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A BRIEF MOSQUITO SURVEY OF JAVA

Report of visit from 18 June to 15 July 1973

by

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I. Introduction

The Vector and Rodent Control Research Unit (VRCRU) was established in Jakarta in January 1973, by the World Health Organization and the Government of Indonesia, in order to conduct research on various aspects of insect vectors and rodent reservoirs of diseases in Indonesia. Among the arthropods of medical importance in Indonesia, the mosquitos constitute, by far, the most important group.

The mosquito fauna of Java is fairly rich and varied. The bulk of the studies carried out on this fauna was made by the early Dutch workers in the two decades prior to the Second World War. The important contributors among these were J. Bonne-Wepster, S. L. Brug, N. H. Swellengrebel and E. Rodenwaldt. Some of their more significant publications pertaining to the Java mosquitos, are listed in the bibliography. Among the post-war publications on the Java mosquitos, are Bonne-Wepster (1953), Brug & Bonne-Wepster (1947), Waktoedi (1954) and, Soemarlan & Oerip (1970). Three of these publications pertain to the genus Anopheles.

Prior to the present survey, a total of 145 species of mosquitos, included within 14 genera, were reported from Java. This included 27 species of Anopheles, 33 of Aedes, 30 of Culex, 4 of Mansonia, 5 of Toxorhynchites, 6 of Tripteroides, 4 of Topomyia, 6 of Ficalbia, 3 of Coquillettidia, 11 of Uranotaenia, 2 of Orthopodomyia, 1 of Aedeomyia and 13 of Armigeres. These species are listed in Appendix I.

Despite the earlier work on the Java mosquitos, there was a complete lack of convenient and adequate keys for the correct identification of the species belonging to the medically important mosquito genera, the only exception to this being the genus Anopheles. This lack was felt when the Unit began to function. In fact, the importance of sound taxonomy was stressed even during the planning phase of the VRCRU. The purpose of this consultantship was therefore: (i) to assist the Unit in a taxonomic review of the mosquito species occurring in their study areas around Jakarta and their field station in Ciloto; (ii) to prepare keys for the identification of the medically important genera of mosquitos and (iii) to assist the Unit in the establishment of a good mosquito reference collection.

At present, there are several collections of mosquitos in Java. The author is extremely grateful to the following entomologists for permitting him to examine their mosquito collections and for the discussions he had with them on the mosquito fauna of Java:

(1) Mr Soeroto Atmosoedjono, Entomologist at the United States Naval Medical Research Unit/2, C.D.C., Jakarta;

(2) Dr R. Immler of the Swiss Technical Cooperation, Central Public Health Laboratory, C.D.C., Jakarta;

(3) Miss Harijani, Chief of the Aedes Subdivision of the National Institute of Medical Research, C.D.C., Jakarta;

(4) Mr Hoedojo, Medical Entomologist, Department of Parasitology and General Pathology, School of Medicine, University of Indonesia;

(5) Dr Soenartono Adisoemarto, Entomologist, Zoological Museum, Bogor;

(6) Mr Rosad, VRCRU Field Station (Formerly Malaria Training Centre), Ciloto;

(7) Mr R. Waktoedi, Biology Department, Bandung Institute of Technology, Bandung.

Useful discussions were held with the following public health workers on mosquito taxonomy and disease transmission:

(1) Professor Dr T. Sulianti Saroso, Director-General, Communicable Disease Control, Department of Health, Jakarta;

(2) Professor Dr Sri Oemijati, Chief, Department of Parasitology and General Pathology, School of Medicine, University of Indonesia, Jakarta;

(3) Dr F. Partono, Department of Parasitology and General Pathology, School of Medicine, University of Indonesia, Jakarta;

(4) Dr P. F. D. Van Peenen, Chief, United States Naval Medical Research Unit/2, C.D.C., Jakarta;

(5) Dr S. W. Joseph, United States Naval Medical Research Unit/2, C.D.C., Jakarta;

(6) Dr S. Kadarsan, Director, Zoological Museum, Bogor. (Unfortunately, Dr Soenartono Adisoemarto was not at the museum at the time of our visit).

II. Field work in Java

The survey in Java was conducted for a period of four weeks, during the months of June and July 1973 (18 June - 15 July 1973). The author spent the bulk of this time with the VRCRU at Jakarta and a shorter period at their field station in Ciloto. The study sites were visited frequently and the surrounding areas were also surveyed for mosquitos. The dates spent at Jakarta and Ciloto are given below:

Jakarta and surrounding areas:		18 June - 15 July 1973
		9 July - 15 July 1973
Bogor	:	2 July 1973
Ciloto and surrounding areas	:	3 July - 8 July 1973
Bandung	:	6 July 1973

Jakarta City, lying on rather flat land at sea level, has a large population and a general lack of proper drainage and sanitation. Outside Jakarta City, the area is also low-lying and relatively flat. The rural areas consist of paddy fields and villages that are associated with the usual vegetation e.g. vegetable and fruit gardens, coconut, bamboo, banana, Nipa palm, Colocasia, etc. Ciloto is situated on a hill, at an elevation of about 4000 ft. The areas surrounding Ciloto, in which routine field work was carried out, range in elevation from 1000 ft to 4500 ft. Terrace cultivation of paddy is practised on the hills. Even here, the population density is relatively high. No secondary forests or dense tropical forests were encountered during the survey, the only areas resembling these, being the botanical gardens in Bogor and Cibodas.

To have an understanding of the mosquito fauna in a given area, it is necessary to obtain a large and representative number of good specimens. To achieve this, a variety of collection techniques were employed. Relevant ecological and biological data was obtained with each collection and this was recorded in the collecting, rearing and identification forms (see Appendix II). The collections were numbered in sequence beginning from In-95, as 94 collections had previously been made by the VRCR Unit.

The following types of mosquito collections were made in Java:

(a) Collections of immature stages: This type of collection is ideal for taxonomic purposes as it is possible to obtain both immature (larval and pupal) and adult stages. Furthermore, the adults are in excellent condition as they are freshly emerged. Further details and the

advantages of this mode of collection are given in Appendix V. A total of 101 larval collections were made from a large variety of breeding habitats, ranging from groundpools, ponds, lakes and streams, to tree holes, bamboo stumps and more specialized containers like leaf axils and pitcher plants.

(b) Adult collections

(1) Biting: These collections were made at night and during the day, while the female mosquitos attempted to feed on various hosts e.g. man, cattle, buffalo and pig. Many of these collections were part of the routine activities of the VRCRU. Mosquito identifications made by members of the Unit were confirmed by the author and a few specimens were sometimes retained for pinning. An idea of the relative abundance of each mosquito species, occurring during the period of the survey in Ciloto can be had from Appendix III. A total of 14 biting collections were made.

(2) Resting: Six collections of adult mosquitos were made while they rested on shrubs, tree trunks and in crab holes. They were collected off shrubbery by "sweep-netting".

(3) Light traps: Two overnight collections, using a Japanese black-light trap ("Catch-More") were made in Ciloto (4100 ft) and in Ciranjang (2600 ft elevation). The mosquitos attracted to the light were all females and were badly damaged by moths and other flying insects that were also attracted to the trap.

MOSQUITOS ATTRACTED TO BLACK-LIGHT TRAP

Species	Ciloto (2 July 1973)	Ciranjang (5 July 1973)
Anopheles (A.) barbirostris	1	1
Anopheles (C.) aconitus	1	32
Anopheles (C.) vagus	2	10
Culex (C.) bitaeniorhynchus	-	3
Culex (C.) fuscocephalus	2	42
Culex (C.) tritaeniorhynchus	2	103

III. Processing the material

A total of 122 collections were made during the survey. For each of these collections, a few relevant collecting data, along with the species obtained, is given in Appendix IV. The adult mosquitos that were collected were killed in the laboratory and glued to paper points, using ambroid. A temporary label with the collection number was attached to each specimen.

The immature collection was brought back to the laboratory with sufficient water from each specific breeding habitat. A few fourth instar larvae were removed from each collection, killed in hot water and preserved in 75% alcohol. The remaining larvae were allowed to emerge as mass and individual rearings. For individual rearings, a single fourth instar larva was kept separately in a vial and allowed to pupate. The larval skin was collected and preserved in alcohol, in a glass vial. When the adult mosquito emerged, its pupal skin was put in the same vial with the larval skin. In mass rearings, only the adults were harvested.

The adults that emerge from both mass and individual rearings were allowed to feed on glucose and were kept for approximately a day in order to harden. They were then killed by chloroform or ether and mounted on paper points. In the author's laboratory in Kuala Lumpur, permanent preparations were made of the whole larvae and the skins that had been preserved in 75% alcohol. Whole larvae were dehydrated, cleared and mounted on a slide, using eupèral as the mounting media. Both the larval- and pupal-skins were mounted in euperal, side by side, on the same slide.

A special set of slide and locality labels was printed for the Java collections. A locality label with the collection number and a species label were attached to each adult specimen. A printed slide label was fixed to each slide and a locality and identification label was then glued on to the slide label. In order to confirm identifications, a number of permanent slide preparations were also made of male genitalia.

Details of the procedures used in the rearing, mounting, labelling, etc. of the specimens are given in Appendix V.

IV. Taxonomic notes on the mosquito fauna of Java

The species collected during this survey represent the more common species occurring in the study areas. This is certainly true for the months of June and July and may, with a few exceptions, be true also for the entire year. Many of the species that were collected during this survey will not be obtained in routine adult collections as they may not require a blood meal or may have other feeding preferences.

The species of mosquitos obtained during this survey are listed in Appendix VI. This table also indicates, for each species, the number and type (adult or immature) of collections, the number of specimens obtained and the general localities in which they were obtained. A total of 10 genera and 60 species were collected, including nine species collected from Java for the first time and thus constituting new records. These are also indicated in Appendix VI.

(a) The medically important genera

(1) Anopheles

The genus Anopheles is represented in Java by 29 species, 14 of which belong to the subgenus Anopheles and the remaining 15 species to the subgenus Cellia.

Anopheles (Anopheles). Of the 14 species belonging to this subgenus that occur in Java, 12 belong to the following species groups: "aitkenii", "barbirostris", "hyrcanus" and "umbrosus". During this survey, the three species commonly encountered were A. barbirostris, A. nigerrimus and A. peditaeniatus. Of these, barbirostris was the most common Anopheline collected. The species group "barbirostris" includes, in Java, A. barbumbrosus and A. barbirostris. The former species was not obtained during this survey. Anopheles campestris, a member of the "barbirostris" group, is an important vector of malaria and of periodic Brugia malayi in Peninsula Malaysia. It is therefore important to know if this species also occurs in Java. This species was reported by Reid (1968) to occur only in Peninsular Malaysia and Southern Thailand. Reid (1968) has separated the adults of barbirostris from that of campestris by two important characters: (i) the extent and distribution of pale scales on the abdominal sternites; and (ii) the extent of dark scales on wing vein five. The adults collected in Java were carefully examined for these two characters and it was found that the first character (pale scales on abdominal sternites) was very much like that of the true barbirostris; whereas with the second character (dark scales on wing vein five), the specimens from Java showed a wider range of variations with some individuals having many more white scales on vein five (a barbirostris character) while others showed mostly dark scales on this wing vein (a campestris character). However, examination of the associated skins showed that these species were actually barbirostris. It appears, therefore, that campestris

is absent from the study areas. More collections will have to be made from a wider area to definitely ascertain that Anopheles campestris is, in fact, absent from Java.

The "hyrcanus" species group is represented in Java by A. argyropus, sinensis, nigerrimus and peditaeniatus. Of these, only the latter two species were collected during this survey. This group is apparently of no medical significance in Java.

The "umbrosus" species group is represented by A. baezai and A. umbrosus, and the "aitkenii" species group by A. aitkenii, bengalensis, insulaeflorum and palmatus. Members of these two species groups are not known to transmit any disease in Java.

Anopheles (Cellia). Fourteen species of this subgenus have previously been reported, of which nine species were collected during this survey. The species most commonly encountered was A. subpictus and A. vagus. The species of medical importance in this subgenus are A. aconitus, maculatus and sundaicus. Of these, the former two species were frequently encountered whereas A. sundaicus was not collected around the Jakarta area. Anopheles karwari was obtained in two adult collections. This is a new record in Java as this species has never been reported from the island previously.

The existing keys available to the Research Unit are adequate for the identification of Anopheles in Java. Reference should also be made to Reid's (1968) "Anopheles Mosquitoes of Malaya and Borneo", especially for identifications within the species groups.

(2) Aedes

Certain species of the genus Aedes are responsible for the transmission of viruses while others may be involved as vectors of filariasis. The genus Aedes is represented by the following subgenera in Java: Finlaya, Stegomyia, Aedimorphus, Neomelaniconion, Mucidus, Alanstonia, Diceromyia, Neomacleaya, Cancraedes, Verrallina and Paraedes. In Java, the last seven subgenera include only a single species in each subgenus.

Important generic characters. Adults are small to large mosquitos. Palpi of male rarely longer than proboscis, sometimes short; female palps one quarter as long as proboscis. Antennae of male more plumose than female. Bristles on scutum well-developed, especially prescutellar bristles; spiracular bristles absent but postspiracular bristles always present; lower mesepimeral bristle present or absent; postnotum without setae. Cerci of female long. Larvae without dorsal chitinous plates in abdominal segments. Siphon with well-developed pecten teeth and with a single pair of ventral hair-tufts. Anal segment with saddle; ventral fan well-developed.

Aedes (Stegomyia). This subgenus is the most important of the Aedes as it includes A. aegypti and A. albopictus, the vectors of dengue and dengue haemorrhagic fever. Six species of this subgenus have been reported to occur in Java i.e. aegypti, albolineatus, albopictus, annandalei, desmotes and pseudalbopictus. Aedes aegypti, the only member of "Group A" of Stegomyia is abundantly represented in Jakarta City. On closer examination of the few specimens, that were retained, it was seen they they were all of the "type form" though, undoubtedly the queenslandsis form also occurs in Java.

Aedes albopictus, a member of the "scutellaris" group, (Group C of Edwards 1932) is without doubt, the most dominant mosquito in Java, and was collected from urban, suburban, rural and semi-forested areas, from elevations ranging from sea level to that of 4500 ft. Of a total of 122 collections made from a variety of habitats in Java, 42 of these contained albopictus. A species easily confused with A. albopictus is A. pseudalbopictus. This species was only recently reported as occurring in Java by Huang (1972), who identified one male specimen from Lembang and another male from Tjandfoer in Java. In the present survey, seven collections were obtained of pseudalbopictus from Iwul and the Ciloto-Bandung area from elevations of 50 ft to 4100 ft. Five of these collections were made from bamboo stumps and

one each was made from coconut shell and Nipa palm axils. Apparently A. pseudalbopictus is more common than it was previously believed to be and care should be taken to correctly identify this species. Adults of pseudalbopictus can be distinguished from albopictus by having a patch of narrow, curved, white or yellowish-white scales on the lateral margin of the scutum, just before the level of the wing root. These scales are white and broad in albopictus. Furthermore, pseudalbopictus has a patch of broad, dark scales on each side of the prescutellar space, just before the scutellum. These scales are narrow in albopictus. The larval stage of pseudalbopictus resembles albopictus closely but can be distinguished from it by having a siphon acus present and by having three to six short and stout pecten teeth, each with three to four basal denticles.

Aedes annandalei was obtained in five collections in bamboo stumps from Bogor, Ciloto and Bandung Road. This species is known to bite man in deep shade. It can be easily recognized in both the adult and larval stages. Only two collections were obtained of A. albolineatus. A key is provided for the identification of adults in this subgenus. The larvae are included in the key to the larva of Aedes.

Aedes (Finlaya). This subgenus of Aedes includes 13 species previously recorded from Java. Only three of these were collected in this survey. Aedes (F.) poecilus, a member of the "kochi" group, was obtained in 11 collections. It is easily obtained in adult catches at night, in cattle and pig sheds, and will also bite man readily. The immature stages were obtained chiefly from leaf axils (Nipa palm, Pandanus, banana, alocasia) but are also found in bamboo stumps. Aedes poecilus is an important vector of Wuchereria bancrofti in the Philippines. A single male specimen was obtained of Aedes (F.) flavipennis. This species resembles A. poecilus in having the wings elaborately speckled with dark and light scales. They can be easily distinguished from each other by the characters given in the key (Appendix XII). This is the first time that flavipennis has been collected in Java and, therefore, this is a new record of this species in Java. It was obtained breeding in the leaf axils of Pandanus.

Four species of the "niveus" group were known to occur in Java i.e. alboniveus, idjenensis, niveoides and niveus. In Thailand, members of this group are suspected of being involved in the transmission of subperiodic Wuchereria bancrofti. Members of this group are generally container breeders and are commonly found in tree holes and bamboo stumps. During this survey, the predominant species of the "niveus" group in the Bogor-Ciloto area was found to be A. novoniveus, also a new record in Java. Five collections were made of this species from bamboo stumps. Members of this group can be separated by characters given in the key (Appendix XII).

The "chrysolineatus" group of Aedes (Finlaya) is represented in Java by four species i.e. chrysolineatus, formosensis, harveyi and saxicola. The only member of this group that was collected during this survey was A. formosensis. Two collections of immature stages were obtained in Ciloto, from banana leaf axils. A rather large collection of formosensis was obtained from the Botanical Garden at Cibodas at approximately 4500 ft elevation while they ferociously attacked man. It was noted that the pale scaling on the proboscis was very variable, with the majority of the specimens having a small patch of pale scales on the ventral aspect of the proboscis, a few pale scales on the lateral aspect and the dorsal aspect completely dark, and other specimens in which the pale scales covered the middle half of the proboscis on the ventral aspect and extended extensively on to the lateral and dorsal aspect as well. This apparently is a highly variable character in this species (Knight, 1968).

Aedes (Aedimorphus). Six species belonging to this subgenus have been reported from Java i.e. alboscutellatus, caecus, culicinus, mediolineatus, niveoscutellum and vexans. During this survey, three collections were made of Aedes (Aedi.) caecus in Iwul. This species will readily enter shelters to bite man and cattle. They breed in groundpools. A single collection of only two adult females was obtained of Aedes vexans while attempting to bite man in the coastal area of Kamal (Coll. In-158). These were allowed to feed and were kept for egg laying, but were unfortunately destroyed by ants.

Aedes (Diceromyia). The only other species of Aedes obtained in this survey was that of Aedes (D.) iyengari. Three immature collections were made of this species from tree holes. None were collected while attempting to feed on man, although they have been reported as biting man in Thailand (Scanlon & Esah, 1965).

Aedes (Mucidus). This subgenus is represented by a single species in Java i.e. laniger. The larval stages are predacious and feed on other mosquito larvae. These are found in groundpools. Adults are known to feed on man.

Aedes (Alanstonia). This subgenus is also represented by only one species in Java i.e. treubi. They breed in Nepenthes pitchers.

Aedes (Neomelaniconion). Two species of this subgenus occur in Java i.e. imprimens and lineatopennis. They breed in groundpools and swamps in forests. The adults bite man, but are not known to transmit any disease.

Neomacleaya, Cancraedes, Verrallina and Paraedes. These subgenus are each represented by a single species in Java i.e. Aedes (N.) dux; Aedes (C.) cancricomes; Aedes (V.) butleri and Aedes (P.) ostentatio. They are all found in swamps and are brackish water breeders. Aedes (N.) dux is not known to bite man but the other three species will feed on man, especially Aedes (V.) butleri which bites man vigorously, both in the day and at night. None of these species are known to transmit any disease.

(3) Culex

The genus Culex is represented in Java by 30 species and these are included within the following five subgenera: Lutzia, Eumelanomyia, Lophoceraomyia, Culiciomyia and Culex.

Important generic characters. Adults are small to large mosquitos. Most of the characters of the genus Culex are negative and the only positive and distinct character is the presence of pulvilli at the tip of all the legs. The larvae have more than one pair of subventral hairs on the siphon, which also always bears an acus.

Culex (Lutzia). The subgenus Lutzia can claim some importance, as the larval stage of this subgenus are cannibalistic and will feed voraciously on other mosquito larvae. As they breed in the same habitat as Culex pipiens fatigans they are a potential biological control agent of that notorious species. Two species of Lutzia have been previously reported from Java i.e. fuscanus and halifaxi. During this survey only halifaxi was collected. The larval stages of these species cannot be recognized from each other but the adults can be easily distinguished.

Culex (Culex). The subgenus Culex is important as it includes the widespread species, Culex pipiens fatigans, a common pest mosquito in most cities in the tropics and a vector of urban W. bancrofti. This subgenus also includes Culex tritaeniorhynchus and Culex gelidus, vectors of Japanese B. encephalites in South-East Asia. The subgenus includes 12 species reported from Java, of which eight species were collected in this survey.

The pipiens group includes two species in Java: Culex pipiens fatigans and Culex fuscocephalus. Both species are very common throughout Java and several collections were made of them. The former species prefers highly polluted waters whereas the latter prefers clear waters with emergent vegetation. They can be easily distinguished from each other.

The vishnui group is another important group and includes two species previously reported from Java i.e. tritaeniorhynchus and vishnui (= annulus) (Reuben, 1968). A third species (collected also by the VRCRU) is now reported for the first time as occurring in Java, namely, pseudovishnui. The adults of these three species can be distinguished with some difficulty. The larval stages are, however, distinctive. Three collections of pseudovishnui were obtained, two from paddy fields at elevations of 2000 ft and 4000 ft near the field station in Ciloto and from a groundpool in Kamal.

Two species of the bitaeniorhynchus group have been reported to occur in Java. They are C. bitaeniorhynchus and C. sinensis. It is possible that a third species, C. pseudosinensis (Colless, 1955), may also occur in Java or may occur there instead of C. sinensis. The adult females of these two species can be separated by the basal and apical pale bands on the abdominal tergites. In sinensis, the basal band is narrow and the apical band is narrow and has a proximal straight margin. C. pseudosinensis has a broad basal pale band and the apical band consists of triangular lateral patches which may converge at the centre. Some specimens may show an overlap in these characters. The larval stages are, however, distinctive as the mentum has less than 10 large teeth on either side in sinensis, whereas in pseudosinensis the lateral teeth are very numerous and small. Unfortunately, during the survey, immature stages of sinensis/pseudosinensis were not collected, and therefore it was not possible, at this stage, to determine if both these species or only one of them occurs in Java. It is suggested that immature collections be made and that associated rearings obtained, so that this matter can be sorted out. Culex sinensis is known to enter houses and bite man but it has not been associated with the transmission of disease. Seven collections of Culex bitaeniorhynchus were made in Java: three from paddy fields, one in a groundpool, two resting on vegetation and one coming in to bite man. It was recently shown (Sirivanakarn, 1973) that C. bitaeniorhynchus itself consists of several forms. Examination of the material from Java shows the presence of at least two forms, bitaeniorhynchus (typical) and tenax. Appendix VII shows the frequency of occurrence of these two forms in Java. In West Irian, de Rook (1957) has reported this species as being infected with Wuchereria bancrofti.

In the "gelidus" group, two species have been reported from Java i.e. gelidus and whitmorei. The adults and larval stages can be easily distinguished in these two species (see key). Culex gelidus is a relatively common species. During this survey, seven collections were obtained, four of these being biting collections at night, one of adults resting on vegetation and two larval collections in old paddy fields. They are found in large numbers in and around cattle and pig sheds. Culex whitmorei is a rarer species compared to gelidus. A total of nine specimens in five biting collections were obtained during this survey.

The sitiens subgroup is represented by only one species in Java i.e. C. sitiens. This species is medium to large in size with dark and pale scales on the mid-femora and narrow pale basal bands on the abdominal tergites. It is a coastal form and breeds in brackish water. Three collections were obtained of this species, one biting man at night, one resting in crab holes in brackish water pools and one from a brackish water groundpool.

The "mimeticus" group is represented in Java by Culex diengensis, mimulus and solitarius. This group is characterized by the adults having their wings spotted with distinct patches of white or yellow scales. No collections were made of these three species. They are uncommon and are not of any medical importance.

Culex (Eumelanomyia). This subgenus now includes species that were formerly included in the subgenera Neoculex and Mochthogenes. The four species reported from Java are brevipalpis, tenuipalpis, foliatus and malayi. The feeding preference of these species are poorly known and they very rarely bite man. Of the four species, only brevipalpis was collected during this survey. This species, however, is very common and 15 collections were made of it from tree holes, bamboo stumps, coconut shells and Nipa palm axils.

Culex (Lophoceraomyia). This subgenus was known to be represented in Java by six species namely, cinctellus, infantulus, jenseni, minor, bandoengensis and rubithoracis. Of these, only two species, bandoengensis and jenseni, were collected during this survey. A third species, Culex (L.) peytoni, was also collected and forms a new record in Java. Species of the subgenus Lophoceraomyia very rarely bite man and are not important as vectors of diseases.

Culex (Culiciomyia). This subgenus is represented in Java by six species namely, bahri, fragilis, javanensis, nigropunctatus, pallidothorax and spathifurca. They have a variety of breeding habitats, from containers to ground streams and pools. The adults rarely feed on man and they are not known to transmit any disease. None were collected during this survey.

(4) Mansonia

Important generic characters. Adult mosquitos moderate in size and robust in build. Female palps short and male palps longer than proboscis, with last segment very small. Spiracular bristles absent but postspiracular bristles present. Scales on scutum and scutellum usually narrow. Eighth abdominal tergite provided with stout spines. Wings with dark and light coloured, broad scales, many of which are assymetrical. Larvae with antennae spiculate, hair one much branched. Comb with two large blunt teeth. Valves of siphon large and serrated, modified for piercing.

Four species of Mansonia (Mansonoides) have been reported from Java i.e. annulifera, dives, indiana and uniformis. Of these, M. uniformis is the predominant species occurring in the Jakarta study areas. Several adult collections were made of this species resting on vegetation and biting man and cattle at night. During the period of the survey, no other species of Mansonia was obtained. Apparently, about two to three decades ago, the predominant Mansonia in the Kamal-Kapuk area of greater Jakarta was M. indiana, a species rather rare in the area now. This interesting replacement of one species of Mansonia by another is explained by the increase in the human population in the area and the conversion of extensive swamp areas into paddy fields (Hoedojo - personal communications). Mansonia bonneae, a species closely resembling M. dives, has not been reported from Java as yet.

Mansonia uniformis is an important vector of periodic Brugia malayi and is also capable of transmitting the subperiodic strain of this species. M. annulifera and M. indiana are vectors of the periodic strain of B. malayi whereas M. dives is an important vector of the subperiodic strain.

A key for the identification of the species of Mansonia in Java is provided (Appendix XXIII).

(5) Coquillettidia

Important generic characters. Adults are moderate in size and are coloured a bright yellow-orange or are dark metallic. The palps of the female are short and the male palps are as long or longer than the proboscis. The spiracular and postspiracular bristles are absent. The eighth abdominal tergite in the female is normal and do not bear spines. The wing scales are narrow. Squama fringed. Larvae have a very long antennel flagellar segment. The valves of the siphon are large and serrated.

This genus was included as a subgenus of Mansonia until 1966 when it was raised to generic rank (Delfinado, 1966). Three species of this genus occur in Java: aureosquammata, crassipes and ochracea. They bite man readily and are known to enter houses to feed, but not known to transmit any disease to man. This genus was not collected during the survey.

(6) Armigeres

Important generic characters. Adults medium to large in size. Proboscis rather stout and laterally flattened towards tip. Palpi of male as long or longer than proboscis. Palpi of female short, about one quarter the length of proboscis in subgenus Armigeres and

approximately half or more the length of the proboscis in subgenus Leicesteria. Scutum without bristles on top. Prespiracular bristles absent; postspiracular and lower mesepimeral bristles present in subgenus Armigeres. Postspiracular area always with scales. Wings with vein A ending well beyond branching of vein Cu. Larvae large and usually white or cream in colour. Segment eight with a row or with a triangular patch of comb teeth. Siphon short, without pecten teeth. Anal segment with large and rounded anal gills.

Notes. Members of the genus Armigeres prefer to breed in waters that are highly polluted with organic matter. Their breeding places are rotting coconuts and septic tanks, bamboo stumps and internodes, rotting fruits, leaf axils and pitcher plants. The adults will readily attack man for a blood meal. Members of this genus are known to be involved in the transmission of animal filariae. Six species of Armigeres (Armigeres) and seven species of Armigeres (Leicesteria) have been reported to occur in Java. They are: Armigeres (Armigeres) durhami, jugraensis, malayi, maximus, moultoni, subalbatus; Armigeres (Leicesteria) annulitarsis, digitatus, dolichocephalus, flavus, magnus, omissus and pectinatus.

During this survey, the following species were collected. One collection of Ar. (Ar.) durhami from a rotting fern stump in Cibodas, at 4500 ft elevation. One adult collection of Ar. (Ar.) malayi from Iwul. Seven collections of Ar. (Ar.) subalbatus from bamboo stumps, tree holes, banana stump, arecanut bract, coconut shell and adults resting on vegetation. This species is the most common Armigeres in Java. One collection of Ar. (Ar.) kuchingensis was made from a tree hole in Jakarta. This species was described from Kuching, Sarawak and was not reported from Java previously. It is, therefore, a new record in Java. Three collections of Ar. (Ar.) foliatus were made in bamboo stumps in the Ciloto area (4100 ft elevation). This species was described from Sumatra and was not known to occur in Java. It is also a new record. One collection of Ar. (L.) flavus was made from bamboo stumps in Ciloto. A single collection of Ar. (L.) omissus was made in a bamboo internode in Ciloto. A single collection was also made of Ar. (L.) annulipalpis from a bamboo stump at Ciranjang (2600 ft elevation). This is a new record in Java.

(b) The other mosquito genera

(7) Toxorhynchites

Important generic characters. Adults are large to very large mosquitos with metallic coloured scales on their body. Basal half of proboscis very stout and rigid; apical half thin, flexible and curved backwards. Clypeus broader than long. Posterior margin of scutellum evenly rounded. Row of spiracular bristles present; postspiracular bristles absent. Wing with cell R_2 very short, its stem many times longer; a V-shaped thickening present between branches of vein Cu. Larvae are very large and red to reddish-brown in colour. Head large and heavily chitinized. Mouthparts adapted for predation; brush composed of 10 stout, flattened bristles. Segment VIII with lateral chitinized plate but without comb teeth. Siphon without pecten.

Notes. The Toxorhynchites are strictly container breeders and will breed in artificial containers, tree holes, bamboo stumps and internodes, leaf axils and in pitcher plants. The adults are active by day. Both males and females feed on nectar and other plant exudates. The females do not take a blood meal and hence are incapable of transmitting any disease. The larval stages are predacious and cannibalistic, and each larva is capable of feeding on 8-15 mosquito larvae everyday. Because of this habit, several attempts have been made in the past to use Toxorhynchites larvae as biological control agents against vector mosquitos that share the same habitat.

In Java, six species of Toxorhynchites have been reported in the past, namely, amboinensis, aurifluus, kempi, metallicus, quasiferox and splendens. During the current survey, two species were collected, i.e. metallicus and splendens. Toxorhynchites splendens was found at lower elevations around Jakarta and in Bogor. An adult collection comprising several males and

females, resting on the trunks of coconut trees, was made at the zoo in Jakarta. Several immature collections of the species were also made from bamboo stumps and internodes, Nipa palm axil and a coconut shell. Two collections of Toxorhynchites metallicus were made in the Ciloto area: one from a bamboo stump and the other in a coconut shell.

(8) Tripteroides

Important generic characters. Adults small and medium in size with long, slender proboscis, usually longer than the abdomen and sometimes longer than the thorax and abdomen combined. Palpi very short, approximately one-sixth of proboscis. Anterior pronotal lobes widely separated. Spiracular bristles present. Postspiracular and lower mesepimeral bristles absent. Fore claws of male unequal, all claws of female simple. Pulvilli absent. Wings with cell R_2 always longer than its stem, anal vein reaching much beyond the branch of Cu. Squama fringed, with at least six hairs. Larvae: the thorax and abdomen densely covered with stellate hairs. Metathorax with well-developed dorso-lateral spine. Smaller one present on each side of the mesothorax. Comb teeth usually in a row, sometimes attached to lateral plate. Siphon varying in length and tapering towards tip with a double row of fairly long hairs on the ventral border. An incomplete siphon present on anal segment with strong spines on the posterior border. Ventral hair tuft on the anal segment represented by single pair of branched hairs.

Notes. The Tripteroides are container breeders and are very commonly found in bamboo stumps and tree holes. They also occur in leaf axils and in pitcher plants. The adults are not known to bite man. Six species of Tripteroides have been reported to occur in Java, namely: aranoides, caeruleocephalus, plumosus, proximus, powelli and similis. Of these, aranoides, caeruleocephalus, powelli and similis were collected. The most commonly collected species was aranoides which was obtained at all elevations from sea level to 4000 ft. They were collected mainly in bamboo stumps, but also in bamboo internodes and in an artificial container. Three collections were made of Tripteroides caeruleocephalus from Bogor and Cilot. Two of these were from bamboo stumps and one from a hollow fern tree stump. Five collections were obtained of Tripteroides powelli, three from bamboo stumps and one each from banana leaf axils and a coconut shell. Two collections of Tripteroides similis were made, one from bamboo stumps and the other from banana leaf axils. All collections made of the Tripteroides, were of the immature stages.

(9) Malaya

Important generic characters. Adults are small and delicate. Clypeus about twice as long as broad. Palpi very short in both sexes. Antenna similar in both sexes. Proboscis with a flexible joint about two-third its length beyond which it is swollen and strongly chitinized. Swollen part of proboscis with many long hairs at tip. Proboscis folds backwards under the body when not in use. Scutum usually with a median stripe of broad, flat, silvery scales. Wings with cell R_2 longer than its stem; squama bare; vein A just about reaching the level of the branch of vein Cu. Larvae without stellate hairs and without lateral spines on meso- and metathoracic segments. Comb teeth in irregular patch. Siphon small with scattered tufts of hair on ventral margin. Anal segment with small saddle and a single pair of unbranched ventral hairs.

Notes. The genus Malaya breeds mostly in the leaf axils of plants. The adult female mosquitos will not take a blood meal but instead have the peculiar habit of obtaining their food from Cremastogaster ants. This genus is a biological curiosity but of no medical significance. The two species of Malaya previously reported from Java are genurostris and splendens. Of these, Malaya genurostris was collected during the present survey. Five collections of the immature stages of this species were made, three from the leaf axils of Alocasia and Colocasia and two from banana axils.

(10) Topomyia

Important generic characters. Adults are small to moderate mosquitos. Clypeus small, slightly longer than broad. Proboscis usually slender, sometimes with tip swollen and probably bent below the body when at rest. Antenna same in both sexes, not strongly plumose. Palpi same in both sexes, very short. Head scales broad with a patch of silvery scales near eyes. Flat silvery scales on anterior pronotum, pleurae and scutellum; median stripe consisting of two rows of flat, silvery scales on scutum. Spiracular bristles 1-6 present; no postspiracular bristles. Scutellum very narrow, only about half of width of scutum between wing bases. Claws equal and simple in both sexes. Wings with cells R_2 longer than its stem; vein A ending slightly beyond level of branching of Cu; squama bare. Larvae without stellate hair on thorax and abdomen. Metathorax without long dorsal lateral spines. Siphon with dorsal and ventral series of hair tufts. Comb-teeth not in regular row. Anal segment with single pair of branched ventral hairs.

Notes. Most species of Topomyia breed in the leaf axils of plants that hold water. Some species breed in bamboo stumps and internodes. Members of this genus do not take a blood meal and probably depend on nectar and plant sap. The species of Topomyia previously reported from Java are: argyropalpis, gracilis, nigra, and tipuliformis. Of these, only one species, T. gracilis, was collected during this survey. Two immature collections were obtained of gracilis, one from banana leaf axils and the other from a bamboo stump. Another species, Topomyia spathylirostris, was collected during this survey and constitutes a new record in Java. Two immature collections of this species were made in the zoo of Jakarta, one from a bamboo stump and the other from a bamboo internode.

(11) Ficalbia

Important generic characters. Adults are small in size. Proboscis of moderate length, slightly swollen in female, more so in male. Palpi of female about one-quarter the length of proboscis. Spiracular and postspiracular bristles absent. Lower mesepimeral bristle single or none. Wing with vein A ending well beyond fork of Cu; squama fringed. Larvae with large head. Antennal tuft branched. Maxilla usually with a single long and stout apical spine. Pleural plates of meso- and metathoracic segments with long spine. Comb-teeth in single row. Siphon long, pecten teeth few or none; one pair of ventral brush near middle.

Notes. The Ficalbia breed in deeper ground ponds with vegetation and weedy swamps. The adults are rarely encountered and are not known to bite man. Five species of Ficalbia belonging to three subgenera are known from Java. They are Ficalbia (F.) ludlowae, F. (F.) minima, F. (Mimomyia) chamberlaini, F. (M.) hybrida and F. (Ravenalites) fusia. None of these were collected during this survey.

(12) Uranotaenia

Important generic characters. Adults small to medium-sized. Proboscis variable in length and usually slightly swollen at tip. Palpi of both sexes short and about one-sixth the length of proboscis. Scutum with well-developed acrostichal and dorso-central bristles. One spiracular and one lower mesepimeral bristle present, no postspiracular bristles. Wing membrane with microtrichia very fine, visible only under 80x magnification. Cell R_2 shorter than its stem; vein A ends before the branching of Cu. Squama without fringe. Larvae with head usually longer than broad, though it may be rounded. Eighth abdominal segment usually with lateral plates bearing the comb scales (absent in ascidiicola). Saddle with pecten teeth and acus well-developed, pecten teeth wide at tip and with lateral and terminal delicate fringe. Anal saddle complete.

Notes. The breeding place of members of this genus is very variable. Most of the species prefer groundpools, streams and marshes though some species will breed in container

habitats such as tree holes, bamboo and even the pitcher plant. Little is known about the adult. There are very few reports of females biting man and the group is probably not important in disease transmission.

Eleven species of Uranotaenia have been reported from Java i.e. ascidiicola, lateralis, bimaculiala, campestris, longirostris, macfarlanei, metatarsata, micans, nivipleura, quinquemaculata, and subnormalis. In this survey only two species were collected: U. campestris from a groundpool in Iwul and U. ascidiicola in Nepenthes pitchers and an artifical container from Cibodas (4500 ft) and Jakarta respectively.

(13) Orthopodomyia

Important generic characters. Adults are of moderate size and have a conspicuous ornamentation. Proboscis moderately long, with broad white ring in apical half. Male palpi as or nearly as long as proboscis with last two segments short and not so hairy. Female palpi about one-third the length of proboscis. Spiracular and postspiracular bristles absent. Upper margin of meron well above base of hind coxa. Fourth tarsi of mid-leg much shorter than fifth and only a little longer than broad. Wings with broad scales; anterior vein with four to five white spots; squama fringed. Larvae pink or reddish in colour. Dorsal chitinous plates present on abdominal segments VI, VII and VIII of fourth stage larvae. Comb alternating, large and small teeth. Siphon without pecten teeth, hair tuft before middle.

Notes. Members of this genus breed mostly in tree holes and bamboo stumps. The adults are not easily encountered and they bite man only rarely. This genus has a world-wide distribution. Only one species, O. anopheles, has been reported to occur in Java. No collection of this species was made during the brief survey.

(14) Aedeomyia

Important generic characters. Adults medium-sized with conspicuous light and dark scaling. Proboscis shorter than abdomen with two light bands. Palpi in both sexes about one foot as long as proboscis. Antenna of male strongly plumose, last two segments short and thickened. Antenna of female thick, bead-like segments. Scutum with well-developed dorsocentral bristles. Spiracular and postspiracular bristles absent, several lower mesepimeral bristles present. The femora of middle and hind legs in both sexes with conspicuous tufts of sub-erect scales apically. Wings with broad scales, vein A ending well beyond branching of vein Cu. Squama fringed. Larvae with large head that is nearly as broad as the thorax. Antenna very broad and large with a huge hair tuft near middle and three long apical hairs. Siphon short and somewhat curved, no pecten. Gills small.

Notes. This genus is represented in South-East Asia by only two species. Their breeding places are groundponds and swamps which contain a lot of vegetation. Females of this genus are known to feed on birds. It is, however, still uncertain if they will feed on man. Only one species has been reported to occur in Java i.e. Aedeomyia catasticta. No collection of this species was made during this survey.

V. Keys to the identification of the Java mosquitos

Keys for the identification of the common and important mosquitos are provided with this report. Relevant illustrations (Fig. 1 and Fig. 2) of the morphology of the adult and larval mosquito are also provided to facilitate the use of these keys. All the keys have been prepared specifically for the use of the Java mosquitos and they cannot be used for the entire Indonesian fauna. Some keys have been adapted from other sources, and these are acknowledged at the end of the key. Keys are provided for the identification of the genera of Java mosquitos (both adults and larvae) and for the species of the following genera: Aedes, Culex, Mansonia, Coquillettidia and Armigeres. Keys to the genus Anopheles are not provided as these are already available in Java. Furthermore, Reid's (1968) excellent monograph on the Anopheles should be used for identification within the species groups of Anopheles. The keys provided are listed below:

1.	Key to the genera of mosquitos of Java - adults.	Appendix VI
2.	Key to the genera of mosquitos of Java - larvae.	Appendix VII
3.	Key to the subgenera of Aedes in Java - adults.	Appendix VIII
4.	Key to the species of Aedes in Java - larvae.	Appendix IX
5.	Key to the species of Aedes (Finlaya) in Java - adults.	Appendix X
6.	Key to the species of Aedes (Stegomyia) in Java - adults.	Appendix XI
7.	Key to the Aedes (Aedimorphus) in Java - adults.	Appendix XII
8.	Key to the subgenera of Culex in Java - adults.	Appendix XIII
9.	Key to the subgenera of Culex in Java - larvae.	Appendix XIV
10.	Key to the species of Culex (Eumelanomyia) in Java - adults and larvae.	Appendix XV
11.	Key to the species of Culex (Lophoceraomyia) in Java - adults (male).	Appendix XVI
12.	Key to the species of Culex (Lophoceraomyia) in Java - larvae.	Appendix XVII
13.	Key to the species of Culex (Culiciomyia) in Java - adults and larvae.	Appendix XVIII
14.	Key to the species of the subgenus Culex in Java - adult (females).	Appendix XIX
15.	Key to the species of the subgenus Culex in Java - larvae.	Appendix XX
16.	Key to the species of Mansonia in Java - adults.	Appendix XXI
17.	Key to the species of Coquillettidia in Java - adults.	Appendix XXII
18.	Key to the species of Armigeres in Java - females.	Appendix XXIII

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APPENDIX I

MOSQUITOS PREVIOUSLY REPORTED FROM JAVA

No.	Species	Remarks	No.	Species	Remarks
	Anopheles (Anopheles)			Toxorhynchites (I.)	
1	aitkenii		1	amboinensis	
2	albotaeniatus		2	aurifluus	
3	annandalei		3	metallicus	
4	argyropus		4	quasiferox	
5	baezai		5	splendens	
6	'barbirostris'			Tripteroides (Tripteroides)	
7	barbumrosus		1	aranoides	
8	bengalensis		2	caeruleocephalus	
9	insulaeflorum		3	plumosus	
10	nigerrimus		4	powelli	
11	palmatus		5	proximus	
12	peditaeniatus		6	similis	
13	'umbrosus'				
	Anopheles (Cellia)			Topomyia (Topomyia)	
14	aconitus		1	argyropalpis	
15	annularis		2	gracilis	
16	balabacensis		3	nigra	
17	indefinitus		4	tipuliformis	
18	kochi			Ficalbia (Ficalbia)	
19	maculatus		1	ludlowae	?
20	minimus		2	minima	
21	philippinensis			Ficalbia (Mimomyia)	
22	ramsayi		3	chamberlaini	
23	schuffneri		4	hybrida	
24	subpictus			Ficalbia (Ravenalites)	
25	sundaicus		5	fusca	
26	tessellatus			Ficalbia (Etorleptiomyia)	
27	vagus		6	luzonensis	

? - Doubtful record

Appendix I

No.	Species	Remarks	No.	Species	Remarks
	Coquillettidia			Aedes (Mucidus)	
1	aureosquammata		1	laniger	
2	crassipes			Aedes (Finlaya)	
3	ochracea		2	alboniveus	
	Mansonia (Mansonoides)		3	assamensis	
1	annulifera		4	aureostriatus	
2	dives		5	chrysolineatus	
3	indiana		6	formosensis	
4	uniformis		7	harveyi	
	Uranotaenia		8	idjenensis	
1	ascidiicola		9	macdougalli	
2	atra		10	niveoides	
3	bimaculiala		11	niveus	?
4	campestris		12	notoscriptus ssp. montanus	
5	longirostris		13	poecilus	
6	macfarlanei		14	saxicola	
7	metatarsata			Aedes (Stegomyia)	
8	micans		15	albolineatus	
9	nivipleura		16	albopictus	
10	quinquemaculata		17	annandalei	
11	subnormalis		18	desmotes	
	Orthopodomyia		19	pseudalbopictus	
1	andamanensis			Aedes (Alanstonia)	
2	anopheloides		20	treubi	
	Aedeomyia				
1	catastica				

? - Doubtful record

Appendix I

No.	Species	Remarks	No.	Species	Remarks
	Aedes (Aedimorphus)			Armigeres (Leicesteria)	
21	alboscutellatus		7	annulitarsis	
22	caecus		8	digitatus	
23	culicinus		9	dolicocephalus	
24	mediolineatus		10	flavus	
25	pampangensis		11	magnus	
26	vexans		12	omissus	
	Aedes (Neomalaniconion)		13	pectinatus	
27	imprimens			Culex (Lutzia)	
28	lineatopennis		1	fuscanus	
	Aedes (Diceromyia)		2	halifaxi	
29	iyengari			Culex (Eumelanomyia)	
	Aedes (Neonacleaya)		3	brevipalpis	
30	dux		4	tenuipalpis	
	Aedes (Cancraedes)		5	foliatus	
31	cancricomes		6	malayi	
	Aedes (Verrallina)			Culex (Lophoceraomyia)	
32	butleri		7	cinctellus	
	Aedes (Paraedes)		8	infantulus	
33	ostentatio		9	jenseni	
	Armigeres (Armigeres)		10	minor	
1	durhami		11	bandoengensis	
2	jugraensis		12	rubithoracis	
3	malayi			Culex (Culiciomyia)	
4	maximus		13	bahri	
5	moultoni		14	fragilis	
6	subalbatus		15	javanensis	
			16	nigropunctatus	
			17	pallidothorax	
			18	spathifurca	

Appendix I

No.	Species	Remarks	No.	Species	Remarks
	Culex (Culex)			Malaya	
19	bitaeniorhynchus		1	genurostris	
20	diengensis		2	splendens	
21	fuscocephalus				
22	gelidus				
23	mimulus				
24	sinensis				
25	sitiens				
26	tritaeniorhynchus				
27	pipiens fatigans				
28	vishnui				
29	whitmorei				
30	solitarius				

APPENDIX II

SMITHSONIAN INSTITUTION
MOSQUITOS OF SOUTHEAST ASIA
(Mosquitos of Malaysia Project)

COLLECTION RECORD

(2-3) Country	(4-8) Collection number	(9-14) Map designation
(15-20) Coordinates	(21-24) Date	(25-28) Time
(29-30) Air temperature - Dry	(31-32) Air temperature - wet	(33-34) Altitude
(35-36) Water temperature	Collector	Locality

(37-38) Collection type
01. Immature
02. Resting-house
03. Resting-animal shelter
04. Resting-cave
05. Resting-tree hole
06. Resting-vegetation
07. Resting-other _____
08. Biting
09. Net
10. Light trap-N.J.
11. Light trap-chamb.
12. Light trap _____
13. Bait trap-net
14. Bait trap-magoon
15. Bait trap-other
16. Swarming
17. Landing
18. At light
19. Other _____

(39) Terrain
1. Mountain
2. Hill
3. Valley
4. Plateau
5. Plain

(40) Distance from homes
1. 10M
2. 10-99M
3. 100-999M
4. 1000M and over

(41) Sky
1. Clear
2. Partially cloudy
3. Overcast
4. Fog
5. Mist
6. Light rain
7. Heavy rain

(42) Shade
1. None
2. Partial
3. Heavy

(43) Host
1. Man
2. Horse
3. Pig
4. Cow
5. Donkey
6. Chicken
7. Buffalo
8. Monkey
9. Other _____

(44-45) Environment
01. Rain forest
02. Evergreen forest
03. Deciduous forest
04. Cloud forest
05. Coniferous forest
06. Scrub
07. Savannah
08. Prairie
09. Swamp-forest
10. Swamp-open
11. Salt marsh
12. Beach
13. Mangrove
14. Orchard-plantation
15. Cultivated field
16. Rice paddy
17. Bamboo grove
18. Urban
19. Village

(46) Modifiers to 44-45
1. Primary
2. Secondary
3. Banana
4. Rubber
5. Fruit
6. Palm
7. Pineapple
8. Sugarcane
9. Other _____

(47) Wind
1. None
2. Light breeze
3. Gusts
4. Strong wind
5. Gale

(48) Height above ground
1. 1M.
2. 1-2M.
3. 2-3M.
4. 3-10M.
5. 10-20M.
6. Canopy _____M.

(49-50) Larval Habitat
01. Pond-Lake
02. Ground pool
03. Swamp
04. Marshy depression
05. Stream margin
06. Stream pool
07. Rock pool
08. Seepage-spring
09. Flood pool
10. Ditch
11. Pit
12. Well
13. Cistern
14. Artificial container
15. Tyre
16. Tree hole
17. Stump hole
18. Bamboo internode
19. Bamboo stump
20. Banana axil
21. Callocasia axil
22. Pandanus axil
23. Ginger axil
24. Pineapple axil
25. Pitcher plant
26. Palm frond
27. Fallen leaf
28. Coconut shell
29. Other plant _____
30. Salt marsh
31. Crab hole
32. Coral
33. Footprint-wheeltrack
34. Elephant footprint
35. Rice paddy
36. Roof gutter
37. Bog
38. Other _____
39. Nipa palm axil
40. Allocasia axil
41. Ginger inflorescence

(51) Modifier to 49-50
1. Large
2. Small
3. Inside
4. Outside

(52) Water permanency
1. Permanent
2. Temporary

(53) Water movement
1. Stagnant
2. Slow
3. Moderate
4. Fast

(54) Water salinity
1. Fresh
2. Brackish

(55) Water condition
1. Clear
2. Coloured
3. Turbid
4. Polluted

(56) Aquatic vegetation
1. Submerged
2. Floating
3. Emergent
4. Submerged and floating
5. Submerged and emergent
6. Floating and emergent
7. All types

(57) Aquatic vegetation amount
1. None
2. Scarce
3. Abundant

(58) Algae
1. Green
2. Brown

(59) Algae-density
1. None
2. Scarce
3. Abundant

Notes:

Appendix II

MOSQUITOES OF SOUTHEAST ASIA

REARING RECORD

Country	Collection Number	Map Reference
Collector	**Locality**	**Larval Habitat**

Sub-number	Larval skin	Pupal skin	Sex ♂	Sex ♀	Terminalia	Identification Notes

Mass Rearings: ♂:
♀:

Larvae Preserved:

Appendix II

SMITHSONIAN INSTITUTION
MOSQUITOES OF SOUTHEAST ASIA

IDENTIFICATION RECORD			
(2-3) Country	(4-8) Collection Number	(9-14) Map Reference	
Collector	Locality		
Generic	Specific	Stage and number	Code
(9-10)	(11-12)	♂: L: ♀: S:	(13)
(14-15)	(16-17)	♂: L: ♀: S:	(18)
(19-20)	(21-22)	♂: L: ♀: S:	(23)
(24-25)	(26-27)	♂: L: ♀: S:	(28)
(29-30)	(31-32)	♂: L: ♀: S:	(33)
(34-35)	(36-37)	♂: L: ♀: S:	(38)
(39-40)	(41-42)	♂: L: ♀: S:	(43)
(44-45)	(46-47)	♂: L: ♀: S:	(48)
(49-50)	(51-52)	♂: L: ♀: S:	(53)
(54-55)	(56-57)	♂: L: ♀: S:	(58)
(59-60)	(61-62)	♂: L: ♀: S:	(63)
(64-65)	(66-67)	♂: L: ♀: S:	(68)
(69-70)	(71-72)	♂: L: ♀: S:	(73)

APPENDIX III

METHODS OF COLLECTING, REARING, PRESERVING, MOUNTING AND LABELLING OF MOSQUITOS FOR REFERENCE COLLECTIONS AND TOXONOMIC STUDIES

There are several methods and procedures for the collecting, rearing, preserving and mounting of mosquitos. The techniques given below have been used extensively and found to be very useful.

I. ADULT COLLECTIONS

Adult mosquitos are extremely fragile and tend to lose their scales and hairs very easily. Adults in the field represent specimens of various ages and, therefore, adult collections frequently contain specimens that are completely denuded and that may even have the wings damaged. Needless to say, these specimens will make very poor taxonomy study material. However, if collections of adults are made with care, valuable material can be obtained. Some of the important methods used in collecting adult mosquitos are:

1. Test-Tube and Aspirator: Good material can be obtained by picking out individual specimens by inverting a test-tube over them or by gently sucking with an aspirator. Test-tubes and aspirators are particularly useful for collecting mosquitos resting indoors and while biting man and animals. Mosquitos that have obtained a full blood meal are valuable, as progeny rearings can be obtained from them.

2. Bait Traps: There are several bait traps that are in use. In all of these, a live animal is kept within the trap to attract mosquitos. Bait traps can be set up during the day and night. The mosquitos obtained in such traps are mostly females. The species collected would depend on the type of bait used.

3. Light traps: These traps are very useful for collecting mosquito species that are nocturnally active and are positively phototropic. The advantage of light traps is that very large numbers of specimens can be obtained. Unfortunately, most of the specimens are badly damaged and this makes for poor taxonomic material.

4. Netting: Satisfactory specimens may be obtained by using small light nets to "sweep" vegetation for resting mosquitos. Swarming mosquitos may also be collected by "sweep-netting". Both males and females can be collected by this method.

II. COLLECTION OF IMMATURE MOSQUITOS

The collections of immature stages of mosquitos are especially important when determining the mosquito fauna of a particular area. This is because: (a) a greater number of species can be collected in immature stages as compared to adults; (b) fresh and excellent adults can be reared from these stages in the laboratory with relative ease; and (c) by making individual rearings, a definite association is possible between the immature (egg, larval, pupal) stage and the adult, and between the sexes. Reared material is excellent for taxonomic work, for reference collections and for teaching purposes. There may be a few species, however, that will not be obtained by immature collection alone. Adult collections (resting, baits, traps, lights, etc.) should, therefore, always augment larval collections. When the larvae and pupae are collected, care should be taken to obtain a sufficient quantity of water from the breeding habitat.

Appendix III

1. Collecting Equipment: The items listed below are used for making collections of immature stages of mosquitoes: (a) dippers; (b) aquatic and plankton nets; (c) pipettes; (d) tea strainers; (e) crab-hole pump; (f) plastic or enamel pan; (g) plastic cup with lid, plastic bags and (h) plastic vials.

In addition, a sturdy canvas collecting bag, fully equipped with the following, should always be carried on collecting trips: supply of collecting forms, field book, maps, altimeter, "tel-tru" thermometer, hand lens, pencils, wax pencils, masking tape, paper towel and tissue, cotton, small scissors, forceps, camel hair brush, scalpel, pocket knife, parang (large knife), trowel and torch.

2. Breeding Sites: Any collection of water, however small, is a potential breeding site for mosquitos. A list of 37 mosquito breeding habitats is given in the collecting form of the "Mosquitos of Southeast Asia Project" (See Appendix II). A few additional breeding habitats are: (a) animal tracks; (b) flooded forests; (c) gutters; (d) fallen trees; (e) animal containers on ground; (f) fallen fruits and nuts; (g) attached fruits and (h) flower bracts and spathes. The collector should always be alert for new breeding sites.

3. Collection of Eggs: Collecting eggs from natural habitats is a rich source for obtaining Aedes and other mosquitoes with resistant eggs. This is especially true in countries with a dry season. Resistant eggs are usually found in tree holes, bamboo stumps, etc. The dry material from such places is collected in a plastic bag and taken to the laboratory where it is submerged under rain water or distilled water. The eggs usually hatch in a few minutes. Egg clusters of Mansonia may be found on the undersurface of leaves of floating plants. Egg rafts of Culex are readily spotted in polluted collections of water. Even the eggs of Anophelines and Toxorhynchites may be collected in nature on the water surface or on vegetation emerging from water.

III. INFORMATION TO BE OBTAINED WITH COLLECTIONS

It is extremely important that every collection should be accompanied by adequate data and field notes. In the absence of this data, the collection loses much of its value. Notes may be made in a field note-book regarding the date, environment and habitat of every collection. When making detailed faunal studies it is customary to use printed forms so that the maximum amount of information can be obtained with minimum labour. A sample collecting form from the "Southeast Asia Mosquito Project" is included with this appendix. The amount of information to be obtained with each collection varies with the type of study being made. But the minimum information should include the following: (a) locality - the place of collection should be given so that it can be located on a good map; (b) date; (c) collector; (d) general environment and (e) habitat or host. If forms are used, each form is numbered, and the number is attached to the collection itself. There are many numbering systems. The simplest would be to use a consecutive numbering system starting from 1.

IV. MOSQUITO REARINGS

Rearings can be made very easily as it involves the simplest of equipment and can be made at room temperature without the necessity of air-conditioning. Long tables or racks, provided with ant-guards are the only furniture needed. Equipment used for rearing is: (a) pipettes and droppers; (b) aspirators; (c) plastic cups with lids; (d) plastic or cardboard cages; (e) plastic vials with lids (3-1/2 drams and 9 drams); (f) insect forceps; (g) plastic pill boxes and (h) rearing forms.

1. Mass Rearings: The purpose of mass rearing is to obtain large numbers of adults in excellent condition. When the collections are brought into the laboratory a representative sample of fourth instar larvae and pupae are removed, killed and preserved. A cage is placed over the plastic container so that the emerging adults are trapped. The adults are removed from the cage and kept in a plastic vial for 12 to 24 hours to harden before they are killed and

Appendix III

mounted. During the time that they are being held, they are allowed to feed on 10% glucose solution in a cotton pad. This helps to stretch out the tergites and sternites.

2. Individual Rearings: Individual rearings are usually made with larvae, so that there is a definite association between the larva, pupa and adult. About 5 to 10 fourth instar larvae of each species are removed from the mass rearing container and each larva is put into a separate 3-1/2 dram plastic vial with a little water from the container. When the larva moults the larval skin or pelt is removed and placed in a perfume vial in 75% alcohol. A cotton plug is placed over the skin and the rearing number added. The cotton plug is put in to prevent air bubbles from damaging the hairs on the pelt. The vial containing the pupa is covered over by a 9 dram vial, so that when the adult emerges, it enters the 9 dram vial. The pupal skin is removed and added to the vial containing its larval skin. The adult is allowed to harden before being killed and mounted. Each individual rearing is numbered by adding a hyphen separating them. The rearing number is a two digit number (10 to 99) if the rearing starts from the larvae and a three digit number (100 upwards) if the rearing starts from the pupa. Thus if the collection number is 65 the first, second and third individual rearing from larvae are labelled 65-10, 65-11 and 65-12 respectively. Similarly the first, second and third rearing from pupa is labelled as 65-100, 65-101 and 65-102 respectively.

3. Progeny Rearings: Progeny rearings are extremely important for taxonomic purposes as a range of variations in the offspring is obtained from a single pair of parents. By this method, immature stages of some rare species of mosquitos might also be obtained. The gravid or fully fed mosquitos that are collected in the field (either resting, biting or in traps) are retained in a large plastic vial and provided with glucose and favourable conditions for egg laying. A few eggs from the batch are preserved in 2% formaldehyde while the rest are allowed to hatch. Rearings are made individually and en masse.

V. KILLING AND PRESERVATION OF ADULTS AND LARVAE

1. Immature Stages: The larval and pupal stages are killed by dropping them into a beaker containing hot water (50-65°C). Water at this temperature kills instantly and leaves the specimens well distended. Larvae and pupae are generally preserved in 75% ethyl alcohol. Some workers prefer to add 2-3% glycerine to 75% alcohol. After killing, the larvae and pupae are kept for a few hours in the preserving fluid in a flat dish to allow them to harden (3-4 hours). The immature stages are stored in glass shell vials with neoprene stoppers or in any other suitable glass container with tight stoppers.

2. Adult Stages: Adult mosquitos should preferably be killed in the field and brought back in pill boxes to the laboratory for further processing. Specimens reared in the laboratory from immature stages are fed with glucose and allowed to harden before they are killed. The time for hardening varies from twelve to twenty-four hours.

Chloroform, ether and ethyl acetate are the common killing agents used. A few drops of chloroform may be put on a piece of cotton and added into the container with the specimens, or the specimens may be introduced into a specially prepared killing tube. Many workers prefer ethyl acetate to chloroform as it leaves the specimens more relaxed.

VI. MOUNTING OF MOSQUITOS

1. Adults: The equipment needed for mounting adult mosquitos includes entomological forceps, pinning forceps, step-block, entomology pins, point punch, ambroid, Bristol board and storage containers.

(a) Relaxing: Only freshly-killed mosquitos should be directly mounted. Specimens that have stiffened, and material from pill boxes should be relaxed before they are mounted, in order to avoid losing parts. A relaxing jar or chamber consists of a glass jar with a layer of moist sand or wet paper towels, a wire shelf over the latter and a tight fitting

Appendix III

lid. A little phenol or thymol is added to prevent the growth of fungus. Relaxing may require a few hours to a day or more, depending upon the size of the specimens. Once they are relaxed the specimens should be treated like fresh material.

(b) Mounting on Card Points: Card points are slender triangles of paper that may be cut out by scissors or punched out. Punches are available in various sizes and are preferable as they are faster to use and the points are uniform. Points are cut out from heavy rag ledger or Bristol board. A stepping-block is used to set the point about 1/3 way from the top of a No. 3 size pin. The insect is usually mounted on the paper point, with the left side up and the legs arranged towards the pin. The paper point method is more efficient than the "minuten" method and can be used for both fresh and relaxed specimens. The labels are put below the paper point.

(c) Pill Boxes: Field collected adults may be stored safely in pill boxes and mounted later in the laboratory. Pill boxes of cardboard, metal and plastic may be used. A tiny crystal of thymol is glued to the base of the pill box and over this is placed a layer or two of tissue paper cut exactly to the size of the pill box. The specimens are carefully laid on the paper, a single collection may be kept in a pill box and the label put in, or else, several collections may be put in each pill box, the collections separated from each other by a layer of tissue paper. A small label is placed with each layer.

2. Slide Mounts: For detailed study of morphological characters, the larvae and adults may be mounted on slides. Slide mounts may be either temporary or permanent. When using permanent mounting mediums like Canada Balsam and Euperal, the specimens will have to be dehydrated in increasing strengths of ethyl alcohol. Clove oil can then be used to clear the specimens. If at all staining is required, Acid Fuchsin may be used while the specimen is still in water.

(a) Whole Larvae: Most mosquitos' larvae can be mounted without using a macerating agent like KOH. Only the very large larvae, e.g. larvae of Toxorhynchites, need to be cleared with 2% KOH. The terminal segments of the larvae are cut off with a sharp microscalpel at the base of segment seven. The terminal segments are then placed with the siphon flat immediately behind the rest of the larvae. The larvae are dehydrated by using higher concentrations of ethyl alcohol (75% or 96%). The larvae are then cleared in clove oil for approximately 20-30 minutes and are then mounted in Canada Balsam or in Euperal. Euperal is preferable to Canada Balsam as it dries faster and it is possible to place the specimens exactly as desired, without their moving away. Canada Balsam is soluble in Xylene and Euperal in Euperal Essence.

(b) Larval and Pupal Skins: Larval and pupal skins should be mounted next to each other on the same side and under the same cover slip. The larval skin is carefully stretched out and the terminal segments placed on the side as with the whole larvae. The cephalothorax of the pupal skin should be dissected out and mounted flat on the slide. The abdomen is stretched and mounted and placed below the cephalothorax.

(c) Male Genitalia: The male genitalia is extremely useful for accurate taxonomic determination. These are prepared as follows: The adults are first relaxed and the terminal segments are cut off under a stereo-microscope using a pair of fine iris scissors. The snip is made at the base of the seventh segment. The genitalia and terminal segments are placed in a small dish containing 10% KOH and this is placed in an oven at 50°C for a period of half an hour to an hour. The terminalia is then transferred to another container with distilled water and kept in the oven for about an hour. The distilled water may be changed once during this period. The terminalia is then dehydrated in increasing grades of ethyl alcohol (75%, 96% or absolute) and then cleared in clove oil for approximately thirty minutes. It is then placed on one end of the slide in clove oil and dissected under the stereomicroscope. For most species, it is sufficient to remove the genitalia from the terminal segments and mount them close together in Euperal or Canada Balsam in the centre of the slide. In some species, it may be necessary to further dissect the genitalia.

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VII. LABELLING

Permanent labels, either handwritten with Indian Ink or printed, are attached to all mounted specimens. Generally two labels are attached to each specimen. The first label is the Locality label and contains information of the locality, the date and the collector. The host plant or animal may also be given. The second label is the identification label and gives the name of the species along with the name or initials of the person who identified it. A special set of locality-, species- and slidelabels have been prepared for use by the Unit.

VIII. STORAGE

Adult mosquitos are best stored in air-tight boxes. Small collections can be kept in boxes with the base lined with a cork sheet. An example of this kind of box is the Schmitt boxes. Care should be taken to treat these boxes so as to keep away insect pests and fungus. The following mixture has been found to be satisfactory in Malaya: Chloroform - 56 ml.; Petrol - 326 ml.; Naphthalene flakes - 150 gms. The naphthalene flakes or balls are ground up into a powder and this is added to the petrol, a little at a time. The petrol is heated on a water-bath. Care should be taken that no open flame is brought near the mixture. After the naphthalene is dissolved, the chloroform is added. The mixture is liberally painted on to the boxes. It will usually last for a few months. Bigger collections in institutions should be stored, for convenience, in glass-top drawers. The specimens are pinned in unit trays with polyethylene foam pinning bottoms. Napththalene balls (moth balls) are placed in a small tray within the drawer.

IX. PACKING AND SHIPPING

1. Live Specimens: The resistant eggs of Aedes can be sent very easily. The eggs are conditioned on a filter paper and placed between two stiff cardboards with some space between them. Larvae of mosquitos are not easily sent over long distances. Adult mosquitos can be packed carefully in cages or containers, provided with sugar solution and adequate humidity. The cage is packed in a stout cardboard box and shipped by air. The moulded styroform containers used for packing new cameras can be very easily adapted and are ideal for the air-shipping of adult mosquitos.

2. Preserved Specimens: Dead mosquitos are mounted firmly in a cork box and if necessary additional pins are placed by the side to restrict movement of the stage, labels, etc. The box is treated with the naphthalene mixture before the specimens are mounted. It is then sealed by using masking tape. Glass vials are packed in cotton or tissue and packed in boxes, so that they do not move. The boxes containing the adults and vials are then packed in larger cardboard boxes so that there is a space of at least two inches between the inner and outer boxes. This is filled with packing material (wooden shavings, styroform, etc.). A few crystals of paradichlorobenzene are added to the packing material. This is to discourage any pests that may be lurking in the packing material. It is preferable to send all material by air parcel.

APPENDIX IV

SUMMARY DATA OF

MOSQUITOS COLLECTED DURING SURVEY IN JUNE-JULY 1973

SPECIES	Number of Collections	Type of Collection		SPECIMENS OBTAINED				LOCALITIES**						REMARKS
		Adult	Immature	♂	♀	Slides L	Slides Assoc. Skins	Jakarta	Iwul (S. of Jakarta)	E. of Jakarta	W. & S.W. of Jakarta	Bogor (Bot. Garden)	Chiloto	
Anopheles (A.) barbirostris	8	+	+	2	10	5	2	+	+	+			+	
" " nigerrimus	1	+			3			+						
" " peditaeniatus	2	+			8			+	+					
Anopheles (C.) aconitus	2	+			5				+					
" " annularis	1	+			4			+						
" " karwari	2	+			2				+					✱
" " kochi	2	+	+		3		2		+					
" " maculatus	3		+	2	2	4			+				+	
" " philippinensis	1	+			1				+					
" " schuffneri	2	+							+					No Specimens
" " subpictus	6	+	+	17	31		4	+	+					
" " tessellatus	1	+			1				+					
" " vagus	5	+	+	6	67	3			+	+			+	
Toxorhynchites (T.) metallicus	2		+	4			4						+	
" " splendens	5	+	+	1	4	3	5	+			+	+		
Tripteroides (T.) aranoides	21		+	95	84	41	37	+	+		+	+	+	
" " caeruleocephalus	3		+	12	12		6					+	+	
" " powelli	5		+	10	7	2	2				+		+	
" " similis	2		+	1	1	4	2						+	
Malaya genurostris	5		+	10	10	6	6	+	+				+	
Topomyia gracilis	2		+	4	4	3	8						+	
" spathurlirostris	2		+	1	5		6	+						✱
Mansonia uniformis	5	+		7	16			+			+			
Uranotaenia campestris	1				1				+					
" acidicola	2		+	5	7	5		+					+	

✱ New Record in Java

**The following localities are included in

JAKARTA: City, KAPUR, KAMAL, KARONG ARYGAR, CILANDAK

IWUL: IWUL, REMPOA, KALI JATI

E. of JAKARTA: GARBUMUKA, KONDOK UNGU, TAMBUN

W. & S.W. of JAKARTA: BALAKAN JAMBU, KARANG BOLONG, SADATANI

CILOTO: Includes areas surrounding field station from elevation of 4,500' to 500' above Sea Level; CIBODAS; CIRANJANG; CIANSUR; SUKANAKALIH, PANEM BONG & Road E. of Bandung

Appendix IV

SPECIES	Number of Collections	Type of Collection		SPECIMENS OBTAINED				LOCALITIES**						REMARKS
		Adult	Immature	♂	♀	Slides L	Slides Assoc. Skins	Jakarta	Iwul (S of Jakarta)	E. of Jakarta	W. & S.W. of Jakarta	Bogor (Bot. Garden)	Chiloto	
Aedes (F.) flavipennis	1		+	1								+		*
" " formosensis	3	+	+	3	24		3						+	
" " niveus	1				1									
" " novoniveus	5		+	7	4	4	3						+	*
" " poecilus	11	+	+	20	30	16	7		+		+	+		
Aedes (Aed.) caecus	3		+	19	11	3			+					
" " vexans	1	+			2			+						Damaged
Aedes (D.) iyengari	3		+	4	2	5		+						
Aedes (S.) aegypti	2			5	5			+	+					
" " albolineatus	2		+	2		2			+				+	
" " albopictus	42	+	+	110	122	62	28	+	+	+	+	+	+	
" " annandalei	5		+	28	43	9	17					+	+	
" " pseudoalbopictus	7		+	4	6	2	3		+				+	
Armigeres (A.) durhami	1		+	9	8	6	3						+	
" " foliatus	3		+	15	9	7	14		+				+	*
" " kuchingensis	1		+		1		1	+						*
" " malayi	1				1				+					
" " subalbatus	7		+	56	48	18	15	+	+		+			
Armigeres (L.) annulipalpis	1		+	1	1	2							+	*
" " flavus	1		+	2	3	1							+	
" " omissus	1				1		1						+	
Culex (Lu.) halifaxi	1		+	1	2		2		+					
Culex (E.) brevipalpis	15		+	23	17	32	12	+	+	+	+	+	+	
Culex (Lo.) bandoengensis	2			2	3							+		
" " jenseni	2		+		1	1	1	+					+	
" " peytoni	2		+		1	2	1				+		+	*
Culex (C.) bitaeniorhynchus	7	+	+	9	10	21	4	+	+				+	
" " fuscocephalus	13	+	+	14	45	5	4	+	+	+			+	
" " gelidus	7	+	+	4	24	8	2	+	+	+			+	
" " pipiens fatigans	13	+	+	41	57	36	12	+	+				+	
" " pseudovishnui	3		+	1	3	7	1	+					+	*
" " sitiens	3		+	20	20		1	+						
" " tritaeniorhynchus	20	+	+	45	73	38	21	+	+	+			+	
" " vishnui	1		+		1			+						
" " whitmorei	5	+			9				+				+	
TOTAL				623	876	383	240							

APPENDIX V

FREQUENCY OF BITAENIORHYNCHUS FORMS IN JAVA

Collection No.	Form				Remarks
	Bitaeniorhynchus (Typical)		Tenax		
	Adults	Larvae	Adults	Larvae	
In-105	10	10			IWUL. Paddy fields.
In-155			2		KAMAL. Adults - resting vegetation.
In-178			1		CIRANJANG, CILOTO. Adults - biting man, night.
In-184		2		1	CIANSUR, CILOTO. Paddy fields.
In-185		1		7	CIANSUR, CILOTO. Paddy fields.
In-205	2				SUKANAKALIH, CILOTO. Adults - resting vegetation.
In-214	4				KAMAL. Groundpool.
In-21		2		4	IWUL. Paddy fields.
In-57				2	KAPUK. Swamp.

APPENDIX VI

KEY TO THE GENERA OF MOSQUITOS OF JAVA

Adults

1. Posterior margin of scutellum evenly rounded 2

   Posterior margin of the scutellum trilobed 3

2(1). Apical half of proboscis sharply bent downwards and backwards and conspicuously more slender than basal half; wing with a V-shaped thickening in hind margin between branches of vein Cu . . . . . Toxorhynchites

   Proboscis not rigid, of nearly uniform thickness, the apical half not bent downwards or backwards; wing without a V-shaped thickening in hind margin between branches of vein Cu . . . . . Anopheles

3(1). Vein 6 short, ending near or before the fork of vein Cu 4

   Vein 6 not short, ending at or well beyond the fork of Vein Cu 5

4(3). Proboscis heavily chitinized and enlarged at tip, with long setae at apex; cell R_2 longer than $vein_{2+3}$ . . . . . Malaya

   Proboscis not heavily chitinized or enlarged at tip, with no long setae at apex; cell R_2 shorter than vein R_{2+3} . . . . . Uranotaenia

5(3). Squama bare, or with one or two setae; scutum with a central line of silvery iridescent, broadly ovate scales . . . . . Topomyia

   Squama fringed, or with more than two setae; scutum without a central line of silvery, iridescent, broadly ovate scales 6

6(5). Anterior pronotal lobes enlarged and close together behind head . . . . Heizmannia

   Anterior pronotal lobes of normal size and well separated behind head 7

7(6). Middle and hind femora with distinct tufts of scales at apex; flagellar segments of female and last two of male short and thick . . . . . Aedeomyia

   Middle and hind femora with no distinct tufts of scales at apex; flagellar segments not short or thick 8

8(7). Spiracular bristles present . . . . . Tripteroides

   Spiracular bristles absent 9

9(8). Proboscis of female somewhat swollen at tip, more so in the male . . . . . Ficalbia

   Proboscis not swollen at tip 10

10(9). Penultimate segment of fore tarsi very short, only about as long as wide . . . . . Orthopodomyia

   Penultimate segment of fore tarsi not short and longer than wide 11

11(10). Pulvillus present . . . . . Culex

   Pulvillus absent 12

Appendix VI

12(11). Dorsocentral and prescutellar bristles absent; proboscis somewhat laterally compressed . . . . . Armigeres

Dorsocentral and prescutellar bristles present; proboscis not laterally compressed 13

13(12). Postspiracular bristles absent . . . . . Coquillettidia

Postspiracular bristles present 14

14(13). Dorsal wing scales broad and strongly asymmetrical; female claws simple . . . . . Mansonia

Dorsal wing scales not usually broad, or if broad, female claws toothed . . . Aedes

APPENDIX VII

KEY TO THE GENERA OF MOSQUITOS OF JAVA

Larvae

1. Siphon absent . . . . . Anopheles

Siphon present, elongate, tube-like 2

2(1). Mouth brush composed of 10 stout rods, prehensile; pecten absent; large reddish larva . . . . . Toxorhynchites

Mouth brush composed of 30 or more hairs, not prehensile; pecten present; or if pecten absent, mouth brush not prehensile (except in some Ficalbia spp.) 3

3(2). Ventral fan of anal segment absent, or of 1-2 pairs of setae or tufts 4

Ventral fan of anal segment with 4 or more pairs of tufts 9

4(3). Siphon with 1 pair of subventral tufts . . . . . Ficalbia (in part)

Siphon with 2 or more pairs of tufts or scattered setae 5

5(4). Maxilla normal, unmodified 6

Maxilla modified into horn-like projections 8

6(5). Seta of ventral fan single; abdomen without stellate setae; metathorax without long spines . . . . . Malaya

Seta of ventral fan usually branched 7

7(6). Metathorax with long dorso-lateral spine; abdomen with stellate setae, usually numerous . . . . . Tripteriodes (in part)

Metathorax without long dorso-lateral spine; abdomen usually without stellate setae, may have few . . . . . Topomyia (in part)

8(5). Maxilla large, produced into a long non-articulated horn . . . . . Topomyia (in part)

Maxilla large, bearing 2 strong articulated horns . . . . . Tripteroides (in part)

9(3). Antenna usually large, flattened, heavily spiculated; siphon covered with hairs, ventral tuft much longer than siphon; large tuft on ventral spiracular valve flap; hairs 2, 3 - X feathered on dorsum only . . . . . Aedeomyia

Antenna not usually large, flattened, nor heavily spiculated; siphon otherwise; tuft moderately long or minute; hairs 2, 3 - X simple or evenly feathered 10

Appendix VII

10(9). Siphon with more than 1 pair of ventral tufts . . . . . Culex

Siphon with 1 pair of ventral tufts or more 11

11(10). Siphon valves narrowed at apex, modified for piercing aquatic plants 12

Siphon valves not modified for piercing aquatic plants 13

12(11). Siphonal valves saw-like; ventral fan well developed; pecten absent; pair of large tracheal air-sacs present in thorax; head setae 5 and 6 shorter than head . . . . . Mansonia

Siphonal valves not saw-like; ventral fan small; pecten present; air-sacs in thorax absent; head setae 5 and 6 much longer than head . . . . . Ficalbia (in part)

13(11). Siphon without pecten 14

Siphon with pecton 16

14(13). Abdominal segments VII and VIII usually with large dorsal or complete saddles; comb of alternating large and small scales . . . . . Orthopodomyia

Abdominal segments VII and VIII without dorsal saddles; comb scales similar in size 15

15(14). Antenna short, smooth; antennal tuft of single seta . . . . . Armigeres

Antenna long, spiculated; antennal tuft large, branched . . . . . Ficalbia (in part)

16(13). Abdominal segment VIII with lateral sclerotized plate bearing comb scales 17

Abdominal segment VIII without sclerotized plate 18

17(16). Pecten teeth with fringe or lateral denticles on both sides from base to apex . . . . . Uranotaenia

Pecten teeth with denticles from base to apex on one side only . . . . . Aedes (some species of subgenus Stegomyia)

18(16). Pecten teeth few (1-4) smooth; hairs 2, 3 - X branched . . . . . Ficalbia (in part)

Pecten teeth numerous, with lateral denticles; hairs 2, 3 - X long, single or double . . . . . Aedes

APPENDIX VIII

KEY TO THE SUBGENERA OF *AEDES* IN JAVA

Adults

1. Large, light brown, shaggy mosquitos, with outstanding scales on body and legs; wing membrane clouded at cross veins . . . . . *Mucidus* (*laniger*)

   Smaller and darker mosquitos, without shaggy appearance; wing membrane not clouded at cross veins 2

2(1). Scutum dark, with a broad border in front and at sides, of cream or golden scales 3

   Scutum various, but never with a broad border of cream or golden scales in front and at sides 4

3(2). Large mosquitos; proboscis laterally compressed and with a marked downward curvature; decumbent scales of head broad; segment VIII broad and not retractile . . . . . *Alanstonia* (*treubi*)

   Average sized mosquitos; proboscis not laterally compressed and without marked downward curvature; decumbent scales of head narrow; segment VIII narrow and retractile . . . . . *Neomelanconion*

4(2). Abdominal segment VIII narrow and completely retractile; circi long and narrow, projecting from ring of segment VII 5

   Abdominal segment VIII broad and not completely retractile; circi shorter and broader, though sometimes they may be longer and cone-shaped (*Neomacleaya*) . . . 6

5(4). Tarsi with narrow, basal, pale bands . . . . . *Aedimorphus*

   Tarsi dark, without basal pale bands . . . . . *Paraedes* (*ostentatio*)

6(4). Scutellum with narrow scales 7

   Scutellum with broad scales 8

7(6). Abdominal terga with pale markings on lateral aspect . . . . . *Verrallina* (*butleri*)

   Abdominal terga dark, without lateral pale patches or pale bands . . . *Neomacleaya* (*dux*)

8(6). Head dark with white stripe on either side of midline; pleura with white line of scales extending across the middle; paratergites with white scales . . . . . *Diceromyia* (*iyengari*)

   Without the combination of all the above three characters 9

Appendix VIII

9(8). Lower mesepimeral bristles present; palpi in both sexes very short, barely 1/6 of proboscis; alula with scales; anal vein very short, ending at fork of vein Cu; pleura bare . . . . . Cancraedes (cancricomes)

Lower mesepimeral bristles absent; female palpi normal about 1/4 length of proboscis; alula with hairs; anal vein generally longer and ending beyond fork of Cu; pleura with scales 10

10(9). Two or more basal white bands on tarsi of at least one pair of legs or with one or more tarsal segments completely white; proboscis all dark; scutum never with narrow golden lines . . . . . Stegomyia

Tarsi all dark, or if white bands present on base of tarsi, then scutum with narrow golden lines; proboscis with white scales or all dark . . . . Finlaya

APPENDIX IX

KEY TO THE SPECIES OF AEDES IN JAVA

Larvae

1. Ventral brush (4 - X) extending along the whole length of the anal segment; mouth parts modified for predation . . . . . (Mucidus) . . . . laniger

   Ventral brush (hairs 4 - X) not extending throughout ventral aspect of anal segment; mouth parts not modified for predation 2

2(1). Abdominal segment VIII with a semicircular sclerotized plate on each side, from the posterior margin of which the comb teeth arise 3

   Abdominal segment VIII without sclerotized plate on each side, comb teeth free 4

3(2). Comb of 3-5 teeth, usually with basal, lateral denticles . . (Stegomyia) . desmotes

   Comb of 5 or more teeth without basal denticles . . . . . (Stegomyia) . annandalei

4(2). Siphon with a ring of spines near apex and a midian patch of similar spines on anterior surface . . . . . (Aedimorphus) . . caecus

   Siphon without such spines 5

5(4). Comb consisting of 5-19 teeth in a single row or in an irregular row or more or less in two rows 6

   Comb consisting of 20-70 teeth, usually small, arranged in several rows, or more or less in a triangular patch 22

6(5). Antennal shaft with small spicules or spines 7

   Antennal shaft smooth or with very fine spines which are sparcely distributed . . . . . (dux, butleri) 16

7(6). Pecten teeth extending to tip of siphon, hair 1 - S near apex of siphon; hair 2 - X single; ventral brush of anal segment with 8-9 tufts, all unbranched . . . . . (Alanstonia) . . . . . treubi

   Pecten teeth not extending to tip of siphon; hair 1 - S not at apex of siphon, hair 2 - X usually branched; ventral brush with hair tufts usually branched 8

8(7). The 4-5 pecten teeth nearest base of siphon simple and larger than the more distal teeth which have lateral denticles . . . . . (Finlaya) . . . 9

   Basal pecten teeth with lateral denticles and smaller or at least not larger than more distal teeth 10

9(8). Siphon tapering sharply from about the middle, index about 3 or 4; integument of siphon and saddle relatively smooth; subapical bristles of antenna markedly unequal in length . . . . . novoniveus

   Siphon tapering smoothly from base to apex, index about 5 or 6; integument of siphon and saddle sometimes highly spiculate; subapical bristles of antenna subequal in length . . . . . niveoides

Appendix IX

10(8). Apical 2-3 pecten teeth more widely spaced than those nearest base and usually larger than basal teeth 11

All pecten teeth evenly spaced and all about same size, those furthest from base being but little larger than remainder 15

11(10). Head hair 6 - C single or double; 8 - C single . . (Aedimorphus) . . . . . vexans

Head hair 6 - C 3 to 6 branched; 8 - C double to many branched 12

12(11). Comb of 6-8 large pointed teeth, fringed with hairs at base; pecten teeth extending well beyond middle of siphon and distal teeth nearly reaching hair 1 - S . . . . . .(Neomelaniconion) . lineatopennis

Comb of 9-18 pointed teeth 13

13(12). Anal saddle complete; anal hair 3 - X with 3-5 branches (Neomelaniconion) imprimens

Anal saddle incomplete on ventral aspect, anal hair 3 - X single 14

14(13). Prothoracic hair 7 - P double; metathoracic hair 7 - T with 5-6 branches; siphon index 3.9 to 4.5 . . . . . (Aedimorphus) . . . culicinus

Prothoracic hair 7 - P triple; metathoracic hair 7 - T with 7-14 branches; siphon index 5.9 to 7.9 . . . . . (Aedimorphus) . mediolineatus

15(10). Comb of 16-19 teeth each with a fringe from base to apex; siphon about 2-1/2 times the length of diameter at base . . . . . (Finlaya) . niveus

Comb of 8-12 teeth, each fringed not more than 1/2 way from base to apex; siphon 3-1/2 times length of diameter at base . . . . (Finlaya) . alboniveus

16(6). Comb-teeth with strong basal lateral denticles (Stegomyia) . . . . . aegypti

Comb-teeth without strong basal lateral denticles, but usually finely fringed 17

17(16). Ventral brush of 12 to 17 tufts 18

Ventral brush of 10 tufts or less 19

18(17). Comb scales with complete apical fringe, no prominent terminal spine; abdominal hair 2 - VIII with 4-6 branches . . . . . .(Verrallina) . . . . . butleri

Comb scales with a distinct terminal spine; abdominal hair 2 - VIII with 1-3 branches . . . . . .(Neomacleaya) . . . . . dux

19(17). Head hair 5 - C many branched; pecten with only 5-8 teeth; comb-teeth in a regular row . . . . . .(Stegomyia) . . . albolineatus

Head hair 5 - C single or bifid; pecten teeth more numerous 20

20(19). Pecten teeth with lateral denticles along one side from base to apex . . . . . .(Diceremyia) . . . . . iyengari

Pecten teeth with basal lateral denticles only 21

Appendix IX

21(20). Siphon acus present; pecten teeth 3-6, each tooth short and stout, usually with 3-4 basal denticles . . . . . .(Stegomyia). . . . . pseudalbopictus

Siphon acus absent, at least 8 pecten teeth, each tooth long, at least 4 times as long as wide . . . . . .(Stegomyia). . . . . albopictus

22(5). Several of the more distal pecten teeth bare, without lateral denticles or fringe and usually larger than the more basally situated teeth 23

All pecten teeth with lateral denticles or with fringe, and usually all about same size, though the basal teeth may sometimes be smaller . . . . . (poecilius and flavipennis) 27

23(22). Thoracic hair 7 - M with 3-4 strong, almost spine-like and barbed branches; 4 to 5 simple pecten teeth between hair 1 - S and apex of siphon, but 2-3 very large . . . . . .(Finlaya). . . . . saxicola

Thoracic hair 7 - M not unusually developed, at most 3 simple pecten teeth between 1 - S and apex of siphon 24

24(23). Siphon long, index 7-9 . . . . . .(Aedimorphus) . . . . phampangensis

Siphon shorter, index not more than 4 25

25(24). None of the branches of the siphon hair tuft reaching apex of siphon plus valves . . . . . .(Finlaya). . . . . formosensis

At least some of these branches reaching to or beyond apex of siphon plus valves 26

26(25). Individual comb scales expanded apically; denticles of pecten teeth small . . . . . .(Finlaya). . . . . harveyi

Individual comb scales distally tapered to a stout central spine; denticles of pecten teeth large, elongate, conspicuous . .(Finlaya). . chrysolineatus

27(22). Pecten of 12 or less teeth, long, slender and fringed on one side 28

Pecten teeth nearly always more than 12 in number 29

28(27). Head hair 1 - C with 2 branches (rarely single); prothoracic hair O - P large stellate with at least 9 branches; margin of saddle ventral to hair 1 - X with large spines . . . . . poecilus

Head hair 1 - C single; prothoracic hair O - P small, with not more than 5 branches; margin of saddle with no spines ventral to hair 1 - X. .flavipennis

29(27). Head hair 5 - C usually single and standing posteriorly in line with head hair 6 - C 30

Head hair 5 - C with 2 or more branches and hairs 4, 5 and 6 - C standing almost in a line or else 6 - C placed anteriolaterad of 5 - C 31

30(29). Head hair 4 - C closer to hair 6 - C than to 5 - C . . .(Finlaya). . . . notoscriptus

Head hair 4 - C closer to hair 5 - C than to 6 - C . . .(Finlaya). . . . . assamensis

Appendix IX

31(29). Head hairs 4, 5 and 6 - C placed well forward towards anterior margin of clypeus . . . . . (Finlaya) . . . . . macdougalli

Head hairs 4, 5 and 6 - C are placed much further back, towards middle of clypeus 32

32(31). Head hair 6 single and well-developed, longer than entire head . . . . . (Finlaya) . . . . . aureostriatus

Head hair 6 with 2-5 branches, much shorter than length of head . . . . . (Aedimorphus) . . alboscutellatus

APPENDIX X

KEY TO THE SPECIES OF AEDES (FINLAYA) IN JAVA

Adults

1. Wing elaborately speckled with dark and light scales 2

   Wing scales all dark above 3

2(1). Species with black and white scaling; fourth hind tarsal segment all dark; abdominal tergites mostly dark dorsally, with a few white spots . . . . . poecilus

   Species with yellow, black and white scaling; fourth hind tarsal segment with some light scales; abdominal tergites with large patches of yellow scales dorsally . . . . . flavipennis

3(1). Anterior area of scutum with large conspicuous pale spot; tarsi all dark and paratergites without scales (niveus group). 4

   Anterior area of scutum without large conspicuous pale spot, narrow golden lines present on scutum; at least some tarsi with white spots; paratergites with or without scales 7

4(3). Pale patch on anterior part of scutum with golden scales; posterior margin of ppn. with a patch of white, flat, broad scales . . . . . idjenensis

   Pale patch on anterior part of scutum with silver-white scales; ppn. usually unscaled or with dark scales on posterior margin 5

5(4). Prealar scale patch absent . . . . . niveoides

   Prealar scale patch present 6

6(5). Propleural setae 4-6 in number . . . . . novoniveus

   Propleural setae 10 or more in number (usually 15) . . . . . niveus

7(3). Proboscis all dark scaled 8

   Proboscis with ring of white scales or at least some white scales on ventral aspect 9

8(7). Tip of palpi with some white scales; ppn. all dark scaled . . . . . saxicola

   Tip of palpi dark scaled; ppn. with narrow golden scales on upper and posterior border . . . . . aureostriatus

9(7). Proboscis with narrow or broad pale ring 10

   Proboscis with pale scales on ventral aspect, but not forming complete pale ring 11

10(9). Pale ring of proboscis narrow; palpi with white scales at tip only; upper margin of ppn. with dark scales . . . . . notoscriptus

   Pale ring of proboscis very broad; palpi with white scales at tip and middle; upper margin of ppn. with narrow golden scales . . . . . macdougalli

Appendix X

11(9). Paratergite and usually subspiracular areas, each with a small patch of broad white scales . . . . . formosensis

Paratergite and subspiracular areas without scales 12

12(11). Middle of female proboscis with ventral pale-scaled area broadly produced laterally and to a somewhat lesser extent dorsally; male proboscis with narrow white band medially . . . . . chrysolineatus

Middle of female proboscis with ventral pale scaled area not visible, or only slightly so from above; male proboscis with pale scaling visible laterally or even from above, but not forming a sharp complete band . . . . . harveyi

Note: Aedes (F.) alboniveus and A.(F.) assamensis have been excluded from this key due to lack of specimens and an inadequate description in the literature.

References: Barraud, 1934; Belkin, 1962; Brug, 1934; Colless, 1958-59; Knight, 1968.

APPENDIX XI

KEY TO THE SPECIES OF AEDES (STEGOMYIA) IN JAVA

Adults

1. Middle of hind tibia with broad white band . . . . . desmotes

   Hind tibia all black scaled 2

2(1). Scutum with a pair of silvery-white, lateral, curved lines and a thin pair of submedian lines (lyre shaped marking) . . . . . aegypti

   Scutum with a central silvery-white stripe or with a large anterior patch of silvery-white scales; lyre shaped marking absent 3

3(2). Proboscis longer than fore femur; palpi entirely dark; last two hind tarsi entirely dark . . . . . albolineatus

   Proboscis as long as fore femur; palpi white at tip; last two hind tarsi with some white scaling at least 4

4(3). Scutum with large anterior patch of silvery-white scales . . . . . annandalei

   Scutum with a narrow median stripe running nearly the whole length 5

5(4). Scutum with a patch of broad, flat, white scales on lateral margin just before base of wings; the prescutellar dark scales, just anterior to the scutellum are all narrow and curved . . . . . albopictus

   Scutum with narrow white scales on lateral margin just before base of wings; the prescutellar dark scales just anterior to the scutellum are flat and broad . . . . . pseudalbopictus

Reference: Huang 1972.

APPENDIX XII

KEY TO THE AEDES (AEDIMORPHUS) IN JAVA

Adults

1. Tarsi II, III with basal white bands 2

   Tarsi II, III without basal white bands (some species may have lateral longitudinal white stripes) 3

2(1). Wing with dorsal veins brown scaled or with only a small spot of white scales at base of costa; anterior part of femora I, II brown; scutellum with broad and narrow white scales on each lobe . . . . . caecus

   Wing with a number of white scales on posterior margin and base of costa; femora I, II with a large number of white scales intermixed with brown ones; scutellum with narrow white scales on all lobes . . . . . vexans

3(1). Propleuron with narrow curved scales; scutum with 2-3 distinct longitudinal stripes of pale scales . . . . . mediolineatus

   Propleuron with broad scales; scutum without stripes of pale scales 4

4(3). Scutellum with narrow curved white scales on each lobe; subspiracular area with 2 patches of broad white scales . . . . . culicinus

   Scutellum with broad silvery-white scales on each lobe; subspiracular area with 1 patch of moderately broad white scales or with a patch of short fine hairs and without scales 5

5(4). Abdomen with dorsobasal white bands on terga III, IV; subspiracular area with a patch of short fine hairs . . . . . alboscutellatus

   Abdomen without dorsobasal pale bands on terga III, IV; subspiracular area with a patch of white scales . . . . . pampangensis

Reference: Reinert 1973

APPENDIX XIII

KEY TO THE SUB-GENERA OF *CULEX* IN JAVA

Adults

1. Four or more strong, lower mesepimeral bristles present; relatively large species (wing length usually ranging from 4 to 5 mm). . . . . *Lutzia*

   Mesepimeral bristles absent, or if present, repressed by 1 or 2 rather weak ones; in general moderately sized to small species (wing size usually less than 4 mm) 2

2(1). Pleuron with distinct scale patches at least on the upper and lower sternopleuron and the anterior mesepimeron. . . . . *Culex*

   Pleuron without distinct scale patch. 3

3(2).6 Palpus of the male 1/4 to 3/4 the length of the proboscis . . . . . *Eumelanomiya*

   Palpus of the male greater than or equal to the length of the proboscis 4

4(3). Scaling of scutum sparse, rough in appearance; male antenna with specialized scales and setae usually present on flagellomeres V to IX, always present on VII and VIII. . . . . *Lophoceraomyia*

   Scaling of scutum very dense, smooth in appearance; male antenna without specialized scales or setae . . . . . *Culiciomyia*

Reference: Bram 1967

APPENDIX XIV

KEY TO THE SUB-GENERA OF *CULEX* IN JAVA

Larvae

1. Pecten extending nearly to the apex of the siphon; mouth-parts adapted for predation; antennal hair 1 - A short, single and inserted on the basal half of the shaft. . . . . *Lutzia*

   Pecten restricted to the basal half of the siphon or absent; mouth-parts not adapted for predation; antennal hair 1 - A generally multiple, always inserted on the distal half of the shaft; small to moderately sized species. 2

2(1). Ventral brush consisting of 8 hair tufts inserted on the grid; head hair 1 - C fine and filamentous and thoracic hair 3 - P much slenderer than 1 - P and usually about half its length, *or* if head hair 1 - C stout, 1 - P bifid or trifid and 3 - P with 2 or more branches . . . . *Culiciomyia*

   Ventral brush consisting of 10 or more hair tufts; if head hair 1 - C is filamentous, then thoracic hairs 1, 3 - P single and of the same order of length and thickness, *or* 1 - C robust and 1 - P unbranched. 3

3(2). Thoracic hair 3 - P always single, of the same order of length and thickness as 1 - P . . . . . *Culex*

   Thoracic hair 3 - P single or branched, slenderer than 1 - P and usually less than half its length. 4

4(3). Head hair 14 - C single, often dendritic beyond the basal half . . . . . (formerly *Neoculex*) . . . . . *Eumelanomyia* (in part)

   Head hair 14 - C bifid, with the branches strongly divergent from the base . 5

5(4). Individual pecten tooth fringed with many fine, parallel, closely placed denticles distally and a few coarse, widely placed denticles proximally; head hairs 5, 6 - C short, weak, 5 - C about 1/2 the length of 6 - C . . . (formerly *Mochthogenes*). . . . . *Eumelanomyia* (in part)

   Individual pecten tooth without 2 distinct types of denticles as indicated above (although the proximal 2 or 3 denticles may be enlarged); head hairs 5, 6 - C strong, long, subequal in length. . . . . *Lophoceraomyia*

Reference: Bram 1967

APPENDIX XV

KEYS TO THE SPECIES OF CULEX (EUMELANOMYIA) IN JAVA

Adults

1. Acrostichal bristles well developed on the scutum; palpus of the male less than 1/4 the length of the proboscis . . (formerly Mochthogenes). 2

   Acrostichal bristles not developed, except at extremely anterior end rarely near the prescutellar space; palpus of the male approximately 1/2 to 2/3 length of proboscis. . . . (formerly Neoculex). 3

2(1). Decumbent scales of the vertex uniformly dark; anterior surface of the hind femur pale; abdominal sterna dark . . . . . foliatus

   Decumbent scales of the vertex uniformly pale; anterior surface of the hind femur dark; abdominal stern mainly pale . . . . . malayi

3(1). One long mesepimeral bristle present; abdominal terga with narrow, pale basal bands . . . . . tenuipalpis

   Lower mesepimeral bristle absent; abdominal terga completely dark . . . brevipalpis

Larvae

1. Head hair 14 - C simple, often dendritic beyond the basal half 2

   Head hair 14 - C bifid, with the branches strongly divergent from the base 3

2(1). Length of the subventral siphon tufts greater than the width of the siphon at the point of insertion; individual pecten tooth with the lateral barbs very numerous and fine on the distal half and widely spaced and coarse on the proximal half . . . . . tenuipalpis

   Length of the subventral siphon tufts less than the width of the siphon at the point of insertion; individual pecten tooth with the lateral barbs all coarse and subequal in size . . . . . brevipalpis

3(1). Comb possessing 2 distinct types of scales, some fan-shaped and others with the median apical spine broader and longer than the other spines; head hairs 5, 6 - C simple . . . . . malayi

   All comb scales fan-shaped, fringed with subequal spines; head hairs 5, 6 - C, pectinate . . . . . foliatus

Reference: Bram 1967

APPENDIX XVI

KEY TO THE SPECIES OF CULEX (LOPHOCERAOMYIA) IN JAVA

Adults - Male

1. Torus of antenna normal; segment XI of antenna with an external tuft of narrow lanceolate scales; palp with a pair of basal processes; phallosome with a pointed, toothless dorsal process only . . . . . (Fraudatrix group). 2

   Torus of antenna with a distinct prominence or process on inner surface; segment XI of antenna with, at most, an internal tuft of stout setae; palp without basal process, phallosome with both an internal process and a spinose or toothed dorsal process . . (Mammilifer group). . 4

2(1). Abdomen with complete basal pale bands on some tergites; lower mesepimeral bristle present. 3

   Abdomen without basal pale bands on tergites; lower mesepimeral bristle absent; integument with reddish tint. . . . . rubithoracis

3(2). Basimere with a patch of prominent submarginal setae; flagellomeres V and VI of male antennae with specialized setae . . . . . cinctellus

   Basimere with few prominent submarginal setae in a line; flagellomeres V and VI of male antennae without tufts of scales or specialized setae . infantulus

4(1). Palp more or less straight, between 1/2 and 3/4 the length of the proboscis; lower mesepimeral bristles absent. . . . . jenseni

   Palp with 2 apical segments curved upwards, as long as or longer than proboscis; lower mesepimeral bristle present . . . . . minor
   bandoengensis
   peytoni

Reference: Bram 1967

APPENDIX XVII

KEY TO THE SPECIES OF CULEX (LOPHOCERAOMYIA) IN JAVA

Larvae

1. Antenna with all bristles together at apex; antennal tuft weak, 2 - 4 branched; siphon with 10 to 12 ventral tufts; in pitcher plants . . . . . jenseni

   Antenna with a pair of distinctly subapical bristles, separated from apical bristle by a distance equal to, or usually much greater than, the apical width of antenna; antennal tuft strong; siphon with 9 or less ventral tufts; habitat various but not in pitcher plants 2

2(1). Head hair 4 - C shorter than the distance between the bases of the pair; abdominal hair 2 - VIII bifid (except infantulus); thoracic hair 14 - P single (except infantulus); usually in groundpools (except infantulus) 3

   Head hair 4 - C longer than the distance between the bases of the pair; abdominal hair 2 - VIII single; prothoracic hair 14 - P branched; usually in container habitat (except infantulus which may occur in both habitats) . . . . . (Mammilifer group) 5

3(2). Head hair with 3 or 4 branches . . . . . cinctellus

   Head hair 5 - C bifid 4

4(3). Thoracic hair 3 - P with 4-10 branches, thoracic integument strongly spiculate. . . . . rubithoracis

   Thoracic hair 3 - P single or at most bifid; thoracic integument not spiculate. . . . . infantulus

5(2). Comb consisting of 2 distinct types of scales, the posterior scales tapering to a point, the anterior scales fan-shaped . . . . . minor

   All comb scales fan-shaped, fringed with fine spines. 6

6(5). Siphon tufts usually 6 in number. . . . . bandoengensis

   Siphon tufts usually 8 in number. 7

7(6). Head hair 1 - C thick; thoracic hair 3 - P single; integument of thorax covered with fine long spicules. . . . . peytoni

   Head hair 1 - C fine; thoracic hair 3 - P two branched; integument smooth. . . . . infantulus

Note: Culex (Lo.) infantulus has been keyed out at two different points because of the variations in this species.

Reference: Bram 1967
Colless 1965

APPENDIX XVIII

KEY TO THE SPECIES OF CULEX (CULICIOMYIA) IN JAVA

Adults

1. Abdomen with basal pale bands on tergites; integument of pleurae with dark markings 2

   Abdominal tergites entirely dark; pleurae uniform in colour 3

2(1). Pleurae pale, with a distinct black spot on the upper part of the mesepimeron. . . . . nigropunctatus

   Pleurae with a light brown stripe across upper part and another dark area on sternopleuron. . . . . pallidothorax

3(1). Plume scales of wings narrow (about 10 times length of greatest width) . . . . bahri

   Plume scales of wings broad (about 5 times length of greatest width) 4

4(3) Penultimate segment of ♂ palpi about twice as long as labella; mid-ventral area of ♂ proboscis with 2 or 3 fine setae . . . . . fragilis

   Penultimate segment of ♂ palpi about three times as long as labella; mid-ventral area of ♂ proboscis with a tuft of strong setae. . . . . spathifurca

Note: Culex (Cu.) javanensis is excluded from this key due to lack of specimens and lack of the original description.

Larvae

1. Thoracic hairs 1 - P bifid, 2 - P single, and 3 - P either single or with 2 or more branches; siphon swollen medially. . . . . pallidothorax

   Thoracic hairs 1, 2, 3 - P single; siphon not swollen medially. 2

2(1). Siphon with a false joint beyond middle due to lack of sclerotization in an irregular ring . . . . . nigropunctatus

   Siphon without false joint beyond middle 3

3(2). Head hairs 5, 6 - C with 3 or 4 branches; individual siphon tufts single . . . . . spathifurca

   Head hairs 5, 6 - C with from 5 to 7 branches; individual siphon tufts bifid or trifid. . . . . fragilis

Note: The larval stages of bahri and javanensis are as yet unknown.

Reference: Barraud 1934
Bram 1967

APPENDIX XIX

KEY TO SPECIES OF THE SUBGENUS CULEX IN JAVA

Adult - Females

1. Proboscis without distinct white banding; 1 or 2 lower mesepimeral bristles present; tarsi unbanded . . . . . (pipiens group). 2

   Proboscis ringed with a distinct white band; lower mesepimeral bristles absent; tarsi with narrow, pale basal bands . . . (sitiens group). . . . 4

2(1). Abdominal terga unbanded . . . . . fuscocephalus

   Abdominal terga with narrow, white, basal bands. 3

3(2). Integument of the pleuron with blackish-brown areas. . . . . hutchinsoni

   Integument of the pleuron usually uniformly pale . . . . . pipiens fatigans

4(1). Abdominal terga with white apical bands, with apical, lateral triangular patches and basal bands, or with the distal segments completely covered with pale scales. . . . (bitaenioryhnchus subgroup) 5

   Abdominal terga with white basal bands or, rarely, unbanded; apical bands or patches not present 7

5(4). Wings with pale scales scattered among the dark, particularly on the costa and subcosta; scutum without silver scales. . . . . bitaeniorhynchus

   Wings without pale scales scattered among the dark; scutum with silver scales anterior to the prescutellar space. 6

6(5). Apical pale tergal bands with the proximal margin straight; basal tergal bands very narrow . . . . . sinensis

   Apical pale tergal bands represented on the proximal segments by triangular lateral patches which may converge at the centre; basal tergal bands rather broad. . . . . pseudosinensis

7(4). Scutum densely covered with distinct, silvery scales, at least anterior to the prescutellar space . . . . . (gelidus subgroup). 8

   Scutum uniformly brown or with some golden or yellow scales. 9

8(7). Silver scaling on the scutum terminating at the level of the wing base; basal abdominal bands reaching to the lateral edges of the terga, frequently with a v-shaped median, posterior projection . . . . . gelidus

   Silver scaling on the scutum continued posteriorly through the prescutellar space and onto the middle of the scutellum; basal abdominal bands not reaching the lateral edges of the terga. . . . . whitmorei

9(7). Wings spotted, with distinct patches of yellow or white scales 10

   Wings without distinct patches of white scales 12

Appendix XIX

10(9). Basal pale bands on abdominal tergites II to VII 11

Basal pale bands on abdominal tergites II, III and VI only . . . . . diengensis

11(10). Pale spot at middle of wing involving only costa and subcosta. . . . . solitarius

Pale spot at middle of wing involving Radius (vein 1) in addition to costa and subcosta. . . . . mimulus

12(9). Proboscis usually with accessory pale patches proximal to the median pale band on the ventral surface; erect scales on occiput dark brown; usually a small, dark brown species. . . . . tritaeniorhynchus

Proboscis without accessory pale patches on the ventral surface; erect scales on the occiput varying from pale golden to dark brown; usually larger species 13

13(12). Erect scales of the vertex uniformly dark brown, or dark brown on the occiput and with several almost black scales posteriolaterally 14

Erect scales of the vertex yellowish to golden brown on the occiput, dark brown to black posteriolaterally . . pseudovishnui vishnui (= annulus) (in part)

14(13). Anterior surface of the mid-femur speckled with brown and white scales; mid and hind tibiae dark with a trace of pale scales forming somewhat of a stripe. . . . . sitiens

Anterior surface of the mid-femur predominantly dark, slightly lighter on the ventral margin, but without pale speckling; mid and hind tibiae not as above. . . . . vishnui (= annulus) (in part)

Reference: Bram 1967

APPENDIX XX

KEY TO THE SPECIES OF THE SUBGENUS CULEX IN JAVA

Larvae

1. Head hair 1 - C fine, tapering and filamentous distally 2

   Head hair 1 - C thicker, acuminate, truncate or bluntly pointed 3

2(1). Siphon index approximately 5:1 or greater; head hairs 5, 6 - C with 2 or 3 branches . . . . . fuscocephalus

   Siphon index approximately 3:1, the siphon expanded medially; head hairs 5, 6 - C with 5 or more branches. . . . . pipiens fatigans

3(1). Head hair 1 - C lightly pigmented, long, of even width to apex; pecten inconspicuous, restricted to the basal fifth of the siphon or less. 4

   Head hair 1 - C strongly pigmented, shorter, tapering to apex or short and truncate; pecten obvious, extending through approximately the basel 1/4 or 1/3 of the siphon. 6

4(3). Lateral teeth of the mentum robust, distinctly separated and less than 10 on each side; thoracic hair 4 - P short, simple . . . . . sinensis

   Lateral teeth of the mentum numerous, extremely short and compact; thoracic hair 4 - P long, pectinate 5

5(4). Siphon usually with 4 pairs of subventral tufts; individual comb scales elongated; pecten extending only a very short distance from the base . . . . . bitaeniorhynchus

   Siphon with 3 pairs of subventral tufts, the basal tuft frequently not paired; individual comb scales relatively short; length of pecten somewhat greater than above. . . . . pseudosinensis

6(3). Head hair 1 - C broad and somewhat flattened, its apex rounded or irregular; anal gills bulbous, not as long as the saddle . . . . . sitiens

   Head hair 1 - C slender or moderately thickened, its apex acuminate; anal gills elongate, at least as long as the saddle, usually longer 7

7(6). Individual comb scales fan-shaped, fringed with subequal spicules, or rarely with the median distal spicule only slightly longer than the lateral spicules. 8

   At least some of the individual comb scales with the median distal spine obviously longer and broader than the lateral spicules. 12

8(7). Siphon with a single, prominent, subapical spine. . . . . hutchinsoni

   Siphon without a prominent, subapical spine 9

9(8). Siphon greatly expanded medially; subventral tufts of the siphon all inserted in a straight line . . . . . gelidus

   Siphon not greatly expanded medially; 1 or more pairs of subventral tufts of the siphon inserted laterally out of line. 10

Appendix XX

10(9). Thoracic hair 4 - P single; median distal spicule of the comb scale occasionally slightly longer than the lateral spicules. 11

Thoracic hair 4 - P bifid; median distal spicule of the comb scale never longer than the lateral spicules; abdominal hair 1 - X with 3 or 4 short branches . . . . . tritaeniorhynchus

11(10). Subventral tufts of siphon less than the width of the siphon at the point of insertion; anal gills less than 2 times the length of the saddle . . . . . mimulus

Subventral tufts of siphon longer than the width of the siphon at the point of insertion; anal gills 2 to 2-1/2 times the length of the saddle . . . . . solitarius

12(7). Subventral tufts of the siphon bifid, pectinate, with 2 additional shorter, simple pairs inserted laterally out of line . . . . . whitmorei

Subventral tufts of the siphon with 2 or more branches which are always simple, usually with only 1 pair inserted laterally out of line 13

13(12). Subventral tufts of the siphon usually with 6 or more branches; thoracic integument minutely spiculose; comb consisting approximately of 45 scales arranged in a triangular patch. . . . . vishnui (= annulus)

Subventral tufts of the siphon usually with 5 or less branches; thoracic integument glabrous; comb consisting of 5-13 long, sharp scales arranged in an irregular row. . . . . pseudovishnui

Note: The larval stage of Culex (C.) diengensis has not yet been described.

Reference: Modified from Bram 1967.

APPENDIX XXI

KEY TO THE SPECIES OF *MANSONIA* IN JAVA

Adults

1. Scutum with a pair of broad longitudinal stripes of greenish scales against a brown background. . . . . *uniformis*

   Scutum with round spots or irregular patches of scales but without distinct stripes 2

2(1). Scutum with distinct and regular round spots of light scales 3

   Scutum without distinct round spots of light scales but with irregular patches of pale scales. 5

3(2). Scutum with at least two pairs of distinct round spots of white scales; broad white scales present on the middle of the scutellum; a pale yellow-brown species . . . . . *annulifera*

   Scutum with only one pair of distinct round spots of white scales (though other less distinct markings may also be present); curved scales on mid-lobe of scutellum; dark brown to black species. 4

4(3). A small patch of flat white scales above wing roots; comb on eighth tergite of female with 4.11.4 teeth and rarely with detached tooth; usually a complete white band at base of fore-tibia. . . . . *dives*

   No white scales present above wing roots; comb on eighth tergite of female with 4.1.9.1.4 teeth and always with detached tooth; white scales at base of fore-tibia not forming a complete band . . . . . *bonneae**

5(2). Hind femur with three sharply defined bands of pale scales; scutum with irregular pattern of narrow yellow scales against dark background; pleural region light in contrast to dark scutum and coxae. . . . . *annulata**

   Hind femur with about five bands of pale scales; scutum with irregular patches of white scales against golden-brown background; pleural region not in marked contrast with scutum and coxae . . . . . *indiana*

*Not reported from Java

Reference: Wharton 1962

APPENDIX XXII

KEY TO THE SPECIES OF *COQUILLETTIDIA* IN JAVA

Adults

1.	Dark metallic species; mesonotum with pale scales on anterior two-thirds; tarsi uniformly dark.	*aureosquammata*
	Yellowish-brown or yellow species.	2
2(1).	Wing scales mainly dark; purplish scales on abdominal tergites.	*crassipes*
	Wing scales mainly yellow.	3
3(2).	Scutum and scutellum yellow; tarsi without dark bands.	*ochracea*
	Scutum with central longitudinal dark lines and large dark patches over the wing-roots; tarsi with dark spical bands	*nigrosignata*

APPENDIX XXIII

KEY TO THE SPECIES OF ARMIGERES IN JAVA

Females

1. Palpus 1/4 or at most 1/3 the length of the proboscis. . . (Subgenus Armigeres). 2

   Palpus 1/2 or more the length of the proboscis. . . (Subgenus Leicesteria) . . . 9

2(1). Numerous lower mesepimeral bristles . . . . . maximus

   Only 1 or 2 lower mesepimeral bristles 3

3(2). White band of scales on outer side of hind femur reaches 1/2 to 2/3 of femur from base . . . . . moultoni

   White band of scales on outer side of hind femur reaches up to the knee, or almost to the knee. 4

4(3). Abdominal sternites 3 and 4 mostly black scaled, with a few white scales in basal lateral area . . . . . durhami

   Abdominal sternites 3 and 4 all white scaled or else banded black and white. . . 5

5(4). Abdominal sternites 3 to 6 white, with broad, black apical bands . . . . subalbatus

   Abdominal sternites 3 to 6 all white 6

6(5). Continuous pale margin of white scales around menosotum. . . . . kuchingensis

   No pale margin of white scales around menosotum. 7

7(6). Clypeus without any white scales . . . . . jugraensis

   Clypeus with white scales 8

8(7). Abdominal sternite VII all white scales. . . . . malayi

   Abdominal sternite VII basal 1/4 to 1/2 dark scaled. . . . . foliatus

9(1). Hind tarsi with narrow, basal, pale rings 10

   Hind tarsi entirely dark 14

10(9). Abdominal tergites - VI with narrow, apical patches of pale yellow scales; postnotum with a small tuft of pale scales and setae; 1 or 2 lower mesepimeral setae present; hind tibiae distinctly shorter than fore tibiae . . . . . flavus

   Abdominal tergites without yellow, apical patches; no postnotal setae or scales; no lower mesepimeral setae; hind tibiae not shorter than fore tibiae 11

11(10). Abdominal tergites II - VII with dull, pale, basal markings; clypeus with scales in female. . . . . magnus

   Abdominal tergites II - VII without basal markings; clypeus with or without scales 12

Appendix XXIII

12(11). Abdominal tergite II with median, basal, white patch; female palps with clear white ring about the middle; male mid-claws simple . . . annulipalpis

Abdominal tergites II without median, basal, white patch; female palps usually without central white ring; male mid-claws toothed. 13

13(12). Clypeus scaled; female palps white at tip . . . . . annulitarsis

Clypeus without scales; female palps dark at tip. . . . . dolichocephalus

14(9). Propleural-fore coxal scale patch with two bands of black scales sandwiched between white scales. 15

Propleural-fore coxal scale patch with a single band of black scales between white scales 16

15(14). Lateral tergal markings entirely white; sternites largely white or with narrow, apical, dark bands; scale patch on mesepimeron widens towards the lower suture and barely reaches the suture . . . . . pectinatus

Lateral tergal markings of both white and yellow scales, at least on the more distal segments; sternites usually with clear, apical, dark bands . . . . . omissus

16(14). Lateral tergal markings of both white and yellow scales. . . . . dolichocephalus

Lateral tergal markings entirely white . . . . . digitatus

Reference: Macdonald 1960

APPENDIX XXIV

LIST OF ITEMS NEEDED FOR TAXONOMIC SURVEY

EQUIPMENT

Stereoscopic Microscope, Leitz	2
B. and L. Nicholas Illuminator	2
Drying oven	1
Altimeter	2
Metal Thermometer	2
Entomological forceps, fin (featherweight)	6
Insect pinning forceps	2
Paper punch (for 2 sizes)	2
Arial net	3
Plankton net	2
Diamond point pencil	3
Schmitt boxes	1 dozen
California Academy (or Cornell) drawers	4 dozen
Unit pinning trays (4 sizes)	3 gross
Wooden slide boxes (ROWI-408)	3 dozen

SUPPLIES (Annual basis)

Microscopic slides (good quality)	20 gross
Coverslips: 15 mm, 18 mm, 22 mm	12 ozs
Glass perfume vials with caps (for skins)	8 gross
Glass 1/4 dram, shell vials with neoprene stoppers	8 gross
Pipettes - large (4 oz)	12
Same, but medium size and small	12 each size
Plastic pill box	3 dozens
Plastics vials, 3-1/2 dram with lids	4 gross
Same, but 9 dram with lids	4 gross
1 quart plastic containers (mass rearing)	3 gross
1 quart ice-cream containers (board)	3 gross
Cotton	3 lb
Insect pins, No. 3 stainless steel (packets of 100)	30 packets
Aspirators (suction tube)	12
Euparal	2 lb
Euparal essence	2 lb
Clove oil	2 lb
Ambroid	12 oz
Ethyl acetate	1 lb
Alcohol	20 lb
KOH	1 lb

FIG. 1. MORPHOLOGY OF ADULT

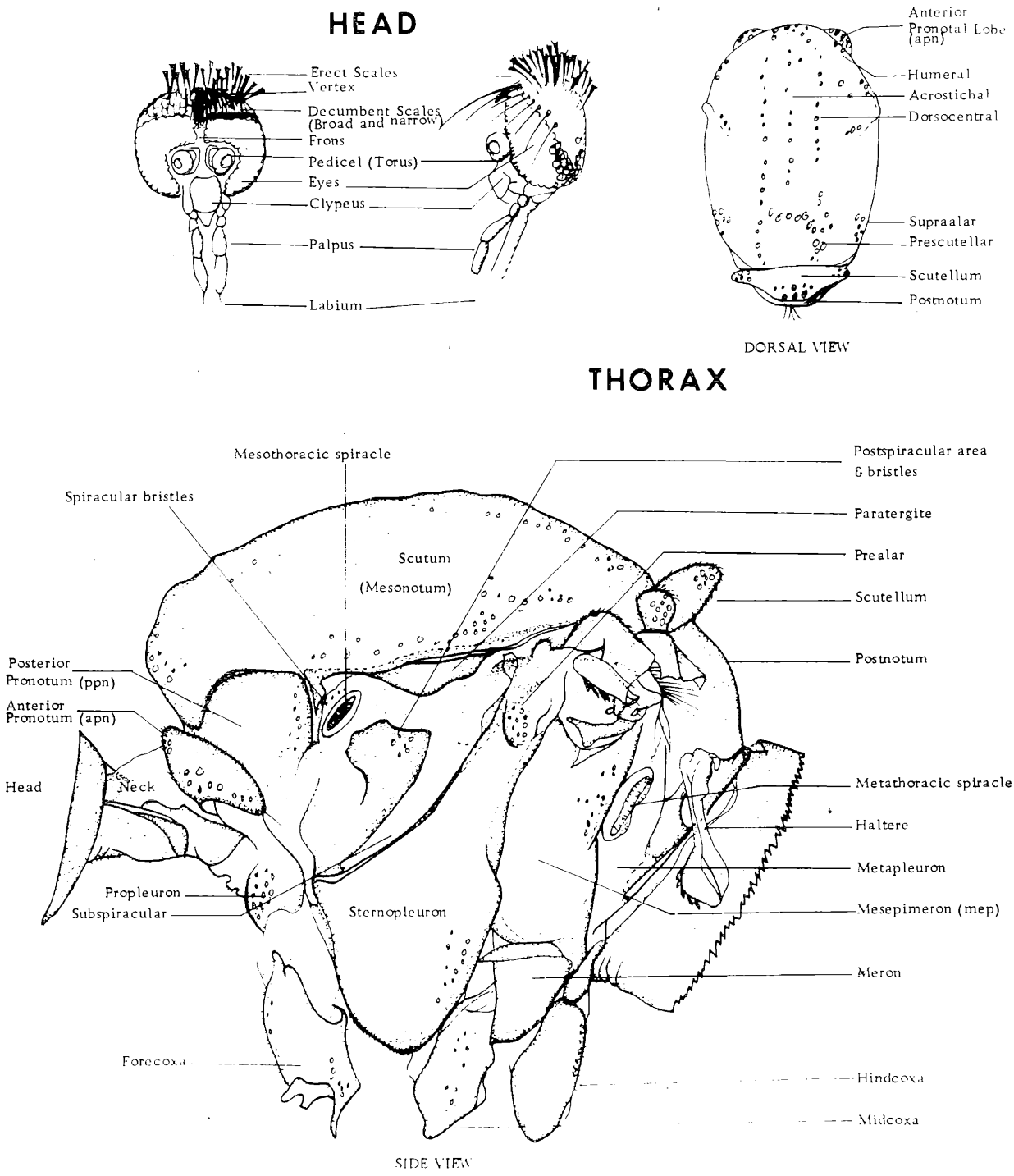

FIG. 2. MORPHOLOGY OF ADULT AND LARVAE

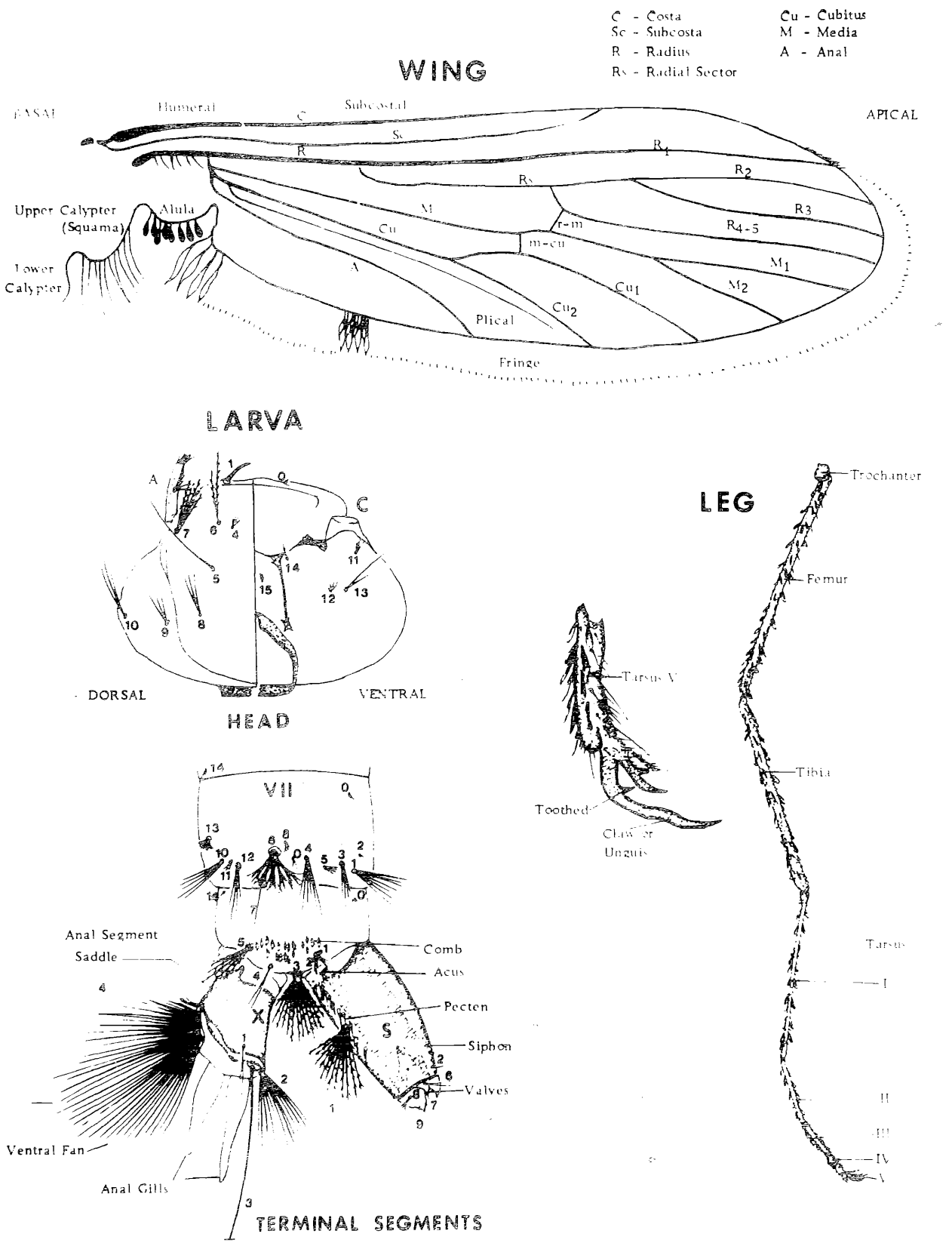

FIG. 3. COLLECTING EQUIPMENT AND MOUNTING METHODS