, identification keys, India

1. Introduction
How many species of mosquitoes are there in India? And, why is it so compellingly important to enlist these tiny creatures popularly believed to be either as dangerous vectors of several deadly and/or debilitating diseases such as malaria, filariasis, dengue, chikungunya and Japanese encephalitis, just to name a few important ones, or serious pests of human being in all places and times. Amosquito is considered the deadliest foe of man in his successful survival since it is singularly the reason for transmitting so many fatal diseases responsible for retarding the national health and economy, besides stunting the intelligentia [1, 2]. Notwithstanding, the fact is that there are even less than 20% of the total species in the world which either 'vectorize' some disease pathogens to man and his associates or 'vex' their tranquillity in some way or the other, earning them a streak of sobriquets painting them as if they are the most dreaded and abhorrable creatures on the earth! In fine, what is most important is the knowledge of our mosquito faunal wealth, irrespective of being harmful or innocuous, and in terms of the modern scientific requirements, the genomic information!

The first compilation of the world mosquitoes was attempted more than a century ago, but this catalogue enlisted very few species from the Indian subcontinent. An annotated catalogue for Indian mosquitoes has been prepared with a view to primarily enlist all the extant taxa, along with simplified field- friendly identification keys for the 4th instar larvae and adults of the major vector species of public health importance in India. This is by far the most complete and comprehensive inventory compiled post-independence in single volume of the entire mosquito faunal wealth in the country. The Catalogue offers many novelties; first, it has inventoried the largest ever number of species and subspecies (404/3541), which is >12% of all the world fauna, belonging to 50 genera and 2 subfamilies (12 tribes); secondly, it has organized all the taxa in a more modern and universally acceptable classificatory system proposed [4], with of course some consideration of the other popular systems earlier used in their respective *magnum opuses* 'Anophelini', and 'Culicini and Magarhirini' under Culicidae volumes of the internationally famous The Fauna of British India series; and thirdly, within the limited scope of the Catalogue an attempt has been made to remove certain 'dark points' in the taxonomy and systematics of the important vector species prevalent in India (Table 1).

Table 1: Mosquitoes species recorded in world, India and CRME Museum (upto November 2014)

Subfamily	Tribes	World		India		CRME Museum	
		No. of Genera	No. of species	No. of Genera	No. of species	No. of Genera	No. of species
Anophelinae		3	481	1	63	1	45
Culicinae	Aedeomyiini	1	7	1	2	1	1
	Aedini	81	1253	34	175	24	92
	Culicini	4	796	2	85	2	56
	Culisetini	1	37	1	3	0	0
	Ficalbiini	2	53	2	8	2	5
	Hodgesiini	1	11	1	2	1	1
	Mansoniini	2	82	2	7	2	4
	Orthopodomyiini	1	36	1	5	1	4
	Sabethini	14	429	3	16	3	9
	Toxorhynchitini	1	89	1	9	1	7
	Uranotaeniini	1	267	1	29	1	18
2	11	112	3541	50	404	39	242

Up till now little systematic effort has been made to inventorize the Indian mosquitoes (Culicidae) post-independence. During pre-independence era some workers, mostly drawn from medicine background, have brought about a series of publications dealing with either anopheline or culicine mosquitoes [5, 6], culminating into their two unparalleled *magnum opuses* of mosquito taxonomy on Anophelini, and Culicini and Magarhirini (Toxorhynchitinae) under *The Fauna of British India* series. The latter, in spite of being largely outdated in modern context of classification and identification such as the redundancy to mention Dixinae and Chaoborinae as mosquitoes (*sic*! since both these groups are *not* mosquitoes at all), several instances of species synonymization, and lack of clarity on various dark points in the taxonomic identification or distribution of a large number of taxa, and finally, rather most importantly, their inadequacy to represent the India of today, still remain the most authentic reference works on Indian mosquitoes. However, as it stands now, post-independence India needs an updated, realistic and practical inventory of mosquito fauna [2, 7] which could meet the international standards of taxonomic knowledge on classification of taxa, on one hand, and provide a firsthand information on the natural wealth of these tiny creatures, the mosquitoes, many of which are deadly vectors as well as highly vexing pests [8]. Soon following the independence of India, a crop of highly energetic entomologists emerged and brought out significant check-lists of Indian mosquitoes. [9, 17] However, all this literature dealt exclusively with *Anopheles* mosquitoes possibly due to an unprecedented high significance tagged with malaria in the country! The attention to malaria control was so focused that only one new species, *Anopheles pseudosundaicus* [18], could be brought on record from India in more than eighty years; the last new species having been described was *An. pinjaurensis* [5].

Due to a fervent nationwide anti-malaria campaign between 1950 and 1980, hardly any attention was given to the non-anopheline mosquitoes, and the biomedical significance of culicine mosquitoes was almost completely overshadowed in terms of their taxonomic biodiversity, albeit many of the culicine mosquitoes playing key roles in transmitting several deadly and/or debilitating diseases such as lymphatic filariasis and Japanese encephalitis, apart from dengue and chikungunya diseases transmitted exclusively by *Aedes* mosquitoes in India. Yet, a few abridged attempts were made to comprehend distributional patterns of culicines on regional basis such as those in the Western Himalayas [19], Southern India including Western Ghats and Eastern Ghats as well as Andaman & Nicobar Islands [15, 20-23], Northeastern states of seven sisters [24], the Thar Desert in western Rajasthan and the Great Runn of Kutchch in Gujarat [25], various districts of Punjab and Himachal Pradesh [26] and Malwa region of Punjab [27]. Certain international works did report Indian Culicines [28, 32], however these have but given a passing reference to the Indian fauna while describing *in extenso* the mosquitoes of the Oriental Region. Currently mosquito inventories are being updated on-line [4, 33], but both these services might overlook many a journal in India where mosquito taxonomic publications appear, hence incomplete inasmuch as Indian information on mosquito taxonomy is concerned. The rather pathetic state of Indian mosquito taxonomy can be gauged from the fact that less than a dozen new species only were described following the famous BFI volumes [18, 34, 43].

At present nobody knows how many mosquito species and subspecies exist in India since there is no authoritative compilation of information on the subject. The few national museums/repositories in the country (e.g., National Centres for Diseases Control, Delhi; National Vector Borne Diseases Control Programme, Delhi; Indian Museum, Kolkata) house vouched specimens of many kinds, but in most of these the 'designated type specimens' (i.e., holotype, allotype, paratype etc.) are either now non-existent or are in a highly dilapidated state and of no avail to a student of mosquito taxonomy. The museums maintained in Centre for Research in Medical Entomology, Madurai, Vector Control Research Centre, Puducherry, National Institute of Malaria Research, Delhi, Regional Medical Research Centre, Dibrugarh, and National Institute of Virology, Pune are extensive and well documented, but these too are yet to be integrated and made comprehensible with identification keys for all the taxa for the country in one volume [44-47]. This is indeed a serious state of our efforts to conserve genomic information of our indigenous faunal wealth. Therefore, the main purpose of the Catalogue is to offer an authentic check- list of all the extant taxa of mosquitoes in India as a first step towards conserving knowledge on the genome-resources and, secondly, to provide a culicidologist interested in diverse mosquito taxonomy an annotated catalogue to facilitate comprehension about the intricate organization of various species, with an extensive bibliography. Another aspect is to consider this catalogue as a launching pad for preparing a "Type data based inventory" so that dependence on overseas international museums could be minimised, if not completely set free!!

2. CATALOGUE OF INDIAN MOSQUITOES

Order: Insecta Family: Culicidae

Subfamily: Anophelinae Tribe Anophelini

I. Genus **Anopheles** Meigen, 1818

(i) Subgenus Anopheles Meigen, 1818

1. *Anopheles* (*Anopheles*) *ahomi* Chowdhury, 1929
2. *Anopheles* (*Anopheles*) *aitkenii* James, 1903
3. *Anopheles (Anopheles) annandalei* Prashad, 1918
4. *Anopheles (Anopheles) argyropus* (Swellengrebel, 1914)
5. *Anopheles (Anopheles) baileyi* Edwards,1929
6. *Anopheles (Anopheles) barbirostris* van der Wulp, 1884
7. *Anopheles (Anopheles) barbumbrosus* Strickland & Chowdhury, 1927
8. *Anopheles (Anopheles) barianensis* James, 1911
9. *Anopheles (Anopheles) bengalensis* Puri, 1930
10. *Anopheles (Anopheles) crawfordi* Reid, 1953
11. *Anopheles (Anopheles) culiciformis* Cogill, 1903
12. *Anopheles (Anopheles) gigas* Giles, 1901
13. *Anopheles (Anopheles) hodgkini* Reid, 1962
14. *Anopheles (Anopheles) insulaeflorum* (Swellengrebel & Swellengrebel de Graaf, 1920)
15. *Anopheles (Anopheles) interruptus* Puri, 1929
16. *Anopheles (Anopheles) lesteri paraliae* Sandosham, 1959
17. *Anopheles (Anopheles) lindesayi* Giles, 1900
18. *Anopheles (Anopheles) nigerrimus* Giles, 1900
19. *Anopheles (Anopheles) nilgiricus* Christophers, 1924
20. *Anopheles (Anopheles) nitidus* Harrison, Scanlon & Reid, 1973
21. *Anopheles (Anopheles) peditaeniatus* (Leicester, 1908)
22. *Anopheles (Anopheles) pinjaurensis* Barraud, 1932
23. *Anopheles (Anopheles) roperi* Reid, 1950
24. *Anopheles (Anopheles) sinensis* Wiedemann, 1828
25. *Anopheles (Anopheles) sintoni* Puri, 1929
26. *Anopheles (Anopheles) umbrosus* (Theobald, 1903)

(ii) Subgenus Cellia Theobald, 1902

27. *Anopheles* (*Cellia*) *aconitus* Donitz, 1902
28. *Anopheles (Cellia) annularis* van der Wulp, 1884
29. *Anopheles (Cellia) baimaii* Sallum & Peyton, 2005
30. *Anopheles (Cellia) balabacensis* Baisas, 1936
31. *Anopheles (Cellia) culicifacies* Giles, 1901
32. *Anopheles (Cellia) dravidicus* Christophers, 1924
33. *Anopheles (Cellia) d'thali* Patton, 1905
34. *Anopheles (Cellia) elegans* (James, 1903)
35. *Anopheles (Cellia) fluviatilis* James, 1902
36. *Anopheles (Cellia) jamesii* Theobald, 1901
37. *Anopheles (Cellia) jeyporiensis* James, 1902
38. *Anopheles (Cellia) karwari* (James, 1903)
39. *Anopheles (Cellia) kochi* Donitz, 1901
40. *Anopheles (Cellia) maculatus* Theobald, 1901
41. *Anopheles (Cellia) majidi* Young & Majid, 1928
42. *Anopheles (Cellia) minimus* Theobald, 1901
43. *Anopheles (Cellia) mirans* Sallum & Peyton, 2005
44. *Anopheles (Cellia) moghulensis* Christophers, 1924
45. *Anopheles (Cellia) multicolor* Cambouliu, 1902
46. *Anopheles (Cellia) nivipes* (Theobald, 1903)
47. *Anopheles (Cellia) pallidus* Theobald, 1901
48. *Anopheles (Cellia) philippinensis* Ludlow, 1902
49. *Anopheles (Cellia) pseudojamesi* Strickland & Chowdhury, 1927
50. *Anopheles (Cellia) pseudosundaicus* Tyagi et al., 2009
51. *Anopheles (Cellia) pseudowillmori* (Theobald, 1910)
52. *Anopheles (Cellia) pulcherrimus* Theobald, 1902
53. *Anopheles (Cellia) sergentii* (Theobald, 1907)
54. *Anopheles (Cellia) splendidus* Koidzumi, 1920
55. *Anopheles (Cellia) stephensi* Liston, 1901
56. *Anopheles (Cellia) subpictus* Grassi, 1899
57. *Anopheles (Cellia) sundaicus* (Rodenwaldt, 1925)
58. *Anopheles (Cellia) tessellatus* Theobald, 1901
59. *Anopheles (Cellia) theobaldi* Giles, 1901
60. *Anopheles (Cellia) turkhudi* Liston, 1901
61. *Anopheles (Cellia) vagus* Donitz, 1902
62. *Anopheles (Cellia) varuna* Iyengar, 1924
63. *Anopheles (Cellia) willmori* (James, 1903)

Subfamily: Culicinae

Tribe: Aedeomyiini Theobald, 1901

I. Genus **Aedeomyia** Theobald, 1901

(i) Subgenus Aedeomyia Theobald, 1901

64. *Aedeomyia* (*Aedeomyia*) *catasticta* Knab, 1909
65. *Aedeomyia* (*Aedeomyia*) *venustipes* (Skuse, 1889)

Tribe: Aedini Neveu-Lemaire, 1902

I. Genus **Aedimorphus** Theobald, 1903

66. *Aedimorphus alboscutellatus* (Theobald, 1905)
67. *Aedimorphus caecus* (Theobald, 1901)
68. *Aedimorphus culicinus* (Edwards, 1922)
69. *Aedimorphus jamesi* (Edwards, 1914)
70. *Aedimorphus lowisii* (Theobald, 1910)
71. *Aedimorphus mediolineatus* (Theobald, 1901)
72. *Aedimorphus nigrostriatus* Barraud, 1927
73. *Aedimorphus pallidostriatus* (Theobald, 1907)
74. *Aedimorphus pampangensis* (Ludlow, 1905)
75. *Aedimorphus pipersalatus* (Giles, 1902)
76. *Aedimorphus punctifemoris* (Ludlow, 1921)
77. *Aedimorphus stenoetrus* (Theobald, 1907)
78. *Aedimorphus syntheticus* (Barraud, 1928)
79. *Aedimorphus taeniorhynchoides* (Christophers,1911)
80. *Aedimorphus trimaculatus* (Theobald,1905)
81. *Aedimorphus vexans* (Meigen, 1830)

II. Genus **Armigeres** Theobald, 1901

(i) Subgenus Armigeres Theobald,1901

82. *Armigeres (Armigeres) aureolineatus* (Leicester, 1908)
83. *Armigeres (Armigeres) durhami* (Edwards, 1917)
84. *Armigeres (Armigeres) joloensis* (Ludlow, 1904)
85. *Armigeres (Armigeres) kesseli* Ramalingam, 1987
86. *Armigeres (Armigeres) kuchingensis* Edwards, 1915
87. *Armigeres (Armigeres) mahantai* Bhattacharyya *et al*., 2009
88. *Armigeres (Armigeres) pallithorax* Dong, Zhou & Dong, 2004
89. *Armigeres* (*Armigeres*) *subalbatus* (Coquillett, 1898)
90. *Armigeres (Armigeres) theobaldi* Barruad, 1934

(ii) Subgenus Leicesteria Theobald, 1904

91. *Armigeres (Leicesteria) annulipalpis* (Theobald, 1910)
92. *Armigeres (Leicesteria) annulitarsis* (Leicester, 1908)
93. *Armigeres (Leicesteria) dentatus* Barraud, 1927
94. *Armigeres (Leicesteria) digitatus* (Edwards, 1914)
95. *Armigeres (Leicesteria) dolichocephalus* (Leicester, 1908)
96. *Armigeres (Leicesteria) flavus* (Leicester, 1908)
97. *Armigeres (Leicesteria) inchoatus* Barraud, 1927
98. *Armigeres (Leicesteria) longipalpis* (Leicester, 1904)
99. *Armigeres (Leicesteria) magnus* (Theobald, 1908)
100. *Armigeres (Leicesteria) omissus* (Edwards, 1914)

III. Genus **Ayurakitia** Thurman, 1954

101. *Ayurakitia peytoni* (Reinert, 1972)

IV. Genus **Bruceharrisonius** Reinert, 2003
102. *Bruceharrisonius aureostriatus* (Doleschall, 1857)
103. *Bruceharrisonius christophersi* (Edwards, 1922)
104. *Bruceharrisonius doonii* (Wattal, Bhatia & Kalra, 1958)
105. *Bruceharrisonius greenii* (Theobald, 1903)

V. Genus **Cancraedes** Edwards, 1929
106. *Cancraedes cancricomes* (Edwards, 1922)
107. *Cancraedes simplex* (Theobald, 1903)

VI. Genus **Christophersiomyia** Barraud, 1923
108. *Christophersiomyia annulirostris* (Theobald, 1905)
109. *Christophersiomyia gombakensis* (Mattingly, 1959)
110. *Christophersiomyia ibis* (Barraud, 1931)
111. *Christophersiomyia thomsoni* (Theobald, 1905)

VII. Genus **Collessius** Reinert, Harbach & Kitching, 2006
(i) Subgenus Alloeomyia Reinert, Harbach & Kitching, 2008
112. *Collessius* (*Alloeomyia*) *pseudotaeniatus* (Giles, 1901)
(ii) Subgenus Collessius Reinert, Harbach & Kitching, 2006
113. *Collessius* (*Collessius*) *elsiae* (Barraud, 1923)
114. *Collessius* (*Collessius*) *macdougalli* (Edwards, 1922)
115. *Collessius* (*Collessius*) *shortti* (Barraud, 1923)

VIII. Genus **Danielsia** Theobald, 1904
116. *Danielsia albotaeniata* Leicester, 1904
117. *Danielsia lepchana* (Barruad, 1923)

IX. Genus **Dendroskusea** Edwards, 1929
118. *Dendroskusea kanarensis* (Edwards, 1934)
119. *Dendroskusea micropterus* (Giles, 1901)
120. *Dendroskusea periskelata* (Giles, 1902)
121. *Dendroskusea ramachandrai* (Reuben, 1967)
122. *Dendroskusea reginae* (Edwards, 1922)

X. Genus **Downsiomyia** Vargas, 1950
123. *Downsiomyia albolateralis* (Theobald, 1908)
124. *Downsiomyia albonivea* (Barruad,1934)
125. *Downsiomyia mohani* (Knight, 1969)
126. *Downsiomyia nivea* (Ludlow,1903)
127. *Downsiomyia niveoides* (Barruad, 1934)
128. *Downsiomyia novonivea* (Barraud,1934)

XI. Genus **Edwardsaedes** Belkin, 1962
129. *Edwardsaedes imprimens* (Walkar, 1860)

XII. Genus **Finlaya** Theobald, 1903
130. *Finlaya flavipennis* Giles, 1904
131. *Finlaya poicilia* Theobald, 1903

XIII. Genus **Fredwardsius** Reinert, 2000
132. *Fredwardsius vittatus* (Bigot, 1861)

XIV. Genus **Gilesius** Reinert, Harbach & Kitching, 2006
133. *Gilesius pulchriventer* (Giles, 1901)

XV. Genus **Heizmannia** Ludlow, 1905
(i) Subgenus Heizmannia Ludlow, 1905
134. *Heizmannia (Heizmannia) aureochaeta* (Leicester, 1908)
135. *Heizmannia (Heizmannia) chandi* Edwards, 1922
136. *Heizmannia (Heizmannia) chengi* Lien, 1968
137. *Heizmannia (Heizmannia) complex* (Theobald, 1910)
138. *Heizmannia (Heizmannia) covelli* Barraud, 1929
139. *Heizmannia (Heizmannia) funerea* (Leicester, 1908)
140. *Heizmannia (Heizmannia) greenii* (Theobald, 1905)
141. *Heizmannia (Heizmannia) himalayensis* Edwards, 1922
142. *Heizmannia (Heizmannia) indica* (Theobald, 1905)
143. *Heizmannia (Heizmannia) metallica* Leicester, 1908
144. *Heizmannia (Heizmannia) reidi* Mattingly, 1957
145. *Heizmannia (Heizmannia) viridis* Barraud, 1929

(ii) Subgenus Mattinglyia Lien, 1968
146. *Heizmannia* (*Mattinglyia*) *discrepans* (Edwards, 1922)
147. *Heizmannia* (*Mattinglyia*) *tripunctata* (Theobald, 1908)

XVI. Genus **Himalaius** Reinert, Harbach & Kitching, 2006
148. *Himalaius gilli* (Barraud, 1924)
149. *Himalaius simlensis* (Edwards, 1922)

XVII. Genus **Hopkinsius** Reinert, Harbach & Kitching, 2008
(i) Subgenus Yamada Reinert, Harbach & Kitching, 2008
150. *Hopkinsius (Yamada*) *albocinctus* (Barraud, 1924)

XVIII. Genus **Hulecoeteomyia** Theobald, 1904
151. *Hulecoeteomyia chrysolineata* (Theobald, 1907)
152. *Hulecoeteomyia formosensis* (Yamada, 1921)
153. *Hulecoeteomyia harveyi* (Barraud, 1923)
154. *Hulecoeteomyia pallirostris* (Edwards, 1922)
155. *Hulecoeteomyia saxicola* (Edwards, 1922)

XIX. Genus **Indusius** Edwards, 1934
156. *Indusius pulverulentus* (Edwards, 1922)

XX. Genus **Jihlienius** Reinert, Harbach & Kitching, 2006
157. *Jihlienius unicinctus* (Edwards, 1922)

XXI. Genus Kenknightia Reinert, 1990
158. *Kenknighti adissimilis* (Leicester, 1908)
159. *Kenknightia karwari* (Barraud, 1924)

XXII. Genus **Lorrainea** Belkin, 1962
160. *Lorrainea amesii* (Ludlow, 1903)
161. *Lorrainea fumida* (Edwards, 1928)

XXIII. Genus **Mucidus** Theobald, 1901
(i) Subgenus Mucidus Theobald, 1901
162. *Mucidus* (*Mucidus*) *laniger* (Wiedemann, 1820)
163. *Mucidus* (*Mucidus*) *quasiferinus* (Mattingly, 1961)
164. *Mucidus* (*Mucidus*) *scatophagoides* Theobald, 1901

XXIV. Genus **Neomelaniconion** Newstead, 1907
165. *Neomelaniconion lineatopenne* (Ludlow, 1905)

XXV. Genus **Ochlerotatus** Lynch Arribalzaga, 1891 *Sensu*
(i) Subgenus Finlaya Theobald, 1903 *Sensu auctorum*
166. *Ochlerotatus* (*Finlaya*) *auronitens* (Edwards, 1922)
167. *Ochlerotatus* (*Finlaya*) *oreophilus* Edwards, 1916
168. *Ochlerotatus (Finlaya*) *sintoni* (Barraud, 1924)
169. *Ochlerotatus* (*Finlaya*) *suffusus* (Edwards, 1922)
170. *Ochlerotatus* (*Finlaya*) *versicolor* (Barraud,1924)
171. *Ochlerotatus pulcritarsis* (Rondani, 1872)
172. *Ochlerotatus pullatus* (Coquillett, 1904)

XXVI. Genus **Paraedes** Edwards, 1934
173. *Paraedes barraudi* Edwards, 1934
174. *Paraedes chrysoscuta* (Theobald, 1910)
175. *Paraedes menoni* (Mattingly, 1958)
176. *Paraedes ostentatio* (Leicester, 1908)

XXVII. Genus **Petermattinglyius** Reinert, Harbach & Kitching, 2009
(i) Subgenus Petermattinglyius Reinert, Harbach & Kitching, 2009
177. *Petermattinglyius* (*Petermattinglyius*) *franciscoi* (Mattingly, 1959)
178. *Petermattinglyius* (*Petermattinglyius*) *iyengari* (Edwards, 1923)

XXVIII. Genus **Phagomyia** Theobald,1905
179. *Phagomyia assamensis* (Theobald, 1908)
180. *Phagomyia cacharana* (Barraud, 1923)
181. *Phagomyia cogilli* (Edwards, 1922)
182. *Phagomyia deccana* (Barraud, 1923)
183. *Phagomyia feegradei* (Barraud, 1934)
184. *Phagomyia gubernatoris* (Giles, 1901)
185. *Phagomyia inquinata* (Edwards, 1922)
186. *Phagomyia khazani* (Edwards, 1922)
187. *Phagomyia lophoventralis* (Theobald, 1910)
188. *Phagomyia prominens* (Barraud, 1923)
189. *Phagomyia stevensoni* (Barraud, 1923)

XXIX. Genus **Rhinoskusea** Edwards, 1929
190. *Rhinoskusea longirostris* (Leicester, 1908)
191. *Rhinoskusea portonovoensis* (Tewari & Hiriyan, 1992)
192. *Rhinoskusea wardi* (Reinert, 1976)

XXX. Genus **SCUTOMYIA** Theobald, 1904
193. *Scutomyia albolineata* Theobald, 1904

XXXI. Genus **Stegomyia** Theobald, 1901
(i) Subgenus Actinothrix Reinert, Harbach & Kitching, 2009
194. *Stegomyia* (*Actinothrix*) *edwardsi* Barraud, 1923
195. *Stegomyia* (*Actinothrix*) *seampi* (Huang, 1974)

(ii) Subgenus Heteraspidion Reinert, Harbach & Kitching, 2009
196. *Stegomyia* (*Heteraspidion*) *annandalei* Theobald, 1910
197. *Stegomyia* (*Heteraspidion*) *craggi* Barraud, 1923

(iii) Subgenus Huangmyia Reinert, Harbach & Kitching, 2009
198. *Stegomyia* (*Huangmyia*) *mediopunctata* Theobald, 1905
199. *Stegomyia* (*Huangmyia*) *perplexa* Leicester, 1908

(iv) Subgenus Stegomyia Theobald, 1901
200. *Stegomyia* (*Stegomyia*) *aegypti* (Linnaeus, 1762)

(v) Subgenus Xyele Reinert, Harbach & Kitching, 2009
201. *Stegomyia* (*Xyele*) *desmotes* Giles, 1904
[Subgenus unassigned yet for following]
202. *Stegomyia albopicta* (Skuse, 1895)
203. *Stegomyia flavopicta* (Yamada, 1921)
204. *Stegomyia gardnerii imitator* (Leicester, 1908)
205. *Stegomyia krombeini* (Huang, 1975)
206. *Stegomyia malayensis* (Colless, 1962)
207. *Stegomyia novalbopicta* (Barraud, 1931)
208. *Stegomyia patriciae* (Mattingly, 1954)
209. *Stegomyia pseudalbopicta* Borel, 1928
210. *Stegomyia scutellaris* (Walker, 1859)
211. *Stegomyia subalbopicta* (Barraud, 1931)
212. *Stegomyia unilineata* (Theobald, 1906)
213. *Stegomyia w-alba* Theobald, 1905

XXXII. Genus **Tewarius** Reinert, 2006
214. *Tewarius agastyai* (Tewari & Hiriyan, 1992)
215. *Tewarius nummatus* (Edwards, 1923)
216. *Tewarius reubenae* (Tewari & Hiriyan, 1992)
XXXIII. Genus **Udaya** Thurman, 1954
217. *Udaya argyrurus* (Edwards, 1934)
218. *Udaya subsimilis* (Barraud, 1927)

XXXIV. Genus **Verrallina** Theobald, 1903
(i) Subgenus Harbachius Reinert, 1999
219. *Verrallina* (*Harbachius*) *abdita* (Barraud, 1931)
220. *Verrallina* (*Harbachius*) *consonensis* (Reinert, 1973)
221. *Verrallina* (*Harbachius*) *uniformis* (Theobald, 1910)
222. *Verrallina* (*Harbachius*) *yusafi* (Barraud, 1931)

(ii) Subgenus Neomacleaya Theobald, 1907
223. *Verrallina (Neomacleaya) agrestis* (Barraud, 1931)
224. *Verrallina (Neomacleaya) andamanensis* (Edwards, 1922)
225. *Verrallina (Neomacleaya) assamensis* Bhattacharyya *et al*., 2004
226. *Verrallina (Neomacleaya) atria* (Barraud, 1928)
227. *Verrallina (Neomacleaya) cauta* (Barraud, 1928)
228. *Verrallina (Neomacleaya) clavata* (Barraud, 1931)
229. *Verrallina* (*Neomacleaya*) *comata* (Barraud, 1931)
230. *Verrallina (Neomacleaya) hirsutipleura* Barraud, 1928
231. *Verrallina (Neomacleaya) indica* (Theobald, 1907)
232. *Verrallina (Neomacleaya) pseudodiurna* (Theobald, 1910)
233. *Verrallina (Neomacleaya) pseudomediofasciata* (Theobald, 1910)
234. *Verrallina (Neomacleaya) rami* (Barraud, 1928)
235. *Verrallina* (*Neomacleaya*) *seculata* (Menon, 1950)
236. *Verrallina (Neomacleaya) vallistris* (Barraud, 1928)
237. *Verrallina (Neomacleaya) unca* (Theobald,1901)

(iii) Subgenus Verrallina Theobald, 1903
238. *Verrallina* (*Verrallina*) *butleri* (Theobald, 1901)
239. *Verrallina* (*Verrallina*) *dux* (Dyar & Shannon, 1925)
240. *Verrallina* (*Verrallina*) *lugubris* (Barraud, 1928)

Tribe: Culicini Meigen, 1818
I. Genus **Culex** Linnaeus, 1758
(i) Subgenus Barraudius Edwards, 1921
241. *Culex* (*Barraudius*) *modestus* Ficalbi, 1890

(ii) Subgenus Culex Linnaeus, 1758
242. *Culex (Culex) alienus* Colless, 1957
243. *Culex (Culex) annulus* Theobald, 1901
244. *Culex (Culex) barraudi* Edwards, 1922
245. *Culex (Culex) edwardsi* Barraud, 1923
246. *Culex (Culex) fuscifurcatus* Edwards, 1937
247. *Culex (Culex) fuscocephala* Theobald, 1907
248. *Culex (Culex) gelidus* Theobald, 1901
249. *Culex (Culex) hutchinsoni* Barraud, 1924
250. *Culex (Culex) jacksoni* Edwards, 1934
251. *Culex (Culex) mimeticus* Noe, 1899
252. *Culex (Culex) mimuloides* Barraud, 1924
253. *Culex (Culex) mimulus* Edwards, 1915
254. *Culex (Culex) murrelli* Lien, 1968
255. *Culex (Culex) nilgiricus* Edwards, 1916
256. *Culex (Culex) perexiguus* Theobald, 1903
257. *Culex (Culex) perplexus* Leicester, 1908
258. *Culex (Culex) pseudovishnui* Colless, 1957
259. *Culex (Culex) quinquefasciatus* Say, 1823
260. *Culex (Culex) sitiens* Wiedemann, 1828
261. *Culex (Culex) theileri* Theobald, 1903

262. *Culex (Culex) tritaeniorhynchus* Giles, 1901
263. *Culex (Culex) univittatus* Theobald, 1901
264. *Culex (Culex) vagans* Wiedemann, 1828
265. *Culex (Culex) vishnui* Theobald, 1901
266. *Culex (Culex) whitei* Barraud, 1923
267. *Culex (Culex) whitmorei* (Giles, 1904)

(iii) Subgenus Culiciomyia Theobald, 1907
268. *Culex (Culiciomyia) bailyi* Barraud, 1934
269. *Culex (Culiciomyia) fragilis* Ludlow, 1903
270. *Culex (Culiciomyia) harrisoni* Sirivanakarn, 1977
271. *Culex (Culiciomyia) nigropunctatus* Edwards, 1926
272. *Culex (Culiciomyia) pallidothorax* Theobald, 1905
273. *Culex (Culiciomyia) ramakrishnii* Wattal & Kalra, 1965
274. *Culex (Culiciomyia) scanloni* Bram, 1967
275. *Culex (Culiciomyia) shebbearei* Barraud, 1924
276. *Culex (Culiciomyia) spathifurca* (Edwards, 1915)
277. *Culex (Culiciomyia) viridiventer* Giles, 1901

(iv) Subgenus Eumelanomyia Theobald, 1909
278. *Culex (Eumelanomyia) brevipalpis* (Giles, 1902)
279. *Culex (Eumelanomyia) castrensis* Edwards, 1922
280. *Culex (Eumelanomyia) foliatus* Brug, 1932
281. *Culex (Eumelanomyia) hinglungensis* Chu, 1957
282. *Culex (Eumelanomyia) iphis* Barraud, 1924
283. *Culex (Eumelanomyia) khazani* Edwards, 1922
284. *Culex (Eumelanomyia) malayi* (Leicester, 1908)
285. *Culex (Eumelanomyia) mohani* Sirivanakarn, 1977
286. *Culex (Eumelanomyia) pluvialis* Barraud, 1924
287. *Culex (Eumelanomyia) tenuipalpis* Barraud, 1924

(v) Subgenus Lophoceraomyia Theobald, 1905
288. *Culex (Lophoceraomyia) aculeatus* Colless, 1965
289. *Culex (Lophoceraomyia) bengalensis* Barraud, 1934
290. *Culex (Lophoceraomyia) bicornutus* (Theobald, 1910)
291. *Culex (Lophoceraomyia) cinctellus* Edwards, 1922
292. *Culex* (*Lophoceratomyia) cubitatus* Colless, 1965
293. *Culex (Lophoceraomyia) demissus* Colless, 1965
294. *Culex (Lophoceraomyia) flavicornis* Barraud, 1924
295. *Culex (Lophoceraomyia) gracicornis* Sirivanakarn, 1977
296. *Culex (Lophoceraomyia) inculus* Colless, 1965
297. *Culex (Lophoceraomyia) infantulus* Edwards, 1922
298. *Culex (Lophoceraomyia) lasiopalpis* Sirivanakarn, 1977
299. *Culex (Lophoceraomyia) macdonaldi* Colless, 1965
300. *Culex (Lophoceraomyia) mammilifer* (Leicester, 1908)
301. *Culex (Lophoceraomyia) minor* (Leicester, 1908)
302. *Culex (Lophoceraomyia) minutissimus* (Theobald, 1907)
303. *Culex (Lophoceraomyia) paraculeatus* Sirivanakarn, 1977
304. *Culex (Lophoceraomyia) peytoni* Bram & Rattanarithikul, 1967
305. *Culex (Lophoceraomyia) pholeter* Bram & Rattanarithikul, 1967
306. *Culex (Lophoceraomyia) pilifemoralis* Wang & Feng, 1964
307. *Culex (Lophoceraomyia) quadripalpis* (Edwards, 1914)
308. *Culex (Lophoceraomyia) raghavanii* Rahman, Chowdhury & Kalra, 1968
309. *Culex (Lophoceraomyia) rubithoracis* (Leicester, 1908)
310. *Culex (Lophoceraomyia) seniori* Barraud, 1934
311. *Culex (Lophoceraomyia) singhbhumensis* Natarajan & Rajavel, 2009
312. *Culex (Lophoceraomyia) uniformis* (Theobald, 1905)
313. *Culex (Lophoceraomyia) variatus* (Leicester, 1908)
314. *Culex (Lophoceraomyia) wilfredi* Colless, 1965

(vi) Subgenus Maillotia Theobald, 1907
315. *Culex* (*Maillotia*) *hortensis* Ficalbi, 1889

(vii) Subgenus Oculeomyia Theobald, 1907
316. *Culex* (*Oculeomyia*) *bitaeniorhynchus* Giles, 1901
317. *Culex* (*Oculeomyia*) *cornutus* Edwards, 1922
318. *Culex* (*Oculeomyia*) *epidesmus* (Theobald, 1910)
319. *Culex* (*Oculeomyia*) *infula* Theobald, 1901
320. *Culex* (*Oculeomyia*) *luzonensis* Sirivanakarn, 1976
321. *Culex* (*Oculeomyia*) *sinensis* Theobald, 1903

II. Genus **Lutzia** Theobald, 1903
(i) Subgenus Metalutzia Tanaka, 2003
322. *Lutzia* (*Metalutzia*) *agranensis* Singh & Prakash, 2008
323. *Lutzia* (*Metalutzia*) *fuscana* (Wiedemann, 1820)
324. *Lutzia* (*Metalutzia*) *halifaxii* (Theobald, 1903)
325. *Lutzia* (*Metalutzia*) *vorax* Edwards, 1921

Tribe: Culisetini Belkin, 1962
I. Genus **Culiseta** Felt, 1904
(i) Subgenus *Allotheobaldia* Broelemann, 1919
326. *Culiseta* (*Allotheobaldia*) *longiareolata* (Macquart, 1838)
(ii) Subgenus Culiseta Felt, 1904
327. *Culiseta* (*Culiseta*) *alaskaensisindica* (Edwards, 1920)
328. *Culiseta* (*Culiseta*) *niveitaeniata* (Theobald, 1907)

Tribe: Ficalbiini Belkin, 1962
I. Genus **Ficalbia** Theobald, 1903
329. *Ficalbia minima* (Theobald, 1901)

II. Genus **Mimomyia** Theobald, 1903
(i) Subgenus Etorleptiomyia Theobald, 1904
330. *Mimomyia* (*Etorleptiomyia*) *luzonensis* (Ludlow, 1905)

(ii) Subgenus Ingramia Edwards, 1912
331. *Mimomyia* (*Ingramia*) *fusca* (Leicester, 1908)

(iii) Subgenus Mimomyia Theobald, 1903
332. *Mimomyia* (*Mimomyia*) *aurea* (Leicester, 1908)
333. *Mimomyia* (*Mimomyia*) *chamberlaini* Ludlow, 1904
334. *M.* ssp. *clavipalpus* (Theobald, 1908)
335. *Mimomyia* (*Mimomyia*) *hybrida* (Leicester, 1908)
336. *Mimomyia* (*Mimomyia*) *intermedia* (Barraud, 1929)

Tribe: Hodgesiini Belkin, 1962
I. Genus **Hodgesia** Theobald, 1904
337. *Hodgesia bailyi* Barraud, 1929
338. *Hodgesia malayi* Leicester, 1908

Tribe: Mansoniini Belkin, 1962
I. Genus **Coquillettidia** Dyar, 1905
(i) Subgenus Coquillettidia Dyar, 1905
339. *Coquillettidia* (*Coquillettidia*) *crassipes* (van der Wulp, 1881)
340. *Coquillettidia* (*Coquillettidia*) *novochracea* (Barraud, 1927)
341. *Coquillettidia* (*Coquillettidia*) *ochracea* (Theobald, 1903)

II. Genus **Mansonia** Blanchard, 1901
(i) Subgenus Mansonioides Theobald, 1907
342. *Mansonia* (*Mansonioides*) *annulifera* (Theobald, 1901)
343. *Mansonia* (*Mansonioides*) *dives* (Schiner, 1868)
344. *Mansonia* (*Mansonioides*) *indiana* Edwards, 1930
345. *Mansonia* (*Mansonioides*) *uniformis* (Theobald, 1901)

Tribe: *Orthopodomyia* Belkin, Heinemann & Page, 1970
I. Genus Orthopodomyia Theobald, 1904
346. *Orthopodomyia albipes* Leicester, 1904
347. *Orthopodomyia andamanensis* Barraud, 1934
348. *Orthopodomyia anopheloides* (Giles, 1903)
349. *Orthopodomyia flavicosta* Barraud, 1927
350. *Orthopodomyia flavithorax* Barraud, 1927

Tribe: Sabethini Blanchard, 1905
I. Genus **Malaya** Leicester, 1908
351. *Malaya genurostris* Leicester, 1908
352. *Malaya jacobsoni* (Edwards, 1930)

II. Genus **Topomyia** Leicester, 1908
(i) Subgenus Suaymyia Thurman, 1959
353. *Topomyia* (*Suaymyia*) *cristata* Thurman,1959

(ii) Subgenus Topomyia Leicester, 1908
354. *Topomyia* (*Topomyia*) *aureoventer* (Theobald, 1910)
355. *Topomyia* (*Topomyia*) *bifurcata* Dong,Wang & Lu,1995
356. *Topomyia* (*Topomyia*) *hirtusa* Gong,1989

III. Genus **Tripteroides** Giles, 1904
(i) Subgenus Rachionotomyia Theobald, 1905
357. *Tripteroides* (*Rachionotomyia*) *affinis* (Edwards, 1913)
358. *Tripteroides* (*Rachionotomyia*) *aranoides* (Theobald, 1901)
359. *Tripteroides* (*Rachionotomyia*) *ceylonensis* (Theobald 1905)
360. *Tripteroides* (*Rachionotomyia*) *coonorensis* Mattingly, 1981
361. *Tripteroides* (*Rachionotomyia*) *edwardsi* (Barraud, 1929)
362. *Tripteroides* (*Rachionotomyia*) *serratus* (Barraud, 1929)

(ii) Subgenus Tripteroides Giles, 1904
363. *Tripteroides* (*Tripteroides*) *indicus* (Barraud, 1929)
364. *Tripteroides* (*Tripteroides*) *powelli* (Ludlow,1909**)**
365. *Tripteroides* (*Tripteroides*) *similis* (Leicester, 1908)
366. *Tripteroides* (*Tripteroides*) *tarsalis* Delfinado & Hodges, 1968

Tribe: Toxorhynchitini Lahille, 1904
I. Genus **Toxorhynchites** Theobald, 1901
(i) Subgenus Toxorhynchites Theobald, 1901
367. *Toxorhynchites (Toxorhynchites) albipes* (Edwards, 1922)
368. *Toxorhynchites (Toxorhynchites) edwardsi* (Barraud, 1924)
369. *Toxorhynchites (Toxorhynchites) gravely* (Edwards, 1921)
370. *Toxorhynchites(Toxorhynchites)kempi* (Edwards,1921)
371. *Toxorhynchites (Toxorhynchites) klossi* (Edwards, 1921)
372. *Toxorhynchites (Toxorhynchites) metallicus* Leicester 1904
373. *Toxorhynchites (Toxorhynchites) minimus* (Theobald, 1905)
374. *Toxorhynchites (Toxorhynchites) splendens* (Wiedemann, 1819)
375. *Toxorhynchites(Toxorhynchites)tyagii* Krishnamoorthy *et al*., 2013

Tribe: Uranotaeniini Lahille, 1904
I. Genus **Uranotaenia** Lynch Arribalzaga, 1891
(i) Subgenus Pseudoficalbia Theobald, 1912
376. *Uranotaenia (Pseudoficalbia) atra* Theobald, 1905
377. *Uranotaenia (Pseudoficalbia) bicolor* Leicester, 1908
378. *Uranotaenia (Pseudoficalbia) bimaculata* Leicester, 1908
379. *Uranotaenia(Pseudoficalbia) dibrugarhensis* Bhattacharyya et al., 2004
380. *Uranotaenia (Pseudoficalbia) husaini* Qutubuddin, 1947
381. *Uranotaenia (Pseudoficalbia) luteola* Edwards, 1934
382. *Uranotaenia (Pseudoficalbia) lutescens* Leicester, 1908
383. *Uranotaenia (Pseudoficalbia) maculipleura* Leicester, 1908
384. *Uranotaenia (Pseudoficalbia) mattinglyi* Qutubuddin, 1951
385. *Uranotaenia (Pseudoficalbia) maxima* Leicester, 1908
386. *Uranotaenia (Pseudoficalbia) nivipleura* Leicester, 1908
387. *Uranotaenia (Pseudoficalbia) novobscura* Barraud, 1934
388. *Uranotaenia (Pseudoficalbia) obscura* Edwards, 1915
389. *Uranotaenia (Pseudoficalbia) ohamai* Tanaka, Mizusawa & Saugstad, 1975
390. *Uranotaenia (Pseudoficalbia) recondita* Edwards, 1922
391. *Uranotaenia (Pseudoficalbia) stricklandi* Barraud, 1926
392. *Uranotaenia (Pseudoficalbia) unguiculata* Edwards, 1913

(ii) Subgenus Uranotaenia Lynch Arribalzaga, 1891
393. *Uranotaenia (Uranotaenia) alboannulata* (Theobald, 1905)
394. *Uranotaenia (Uranotaenia) annandalei* Barraud, 1926
395. *Uranotaenia (Uranotaenia) campestris* Leicester, 1908
396. *Uranotaenia (Uranotaenia) christophersi* Barraud, 1926
397. *Uranotaenia (Uranotaenia) edwardsi* Barraud, 1926
398. *Uranotaenia (Uranotaenia) hebes* Barraud, 1931
399. *Uranotaenia (Uranotaenia) lateralis* Ludlow, 1905
400. *Uranotaenia (Uranotaenia) longirostris* Leicester, 1908
401. *Uranotaenia (Uranotaenia) macfarlanei* Edwards, 1914
402. *Uranotaenia (Uranotaenia) micans* Leicester, 1908
403. *Uranotaenia (Uranotaenia) orientalis* Barraud, 1926
404. *Uranotaenia (Uranotaenia) testacea* Theobald, 1905

3. IDENTIFICATION KEYS TO THE FOURTH INSTAR LARVAE OF MAJOR VECTORS OF PUBLIC HEALTH IMPORTANCE IN INDIA

3.1 Larval Characters Used In Identification

Head: Inner, outer and posterior clypeal hairs: They may be placed close together or with their bases widely separated; these hairs may be simple, very finely frayed, or may bear conspicuous lateral branches.

Head setae 4-C, 5-C, 6-C, and 7-C: simple, multiple branches, distance between each hairs; hypostomal sutures well developed, incomplete or absent numbers of lateral teeth on mentum.

Antenna: Size of antenna; setae 2, 3-A as long as or longer than the proximal part.

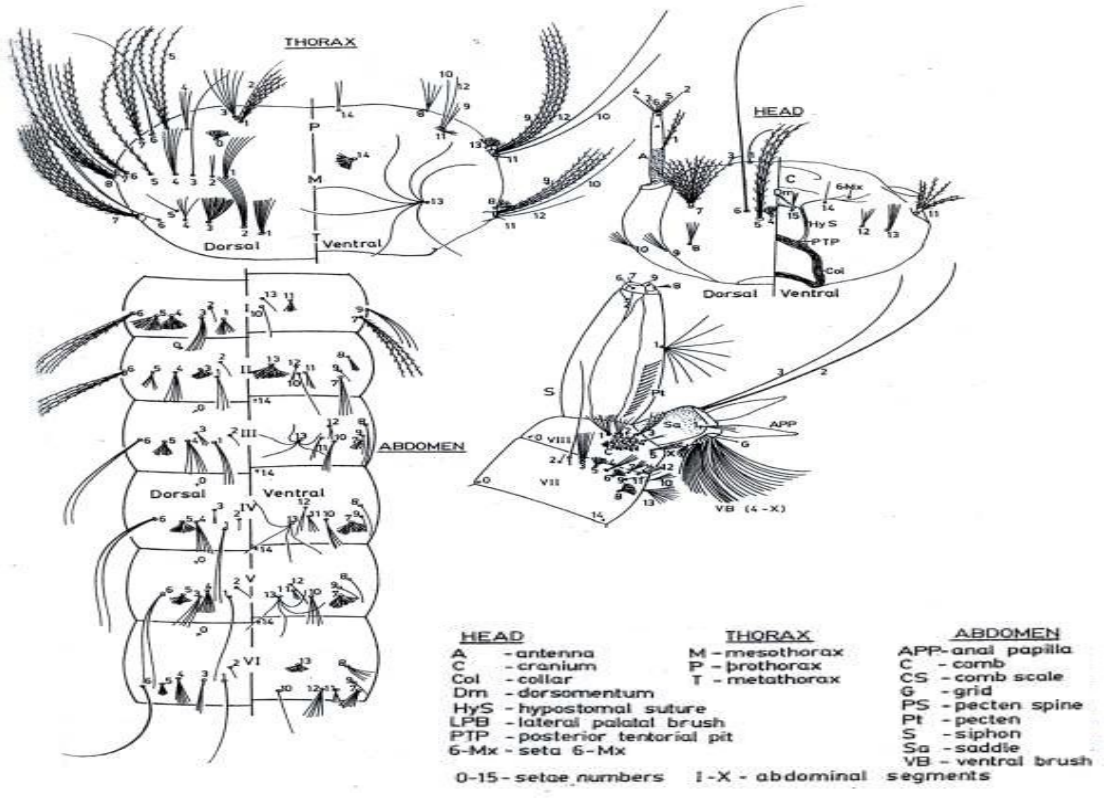
Thorax: Pleural area of thorax speculate or non speculate; hairs on Pro, Meso and Meta thoracic pleural hairs simple or pectinate.

Abdomen: Size of the anterior tergal plates; presence or absence of palmate hairs; number and rows of comb scales; presence or absence of sclerotized comb plate; size and shape of individual comb scales.

Siphon: Presence or absence of siphon and pecten teeth; size of the siphon; number of sub ventral setae; siphonal valves simple or modified.

Saddle: Ventral brush (4x) single or with many pairs.

3.2 Morphology of Fourth Instar Larva



3.3 Identification key for Genera

1. Respiratory siphon absent; abdominal seta 1 palmate, on

at least on segments IV-VII (Fig.1)..... *Anopheles*
Respiratory siphon present; abdominal seta 1
never palmate (Fig.4a). 2

2(1). Lateral palatal brush (mouth brush) with 10 thick curved, simple filaments; antenna with setae 2, 3-A arising basad of seta 1-A (Fig.2 a, b), comb scales and pecten absent…..... *Toxorhynchites*

Lateral palatal brush with numerous fine setae; antenna with setae 2,3-A distad of 1-A (Fig. 3), comb scales always present; pecten present or absent……. 3

3(2). Ventral bush (4-X) with a single pair of setae; siphon with two or (usually) more sub-dorsal setae as well as various ventral and sub-ventral setae;
antenna short, without articulated apical segment (Fig. 4 a, b) ……..…….. 4

Without this combination or characters, ventral brush (4-X)
with 3 or more pairs of setae (Fig.15a) .....……..…….. 6

4(3). Thoracic setae 5,6-P large, fan shaped tufts arising from a common tubercle (Fig. 5); 6-M and 7-T never stout spines;
comb usually a patch of scales in two or more rows……..……...…….. 5

Thoracic seta 6-M and / or seta 7-T often a
stout spine (Fig. 6); comb scales in single row, sometimes
arising from a sclerotized plate scale…….....…… *Tripteroides*

Legends to the Figures (1-6)
Fig.1 - Abdomen seta-1 palmate
Fig.2a - Mouth brush
Fig.2b - Setae 2,3-A position
Fig.3 - Setae 2,3-A position
Fig.4a - Ventral brush (4-X)
Fig.4b - Antenna short
Fig.5 - Thoracic setae 5,6-P
Fig.6 - Setae 6-M & setae 7-T

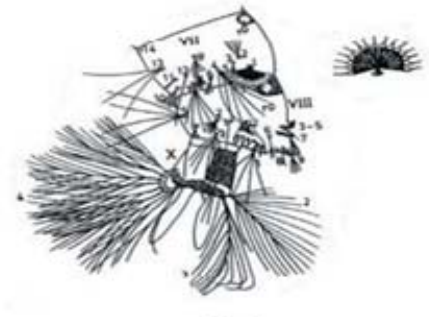


Fig. 1


Fig. 2a

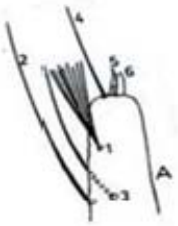


Fig. 2b


Fig. 3

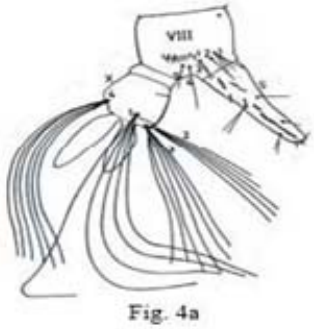


Fig. 4a


Fig. 4b


Fig. 5


Fig. 6

5(4). Abdominal segments V-VI with one or more pairs of stellate setae with numerous, short, stiff branches; maxillae with conspicuous horn; siphon at least 6times as long as saddle (Fig.7a,b,c) ……..... *Topomyia*

Maxillary horn absent; abdominal segments V-VI never with stellate setae; siphon at most 4 times as long as saddle (Fig. 8)……..... *Malaya*

6(3). Siphonal valves modified for piercing tissues of aquatic plants with sclerotized saw-toothed process at tip (Fig.9a). 7
Siphon not so modified or, if so, without any saw-toothed process……..……. 8

7(6). Antenna with part distal to setae 2,3-A flexible, as long as or longer than the proximal part (Fig.9b)…..……..…….....….. *Coquillettidia*
Antenna with part distal to setae 2,3-A not flexible, less than 0.5 of the proximal part (Fig.9c)…….....….....*Mansonia*

8(6). Antenna broad flattened; some thoracic setae enormously long, others stellate; tip of siphon with paired hooks and branched setae (Fig.10a, b, c)……..……..…..…… *Aedeomyia*
Antenna, thoracic setae and siphon otherwise ……..……..…..... 9

Legends to the Figures (7-10)

Fig. 7a - Stellate setae in abdominal segments V-VI Fig.
Fig.7b - Maxillary horn
Fig.7c - Long siphon
Fig. 8: Short siphon
Fig.9a - Modified siphon
Fig.9b - Setae 2,3-A length
Fig.9c - Setae 2,3-A length
Fig.10a - Antenna broad flattened
Fig.10b - Long thoracic setae
Fig.10c - Siphon with hooks

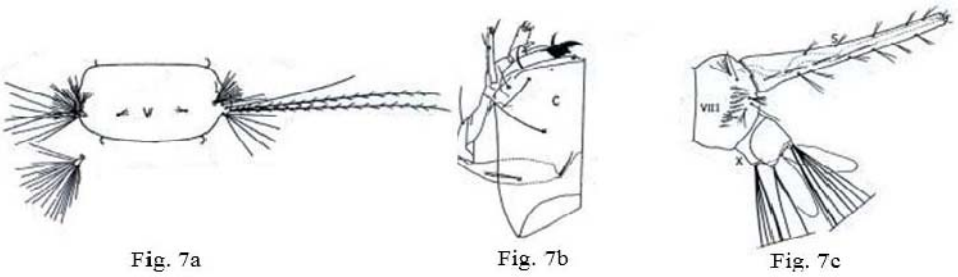


Fig. 7a Fig. 7b Fig. 7c

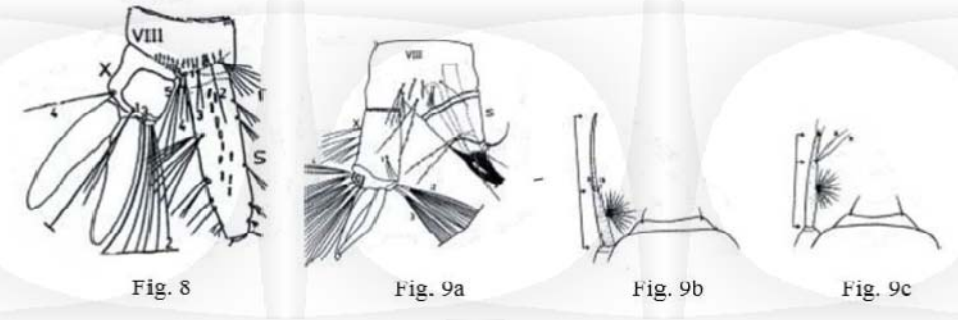


Fig. 8 Fig. 9a Fig. 9b Fig. 9c

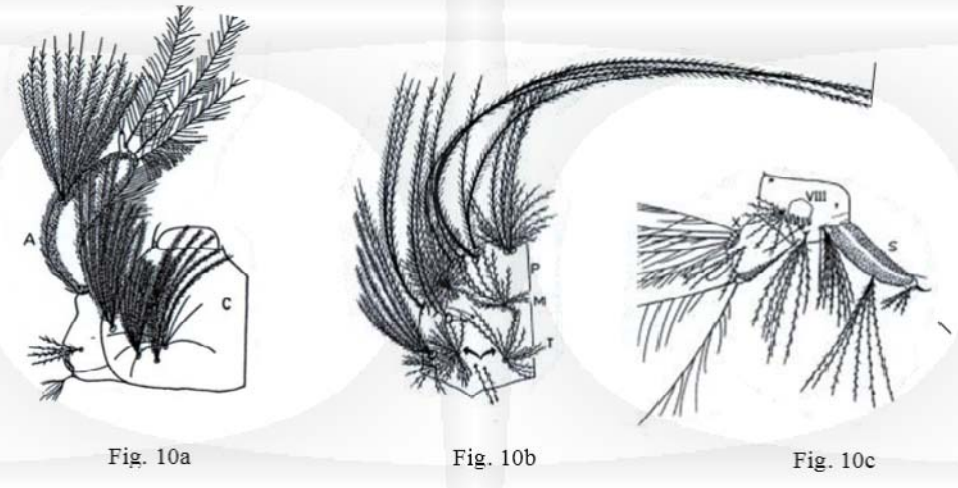


Fig. 10a Fig. 10b Fig. 10c

9(8) Siphon with a single pair of sub-ventral setae arising at not more than 0.2 of the distance from base; comb in a single row of at most 20 scales; siphon as long as saddle (Fig.11a)……..... 10
Without this combination of characters ……..…... 11

10(9). Pecten with at least 3 teeth, usually more; Seta 1-C simple; Seta 6-C single, long; Seta 4-C nearly as long as 5-C (Fig. 11a,b)...……..*Hodgesia*
Head seta 1-C strongly barbed; pecten with at most 2 teeth (Fig. 12a, b).....….....*Ficalbia*

11(9). Distal portion of antenna freely articulated, setae 2,3-A attached at joint; siphon with a single pair of sub-ventral setae (Fig. 13a,b); pecten absent or sometime present; ventral brush with 2-4 pairs of setae .....….....…….....*Mimomyia*

Antenna never thus; siphons often otherwise; ventral brush with at least 3 pairs of setae, often with 5 or more pairs ……..…….. 12

12(11). Pecten absent; siphon very short and broad with a single pair of sub-ventral setae arising beyond half way; antennal seta 1-A minute (Fig.14a, b) ...……..... *Armigeres*

Without this combination of characters ……..…… 13

13(12). Pecten absent; siphon very long, with a single pair of sub-ventral setae; ventral brush with 6 pairs of setae or more; antennal seta 1-A arising on basal half, with 4 or more branches (Fig.15a,b) .....*Orthopodomyia*

Without this combination of characters ……..…… 14

14(13). Siphon with a single pair of sub-ventral setae arising not less than 0.25 distances from base. …… 15

Siphon with several pairs of sub-ventral setae or if with a single pair then arising about 0.2 distances from the base…….. 18

Legends to the Figures (11-15)

Fig.11a - Sub-ventral setae
Fig. 11b: Seta 6-C
Fig.12a - Head seta 1-C
Fig. 12b: Pecten teeth
Fig.13a - Position of setae 2,3-A
Fig.13b - Siphon with single pair of sub-ventral setae
Fig.14a - Pecten absent
Fig. 14b: Seta 1-A minute
Fig.15a - Long siphon with sub-ventral setae
Fig.15b - Seta 1-A with 4 or more branches

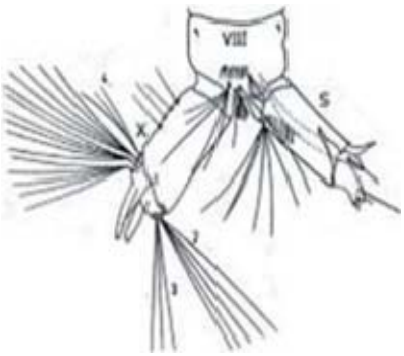


Fig. 1la

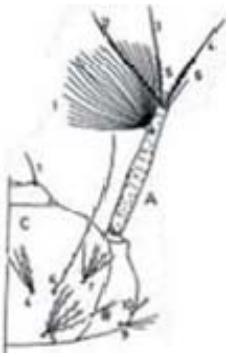


Fig. 1lb

Fig. 12a

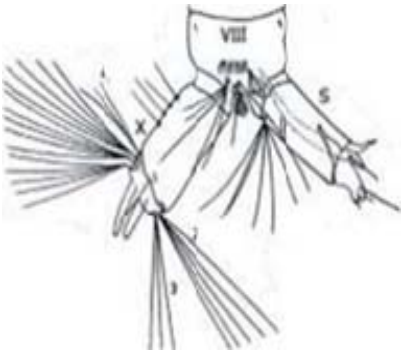


Fig. 12b

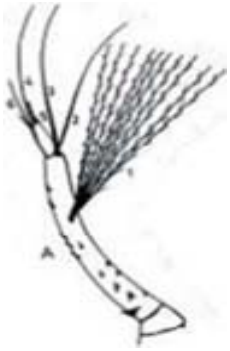


Fig. 13a

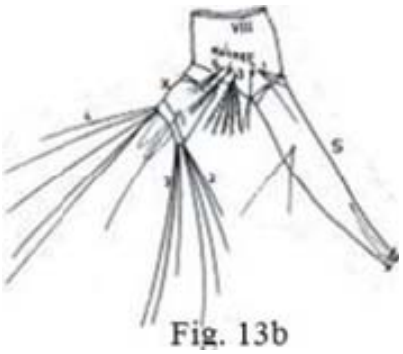


Fig. 13b

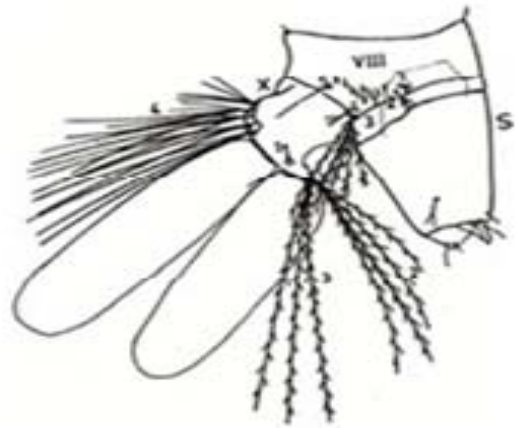


Fig. 14a

Fig. 14b

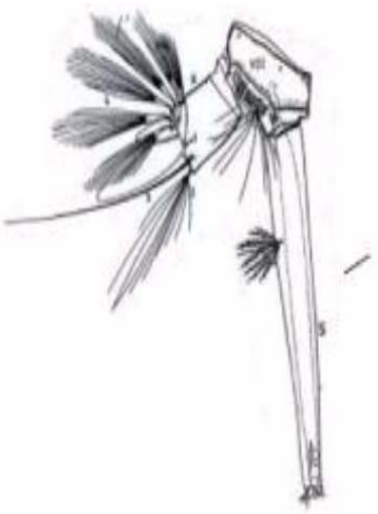


Fig. 15a

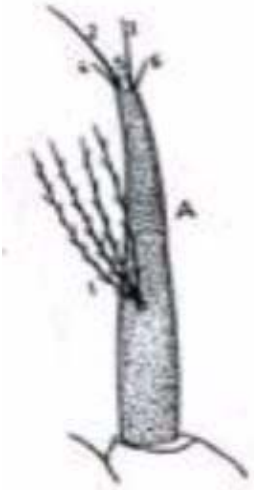


Fig. 15b

15(14). Hypostomal sutures absent or incomplete, not reaching posterior tentorial pit; head setae 5-C or 6-C or both sometimes spine like; comb often arising from a large sclerotized plate (Fig 16 a,b) …….*Uranotaenia*

Hypostomal sutures well developed, extending from the level of the mentum to the posterior tentorial pit; head setae 5-C or 6-C never spine like(Fig.17a); comb plate, if present, smaller……....16

16(15). Comb with at most 10 teeth, in a single row; head seta 5-C single, 4,6-C shorter than 5-C, with 2 or more delicate branches, 7-C single and much longer than any of these (Fig.17b,c). ……..…….....*Udaya*
Without this combination of characters……..……. 17

17(16). Head seta 4-C large multiple branch subequal in size to 7-C; 6-C with 2 unequal branches (Fig.18a); 7-C at least 5 branched; thoracic integument without spicules; comb plate absent; saddle incomplete…….....*Heizmannia*

Head seta 4-C small variously branched, less than 0.5 length of 7-C; 6-C single or with two equal branches; Seta 4-C closer to 6-C than to 5-C (Fig. 18b) ...…….....*Aedes*

18(14). Siphon with a single pair of sub-ventral setae arising near the base (Fig.19)…….…….....*Culiseta*

Siphon with several pairs of sub-ventral setae (Fig. 20)…….....*Culex*

Legends to the Figures (16-20)

Fig.16a - Hypostomal sutures absent
Fig.16b - Sclerotized comb plate
Fig.17a - Well developed hypostomal sutures
Fig.17b - Comb scales
Fig. 17c: Seta 7-C long
Fig.18a - Seta 6-C with unequal branches
Fig.18b - Seta 4-C
Fig.19 - Single pair of sub-ventral setae
Fig.20 - Several pairs of sub-ventral setae

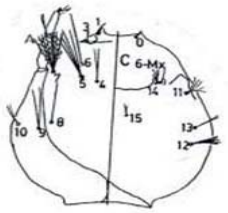


Fig. 16a

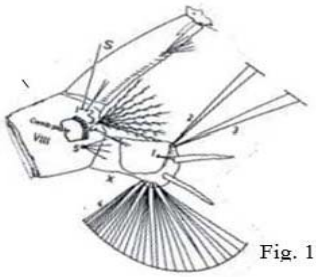


Fig. 16b

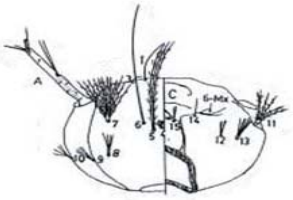


Fig. 17a

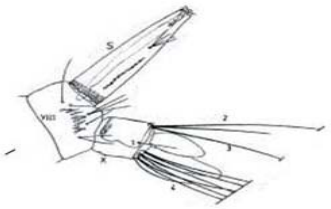


Fig. 17b

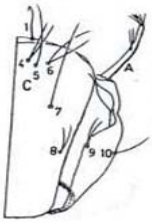


Fig. 17c

Fig. 18a

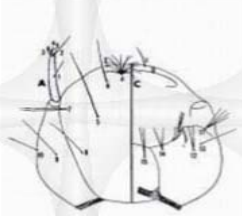


Fig. 18b

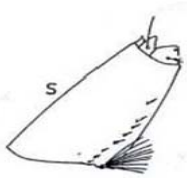


Fig. 19

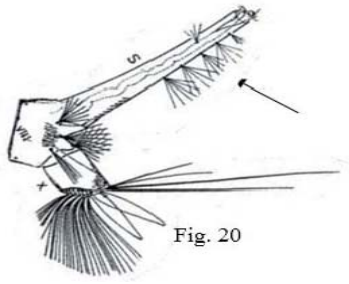


Fig. 20

3.4 Vectors of Japanese Encephalitis

Japanese encephalitis (JE) was first recognized in Japan during 1871. This neurotrophic killer disease is caused by JE virus (JEV), the member of the genus flavivirus under the family flaviviridae. It is a disease of major public health importance due to its high epidemic potential, high case fatality rate and neurological sequelae among survivors. Approximately 3 billion people (40% of the world's population) live in JE endemic regions. The world-wide incidental scenario of JE is 30,000 - 50,000 cases per year, with the estimated mortality about 10,000 per year, whereas about 30% of survivors develop serious permanent neuropsychiatric problems. JE is among the most important viral encephalitis in Asia, especially in rural and suburban areas where rice culture and pig farming coexist. It has also occurred rarely and sporadically in northern Australia and parts of the Western Pacific. The incidence of encephalitis has been reported in several southeast Asian countries, including India, affecting mainly children <12 years of age. It is rapidly increasing and spreading to other part of the world. Now, it has become the most epidemic disease worldwide. In India, the first JE case was identified in Tamil Nadu in 1955, since the infection has spread to Bihar, Uttar Pradesh, Assam, Manipur, Andhra Pradesh, Karnataka, Madhya Pradesh, Maharashtra, Tamil Nadu, Haryana, Kerala, West Bengal, Orissa and union territories of Goa and Pondicherry, etc. An epidemic of viral encephalitis was reported from July through November 2005 in Gorakhpur, Uttar Pradesh, India. It was the longest and most severe epidemic in 3 decades; 5,737 persons were affected in 7 districts of eastern Uttar Pradesh, and 1,344 persons died. In year 2011, around 891 people, including 508 in Uttar Pradesh alone and 200 in Bihar, died due to encephalitis.

The JEV can only be spread by the bite of an infected mosquito. Mosquitoes become infected soon after they bite infected pigs and other amplifying host such as birds. After a person is bitten by an infected mosquito, it usually takes 5 – 15 days for the first symptoms to appear, such as headache, high fever, convulsions and coma. Of these severe cases approximately one third die and another one third are left with permanent disabilities. There is no specific treatment, though there is a vaccine for protection against JE

3.4.1 Vectors in India

1. *Culex (Culex) tritaeniorhynchus*
2. *Culex (Culex) vishnui*
3. *Culex (Culex) pseudovishnui*
4. *Culex (Culex) gelidus*
5. *Culex (Culex) fuscocephala*
6. *Culex (Culex) quinquefasciatus*
7. *Culex (Culex) whitmorei*
8. *Culex (Oculeomyia) epidesmus*
9. *Culex (Oculeomyia) bitaeniorhynchus*
10. *Culex (Oculeomyia) infula*
11. *Mansonia (Mansonioides) indiana*
12. *Mansonia (Mansonioides) annulifera*
13. *Mansonia (Mansonioides) uniformis*
14. *Anopheles (Anopheles) peditaeniatus*
15. *Anopheles (Anopheles) barbirostris*
16. *Anopheles (Cellia) subpictus*

3.4.2 Key to the Japanese encephalitis vector mosquito larvae (IVth Instar)

1. Seta 1-A present at mid length; median labral plate not distinguished completely, fused with dorsal apotome (Fig 21)..…….…… Subgenus *Oculeomyia*

   Pecten restricted to basal half of siphon; ventral brush (4-X) consists of 10 or more hair tufts; precratal setae absent; thoracic seta 3-P always single, as long and as thick as 1-P (Fig. 22a, b) …..... Subgenus *Culex* (2)

2(1). Median labral plate of head capsule separated from dorsal apotome as a distinct transverse bar (Fig. 23a)…….……..3

   Median labral plate of head capsule not separated from dorsal apotome (Fig. 24)……..…….12

3(2). Seta 1-C pale, slender and distally strongly tapered and filamentous (Fig.23a)…….……...4

   Seta 1-C dark, stout, spiniform and abruptly pointed or blunt apically (Fig. 23b)……...……...……5

4(3). Setae 5, 6-C double; mentum with 6,7 lateral teeth on each side of central tooth (Fig.23a, c); siphon slender, more or less cylindrical, and distally tapered..... *fuscocephala*
   Setae 5,6-C with 4-6 branches ; mentum with 10-12 lateral teeth on each side of central tooth; siphon short, fusiform, and basal half strongly swollen (Fig.25a,b)..... *quinquefasciatus*

5(3). Abdominal seta 7-I double…….……..…..……6
   Abdominal seta 7-I single…….……...……7

6(5). Seta 6-C double; siphon brownish, slender, ventral valve of spiracular apparatus small, siphonal tufts weak, with 2-5 branches; individual comb scales, apically rounded (fan shaped) fringed with subequal spicules (Fig. 26 a, b, c)..... *tritaeniorhynchus*

   Seta 6-C triple; siphon yellowish, thick; ventral valve of spiracular apparatus large (Fig.27)..... *whitei* & *barraudi*

Legends to the Figures (21-27)

Fig.21 - Pecten teeth
Fig.22a - Pecten teeth
Fig.22b - Seta 3-P –single
Fig.23a - Transverse bar
Fig.23b - Seta 1-C
Fig.23c – Mentum
Fig.24 - No transverse bar
Fig.25a - Mentum
Fig.25b - Fusiform siphon
Fig.26a - Seta 6-C double
Fig.26b - Weak siphonal tufts
Fig.26c - Fan shaped comb scales
Fig.27 - Seta 6-C triple

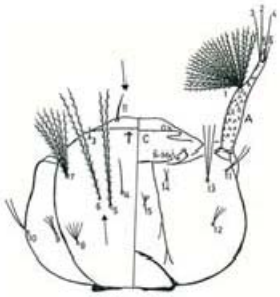


Fig. 23a

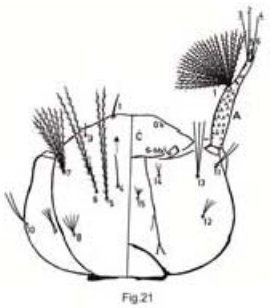


Fig.21

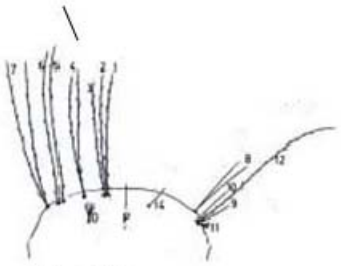


Fig. 22b

Fig. 24

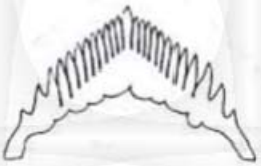


Fig. 25a

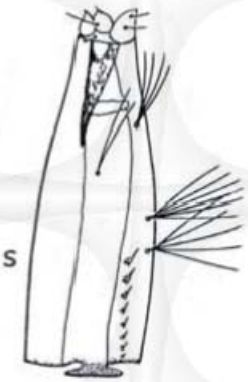


Fig. 25b

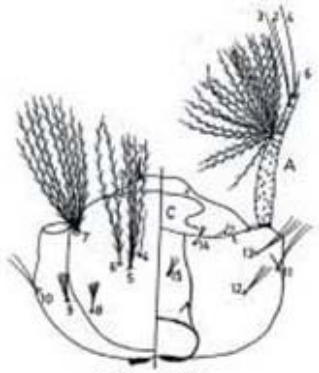


Fig. 26a

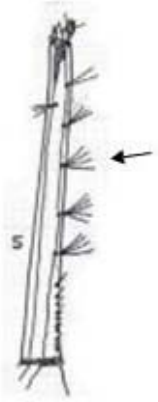


Fig. 26b

Fig. 26c

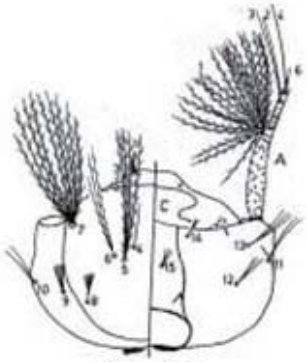


Fig. 27

7(5) Siphon short, fusiform, distinctly swollen in middle (Fig.28).....*gelidus*

Siphon long, cylindrical (Fig. 32a)……8

8(7). Seta 4-P double or multiple (Fig.29)……..……...…….9

Seta 4-P single (Fig.30); siphon with some prominent spines on ventral surface of apical half ..... *jacksoni*

9(8) Comb scales usually with 4-8, large spiniform scales more or less in a single row……..10

Comb scales small, with 16-20 or more, in 3 or 4 rows……...11

10(9). Siphon strongly tapered and up-curved distally; siphonal tufts very strong with 2-3 barbed branches (Fig. 31);
4-P always double .....*whitmorei*

Siphon moderately tapered, slightly curved apical; siphonal tufts weaker with 4-6 branches; comb scale very large with long and strong apical spine,4-P double or multiple (Fig. 32a, b)..... *pseudovishnui*

11(9). Pleural areas of thorax spiculate; comb scales about 22, pointed apically with strong apical spine (Fig. 33a, b); seta 5-C usually
double or triple; 6-C double .....*vishnui*

Pleural areas of thorax not spiculate; comb scales about 40 or more rounded apically with even fringe of fine spicules (Fig.34),
seta 5-C branched (4-6); 6-C triple.....*mimuloides*

12(2). Setae 2,3-A located halfway between apex
and base of seta 1-A; seta 4-P short and minute, rather indistinct; Siphon with 4 or 5 pairs of sub-ventral tufts (Fig.35a,b,c) .....*sinensis* and *cornutus*

Setae 2,3-A sub-apical or closer to apex than to base of
seta 1-A; seta 4-P strong and distinct (Fig. 36a, b)……13

13(12). Siphon usually with 4 pairs of sub-ventral tufts (Fig.37) .....*bitaeniorhynchus*
Siphon usually with 3 pairs of sub-ventral tufts (Fig.38) .....*infula*

Legends to the Figures (28-38)

Fig.28 - Short siphon
Fig.29 - Seta 4-P double
Fig.30 - Seta 4-P single
Fig.31 - Barbed siphonal tufts
Fig.32a - Long cylindrical siphon
Fig.32b - Comb scales
Fig.33a - Spiculate thorax
Fig.33b - Comb scales
Fig.34 - Comb scales
Fig.35a - Setae 2,3-A
Fig.35b - Seta 4-P minute
Fig.35c - Sub-ventral tufts
Fig.36a - Setae 2,3-A
Fig.36b - Seta 4-P
Fig.37 - 4 pairs of sub-ventral tufts
Fig.38 - 3 pairs of sub-ventral tufts

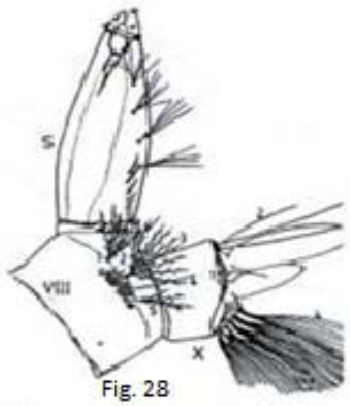


Fig. 28


Fig. 29

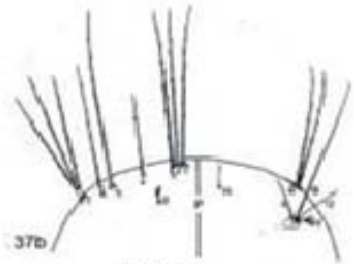


Fig. 30

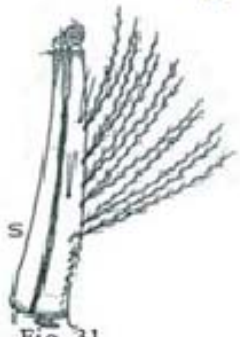


Fig. 31

Fig. 32a

Fig. 32b

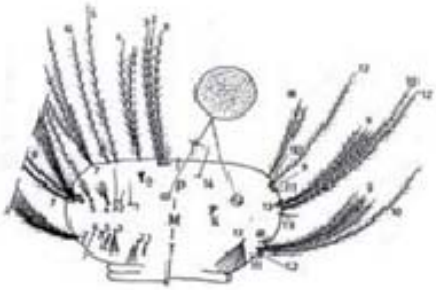


Fig. 33a

Fig. 33b

Fig. 34

Fig. 35a

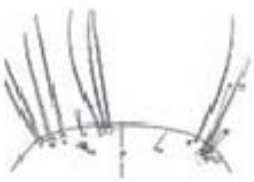


Fig. 35b

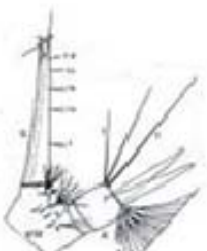


Fig. 35c

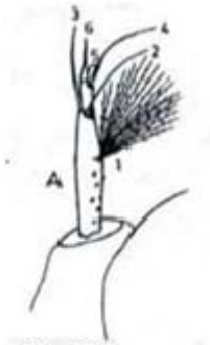


Fig. 36a

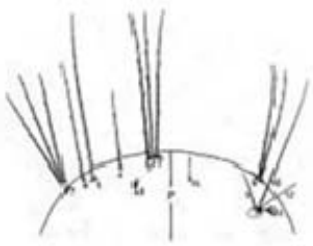


Fig. 36b

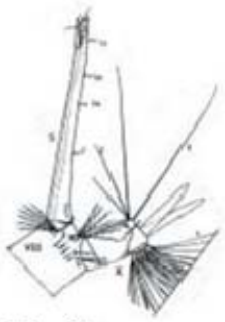


Fig. 37

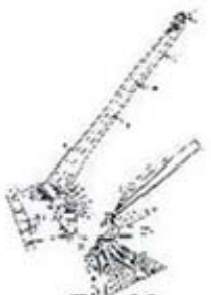


Fig. 38

1. Bases of inner clypeal hairs much closer to one another than to outer clypeal hairs; antennal hair branched or simple(Fig.39).....….....Subgenus *Anopheles* (2)

   Bases of inner clypeal hairs wide apart and closer to the bases of outer clypeal hairs; antennal hair simple (Fig.40)..…….……...Subgenus *Cellia* (3)

2(1). Outer clypeal hairs profusely branched forming a tuft; seta 1-P with many branches arising very near the base (Fig.41a, b).....*barbirostris*

   Outer clypeal hairs profusely branched forming a tuft; seta 1-P simple or bifid (Fig.42).....*peditaeniatus*

3(1). Posterior clypeal hair placed not very close to inner clypeal hair; mosothoracic hair 4 most often with 2 branches (Fig. 43a,b).....……..……..... *subpictus*

   Posterior clypeal hair placed not very close to inner clypeal hair; mosothoracic hair 4 most often with 3 branches (Fig.44) ….....……..... *sundaicus*

Legends to the Figures (39-44)

Fig.39 - Inner clypeal hairs- closure
Fig.40 - Inner clypeal hairs – wider
Fig.41a - Outer clypeal hairs with tuft
Fig.41b - Seta 1-P with many branches
Fig.42 - Seta 1-P simple
Fig.43a - Position of posterior clypeal hairs
Fig.43b - 4-M with 2 branches
Fig.44 - 4-M with 3 branches

Fig. 39

Fig. 40

Fig. 41a

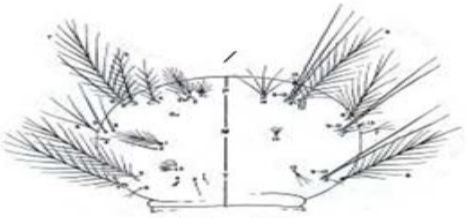


Fig. 41b

Fig. 42

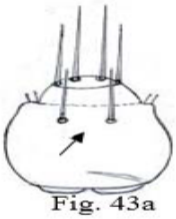


Fig. 43a

Fig. 43b

Fig. 44

1. Siphon without pecten; siphonal valves modified for piercing tissues of aquatic plants with sclerotized saw toothed process at tip; (Fig.45)..... *Mansonia*

1a. Setae 2,3-A long and not reaching very beyond end of antenna; basal half of antenna darkened; setae 6,7-C with 6-7 branches without barbed; seta 7-C distally split into 2or 3 branches (Fig.46 a,b).....*annulifera*

1b. Setae 2,3-A long and reaching beyond end of antenna; antenna with a dark ring at base and another at level of origin of hair tuft; setae 6,7-C barbed with 7-9 branches (Fig.47 a, b).....*uniformis* & *indiana*

Legends to the Figures (45-47)

Fig.45 - Modified siphon
Fig.46a - Basal half of antenna darkened
Fig.46b - Seta 7-C distally split
Fig.47a - Antenna with two dark rings
Fig.47b - Seta 6,7-C barbed

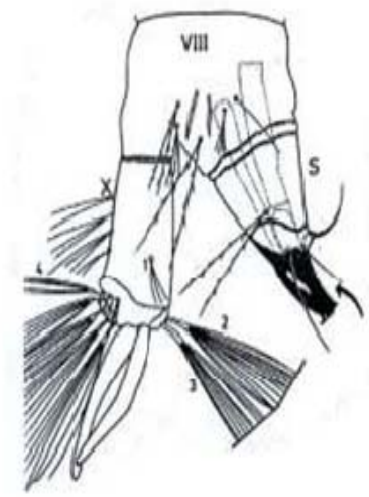


Fig. 45

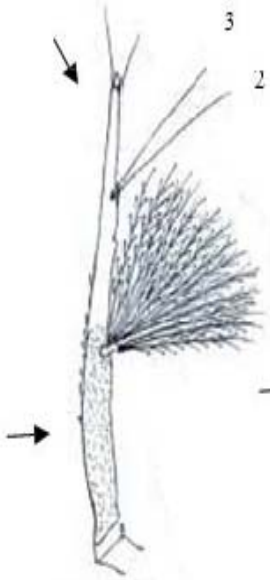


Fig. 46a

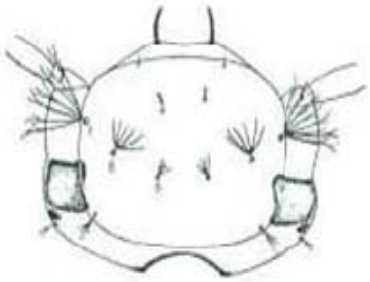


Fig. 46b

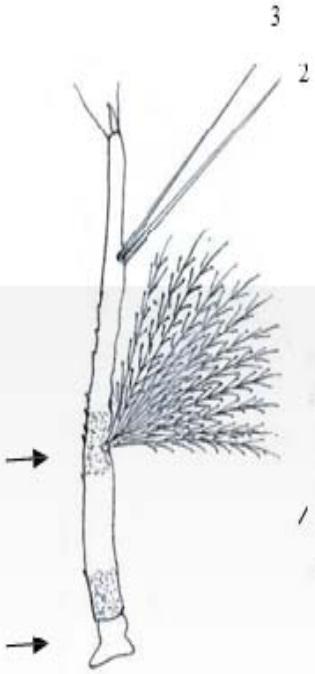


Fig. 47a

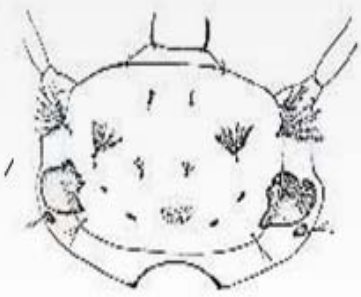


Fig. 47b

3.5 Vectors of Lymphatic Filariasis

Lymphatic filariasis, commonlsy known as elephantiasis, is a neglected tropical disease. Infection occurs when filarial parasites are transmitted to humans through mosquitoes. The painful and profoundly disfiguring visible manifestations of the disease, lymphoedema, elephantiasis and scrotal swelling occurring during lifetime lead to permanent disability. These patients are not only physically disabled, but suffer mental, social and financial losses contributing to stigma and poverty.

Currently, more than 1.4 billion people in 73 countries are living in areas where lymphatic filariasis parasite is transmitted and are at risk of being infected. Globally, an estimated 25 million men suffer with genital disease and over 15 million people are afflicted with lymphoedema. In response, WHO launched its Global Programme to Eliminate Lymphatic Filariasis (GPELF) in 2000 with the aim of eliminating the disease as a public- health problem. In 2012, the WHO NTD Roadmap reconfirmed the target date for achieving elimination by 2020.

WHO's strategy is based on 2 key components:

(i) stopping transmission through large-scale annual treatment of all eligible people in an area or region where infection is present; and

(ii) alleviating the suffering caused by lymphatic filariasis through increased morbidity management and disability prevention activities

There are 3 types of thread-like filarial worms:

Wuchereria bancrofti
Brugia malayi, and
Brugia timori

Lymphatic filariasis is transmitted by different types of mosquitoes:

Culex quinquefasciatus
Mansonia uniformis
Mansonia annulifera
Aedes niveus (sub-periodic filariasis in Andaman & Nicobar Islands)

3.5.1 Key to the Lymphatic Filariasis vector mosquito larvae (IVth Instar)

1. Pecten restricted to basal half of siphon; ventral brush (4-X) consists of 10 or more hair tufts; prerectal setae absent; thoracic seta 3-P always single, as long and as thick as 1-P (Fig.48a, b) ..... Subgenus Culex (2)

   Siphon without pecten; siphonal valves modified for piercing tissues of aquatic plants with sclerotized saw toothed process at tip; (Fig.49)..... Genus *Mansonia* (3)

2(1). Setae 5, 6-C double; mentum with 6,7 lateral teeth on each side of central tooth (Fig.50a, b); siphon slender, more or less cylindrical, and distally tapered..... *fuscocephala*

   Setae 5,6-C with 4-6 branches; mentum with 10-12 lateral teeth on each side of central tooth; siphon short, fusiform; basal half strongly swollen (Fig.51a, b).....*quinquefasciatus*

3(1). Setae 2,3-A long and not reaching very beyond end of antenna; basal half of antenna darkened; setae 6,7-C with 6-7 branches without barbed; seta 7-C distally split into 2or 3 branches (Fig. 52a,b).....*annulifera*

   Setae 2,3-A long and reaching beyond end of antenna; antenna with a dark ring at base and another at level of origin of hair tuft; setae 6,7-C barbed with 7-9 branches (Fig.53 a,b).....*uniformis* & *indiana*

Diurnally subperiodic filariasis vector in Andaman & Nicobar Islands

1. Head seta 4-C small, variously branched, less than 0.5 length of 7-C; 6-C single or with two equal branches; Seta 4-C closer to 6-C than to 5-C (Fig. 54) ..... genus Aedes

1a. Ventral brush (4-X) with 5 pairs of setae; 12-16 comb scales arranged in a single row; individual comb scales pointed, fringed almost to apex, pecten uniformly pigmented with 15-22 spines (Fig. 55a, b)…….....…….....*nivea**

**Downsiomyia nivea (=Aedes* (*Finlaya*) *niveus)*

Legends to the Figures (48-55)

Fig.48a - Ventral brush with 10 or more tufts Fig. 48b: Seta 3-P single
Fig.49 - Modified siphon Fig. 50a: Setae 5,6-C double Fig. 50b: Mentum
Fig.51a – Mentum
Fig.51b - Siphon strongly swollen
Fig.52a - Basal half of antenna darkened Fig. 52b: Seta 7-C distally split
Fig.53a - Antenna with two dark rings Fig. 53b: Seta 6,7-C barbed
Fig.54 - Position of seta 4-C Fig. 55a: Ventral brush
Fig.55b - Comb scales and pecten teeth

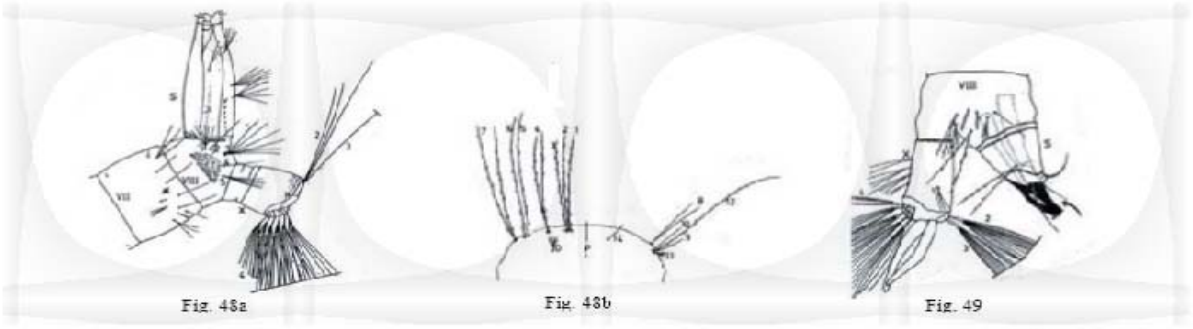


Fig. 48a

Fig. 48b

Fig. 49

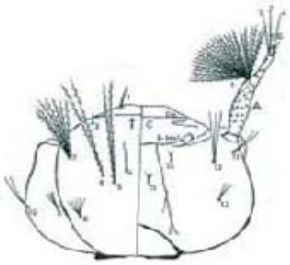


Fig.50a

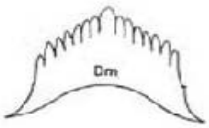


Fig. 50b

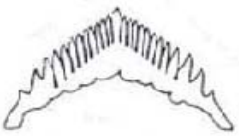


Fig. 51a

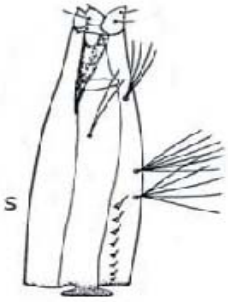


Fig. 51b

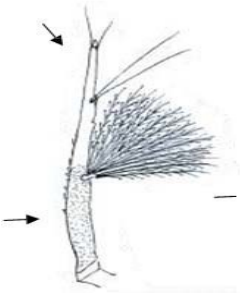


Fig. 52a


Fig. 52b

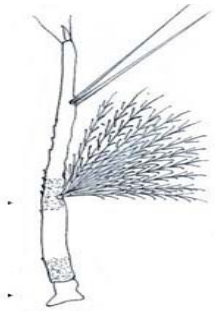


Fig. 53a

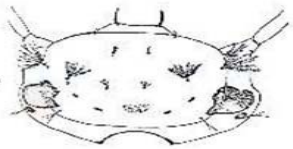


Fig. 53b

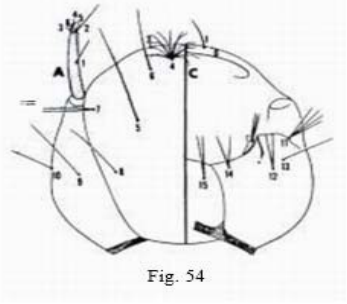


Fig. 54

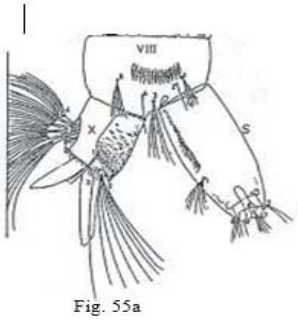


Fig. 55a

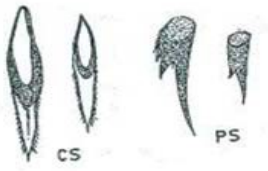


Fig. 55b

3.6 Vectors of Dengue /Chikungunya

Dengue

Dengue is a mosquito borne viral infection. The infection is found in both tropical and subtropical climates, mostly in urban and semi-urban areas. Worldwide, 2.5 billion people in more than 100 countries are at risk of contracting dengue alone. WHO currently estimates that there may be 50-100 million dengue infections worldwide every year. There is no specific treatment for dengue and dengue hemorrhagic fever, but early detection and access to proper medical care lowers fatality rate. There are four distinct but closely related serotype of the virus that causes dengue (DEN-1, DEN-2, DEN-3 & DEN-4). *Aedes aegypti* mosquito is the primary vector of dengue virus, although in rural sylvatic ecosystems *Ae. albopictus* can transmit dengue virus as a major vector.

Chikungunya

Chikungunya fever is a viral disease transmitted to humans by the bite of infected mosquitoes. Chikungunya virus was first isolated from the blood of febrile patient in Tanzania in 1953. *Aedes aegypti* is the primary vector of Chikungunya virus to humans. *Aedes albopictus* plays a secondary role in human transmission. There is no vaccine or preventive drug currently available.

Aedes aegypti is a highly anthropophilic mosquito and breeds in man-made containers. *Ae. albopictus* is another important dengue vector in Asia and is mostly rural in nature. At present the only method to control or prevent the transmission of dengue/chikungunya virus is to combat vector mosquitoes through community participation by preventing mosquitoes from accessing egg laying habitats through;

1. Environmental management and ecosystem modification,
2. Removing artificial man-made habitats,
3. Covering, emptying and cleaning of domestic water storage containers on a weekly basis, and
4. Using personal household protection measures such as window screens, long sleeved clothes and insecticide treated materials (coils, vaporizers and repellents).

3.6.1 Vectors in India

Aedes aegypti (= *Stegomyia aegypti*)
Aedes albopictus (= *Stegomyia albopicta*)

3.6.2 Key to the Dengue/Chikungunya vector mosquito larvae (IVth Instar)

1. Head seta 4-C small variously branched, less than 0.5 length of 7-C; 6-C single or with two equal branches; Seta 4-C closer to 6-C than to 5-C (Fig. 56) ...…….....*Stegomyia*

1a. Ventral brush (4-X) with five pairs of setae each with two branches; Pecten scales usually 8-20, each scales with 1-4 basal denticles: comb scales with distinct large median spine with strong and stout lateral denticles (Fig. 57).....…….....…..…..…..…..…..…..*aegypti*

1b. Ventral brush (4-X) with four pairs of setae each with single; Pecten scales 8-14, each scales with 2 main basal denticles: comb scales with fringed denticles at the base of apical spine (Fig. 58).....…..…..…..…..…..…..*albopicta*

Legends to the Figures (56-58)

Fig. 56 - Position of seta 4-C
Fig. 57 - Ventral brush with 5 pairs each with 2 branches
Fig. 58 - Ventral brush with 4 pairs each single

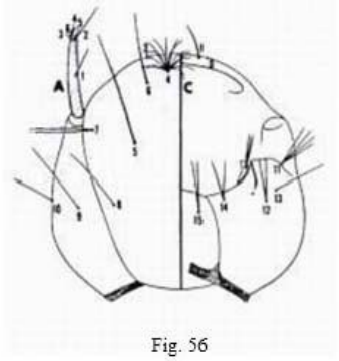


Fig. 56

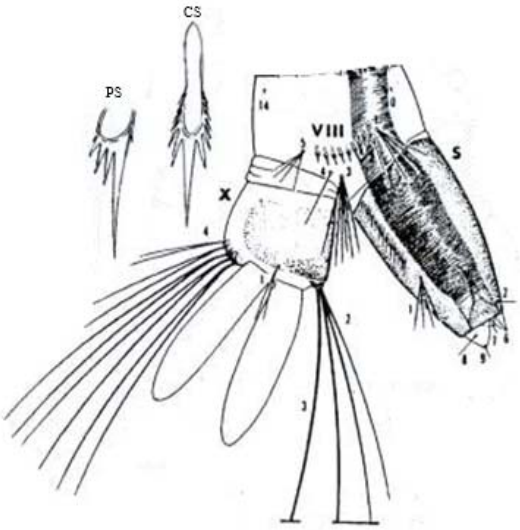


Fig. 57

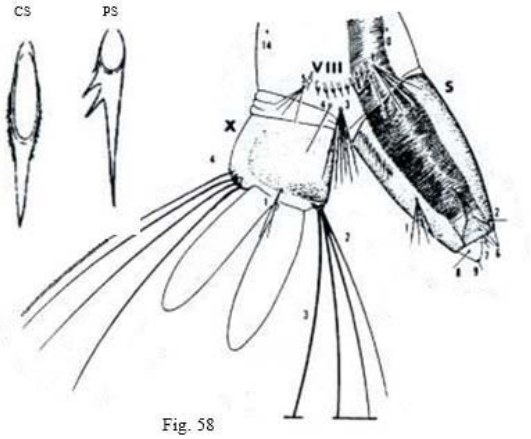


Fig. 58

3.7 Vectors of Malaria

Malaria continues to be one of the most important infectious diseases worldwide. About 350 million cases of malaria occur worldwide, affecting 97 countries and killing over one million people annually48. In 2012, malaria killed an estimated 4,82,000 children (<5 years of age), i.e., 1300 children every day or one child almost every minute. The disease causing parasite is transmitted by anopheline mosquitoes, particularly in the tropics.

There are four species of parasites that cause malaria in humans-
Plasmodium falciparum, Plasmodium vivax, Plasmodium malariae and *Plasmodium ovale*.

Malaria control methods that aim to reduce vector populations by targeting their aquatic immature stages are gaining ground. Most studies focus on the adult stage of malaria vectors, and surprisingly few studies are directed to understand the biology and ecology of aquatic immature stages. The development and nutrition during these immature stages determine the abundance, dynamics and fitness of the adults, and, as a consequence, malaria transmission. This field based hand book will be helpful to better understand the larval characters of malaria vectors, which will pave the way for effective vector control operations. At present there are 20 different anopheline species which are important around the world. In India, seven primary vectors are playing a major role in the transmission of malaria.

3.7.1 Major Malaria vectors in India:

1. *Anopheles (Cellia) culicifacies*
2. *Anopheles (Cellia) stephensi*
3. *Anopheles (Cellia) fluviatilis*
4. *Anopheles (Cellia) minimus*
5. *Anopheles (Cellia) sundaicus*
6. *Anopheles (Cellia) baimaii (= dirus D)*
7. *Anopheles (Cellia) philippinensis*

3.7.2 Key to the Malaria vector mosquito larvae (IVth Instar)

1. Bases of inner clypeal hairs much closer to one another than to outer clypeal hairs; antennal hair branched or simple(Fig. 59).....Subgenus *Anopheles*

Bases of inner clypeal hairs wide apart and closer to the bases of outer clypeal hairs; antennal hair simple (Fig. 60)…….....….Subgenus *Cellia* (2)

2(1). Anterior tergal plates on abdominal segments III-VII very wide, and enclose the rounded median chitinous spot posteriorly (Fig. 61)….....……..……..……..…..3

Anterior tergal plates on abdominal segments III-VII not very wide and never enclosing the rounded median chitinous spot (Fig.62)…..…….....……..……5

3(2). Inner and outer clypeal hairs simple (Fig. 60)…..……..……4

Inner and outer clypeal hairs with short scattered branches (Fig.63)….....….. *aconitus*

4(3). A pair of minute hairs arising from the tergal plate on segments II –VIII (Fig.64)…….....…….....…*varuna*

The pair of minute hairs not arising from the tergal plate but lying external and a little posterior to the plate on each side(Fig. 65)…….....……...……*minimus and fluviatilis*

5(2). Inner and outer clypeal hair simple or with short in inconspicuous lateral fraying .....……..……6

Inner and outer clypeal hair with conspicuous lateral branches (Fig. 66)……..……..……..……..……..12

6(5). Mesothoracic pleural hairs all simple, with two long hairs (Fig. 67) ….....…… 7

One of the long mesothoracic pleural hair pectinate others simple (Fig. 68)…….....……..10

Meso and metathoracic pleural hairs all simple (Fig. 69)…....……...……..…11

Legends to the Figures (59-69)

Fig.59 - Inner clypeal hairs – closure
Fig.60 - Inner clypeal hairs - wider
Fig.61 - Anterior tergal plates
Fig.62 - Anterior tergal plates
Fig.63 - Inner and outer clypeal hairs
Fig.64 - Minute hairs in tergal plate
Fig.65 - Minute hairs not in tergal plate
Fig.66 - Inner and outer clypeal hairs with branches
Fig.67 - Mesothoracic hairs simple
Fig.68 - Mesothoracic hair with pectinate
Fig.69 - Meso and metathoracic hairs simple

Fig. 59

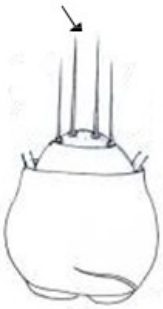


Fig. 60

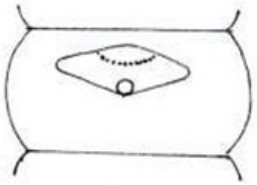


Fig. 61

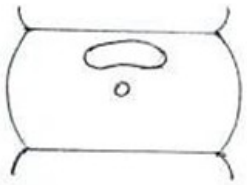


Fig. 62

Fig. 63

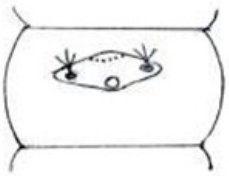


Fig. 64

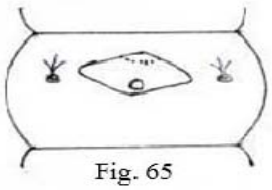


Fig. 65

Fig. 66

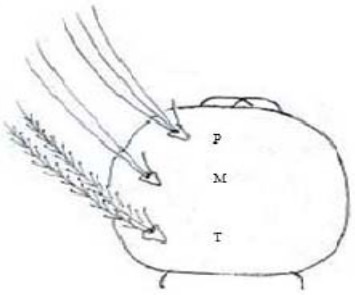


Fig. 67

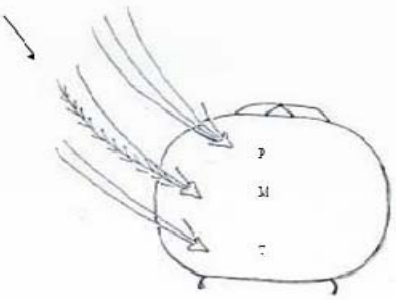


Fig. 68

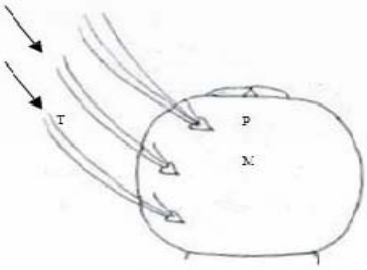


Fig. 69

7(6). Both the long metathoracic pleural hairs pectinate (Fig. 70);
palmate hair on thorax not differentiated 8

One of the long metathoracic pleural hair pectinate others simple (Fig. 71); palmate hair on thorax well differentiated 9

8(7). Posterior clypeal hair short, and placed very close to
inner clypeal hair (Fig.72).....*vagus*

Posterior clypeal hair placed not very close to inner clypeal hair; mesothoracic hair 4 most often with 3 branches (2-4) from near the base (Fig.73a, b) ..... *sundaicus*

Posterior clypeal hair placed not very close to inner clypeal hair; mesothoracic hair 4 most often with 2 branches (1-3)from near the base (Fig.73a, 74) ..... *subpictus*

9(7). Filaments of abdominal palmate hairs about half as long
as the blades of leaflets; Seta 9-T with few branches, 10-T simple; only the end of outer
submedio-dorsal caudal hairs curved to form hooks, the branches of inner hairs,
fine and straight (Fig.75a, b, c)…..……..……..……*culicifacies*

Filaments of abdominal palmate hairs about half as long
as the blades of leaflets; both the ends of inner and outer
submedio- dorsal caudal hairs curved to form hooks,
the branches of inner hairs stout (Fig.75a, 76)…..……..……..……..……*d'thali*

Legends to the Figures (70-76)

Fig.70 - Both the metathoracic hairs pectinate
Fig.71 - Single metathoracic hair pectinate
Fig.72 - Position of posterior clypeal hair
Fig.73a - Position of posterior clypeal hair
Fig.73b - Seta 4-M with 3 branches
Fig.74 - Seta 4-M with 2 branches
Fig.75a - Filaments of palmate hair
Fig.75b - Seta 9-T with few branches
Fig.75c - Outer submedio-dorsal caudal hairs
Fig.76 - Inner & outer submedio-dorsal caudal hairs

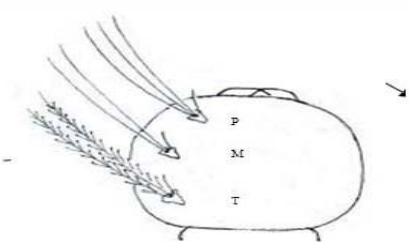


Fig. 70

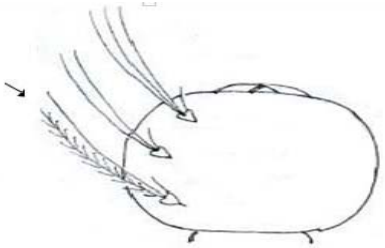


Fig. 71

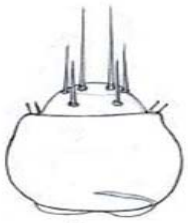


Fig. 72

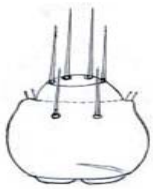


Fig. 73a


Fig. 73b

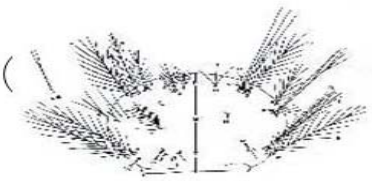


Fig. 74


Fig. 75a


Fig. 75c

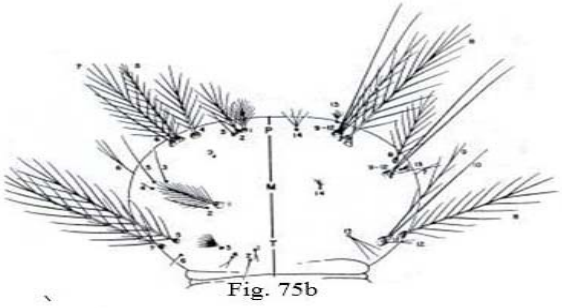


Fig. 75b

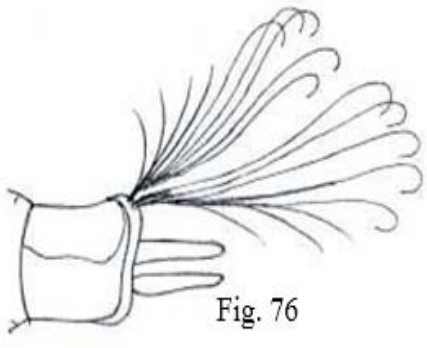


Fig. 76

10(6). Outer clypeal hairs always simple; abdominal seta 1-I with
3-5 branches; setae 9,10-T both branched (Fig.77a, b)……..……..…..*stephensi*

Inner and outer clypeal hairs finely frayed; filamentous
of abdominal seta 1 with sharp point; Seta 6-III with
20 or more branches(Fig.78) …..…….…….....…….....*maculatus*

11(6). Seta 1-P with 2-5 branches; abdominal seta 1-II
with filamentous branches (Fig.79a,b)…..……..*tessellatus*
Innermost sub median prothoracic hair (1-P) with more than
four branches arising from a large root (Fig.80).....……..*baimaii* (=*dirus D*)

12(5). Outer clypeal hairs with a large no. of long branches forming a broom like tuft; posterior clypeal hairs with
2-5 branches; filament of palmate hairs more than half or
as long as blade of leaflet (Fig.81a, b)…….....…….…….*pallidus*

Outer clypeal hairs with a large no. of long branches
forming a broom like tuft; posterior clypeal hairs
with 7-10 branches; filament about ¼ length
of leaflet (Fig.82a, b)……..……..…….....……..…….*philippinensis*

Legends to the Figures (77-82)
Fig.77a - Abdominal seta 1-I with 3-5 branches
Fig.77b - Setae 9,10-T both branched
Fig.78 - Seta 6-III with 20 or more branches
Fig.79a - Seta 1-P with 2-5 branches
Fig.79b - Abdominal seta 1-II with many branches
Fig.80 - 1-P with more than 4 branches
Fig.81a - Posterior clypeal hairs with 2-5 branches
Fig.81b - Filaments of palmate hair
Fig.82a - Posterior clypeal hairs with 7-10 branches
Fig.82b - Filaments of palmate hair

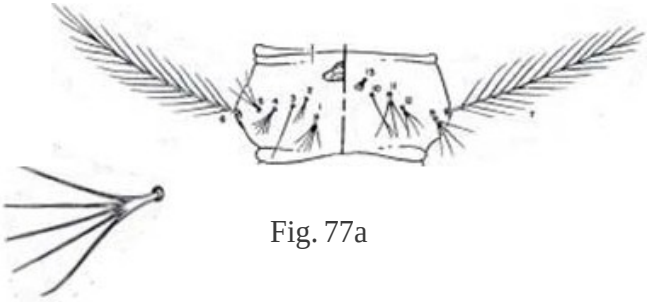


Fig. 77a

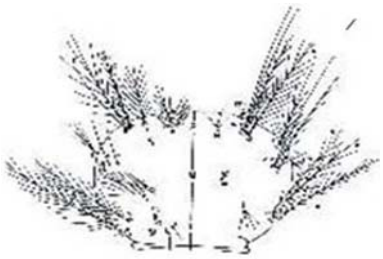


Fig. 77b

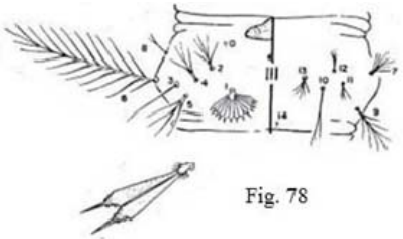


Fig. 78

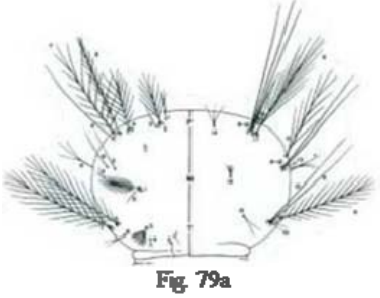


Fig. 79a

Fig. 79b

Fig. 80

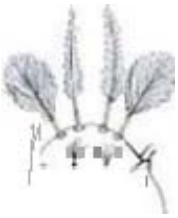


Fig. 81a

Fig. 81b

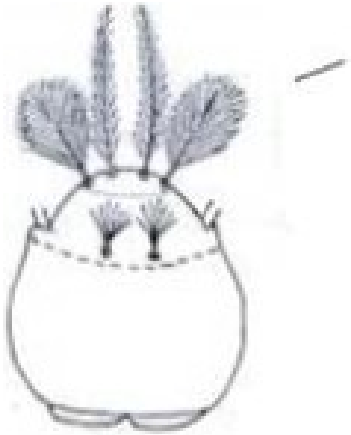


Fig. 82a

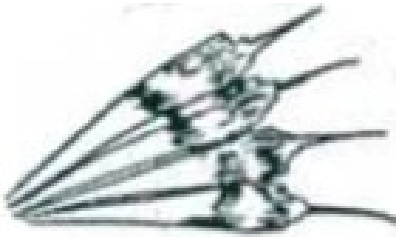


Fig. 82b

4. IDENTIFICATION KEYS TO THE FEMALES OF MAJOR VECTORS OF PUBLIC HEALTH IMPORTANCE IN INDIA

4.1 FEMALE ADULT CHARACTERS USED IN IDENTIFICATION

Head: Character and coloration of scaling, and arrangement of bristles; erect, narrow and broad scales on vertex.

Antenna: Coloration of torus, and presence or absence of scales; length of antenna compared with that of proboscis.

Clypeus: Shape; presence or absence of scales.

Palpi**:** Length, shape, ornamentation, tips of palpi dark or white; palpi with 3 or 4 pale bands; with or without speckling.

Proboscis**:** Ratio of palpi and proboscis, size and shape, pale rings; pale patches on ventral surface.

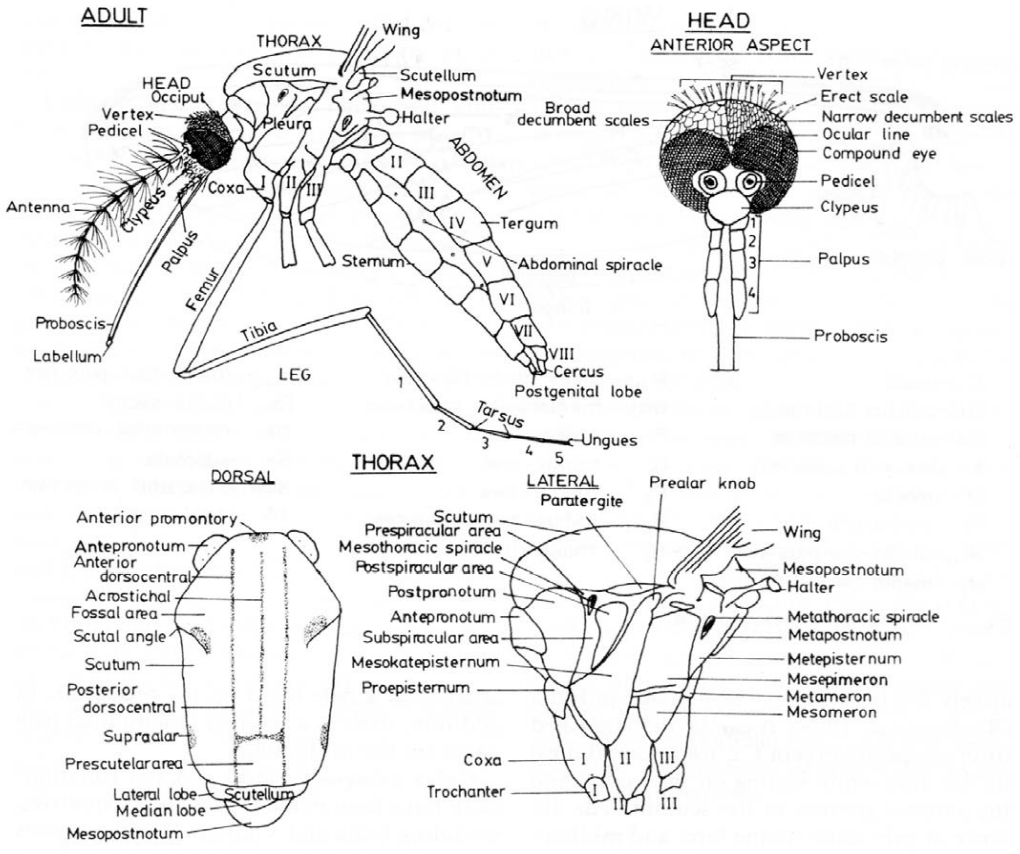
Thorax: Shape, with or without pale markings (ornamentation); with or without scale patches in antepronotum and postpronotum; postspiracular area with our without scales or setae, and shape of scutellum.

Legs: With or without speckling, especially presence or absence of pale rings or bands on tarsal segments, if present whether basal or apical, or both; comparative length of tibia and of tarsal segments; ornamentation of the legs is usually in connection with the tarsal segments. They may be uniformly dark, or they may be marked with white or pale bands at the joints; tarsal claws, whether toothed or simple; presence or absence of pulvilli.

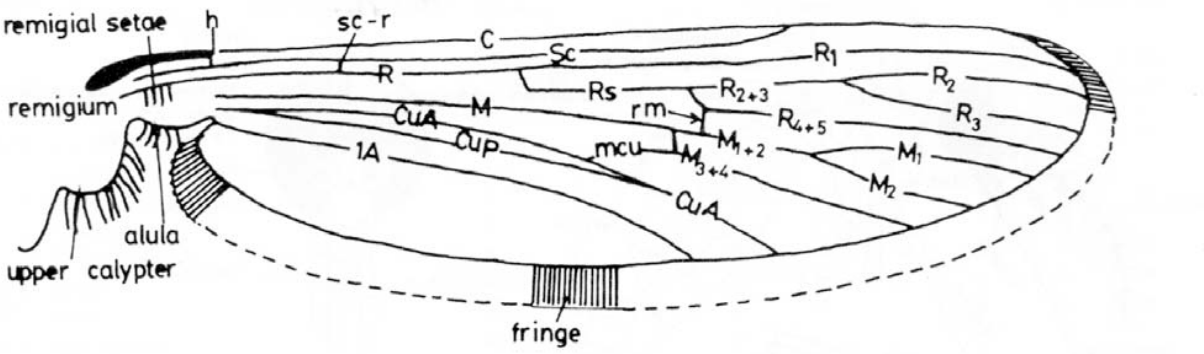
Wings**:** Venation or arrangement of veins; venation and spotting of wing; shape of scales on veins; length of wing from base of costa to tip; presence or absence of hairs or scales on upper calypter and alula.

Abdomen**:** The abdomen consists of eight visible segments. The first segment usually forms a somewhat transverse bar dorsally carrying long, outstanding hairs. The dorsal surface or dorsum is called as tergites and ventral surface or venter is called as sternites; with or without basal or apical, or both pale bands.

4.2 Morphology of Female Mosquito



Main body parts



C -costa	M_{3+4} - media-three-plus-four	R_{4+5} - radius four-plus-five
CuA - cubitus anterior	mcu - mediocubital crossvein	Rs -radial sector
CuP - cubitus posterior	R - radius	rm -radiomedial crossvein
h -humeral crossvein	R_1 - radius - one	Sc -subcosta
M -media	R_2 - radius - two	sc-r -subcostal crossvein
M_1 -media-one	R_{2+3} - radius - two-plus-three	1A -anal vein
M_{1+2} -media-one-plus-two	R_3 - radius - three	
M_2 -media-two		

Wing

4.3 Identification key for Genera harbouring species of public health importance in India

1. Scutellum evenly rounded; palpus about equal to the length of proboscis (Fig.1, 1a); abdomen with sterna and usually terga largely or wholly devoid of scales ..... ***Anopheles***

   Scutellum trilobed; palpus short (Fig. 2, 2a); abdominal sterna and terga with dense, uniform covering of scales …….....……...……..... 2

2(1). Postspiracular setae present, or fore ungues toothed, or both (Fig. 3, 3a) 3
Postspiracular setae absent; ungues simple (Fig. 4, 4a) 5

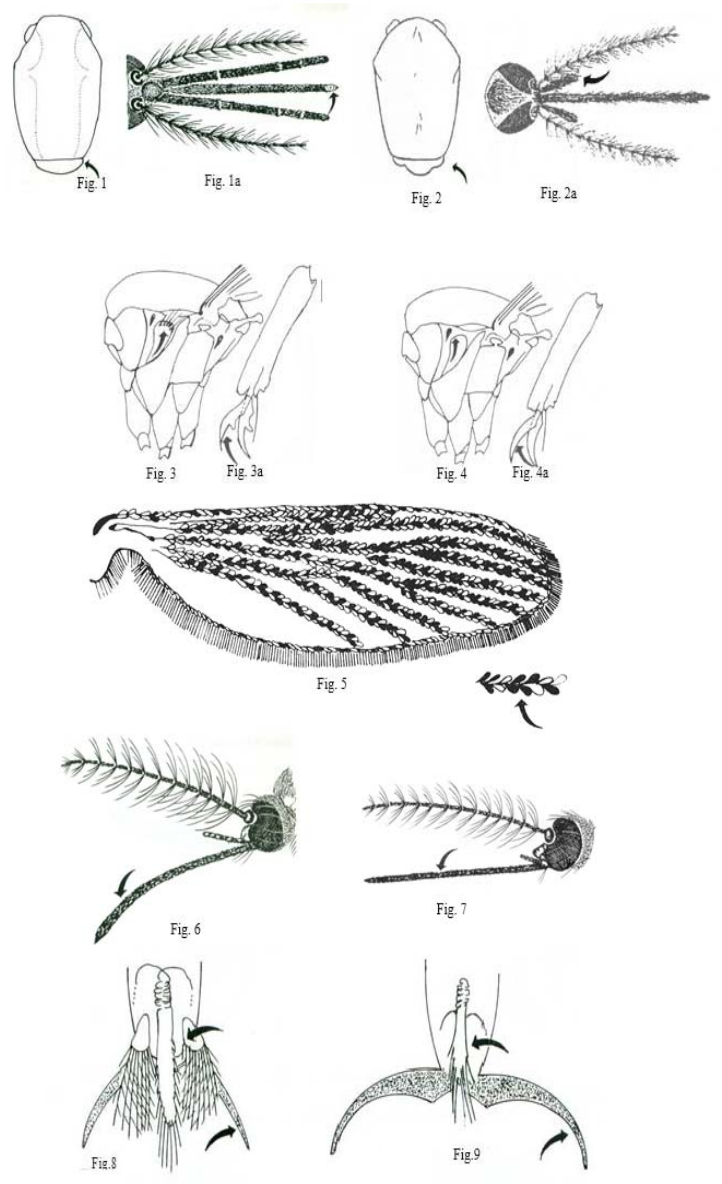
3(2). Wing with broad, often asymmetrical scales; dark and pale scales intermixed (Fig.5)..... ***Mansonia***
Wing with normal scales 4

4(3). Proboscis curved and laterally compressed (Fig .6)..... ***Armigeres***
Proboscis slender and usually straight, never laterally compressed (Fig.7)..... ***Aedes***

5(2). Hindtarsi with ungues very small and inconspicuous; pulvilli present (Fig. 8) ..... ***Culex***
Hindtarsi with ungues not very small; pulvilli absent (Fig. 9); yellow or yellowish brown mosquitoes..... ***Coquillettidia***

Legends to the Figures (1-9)

Fig. 1 - *Anopheles* scutellum
Fig. 1a - *Anopheles* palpi and proboscis
Fig. 2 - *Culicine* scutellum
Fig. 2a - *Culicine* palpi and proboscis
Fig. 3 - pleuron with postspiracular setae
Fig. 3a - toothed fore ungues
Fig. 4 - pleuron without spiracular setae
Fig. 4a - untoothed fore ungues
Fig. 5 - wings with asymmetrical scales
Fig. 6 - laterally compressed proboscis
Fig. 7 - slender proboscis
Fig. 8 - pulvilli present
Fig. 9 - pulvilli absent



4.4 Key to Vectors of Japanese Encephalits

Lower mesepimeral setae absent or 1, 2 weak ones; pleuron with distinct pale scale patches on at least upper and lower mesokatepisternum and anterior mesepimeron (Fig.10)……..……..... ..... subgenus *Culex*

Wing heavily/moderately speckled with pale scale; abdominal terga II-VI with apical bands and/or apicolateral pale patches and basal pale bands (Figs. 24-26)……...……..(Subgenus *Oculeomyia*)

1. Proboscis and tarsi without pale rings;
   1 or 2 lower mesepimeral setae present (Figs. 11,12)……...2

   Proboscis and tarsi with pale rings;
   lower mesepimeral setae absent (Figs. 13, 14).....4

2(1). Abdominal terga without pale bands, occasionally a few indistinct bands on posterior segments; pleuron with striking pattern of dark and pale stripes (Figs. 15, 16).....*fuscocephala*

Legends to the Figures (10-16)

Fig. 10 - pleuron with pale scale patches
Fig. 11 - proboscis without pale ring
Fig. 12 - with lower mesepimeral setae
Fig. 13 - proboscis with pale ring
Fig. 14 - without lower mesepimeral setae
Fig. 15 - abdomen terga without pale band
Fig. 16 - pleuron with dark and pale stripes

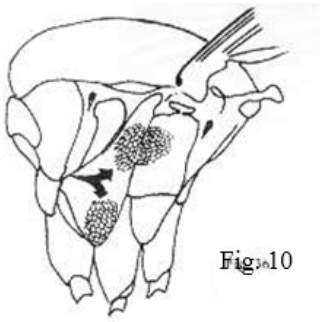


Fig. 10

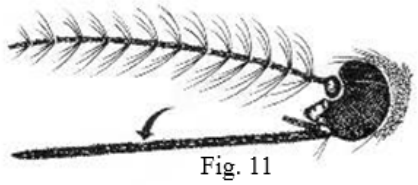


Fig. 11

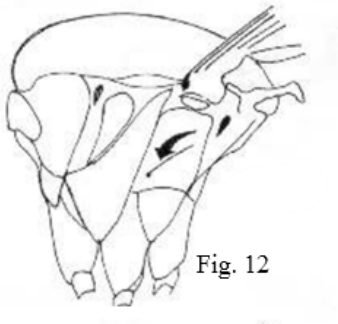


Fig. 12

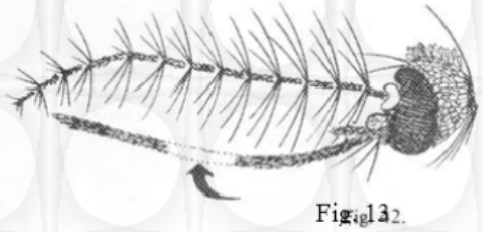


Fig. 13

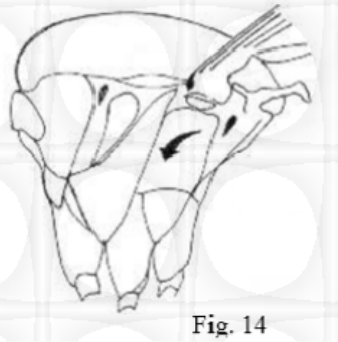


Fig. 14

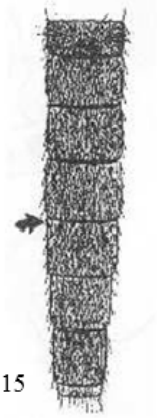


Fig. 15

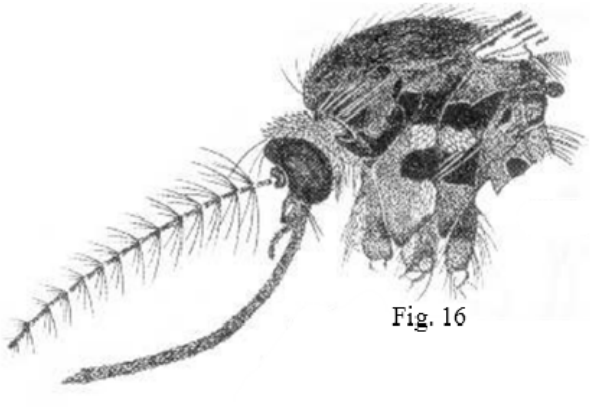


Fig. 16

Abdominal terga with basal pale bands; pleuron without striking pattern of dark
and pale stripes (Figs. 17, 18)……...……...……...…. 3

3(2). Postspiracular area with pale scale patch (Fig. 19)……..…….....*perexiguus*
Postspiracular area without pale scale patch (Fig.20) ….....……..…….*quinquefasciatus*

4(1). Wing with pale spots on at least 2 areas of costa and
1 area of other veins (Fig. 21).....….....Mimeticus Subgroup
Wing without distinct pale spots…..…….……..……..... 5

Legends to the Figures (17 - 21)
Fig.17 - abdominal terga with basal pale band
Fig.18 - pleuron without dark and pale stripes
Fig.19 - postspiracular area with pale scales
Fig.20 - postspiracular area without pale scales
Fig.21 - wing with pale spots

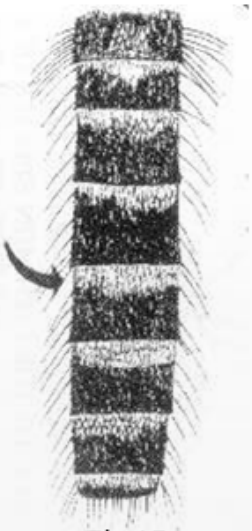


Fig.17

Fig. 18

Fig. 19

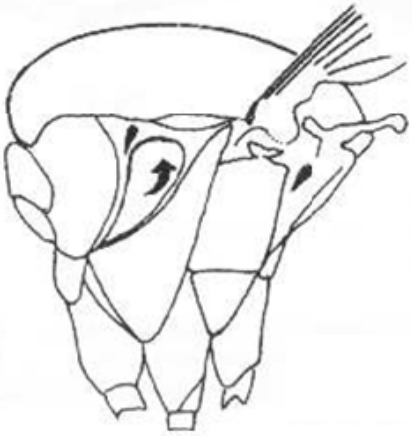


Fig. 20

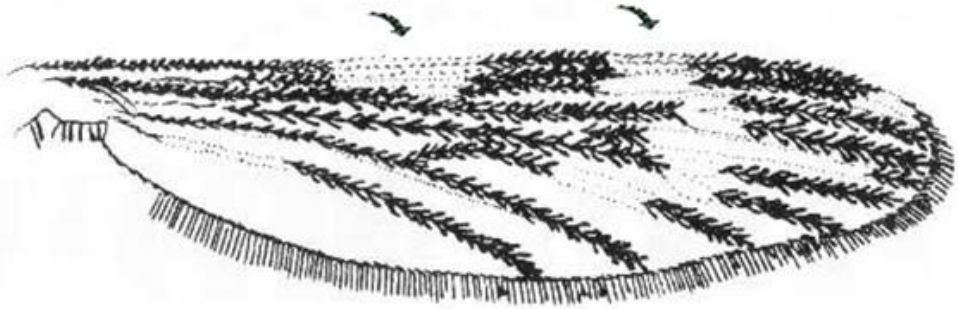


Fig. 21

5(4). Abdominal terga II- VIII largely yellowish or golden; pale yellow scales on apical portions of wing veins C, R1, R2, R3, and R4+5, forming apical pale area (Figs. 22, 23)..... *epidesmus*

Abdominal terga II- VIII with dark and pale bands, or completely dark; wing tip without definite pale area…..6

6(5). Wing heavily / moderately speckled with pale scale; abdominal terga II-VI with apical bands and/or apicolateral pale patches and basal pale bands……. 7

Wing without speckling of pale scales; abdominal terga II-VI with basal pale bands…….8

7(6). Abdominal terga II-VII with evenly broad apical pale bands and without apicolateral pale patches; femora, tibiae, and wings heavily speckled with pale scales (Figs. 24, 25)..... *bitaeniorhynchus*

Abdominal terga II-IV largely dark, or with narrow apical bands, apicolateral yellowish patches, and median basal pale bands or spots; terga V-VII with apical and basal bands, basal bands narrower; legs and wings lightly or moderately speckled (Fig. 26)..... *infula*

Legends to the Figures (22 - 26)

Fig.22 - abdomen terga II-VIII with yellowish scales
Fig. 23 - apical portion of wing with pale area
Fig.24 - legs with speckling
Fig.25 - abdomen terga II-VII broad apical band
Fig.26 - abdomen terga II-IV largely dark with narrow apical bands

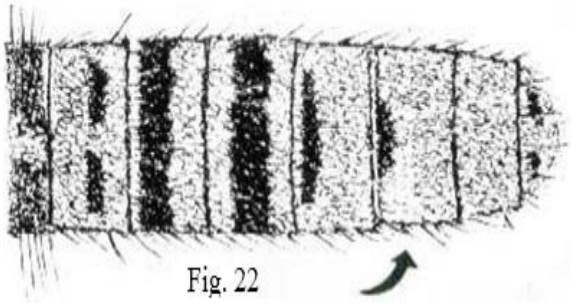


Fig. 22

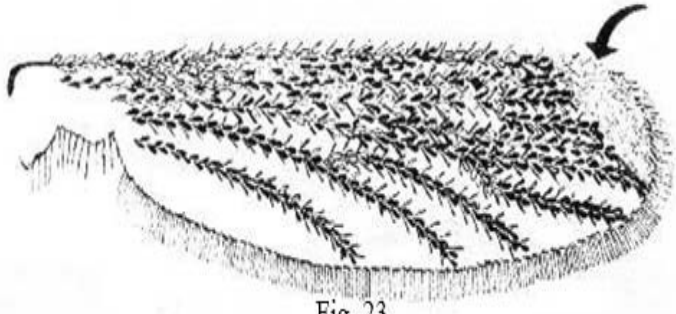


Fig. 23

Fig. 24

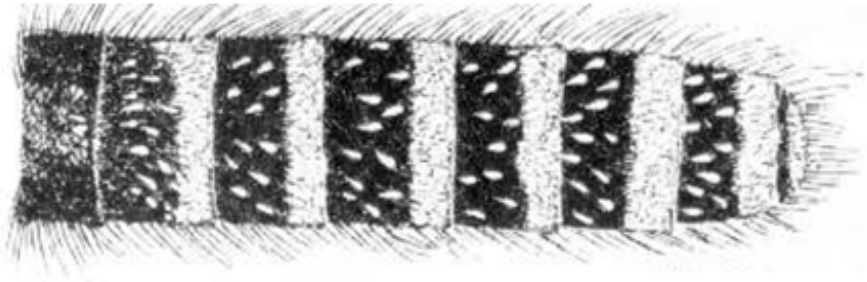


Fig. 25

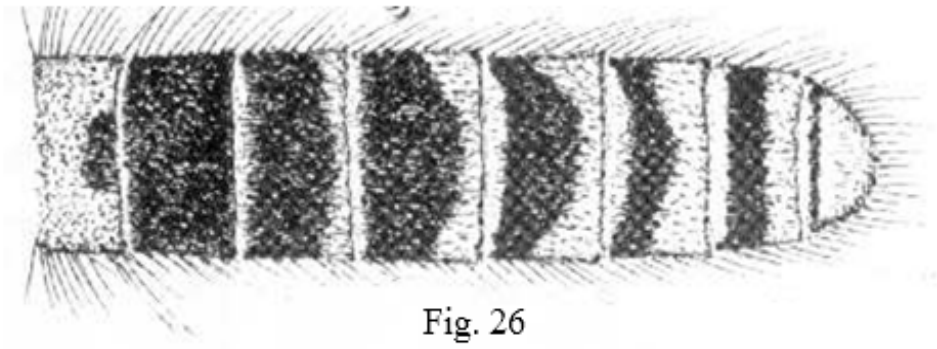


Fig. 26

8(6). Anterior 0.7 of scutum covered with pure
white scales…….....…….9
Anterior 0.7 of scutum covered with beige,
yellow, golden or dark scales……. 10

9(8). Anterior surface of fore-and midfemora without speckling
of pale scales; scales on prescutellar space, behind wing base,
and on scutellum entirely dark; pale band on proboscis narrow,
less than length of basal dark area (Figs. 27-29).....….....……*gelidus*

Anterior surface of fore-and midfemora speckled with
pale scales; scales on prescutellar space, behind wing
base, and on scutellum mainly pale; pale band on proboscis broad,
as long as or longer than basal dark area (Figs. 30-32).....*whitmorei*

10(8). Anterior surface of fore and midfemora speckled
with several pale scales, at least on apicodorsal surface…….11
Anterior surface of fore and midfemora entirely dark……12

Legends to the Figures (27 - 32)

Fig.27 - legs without speckling
Fig.28 - scutellum entirely dark
Fig.29 - proboscis with narrow pale band
Fig.30 - legs with speckling
Fig.31 - scutellum mainly pale
Fig.32 - proboscis with broad pale band

Fig. 27

Fig. 28

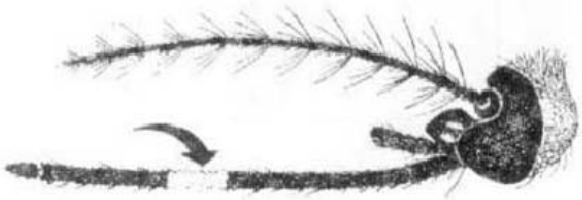


Fig. 29

Fig. 30

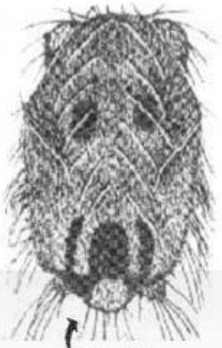


Fig. 31

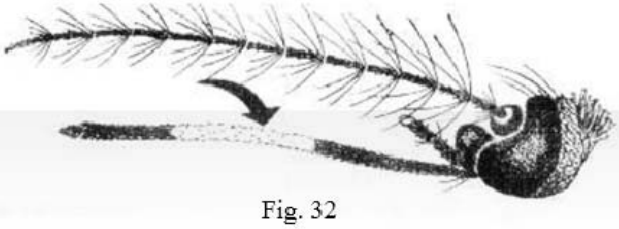


Fig. 32

11(10). Wing scales mainly dark; scutal integument dark; speckling of pale scales on femora contrasting sharply with dark-scaled area (Fig. 33).....*sitiens*

Wing with few to several scattered pale scales; scutal integument light brown; anterior surface of hindfemur with pale stripe not contrasting with dark-scaled area (Fig. 34)…….....*vishnui*

12(10). Proboscis usually with accessory pale patches or stripe on ventral surface: hindfemur pale with an apical dark ring (Figs. 35, 36); erect scales on vertex all dark.....*tritaeniorhynchus*

Prescutellar area entirely covered with pale scales; hindfemur with pale stripe on anterior surface contrasting well with dark areas (Figs. 37, 38)….....*pseudovishnui*

Legends to the Figures (33 - 38)

Fig.33 - legs with speckling
Fig.34 - hindfemur not contrasting with dark scales
Fig.35 - proboscis with accessory pale patches
Fig.36 - hindfemur with apical dark ring
Fig.37 - prescutellar area with pale scales
Fig.38 - hindfemur well contrasting with dark scales

Fig. 33

Fig. 34

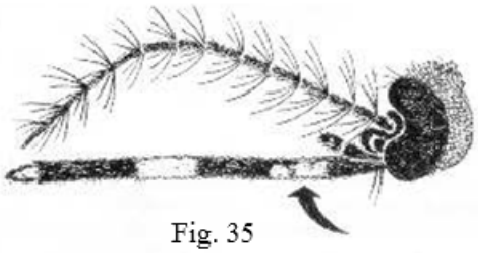


Fig. 35

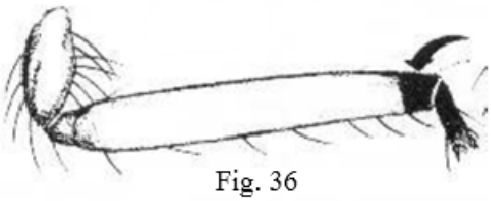


Fig. 36

Fig. 37

Fig. 38

Wing with broad, often asymmetrical scales; dark and pale scale intermixed (Fig. 39)..... ***Mansonia***

1. Mesonotum marked with distinct round spots of white scales…….....……..... 2

   Mesonotum not so (though there may be small indefinite white spots or patches) …..... 3

2(1). Yellowish-brown; mesonotum marked with 4 (or more) distinct round white spots; rather broad white scales on mid-lobe of scutellum (Fig. 40).....……..... *annulifera*

   Brownish-black; mesonotum marked with 2 (or 3) round white spots; scales on mid-lobe of scutellum narrow (Fig. 41).....…..... *longipalpis*

3(1). Mesonotum marked with a pair of sublateral greenish stripes on a brown ground (Fig. 42)..... *uniformis*

Mesonotum dark brown, not marked with
greenish stripes; some white scales, tending to form
indistinct spots or patches,
in some specimens (Fig. 43)..... *indiana*

Legends to the Figures (39 - 43)

Fig.39 - wing with asymmetrical scales
Fig.40 - mesonotum with 4 round white spots
Fig.41 - mesonotum with 2 round white spots
Fig.42 - mesonotum with sublateral greenish stripes
Fig.43 - mesonotum without greenish stripes

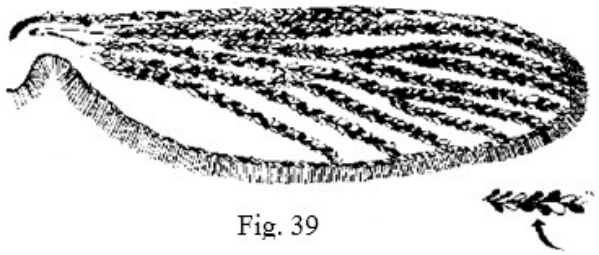


Fig. 39

Fig. 40

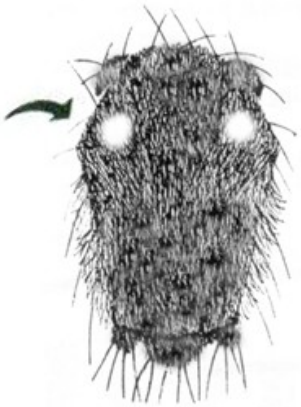


Fig. 41

Fig. 42

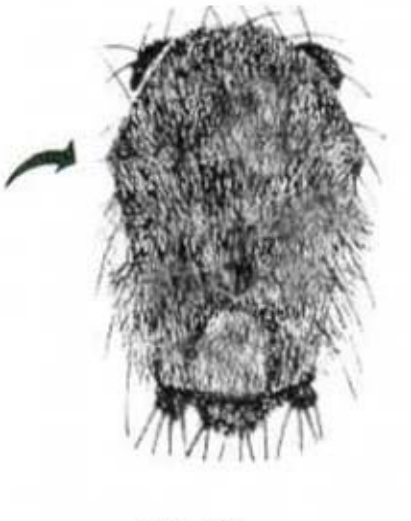


Fig. 43

1. Wings with less than three dark spots
on costa, which also involve vein 1 (Fig. 44)..... (Subgenus *Anopheles*)

1a. Hind tarsomeres with broad apical pale bands;
wing humeral cross vein without dark scales; remigium mostly pale scaled (Figs. 45, 46) ..... *peditaeniatus*

1b. A prominent tuft of dark scales on ventral side of abdominal segment VII; inner quarter of costa with scattered pale scales, usually with a fringe spot at vein 5.2; wing with narrow lower apical fringe spot opposite to vein 3 only (Figs. 47, 48)..... *barbirostris*

2. Wings with 4 (or) more dark spots on costa which also involve vein 1 (Fig. 49)..... (Subgenus *Cellia*)

2a. Femur and tibia not speckled; hind tarsomere 5 not white; fore tarsi with broad pale bands; palpi with subapical dark band equal to the apical pale band (Figs. 50, 51)..... *subpictus*

Legends to the Figures (44 - 51)

Fig.44 - wings with less than three dark spots
Fig.45 - hind tarsomere with broad apical pale bands
Fig.46 - remigium with pale scales
Fig.47 - abdomen segment VII with tuft
Fig.48- wing with fringe spot at vein 3 and 5.2
Fig.49 - wings with four or more dark spots
Fig.50 - fore tarsi with broad pale bands
Fig.51 - palpi with subapical dark band equal to apical pale band

Fig. 44

Fig. 45

Fig. 46

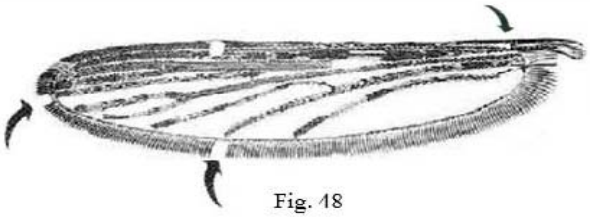


Fig. 48

Fig. 47

Fig. 49

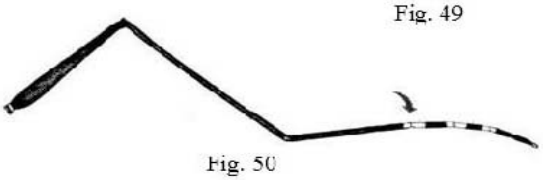


Fig. 50

Fig. 51

4.5 Key to Vectors of Dengue / Chikungunya

1. Post spiracular setae present; proboscis slender and usually straight, never laterally compressed ..... *Aedes*

1a. Mesonotum marked with a pair of lateral curved white lines, and usually also with a pair of submedian yellowish lines; tibiae without white rings; two dots of white scales on clypeus (Fig. 52)..... *aegypti*

1b. Mesonotum with a narrow median silvery white line; white scales on pleurae arranged in irregular patches; tibiae without white rings; abdomen with silvery basal bands on dorsum (Fig. 53)..... *albopictus*

1c. Mesonotum marked with 4-6 small white spots; all tibiae with white rings (Fig. 54)..... *vittatus*

Legends to the Figures (52 - 54)

Fig.52 - mesonotum marked with a pair of lateral curved white lines
Fig.53 - mesonotum with narrow median silvery white line
Fig.54 - mesonotum marked with 4-6 white spots

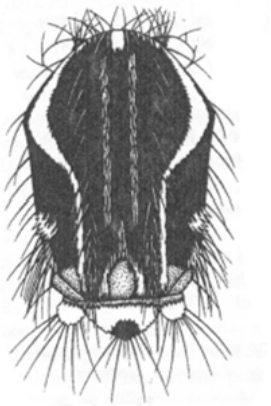


Fig. 52

Fig. 53

Fig. 54

4.6 Key to Vectors of Lymphatic Filariasis

1. Lower mesepimeral setae absent or 1, 2 weak ones;
   pleuron with distinct pale patches on at least upper
   and lower mesokatepisternum
   and anterior mesepimeron …..……..…….... Subgenus Culex

1a. Proboscis and tarsi without pale rings;
   pleuron without striking pattern of dark and
   pale stripes; abdominal terga with
   basal pale bands; (Figs. 55-57).....…….....… *quinquefasciatus*

2. Wing with broad, often asymmetrical scales; dark and
   pale scale intermixed (Fig. 58)..... *Mansonia*

2a. Mesonotum marked with a pair of sublateral greenish
   stripes on a brown ground (Fig. 59)..... *uniformis*

2b. Yellowish-brown; mesonotum marked with 4
   (or more) distinct round white spots; rather broad
   white scales on mid-lobe of scutellum (Fig. 60).....……..…….... *annulifera*

Legends to the Figures (55 - 60)
Fig.55 - proboscis without pale ring
Fig.56 -pleuron without striking pattern of dark and pale stripes
Fig.57 - abdominal terga with basal pale band
Fig.58 - wing with asymmetrical scales
Fig.59 - mesonotum with sublateral greenish stripes
Fig.60 - mesonotum with four round white spots

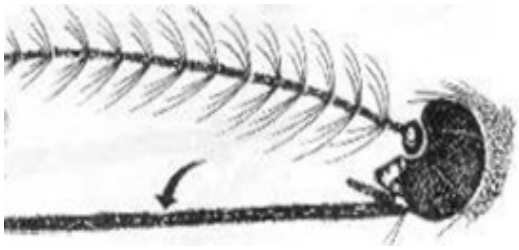


Fig. 55

Fig. 56

Fig.57

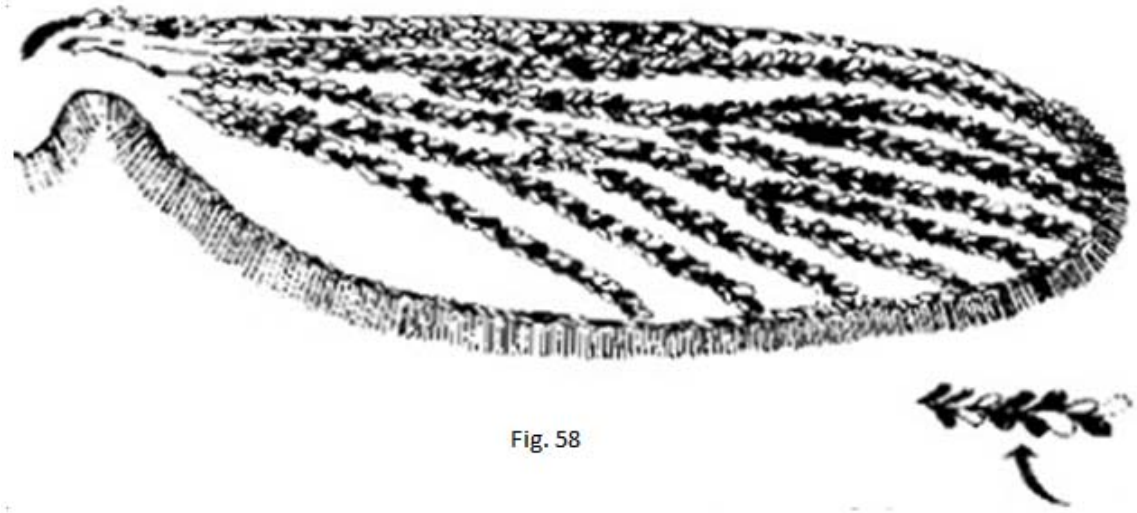


Fig. 58

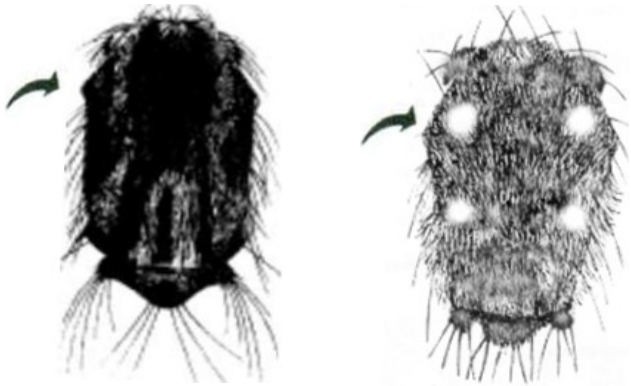


Fig. 60

Diurnally subperiodic filariasis vector in Andaman & Nicobar islands

1. Postspiracular setae present; proboscis slender and usually straight, never laterally compressed (Fig. 61).....…..... Aedes

1a. Mesonotum with a large snowy white patch in front; wing scales all dark; tarsi entirely dark (Figs. 62, 63)..... *nivea**

* Downsiomyia nivea (=Aedes (Finlaya) niveus)

Legends to the Figures (61 - 63)

Fig.61 - proboscis slender and straight
Fig.62 - mesonotum with snowy white patch
Fig.63 - tarsi entirely dark

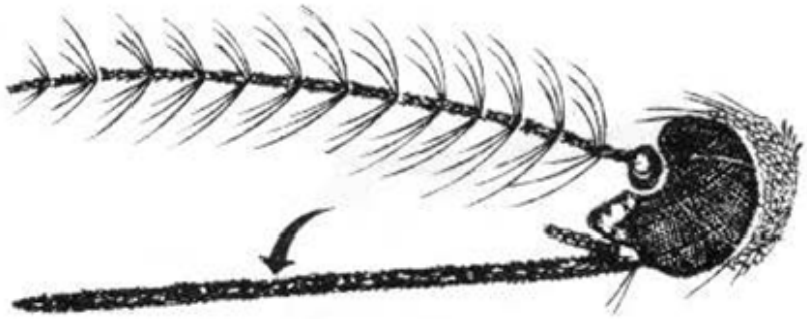


Fig. 61

Fig. 62

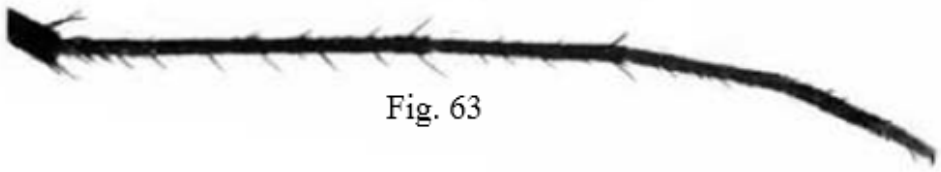


Fig. 63

4.7 Key to Vectors of Malaria

Wings with 4 or more dark spots on costa (Fig.64)…..... (Subgenus Cellia)

1. Femur and tibia speckled (Fig. 65)…..... 2

Femur and tibia not speckled (Fig. 66) 7

2(1). Hind tarsomere 5 not white (Fig. 66) …..... 3

Hind tarsomere 5 white (Fig. 67) ……..6

3(2). Palpi with three pale bands (Fig. 68)……..... 4

Palpi with four pale bands (Fig. 69)……..... 5

Legends to the Figures (64 - 69)

Fig.64 - wings with 4 or more dark spots on costa
Fig.65 - femur and tibia speckled
Fig.66 - femur and tibia not speckled
Fig.67 - Hind tarsomere 5 white
Fig.68 - palpi with 3 pale bands
Fig.69 - palpi with 4 pale bands

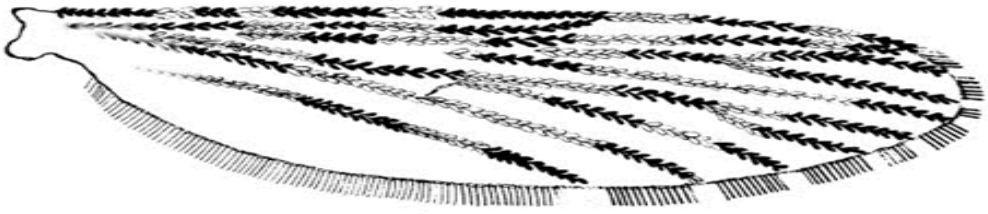


Fig.64

Fig. 65

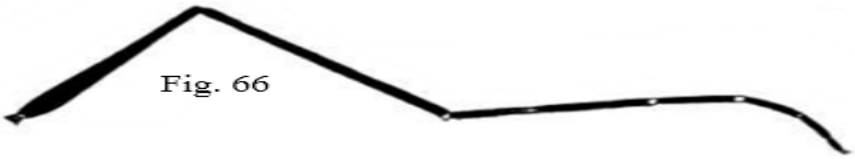


Fig. 66

Fig. 67

Fig. 68

Fig. 69

4(3). Apical and subapical pale bands of palpi equal;
palpi speckled (Fig. 70)..... *stephensi*

Apical and subapical pale bands of palpi unequal;
palpi not speckled (Fig. 71)..... *sundaicus*

5(3). Hind leg with a broad white band at the tibio-tarsal
joint; presector dark mark on vein 1 without any
pale interruption; apical pale band on hind
tibia with a longitudinal basal dark stripe on
ventral aspect (Figs. 72, 73)..... *baimaii(=dirus D)*

Hind leg with a broad white band at the tibio-tarsal
joint; presector dark mark on vein 1 with one or more pale
interruption; apical pale band on hind tibia without
a ventral dark stripe (Figs. 74, 75)..... *elegans*

Legends to the Figures (70 - 75)
Fig.70 - palpi with speckling
Fig.71 - palpi without speckling
Fig.72 - hindleg with broad white band at tibio-tarsal joint
Fig.73 - presector dark mark on vein 1 without pale interruption
Fig.74 - hind tibia without ventral dark stripe
Fig.75 - presector dark mark on vein 1 with pale interruption

Fig. 70

Fig. 71

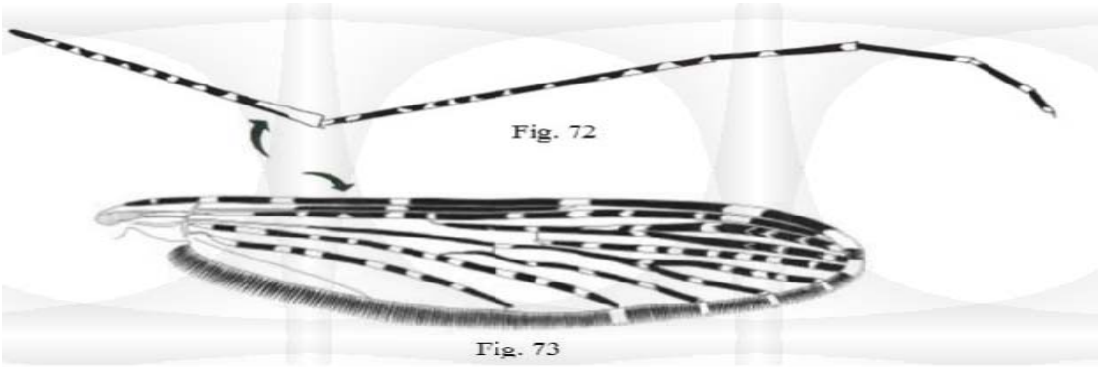


Fig. 72

Fig. 73

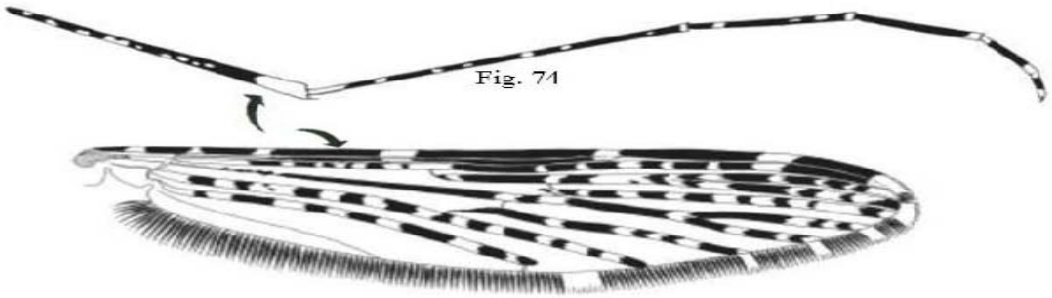


Fig. 74

Fig. 75

6(2). Abdominal terga II-VIII shiny, with no pale scales (Fig. 76).....……..*pseudowillmori*

Abdominal terga IV-VIII with a few pale scales (Fig. 77).....…..... *maculatus*

7(1). Hind tarsomere 5,4 and 3 completely white; apex of hind tarsomere 1 usually with white band; wing vein 5 mainly white, no dark spot at the point of bifurcation (Figs. 78, 79).....….....…….....……*philippinensis*

Hind tarsomere not white; fore tarsi with narrow pale bands (Fig. 80).....……...8

Legends to the Figures (76 - 80)
Fig.76 - abdominal terga II - VIII without pale scales
Fig.77 - abdominal terga IV - VIII with few pale scales
Fig.78 - hind tarsomere 1 with white band

Fig.79 - wing vein 5 white no dark spot at the point of bifurcation
Fig.80 - fore tarsi with narrow pale band

Fig. 76

Fig. 77

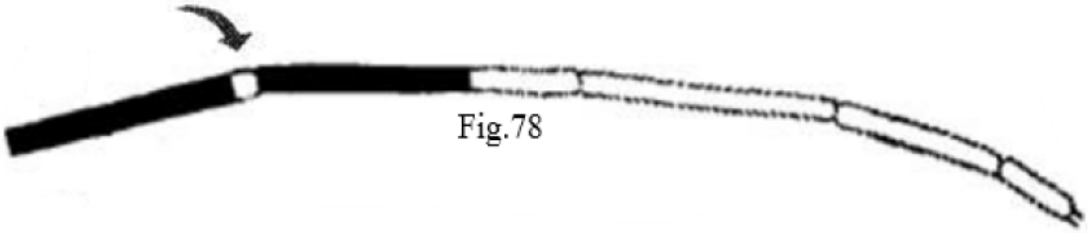


Fig.78

Fig. 79

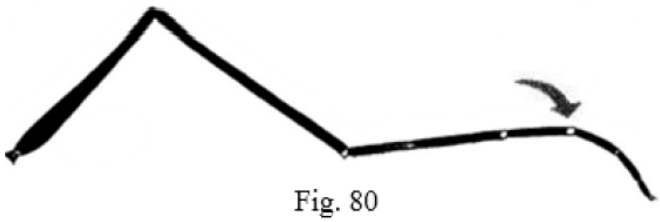


Fig. 80

8(7). Wing vein 3 mainly dark; inner quarter costa usually with pale interruption (Fig. 81)….....……....… *culicifacies*
Wing vein 3 mainly white (Fig. 82)……..... 9
..

9(8). Female palpi with both apical and subapical pale bands as broad as or broader than subapical dark band; basal third of costa with white interruption; fore tarsomere 1-4 with very small dorso-apical pale patches (Figs. 82-84)...…..... minimus

Female palpi with subapical pale band, narrow and subapical dark band much broader; vein 6 with two dark spots, distal half mainly dark; hind tarsomeres uniformly dark (Figs. 85-87)...…....…….…… fluviatilis

Legends to the Figures (81 - 87)
Fig.81 - wing vein 3 mainly dark
Fig.82 - wing vein 3 mainly white
Fig.83 - palpi - apical and subapical pale bands broader than subapical dark band
Fig.84 - fore tarsomere 1-4 with very small pale patches
Fig.85 - palpi - subapical pale band narrow and subapical dark band broader Fig.86 - wing vein 6 with 2 dark spots
Fig.87 - hind tarsomere uniformly dark

Fig. 81

Fig. 82

Fig. 83

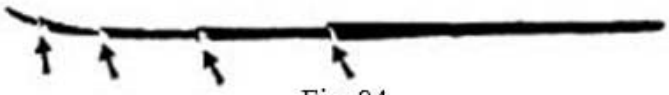


Fig. 84

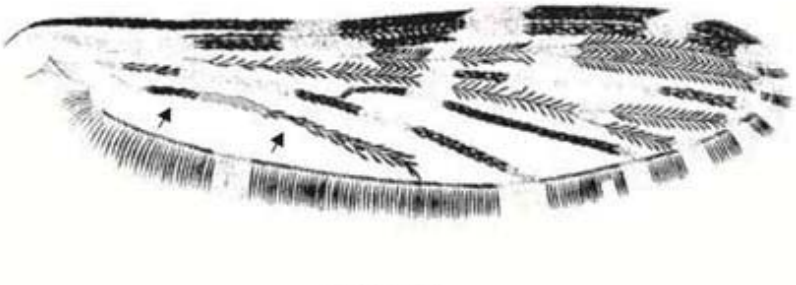


Fig. 86

Fig. 85

Fig. 87

5. Acknowledgement
The authors are grateful to the Director General, Indian Council of Medical Research, New Delhi for encouragement and facilities. They are also thankful to the various national and regional institutes for permission to examine their collections. Grateful thanks are also due to various scientific and technical staff of the CRME for their manifold help in both laboratory and field work.

6. References

1. Spielman A, Antonio D. Mosquito: The Story of Man's Deadliest Foe. Hyperion, 2002, 272.
2. Tyagi BK. The invincible deadly mosquitoes: India`s Health and Economy Enemy No.1. Scientific Publishers, India, 2004, 266.
3. Theobald FV. A monograph on Culicidae mosquitoes: Brit. Mus. (Nat. Hist.), London, 1910, 1-646.
4. Harbach R. Mosquito taxonomic inventory. 1910. http://mosquito-taxonomic-inventory.info/node/11667 (assessed on 31st July 2014).
5. Christophers SR. The fauna of British India, including Ceylon and Burma. Diptera: Family Culicidae; Tribe Anophelini. 1933; Vol. 4, Taylor & Francis, London.
6. Barraud PJ. The fauna of British India, including Ceylon and Burma. Diptera: Family Culicidae; Tribes Megarhinini and Culicini. 1934; Vol. 5, Taylor & Francis, London, 1934, 463.
7. Tyagi BK. The Indian mosquito taxonomy at crossroads: Glorious past, dwindling present and promising future roadmap with a preliminary catalogue of Indian mosquitoes. (In: Advances in Entomology. Eds. Jagbir

Singh Kirti and Ashwani Kumar), Punjabi University, Patiala, 2010, 142-160.
8. Tyagi BK. Medical Entomology: A hand-book of medical importance insects and other arthropods. Scientific Publishers, Jodhpur, 2003, 262.
9. Puri IM. Anopheline of the Oriental region. Body's "*Malarioogy*", W.B. Saunders & Co., New York, 1949, 483-505
10. Watttal BL, Kalra NL. Region wise keys to female Indian *Anopheles*. Bulletin of Natural Society of India Malaria Mosquito Borne Diseases 1961; 10:55-138.
11. Wattal BL. Keys to the *Anopheles* of the world. 5. Southern and northern Asia. *In*: Russell, P.F., West, L.S., Manwell, R.D. & MacDonald, G., *Practical malariology*. Second edition. Oxford University Press, London, 1963, 680–696.
12. Roy DN, Brown AWA. *In*: Entomology (3rdEdition), *Bangalore Press*, Bangalore, 1970, 1-855.
13. Rao TR. *In:* The Anopheline of India (Revised Edition.), Malaria Research Centre, Indian Council of Medical Research, New Delhi, 1984, 1-518.
14. Das BP, Rajagopal R, Akiyama J. Pictorial key to the species of Indian Anopheline mosquitoes. Journal of Pure Applied Zoology 1990; 2:131-162.
15. Reuben R, Tewari SC, Hiriyan J, Akiyama J. Illustrated key to species of *Culex (Culex)* associated with Japanese encephalitis in southeast Asia (Diptera: Culicidae*).* Mosquito Systematics 1994; 26:75-96.
16. Nagpal BN, Sharma VP. Anophelines, Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi, 1995.
17. Munirathinam A, Krishnamoorthi, Venkatesh A, Tyagi BK. A note on spatial and temporal distribution of Anopheline mosquitoes in Western Ghats, Southern India. International Journal of Mosquito Research 2014; 1:14-18.
18. Tyagi BK, Hiriyan J, Tewari SC, Ayanar K, Philip Samuel P, Arunachalam N, Paramasivan R, Krishnamoorthy R, Dhananjeyan KJ, Victor Jerald Leo S, Rajendran R. Description of a new species of *Anopheles pseudosundicus* (Diptera : Culicidae) from coastal Kerala. Zootaxa 2009; 2219: 49-60.
19. Rao TR, Dhanda V, Bhat HR Kulkarni SM. A survey of Haematophagous arthropods in western Himalayas Sikkim and hill districts of West Bengal: A general account. Indian Journal of Medical Research 1973: 61:1421-1461.
20. Reuben R, Tewari SC, Hiriyan J. Studies of the mosquito fauna of South India. In proceeding of Entomologist Extraordinary: A festschrift in honour of Botha De Meillon, 1993, 47-50.
21. Rajavel AR, Natarajan R, Vaidyanathan K. Mosquito of mangrove forests of India: Part I- Bhitarkanika, Orissa. Journal of American Mosquito Control Association 2005; 21: 131-135.
22. Rajavel AR, Natarajan R, Vaidyanathan K. Mosquito of mangrove forests of India: Part II- Sundarbans, West Bengal. Journal of American Mosquito Control Association 2005; 21:136-138.
23. Rajavel AR, Natarajan R, Vaidyanathan K, Saniya NP. Mosquito collections in the Jeypore hill trcts of Orissa, India, with notes on three new country records. *Culex (Lophoceraomyia) pilifemoralis. Culex (Lophoceraomyia) wilfredi, and Heizmannia (Heizmannia) Chengi.* Journal of American Mosquito Control Association 2005; 21:121-127.
24. Dutta P, Khan SA, Sharma AM, Hazarika CK Mahanta J. Survey of medically important mosquito fauna in Mizoram. Entomon, 2003; 28:237-240.
25. Tyagi BK, Verma KVS. Anopheline mosquitoes of Sri Ganganagar district (Rajasthan) transmitting malaria parasite. Journal of Applied Zoological Researches 1991; 2:85-91.
26. Sagandeep, Kapoor VC, Grewal JS. Some mosquito (Diptera: Culicidae) species of Punjab and Himachal Pradesh. Journal of Insect Science 1994; 7:48-50.
27. Jagbir SK, Jagdish K. Mosquitoes of Malwa region of Punjab. Geobios new Reports, 1999; 18:75-76.
28. Stone A. A synoptic catalogue of the mosquitoes of the world. Supplement 1 (Diptera: Culicidae). Proc: Entom. Soc. Washington. 1961; 63:97-152.
29. Stone A, Delfinado MD. Family – Culicidae – Catalog of the Diptera of Oriental region'. Vol. I. Subllorder Nematocera. Univrsity Press. Hawali, Honolulu 1973; 9:1-618.
30. Sirivanakarn S. Contributions of American Entomological Institute-III (A revision of the subgenus *Culex* in the Oriental region (Diptera: Culicidae). Contribution of American Entomological Institute Vol.12, 1976; pp: 1-272.
31. Knight KL, Stone A. A catalog of the mosquitoes of the world (Diptera: Culicidae). II edition. 6, 1-611. College Park, MD: The Thomas Say Foundation, Entomological Society of America, 1977.
32. Rampa Rattanarithikul, Prachong Panthusiri, Suvanee Supavej. illustrated Keys to the Mosquitoes of Thailand: Southeastern Asian Journal of Tropical Medicine and Public Health 2005; 36:1-80.
33. Lewis MAJ, Long S. Walter Reid Biosystematics Unit (WRBU) http://www.wrbu.org/index.html 2013. (assessed on 30th November 2014)
34. Bhattacharyya DR, Anil Prakash PK, Mapatra PK, Mahanta J. *Uranotaenia dibrugarhensis* a new species in subgenus *Pseudoficalbia* from Assam, India. Mosquito Systematics 2004; 20:1-5.
35. Bhattacharyya DR, Tewari SC, Anil Prakash, Mohapatra PK. *Verrallina (Neomacleaya) assamensis*, a new species from Assam, India. Mosquito Systematics 2004; 20:115-120.
36. Bhattacharya DR, Anil Prakash, Mohapatra PK, Sarma DK. *Armigeres (Armigeres) mahantai*, a new mosquito species from India. Mosquito Systematics 2009; 25(1):1-5.
37. Ramalingam S. On the restriction of *Armigeres durhami* Edwards and the description of *Armigeres kessli* n.sp. (Diptera: Culicidae). Tropical Biomedicine 1987; 4:55-65.
38. Tewari SC, Hiriyan J, Reuben R. Description of a new species of *Aedes* (*Rhinoskusea*) from south India. Mosquito Systematics 1991; 23:123-131.
39. Tewari SC, Hiriyan J, Reuben R. Description of two new species of *Aedes* (Diceromyia) from south India (Diptera: Culicidae). Mosquito Systematics 1992; 24:154-175.
40. Tewari SC, Hiriyan J, Reuben R. Description of *Aedes (Finlaya) niveus* (Diptera: Culicidae) from south India. Mosquito Systematics 1995; 27:167-176.
41. Natarajan R, Rajavel AR. Description of a new species *Culex (Lophoceraomyia)* from Orissa, India. Journal of American Mosquito Control Association 2009; 25:403-408.

42. Singh G, Prakash S. A new species of *Lutzia* (Diptera: Culicidae) comparable with *halifaxii* Theobald 1903 in a semi-arid zone of India. Vector borne diseases; Epidemiology and Control. Chapter 2008; 24:195-204.
43. Krishnamoorthy R. Munirathinam A, Dhananjeyan K.J, Hiriyan J, Mariappan T, Philip Samuel P, Venkatesh A. (2013). Description of a new species, *Toxorhynchites (Toxorhynchites) tyagii* (Diptera: Culicidae), from Nilgiri hills, Western Ghats, southern India. Zootaxa. 2013; 4(4):3701.
44. Tewari SC, Hiriyan J, Ayanar K, Munirathinam A, Venkatesh A, Reuben R Tyagi BK. CRME Mosquito Museum: An Annotated Checklist of Indian Mosquito Species. Contributions of the Centre for Research in Medical Entomology, Madurai, 2007, 175.
45. Rajavel AR, Natarajan R, Vaidyanathan K, Saniya NP. (2005). A list of the mosquitoes housed in the mosquito museum at the Vector Control Research Centre, Pondicherry, India. Journal of American Mosquito Control Association 2005; 21:243-51.
46. Tyagi BK, Munirathinam A, Krishnamoorthy R, Venkatesh A. A field-based handbook of identification keys to mosquitoes of public health importance in India. Volume 1; Taxonomy and Biodiversity Cell. Centre for Research in Medical Entomology. 2012; 1-55.
47. Tyagi BK, Munirathinam A, Krishnamoorthi R, Baskaran G, Venkatesh A, Kalimuthu M and Govindarajan R. A field-based handbook of identification keys to 4th instar larvae of mosquitoes of public health importance in India. Volume 2; Taxonomy and Biodiversity Cell. Centre for Research in Medical Entomology, 2014, 1-45.
48. WHO. World Malaria Report, 2013. World Health Organization, Geneva, 2013, 1-284.