

Faunal richness and the checklist of Indian mosquitoes (Diptera: Culicidae)

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ABSTRACT: A review of published studies revealed that the Indian mosquito fauna comprises 393 species in 49 genera and 41 subgenera. The subfamily Anophelinae contains 61 species in one genus followed by Culicinae with 332 species in 11 tribes and 48 genera. The tribe Aedini (subfamily Culicinae) contains the highest number of species (176 species in 33 genera and two groups of *incertae sedis*; i.e., “*Aedes*” *sensu auctorum* and “*Ochlerotatus*” *sensu auctorum*). With the recent taxonomic changes in tribe Aedini, the Indian mosquito genera have gone up from 22 to 49. Changes to the Indian Aedini fauna subsequent to the reclassification of tribe Aedini are discussed. A total of 31 species are currently recognized in India for transmitting various mosquito-borne agents of human diseases. A checklist for the Indian mosquito species is presented and the need for a comprehensive study is emphasized.

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INTRODUCTION

Mosquitoes, belonging to family Culicidae and order Diptera, are a large group of insects present throughout the temperate and tropical regions and even beyond the Arctic Circle of the world (Harbach 2007). The Oriental Region, which includes India, is regarded as one of the richest biogeographic regions for mosquitoes of the world, along with the Neotropics (Gaston and Hudson 1994). At present, a total of 3,540 recognized mosquito species, divided between two subfamilies and 112 genera, are recorded in the world (Harbach 2014). A three to five-fold increase of the present numbers can be foreseen with more discoveries and naming of sibling species mainly in *Anopheles*, as a result of application of DNA-based methods (Harbach 2007). India is ranked fifth in terms of mosquito biodiversity after Brazil, Indonesia, Malaysia and Thailand (Foley *et al.* 2007). After the monumental works of Christophers (1933) and Barraud (1934), not many comprehensive biosystematics studies of Indian Culicidae have been undertaken. Since that time, many changes have taken place in the mosquito taxonomic literature. However, in the absence of any up-to-date monograph on Indian Culicidae, entomologists in India are still compelled to use these two books. In this context, as mentioned by Reuben *et al.* (1993), it needs to be emphasized that publications of the Southeast Asian Mosquito Project are very useful for the identification of Indian mosquito species. Berlin (1972) rightly proposed for a systematic study of Indian Culicidae because of increasing mosquito-borne diseases, changing ecology and advances in mosquito systematics. The online systematic catalog of Culicidae listed 356 species in India (Gaffigan *et al.* 2014). Although fewer in

numbers, since the 1980s some faunistic surveys carried out in various parts of India detected many species which are new additions to the mosquito fauna of India. It seems that some of these records did not reach the mosquito catalog. As such, an up-to-date check list of mosquitoes of India is still not available, and the actual number of species present in India, has to be approximated. Moreover, with the advancement of molecular biology, many researchers from non-entomology backgrounds are now working with mosquitoes, and there is confusion about the informal taxonomic series, groups and subgroups to which mosquito species belong. Confusion seems to have increased after the changes made to the classification of tribe Aedini (Reinert *et al.* 2004, 2006, 2008, 2009) as journals are using two systems of classification. Reclassification of the tribe Aedini brought major changes raising the number of genera in this tribe from 11 to 81 along with changes to the spelling of names of some species in accordance with provisions of the *International Code of Zoological Nomenclature*. Hence, a checklist seems essential for the entomologists and public health personnel working in India to reflect changes to nomenclature to promote familiarity with the new names. Considering this, an up-to-date check list of the mosquito species of India based on the current classification is provided. The present status of the mosquito fauna of India and need for future work are also discussed.

MATERIALS AND METHODS

Information was collected from two online resource databases, namely systematic catalog of Culicidae and mosquito taxonomic inventory and published materials

mainly since the 1980s (Bhattacharyya *et al.* 2000, 2002, 2003, 2004a, 2004b, 2005, 2007, 2008, 2009; Khan *et al.* 1998; Rajavel and Natarajan 2006, 2011; Rajavel *et al.* 1998, 2004, 2005a, 2005b, 2005c, 2005d, 2011; Rajput and Singh 1987a, 1987b, 1987c, 1989, 1990; Reuben *et al.* 1993; Tewari *et al.* 1987; Tewari and Hiriyan 1991, 1992, 1995). The systematic catalog of Culicidae provides information on country occurrence records of mosquito species. The mosquito taxonomic inventory contains up-to-date information on world Culicidae. The internal classification of genera *Anopheles*, *Culex*, *Verrallina* and *Uranotaenia* are available in the website of mosquito taxonomic inventory, which is followed here for the Indian mosquito fauna belonging to these genera. Recent abbreviations of generic and subgeneric names provided by Reinert (2009a) are followed here. The authorship of generic and species names is provided in the check list (Appendix 1).

RESULTS AND DISCUSSION

Records indicate that the Indian mosquito fauna includes 393 species divided among 49 genera and 41 subgenera. Subfamily Anophelinae contains 61 species in one genus followed by subfamily Culicinae with 332 species in 11 tribes and 48 genera. Tribe Aedini of subfamily Culicinae contains the highest number of species (176 species in 33 genera and two groups of *incertae sedis*, i.e., "*Aedes*" *sensu auctorum*, "*Ochlerotatus*" *sensu auctorum*) (Table 1). The check list of the Indian Culicidae is presented as Appendix 1. In India, 31 species are currently recognized for transmitting various mosquito-borne pathogens; these are listed in Table 2.

Subfamily Anophelinae: Subfamily Anophelinae has three genera globally. Indian species are confined to genus *Anopheles*, with 61 formally named species divided between subgenera *Anopheles* and *Cellia*. However, the number of species will increase with the naming or recognition of synonymous names of sibling species in several groups or complexes. In India, subgenus *Anopheles* contains 26 species. In this subgenus, the assemblage of species in two most important groups (Hyrceanus and Barbirostris Groups) is still uncertain in India. The Hyrceanus Group is a highly complex group, which includes 30 closely related species distributed widely in the Oriental and Palaearctic regions, with some species playing important role in transmission of malaria and filariasis (Ma and Xu 2005). This Group was also incriminated as a vector of Japanese encephalitis in India and neighboring countries. Only seven species of this Group were recorded from India in comparison to 25 species recorded in China (Ma *et al.* 1998, 2000a, 2000b). Morphological identification of these species in adult stage seems to be very difficult or impossible unless accompanied by associated immature skins (Harrison and Scanlon 1975). Many anopheline surveys carried out in India recorded *An. nigerrimus* of Hyrceanus Group to be the most predominant, seemingly because their identification was based on adult stage (Malhotra *et al.* 1987; Nagpal and Sharma 1987). However, surveys carried out in north-east India and Western Ghats of South India, where species identification was done using adult as well as associated larval and pupal characters, recorded *An. peditaeniatus* to be the most

prevalent and *An. nigerrimus* as rather uncommon species (Khan *et al.* 1998; Tewari *et al.* 1987). Immature surveys carried out in upper Brahmaputra valley detected *An. crawfordi*, *An. paraliae*, *An. peditaeniatus* and *An. sinensis* of Hyrceanus Group from the north-east India, but did not collect any specimen of *An. nigerrimus* (Khan *et al.* 1998). A few specimens identified as *An. paraliae* in these surveys were collected as immatures from a forest fringe area of Assam. Earlier considered as a subspecies of *An. lesteri*, *An. paraliae* was later elevated to species status by Harrison *et al.* (1990), but more recently it has been synonymized with *lesteri* by Taai *et al.* (2013), hence it is listed as *lesteri* here. However, distribution of this species is restricted to low elevation coastal areas of Malaysia, Brunei, Vietnam and Thailand (Harrison and Scanlon 1975). This species is also easily misidentified with *An. pursati*. Hence, record of this species in India needs further investigation, incorporating DNA-based analysis similar to China, where, ITS2 marker of r-DNA was used to differentiate member species of *An. hyrceanus* group (Ma *et al.* 1998, 2000a, 2000b). Recently, ITS2 sequencing of some specimens of Hyrceanus Group confirmed the presence of *An. crawfordi*, *An. peditaeniatus* and *An. sinensis* in the north-east India (Regional Medical Research Centre, Dibrugarh, Assam, India; unpublished data). Similarly Barbirostris Group which includes 11 species globally also has uncertain distribution records for most of the species, particularly in Indonesia and Indian sub-region, mainly because of identification difficulties (Harrison and Scanlon 1975). Four species were recognized in this group from India. *An. hodgkini* was detected from Assam during larval collections (Khan *et al.* 1998).

Subgenus *Cellia* containing 35 species encompasses all important vectors of human malaria in India. Recently, two new species have been described from this subgenus from India. *An. pseudosundaicus* belonging to Pyrethophorus Series was described from coastal areas of Kerala (Tyagi *et al.* 2009). Another species belonging to Maculatus Group of the Neocellia Series named as *An. krishnai* was described (Sathe and Jagtap 2012). However, Harbach (2014) noted the lack of credible evidence to support the recognition of this proposed species. Hence, *krishnai* is regarded as *nomen nudum* and is not included in our list of Indian *Anopheles*. *Anopheles dthali* and *Anopheles superpictus* have been known only from extreme north-west (Baluchistan) which is not part of India. They have also not been recorded subsequently in India and therefore not included in the present checklist.

Several anopheline taxa recognized earlier to be medically important are now found to be complexes or groups of morphologically indistinguishable species (Rattanaarithikul *et al.* 2006). Some important complexes and groups recorded in India are, *An. annularis* (species A and B), *An. culicifacies* (species A, B, C, D and E), *An. dirus* (species X), *An. fluviatilis* (species S, T, U and V), *An. subpictus* (species A, B, C, and D) and the *An. sundaicus* (cytotype D) complexes (Walton *et al.* 1999; WHO 2007). With the advances in mosquito taxonomy several species belonging to such groups or complexes are now formally named. *An. maculatus*, recognized as one such species group, includes nine formally named species (Harbach 2014; Somboon *et al.* 2011). A recent study revealed the

TABLE 1 Member species of Culicidae in India.

SUBFAMILY	TRIBE	GENUS	SUBGENUS	NUMBER OF SPECIES
Anophelinae		<i>Anopheles</i>	<i>Anopheles</i>	26
			<i>Cellia</i>	35
Culicinae	Aedeomyiini	<i>Aedeomyia</i>	<i>Aedeomyia</i>	1
	Aedini	<i>"Aedes" sensu auctorum</i>		4
		<i>Aedimorphus</i>		15
		<i>Armigeres</i>	<i>Armigeres</i>	9
			<i>Leicesteria</i>	11
		<i>Ayurakitia</i>		1
		<i>Bruceharrisonius</i>		4
		<i>Christophersomyia</i>		4
		<i>Canraedes</i>		2
		<i>Collessius</i>	<i>Collessius</i>	3
			<i>Alloeomyia</i>	1
		<i>Danielsia</i>		2
		<i>Dendroskusea</i>		5
		<i>Downsiomyia</i>		6
		<i>Edwardsaedes</i>		1
		<i>Finlaya</i>		2
		<i>Fredwardsius</i>		1
		<i>Gilesius</i>		1
		<i>Himalaius</i>		2
		<i>Heizmannia</i>	<i>Heizmannia</i>	11
			<i>Mattinglyia</i>	2
		<i>Hopkinsius</i>	<i>Yamada</i>	1
		<i>Hulecoeteomyia</i>		5
		<i>Jihlienius</i>		1
		<i>Kenknightia</i>		2
		<i>Lorrainea</i>		2
		<i>Mucidus</i>	<i>Mucidus</i>	3
		<i>Neomelaniconion</i>		1
		<i>Ochlerotatus</i>		1
		<i>"Ochlerotatus" sensu auctorum</i>	<i>"Finlaya" sensu auctorum</i>	5
		<i>Paraedes</i>		4
		<i>Petermattinglyius</i>	<i>Petermattinglyius</i>	2
		<i>Phagomyia</i>		11
		<i>Rhinoscusea</i>		3
		<i>Scutomyia</i>		1
		<i>Stegomyia</i>	<i>Actinothrix</i>	2
			<i>Heteraspidion</i>	2
			<i>Huangmyia</i>	2
			<i>Stegomyia</i>	1
			<i>Xyele</i>	1
			<i>Without subgenus</i>	11
		<i>Tewarius</i>		3
		<i>Udaya</i>		2
		<i>Verrallina</i>	<i>Harbachius</i>	4
			<i>Neomacleaya</i>	16
			<i>Verrallina</i>	3
	Culicini	<i>Culex</i>	<i>Culex</i>	23
			<i>Culiciomyia</i>	9
			<i>Eumelanomyia</i>	10
			<i>Lophoceraomyia</i>	28
			<i>Maillotia</i>	1
			<i>Oculeomyia</i>	6
		<i>Lutzia</i>	<i>Metalutzia</i>	4
	Culisetini	<i>Culiseta</i>	<i>Allotheobaldia</i>	1
			<i>Culiseta</i>	2
	Ficalbiini	<i>Ficalbia</i>		1
		<i>Mimomyia</i>	<i>Etorleptomyia</i>	1
			<i>Mimomyia</i>	4
			<i>Ingramia</i>	1
	Hodgesini	<i>Hodgesia</i>		1
	Mansoniini	<i>Coquilletidia</i>	<i>Coquilletidia</i>	3
		<i>Mansonia</i>	<i>Mansonioides</i>	4
	Orthopodomyiini	<i>Orthopodomyia</i>		5
	Sebethini	<i>Malaya</i>		2
		<i>Topomyia</i>	<i>Suaymyia</i>	1
			<i>Topomyia</i>	3
		<i>Tripteroides</i>	<i>Rachionotomyia</i>	5
			<i>Tripteroides</i>	3
	Toxorhynchitini	<i>Toxorhynchites</i>	<i>Toxorhynchites</i>	9
	Uranotaeniini	<i>Uranotaenia</i>	<i>Pseudoficalbia</i>	15
			<i>Uranotaenia</i>	13
Total of each taxonomic level				
2	11	49 + 2 <i>sensu auctorum</i>	41 + 1 <i>sensu auctorum</i>	393

presence of six member species of the Maculatus Group in the north-east India, with detection of *An. rampae* constituting a new country record (Singh *et al.* 2012). Such studies may be extended to other areas where Maculatus Group is present. Similarly, species X of the Dirus Complex, reported earlier from Yunnan province of China, was also detected in Haflong area of Assam in the north-east India (Prakash *et al.* 2010).

Subfamily Culicinae: Subfamily Culicinae is comprised of 332 species divided into 11 tribes and 48 genera in India.

Tribe Aedeomyiini: A single genus *Aedeomyia* is included in this tribe. This genus is not listed in the mosquito catalog under the Indian mosquito fauna. However, Tyson (1970) reported Andaman Islands as one of the distribution localities for *Aedeomyia catastica*. This species was also reported from mainland India from Assam and Western Ghats (Khan *et al.* 1998; Reuben *et al.* 1993) and in the mangrove forests of Sunderbans, West Bengal (Rajavel *et al.* 2005a).

Tribe Aedini: In the earlier classification the tribe Aedini contained 11 genera (Knight and Stone 1977 and its supplements). Recent reclassification of this tribe has raised the number of genera to 81 (Reinert *et al.* 2004, 2006, 2008, 2009). Reinert (1999, 2000a) earlier resurrected *Verrallina* and *Ayurakitia* to generic rank. Revision of tribe Aedini resulted in the elevation of many former subgenera of *Aedes* to generic status (Reinert *et al.* 2004). *Downsiomyia* was elevated to genus level from synonymy with *Finlaya*. Further examination and revision of *Finlaya* and allied taxa and *Ochlerotatus* and allied taxa (Reinert *et al.* 2006, 2008), followed by comprehensive phylogenetic study of tribe Aedini (Reinert *et al.* 2009) resulted in recognition of more genera and rearrangement of taxa.

As per the current classification, Indian fauna of tribe Aedini includes 176 species in 33 genera and two groups of *incertae sedis* species ("*Aedes*" *sensu auctorum*-4 and "*Ochlerotatus*" *sensu auctorum*-5). Indian species belonging to subgenus *Finlaya* genus *Aedes* are now placed in 12 genera (*Bruceharrisonius*, *Collessius*, *Downsiomyia*, *Danielsia*, *Finlaya*, *Gilesius*, *Hopkinsius*, *Hulecoeteomyia*, *Himalaius*, *Jihlienius*, *Ochlerotatus* and *Phagomyia*). Similarly species of the subgenus *Diceromyia* of India are now placed in three genera *Dendroskusea*, *Petermattinglyius* and *Tewarius*. Illustrated keys of these new genera present in Thailand were provided by Rattanaarithikul *et al.* (2010). Further details are available in the website of mosquito taxonomic inventory. Kaur (2003) provided updated distribution maps of Indian Aedini fauna.

Genus Aedimorphus: Earlier recognized as a subgenus of genus *Aedes*, *Aedimorphus* is now elevated to generic rank (Reinert *et al.* 2009). Mostly Oriental in distribution, of the 67 species recognized in this genus, 15 species were recorded from India.

Genus Armigeres: Distributed mainly in the Oriental region and also in the Palaearctic and Australasian regions, the genus *Armigeres* is represented by 20 species in India, between two subgenera *Armigeres* and *Leicesteria*. Rajput and Singh (1987c) reported the detection of *Ar. dolichocephalus* from Manipur state. *Ar. joloensis*, a rare mosquito species, was detected from upper Assam

(Bhattacharyya *et al.* 2000). Recently a new species *Ar. mahantai* collected as immatures from endemic pitcher plant *Nepenthes khasiana* of Meghalaya state in the north-east India was described (Bhattacharyya *et al.* 2009). *Ar. pallithorax*, described from Yunnan, China was detected from Namsai, Arunachal Pradesh (Rajavel *et al.* 2011).

Genus Ayurakitia: This genus is represented by only two species detected from mountainous areas of western Thailand (Reinert 1972). Recently, occurrence of this genus was reported for the first time from India as larvae collected from *Pandanus* axils in Meghalaya, north-east India and reared to adults, were found to be *Ayurakitia peytoni* (Rajavel and Natarajan 2011).

Genus Bruceharrisonius: An earlier subgenus of genus *Ochlerotatus* (Reinert 2003) *Bruceharrisonius* was later elevated to generic rank (Reinert *et al.* 2006). This genus includes four species in India. Three species earlier in Aureostriatus Subgroup (Aureostriatus Group) and one species of Auronitens Subgroup (Alboannulatus Group) of subgenus *Finlaya* genus *Aedes* (Knight and Marks 1952) are now placed in genus *Bruceharrisonius*.

Genus Christophersiomyia: A former subgenus of genus *Aedes*, now elevated to generic rank (Reinert *et al.* 2004), *Christophersiomyia* includes five species, of which, four occur in India. *Cr. gombakensis*, reported for the first time from Western Ghats, is a new country record (Reuben *et al.* 1993).

Genus Canraedes: *Canraedes* was elevated to genus from former subgenus of *Aedes* (Reinert *et al.* 2009). Of the total ten species included in this genus from Oriental Region, only two species occur in India.

Genus Collessius: A newly recognized genus *Collessius* (Reinert *et al.* 2006) includes species formerly in Pseudotaeniatus Subgroup of Mediovittatus Group, subgenus *Finlaya* of genus *Aedes* (Knight and Marks 1952). In India this genus is represented by four species divided into two subgenera.

Genus Danielsia: *Danielsia* was elevated to generic rank from synonymy with *Finlaya* and included three taxa (Reinert 2009b). In India this genus is comprised of two species formerly in Alboteniatus Subgroup of subgenus *Finlaya*, genus *Aedes*.

Genus Dendroskusea: All five species included in genus *Dendroskusea* are found in India. These species were earlier placed in subgenus *Diceromyia* of genus *Aedes*.

Genus Downsiomyia: *Downsiomyia* as a genus was resurrected from synonymy with *Finlaya* (Reinert *et al.* 2006; Reinert and Harbach 2006). This genus is represented by six species in India which were earlier placed in the Niveus Subgroup of subgenus *Finlaya*. The species *Do. nivea* (*Ae. niveus*) has been incriminated as a vector of diurnally subperiodic *Wuchereria bancrofti* in the Nicobar islands (Tewari *et al.* 1995). Tewari and Hiriyani (1995) redescribed this species from Andaman and Nicobar Islands.

Genus Edwardsaedes: Comprising of three species, the genus *Edwardsaedes* is represented by only one species in India.

Genus Finlaya: In the earlier classification *Finlaya* was one of the largest subgenus of genus *Aedes* comprising of 42 species in India. However, in the current classification, the genus *Finlaya* includes species only from Kochi Group

of subgenus *Finlaya* (Reinert *et al.* 2004, 2006; Reinert and Harbach 2005). Two species of *Finlaya* are found in India. *Fl. flavipennis* was reported for the first time from mangrove forest ecosystem of Andaman and Nicobar Islands (Rajavel and Natarajan 2006).

Genus *Fredwardsius*: *Fredwardsius vittatus* is the only species included in this genus, which is present in India.

Genus *Gilesius*: Of the two species included in this genus, only one species occurs in India.

Genus *Heizmannia*: This genus is represented by 13 species in India, 11 species under subgenus *Heizmannia* and two species under subgenus *Mattinglyia*. Rajput and Singh (1987b) first reported the occurrence of *H. aureochaeta* in India from Manipur state. Similarly *H. chengi* was reported for the first time from Jeypore hill tracts of Orissa (Rajavel *et al.* 2005b).

Genus *Himalaius*: Two species representing this genus are found in India.

Genus *Hopkinsius*: *Hopkinsius* contains two subgenera, *Hopkinsius* and *Yamada*. Only one species belonging to subgenus *Yamada* occurs in India.

Genus *Hulecoeteomyia*: Reinert *et al.* (2006) resurrected *Hulecoeteomyia* to generic status from synonymy with *Finlaya*. Five species included in this genus from India were earlier placed in Chrysolineatus Subgroup of subgenus *Finlaya*.

Genus *Jihlienius*: Of the three species recognized in this genus, only one is found in India.

Genus *Kenknightia*: *Kenknightia* comprised of 12 species of which only two species represent this genus in India.

Genus *Lorrainea*: Presence of *Lo. amesii* and *Lo. fumidus* belonging to genus *Lorrainea* were first reported from India based on collections made in mangrove forests of Sundarbans, in West Bengal (Rajavel *et al.* 2005a), Bhitarkanika in Orissa (Rajavel *et al.* 2005c) and Andaman Nicobar Islands (Rajavel *et al.* 2004). Previously, species of this genus were reported from Thailand, Philippines and Solomon Islands.

Genus *Mucidus*: Reinert (2000b) earlier treated *Mucidus* as a subgenus of newly elevated genus *Ochlerotatus*. However, in the later classification *Mucidus* was elevated to generic rank (Reinert *et al.* 2004). Three species of *Mucidus* are known to exist in India. Confirmed occurrence of *Mu. laniger* was reported from two forest areas of Assam, north-east India (Bhattacharyya *et al.* 2005).

Genus *Neomelaniconion*: Mainly distributed in Afrotropical region, only one species *Neomelaniconion lineatopenne* represent this genus in the Oriental region including India.

Genus *Ochlerotatus*: This genus includes only one species in India.

Genus *Paraedes*: Subgenus of the genus *Aedes* in the earlier classification, *Paraedes* has been raised to genus level (Reinert *et al.* 2004) and is represented by four species in India. In this genus the confirmed presence of *Pr. ostentatio* was reported from a tropical forest zone of Dibrugarh district, Assam (Bhattacharyya *et al.* 2002). Barraud (1934) earlier reported this species from Malabar Coast of Kerela on the basis of female specimens. Reinert (1981) on resurrection of *Pr. chrysoscuta* from *Pr. ostentatio* considered Barraud's Indian record under

distribution of *Pr. chrysoscuta*, but pointed that Mattingly (1958) questioned the records from India. Until evidence is available otherwise, we retain Barraud's record as *Pr. chrysoscuta* and include it in the present checklist.

Genus *Petermattinglyius*: *Petermattinglyius* comprises of two species in India. These two species were earlier placed in subgenus *Diceromyia*. *Pe. franciscoi* was reported for the first time from mangrove forest ecosystem of Orissa (Rajavel *et al.* 2005c).

Genus *Phagomyia*: *Phagomyia* was elevated to generic status from synonymy with *Finlaya* and includes species formerly in Gubernatoris Subgroup of subgenus *Finlaya* (Reinert *et al.* 2006). *Phagomyia* includes 11 species in

TABLE 2. Vectors of mosquito-borne diseases in India.

Malaria
<i>Anopheles (Cellia) culicifacies s.l.</i>
<i>Anopheles (Cellia) baimaii</i>
<i>Anopheles (Cellia) fluviatilis s.l.</i>
<i>Anopheles (Cellia) minimus s.l.</i>
<i>Anopheles (Cellia) stephensi</i>
<i>Anopheles (Cellia) sundaicus s.l.</i>
<i>Anopheles (Cellia) annularis s.l.</i>
<i>Anopheles (Cellia) jeyporiensis</i>
<i>Anopheles (Cellia) philippinensis</i>
<i>Anopheles (Cellia) nivipes</i>
<i>Anopheles (Cellia) varuna</i>
<i>Anopheles (Cellia) maculatus s.l.</i>
(WHO 2007; Bhattacharyya <i>et al.</i> 2010; Rao 1984)
Japanese encephalitis
<i>Culex (Culex) vishnui</i>
<i>Culex (Culex) pseudovishnui</i>
<i>Culex (Culex) tritaeniorhynchus</i>
<i>Culex (Culex) fuscocephala</i>
<i>Culex (Culex) quinquefasciatus</i>
<i>Culex (Culex) gelidus</i>
<i>Culex (Culex) whitmorei</i>
<i>Culex (Oculeomyia) bitaeniorhynchus</i>
<i>Culex (Oculeomyia) infula</i>
<i>Culex (Oculeomyia) epidesmus</i>
<i>Anopheles (Anopheles) barbirostris s.l.</i>
<i>Anopheles (Anopheles) peditaeniatus</i>
<i>Anopheles (Cellia) subpictus s.l.</i>
<i>Mansonia (Mansonioides) annulifera</i>
<i>Mansonia (Mansonioides) indiana</i>
<i>Mansonia (Mansonioides) uniformis</i>
(Kanojia 2007)
Dengue
<i>Stegomyia (Stegomyia) aegypti</i>
<i>Stegomyia albopicta</i>
(Kaul <i>et al.</i> 1998; Das <i>et al.</i> 2004)
Chikungunya
<i>Stegomyia (Stegomyia) aegypti</i>
<i>Stegomyia albopicta</i>
(Mourya <i>et al.</i> 2001)
West Nile
<i>Culex (Culex) vishnui</i>
<i>Culex (Culex) quinquefasciatus</i>
(Paramasivan <i>et al.</i> 2003)
Filariasis
<i>Culex (Culex) quinquefasciatus</i>
<i>Mansonia (Mansonioides) annulifera</i>
<i>Mansonia (Mansonioides) uniformis</i>
<i>Downsiomyia nivea</i>
(Agarwal and Sashindran 2006; Tewari <i>et al.</i> 1995)

India. *Ph. feegradei* was new addition to the mosquito fauna of India from the mangrove forest ecosystem of Orissa (Rajavel et al. 2005c).

Genus *Rhinoskusea*: *Rhinoskusea* comprises of three species in India. In this genus one new species *Rh. portonovoensis* was described from mangrove forest of the east coast (Tewari and Hiriyan 1991). The detection of *Rh. wardi* from mangrove forests of Andaman and Nicobar Islands is a new country record (Rajavel and Natarajan 2006). Reinert (2000b) earlier treated *Rhinoskusea* as a subgenus of genus *Ochlerotatus*. However, in the later classification *Rhinoskusea* was elevated to generic status (Reinert et al. 2004).

Genus *Scutomyia*: *Scutomyia* includes only one species in India.

Genus *Stegomyia*: The medically important genus *Stegomyia* includes 19 species in India. In this genus *St. krombeini*, earlier placed in Scutellaris Group of genus *Aedes* and subgenus *Stegomyia* (Huang 1979), was detected first from south India (Tewari et al. 1987) and later from north-east India (Bhattacharyya et al. 2008). Huang (1975) reported this species to be very common in Sri Lanka, which probably remained undetected as it was mistaken for another common species, *St. albopicta*. Hence careful observations during entomological surveys are necessary to differentiate *St. krombeini* from *St. albopicta*, especially in rural and forest areas of India. The records of *St. flavopicta* in Assam, western Himalayas and Coorg (Barraud 1934) was not considered by Huang (1972) who restricted its distribution to Japan and Korea. Its inclusion by Kaur (2003) in Indian species is based on Barraud (1934). While *St. pseudoalbopictus*, *St. subalbopictus* and *St. novalbopictus* have been recorded in collections made in several parts of the country, *St. flavopicta* has not been obtained and hence it is not included in the present checklist. At present of the eight new subgenera recognized for this genus, only eight Indian species are placed in five subgenera. Remaining 11 species under this genus are still without subgeneric placement.

Genus *Tewari*: Of the four species included in this genus, three are found in India. Reinert (2006) placed *Te. agastyai*, *Te. reubenae* and *Te. nummatus* of subgenus *Diceromyia* to a new genus *Tewari*. *Te. agastyai* and *Te. reubenae* were described from Western Ghats (Tewari and Hiriyan 1992).

Genus *Udaya*: *Udaya* includes three species from the Oriental region, of which two are found in India.

Genus *Verrallina*: Divided into three subgenera this genus contains 23 species in India. Subgenus *Neomacleaya* contains most of the species (16) followed by *Harbachius* (four) and *Verrallina* (three). A new species *Ve. assamensis* was described from Assam (Bhattacharyya et al. 2004a) and *Ve. consonensis* was recorded for the first time from Andaman and Nicobar Islands (Rajavel and Natarajan 2006). *Ve. ceylonica* was recently collected from Kerala state (Vector Control Research Centre, Puducherry, India unpublished report).

Incertae sedis species: Nine species belonging to two groups "*Aedes*" *sensu auctorum* and "*Ochlerotatus*" *sensu auctorum*, regarded to be of uncertain taxonomic position, are now under this head. Though, not considered as their formal status, the genus and subgenus of these species

are now kept as provided by the authors. Four new species of undetermined subgenus (*Aedes kolhapuriensis*, *Aedes sangitee*, *Aedes panchgangee* and *Aedes sangiti*) were described from Kolhapur district of Maharashtra (Girhe and Sathe 2001; Sathe and Girhe 2001). However, descriptions of these species were inadequate and mainly based on adult female characters. Comparisons with closely related species were not available in the descriptions. Hence, collections of all life stages may be required for comparing with other related species to establish their validity and placing them in relevant genera and subgenera. Genus *Aedes* is now restricted mainly in the Palaearctic and Nearctic Regions. We retained these species in the checklist as they were already in the list of mosquito catalog and mosquito taxonomic inventory. Similarly, five species retained in genus "*Ochlerotatus*" and subgenus "*Finlaya*" (*Oc. auronitens*, *Oc. oreophilus*, *Oc. sintoni*, *Oc. suffusus* and *Oc. versicolor*) are yet to be placed in relevant genera in the current classification.

Tribe Culicini: Culicini includes 81 species in two genera and seven subgenera in India.

Genus *Culex*: Genus *Culex* is represented by 77 species in six subgenera in India with *Lophoceraomyia* being the predominant subgenus with 28 species, followed by subgenus *Culex* with 23 species. This genus contains many important vectors of Japanese encephalitis (JE) virus and microfilariae in India. In subgenus *Culex*, Vishnui Subgroup contains three most important vectors (*Cx. tritaeniorhynchus*, *Cx. vishnui* and *Cx. pseudovishnui*) of JE in India. Presence of another three members in this subgroup i.e. *Cx. alienus*, *Cx. perplexus* and *Cx. whitei*, which can only be identified distinctively from other members on the basis of larval, pupal and male phallosome characters (Sirivanakarn 1976), can create diagnostic problem in JE vector surveillance in areas of their occurrence. Barraud (1934) earlier collected larvae of *Cx. whitei* from Haflong area of Assam. Few larvae of *Cx. alienus* which is regarded as one of the uncommon members by Sirivanakarn (1976) within this subgroup were collected from Assam. *Cx. perplexus* earlier known only from Andaman Islands was also reported from mangrove forests of Orissa (Rajavel et al. 2005c).

In subgenus *Culiciomyia*, Rajput and Singh (1987a) first reported *Cx. harrisoni* from Senapati district of Manipur. *Cx. spathifurca* was reported for the first time during a mosquito faunistic study in a mangrove forest ecosystem of Tamil Nadu (Rajavel et al. 1998). *Cx. scanloni* known earlier from Indonesia, Malaysia, Thailand and Vietnam was detected from Nagarhole National Park, Karnataka (Rajavel et al. 2011).

Subgenus *Eumelanomyia* is now represented by 10 species in India. One species *Cx. hinglungensis* was reported first time from Manipur state of India (Rajput and Singh 1989).

In subgenus *Lophoceraomyia* one new species *Cx. singhbhumensis* was described from Orissa (Natarajan and Rajavel 2009). Several other species were also recorded from various parts of India such as *Cx. lasiopalpis* and *Cx. pholeter* from south India (Reuben et al. 1993), *Cx. quadripalpis* from the northeast India (Bhattacharyya et al. 2003) and *Cx. pilifemoralis* and *Cx. wilfredi* from Jeypore hills, Orissa (Rajavel et al. 2005b), are new addition to

the mosquito fauna of India. Similarly *Cx. aculeatus*, *Cx. paraculeatus* and *Cx. gracicornis* from Assam, *Cx. cubitatus* from Andaman and Nicobar Islands and *Cx. inculus* and *Cx. demissus* from Orissa are new country records (Rajavel et al. 2011). *Cx. wardi* previously known only from Sri Lanka was recently collected from Kerela state (Vector Control Research Centre, Puducherry, unpublished report).

The subgenus *Maillotia* is represented by only one species in India.

Tanaka (2004) resurrected *Oculeomyia* from synonymy as a new subgenus of genus *Culex*, which includes species earlier placed in the *Bitaeniorhynchus* Subgroup of subgenus *Culex*. This subgenus includes 6 species in India. Under this subgenus two females of *Cx. luzonensis* resting on vegetation were collected from Alwar, Rajasthan (Rajavel et al. 2011).

Genus *Lutzia*: It contains four species all in subgenus *Metalutzia*. A new species *Lt. agranensis* was described by Singh and Prakash (2008).

Tribe Culisetini: This tribe includes a single genus. Three species under two subgenera were recorded from India.

Tribe Ficalbiini: The tribe includes two genera i.e. *Ficalbia* and *Mimomyia*. One species of *Ficalbia* and six species of *Mimomyia* are found in India.

Tribe Hodgesiini: Tribe Hodgesiini includes a single genus and represented by only one species in India.

Tribe Mansoniini: Two genera are included in this tribe. The genus *Coquillettidia* includes three species and genus *Mansonia* is represented by four species in India.

Tribe Orthopodomyiini: Only one genus is included in this tribe which is represented by five species in India.

Tribe Sabethini: Sabethini includes 14 genera of which only three (*Malaya*, *Topomyia* and *Tripteroides*) are found in India. Genus *Malaya* is represented by two species and *Tripteroides* by eight species in India. Our experience indicates that genus *Tripteroides* requires further studies in India, especially in bamboo forested areas of the north-east India. Oriental in distribution (Thurman 1959), the genus *Topomyia* was represented by only one species in India, till Bhattacharyya et al. (2007) added three more species from Arunachal Pradesh. Further collections in high rainfall forested areas may increase the number of species in this genus.

Tribe Toxorhynchitini: Only one genus is included in this tribe. The genus *Toxorhynchites* includes nine species in India. *Tx. tyagii* is a new species described from Nilgiri hills, Western Ghats, southern India (Krishnamoorthy et al. 2013).

Tribe Uranotaeniini: *Uranotaenia* is the only genus in this tribe represented by 28 species (15 in subgenus *Pseudoficalbia* and 13 in subgenus *Uranotaenia*) in India. *Ur. micans* was first reported from India from Manipur state (Rajput and Singh 1990). Subsequently, *Ur. ohamai* was recorded from Western Ghats, South India (Reuben et al. 1993). *Ur. dibrugarhensis* is a new species described from Dibrugarh district of Assam (Bhattacharyya et al. 2004b). *Ur. rutherfordi* reported only from Sri Lanka was recently collected from Kerela state (Vector Control Research Centre, Puducherry, unpublished report).

At least 31 species are recognized in India for transmitting various pathogens to humans (Table 2).

Mosquito taxonomy provides essential inputs for vector control. In Vietnam, non-vector species *An. varuna* was misidentified as *An. minimus* and targeted as vector (Bortel et al 2001). *An. fluviatilis*, a recognized primary vector of malaria in the north-east India (Mohapatra et al. 1998) is now found to be a seasonal variant of *An. minimus* (Singh et al. 2010). In respect of malaria vectors, Manguin et al. (2008) suggested that vector control in a region is dependent on the numbers and complexity of the primary and secondary vectors and hence, requires study of the whole anopheline fauna in order to integrate the diverse information about vector system to formulate appropriate and effective control strategy. Besides, sylvatic cycles of some unknown arboviruses capable of spreading to humans may thrive in our forest ecosystem. The history of Chikungunya virus available in the web resource database of Chikungunya Virus Net suggested this virus to be originally circulated in the sylvatic cycle between forest dwelling mosquitoes and non-human primates, has now spread to different parts of the world including India. These facts clearly signify the importance of mosquito fauna study.

Limited studies carried out in some parts of India since the 1980s detected several new species and many new country records. With the increasing mosquito borne diseases and changing ecology there is a need for the reassessment of Indian Culicidae fauna. Comprehensive surveys with the incorporation of DNA-based methods such as DNA barcoding of mosquitoes (Pradeep Kumer et al. 2007) need to be undertaken on a large scale.

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APPENDIX 1. Systematic checklist of mosquitoes of India.

Subfamily Anophelinae

Genus *Anopheles* Meigen, 1818

Subgenus *Anopheles* Meigen, 1818

ANGUSTICORN SECTION

Anopheles Series

Aitkenii Group

Anopheles (*Anopheles*) *aitkenii* James, 1903

Anopheles (*Anopheles*) *bengalensis* Puri, 1930

Anopheles (*Anopheles*) *insulaeflorum* (Swellengrebel & Swellengrebel de Graaf, 1920)

Anopheles (*Anopheles*) *pinjaurensis* Barraud, 1932

Culiciformis Group

Anopheles (*Anopheles*) *culiciformis* Cogill, 1903

Anopheles (*Anopheles*) *sintoni* Puri, 1929

Lindesayi Group

Gigas Complex

Anopheles (*Anopheles*) *baileyi* Edwards, 1929

Anopheles (*Anopheles*) *gigas* Giles, 1901

Lindesayi Complex

Anopheles (*Anopheles*) *lindesayi* Giles, 1900

Anopheles (*Anopheles*) *nilgiricus* Christophers, 1924

Plumbeus Group

Anopheles (*Anopheles*) *barianensis* James, 1911

Lophoscelomyia Series

Asiaticus Group

Anopheles (*Anopheles*) *annandalei* Prashad, 1918

Interruptus Subgroup

Anopheles (*Anopheles*) *interruptus* Puri, 1929

LATICORN SECTION

Myzorhynchus Series

Barbirostris Group

Barbirostris Subgroup

Anopheles (*Anopheles*) *barbirostris* van der Wulp, 1884

Anopheles (*Anopheles*) *hodgkini* Reid, 1962

Vanus Subgroup

Anopheles (*Anopheles*) *ahomi* Chowdhury, 1929

Anopheles (*Anopheles*) *barbumbrosus* Strickland & Chowdhury, 1927

Hyrcanus Group

Anopheles (*Anopheles*) *argyropus* (Swellengrebel, 1914)

Anopheles (*Anopheles*) *sinensis* Wiedemann, 1828

Lesteri Subgroup

Anopheles (*Anopheles*) *crawfordi* Reid, 1953

Anopheles (*Anopheles*) *lesteri* Baisas & Hu, 1936

Anopheles (*Anopheles*) *peditaeniatus* (Leicester, 1908)

Nigerrimus Subgroup

Anopheles (*Anopheles*) *nigerrimus* Giles, 1900

Anopheles (*Anopheles*) *nitidus* Harrison, Scanlon & Reid, 1973

Umbrosus Group

Letifer Subgroup

Anopheles (*Anopheles*) *roperi* Reid, 1950

Umbrosus Subgroup

Anopheles (*Anopheles*) *umbrosus* (Theobald, 1903)

Subgenus *Cellia* Theobald, 1902

Myzomyia Series

Anopheles (*Cellia*) *majidi* Young & Majid, 1928

Funestus Group

Anopheles (*Cellia*) *jeyporiensis* James, 1902

Aconitus Subgroup

APPENDIX 1. Continued.

- Anopheles (Cellia) aconitus* Donitz, 1902
Anopheles (Cellia) varuna Iyengar, 1924
 Culicifacies Subgroup
Anopheles (Cellia) culicifacies Giles, 1901 (species A, B, C, D and E)
 Minimus Subgroup
 Fluviatilis Complex
Anopheles (Cellia) fluviatilis James, 1902 (species S, T, U and V)
 Minimus Complex
Anopheles (Cellia) minimus Theobald, 1901
 Neocellia Series
Anopheles (Cellia) karwari (James, 1903)
Anopheles (Cellia) moghulensis Christophers, 1924
Anopheles (Cellia) pulcherrimus Theobald, 1902
Anopheles (Cellia) stephensi Liston, 1901
Anopheles (Cellia) theobaldi Giles, 1901
 Annularis Group
Anopheles (Cellia) annularis van der Wulp, 1884 (species A and B)
Anopheles (Cellia) pallidus Theobald, 1901
Anopheles (Cellia) philippinensis Ludlow, 1902
 Nivipes Complex
Anopheles (Cellia) nivipes (Theobald, 1903)
 Jamesii Group
Anopheles (Cellia) jamesii Theobald, 1901
Anopheles (Cellia) pseudojamesi Strickland & Chowdhury, 1927
Anopheles (Cellia) splendidus Koidzumi, 1920
 Maculatus group
Anopheles (Cellia) pseudowillmori (Theobald, 1910)
Anopheles (Cellia) willmori (James, 1903)
 Maculatus Subgroup
Anopheles (Cellia) dravidicus Christophers, 1924
Anopheles (Cellia) maculatus Theobald, 1901
 Sawadwongporni Subgroup
Anopheles (Cellia) sawadwongporni Rattananarithikul & Green, 1987
Anopheles (Cellia) rampae Harbach & Somboon, 2011
 Neomyzomyia Series
 Kochi Group
Anopheles (Cellia) kochi Donitz, 1901
 Leucosphyrus Group
 Hackeri Subgroup
Anopheles (Cellia) mirans Sallum & Peyton, 2005
 Leucosphyrus Subgroup
 Dirus complex
Anopheles (Cellia) baimaii Sallum & Peyton, 2005
Anopheles (Cellia) elegans (James, 1903)
 Tessellatus Group
Anopheles (Cellia) tessellatus Theobald, 1901
 Paramyzomyia Series
 Cinereus Group
Anopheles (Cellia) turkhudi Liston, 1901
 Pyretophorus Series
Anopheles (Cellia) pseudosundaicus (Tyagi, Hiriyan, Tewari, Ayanar, Samuel, Arunachalam, Paramsivam, Krishnamoorthy, Dhanajeyan, Leo & Rajendran, 2009)
Anopheles (Cellia) vagus Donitz, 1902
 Subpictus complex
Anopheles (Cellia) subpictus Grassi, 1899 (species A, B, C and D)
 Sundaicus Complex
Anopheles (Cellia) sundaicus (Rodenwaldt, 1925) (cytotype D)
- Subfamily Culicinae**
Tribe Aedeomyiini
Genus Aedeomyia Theobald, 1901
Subgenus Aedeomyia Theobald, 1901
Aedeomyia (Aedeomyia) catastica Knab, 1909
Tribe Aedini
Genus "Aedes" sensu auctorum
Aedes kolhapuriensis Sathe & Girhe, 2001
Aedes panchgangee Sathe & Girhe, 2001
Aedes sangitee Sathe & Girhe, 2001
Aedes sangiti Girhe & Sathe, 2001
Genus Aedimorphus Theobald, 1903
Aedimorphus alboscuteclatus (Theobald, 1905)
Aedimorphus caecus (Theobald, 1901)
Aedimorphus culicinus (Edwards, 1922)
Aedimorphus jamesi (Edwards, 1914)
Aedimorphus lowisii (Theobald, 1910)
Aedimorphus nigrostriatus (Barraud, 1927)
Aedimorphus pallidostratus (Theobald, 1907)
Aedimorphus pampangensis (Ludlow, 1905)
Aedimorphus pipersalatus (Giles, 1902)
Aedimorphus punctifemoris (Ludlow, 1921)
Aedimorphus stenoetrus (Theobald, 1907)

APPENDIX 1. Continued.

- Aedimorphus syntheticus* (Barraud, 1928)
Aedimorphus taeniorhynchoides (Christophers, 1911)
Aedimorphus trimaculatus (Theobald, 1905)
Aedimorphus vexans (Meigen, 1830)
- Genus *Armigeres*** Theobald, 1901
- Subgenus *Armigeres*** Theobald, 1901
- Armigeres (Armigeres) aureolineatus* (Leicester, 1908)
Armigeres (Armigeres) durhami (Edwards, 1917)
Armigeres (Armigeres) joloensis (Ludlow, 1904)
Armigeres (Armigeres) kesseli Ramalingam, 1987
Armigeres (Armigeres) kuchingensis Edwards, 1915
Armigeres (Armigeres) mahantai Bhattacharyya, Prakash, Mohapatra & Sarma, 2009
Armigeres (Armigeres) pallithorax Dong, Zhou & Dong, 2004
Armigeres (Armigeres) subalbatus (Coquillett, 1898)
Armigeres (Armigeres) theobaldi Barraud, 1934
- Subgenus *Leicesteria*** Theobald, 1904
- Armigeres (Leicesteria) annulipalpis* (Theobald, 1910)
Armigeres (Leicesteria) annulitarsis (Leicester, 1908)
Armigeres (Leicesteria) cingulatus (Leicester, 1908)
Armigeres (Leicesteria) dentatus Barraud, 1927
Armigeres (Leicesteria) digitatus (Edwards, 1914)
Armigeres (Leicesteria) dolicocephalus (Leicester, 1908)
Armigeres (Leicesteria) flavus (Leicester, 1908)
Armigeres (Leicesteria) inchoatus Barraud, 1927
Armigeres (Leicesteria) longipalpis (Leicester, 1904)
Armigeres (Leicesteria) magnus (Theobald, 1908)
Armigeres (Leicesteria) omissus (Edwards, 1914)
- Genus *Ayurakitia*** Thurman, 1954
- Ayurakitia peytoni* (Reinert, 1972)
- Genus *Bruceharrisonius*** Reinert, 2003
- Bruceharrisonius aureostriatus* (Doleschall, 1857)
Bruceharrisonius christophersi (Edwards, 1922)
Bruceharrisonius doonii (Wattal, Bhatia & Kalra, 1958)
Bruceharrisonius greenii (Theobald, 1903)
- Genus *Christophersiomyia*** Barraud, 1923
- Christophersiomyia annulirostris* (Theobald, 1905)
Christophersiomyia gombakensis (Mattingly, 1959)
Christophersiomyia ibis (Barraud, 1931)
Christophersiomyia thomsoni (Theobald, 1905)
- Genus *Cancraedes*** Edwards, 1929
- Cancraedes cancricomus* (Edwards, 1922)
Cancraedes simplex (Theobald, 1903)
- Genus *Collessius*** Reinert, Harbach & Kitching, 2006
- Subgenus *Collessius*** Reinert, Harbach & Kitching, 2006
- Collessius (Collessius) elsiae* (Barraud, 1923)
Collessius (Collessius) macdougalli (Edwards, 1922)
Collessius (Collessius) shortti (Barraud, 1923)
- Subgenus *Alloeomyia*** Reinert, Harbach & Kitching, 2008
- Collessius (Alloeomyia) pseudotaeniatus* (Giles, 1901)
- Genus *Danielsia*** Theobald, 1904
- Danielsia albotaeniata* (Leicester, 1904)
Danielsia lepchana (Barraud, 1923)
- Genus *Dendroskusea*** Edwards, 1929
- Dendroskusea kanarensis* (Edwards, 1934)
Dendroskusea micropterus (Giles, 1901)
Dendroskusea periskelata (Giles, 1902)
Dendroskusea ramachandrai (Reuben, 1967)
Dendroskusea reginae (Edwards, 1922)
- Genus *Downsiomyia*** Vargas, 1950
- Downsiomyia albolateralis* (Theobald, 1908)
Downsiomyia albonivea (Barraud, 1934)
Downsiomyia mohani (Knight, 1969)
Downsiomyia nivea (Ludlow, 1903)
Downsiomyia niveoides (Barraud, 1934)
Downsiomyia novonivea (Barraud, 1934)
- Genus *Edwardsaedes*** Belkin, 1962
- Edwardsaedes imprimens* (Walker, 1861)
- Genus *Finlaya*** Theobald, 1903
- Finlaya flavipennis* Giles, 1904
Finlaya poicilia Theobald, 1903
- Genus *Fredwardsius*** Reinert, 2000
- Fredwardsius vittatus* (Bigot, 1861)
- Genus *Gilesius*** Reinert, Harbach & Kitching, 2006
- Gilesius pulchriventer* (Giles, 1901)
- Genus *Himalaius*** Reinert, Harbach & Kitching, 2006
- Himalaius gilli* (Barraud, 1924)
Himalaius simlensis (Edwards, 1922)
- Genus *Heizmannia*** Ludlow, 1905
- Subgenus *Heizmannia*** Ludlow, 1905
- Heizmannia (Heizmannia) aureochaeta* (Leicester, 1908)

APPENDIX 1. Continued.

- Heizmannia (Heizmannia) chandi* Edwards, 1922
Heizmannia (Heizmannia) chengi Lien, 1968
Heizmannia (Heizmannia) complex (Theobald, 1910)
Heizmannia (Heizmannia) covelli Barraud, 1929
Heizmannia (Heizmannia) funerea (Leicester, 1908)
Heizmannia (Heizmannia) greenii (Theobald, 1905)
Heizmannia (Heizmannia) himalayensis Edwards, 1922
Heizmannia (Heizmannia) indica (Theobald, 1905)
Heizmannia (Heizmannia) reidi Mattingly, 1957
Heizmannia (Heizmannia) viridis Barraud, 1929
- Subgenus *Mattinglyia*** Lien, 1968
Heizmannia (Mattinglyia) discrepans (Edwards, 1922)
Heizmannia (Mattinglyia) tripunctata (Theobald, 1908)
- Genus *Hopkinsius*** Reinert, Harbach & Kitching, 2008
- Subgenus *Yamada*** Reinert, Harbach & Kitching, 1908
Hopkinsius (Yamada) albocinctus (Barraud, 1924)
- Genus *Hulecoeteomyia*** Theobald, 1904
Hulecoeteomyia chrysolineata (Theobald, 1907)
Hulecoeteomyia formosensis (Yamada, 1921)
Hulecoeteomyia harveyi (Barraud, 1923)
Hulecoeteomyia pallirostris (Edwards, 1922)
Hulecoeteomyia saxicola (Edwards, 1922)
- Genus *Jihlienius*** Reinert, Harbach & Kitching, 2006
Jihlienius uncinatus Edwards, 1922
- Genus *Kenknightia*** Reinert, 1990
Kenknightia dissimilis (Leicester, 1908)
Kenknightia karwari (Barraud, 1924)
- Genus *Lorrainea*** Belkin, 1962
Lorrainea amesii (Ludlow, 1903)
Lorrainea fumida (Edwards, 1928)
- Genus *Mucidus*** Theobald, 1901
- Subgenus *Mucidus*** Theobald, 1901
Mucidus (Mucidus) laniger (Wiedemann, 1820)
Mucidus (Mucidus) quasiferinus (Mattingly, 1961)
Mucidus (Mucidus) scatophagoides Theobald, 1901
- Genus *Neomelaniconion*** Newstead, 1907
Neomelaniconion lineatopenne (Ludlow, 1905)
- Genus *Ochlerotatus*** Lynch Arribalzaga, 1891
 Unassigned to Subgenus
Ochlerotatus pullatus (Coquillett, 1904)
- Genus "*Ochlerotatus*" sensu auctorum**
- Subgenus '*Finlaya*' sensu auctorum**
Ochlerotatus (Finlaya) auronitens Edwards, 1922
Ochlerotatus (Finlaya) oreophilus Edwards, 1916
Ochlerotatus (Finlaya) sintoni (Barraud, 1924)
Ochlerotatus (Finlaya) suffusus (Edwards, 1922)
Ochlerotatus (Finlaya) versicolor (Barraud, 1924)
- Genus *Paraedes*** Edwards, 1934
Paraedes barraudi Edwards, 1934
Paraedes chrysoscuta (Theobald, 1910)
Paraedes menoni Mattingly, 1958
Paraedes ostentatio Leicester, 1908
- Genus *Petermattinglyius*** Reinert, Harbach & Kitching, 2009
- Subgenus *Petermattinglyius*** Reinert, Harbach & Kitching, 2009
Petermattinglyius (Petermattinglyius) franciscoi (Mattingly, 1959)
Petermattinglyius (Petermattinglyius) iyengari (Edwards, 1923)
- Genus *Phagomyia*** Theobald, 1905
Phagomyia assamensis (Theobald, 1908)
Phagomyia cacharana (Barraud, 1923)
Phagomyia cogilli (Edwards, 1922)
Phagomyia deccana (Barraud, 1923)
Phagomyia feegradei (Barraud, 1934)
Phagomyia gubernatoris (Giles, 1901)
Phagomyia inquinata Edwards, 1922
Phagomyia khazani (Edwards, 1922)
Phagomyia lophoventralis (Theobald, 1910)
Phagomyia prominens (Barraud, 1923)
Phagomyia stvensoni (Barraud, 1923)
- Genus *Rhinoskusea*** Edwards, 1929
Rhinoskusea longirostris (Leicester, 1908)
Rhinoskusea portonovoensis (Tewari & Hiriyan, 1992)
Rhinoskusea wardi (Reinert, 1976)
- Genus *Scutomyia*** Theobald, 1904
Scutomyia albolineata Theobald, 1904
- Genus *Stegomyia*** Theobald, 1901
- Subgenus *Actinothrix*** Reinert, Harbach & Kitching, 2009
Stegomyia (Actinothrix) edwardsi Barraud, 1923
Stegomyia (Actinothrix) seampi (Huang, 1974)
- Subgenus *Heteraspidion*** Reinert, Harbach & Kitching, 2009
Stegomyia (Heteraspidion) annandalei Theobald, 1910
Stegomyia (Heteraspidion) craggy Barraud, 1923

APPENDIX 1. Continued.

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

Subgenus *Stegomyia* Theobald, 1901
Stegomyia (Stegomyia) aegypti (Linnaeus, 1762)

Subgenus *Xyele* Reinert, Harbach & Kitching, 2006
Stegomyia (Xyele) desmotes Giles, 1904

Species without subgeneric placement
Stegomyia w-alba Theobald, 1905
Stegomyia gardnerii Ludlow, 1905
Stegomyia albopicta (Skuse, 1895)
Stegomyia novalbopicta (Barraud, 1931)
Stegomyia patriciae (Mattingly, 1954)
Stegomyia pseudalbopicta Borel, 1928
Stegomyia subalbopicta (Barraud, 1931)
Stegomyia unilineata (Theobald, 1906)
Stegomyia krombeini (Huang, 1975)
Stegomyia malayensis (Colless, 1962)
Stegomyia scutellaris (Walker, 1858)

Genus *Udaya* Thurman, 1954
Udaya argyrurus (Edwards, 1934)
Udaya subsimilis (Barraud, 1927)

Genus *Tewarius* Reinert, 2006
Tewarius agastyai (Tewari & Hiriyan, 1992)
Tewarius nummatus (Edwards, 1923)
Tewarius reubena (Tewari & Hiriyan, 1992)

Genus *Verrallina* Theobald, 1903

Subgenus *Harbachius* Reinert, 1999
Verrallina (Harbachius) abdita (Barraud, 1931)
Verrallina (Harbachius) consonensis (Reinert, 1973)
Verrallina (Harbachius) uniformis (Theobald, 1910)
Verrallina (Harbachius) yusafi (Barraud, 1931)

Subgenus *Neomacleaya* Theobald, 1907
Verrallina (Neomacleaya) agrestis (Barraud, 1931)
Verrallina (Neomacleaya) andamanensis (Edwards, 1922)
Verrallina (Neomacleaya) assamensis Bhattacharyya, Tewari, Prakash, Mohapatra & Mahanta, 2004
Verrallina (Neomacleaya) atria (Barraud, 1928)
Verrallina (Neomacleaya) cauta (Barraud, 1928)
Verrallina (Neomacleaya) ceylonica (Edwards, 1917)
Verrallina (Neomacleaya) clavata (Barraud, 1931)
Verrallina (Neomacleaya) comata (Barraud, 1931)
Verrallina (Neomacleaya) indica (Theobald, 1907)
Verrallina (Neomacleaya) pseudodiurna (Theobald, 1910)
Verrallina (Neomacleaya) pseudomediofasciata (Theobald, 1910)
Verrallina (Neomacleaya) rami (Barraud, 1928)
Verrallina (Neomacleaya) seculata (Menon, 1950)
Verrallina (Neomacleaya) unca (Theobald, 1901)
Verrallina (Neomacleaya) vallistris (Barraud, 1928)
Verrallina (Neomacleaya) yerburyi (Edwards, 1917)

Subgenus *Verrallina* Theobald, 1903
Verrallina (Verrallina) butleri (Theobald, 1901)
Verrallina (Verrallina) dux (Dyar & Shannon, 1925)
Verrallina (Verrallina) lugubris (Barraud, 1928)

Tribe Culicini

Genus *Culex* Linnaeus, 1758

Subgenus *Culex* Linnaeus, 1758

Piapiens Group
Culex (Culex) nilgiricus Edwards, 1916
 Piapiens Subgroup
Culex (Culex) quinquefasciatus Say, 1823
 Theileri Subgroup
Culex (Culex) theileri Theobald, 1903
 Trifilatus Subgroup
Culex (Culex) hutchinsoni Barraud, 1924
Culex (Culex) vagans Wiedemann, 1828
 Univittatus Subgroup
Culex (Culex) fuscocephala Theobald, 1907
Culex (Culex) perexiguus Theobald, 1903
 Sitiens Group
 Barraudi Subgroup
Culex (Culex) barraudi Edwards, 1922
Culex (Culex) edwardsi Barraud, 1923
 Gelidus Subgroup
Culex (Culex) gelidus Theobald, 1901
 Mimeticus Subgroup
Culex (Culex) jacksoni Edwards, 1934
Culex (Culex) mimeticus Noe, 1899
Culex (Culex) mimuloides Barraud, 1924
Culex (Culex) mimulus Edwards, 1915
Culex (Culex) murrelli Lien, 1968

APPENDIX 1. Continued.

- Sitiens Subgroup
Culex (Culex) sitiens Wiedemann, 1828
Culex (Culex) whitmorei (Giles, 1904)
- Vishnui Subgroup
Culex (Culex) alienus Colless, 1957
Culex (Culex) pseudovishnui Colless, 1957
Culex (Culex) perplexus Leicester, 1908
Culex (Culex) tritaeniorhynchus Giles, 1901
Culex (Culex) vishnui Theobald, 1901
Culex (Culex) whitei Barraud, 1923
- Subgenus *Culiciomyia*** Theobald, 1907
- Fragilis Group
Culex (Culiciomyia) fragilis Ludlow, 1903
Culex (Culiciomyia) nigropunctatus Edwards, 1926
Culex (Culiciomyia) pallidothorax Theobald, 1905
Culex (Culiciomyia) ramakrishnii Wattal & Kalra, 1965
Culex (Culiciomyia) scanloni Bram, 1967
Culex (Culiciomyia) spathifurca (Edwards, 1915)
Culex (Culiciomyia) viridiventer Giles, 1901
- Shebbearei Group
Culex (Culiciomyia) bailyi Barraud, 1934
Culex (Culiciomyia) shebbearei Barraud, 1924
- Subgenus *Eumelanomyia*** Theobald, 1909
- Mochthogenes Group
- Foliatus Subgroup
Culex (Eumelanomyia) foliatus Brug, 1932
- Hinglungensis Subgroup
Culex (Eumelanomyia) castrensis Edwards, 1922
Culex (Eumelanomyia) hinglungensis Chu, 1957
- Iphis Subgroup
Culex (Eumelanomyia) iphis Barraud, 1924
- Khazani Subgroup
Culex (Eumelanomyia) khazani Edwards, 1922
- Malayi Subgroup
Culex (Eumelanomyia) malayi (Leicester, 1908)
- Pluvialis Subgroup
Culex (Eumelanomyia) pluvialis Barraud, 1924
- Tenuipalpis Subgroup
Culex (Eumelanomyia) tenuipalpis Barraud, 1924
Culex (Eumelanomyia) mohani Sirivanakarn, 1977
- Protomelanoconion Group
Culex (Eumelanomyia) brevipalpis (Giles, 1902)
- Subgenus *Lophoceraomyia*** Theobald, 1905
- Fraudatrix Group
- Fraudatrix Subgroup
- Cinctellus complex
Culex (Lophoceraomyia) cinctellus Edwards, 1922
- Quadripalpis complex
Culex (Lophoceraomyia) aculeatus Colless, 1965
Culex (Lophoceraomyia) paraculeatus Sirivanakarn, 1977
Culex (Lophoceraomyia) quadripalpis (Edwards, 1914)
- Rubithoracis complex
Culex (Lophoceraomyia) rubithoracis (Leicester, 1908)
- Seniori complex
Culex (Lophoceraomyia) seniori Barraud, 1934
- Variatus complex
Culex (Lophoceraomyia) cubitatus Colless, 1965
Culex (Lophoceraomyia) gracicornis Sirivanakarn, 1977
Culex (Lophoceraomyia) variatus (Leicester, 1908)
Culex (Lophoceraomyia) macdonaldi Colless, 1965
- Inculus complex
Culex (Lophoceraomyia) inculus Colless, 1965
- Minutissimus Subgroup
Culex (Lophoceraomyia) minutissimus (Theobald, 1907)
Culex (Lophoceraomyia) infantulus Edwards, 1922
- Mammilifer Group
- Mammilifer Subgroup
- Flavicornis complex
Culex (Lophoceraomyia) flavicornis Barraud, 1924
Culex (Lophoceraomyia) lasiopalpis Sirivanakarn, 1977
Culex (Lophoceraomyia) raghavanii Rahman, Chowdhury & Kalra, 1968
- Singhbhumensis complex
Culex (Lophoceraomyia) singhbhumensis Natarajan & Rajavel, 2009
- Mammilifer complex
Culex (Lophoceraomyia) mammilifer (Leicester, 1908)
Culex (Lophoceraomyia) demissus Colless, 1965
Culex (Lophoceraomyia) wardi Sirivanakarn, 1977
- Traubi complex
Culex (Lophoceraomyia) uniformis (Theobald, 1905)

APPENDIX 1. Continued.

Minor complex

- Culex (Lophoceraomyia) bengalensis* Barraud, 1934
Culex (Lophoceraomyia) bicornutus (Theobald, 1910)
Culex (Lophoceraomyia) minor (Leicester, 1908)

Peytoni complex

- Culex (Lophoceraomyia) peytoni* Bram & Rattanaarithikul, 1967

Pholeter complex

- Culex (Lophoceraomyia) pholeter* Bram & Rattanaarithikul, 1967

Wilfredi Group

- Culex (Lophoceraomyia) pilifemoralis* Wang & Feng, 1964
Culex (Lophoceraomyia) wilfredi Colless, 1965

Subgenus *Maillotia* Theobald, 1907

Hortensis Group

- Culex (Maillotia) hortensis* Ficalbi, 1889

Subgenus *Oculeomyia* Theobald, 1907

Bitaeniorhynchus Complex

- Culex (Oculeomyia) bitaeniorhynchus* Giles, 1901
Culex (Oculeomyia) infula Theobald, 1901
Culex (Oculeomyia) luzonensis Sirivanakarn, 1976

Sinensis Complex

- Culex (Oculeomyia) cornutus* Edwards, 1922
Culex (Oculeomyia) epidesmus (Theobald, 1910)
Culex (Oculeomyia) sinensis Theobald, 1903

Genus *Lutzia* Theobald, 1903**Subgenus *Metalutzia*** Tanaka, 2000

- Lutzia (Metalutzia) agranensis* Singh & Prakash, 2008
Lutzia (Metalutzia) fuscana Wiedemann, 1820
Lutzia (Metalutzia) halifaxii Theobald, 1903
Lutzia (Metalutzia) vorax Edwards, 1921

Tribe Culisetini**Genus *Culiseta*** Felt, 1904**Subgenus *Allotheobaldia*** Brolemann, 1919

- Culiseta (Allotheobaldia) longiareolata* (Macquart, 1838)

Subgenus *Culiseta* Felt, 1904

- Culiseta (Culiseta) alaskaensis* (Ludlow, 1906)
Culiseta (Culiseta) niveitaeniata (Theobald, 1907)

Tribe Ficalbiini**Genus *Ficalbia*** Theobald, 1903

- Ficalbia minima* (Theobald, 1901)

Genus *Mimomyia* Theobald, 1903**Subgenus *Etorleptiomyia*** Theobald, 1904

- Mimomyia (Etorleptiomyia) luzonensis* (Ludlow, 1905)

Subgenus *Mimomyia* Theobald, 1903

- Mimomyia (Mimomyia) aurea* (Leicester, 1908)
Mimomyia (Mimomyia) chamberlaini Ludlow, 1904
Mimomyia (Mimomyia) hybrida (Leicester, 1908)
Mimomyia (Mimomyia) intermedia (Barraud, 1929)

Subgenus *Ingramia* Edwards, 1912

- Mimomyia (Ingramia) fusca* (Leicester, 1908)

Tribe Hodgesiini**Genus *Hodgesia*** Belkin, 1962

- Hodgesia bailyi* Barraud, 1929

Tribe Mansoniini**Genus *Coquillettidia*** Dyar, 1905**Subgenus *Coquillettidia*** Dyar, 1905

- Coquillettidia (Coquillettidia) crassipes* (van der Wulp, 1881)
Coquillettidia (Coquillettidia) novochracea (Barraud, 1927)
Coquillettidia (Coquillettidia) ochracea (Theobald, 1903)

Genus *Mansonia* Blanchard, 1901**Subgenus *Mansonioides*** Theobald, 1907

- Mansonia (Mansonioides) annulifera* (Theobald, 1901)
Mansonia (Mansonioides) dives (Schiner, 1868)
Mansonia (Mansonioides) indiana Edwards, 1930
Mansonia (Mansonioides) uniformis (Theobald, 1901)

Tribe Orthopodomyiini**Genus *Orthopodomyia*** Belkin, Heinemann & Page, 1970

- Orthopodomyia albipes* Leicester, 1904
Orthopodomyia anopheloides (Giles, 1903)
Orthopodomyia andamanensis Barraud, 1934
Orthopodomyia flavicosta Barraud, 1927
Orthopodomyia flavithorax Barraud, 1927

Tribe Sabethini**Genus *Malaya*** Leicester, 1908

- Malaya genurostris* Leicester, 1908
Malaya jacobsoni (Edwards, 1930)

Genus *Topomyia* Leicester, 1908**Subgenus *Suaymyia*** Thurman, 1959

- Topomyia (Suaymyia) cristata* Thurman, 1959

Subgenus *Topomyia* Leicester, 1908

- Topomyia (Topomyia) bifurcata* Dong, Wang & Lu, 1995

APPENDIX 1. Continued.

Topomyia (Topomyia) aureoventer (Theobald, 1910)

Topomyia (Topomyia) hirtusa Gong, 1989

Genus *Tripteroides* Giles, 1904**Subgenus *Rachionotomyia*** Theobald, 1905

Tripteroides (Rachionotomyia) affinis (Edwards, 1913)

Tripteroides (Rachionotomyia) aranoides (Theobald, 1901)

Tripteroides (Rachionotomyia) coonorensis Mattingly, 1981

Tripteroides (Rachionotomyia) edwardsi (Barraud, 1929)

Tripteroides (Rachionotomyia) serratus (Barraud, 1929)

Subgenus *Tripteroides* Giles, 1904

Tripteroides (Tripteroides) indicus (Barraud, 1929)

Tripteroides (Tripteroides) similis (Leicester, 1908)

Tripteroides (Tripteroides) tarsalis Delfinado & Hodges, 1968

Tribe Toxorhynchitini**Genus *Toxorhynchites*** Theobald, 1901**Subgenus *Toxorhynchites*** Theobald, 1901

Toxorhynchites (Toxorhynchites) albipes (Edwards, 1922)

Toxorhynchites (Toxorhynchites) edwardsi (Barraud, 1924)

Toxorhynchites (Toxorhynchites) gravelyi (Edwards, 1921)

Toxorhynchites (Toxorhynchites) kempi (Edwards, 1921)

Toxorhynchites (Toxorhynchites) klossi (Edwards, 1921)

Toxorhynchites (Toxorhynchites) metallicus Leicester, 1904

Toxorhynchites (Toxorhynchites) minimus (Theobald, 1905)

Toxorhynchites (Toxorhynchites) splendens (Wiedemann, 1819)

Toxorhynchites (Toxorhynchites) tyagii Krishnamoorthy et al., 2013

Tribe Uranotaeniini**Genus *Uranotaenia*** Lynch Arribalzaga, 1891**Subgenus *Pseudoficalbia*** Theobald, 1912

Section A

Bicolor series

Uranotaenia (Pseudoficalbia) atra Theobald, 1905

Uranotaenia (Pseudoficalbia) bicolor Leicester, 1908

Uranotaenia (Pseudoficalbia) lutescens Leicester, 1908

Uranotaenia (Pseudoficalbia) obscura Edwards, 1915

Bimaculata Series

Uranotaenia (Pseudoficalbia) nivipleura Leicester, 1908

Uranotaenia (Pseudoficalbia) novobscura Barraud, 1934

Recondita Series

Uranotaenia (Pseudoficalbia) dibrugarhensis Bhattacharyya, Prakash, Mohapatra & Mahanta, 2004

Uranotaenia (Pseudoficalbia) husaini Qutubuddin, 1947

Uranotaenia (Pseudoficalbia) luteola Edwards, 1934

Uranotaenia (Pseudoficalbia) maculipleura Leicester, 1908

Uranotaenia (Pseudoficalbia) mattinglyi Qutubuddin, 1951

Uranotaenia (Pseudoficalbia) recondita Edwards, 1922

Uranotaenia (Pseudoficalbia) ohamai Tanaka, Mizusawa & Saugstad, 1975

Uranotaenia (Pseudoficalbia) stricklandi Barraud, 1926

Section B

Maxima Series

Uranotaenia (Pseudoficalbia) maxima Leicester, 1908

Subgenus *Uranotaenia* Lynch Arribalzaga

Uranotaenia (Uranotaenia) alboannulata (Theobald, 1905)

Uranotaenia (Uranotaenia) annandalei Barraud, 1926

Uranotaenia (Uranotaenia) campestris Leicester, 1908

Uranotaenia (Uranotaenia) christophersi Barraud, 1926

Uranotaenia (Uranotaenia) edwardsi Barraud, 1926

Uranotaenia (Uranotaenia) hebes Barraud, 1931

Uranotaenia (Uranotaenia) lateralis Ludlow, 1905

Uranotaenia (Uranotaenia) longirostris Leicester, 1908

Uranotaenia (Uranotaenia) micans Leicester, 1908

Uranotaenia (Uranotaenia) macfarlanei Edwards, 1914

Uranotaenia (Uranotaenia) orientalis Barraud, 1926

Uranotaenia (Uranotaenia) rutherfordi Edwards, 1922

Uranotaenia (Uranotaenia) testacea Theobald, 1905