

NEW GUINEA CULICIDAE, A SYNOPSIS OF VECTORS, PESTS AND COMMON SPECIES

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I. Introduction

The present paper has been written for practical purposes in the first place. It intends to provide medical men in the field with some useful information on important mosquitoes. It is also meant to rouse some interest in those insects, that are of primary importance to public health. Three main categories will be dealt with: (a) Species known to be vectors of any human disease in the New Guinea territory; (b) Man-biting species without vector properties, merely annoying by their numbers (pest-mosquitoes); (c) Some species, not man-biting, but easily recognizable, wide-spread, and frequently present in mosquito collections.

The present synopsis has no pretensions as to its complete originality. Bonne-Wepster & Brug (1937, 1939) already published a paper on 40 Culicines, later on modernized and extended to one hundred species by Bonne-Wepster (1954). Both these reviews, however, which are more or less out of date by now, are dealing with the whole area of the former Dutch East Indies, i.e. the Indonesian Republic including Western New Guinea ¹⁾. This area includes parts of two entirely different faunistic provinces (the oriental and the australian), between which a natural, be it somewhat flexible, borderline exists. From a New Guinea point of view both papers carry a lot of ballast species: orientals, not occurring in the territory. On the other hand some New Guinea species which have become known as common are scarcely mentioned, or omitted. The monograph by Bonne-Wepster & Swellengrebel (1953) on the anophelines of the Indo-Australian region is

¹⁾ The manuscript was closed in 1959. Although the name Netherlands New Guinea is consistently changed in Western New Guinea, the localities are still indicated by the old names (e.g., Geelvink bay, not Teluk Tjenderawasih).

hardly accessible to a non-entomologist because of the huge number of species dealt with. Yet, the anopheline fauna of New Guinea proper is poor and its most important species are easily identified. For all these reasons we feel sure that there is a need for a simple mosquito guide for both anopheline and culicine species.

Besides a part dealing with systematics and descriptions, some space has been reserved here for a review of the native vector species and their special properties, for some mosquito biology in general and for a review of the control methods applied in the territory.

The knowledge of the New Guinea mosquito fauna is of a recent date and still far from complete. Up to the second world war the little material collected seldom was complete (i.e. including all developmental stages) and frequently was not in the best of conditions, Miss Cheesman's collections in the thirties excepted. The material originating from government physicians was often one-sided because of their main interest in anophelines. The work of several American entomologists, stationed for longer or shorter periods in New Guinea during the war in the Pacific, brought about much improvement. Before all King & Hoogstraal have to be mentioned in this respect. After the war the interest once aroused continued and still more material became available, resulting in a better insight in the role of some species as vectors of human diseases.

Still one point of general importance — and misunderstanding — should be stressed. Everybody seems to be convinced of the necessity to study vector species as closely as possible. Other species, and especially those which never feed on man, are out of the picture and thought to be irrelevant; somebody interested in them is at best called a money- and time-consuming eccentric. This view, however, is unscientific and moreover incorrect. In the field of research results have never been achieved in the long run if there was no interest in seemingly academic problems as well. On the contrary more often than not these academic problems proved to be the keys for a better understanding of the underlying mechanisms and most fruitful for practical applications. Medical entomology is no exception to this rule. The ideas about the role of mosquitoes in public health, and methods for better control, were only conceived after long series of what seemed at first worthless experiments. If it is necessary to look at the world through the eyes of a mosquito for planning an efficient mosquito control — an expression of Hackett — than it is urgent to make the vision as broad as possible. Mosquitoes with blinkers are non-existent!

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II. General properties of a vector species

The Culicidae (mosquito family) ranks among the most thoroughly known groups of insects in the world. The total number of different mosquito species in existence is estimated to be between 2000 and 2500. A number of these species (vectors) are of primary importance because of their ability to maintain and spread several human (and animal) diseases, a discovery made in the last decade of the 19th century by Manson, Ross and other workers. In New Guinea vector species are known for human malaria (*Plasmodium spec.*), for bancroftian filariasis and for some virus infections (encephalitic infections and dengue). Though many mosquito species prove to be susceptible for many different kinds of infections in the laboratory, the number of vector species in nature is restricted. Special requirements indeed have to be met to make a species an efficient vector. A few points of general interest may be made before inquiring into the nature of vector properties.

a. Animals of any kind, mosquitoes not excepted, live in an environment to which they are adapted by their way of life. The relationship between animal and environment, in which both lifeless and living nature are comprised, is of a dynamic character, because no environment proves to be constant in the long run. The natural laws operating here are object for a conscientious biological study.

b. No mosquito species is to be found everywhere. A hypothetic, though not unrealistic example may illustrate this principle. A mosquito species prefers to lay its eggs in the rainfilled leaf axils of *Colocasia* (keladi or taro) plants. For obtaining its blood meal this mosquito proves to be dainty: it only feeds on frogs. Moreover the temperature in its environment should not rise over 26° C. It will be clear that a combination of factors mentioned above are realised in restricted areas only.

c. No single species proves to be spread homogeneously over its natural range. It is the restricted extensiveness of the special suited environments

or habitats which break up the total number of individuals of any species in natural groups or populations. Populations whose interbreeding members occupy the same locality are the most important biological entities and in fact represent the units of which any species is composed in nature. The question as to what exactly a species is, is one of the most fundamental problems in biology. A discussion is outside the scope of this paper. It may be stressed here that a biological approach seems most promising for the medical entomologist, an approach which will be different from the practical and purely taxonomic approach of the museum biologist.

d. Contacts between human and mosquito populations exist in those, short lasting, moments necessary for mosquito females to obtain a blood meal on a human being (relations of another kind will be mentioned in the chapter on mosquito control). These moments of contact have been utilised by several kinds of pathogens and elaborated into a way of life. In most of the cases the mosquito itself does not act merely as a 'passing-on' mechanism between different men: the insect is the indispensable host for an obligatory phase in the parasite's life as well. Thus in *Plasmodium* there is an alternation between an asexual phase in man and a sexual generation in the mosquito. In filaria maturity is just reached in man.

With these points in mind we may turn to the problem which mosquito species are likely to act as vectors under certain circumstances.

1. The length of the developmental cycle of the parasite within the mosquito is dependent on the temperature of the environment. According to Stratman-Thomas (1940), a development of *Plasmodium vivax* Grassi & Feletti was impossible at temperatures under 15° C, whereas optimal conditions for this parasite were near 28° C. Thus in many places climate will prove to be the inhibiting factor for transmission. Transmission is then merely impossible or only periodical though potentially dangerous mosquito species might be present in numbers. In New Guinea such situations are realized in the Central and Vogelkop peninsula mountains above certain altitudes, the exact altitude dependent on very local conditions.

2. A mosquito vector individual has to live long enough for the parasite to complete its developmental cycle. *Plasmodium vivax* requires 10-12 days for this in the New Guinea lowlands. Besides a mosquito female is 2-3 days old — in *Anopheles* at least — before it is ready to take its first blood meal. The minimum lifespan for an effective *vivax*-vector will thus lay in the order of 12-15 days. No doubt many *Anopheles* individuals live to that age and beyond under natural conditions as can be concluded from the degree of endemicity of *vivax*-malaria in many regions. An almost similar lifespan is

required for other *Plasmodium*'s and for the development of bancroftian filariasis. In higher altitudes, causing a longer developmental cycle of the parasite, the average lifespan of the mosquito may prove to be the limiting factor in transmission.

Different techniques have been developed to estimate the average age of the mosquito individuals in a population. The most simple one has been described by Mer (1932). After the first egg batch has been produced an irreversible change in the so-called ampullae-part of the paired oviduct of the mosquito, is noted. By making use of this character it is possible to separate the individuals of any sample into two categories: nulliparous (no eggs laid before) and parous (one or more egg batches already produced). An average expectation of life for the mosquitoes in the population studied can be estimated from the relation nulliparous — parous (Macdonald, 1950). A very refined technique has been developed by Polovodova (1941), by using the average number of 'corpora lutea' present per ovariole as a measure for the number of egg batches produced. Every 'corpus luteum' corresponds with one completed developmental cycle of an egg. Provided the duration of egg development is known for the area tested — in the New Guinea lowlands e.g. 2 days — the composition as to different age groups of the population can be assessed accurately in this way. It is not sure, however, whether this technique is applicable in all *Anopheles*, or in all mosquito species; its practical drawback is that it requires considerable skill and moreover is very time-consuming.

3. A species will act as an effective vector only if its contact with man occurs frequently. The presence of numerous attractive baits of other kinds counteracts the vector efficiency.

It seems useful to give more details here on the host seeking behaviour of the mosquito female in general. It is taken for granted that only females require blood. The females of some species exhibit an aberrant behaviour: in New Guinea *Toxorhynchites* feeds on honey, *Malaya* is fed by certain ants.

A mosquito is not ready to seek a donor at any moment. Only the females whose eggs are still in a first phase of development become activated, being in need of a blood meal for a normal development of their next egg-batch. Such females are either young ones that emerged recently or individuals that recently laid eggs. They start seeking a donor at a time of day or night which is characteristic for their species. Some of them exhibit short and well defined periods of host seeking behaviour, other species are much less exclusive.

A mosquito once activated flies around until the presence of a suitable host is perceived by its sense organs. Special stimuli will guide the mosquito

to the exact locality where the host is to be found, biting and blood sucking may follow. It will be clear that this behaviour pattern is complex and different for different species. Everybody who pays attention will notice that an attacking *Aedes scutellaris* acts quite differently from *Tripteroides* species, which in turn differ from *Mansonia*'s and anophelines.

The host seeking behaviour of a few species only has been analysed thus far. It is very probable that every mosquito species possesses an innate knowledge of the kind of its suitable blood donors. From research on other animals it has been concluded that such knowledge can be restricted to a few simple specific characters (innate scheme). In mosquitoes temperature gradients and chemical stimuli probably play important roles as such. It is quite sure that the innate host schemes differ considerably from species to species, though our present knowledge is far from complete. In fact man meets the requirements of a number of species. The existence of mosquito populations which will accept only man for a host is very doubtful; domesticated populations in large urban areas (unknown in New Guinea) might feed almost exclusively on man, not because of a preference but because of his availability.

In literature one often meets the terms *zoophilic* and *anthropophilic* used to characterize the host seeking behaviour. One should call *zoophilic* those species only whose host scheme excludes man; it goes without saying that these species never can be vectors for human diseases. *Anthropophilic* is in fact an unrealistic term. In practice *anthropophilic* species are called those which feed on a number of warm blooded vertebrates including man. Some species called *zoophilic* might in fact accept man for a host though in nature the opportunity never arises: e.g. mosquitoes living in the jungle at the canopy level and feeding on birds and quadrupeds.

The terms *endophilic* and *exophilic* (Roubaud, 1920; Senior-White, 1954) require some comment as well. As noted above, only mosquitoes in a certain physiological state become activated to obtain a blood meal. Many species however are not ready to attack a host under all circumstances. Factors from the environment may inhibit the activity at a given moment. This is very clear for instance in certain day-biting species to be found in wet or swampy forest, e.g. several New Guinea *Aedes* (*Aedes*) species. In places one may be attacked by such huge numbers of these insects that it is virtually impossible to hold on. However, only a few metres away from the edge of the jungle into the open of a clearing, no specimens can be found any more. The transition from forest conditions to the open (considerable differences in temperature, humidity and light conditions play a role) seems sufficient to inhibit the host seeking behaviour in the latter locality.

A similar mechanism is found in the transition from outside to indoors which prevents many a species from entering. Species not found biting indoors are called typically exophilic, contrary to endophilic species which are ready to overcome the obstacle of coming inside houses. It will be clear that these differences are a matter of degree only, the latter category being a bit more 'liberal' than the former.

In many areas of New Guinea native housing conditions are still such that little difference can be observed between in and outdoors at all.

4. The lapse of time between two successive blood meals is another important factor. A high biting frequency is a requisite for a good vector. This frequency depends for a good deal on the duration of development of the eggs in the ovary, governed by species-specific factors and climate (i.e. temperature factors in the first place). In the New Guinea lowlands the egg cycle in *Anopheles koliensis* and *Anopheles farauti* takes 2 days — biting as a consequence may occur every other day in these species. In *Culex fatigans* it lasts 2-5 days, in *Mansonia uniformis* at least 3-5 days. Some species may take more than one blood meal per egg cycle, e.g. *Mansonia uniformis*.

5. Potentially efficient vectors will be found only among those species that are present in considerable numbers. Transmission seems to become impossible below a critical density. In areas with a distinct alternation of dry and wet seasons mosquito densities vary accordingly. A seasonal transmission may be the result as is the case for human malaria in the Merauke area of southern New Guinea. Moderate densities of several mosquito species together might be thought to have the same effect in transmission as a very high density for one species. Yet, transmission seems to be less effective as a rule in the former case. No two mosquito species will constitute entirely equally favourable environments for the development of the parasite. The average developmental results in one species will be better, however slightly, than in others. Specialization to a certain degree on the most favourable mosquito species will have survival value for the parasite; in the course of evolution such relationship may grow more and more obligate, consequently resulting in a loss of possibilities regarding other mosquito species. The unsuitability of many species to certain parasites will be the result of the specialization processes in which they were discarded because of some of their less favourable properties.

The transmission of filariasis is complicated by two further points:

a. it has been shown that a hyper-infection is definitely deleterious to the mosquito, and

b. in New Guinea *Wuchereria bancrofti* shows a nocturnal periodicity.

No filaria vectors are to be found among species biting in day light or in early evening hours.

It is most fruitful to present the complex relationship between men, mosquitoes and parasites as very subtle equilibria of biological forces. This equilibrium may exhibit important local differences, according to the actual properties of mosquito populations and parasite strains, which are never quite identical in different places. It can thus easily be imagined that one species plays a major role as a vector in one locality and is of only minor importance in another. Some evidence for this is produced by the researches on transmission of *Wuchereria bancrofti* in different parts of New Guinea. *Culex annulirostris* was found to be a major vector in the Berau district by De Rook (1957 b): 1.6% of the specimens collected proved to harbour infective phases of the parasite, whereas 25.5 % of the total number harboured a developmental phase of this worm. As much as 82.5 % (33 out 40) of the specimens collected on a microfilaria carrier became infected by him. Comparable results were obtained in the Inanwatan district (De Rook, 1959). Earlier De Rook (1957 a) found that the same species was only of minor importance on Pam Island: 2.0% of the total number collected proved to be infective, 7% (3 out 44) harboured any developmental stage and only 6.5% (5 out 77) became infected on a microfilaria carrier. Also in the Hollandia area, *Culex annulirostris* hardly becomes infected in transmission experiments (Van Dijk, pers. comm.).

6. In conclusion it can be said:

An ideal — not existent — vector population in a given area has to meet the following requirements. It must be composed of a great number of individuals which will bite men readily, outside as well as indoors, without being distracted by numerous baits of other kinds. The expectation of life of the mosquito individuals has to be well over the time needed by the parasite for its extrinsic development, the mosquito biting frequency has to be high and climatic conditions such as to provide optimum developmental conditions for both parasite and mosquito. All transmission mechanisms existent in nature are compromises of this ideal.

III. New Guinean mosquito species found to be actual vectors or suspected to be so

A review of mosquito species found to harbour infective parasite stages in nature is represented in table I. Species mentioned in table II are such in which a full development of the parasite proved to be possible under controlled conditions. Species occurring in New Guinea for which vector properties were proven elsewhere are represented in table III.

TABLE I

Mosquito species found infective in nature in New Guinea

a. Human plasmodia

species	author	% infective	locality
<i>Anopheles bancrofti</i>	Metselaar (1957)	0.2 (2 o. 982)	Merauke in transm. season.
<i>Anopheles farauti</i>	Mackerras & Aberdeen (1946)	2.0 (4 o. 200) 2.4 (3 o. 126)	Wewak T.N.G.
<i>Anopheles karwari</i>	Metselaar (1957)	3.1 (4 o. 128)	Nimboran distr.
<i>Anopheles koliensis</i>	Metselaar (1955)	1.4 (2 o. 138)	Sentani lake distr.
	Toffaletti & King (1947)	1.1 (3 o. 268)	Hollandia
	Metselaar (1957)	5.0 (5 o. 100)	Nimboran distr.
	Meuwissen (1958)	1.4 (4 o. 296)	Djik
<i>Anopheles punctulatus</i>	Metselaar (1957)	2.8 (19 o. 663)	Nimboran distr.
	Meuwissen (1958)	2.2 (15 o. 658)	Arso

b. *Wuchereria bancrofti*

<i>Aedes kochi</i>	De Rook (1957a)	1.6	Pam Isl.
<i>Anopheles bancrofti</i>	Elsbach (1937)		Tanahmerah
<i>Anopheles farauti</i>	Toffaletti & King (1947)	*	Hollandia
	Backhouse & Heydon (1950)	—	Rabaul (New Brit.)
	De Rook (1957a)	6.6	Pam Isl.
<i>Anopheles koliensis</i>	Toffaletti & King (1947)	*	Hollandia
<i>Anopheles punctulatus</i>	Toffaletti & King (1947)	*	Hollandia
	Meuwissen (1958)	—	Djik
<i>Culex annulirostris</i>	De Rook (1957a)	2.0	Pam Isl.
	De Rook (1957b)	1.6	Berau distr.
<i>Culex bitaeniorhynchus</i>	De Rook (1957b)	2.1	Berau distr.
<i>Culex fatigans</i>	De Rook (1957a)	1 o. 23	Pam Isl.
<i>Mansonia uniformis</i>	De Rook (1957b)	1.3	Berau distr.

* Toffaletti and King found 7 full grown filaria instars in 203 specimens of Anophelines of the *punctulatus*-group (3.1 %).

c. Dengue

<i>Aedes scutellaris</i>	Mackerras (1946)		Territory of Papua and New Guinea (T.P.N.G.)
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TABLE II

Mosquito species in which in controlled infections the infective stage was obtained

a. Human plasmodia

species	author	% infective	locality
<i>Anopheles longirostris</i>	De Rook (p.c.)	once	Mamberamo riv.

b. Wuchereria bancrofti

<i>Aedes kochi</i>	Backhouse & Heydon (1950)	3 o. 8	Rabaul (N. Br.)
<i>Anopheles karwari</i>	Metselaar (1955)	once	Hollandia
<i>Anopheles koliensis</i>	Van Dijk (1959)	21 o. 22	Hollandia
<i>Culex fatigans</i>	Backhouse & Heydon (1950)	9 o. 96	Rabaul (N. Br.)
<i>Culex squamosus</i>	Van Dijk (1958)	once	Edera distr.
<i>Mansonia uniformis</i>	Van Dijk (1958)	18 o. 19	Edera distr.
<i>Mansonia papuensis</i>	Van Dijk (1958)	once	Edera distr.
<i>Culex annulirostris</i>	Van Dijk (p.c.)	1 o. 7	mosquitoes infected
<i>Anopheles koliensis</i>	Van Dijk (p.c.)	4 o. 5	on same carrier
			Hollandia
<i>Anopheles farauti</i> (reported as <i>A. p.</i> var. <i>moluccensis</i>)	Backhouse (1934)	14 o. 20	Rabaul (N. Br.)
<i>Anopheles punctulatus</i>	Backhouse (1934)	3 o. 4	Rabaul (N. Br.)

c. Dengue

<i>Armigeres breinli</i>	Mackerras (1946)		T.P.N.G.
<i>Armigeres milnensis</i>	Mackerras (1946)		T.P.N.G.

a. Human malaria

Anophelines of the *punctulatus*-group — above all *A. farauti*, *A. koliensis* and *A. punctulatus* — are the primary vectors of human malaria in the territory. Details on the distribution of these and other *Anopheles* species within Western New Guinea have been published by Van den Assem & Van Dijk (1958). They occur in most of the lowlands; for particulars on lowland areas in which they are absent due to specific ecological conditions, may be referred to De Rook (1957b) — Berau area; Van Dijk (1958) —

TABLE III

Mosquito species which belong to the New Guinea fauna but whose vector properties were proven elsewhere. N = infective instars found in nature.

E = infective instars found under experimental conditions

a. Human plasmodia

species	author	% infective	locality
<i>Anopheles amictus hilli</i>	Roberts (1943)	1.3 N	Cairns Qld, during a <i>farauti</i> -borne mal. epidemic

b. *Wuchereria bancrofti*

<i>Aedes aegypti</i> 1)	Eyles & Most (1947)	1.8 E	U.S.A.
<i>Aedes vigilax</i> 2)	Iyengar (1954)	5.0 N	Eastcoast New Cal.
	Backhouse & Woodhill (1956)	98.5 E	Sydney Austr.
<i>Culex annulirostris</i> 2)	Symes (1955)	1.9 N	Fiji
<i>Culex fatigans</i>	many references from many localities in the tropics <i>C. fatigans</i> is the vector par excellence		
<i>Culex whitmorei</i>		E	Indonesia

1) The reference by Eyles & Most is about the only one reporting positive results for the development of *W. bancrofti* in *Aedes aegypti*; many other experiments gave negative results.

2) Vector for the non-periodic form of *W. bancrofti*.

c. Dengue

<i>Aedes aegypti</i>	Cleland et al. (1918)	E	Australia
	Simmons (1931)	E	Australia
	Perry (1950)	N	New Caledonia
<i>Armigeres obturbans</i>	Koizumi et al. (1917)	E	Formosa

d. Japanese B encephalitis

<i>Aedes vexans</i>	Tigertt et al. (1950)	E	Guam
<i>Culex fatigans</i>	Tigertt et al. (1950)	E	Guam

e. Murray valley encephalitis (MVE)

<i>Aedes aegypti</i>	Rozeboom & McLean (1956)	E	U.S.A.
<i>Aedes notoscriptus</i>	McLean (1953)	E	Australia
<i>Aedes vigilax</i>	McLean (1953)	E	Australia
<i>Culex annulirostris</i>	McLean (1955)	E	Australia
<i>Culex fatigans</i>	McLean (1953)	E	Australia

Bamgi-Ia district; Van den Assem (1959a) — Frederik Hendrik Island.

In mountainous regions *punctulatus*-group anophelines have been recorded from up to considerable altitudes: 2250 metres (Bonne-Wepster, 1948); 5200 feet (Lee, 1946). The local densities of the *punctulatus* species may be enormous. Catches in the open among native habitations may yield as many as 50-100 specimens per man per hour.

Anopheles farauti is most wide-spread in the territory and is most tolerant in the choice of its breeding places, which are either fresh or brackish. In the vast plain of south New Guinea it is the only *punctulatus*-group member present. *Anopheles koliensis* is more particular and more restricted in distribution: absent from the flat part of south New Guinea and from the mountains of the Vogelkop peninsula, including the adjacent coast, at least between Manokwari and Sorong. *Anopheles punctulatus* proper has the most specialized breeding places: ephemere and bare, often clayish puddles open to full sunlight. Especially this latter species is responsible (besides man) for the malaria accompanying clearing and construction activities. Very suitable breeding places for instance are the rain filled wheel tracks in recently cleared forest and in roads in bad conditions. Due to these habits this species is very instable, i.e. suddenly appearing in huge, fluctuating numbers, mainly dependent on local climatic conditions.

Anopheles bancrofti, a big and entirely black anopheline, is very common in the southern plain of the territory. It does not play a role of great importance in malaria transmission, in many areas at least, contrary to the earlier statements of Bonne-Wepster & Swellengrebel (1953, p. 219), quoting De Rook (1929). Actually this author confirmed the high densities of this species, present at the Upper Digoel river, outnumbering *Anopheles moluccensis* (is mainly *A. koliensis*) by about 3 : 1. The average number of oocysts present on the stomach wall was lower in *bancrofti* than it was in *koliensis*; a ratio of about 8 to 12. Since no salivary gland dissections were made a definite conclusion on actual vector potencies cannot be given. De Rook (pers. comm.) is convinced of the local importance of *A. bancrofti* as such.

Metselaar (1957) records 0.2% only (2 out 982) to be infective, in dissections at Merauke in the transmission season. Moreover, no malaria of importance occurs in areas where *A. bancrofti* is the only anopheline present in numbers, e.g. Frederik Hendrik Island. One of the reasons that *Anopheles bancrofti* is not a good host for New Guinea *Plasmodium* strains might be its systematic position: it is not related to the *punctulatus*-group.

Anopheles karwari is originally not indigenous in New Guinea. Probably it was imported at some (rather recent?) date (though present long before

the Pacific war) from Southeast Asia. So far it has been recorded from the Hollandia and Sepik (T.P.N.G.) districts only. Metselaar (1955) recorded 955 out 10322 (9.5 %) anophelines caught at Hollandia in 1953-54, to belong to this species. Its numbers decreased after the start of the house spraying campaign in this area: no *A. karwari* was found among 3004 anophelines dissected in 1958. Its, albeit very local, importance as a vector was recorded by Metselaar as well. This finding is the more interesting because in New Guinea this species proved to be such a good host for *Plasmodium*, though it is not closely related to the *punctulatus*-group (however nearer than *A. bancrofti*), while in its oriental home-land it is completely unknown as a malaria vector.

b. *Wuchereria bancrofti*

Again anophelines of the *punctulatus*-group are beyond any doubt important vectors of bancroftian filariasis in New Guinea. The percentage infective in *Anopheles farauti* as found by De Rook (1957a) on Pam Island is about the highest ever recorded. According to Van Dijk (1959) the role of *A. koliensis* in many inland localities deserves the closest attention. This species is most probably a very important vector in the Hollandia-hinterland. The role of *Anopheles bancrofti* may have been overestimated by earlier authors.

Research by De Rook (1957b) and Van Dijk (1958) in areas with a fairly high filariasis endemicity in the absence of *punctulatus*-group anophelines brought to light other vector species: several culicines.

Before all *Mansonia uniformis* has to be mentioned here. This species is very wide-spread in the territory; it occurs in countless numbers in places in both low- and highlands. In spite of the abundance of the adults, the larvae are often very difficult to trace; contrary to most other mosquitoes *Mansonia* larvae stay submerged constantly as they possess a peculiar siphon, fit for piercing soft vegetable tissue, which enables them to take oxygen from the roots of water weeds. The common water lettuce (*Pistia*, Araceae) and *Hydrocharis* species (Hydrocharitaceae) proved to be the host plants most frequented in the territory (Van den Assem & Metselaar, 1958; Van den Assem, 1958a, 1958b).

Aedes (Finlaya) kochi belongs to a mosquito group whose members are easily recognized: conspicuous black and white or black and white and yellow coloured species. As far as known all prefer to breed in leaf axils. Larvae were found in *Pandanus*, *Metroxylon* (sago) and *Colocasia* (taro or keladi) axils, sometimes in rain filled coconut shells. *Aedes kochi* is wide-spread in the

western part of New Guinea, up to considerable altitudes (up to 1000 meters in the Western Highlands); it bites easily indoors.

Closely related species *Aedes (F.) wallacei* and *Aedes (F.) josephinae*, are (still?) unknown to be a vector. Locally they occur in astronomical numbers (e.g. in Frederik Hendrik Island; Van den Assem, 1959a). Another relative, not native to New Guinea however, *Aedes (F.) poicilius*, is a notorious vector elsewhere in Indonesia and in the Philippines. The species *Aedes (O.) vigilax* is recorded to be the vector of filariasis in New Caledonia (Iyengar, 1954). In New Guinea this species is most probably not of importance, it was collected occasionally in coastal regions (Sorong, Merauke).

Of the *Culex* vectors, *Culex annulirostris* is one of the most common species of the New Guinea mosquito fauna. In the native villages it plays the same role as *C. fatigans* in the larger settlements, though it certainly is not as domesticated as the latter species is. In some regions it appears most important as a vector (Berau district; De Rook, 1957b); in others it is not (Hollandia and Nimbora districts; Van Dijk, pers. comm.) (see also chapter II).

C. annulirostris larvae are often found in the same breeding places as *Anopheles farauti*.

Culex bitaeniorhynchus is of a more local importance only. The species is wide spread throughout the territory but no second place is known to us where its densities are as high as recorded by De Rook for the Berau area. *Culex squamosus*, closely related to *C. bitaeniorhynchus*, is still less common but also wide spread. Larvae of these species are always associated with filamentous green algae which are important as a diet. *Culex whitmorei*, a vector in Indonesia, was nowhere in the New Guinea lowlands collected in large numbers. In several highland localities it was very common (Enarotali Wissel lakes district, and Homejo); it may replace *Culex annulirostris* here.

Culex fatigans, together with *Aedes aegypti*, is a major problem to public health all over the world. In many tropical countries it is the vector of bancroftian filariasis and also plays a role as vector of several virus diseases. It is a very domesticated species, i.e. always connected with man and dependent on man for a good part. Human habitations meet perfectly the requirements of the daytime resting-places of this mosquito, man provides the necessary breeding places as well: polluted, stagnant water. *Culex fatigans* was originally not endemic in the territory but probably imported at a rather recent date from Asia. It is common now in all European settlements and it is spreading to adjacent localities. It invaded the Wissel lake district (Central highlands) very recently, probably 1954 — by aeroplane from Napan or

Biak. Still more recent is its penetration into the Nimboran district (1957), where it has got a foothold by now in many native villages. So far *Culex fatigans* did not play a role of any importance in filariasis transmission, it might do so however in the future in the highly filariasis-endemic Nimboran plain. Iyengar (pers. comm.) was optimistic in this respect as he doubted that this species could ever develop the necessary densities it does elsewhere, under the conditions prevailing in the sparsely populated native villages in New Guinea. From data given by De Rook (1959) for the Inanwatan area, it may be concluded that the local *W. bancrofti* strains are unable to develop as well in *Culex fatigans* as they do in some of the native species to which they have been adapted for a long time (i.e. *Culex annulirostris* and *Anopheles farauti*).

c. Virus infections

In New Guinea *Aedes (Stegomyia) scutellaris* has been discriminated as a vector for dengue (Mackerras, 1946). This mosquito, attacking preferably in the afternoon, is one of the most notorious pest species of the endemic fauna. Especially in the wet season it may occur massively among native and European habitations where larvae can always be found in disposed tins and other litter holding small quantities of rain water. Species closely related to *scutellaris*, e.g. *Aedes polynesiensis*, are the vectors of the non-periodic form of *Wuchereria bancrofti* on many Pacific islands (Fiji, Samoa, Cook, etc.).

Another virus vector (most notorious in respect to yellow fever, that is, however, absent in Asia and Australia) is *Aedes (S.) aegypti*. This mosquito is another immigrant in New Guinea, according to Edwards (1924) native to tropical Africa. Nowadays this species is common in all tropics. Due to its domestic properties it has developed as the house mosquito par excellence. In New Guinea situations are still different in so far that the species is restricted to a very few coastal settlements only; the circumstances elsewhere are probably still too much in favour of the native *Aedes scutellaris*. *A. aegypti* is recorded from Kaimana settlement (southwest N.G.), a centre of trade with Indonesia before the Pacific war. Larvae are found in the rain-water holding drums present in abundance in the Chinese quarter. The species is of pest density here. Recently (December 1958, Van Dijk, pers. comm.) the species was found in the native village of Soesoenoë — 50 miles more to the northwest on the Argoeni-bay —, where it was absent formerly. De Rook recorded the species fully unexpectedly from drums next to a Chinese shop in Inanwatan, on the south coast of the Vogelkop peninsula. In other old settlements as are Fakfak, Manokwari, Hollandia and Merauke, the species is virtually absent. In the Territory of Papua and New Guinea

Aedes aegypti is known to occur in old trade centres, e.g. Rabaul and Port Moresby.

Aedes (F.) notoscriptus, a vector of Murray valley encephalitis was found by us in pest quantities only at Koembe village, 20 miles west of Merauke. The species had found ideal breeding places there in the rain filled internodes of bamboos used for fences and present in abundance. In all other lowland parts of the territory the species is common but never a pest. *Aedes (Aedimorphus) vexans* is also wide-spread but its importance will be local at the most. It was found to be a pest in Kaimana.

Armigeres milnensis is frequently found to be quite common. Biting occurs in the late afternoon hours. Larvae are found in small water collections which hold heavily polluted water, e.g. the decaying stumps of felled banana palms or in the almost fermenting contents of disposed coconuts. *Armigeres breinli* and *Armigeres ?obturbans* were collected occasionally, the former species more frequently than the latter, though the latter was recorded by Toffaletti & King (1947) as being very abundant in the Hollandia area.

IV. Some notes on mosquito breeding places

It is taken for granted that the larval instars of all mosquitoes live in water; eggs are laid on the water surface or close to it among wet material or glued to water weeds just over the surface. Mosquito eggs may float or sink to the bottom. There are four instars between egg and pupa, the adult mosquito emerges from the pupa.

No mosquito species oviposits indiscriminatorily on all water available; in fact there is a more or less well defined preference for certain types of breeding places in every species. For medical men touring in the field it is very desirable to be able to recognize potentially suitable breeding places.

In the area under consideration the breeding places prevalent can be arranged into groundwater and container habitats.

Groundwater breeding places — all those earthen lined — cover all types of waterbodies from permanent lakes, ponds, back-waters of streams to the transient water collections in wheelruts and footprints. In permanent water, mosquito larvae are absent from the open but have to be searched in the cover of floating or fringing vegetation. The mosquito fauna in semi-permanent pools is notably rich and most diversified. In New Guinea the genera *Anopheles*, *Bironella*, *Hodgesia*, *Mansonia* and *Ficalbia* are groundwater breeders, as are almost all *Uranotaenia*, most *Culex* and many *Aedes* species.

Larvae of three species of malaria vectors, *A. farauti*, *A. koliensis* and *A. punctulatus* are to be found in transient pools, provided there is full

access for sunlight. *A. punctulatus* prefers short lasting and often clayish puddles, bare of any vegetation. Due to the open location the conditions can grow fairly extreme, temperatures of about 40° C at noon have been measured. This species is able to survive these conditions and can complete its larval cycle in a record time as short as 7 days (Horsfall & Porter, 1946). The conditions in the other *punctulatus*-group breeding places are less extreme, vegetation is usually present; *A. farauti* moreover does not avoid brackish water. Pools and small ditches, pools at the fringe of wet forest where sunlight penetrates on the floor and pools in the open of sago swamps, grass overgrown pools in neglected roads all meet the requirements of these species.

Quite a typical association constitute larvae of the *Culex bitaeniorhynchus*-group and green filamentous algae, to be found in semi-permanent water in the open or in half shade. Fields of water weeds floating or standing in eutrophic water are suspect for supporting a population of *Mansonia* larvae which are rather difficult to collect due to the habit of being permanently submerged between the roots of the weeds. For the characteristics of the *Mansonia* hostplants we may refer to Van den Assem & Metselaar, 1958.

Shallow pools in shade in sago swamps frequently harbour *Uranotaenia* species in New Guinea; *Uranotaenia* larvae may superficially be mistaken for anophelines due to their short siphon and their position in the water.

Crab-holes constitute a peculiar and exclusive type of breeding place preferred by several *Aedes* species, some of which are man-biting.

Breeding places of the container type comprise all those other than earthen lined, often of a very special character, and containing strictly limited quantities of water: e.g. tree holes, axils of leaves and inflorescences of several native plants (sago, *Pandanus*, many kinds of cultivated and wild keladi or taro, *Curcuma* spec.), bamboo internodes, pitchers of *Nepenthes* species, fallen leaves on the forest floor and in addition a host of artificial structures capable of holding some water (tins, drums, canoes etc.). The genera *Aedes*, *Malaya*, *Toxorhynchites* and *Tripteroides* are the important container breeders in New Guinea. Species of the notorious *Aedes kochi*-group are mostly axil breeders (sago, *Pandanus*, *Colocasia*), also in coconuts. They occur locally in enormous densities. *Aedes scutellaris*, breeding in almost every imaginable container except the most specialized ones, is probably the most wide spread and generally most noxious container breeder in the territory.

For collecting groundwater dwelling larvae the use of a white enamelled soup ladle is recommended, deep dishes may also serve. Larvae of sessile, root-dwelling species as are the *Mansonia*'s have to be washed carefully

from the roots but they are still very difficult to find because of the load of debris washed away from the roots at the same time. Container inhabiting larvae are collected by simply pouring out the container in the collector's jar or with help of a siphon (e.g. for tree holes or cut bamboos). One has to bear in mind that all mosquito larvae travel to the bottom on disturbance and that they may keep perfectly still there for some time, simulating death. Usually mosquitoes prove to be present where at a first look they seem not to be. Patience is one of the most important requirements for success in collecting, besides a disregard for wet feet and dirty clothes.

V. Mosquito control

There are two good reasons to control certain mosquito species: the vector properties and the numbers in which they may occur, numbers sufficient to make them annoying pests. In many cases both properties are found together in the species to be controlled.

In table IV a review of mosquito species regularly found as pests in New Guinea is presented. The species have been divided into two categories — man-made pests and pests under natural conditions — which are not always strictly separable in practice however.

TABLE IV

Man-made pests	Pests under natural conditions
<i>Aedes scutellaris</i>	<i>Aedes</i> (<i>Aedes</i>) spec.
<i>Aedes aegypti</i>	<i>Aedes kochi</i> -group spec.
<i>Aedes vexans</i>	<i>Anopheles bancrofti</i>
<i>Anopheles punctulatus</i> -group spec.	<i>Anopheles punctulatus</i> -group spec.
<i>Armigeres milnensis</i>	<i>Culex annulirostris</i>
<i>Culex annulirostris</i>	<i>Hodgesia quasisanguinae</i>
<i>Culex fatigans</i>	<i>Mansonia</i> (<i>Mansonioides</i>) spec.
	<i>Tripteroides</i> spec.

Pests of several species are virtually man-made. It is irksome to know them originating from carelessness, lack of elementary insight and insufficient social responsibility resulting in a wealth of unnecessary breeding places which in turn support dense mosquito populations. Control of these populations is most simple on paper; it would be in practice as well if not the obstacles mentioned above had proved to be very hard to overcome. Here is a task for a good public health information service backed by governmental legislation.

Sufficient control of man-made pests is usually effected by removal of

the breeding places. Mass-occurrence of *Culex fatigans* is prevented by disposing of stagnant and polluted water that stays behind in defective gutters and ditches, or closing leaking septic tanks. A pest of *Aedes scutellaris* almost always originates from large amounts of disposed and subsequently rainfilled tins, tires, coconut shells etc. *Armigeres milnensis* is numerous under similar conditions provided the available water has been sufficiently polluted. *Aedes aegypti* can be controlled by covering water-holding drums and other vessels with fitting lids or gauze. *Culex annulirostris* and *punctulatus*-group anophelines are easily bred in pest quantities on neglected yards and roads in bad condition.

For a control of several day-biting natural pest species, local felling of the jungle can be a decisive measure. In this way *Aedes* (*Aedes*) species — hardly ornamented, black mosquitoes, extremely numerous in wet places —, *Hodgesia quasisanguinae* — very small but very aggressive biters — and several *Tripteroides* species can be successfully controlled. A serious drawback however is that by felling one might carelessly create ideal breeding places for anophelines, thus effecting a second and far more dangerous pest.

Other pest species under natural conditions are infinitely more difficult to get rid of; besides insight in the nature of the problem, large-scale deliberations and cooperations are required. Social, economic and even political factors appear to play an important role in a nation-wide mosquito control program for such species. In this last category fall important vectors as *Mansonia uniformis*, anophelines of the *punctulatus*-group, *Culex annulirostris*, *Aedes kochi*-group species, *Anopheles bancrofti*. In large areas of New Guinea these species may occur in astronomical numbers due to the presence of optimal life conditions.

Large-scale application of insecticides might seem at first hand the solution for a control of such species. In New Guinea insecticides with residual action are used by indoor spraying, mainly with DDT formulations, as an attempt to control anophelines. The house spraying campaign started in 1954 at Hollandia and has since been extended over large parts of the territory. A treatment of breeding places with similar chemicals has never been done because of its practical infeasibility. A few points may be made concerning the application of insecticides in house spraying.

1. It has to be faced that the use of these chemicals promotes a natural laxity since many people have the impression that the new formulations bring a solution wherever nuisance by mosquitoes occurs. When by experience the contrary is learnt — many species, e.g. *Culex fatigans*, are quite unsusceptible to DDT — the whole malaria control campaign is blamed as being useless. Meanwhile the hygienic conditions have grown worse by general neglect.

2. One seriously has to consider a possible development of resistance in the vector population against the insecticides used. In New Guinea so far no such development has occurred. Tests, standardized by W.H.O. for comparative purposes, regularly carried out revealed that the *punctulatus*-group anophelines remain highly susceptible to DDT so far.

3. There is no question that a complete eradication of the autochthonous vectors could be achieved by the present means, if ever. However, a complete eradication is not necessary for an eradication of the parasite reservoir. The primary aim of a disease control by house spraying is to cut down the average life span of the mosquito vector to a duration below the period of the extrinsic cycle of the parasite. Even this is not easily achieved. An investigation of a population of *Anopheles koliensis* at Hollandia revealed that the average expectation of life of the individuals in this population was hardly, if at all, affected by the routine house treatments (Van den Assem, 1959b). The chance per individual to contract a lethal dose of the insecticide at any time of its life must be very small indeed. Other fundamental data by which the house spraying efficiency could be more exactly evaluated are still unknown: neither the endophilic index i.e. the proportion of the biting population entering for a bloodmeal, nor the proportion of the entering population which in fact contracts a lethal dose of the insecticide are known.

The results quoted above seem to be contrary to those quoted by Metselaar (1957) who had initial success with the spraying campaign around Hollandia. One of the complications that has developed since might be that by spraying, a selection on the population is exerted in the direction of a far greater exophilism.

A control of culicine vectors of filariasis which are less susceptible to DDT and certainly not more endophilous, is inconceivable with the present house spraying technique. It will be clear that efficient control of mosquito-borne diseases in New Guinea is not obtained by simple measures only. The public health control policy must be locally organized and must depend on local social, economic, entomological and epidemiological factors and must imply such measures as house spraying, drug administration, and environmental sanitation. This policy is largely adhered to nowadays in the territory.

VI. Morphological characters of Culicidae used in keys and descriptions

The mosquitoes treated in this synopsis belong to three tribes of the family of Culicidae (Diptera).

1. The Anophelini, to which all vectors of human malaria belong.

2. The Toxorhynchitini, without direct medical importance.
3. The Culicini, to which many vectors of human- and animal diseases belong.

To simplify the identification of the members of these tribes a short summary is given here to the characters used in the keys and the descriptions, with numbered figures to aid finding the characters used on the mosquito. With a glossary of technical terms added we hope to enable the reader to get easily acquainted with the work of identifying his mosquito material. In all identifications use should be made of a low power microscope or a good (preferably binocular) loupe with magnifications ranging between 10 and 50 \times .

Adults. One of the most reliable characters by which Culicini and Toxorhynchitini may be distinguished from Anophelini is the scaling of the

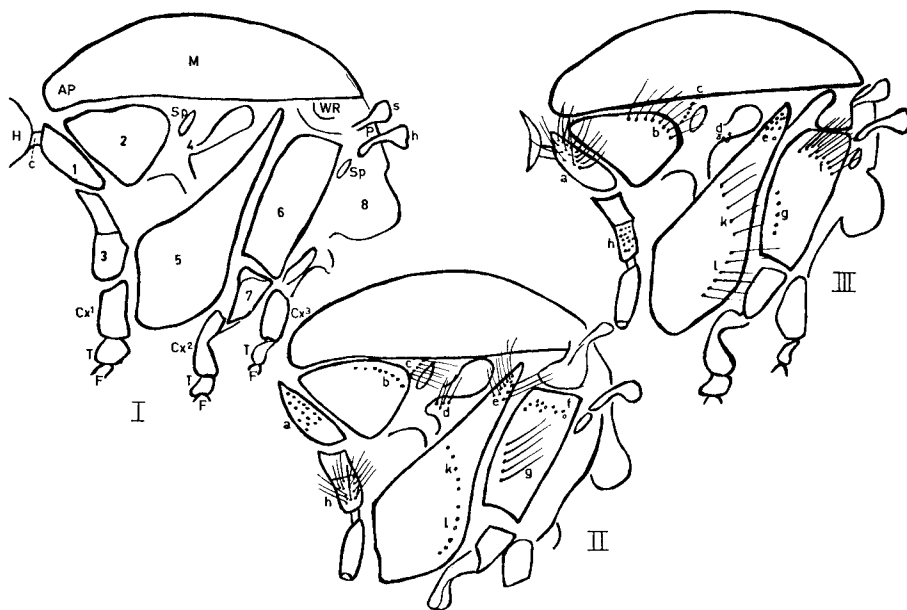


Fig. 1. Side view of thorax of adult mosquito, showing topography of chitinous parts and location of important bristles.

I. AP, anterior promontory of mesonotum; c, cervical sclerite (neck); Cx 1-3, coxae of fore-, mid- and hindlegs; F, femur; H, head; h, halter; M, mesonotum; P, postnotum; S, scutellum; Sp, spiracle; T, trochanter; WR, wingroot; 1, anterior pronotal lobe; 2, posterior pronotum; 3, propleura; 4, postspiracular area; 5, sternopleuron (upper and lower); 6, mesepimeron (upper and lower); 7, meron; 8, metathorax; II and III. a, anterior pronotal hairs; b, posterior pronotal hairs; c, spiracular hairs; d, postspiracular hairs; e, prealar hairs; f, upper mesepimeral hairs; g, lower mesepimeral hairs; h, prosternal hairs; k, upper sternopleural hairs; l, lower sternopleural hairs.

abdomen. In the former two the sternites and tergites of the abdomen are entirely covered with flat, closely arranged scales. In the latter the scales are either absent or sparse, usually only hairs being present.

The attitude of an *Anopheles* resting on a surface shows proboscis, head, thorax and abdomen in one line at an angle of a little less than 45° with the resting surface; mosquitoes of the other two tribes sit with the body (thorax and abdomen) parallel to the surface. Few exceptions to this rule exist: there are some Anophelini resting like a culicine.

The length of the female palpi in Anophelini is usually equal to that of the proboscis; in both other tribes the palpi are usually very short, if longer they are hardly longer than half the length of the proboscis. It should be borne in mind that the palpi of male Culicini are usually long, but they are not always composed of five segments as in *Anopheles* species. The segments are therefore referred to as a. last, apical or ultimate segment; b. the one before last, subapical or penultimate segment; c. long segment. In very short male culicine palpi it is difficult to distinguish the separate segments. In female culicines the palpi are more often very short than moderately long; they never are as long as the proboscis.

The shape of the scutellum is still a reliable character, though here the Toxorhynchitini join the Anophelini in having a scutellum with an

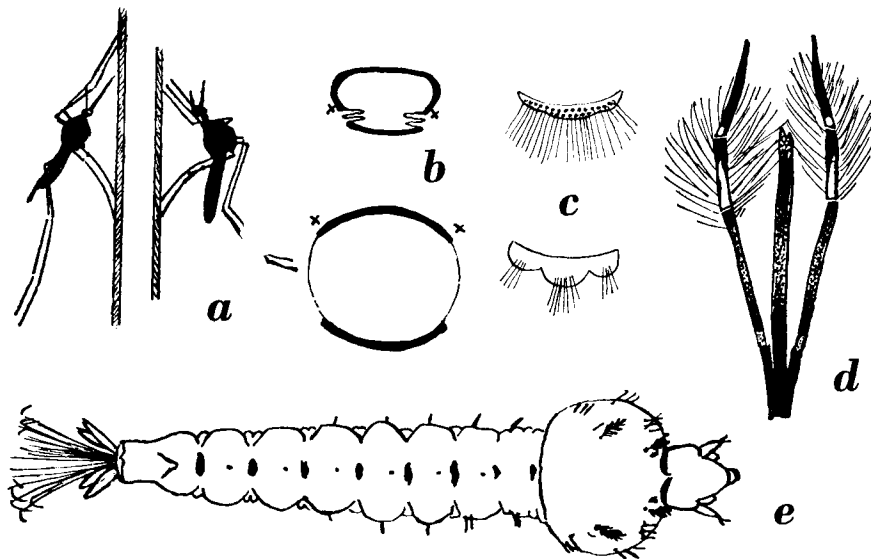


Fig. 2. A. Typical resting attitudes of anopheline (left) and culicine (right) mosquito. B. Cross section of abdomen; empty (above); distended from blood or ovaries (below). C. Scutellum; anopheline (above); culicine (below). D. Plumed palpi of male mosquito (*Culex fatigans*). E. Anopheline larva.

even hind margin. The Culicini have this hind margin uneven so that the whole scutellum appears to be 3-lobed (fig. 2). The spotting of the wings is an unreliable character. For quite a long time all anopheline mosquitoes were supposed to have spotted wings and culicines should have the wings without mixed dark and pale scaling. This opinion is erroneous. Compare fig. 19, 36.

The abdominal wall of mosquitoes shows two rows of segmentally arranged chitinous plates, dorsally the tergites, ventrally the sternites. These plates are connected by lateral, thin, flexible chitinous membranes that do not show when the stomach of the mosquito is empty, but that unfold during a good bloodmeal or, to a lesser extent, when the eggs are ripening inside the female. It is not possible to view the whole of the tergites from above when the abdomen is empty, laterally they 'fold under'. Important diagnostic

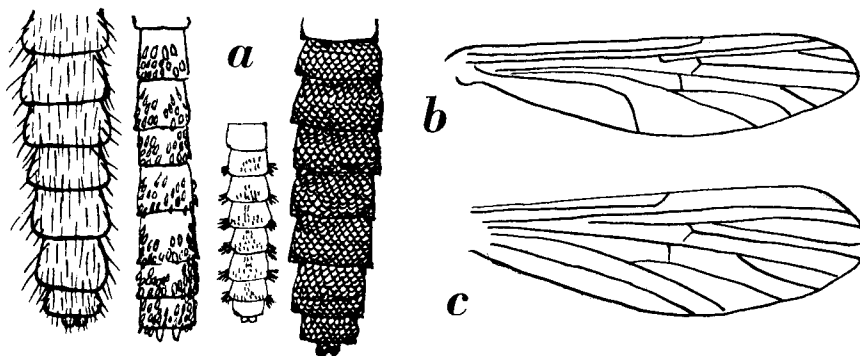


Fig. 3. A. Hairs and scales on mosquito abdomen; three anophelines (left), one culicine (right). B. Wing of *Uranotaenia*: wing vein 6 short and curved downwards. C. Wing of other culicine genera: vein 6 touches edge of wing beyond fork of vein 5.

characters are often found in the lateral patches on the tergites. The various bristles on the pleura, very important for identifying the different culicine genera, are shown in fig. 1. The names of different other parts of the mosquito body which also show important characters for identification are given below in the glossary, compare also the pertinent figures mentioned there.

Larva. (fig. 2, an *Anopheles* larva; fig. 4, a culicine larva). For the identification of culicine larvae the available morphological characters are more numerous and more striking than for *Anopheles* larvae. Characters of importance to be noted are found in the head: shape, index of length and width, mouthbrushes that may be adapted for catching living prey, and shape and arrangement of the head hairs. The denomination of these hairs differs from that used in the Anophelini where the terms clypeal, frontal, sutural and transsutural are used (fig. 6). They are indicated in the Culicini by the letters A, B and C, D and E, sometimes F is added (fig. 4). They all lie on the

dorsum of the head, A near the base of the antennae, B and C more medially, the more lateral of these two called B or when they are inserted at the same distance from the median line the most anterior one is called B; D is always submedian, usually small, not always close to the anterior margin of the head capsule; E is usually inserted far backwards and may be compared with the sutural hair in *Anopheles*. Equally important are the preclypeal spines on the anterior margin of the preclypeus.

The hairs on the thorax may be used for identification as is usual in Anophelini (fig. 5, 6). For Culicini only the spines, if present, at the base of the meso- and metapleural hairs are made use of in this synopsis (fig. 10).

So far the abdomen is concerned, it is the eighth segment which is primarily important in Culicini; in Anophelini the fan-hairs are good characters of the abdomen. On both sides of segment VIII, on the distal half in Culicini, a comb is found which must not be compared to the pecten in *Anopheles* larvae. This comb is quite different in origin and shape; it comprises a group of teeth arranged in one or more rows, either of free teeth or of teeth on a chitinous plate. Arrangement, shape and number of these teeth offer important diagnostic characters. The siphon which is lacking in *Anopheles* larvae, has the same function as the spiracles, that is: allowing the

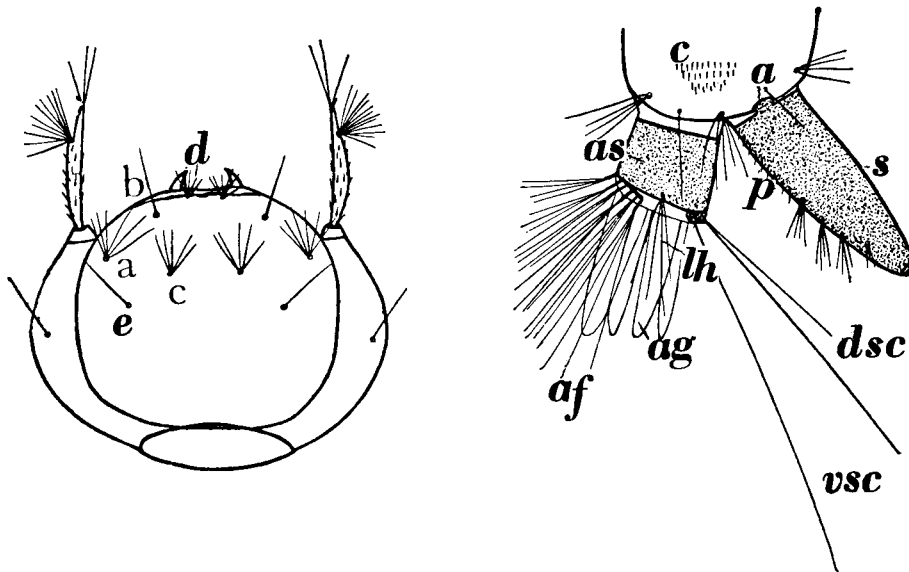


Fig. 4. Details of culicine larva; left: head with hairs A, B, C, D and E; right: terminal segments; a, acus of siphon; af, anal fan; ag, anal gills; as, anal segment; c, comb; dsc, dorsal subcaudal hair; lh, lateral hair; p, pecten; s, siphon; vsc, ventral subcaudal hair.

larvae to take in air at the surface of the water; it may be used to great advantage in identifying Culicini larvae. The index, i.e., the relation between length and largest width, is defined; the siphonal pecten and hairs (see fig. 4) are considered. The teeth of the pecten, which are homologous with the pecten of *Anopheles* are well displayed when the siphon is viewed from the lateral side. The siphonal hairs are usually inserted beyond the most apical tooth of the pecten. The anal segment, on its dorsal surface or all around the segment, shows a strong chitinous plate or band, the former called the saddle, the latter the collar. Close to the median line dorsally and distally, are the submedian dorsal or caudal hairs distinguished in dorsal and ventral subcaudal hairs (dsc and vsc, see fig. 4); they may be simple or branched; the lateral hair is shown in fig. 4; the fan is usually conspicuous. The apical margin of the anal segment may have a number of spines, but they are not present in all species. The anal papillae lie on the apical surface of the anal segment; the shape and length of these papillae are important. Often the anal papillae of species that breed both in brackish and in fresh water are different in size; larvae from brackish water show much shorter papillae.

Mosquito eggs are very small and difficult to detect in the water. They are laid separate or in smaller or larger numbers together; the former collect in more or less geometrical figures, the latter are found in boatshaped masses, easily visible with the naked eye.

GLOSSARY OF TECHNICAL TERMS

- anal fan** (fig. 4): the branched hairs on the distal subventral margin or on the margin of the ninth segment of the larva; this fan is situated outside the chitinous saddle (fig. 23) or collar (fig. 4) and the hairs are inserted on a chitinous bar; in certain species there is one branched hair on each side of the ventral line only and no bar (fig. 11, 12).
- anal papillae** (fig. 4): the usually more or less elongated lobe-like appendages on the distal margin of the larval anal segment.
- anal segment** (fig. 4): the ultimate abdominal segment of the larva, where the anal opening is.
- antenna** (fig. 29, 4): the paired segmented organs, borne one on each side of the head, in the adult implanted extremely close to the eyes; in the larva at some distance from the eyes.
- anterior pronotum** (fig. 1): the lobe-like part of the adult prothorax visible from above on each front corner of the scutum and covering part of the base of the neck.

- cerci:** appendages (in the ♀) of the ultimate abdominal segment.
- clypeus:** in the adult that part of the front of the head to which the labrum is attached; in the larva a chitinous plate covering about half of the head from front margin backwards and carrying most of the dorsal head-hairs.
- comb** (fig. 4, 9): a structure on the lateral distal part of the eighth abdominal segment of the Culicine and Toxorhynchitine larvae, consisting of teeth (or scales) of varying number, size and shape, sometimes attached to a chitinous plate.
- costa** (fig. 5): anterior margin of the wing, running from base to tip.
- coxa:** basal segment of the leg, by means of which it articulates with the body.
- femur** (fig. 29): third segment of the leg counting from the body (the small second segment is the trochanter, hardly ever mentioned in descriptions).
- flagellum** (fig. 29): the part of the adult antenna beyond the torus or pedicel.
- halteres:** the remnants of the second pair of wings in the Diptera.
- labellum** (fig. 6): the remnants of the labellar palpi in the adult.
- mesepimeron** (fig. 1): the middle sclerites of the pleuron in the adult.
- mesonotum** (fig. 1): the middle portion of the thorax of the adult mosquito or the larva.
- mesothoracic spine** (fig. 10): a spine near the lateral margin of the larval mesothorax; present in some genera.
- metathoracic spine** (fig. 10): such a spine on the larval metathorax which is the distal portion of the thorax.
- nape:** part of the head of the adult between the occiput and the neck (a narrow strip).
- occiput:** the hind part of the adult's head between the vertex and the nape.
- palpus** (fig. 5): one of the appendages of the adult's head belonging to the mouth-parts (viz. to the maxilla); in the larva there is also a palpus on the maxilla, usually not used for identification.
- pecten** (fig. 4): a row of teeth in the larva situated in Anophelines on the chitinous bar round the spiracles on the 8th abdominal segment, and

in the other mosquitoes subventrally on the basal part of the siphon; in very few genera the pecten is absent.

- pleuron** (fig. 1): the lateral area of the mesothorax of the adult.
- posterior pronotal bristle** (fig. 1): a usually small bristle-like hair on the hind margin of the posterior pronotum, in the adult.
- postspiracular bristle** (fig. 1): the bristle in the adult on the area behind the first spiracle.
- posterior pronotum** (fig. 1): the part of the prothorax lying just behind the anterior pronotum, in the adult.
- preclypeus** (fig. 7): part of the larval head lying just in front of the clypeal margin.
- prespiracular bristles** (fig. 1): the bristles lying in front of, quite close to the anterior margin of the first spiracle and behind the hind margin of p p n. in the adult.
- proboscis** (fig. 5): the biting-sucking organ of the mosquito sticking out from the middle of the front part of the adult head.
- prothorax** (fig. 1): front part of the thorax of the adult.
- pulvillus** (fig. 30): soft pad-like lobes between the tarsal claws.
- saddle** (fig. 23): the incomplete chitinous band on the larval anal segment; if this band goes all round the segment we call it a collar.
- saddle hair** (fig. 23): the lateral hair on this saddle.
- scutellum** (fig. 2): a narrow sclerite separated by a transverse suture at the posterior margin of the adult's mesothorax.
- scutum** (fig. 1): the dorsal part of the adult's mesothorax.
- segment** (fig. 2): a subdivision of the body or of an appendage between areas of flexibility with muscle attachment.
- shoulder hair** (fig. 6): one of the two groups of the 3 submedian hairs which are inserted near the front margin in the larva of *Anopheles* mosquitoes.
- siphon** (fig. 4): the elongated chitinisation round the breathing opening in non-*Anopheles* mosquito larvae.
- spiraculum** (fig. 1): a breathing pore (the opening to a trachea); in the adult mosquito two are easily visible on pleura; in the larva of an *Anopheles* on segment VIII dorsally also two; in a Culicine larva at the end of the siphon (two).
- sternite** (fig. 29): the ventral side of the adult mosquito's abdomen.

sternopleuron (fig. 1): the part of the pleura between mesepimeron distally and postspiracular area proximally.

subcaudal hairs (fig. 4): the hairs inserted on the dorsal side of the hind margin of the larval anal segment; dorsal and ventral subcaudal hairs are present.

subcosta: the longitudinal wingvein between costa and first longitudinal, only half as long as these veins.

sutural hair (fig. 6): the larval headhair inserted well behind on the dorsal part of the clypeus near the lateral suture.

suture: a seam or impressed line indicating the division of parts of the body wall or the appendages.

tarsus (fig. 22): the jointed appendage attached at the apex of the tibia, bearing the claws.

tergite: a dorsal sclerite or part of the tergum.

tergum: the dorsal surface of any body segment of an insect, it may consist of one or more tergites.

thorax (fig. 1): second region of the body, bearing (in the adult) wings and legs; it consists of pro-, meso-, and meta-thorax; in the larva it bears hairs only.

tibia (fig. 6): fourth division of leg.

transsutural hair (fig. 6): the larval headhair inserted about as much behind on the head as the sutural hair, but lying transsutural.

vertex: triangular shaped front part of the adult head between occiput and eyes.

wingvein (fig. 3): tracheae of the wing.

ABBREVIATIONS USED IN FIGURES, KEYS AND DESCRIPTIONS

Adult

af — anterior forked cell
ap — anterior promontory of mesonotum
apn — anterior pronotal lobes (prothoracic lobes)
fs — flagellar segment (of antenna)
pf — posterior forked cell

Larva

dsc — dorsal subcaudal hair
ic — inner clypeal hairs
is — inner shoulder hair
lh — lateral hair on collar or saddle of anal segment
mps — median plate of scoop
ms — median shoulder hair
oc — outer clypeal hairs

ppn — posterior pronotal lobes	os — outer shoulder hair
S. I-S. VIII — abdominal sternites	pc — posterior clypeal hairs
t — torus (of antenna)	ps — postspiracular hair
t. 1-t. 5. — tarsal segments of legs	spc — spiracular chitinisation
T. I-T. VIII — abdominal tergites	vsc — ventral subcaudal hair
	1-3 — thoracic segments
	I-VIII. — abdominal segments

VII. Key to the genera of New Guinea mosquitoes

A. Adults

- 1 a. Abdomen with only few scales, at least the sternites largely bare; scutellum rounded, not three-lobed 2
- b. Abdomen densely scaled, scutellum usually with three rounded lobes 3
- 2 a. Stem vein of the middle fork wavy (fig. 8) *Bironella*
- b. Stem vein of the middle fork straight (fig. 6) *Anopheles*
- 3 a. Proboscis rigid, apical half strongly bent and very slender beyond bend; very large mosquitoes with a green-metallic shine *Toxorhynchites*
- b. Proboscis flexible, often more or less swollen at apex, however, never with the apical half bent as in a 4
- 4 a. Apical part of proboscis enlarged and very hairy (fig. 12); small mosquitoes with silver ornamentation *Malaya*
- b. Proboscis shaped otherwise; a silver ornamentation may or may not be present 5
- 5 a. Most caudal wing vein very short and reaching the hind border of the wing in front of the fork of vein 5 (fig. 3); small mosquitoes, usually dark and unornamented *Uranotaenia*
- b. Most caudal wing vein longer, reaching the hind border of the wing beyond the fork of vein 5 (fig. 3) 6
- 6 a. Scales on the wing veins long and outstanding with a narrow basal and a broad apical part; very small, dark mosquitoes *Hodgesia*
- b. Long and outstanding scales on the wing veins may be present but they are never shaped like in a 7
- 7 a. Female antennae with all segments very short and broad, male antennae with the two distal segments thus aberrantly shaped; femur of the mid-legs with a tuft of scales at the tip; rather small and speckled mosquitoes *Aedomyia*
- b. Antennae with slender segments, no tuft of scales on mid-femora 8
- 8 a. No post-spiracular bristles present 9
- b. Post-spiracular bristles present 13
- 9 a. There are pre-spiracular bristles present on the pleura of the thorax but no spiraculars; pulvilli at the base of the chitinous claws at the tips of tarsal segments 5 (fig. 30); usually rather unornamented mosquitoes, never with silvery or bluish reflecting scales *Culex*
- b. Bristles on pleura of the thorax otherwise; no pulvilli 10
- 10 a. One or more spiracular bristles present (fig. 1) 11
- b. No spiraculars present 12
- 11 a. Very small mosquitoes with a silver line running medially on the thorax *Topomyia*
- b. Mosquitoes of varying size, sometimes with a very long proboscis, some species ornamented with silvery and bluish reflecting scales, however, never as in 11a; other species dull dark brown or black and white; relatively few bristles present on the pleura of thorax *Tripteroides*

- 12 a. Proboscis with the apical part swollen (rather strong in males, less in females); upper fork cell shorter than its stem vein *Ficalbia*
- b. Proboscis never swollen in its apical part, upper fork cell at least as long as its stem vein; rather large mosquitoes with a conspicuous orange or orange-yellow coloration *Mansonia*
- 13 a. Wing scales broad and asymmetrical (fig. 15) *Mansonia*
- b. Majority of wing scales narrow 14
- 14 a. Rather large, black and white mosquitoes with a strong proboscis whose apical part is slightly bent downwards; flat scales present on the vertex of the head *Armigeres*
- b. Mosquitoes with variable ornamentation — several species also black and white coloured — proboscis slender, not bent downwards *Aedes*

B. Larvae (4th instar)

- 1 a. Larvae without a siphon (fig. 2) 2
- b. Larvae with the spiraculum on top of a siphon (fig. 4) 3
- 2 a. One pair of fan-hairs present dorsally on thorax *Anopheles*
- b. Two pairs of fan-hairs present dorsally on thorax *Bironella*
- 3 a. Anterior mouth brushes prehensile and fit for predation; no pecten on siphon, very large larvae *Toxorhynchites*
- b. Anterior mouth brushes usually comprising many fine hairs, in case there are stout chitinous rods there are always pecten spines to be found on the siphon 4
- 4 a. The ventral tuft on the anal segment comprising only one pair of (be it multi-branched) hairs 5
- b. The ventral tuft comprises more than one pair of hairs 7
- 5 a. Siphon with at most 4 pairs of small hair tufts (those on tip not counted) *Culex* subgenus *Acallynthrum*
- b. Siphon with many more hair tufts arranged in a dorsal and ventral row 6
- 6 a. Abdomen with numerous stellate hairs; there is either a long sideways spine dorso-caudally on the thorax or the larval maxillae exhibit long, conspicuous teeth *Tripteroides*
- b. Abdomen without stellate hairs *Malaya*
- c. In case some stellate hairs are present there is no thoracic spine and there are no conspicuous maxillar teeth *Topomyia*
- 7 a. Siphon very long and slender or in case shaped differently than always with 4 pairs of branched hairs (those on tip not counted) (fig. 33, 34) *Culex*
- b. Siphon never very long and slender, in any case never with more than one pair of branched hairs on siphon (those on tip not counted) (fig. 16, 17) 8
- 8 a. Comb on 8th abdominal segment consists of a chitinous plate with distal teeth (fig. 17) 9
- b. No chitinous plate on segment 8, comb teeth separate 10
- 9 a. Antennae very large, curved and flattened and with a long multi-branched hair tuft *Aedomyia*
- b. Antennae relatively small and inconspicuous; hairs present on it all small *Uranotaenia*
- 10 a. Only few or no pecten teeth at all present on siphon 11
- b. A distinct pecten, comprising at least 5 teeth, can be found on the siphon 13
- 11 a. Distal part of the siphon saw-edged (fig. 14) *Mansonia*
- b. Siphon sometimes provided with large hooks but never saw-edged 12
- 12 a. Antennae in relation to the length of the head capsule rather large, a well developed, multi-branched antennal hair present (fig. 13) *Ficalbia*
- b. Antennae in relation to the length of the head capsule very small, antennal hair small and simple *Armigeres*

- 13 a. Antennae in relation to the length of the head capsule large (at least $\frac{3}{4}$ or more), antennal hair tuft almost at tip *Hodgesia*
 b. Antennae in relation to the length of the head capsule small (at most $\frac{1}{2}$, frequently smaller) *Aedes*

VIII. Descriptions

Genus *Anopheles* Meigen

Meigen, J. W., 1818. Syst. Besch. zweifl. Ins. 1, 10.

The distinguishing characters of the adults of this genus are the long, club-shaped palpi of the male, the long palpi of the female which are usually as long as the proboscis or nearly so and the abdomen which is mainly clothed with hairs. Scattered or even more numerous scales may be present on the abdomen in some species, but the scales are never broad and flat and closely applied as slates on a roof covering the entire abdomen.

The attitude of an *Anopheles* while resting on a surface is quite characteristic: proboscis, thorax and abdomen are in a straight line so that the whole of this makes an angle of about 45° with the surface on which it rests. Exceptions to this rule are few, only certain *Anopheles* species sit on a wall like a *Culex*: thorax and abdomen parallel to the surface. *Anopheles* mosquitoes may be highly ornamented with spots, bands or speckles on various parts of the body. On the other hand they may be without any decoration at all. A good morphological characteristic of the anophelines is the unlobed scutellum, different from all other culicids with the exception of the genus *Toxorhynchites*. In the anophelines and *Toxorhynchites* the curved distal border of the scutellum bears a continuous row of long hairs; the other culicids have this distal border divided into three parts so that the marginal hairs stand in three groups. Anopheline larvae may be recognised at once by their position in the water, they float horizontally while feeding on the surface. This position is brought about by the way they take their oxygen from the air, through spiracles on the eighth abdominal segment instead of through a siphon as is done in the other culicids.

Anopheles eggs are usually characterised by their 'floats': corrugated distal membranes.

Breeding places of *Anopheles* are varying in size, from large water collections with abundant or sparse vegetation, shaded or not, to small hoof-prints and similar water collections without any vegetation at all, shaded or not.

Subgenus *Anopheles* Meigen

The distinguishing characters of this subgenus in the adults are found in the terminalia, out of scope here. In the larvae the shaft hair on the antenna is always branched, even if it is small; it is usually inserted on the inner surface. The inner clypeal hairs are nearly always close together.

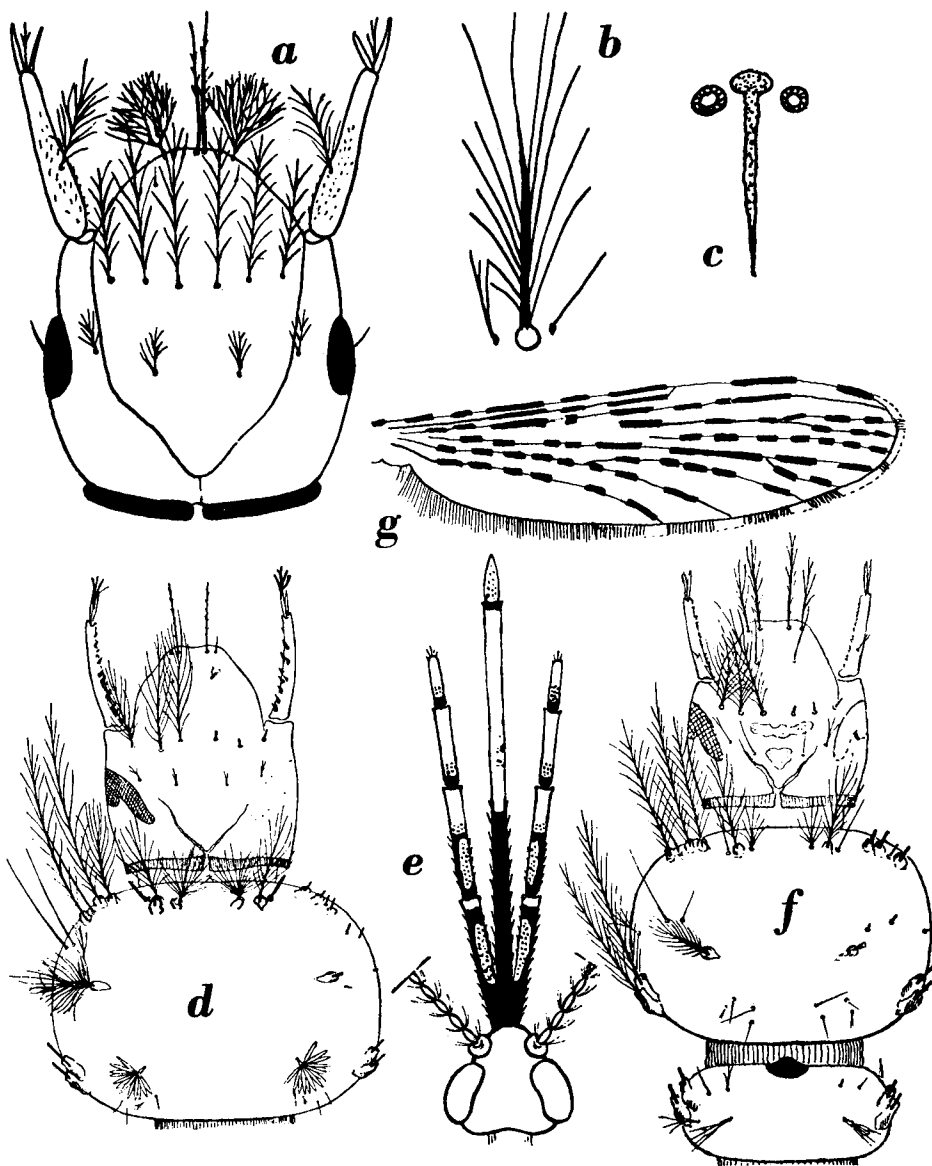


Fig. 5. *Anopheles bancrofti* Giles. A. Head of larva. B. Shoulder hair. C. Stigmal club. *A. longirostris* Brug. D. Details of larva. E. Head of adult. *A. amictus hilli* Woodhill & Lee. F. Details of larva. G. Wing ornamentation. (A, B, C, G after Lee & Woodhill; D, E, F after Swellengrebel & Rodenwaldt).

Anopheles (Anopheles) bancrofti Giles

Giles, G. M., 1902. Handb. Gnats, Ed. 2, 511.

Described from Bupengarry, Queensland.

IDENTIFICATION. This large, black mosquito with shaggy palpi without pale bands and with dark wings with less than four pale spots involving costa and vein 1, can be separated at a glance from all other species treated in this synopsis; in fact it can be separated by its size and its blackness from any other New Guinea *Anopheles*, except *A. barbumbrosus* Strickland and Chowdhury, a rare species which is exclusively known from P. Tjof (Sorong) in this territory.

A. bancrofti larvae are easily identified as belonging to the subgenus *Anopheles* by the obvious subgeneric characters.

DESCRIPTION. Adult female. Occiput brownish black, scales dense and coarse, a vertical pale spot present, frontal tuft yellowish pale; antennae dark, flagellar segment 1 with a dark scale tuft; palpi densely and shaggily clothed with semi-erect black scales; proboscis black. Mesonotum dark brown with a greyish shine clothed with narrow, curved, goldy scales and brown bristles; scutellum brown with black bristles and some elongated, curved pale scales; pleura dark brown with greyish shine; front legs with femora and tibiae largely pale scaled on the underside, mid and hind legs entirely pale scaled on underside; remaining parts of all femora, tibiae and tarsi 1 black scaled with irregular white spotting, apices of the hind tibiae distinctly white on the outside; wings largely black scaled with an irregular mottling of pale scales on some of the veins and some distinct pale patches. Abdomen dark brown dorsally, no scales but only brown hairs present; a line of loose white scales on lateral margins of venter; sternites III to VII with a median patch of white scales, sternite VII with a rather dense patch of black scales, distally from the pale ones, sternite VIII with two patches of white scales on either side of the midline. Adult male. Very similar to the female except for differences as follows: the antennae are strongly plumose, the palpi clubbed apically and rather densely hairy on the inner side of the apex of the third segment and the club.

Larva. Antennae broad below the insertion of the shaft hair, somewhat narrowed beyond, distinctly spinose on inner surface of basal half; shaft hair inserted at about middle, with about 10 branches; terminal hair trifid, small; i c. long, close together, sparsely frayed; o c. with many branches originating from the two or three main branches that split up a little beyond the base; p c. short, usually simple, sometimes bifid; frontal hairs plumose, extending beyond frontal border of head capsule. Shoulder hairs as illustrated in fig. 5. Fans heavily pigmented, complete on segments III to VII, leaflets

with serrations beyond basal half, apex sharply pointed; fans on segments I and II poorly developed; a distinct elongated stigmal club present (fig. 5); anal papillae longer than or as long as anal segment.

BIONOMICS. *Anopheles bancrofti* is locally extremely abundant in the wet season in South New Guinea, in other parts of the territory it occurs regularly but never as a dominant species. Though adult specimens may be collected in great numbers, larvae are seldom found as numerous. Probably this is caused by the huge extensiveness of the breeding places: rather permanent stretches of water in more or less shaded places; Elsbach (1937) records the larvae from old, cut-off courses of the Digoel river where coarse reeds, *Azolla* and other weeds combine to give shade and shelter.

DISTRIBUTION. Moluccas to the Solomons and the Australian mainland. In New Guinea most abundant south of the Central mountain range. Material was seen from: Vogelkop: Soedoe Point, Timboeni; North. plain: Hollandia, Skou, Tami river, Sentani lake, Pionier bivak, Rombebai lake; Meervlakte: Prauwen bivak, Idenburg river, Kloof bivak; South. plain: Lorentz river, Agats, Tanahmerah, Ajarop, Toge, Amboran, Homlokja, Jodom, Kaimogon, Kepi, mouth of Digoel river, Moeting, Boepoel, Basin, Kimaan, Bamol, Teri-Kalwa, Okaba, Koembe, Merauke.

RELATION TO DISEASE. De Rook is convinced that this species is locally important as a malaria vector though never equal to the *punctulatus*-group. *A. bancrofti* is also recorded as a vector of filariasis (Cf. Ch. II and III).

Subgenus *Cellia* Theobald

Theobald, F.V., 1902. J. trop. Med. 5, 183.

The distinguishing characters of this subgenus are found in the male terminalia. The wings always bear distinct, pale markings, including a series of four spots along the costa. The larvae have the antennal shaft hair always short and simple and usually inserted on the outer surface; the inner clypeal hairs are well separated.

Anopheles (Cellia) amictus hilli Woodhill & Lee

Woodhill, A. R. & Lee, D. J., 1944. Proc. Linn. Soc. N.S.W. 69, 63.

Described from Adelaide river, North. Terr. Australia.

IDENTIFICATION. The adult of this species is easily distinguishable from other New Guinea *Anopheles* by the abundant flat, short, white scales on abdominal sternites II-VII. From the likewise scaled *A. meraukensis* Venhuis (not treated in detail in this synopsis) it can be separated by the number of propleural bristles in the adult: 1-5 in *A. meraukensis*, 10-14 in *A. amictus hilli*. From the subspecies *amictus* (common on the Australian mainland) the subspecies *hilli* differs in having basal and apical white bands on the

hind tarsal segments; in *amictus* these bands are completely absent. The larva has the inner shoulder hair without any basal tubercle, arising from a simple alveolus. This is in common with *amictus*; the branches of i s. are usually fewer in *hilli*.

DESCRIPTION. Adult female. Antennae distinctly stout and notably shorter than the proboscis and the palpi, conspicuous white scales on torus and on the first five to eight flagellar segments, where they are numerous and conspicuous on the basal segments, narrower and hair-like towards the apical segments; ornamentation of palpi very variable; labella of proboscis chocolate brown. Conspicuous banding and spotting on tarsal segments present; wings as illustrated in fig. 5, two types of costal markings (i.e. with and without a break in the middle dark spot) are common. Adult male. About similar to female; t. 4 of front legs frequently dark. Larva. Head, i c. and o c. frequently frayed or weakly branched, more rarely simple; p c. usually simple, occasionally bifid at tip or split into three branches; suturals simple or two-branched; transsuturals simple, two- or three-branched. The larvae cannot clearly be differentiated from those of *A. a. amictus* but they show a general tendency towards branching in the anterior clypeals and a reduction in number of the branches of the inner shoulder hairs.

BIONOMICS. The larvae are found in both natural and man-made breeding places, and are often abundant in polluted or brackish water, and even in salt water pools with a salinity greater than that of sea water (up to 4.2 %). They are not however limited to coastal areas, since they occur in inland districts in muddy pools, slit trenches and shallow weedy margins of fresh water swamps. The breeding places are frequently exposed to full sunlight, but may partly be shaded. The adults bite man freely, are most active shortly after sunset, and fed females can be collected readily from houses and tents.

The adult ecology of this species may be rather different from *punctulatus*-group anophelines proper. At Merauke a very significantly higher daily-survival rate was found to exist in this species compared with *A. farauti* (Van den Assem, 1959).

DISTRIBUTION. Southern New Guinea and Australian continent. Up to now no records are known of this species north of the Central mountain range. New Guinea material was seen from south coast localities from Frederik Hendrik Island in the west to Merauke in the east. The species is also recorded from Tanahmerah.

RELATION TO DISEASE. *A. amictus hilli* is considered to be of no importance as a malaria vector. It has been found infective in nature once (by Roberts, 1943), during a *farauti*-born malaria epidemic at Cairns, Australia. *A. amictus hilli* can be infected experimentally.

Anopheles (Cellia) annulipes Walker

Walker, F., 1856. Ins. Saund. Dipt. 1, 433.

Described from Van Diemensland (Tasmania).

IDENTIFICATION. This species, belonging to the *punctulatus*-group, is variable in adult as well as in larval characters, so much so that sometimes confusion with *Anopheles punctulatus* is possible. However, the darker wings of the adult and the strongly branched p.c. (branched from the base) in the larva are reliable differential characters. Specimens with an entirely black proboscis may be confused with *Anopheles farauti*. The dark scaling on the *annulipes*-wingveins is not so abundantly interrupted by pale patches as in the other *punctulatus*-group members, so that the whole vein makes a much darker impression.

DESCRIPTION. Adult. The proboscis is usually pale apically but may vary to completely black, as long as the palpi; palpi with broad, white, apical bands on segments 3, 4 and 5. Mesepimeron has a central patch of white scales; wing vein 1 usually with 5-10 black patches. Larva with clypeal hairs variable (fig. 7), i.c. may be simple or weakly frayed; o.c. varies in having about six small branches to very numerous strong branches forming a dense tuft; p.c. always strongly branched from near the base, branches varying from 5 to 15; i.s. and m.s. may have their bases fused or separate.

BIONOMICS. *A. annulipes* is often found breeding in ground pools of limited depth, with or without suspended clay; also recorded as common from rock pools in association with green algae. It has been recorded from sunlit and shaded clear water, running water over gravel beds, on creek banks, open sandy pools, margins of swamps, hoof marks and wheel tracks and from brackish water with up to 1.6 % salinity.

The female feeds readily on man in the open and indoors; it may stay indoors during the day following the uptake of a blood meal.

DISTRIBUTION. New Guinea and the Australian continent. The species is a common one in the highlands of Eastern New Guinea in altitudes of about 5000 feet. In the western part of the New Guinea highlands it has been found only occasionally so far, which is probably mainly due to the still very insufficient knowledge of that area. Anyway this species is not the common anopheline in the relatively well known Baliem valley (altitudes between 5000 and 6000 feet). The Wissel lake region so far remarkably proved to be free from anophelines.

RELATION TO DISEASE. Experimentally the species was proved to be a potential vector. No natural infections have been demonstrated. In areas where this species is abundant malaria is usually absent — because of climatic conditions?

Anopheles (Cellia) farauti Laveran

Laveran, A., 1902. C. R. Soc. Biol. 54, 908.

Described from Faureville, Ile Vaté, New Hebrides.

Much used synonyms for this species are *Nyssorhynchus annulipes* var. *moluccensis* Swellengrebel & Swellengrebel and *A. punctulatus farauti* Knight & Farner.

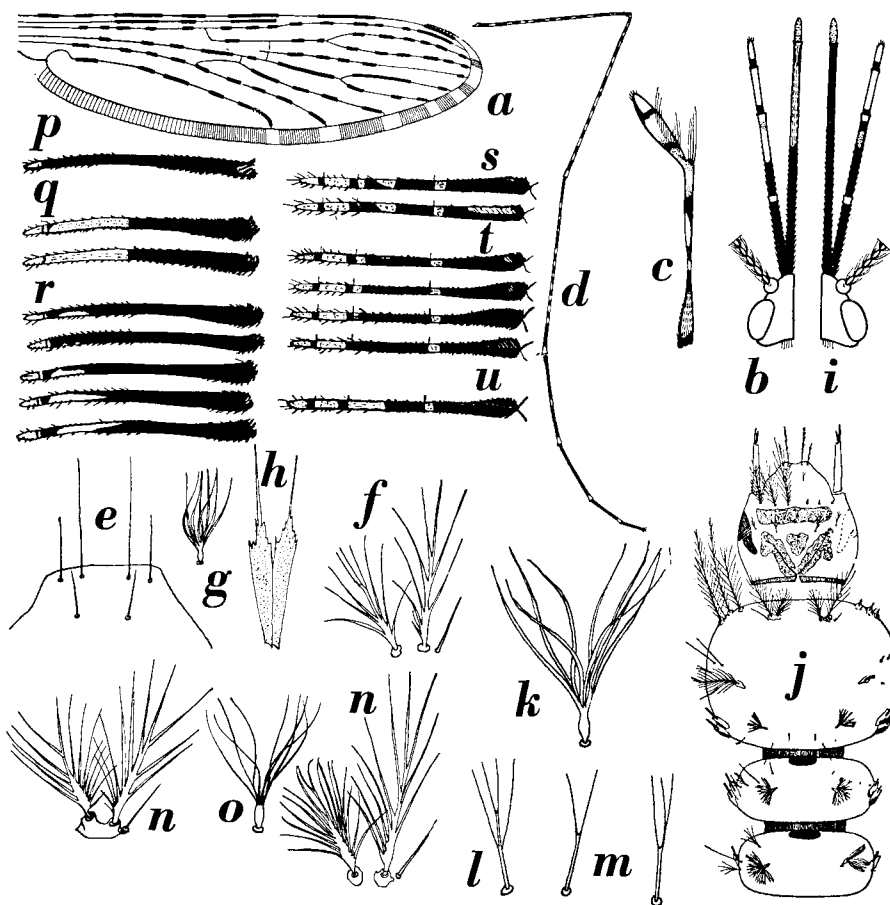


Fig. 6. *Anopheles punctulatus* Dönitz. A. Wing. B. Proboscis and palpus. C. Male palpus. D. Hind leg. E. Clypeal hair of larva. F. Shoulder hairs. G. Hair I on abd. segment I. H. Leaflets on abd. segment IV. *A. farauti* Laveran. I. Proboscis and palpus. J. Details of larva. K. Hair I on abd. segment I. L. Transsutural hair. M. Sutural hairs. *A. kolienensis* Owen. N. Shoulder hairs. O. Hair I on abd. segment I. P, S. Proboscis and palps in *A. farauti*. Q, T. Idem in *A. punctulatus*. R, U. Idem in *A. kolienensis*. (A-D, I, J after Swellengrebel & Rodenwaldt; F, G-U after Rozeboom & Knight; H after Ross & Roberts).

IDENTIFICATION. This much speckled member of the *punctulatus*-group stands apart on account of its entirely dark scaled proboscis — black, except for a narrow light ring at the extreme apex. The highland species *A. annulipes* occasionally has a dark proboscis as well but may be differentiated by its much darker wings and lighter palpi. The *A. farauti* larva is recognized by the small, but complete fan on abdominal segment I; in some areas of its range, however, this fan is replaced by a hair with slender and hair-like branches which makes the larva similar to that of *A. koliensis*. It differs from *A. punctulatus* by having the inner shoulder hair with a stout, swollen stem (fig. 6).

DESCRIPTION. Adult female. Third segment of the palpi usually with a narrow, apical, pale ring, separated from a larger, subapical, pale area by a dark ring, pale markings frequently reduced, however, sometimes the subapical spot completely absent. Small, dark, sectoral spot on wing usually present on costa between basal and median dark spots because the accessory sector pale area involves costa as well as subcosta and vein 1. Adult male. In general similar to *A. punctulatus*, proboscis entirely dark except for a narrow light ring at apex; small, dark sectoral spot usually present on costa between basal and median dark spots. Larva with i.c. (fig. 6) and o.c. usually frayed; p.c. either long, reaching beyond base of i.c. or shorter, usually single, sometimes two-branched. Bases of i.s. and m.s. strong, pigmented and fused together, though some may have them fused on one side and separate on the other (Lee & Woodhill, 1944); metathorax with a small fan with 10-14 leaflets. Abdominal segment I with a fan with slender or hair-like leaflets (fig. 6); fans also present on segments II-VII, leaflets with long filaments, sometimes almost the length of the shaft.

BIONOMICS. *Anopheles farauti* is most probably the commonest New Guinea anopheline species, occurring in lowland and highland localities, recorded up to 6750 feet; highland specimens are distinctly larger than lowland ones. Larvae can be found in any semi-permanent water collection provided it is not shaded, *Culex annulirostris* and *Culex halifaxi* often are the associated species. In coastal regions the species may be found in brackish and salt water with up to 4.6% salinity. The adults are definitely nocturnal mosquitoes, regularly found inside houses. In cool and shaded places they attack in day time as well.

DISTRIBUTION. From the Moluccas to the New Hebrides, including the Bismarck archipelago and the Northern part of the Australian mainland. New Guinea material was seen from: Western Islands: Misool, Salawati, Waigeo, Pam; Vogelkop peninsula: Sorong, Tjof, Remoe, Sausapor, Makbon, Mega, Malakebetoek, Ajamaroe, Aitinjoe, Manokwari, Oransbari, Maripi, Inan-

watan; Mapia atol; Geelvink bay: Korido, Mokmer, Biak, Padaido, Seroei, Miei, Nabire, Wapoga, Waren, Paradoi; North coast and Meervlakte: Siromi, Arbais, Terkami, Sarmi, Demta, Genjem, Ifar, Sentani villages, Hollandia, Skou, Tami river, Motor-, Albatros- and Batavia bivak, Pionier bivak; Kaimana distr.; Mimika: Uta, Prongo, Kokonao, Wania, Mijoko, Potoway; Southern plain: Oewoes, Oetoemboewe river, Kepi, Bade, Masin, Jodom, Tanahmerah, Mawoen, Mindiptana, Selil, Kimaan, Waan, Komolon, Okaba, Koembe, Merauke; Central highlands: West Baliem valley, Araucaria, Baliem and Ibèlè camps.

RELATION TO DISEASE. *Anopheles farauti* is beyond any doubt one of the most important vector species of the territory. It is an efficient vector of both human malaria — Metselaar (1957) recorded 2.4% (3 out 126) infective — and of bancroftian filariasis (6.6% found infective by De Rook (1957) on Pam Island).

Anopheles (Cellia) karwari James

James, S. P., in: Theobald, F. V., 1903. Mon. Cul. 3, 102.

Described from Karwar, India.

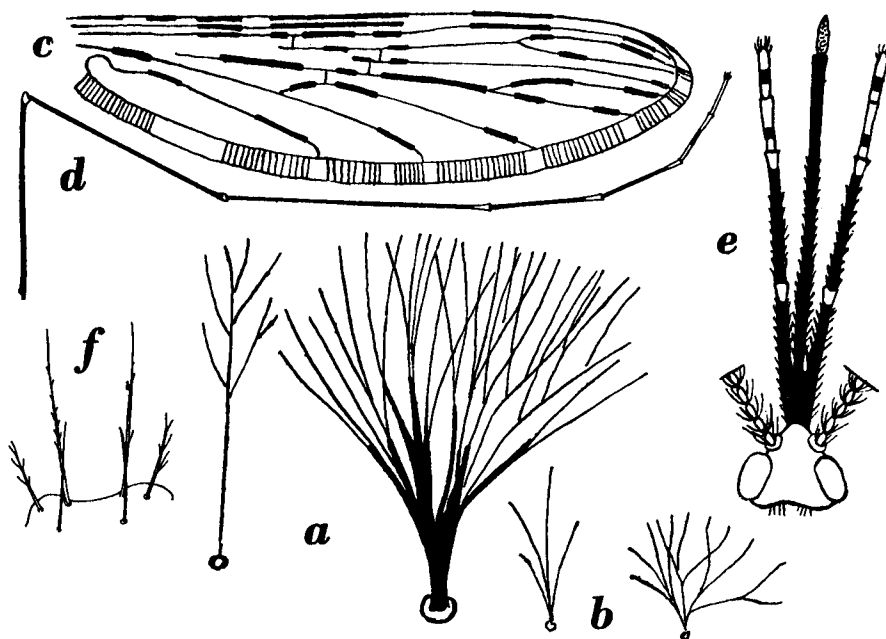


Fig. 7. *Anopheles annulipes* Walker. A. Types of outer clypeal hairs. B. Post clypeal hairs. A. *karwari* James. C. Wing. D. Hind leg. E. Proboscis and palps. F. Clypeal hairs of larva. (A, B after Rozeboom & Knight; D, E (modified) after Swellengrebel & Rodenwaldt).

IDENTIFICATION. This species of *Anopheles* is easily recognized by the unspeckled legs, which have broadly banded hind tarsi, with the fifth segment entirely white. The female palpi have a peculiar ornamentation, there are rather outstanding scales at base, apical segment more than half the length of the preceding, entirely white except for a subbasal black band, 4th segment also entirely white with a rather broad subbasal dark band, 3rd segment dark except for a white apex.

The species is easily distinguished from a *Bironella* by the spotted wings, from the *punctulatus*-group by the entirely different wing pattern.

DESCRIPTION. Adult female. Head with well marked, pale vertical area; frontal tuft long, white, sparse; proboscis blackish brown, labella pale; palpi (fig. 7) with rather outstanding scales at base; most of segment 5 white, towards base there is a dark band, base itself white, next pale band involving large part of segment 4, the third (narrower) band at joint 3-4, the fourth (narrow) white band at 2-3, altogether 4 white bands; the dark scales on apical $\frac{2}{3}$ of 2, and all of 3 have a golden shine. a p n. with black hairs and sometimes a few scales; mesonotum covered all over with broad white scales; in certain lights eye-spots are seen on the light greyish mesonotum; pleura dark with pale lines, hardly any scales present; wing (fig. 7), basally from the presector pale area there may be two or three small dark spots, sometimes fused into one, presector dark spot involves subcosta and vein 1, so does middle dark spot, the latter, however, is broken into 3 small spots on vein 1, preapical and apical dark spots involve vein 1, apical dark spot on vein 2 may be absent, there may be a small dark spot on vein 4 between the cross-veins, apical half of vein 6 largely dark; fringe dark with distinct white areas at apices of veins, an extra white area between vein 5 and 6; legs brownish black; tarsi of front legs with broad apical pale bands on 1-3, much narrower bands on 1-2 of mid tarsi, hind tarsi with narrow apical white band at 1, broad at apex of 2, broad white bands at 3-4, 4-5; 5 entirely white; a few white scales all round base of 3. Abdomen dark, with pale yellowish hairs and narrow, golden scales on dorsum of VIII, sometimes a few very narrow black scales ventrally on the three last segments; cerci with light scales above, black scales below. Male. Palpi with club-shaped apex creamy white, with a black band in the middle, basal part black with a white spot at tip, segment VIII of abdomen with conspicuous black hairs at apex ventrally, coxites with pale and dark scales. Otherwise the male is similar to the female.

NOTE. New Guinea specimens apparently have the wings slightly darker and the mesonotal scales somewhat narrower than oriental specimens.

Larva (fig. 7); i c. always with distinct fraying; leaflets of fans rather

short, filament short and blunt; serrations at shoulder poorly marked and shallow, hair 1 on metathorax has 3-10 branches, which do not arise from the same pit, so that it resembles a short feathered hair and not a fan; caudal hooks not well developed.

BIONOMICS. In its oriental home land the larvae breed in little streams, springs, seepage water along streams and in irrigation canals of rice fields. Around Hollandia the breeding places are seepage water on grassy slopes. Adults readily bite man, both indoors and in the open.

DISTRIBUTION. From India to New Guinea where it used to be a rather common species in the Hollandia area. Material was seen from Hollandia, Sentani villages, Genjem (Nimboran).

RELATION TO DISEASE. Locally discriminated as a vector of malaria (Metselaar, 1955), cf. Ch. III.

Anopheles (Cellia) koliensis Owen

Owen, W. B., 1945, J. Parasit. 31, 236.

Described from Koli area, Guadalcanal, Solomon Isl.

This species is partly *A. punctulatus moluccensis* in older literature.

IDENTIFICATION. This medium sized yellowish grey anopheline with an oval or irregularly shaped patch of light scales ventrally on the proboscis in the female, is closely related to *A. farauti* and *A. punctulatus*. Female *A. koliensis* can be separated from these relatives by the light patch on proboscis. Males of *A. koliensis* can usually be separated from *A. punctulatus* by the absence of a dark spot on the costal margin of the wing between the basal and the median dark spots; the costal markings will as a rule also separate the species from *A. farauti*. *A. koliensis* larvae are separated from *A. punctulatus* by having suturals and transsuturals with more branches and by the enlarged shaft of prothoracic hair I. In easterly areas *A. koliensis* and *A. farauti* larvae can be separated by the presence of a complete small fan on abdominal segment I in *A. farauti*, but larvae of these two species in Western New Guinea are inseparable since most *A. farauti* larvae here have this fan with slender and hair like branches and the posterior clypeals are almost as long in both species (fig. 6).

DESCRIPTION. Adult female. Palpi usually ornamented as illustrated (fig. 6), light scales yellowish to white; proboscis black except for a patch of yellowish scales on the ventral side of apical third, size of this patch very variable, in some specimens extended to the distal or even dorsal side, a few pale scales in basal part of proboscis may be present as well. Wing with pale areas light yellow, mainly as in *A. punctulatus* but the accessory sector pale area usually absent on the costa; legs usually some shades darker than

in *A. punctulatus*. Abdominal scales limited to seventh and eighth segments. Seventh segment with few yellow scales, eighth segment clothed with yellow scales and lateral patch of dark scales at apex. Adult male. General coloration as in the female; proboscis all black; second segment of palpus with few white scales in middle, third with median and apical white bands, fourth and fifth with apical halves white. Larva. Head, i c. widely separated, slender, usually frayed; o c. either branched or simple, about two thirds length of inner; p c. small, unbranched; suturals and transsuturals short, the former 2-4 branched, the latter usually 4 to 9 branched, seldom 1 or 2 branched: fig. 6; i s. if separated with moderate basal tubercle, swollen shaft, six to eight radiating branches on each side, shorter than m s.; tubercles of i s. and m s. may be fused, m s. if separated with moderate tubercle, slender shaft, six to seven branches on each side; metathoracic hair 1 forming a rudimentary fan with five to eight hair-like leaflets. Fan on segment I (fig. 6) poorly developed with hair-like leaflets, on III to VII well developed (14-16 leaflets), weaker on II.

BIONOMICS. Adult *koliensis* readily accept man as host for a blood meal; they have been found resting in houses during the day in great numbers. They become active straight after sunset and continue to fly until daylight. In Hollandia the evening activity was much greater than that of the early morning, but these characteristics seem to vary in different places. The larvae of this species are common in temporary pools in grass lands and along roads or in pools along the edge of jungle. They prefer water exposed to sunlight rather than dense jungle conditions. *Anopheles koliensis* is frequently associated with *A. farauti*.

DISTRIBUTION. From Ceram (Moluccas) to the Solomons. In New Guinea the species is known to occur in both low- and highlands: recorded from the Baliem valley up to 5000 feet. This species, however, is absent from the Vogelkop peninsula mountains with the adjacent coastal region between Manokwari and Sorong, and from the flat part of the southern New Guinea plain. Material was seen from: Vogelkop: Timboeni, Mogoi, Wasiori, Steenkool, Foeog, Aiwasi, Wasian; Japen Isl.: Seroei; Northern plain: Hollandia, Skou, Sentani villages, Genjem, Mamberamo valley, Lake Rombebai, Siromi, Paradoi, Waren, Weinami, Nabire, Kwatisore; Meervlakte: Motor-, Batavia-, Prauwen bivak; Central mountains: Amgaiagama (Tjinga valley), Homejo, Archbold lake, Araucaria-, Baliem camp; Kaimana distr.: Kaimana, Warafoeta; South. plain: Tanahmerah, Mindiptana, Casuaris river (Kiriwake).

RELATION TO DISEASE. This species has to be considered as a dangerous carrier (cf. Ch. II and III).

Anopheles (Cellia) longirostris Brug

Brug, S. L., 1928. Geneesk. Tijdschr. Ned. Ind. 68, 278.

Described from Upper Digoel river (Tanahmerah), West. New Guinea.

IDENTIFICATION. The very long proboscis, 1.4 times as long as the palpi, with the pale scaled apical half is a very good character to distinguish this species in the female from other female anopheline mosquitoes. In the ♂ the proboscis is about as long as the palpi and has usually no pale scales (except an occasional few); the palpi have abundant white scaling in ♀ and ♂, the halteres are entirely white. The larva is only liable to be confused with *A. lungae* Belkin & Schlosser, *A. annulipes* or *A. punctulatus*, from which it is difficult to separate with certainty, owing to the range of variability of certain important characters. It can sometimes be distinguished by the very short, simple o c., and by the short p c. which may be simple or up to three-branched; i s. and m s. are implanted on separate tubercles, and are usually about twice as wide apart as those of *A. punctulatus*. Also i s. is strong, dark and branched in a characteristic manner, and its appearance will in most cases distinguish this species from all but *A. lungae*. From the latter species which may be absent from west New Guinea, the propleural group, with three long simple hairs, will serve as a distinguishing feature.

DESCRIPTION. Adult female. Head, proboscis conspicuously elongated, apical half light scaled. Mesonotum clothed with narrow, pale golden, hair-like scales and coarse, brown, long hairs, golden hairs over wing roots; scutellum with a single row of long, golden hairs and a few scattered hair-like scales in the centre; pleura devoid of scales; halteres conspicuous with pale integument and white scaled knob; femora and tibiae dark with variable patches and rings of white scales; wings are rather similar to those of *A. punctulatus* with much speckling, costa, subcosta and vein 1 have some large dark patches. Abdomen dark brown, clothed with brownish hairs, pale scales present on tergite and sternite VIII and on the cerci. Male, see under identification, palpi with abundant white scaling. All important larval characters have been mentioned above, compare also with fig. 5.

BIONOMICS. The larvae have been found in large swamps in the jungle, also near river banks (Digoel), not in open country; additional breeding places given by Lee & Woodhill (1944): overgrown backwaters, sago swamps and in seepage pools, wheel tracks and pig wallows. It occurs either in the jungle or near its fringe; in the latter case the breeding place may be exposed to direct sunlight, but is far more frequently found to be shaded. Due to its more concealed way of living, this widespread species may well be much more common than is usually realized. In many places of its range actual contact with man occurs relatively seldom — so a population of this

mosquito studied for the precipitine reaction of their bloodmeals, had bitten marsupials for 90 out of 100 specimens. De Rook (1929) records only 0.5 % of 10688 anophelines collected during 12 months in sleeping quarters at Tanahmerah, to belong to this species. On the other hand some places were found in New Guinea where the biting population among native houses consisted almost entirely of *A. longirostris*: this happened in some small villages on the southern shore of Sentani lake and in some inland villages in the Mimika, Asmat and Digoel areas (south New Guinea).

DISTRIBUTION. Moluccas and New Guinea. Up to now this species was recorded from lowland localities only. Material was seen from: Vogelkop peninsula: Sorong, Remoe, Manokwari, Steenkool; Geelvink bay: Korido, Seroei, Wandammen; North. New Guinea: Hollandia, Tami river, Arso, Dojo, Sobejab, Genjem, Mamberamo delta, Waren, Wambiri, Pionier bivak; Fakfak; South. New Guinea: Mware, Djairvillages, Tjemara river, Ajam, Tanahmerah, Tauta, Kiah river.

RELATION TO DISEASE. In the better known parts of New Guinea this species has no practical importance as a vector; its role in places where anopheline catches yielded *A. longirostris* almost exclusively, has not critically been investigated so far. De Rook (p.c.) records a sporozoite positive female which was collected from a gametocyte carrier and dissected 11 days thereafter.

Anopheles (Cellia) punctulatus Dönitz

Dönitz, W., 1901, Insektenbörse 18, 372.

Described from Stephansort, Northeast New Guinea.

IDENTIFICATION. A medium sized, speckled anopheline with the scales on scutum rather broad and with a pale apical half of the proboscis, the pale and dark parts are separated by a straight line. A similar proboscis is found in *A. longirostris* — however clearly longer than the palpi — and in *A. annulipes*. From the latter species it is easily separated by the wing ornamentation which is much darker in the latter species. In the *A. punctulatus* larva the p.c. is fairly long and the tubercles of shoulder hairs 1 and 2 small and separated from one another.

DESCRIPTION. Adult female. Palpi as long as proboscis (fig. 6), second segment with narrow apical light ring, remainder usually black, third segment usually with narrow apical light ring, a broad subapical light band, separated by narrow dark ring, occasionally pale markings fused to form a very broad apical pale area, fourth and fifth segments broadly light with narrow basal black rings; apical third to half of proboscis (fig. 6) entirely

pale except for a narrow subapical dark ring (which may be absent) and scattered dark scales ventrally, labella light. Scutum with vestiture of broad, recumbent, yellowish-white scales and golden hairs, scales somewhat longer in front and above wing-base; a p n. dark with broad, erect, black scales dorsally; patch of 6-7 broad recumbent light scales on upper sternopleura, similar patch of 5-6 scales on lower sternopleura; halteres light at base, dark scaled on knob; wing (fig. 6) extremely variable, veins 2-6 with numerous small dark spots, light scales yellowish white; fringe dark, light spots usually at apices of all veins; femora, tibiae and t. 1 much speckled, most of other tarsi with pale apical bands. Scales absent on tergites I to V and sternites I to VI, a few scales on tergites VI and VII and sternite VII, rather dense scaling on tergite and sternite VIII. Adult male. Proboscis with at least two or three, usually numerous, ventral light spots, frequently with large patches of light scales; second segment of palpi with light patch dorsally in basal half, articulation between second and third segments without scales, light coloured, third segment dark on basal fifth, light scaled to apical fourth, remainder dark, segments four and five narrowly dark at or near base, dark area extending to outer surface usually to apex of segments, remainder light. Larva, fig. 6. Anterior clypeal hairs usually simple, o c. about half the length of i c.; p c. single, usually long enough to reach the tubercles of the anterior clypeals; suturals long, single or double; trans-suturals long, 1-3 (rarely 4-) branched. Tubercles of shoulder hairs 1 and 2 small, unpigmented, separated from one another; stem of hair 1 slender, at most slightly swollen basally. Hair 1 of abdominal segment I with short, slender or hair-like branches; fans present on segments II-VII, all small, especially on segment II, filament of leaflet almost as long as the shaft.

BIONOMICS. *Anopheles punctulatus* is one of the *punctulatus*-group species which may be excessively abundant at certain times of the year. It very readily feeds on man; other populations of this species have been recorded to exist in enormous numbers far from any human habitation (cf. Van den Assem & Van Dijk, 1958). The primary characteristics of the larval breeding places are their ephemeral characters. In fact this species is able, by its rapid development, to exploit water collections that are insuitable to other (i.e. predator) species. Ideal breeding places of this kind are found in the rain filled wheel tracks and other small pools on roads or in open places, containing a yellowish clayish water and open to full sunlight.

De Rook (pers. commun.) stresses the fact that larvae have never been found in brackish water, contrary to those of *A. farauti*.

DISTRIBUTION. From the Moluccas to the Solomons.

Anopheles punctulatus occurs in New Guinea in both low- and highland

localities. The species is absent from large parts of the southern plain (e.g. Merauke dist.)

New Guinea material was seen from: Vogelkop: Sorong, Remoe, Klamono, Andjai, Manokwari, Maripi, Ransiki, Teminaboean, Steenkool, Timboeni, Mogoi, Wasian, Idora; Geelvink bay: Biak, Seroei; North. plain: Hollandia, Skou, Tami river, Sentani villages, Arso, Genjem, Arbais, Siromi, Paradoi, Waren, Nabire, Pionier bivak; Meervlakte: Batavia-, Motor bivak; Fakfak dist.: Pikpik; Centr. Mountains: Bedoe river, Amgaigama (Tjinga valley); Mimika: Hiripao, Mware; South. plain: Tanahmerah, Mindiptana, Mimirop, Arwa, Kimirop, Okwamuwop.

RELATION TO DISEASE: In New Guinea a vector of malaria and filariasis, cf. Ch. II and III.

Genus *Bironella* Theobald

Theobald, F. V., 1905. Ann. hist. nat. Mus. Hung. 3, 69.

All known *Bironella* species are dark coloured mosquitoes with a conspicuously long neck. There is practically no ornamentation, wings are always dark scaled. Adults can be separated from *Anopheles* by the wavy wing veins: vein 4 proximal to the bifurcation and vein 5.2 wavy.

In some species a f. is missing because 2.2 is incomplete. The larvae differ from *Anopheles* larvae in having two pairs of palmate hairs on the thorax (meso- and metathorax). Besides the usual group of three shoulder hairs as seen in all Anophelines, there is a large branched shoulder hair in addition, at some distance laterally from the group of three.

Larvae are known from natural breeding places only, preferring shaded forest streamlets or pools. The genus is typically Australasian, occurring from the Moluccas to the Solomons, including North Queensland.

Bironella bironelli (Christophers)

Christophers, S. R., 1924. Ind. Med. Res. Mem. 3, 16 (*Anopheles*).

Described from Muina, T.N.G.

An old, well-known name for this species is *B. gracilis* Theobald.

IDENTIFICATION. This plain, dark and long-legged *Anopheles*-like mosquito is easily distinguished from a closely related species — *B. travestita* (Brug) — in having a f. very short; from *B. papuae* Swellengrebel & Swellengrebel and others by having this forkcell open. For a *Bironella* it is a rather large-sized species.

DESCRIPTION. Adult female. Antennae without any scales, the whorls sparsely hairy; palpi black with apically grey hairs, shaggy, especially in basal fourth, about $\frac{2}{3}$ the length of the proboscis. Mesonotum brownish with a median group of long, narrow, pale yellowish scales on anterior mar-

gin, laterally a similar group with narrow, almost hairlike scales; rest of mesonotum with longitudinal rows of short, curved, golden hairs, no scales; legs dark without bands except for underside of femora which is very pale yellowish, the pale area spreading laterally towards the apex; wings with a f. about $\frac{1}{3}$ the length of its stem; besides the wavy nets of veins 4 and 5.2, vein 3 is slightly wavy; wing scales all dark. Adult male. Antennae distinctly plumose; palpi are longer than in the ♀, but still shorter than the proboscis, only slightly clubshaped, though the last two segments are swollen.

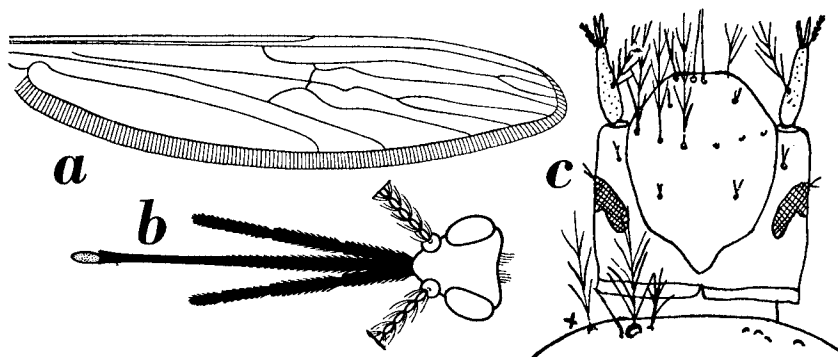


Fig. 8. *Bironella bironelli* (Christophers). A. Wing. B. Head. C. Head of larva; x marks 4th shoulder hair. (A, after Swellengrebel & Rodenwaldt).

Wings with a f. shorter than in the female. Larva has the characters described under genus characters; for further details see fig. 8. The closely approximated inner clypeal hairs are noticeable.

BIONOMICS. Adults are relatively seldom met — twice they were collected from the house of one of us at Ifar N.G. — they hardly ever occur in open country. It has been reported (Brug, pers. comm. by De Rook; Elsbach, 1937) that they bite man occasionally near the breeding places though we ourselves never had this experience. Larvae can be found in densely shaded pools in the jungle, sometimes also in forest streams.

DISTRIBUTION. Moluccas to North Queensland. New Guinea material was seen from: Sorong, Andai, Bumi distr., Manokwari, Biak, Pionier bivak, Hollandia, Ifar (400 m), Tami river, Njau, Tanahmerah, Bade, Merauke.

RELATION TO DISEASE. None.

Genus *Toxorhynchites* Theobald

Theobald, F. V., 1901. Mon. Cul. 1, 244.

This is the genus *Megarhinus* Robineau Desvoidy of earlier writers.

All species belonging to this genus are very large mosquitoes with a metallic shine in fresh specimens; old dry specimens lose their brilliance. Apart from its large size *Toxorhynchites* is easily identified by its particular pro-

boscis which is curved backwards in the distal half (fig. 9). Larvae are very large as well, reddish coloured with a square head and large, modified mouth-parts: no real mouthbrushes but prehensile, hooked lamellae which are used to catch and hold a prey: *Toxorhynchites* larvae are predacious on other mosquito larvae. Larval thorax and abdomen with heavily chitinized plates

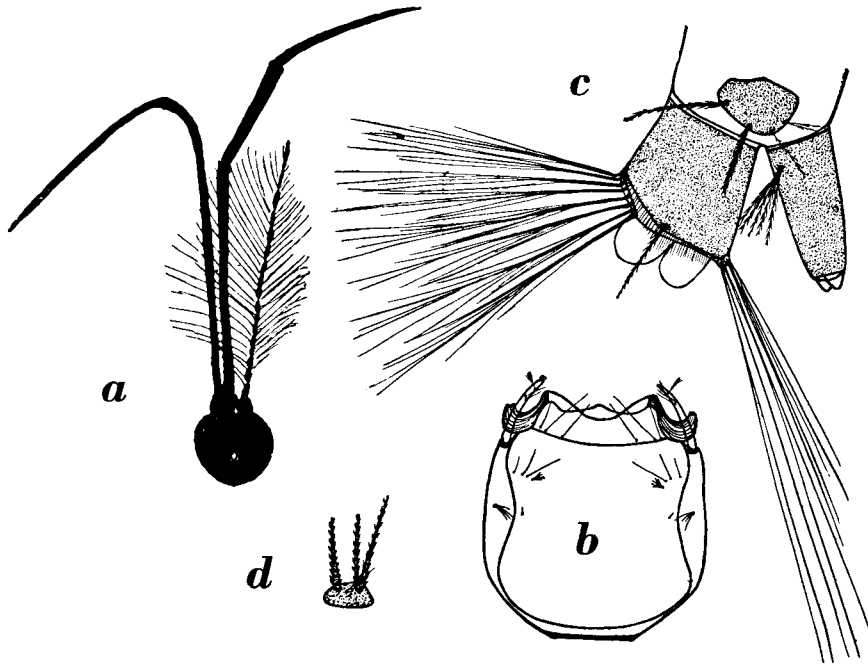


Fig. 9. *Toxorhynchites splendens* (Wiedemann). A Head of adult. B. Head of larva. C. Terminal segments. D. Thoracic and abdominal hairs.

with thick spinulose bristles. Abdominal segment VIII without a comb but with a lateral chitinized plate carrying two plumose bristles. No pecten on siphon.

Toxorhynchites species typically breed in containers, either natural or artificial ones. They may be found in tree holes, cut bamboos, *Nepenthes* cans (though not abundantly so in New Guinea) and in rainfilled drums and tins. The numbers present per breeding place is always low. Larval development takes a relatively long time.

Toxorhynchites adults are sometimes caught inside houses, even collected from inside mosquito nets; all species, however, are completely harmless since the modified proboscis forbids to take a bloodmeal. They live on plant juices and honey from flowers. The genus occurs in the tropics of the whole world.

Toxorhynchites splendens (Wiedemann)

Wiedemann, C. R. W., 1819. Zool. Mag. 2, 1 (*Culex*).

Described from Java.

IDENTIFICATION. A very large, beautiful mosquito with metallic reflection all over and lateral tufts of yellow, black and orange hairs on terminal abdominal segments. Females are rather variable in colour characters; closely related species or subspecies are sometimes difficult to identify correctly. Larvae do not possess striking characters to help to the identification of the species. Males are less variable and easier to recognise, however, mainly on terminalia characters out of scope here.

All individuals collected in Western New Guinea are presumed to belong to the species *T. splendens* (though this is not quite certain). It is impossible to confuse *Toxorhynchites* mosquitoes with any other mosquito known in this territory.

DESCRIPTION. Adult female. Head-scales bright blue and green with purple reflections, a narrow pale border to the eyes; basal portion of proboscis purple or dark blue; palpi purple, about as long as basal six flagellar segments of antenna. Mesonotum with greenish metallic scales on dorsal surface, at the sides the scales may be somewhat bluish, those on scutellum bluish green; a p n. with brassy scales with bluish reflection or the scales may be blue or green; p p n. bluish above, silvery below, scales on pleura silvery; wings with a brownish membrane, especially anteriorly; legs with purple and pale golden scaling and with variable dark and white tarsal markings. Abdomen with dorsum dark blue or green, segments I-VI with larger and smaller pale-yellowish patches laterally; lateral outstanding tufts of yellow, black and orange hairs on segments VI-VIII; venter with pale yellow and dark purple. Adult male. Palpi about as long as proboscis, purple, with yellow and white scaling on long segment subbasally and subapically, variable; antennae densely plumose; t. 3-t. 5 of all legs dark, front tarsi entirely dark or with pale scaling at bases of t. 1 and t. 2 beneath; mid legs with pale scaling near base of t. 1 sometimes forming a broad band, t. 2 with basal white band, very variable in width; t. 1 of hind legs dark or with pale scaling at base, t. 2 with broad basal or subbasal white band.

For larval characters see under genus (fig. 9).

BIONOMICS. See under genus.

DISTRIBUTION. The species *T. splendens* occurs from Sumatra to New Guinea. In New Guinea it is a common species in the lowlands. New Guinea material was seen from: Sorong, Manokwari, Sarmi, Bernhard camp, Hollandia, Ifar (400 m), Tanahmerah, Ambigit, Sabkaheng, Koembe, Merauke.

RELATION TO DISEASE. None.

Genus *Tripteroides* Giles

Giles, G. M., 1904. J. trop. Med. 7, 369.

Moderate to rather large mosquitoes; some species brilliantly ornamented with silvery and bluish scales, others without conspicuous ornamentation. In some species the proboscis is extremely long and slender. In all species the number of pleural bristles is much reduced, true spiracular bristles are always present. Most larvae are covered with conspicuous stellate hairs; in all species the antennae are short with a single antennal hair beyond middle and the ventral hairtuft on the anal segment consisting of one pair only.

Many *Tripteroides* species are a nuisance to men, biting in daytime in the jungle, though never occurring in such huge numbers as *Aedes* (*Aedes*) may do. They were found to be the dominant biters in many localities of the Central Highlands in mountain forest at 6000 feet. Some readily enter houses (e.g. *T. bisquamatus*). This genus is a typical container breeder, larvae can be found in many types of containers, especially in small ones as in cut bamboos, tree holes, *Nepenthes* pitchers, tins and small rock crevices. Many species are very exclusive in the choice of their breeding place. The genus is known to occur from India, Ceylon and Japan to Fiji and New Zealand.

Three different subgenera occur in the territory:

a. *Tripteroides* Giles.

Adults brilliantly ornamented, larvae with two pairs of strong thoracic spines. Most species occur in the oriental region (Philippines and Indonesia), with a few very common species in New Guinea.

b. *Rachisoura* Theobald (Theobald, F. V., 1910. Mon. Cul. 5, 270).

Adults mostly with black and white scaling, broad wing scales on at least veins 1 and 2, larvae with conspicuous maxillar spines which are used for catching prey. Most species of this subgenus occur in New Guinea, a few occur in the Solomons and in tropical Australia.

c. *Polylepidomyia* Theobald (Theobald, F. V., 1905. Ann. hist. nat. Mus. Hung. 3, 118).

Adults lacking any conspicuous ornamentation, proboscis very long and all wing scales long and slender; larvae various, without obvious distinguishing characters like *Rachisoura* (conspicuous maxillary spines) and *Tripteroides* (larvae with 2 pairs of strong thoracic spines).

This subgenus is restricted to the Australasian region.

Tripteroides (*Tripteroides*) *bimaculipes* Theobald

Theobald, F. V., 1905. Ann. hist. nat. Mus. Hung. 3, 114.

Described from Moraka, Papua and Madang, T.N.G.

IDENTIFICATION. The adult of *T. bimaculipes* is a well ornamented spe-

cies and can be distinguished by the broad scaled a p n. and the narrow scaled p p n., the silvery scales on the mesepimeron and the apico-lateral bands of silver scaling on the abdominal tergites III-VII. This species can be confused with the closely related species *T. quasiornatus* (Taylor). The latter species, however, has the scutal integument pale, from yellow to light orange anteriorly and laterally, to brownish medially and posteriorly, with the scutal scales mostly dark and in strong contrast to the integument. In *T. bimaculipes* the scutal integument is dark. The larva has the preclypeal spines strongly bent and quite thick; there are distinct spines on the thorax; the abdominal comb comprises numerous teeth getting smaller towards venter of abdomen. *T. quasiornatus* larvae are rather similar to *T. bimaculipes*, the comb spines are more equal in size and the pecten teeth longer than in the former species.

DESCRIPTION. Adult female. Head covered with azure blue scales in front, black behind; antennae, palpi and proboscis from dark brown to black, proboscis very long and slender, about 14 times as long as the palpi. Scutal integument dark, more distinctly so distally; a p n. and p p n. yellowish brown with black scales, these scales broad on a p n., on p p n. mostly narrow; dorsally the mesonotum is covered with very narrow, black scales, there may be a few broad, black scales over the wing roots; pleura brown, sternopleuron largely covered with flatlying, silvery scales; mesepimeron with a white patch, which varies in size, depending on the locality where the specimens have been collected; scutellum with flat, black scales forming a patch on each lobe; legs mostly black; coxae yellowish, with bright silvery scales laterally; femora with bluish white and silvery markings as follows: front and mid femora have a silvery white spot just beyond the middle and a similar pre-apical one; the mid femora have also a silvery line from base to about halfway apex; hind legs with a similar line extending beyond the middle and a silvery preapical spot; wings with small, broad, dark scales; base of p f. closer to wing base than that of a f. Abdomen black dorsally and golden ventrally; next to the ornamentation mentioned above there is a large silvery lateral area extending from base to apex of T II.

Male. Similar to female. Larva. Head rounded, preclypeal spines bent, thick; dorsal head hairs all simple; antennae short and straight, antennal hair subapical. Thorax and abdomen thickly covered with black, stellate hairs, 14-18-branched, the branches sparsely frayed and ending in 2 or 3 divergent tips; mesothoracic spine simple, metathoracic spine with 3 or 4 teeth (fig. 10). Comb of eighth abdominal segment comprises over 20 teeth, diminishing in length towards venter (fig. 10); siphon is swollen on basal third, narrow on apical third, with 10-12 ventral tufts and about 10 pecten

spines, an irregular series of 2-6 branched dorsal and dorsolateral hairs present on siphon; saddle of anal segment strongly chitinized, apical margin of saddle with a row of strong spines; d s c. 7-branched and v s c. single (fig. 10).

BIONOMICS. This species is a day-biter, to be found around scrub and along jungle margin; it may be quite numerous locally. The related species

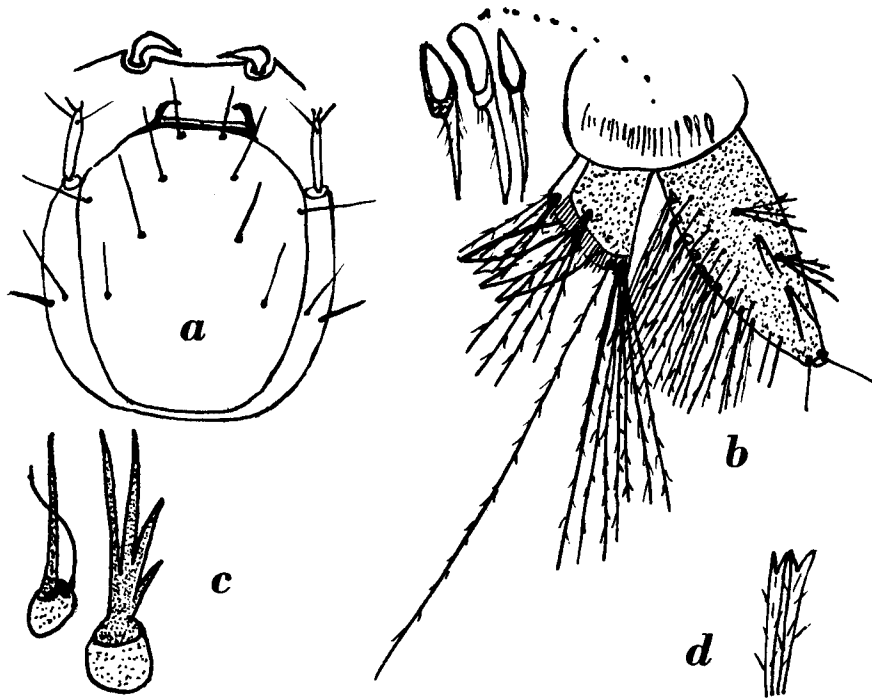


Fig. 10. *Tripteroides bimaculipes* Theobald. A. Head of larva. B. Terminal segments. C. Thoracic spines. D. Branch of stellate hairs.

T. quasiornatus is more a jungle mosquito than *T. bimaculipes* is. The species is a container breeder, larvae can be collected from bamboos, coconut husks, tree holes, *Nepenthes* pitchers, also from small artificial containers.

DISTRIBUTION. Moluccas and New Guinea. Material was seen from Ifar, Hollandia, Kaimana, Uwoes, Ia river, Teri-Kalwa, Koembe.

RELATION TO DISEASE. No records.

Tripteroides (Rachisoura) bisquamatus Lee

Lee, D. J., 1946. Proc. Linn. Soc. N.S.W. 70, 752.

Described from Hollandia, West New Guinea.

IDENTIFICATION. Adult *T. bisquamatus* may be distinguished by the fol-

lowing characters from related species. Wingveins 1 and 2 only with broad scales — in *T. filipes* (Walker) and *T. longipalpatus* Lee all outstanding wingscales are broad; palpi in ♀ up to 0.25 the length of the proboscis, in the ♂ 0.75, no prescutellar bristle and up to 3 spiracular bristles present — in the related species *T. kingi* Lee and *T. vanleeuweni* (Edwards) these characters are: *T. kingi*: palpi ♀ 0.20, ♂ 0.20-0.25, prescutellars 2-3 pairs, spiraculars 4-6; *T. vanleeuweni*: palpi ♀ 0.20-0.25, ♂ 0.65-0.70, prescutellars 1-2 pairs, spiraculars 5.

In the *T. bisquamatus* larva the largest maxillar tooth is as long as the body of the maxilla proper; the comb on abdominal segment VIII with one large and a few more spines of decreasing size. The maxillar teeth of *T. kingi* and *T. filipes* (Walker) are much smaller, those of *T. longipalpatus* Lee much longer. In *T. vanleeuweni* the first and second maxillar tooth are about equal in length and there are more combscales present on segment VIII.

DESCRIPTION. Adults dark scaled, some pale scales present on the centre of the head, at the border of the eyes, on the anterior margin of the thorax and in pale lateral abdominal markings; venter light. Relative measures and bristles as given above; length of hind tibia about 85 % of the mid one. Larva. Maxilla and comb as described above. Siphon tapering, index about 3; ventral hairs on siphon 2-3 branched, present from near base to apex (fig. 11).

BIONOMICS. *T. bisquamatus* larvae were collected from *Nepenthes* pitchers (most frequently), cut bamboos and *Colocasia* axils. The species was most often met in open country, e.g. the grassy slopes on the foothills of the Cyclops Mountains, where they breed in pitchers of *Nepenthes mirabilis* Danser. For further biological data is referred to Van den Assem (1959b). Adults are common biters in the afternoon hours; they frequently enter houses.

DISTRIBUTION. New Guinea. Material was seen from Hollandia, Ifar (400 m), Mamda (Nimboran district), Tami river and Teminaboean? (Vogelkop peninsula).

RELATION TO DISEASE. None, as far as known.

Tripteroides (Polylepidomyia) argenteiventris (Theobald)

Theobald, F. V., 1905. Ann. hist. nat. Mus. Hung. 3, 118 (*Polylepidomyia*).

Described from Painumu river, Papua, New Guinea.

IDENTIFICATION. Adults dull, brownish or blackish-brownish, without conspicuous ornamentation. All wing scales slender, proboscis conspicuously long. It may be differentiated from related species by the large mesonotal scaling (small scales are present in the *microlepis-group*) and the very

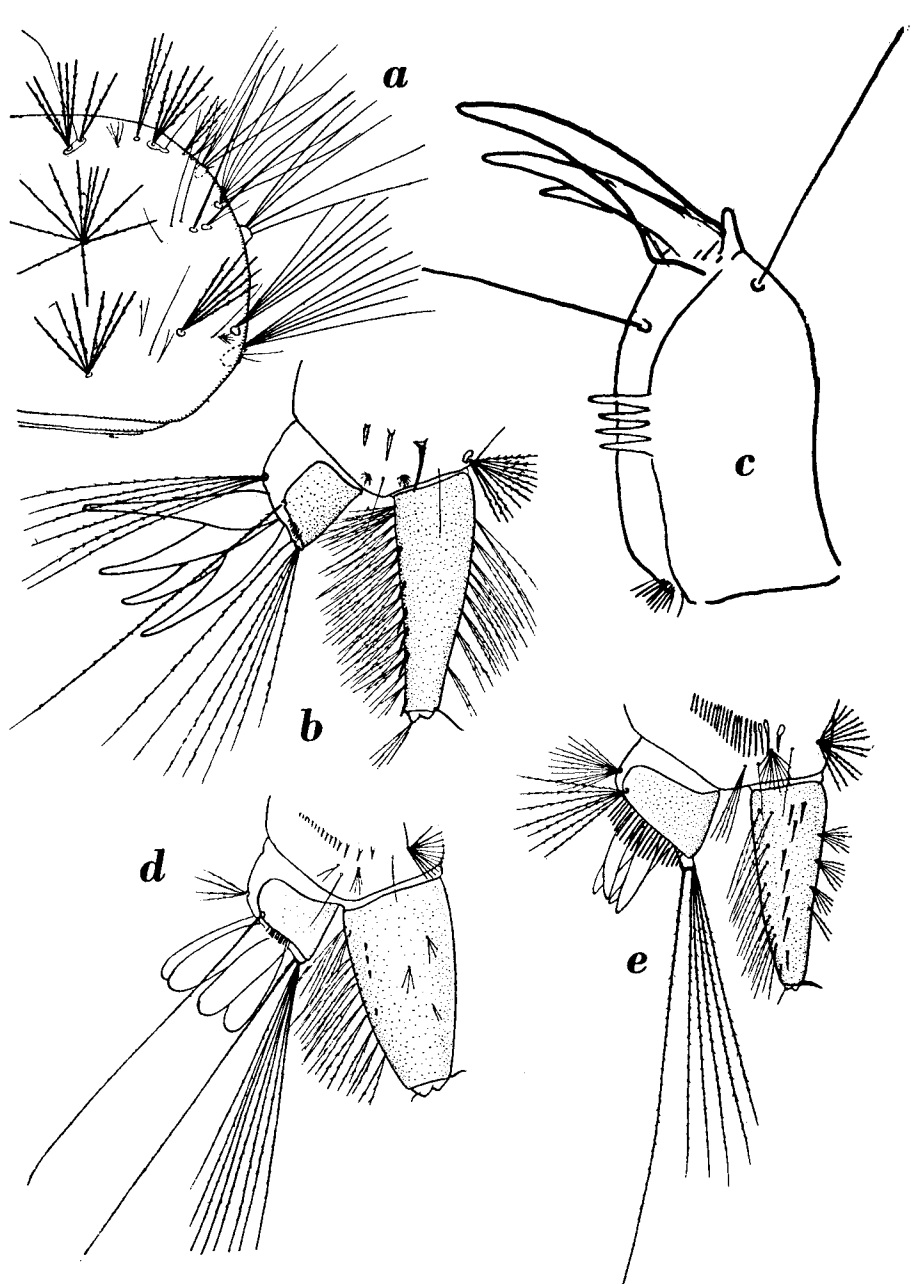


Fig. 11. *Tripteroides bisquamatus* Lee. A. Thorax of larva. B. Terminal segments. C. Larval maxilla. *T. quasiornatus* (Taylor). D. Terminal segments. *T. argenteiventris* (Theobald). E. Terminal segments. (A, B, D, E after Lee).

short female palpi — $\frac{1}{10}$ of the proboscis ($\frac{1}{6}$ in female *T. atra* Taylor). *T. argenteiventris* is most likely to be confused with the latter species.

DESCRIPTION. Adult. Dark scaled, pale scales present in a narrow border to the eyes, on thoracic pleura, ventrally on the femora and in lateral markings on the abdomen. Abdomen ventrally pale scaled. Male palpi are as long as proboscis. Two or three spiraculars and one posterior pronotal bristle present; hind tibia about 90 % the length of the mid-one.

Larva. No modified mandibles and no spines on thorax. Comb on segment 8 with a row of pointed teeth of decreasing size; siphon inflated, few pecten spines present; dorsal subcaudal hair on anal segment at least 5-branched (fig. 11).

BIONOMICS. Adult females were frequently collected while biting in mountain forest in moderate altitudes, locally they may be a pest. The species is a day-biter. Larvae can be found in rotholes in trees and in cut bamboos, mostly in shaded places, occasionally at the road side.

DISTRIBUTION. The species is widespread over New Guinea. Lee (1946) records a number of localities in the T.P.N.G. Material was seen from Hollandia, Ifar (300 m), Tablanoesoe (300 m), Van der Wal river (800 m); from the Central Highlands: Swartvalley (1400 m) and Mappia (2000 m); Vogelkop peninsula: Inanwatan. Material from the latter three localities were females only, however.

RELATION TO DISEASE. None as far as known.

Tripteroides (Polylepidomyia) microlepis (Edwards)

Edwards, F. W., 1927. Nova Guinea (Zoology) 15, 353 (*Rachionotomyia*).

Described from Nassau Mnts. (1500 m). Male and larva described by Van den Assem, 1960, from Enarotali, Wissel lakes.

IDENTIFICATION. Adults brownish, proboscis long and slender, mesonotal scaling small, pleura of thorax covered with pale scales. In the larva the ventral hairs on the siphon are single, except for the bifid basal pair; there are no modified mandibles or thoracic spines. According to Dr. E. N. Marks *T. microlepis* belongs to a group of small-scaled species collected in the Central Highlands and still to be described.

DESCRIPTION. Adults dark brown scaled, female palpi as long or slightly longer than clypeus, in the male 0.8 the length of the proboscis. One posterior pronotal and 2-4 spiracular bristles present; pleura covered with pale scales. On the abdomen an indefinite pattern of pale scaling, venter completely pale scaled. Larva with head hairs A 4-, B 3- and C 4-branched, all close to the anterior border of the head capsule. Lateral comb on 8th abdominal segment comprises a row of 6-9 pointed teeth; siphon cone-shaped, pecten

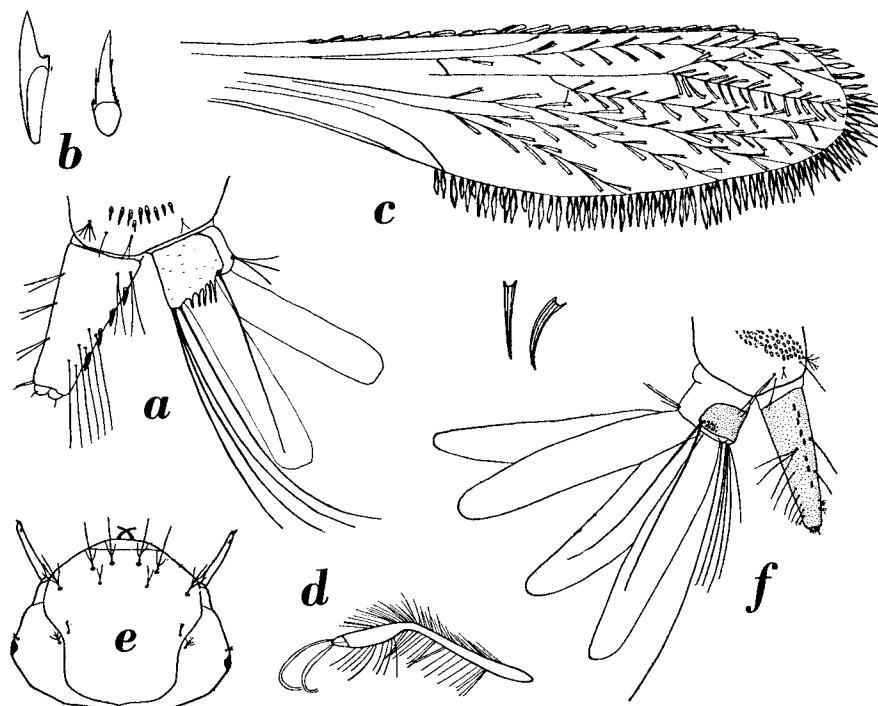


Fig. 12. *Tripteroides microlepis* (Edwards). A. Terminal segments of larva. B. Comb tooth (left); pecten spine (right). *Hodgesia quasisanguinae* Leicester. C. Wing; below two of its remarkable scales. *Malaya lee* (Wharton). D. Proboscis. E. Head of larva. F. Terminal segments. (E, F after Wharton).

with 4-5 teeth. Ventral hairs single, except for the basal pair which is bifid. Saddle with few but strongly developed spines on the distal margin; dorsal subcaudal tuft 3-branched, ventral subcaudal single (fig. 12).

BIONOMICS. Adult females were collected biting in day time in mountain forest in high altitudes. Locally (e.g. near Enarotali) they proved to be very annoying by their numbers present. Larvae were collected from pitchers of a tree-creeping *Nepenthes*. The species occurs in higher altitudes: all records between 950 and 2000 metres.

DISTRIBUTION. Apart from the type locality, Nassau Mnts., there are records by Lee (1946) from the Cyclops Mnts. (Hollandia district). The authors saw material from the western Central Highlands: Enarotali and Homejo (Kemaboe valley) and Wasirawa (1680 m, Vogelkop Mnts.).

RELATION TO DISEASE. None as far as known.

Genus *Malaya* Leicester

Leicester, G. F., 1908. Cul. Malaya, 258.

An old, well-known name for this genus is *Harpagomyia* De Meyere. Mosquitoes of small size, blackish, with silver patches on head, thorax and abdomen. *Malaya* is immediately recognized by its proboscis (fig. 12) with its apical third part upturned, swollen and with four long hairs on tip. Palpi short in both sexes, male antennae not plumose; clypeus twice as long as broad, pointed in front. Full grown larvae do not show any constant characters by which they can be distinguished from larvae of the related genus *Topomyia* Leicester. Larvae can be collected from leaf axils, in this territory mostly from keladi or taro species (*Alocasia* and *Colocasia*, Araceae).

Females of *Malaya* are fed by ants. One of us frequently observed this behaviour in Indonesia in an oriental *Malaya* species: the mosquitoes may be seen hovering over a procession of ants on which from time to time a *Malaya* alights. It places itself directly in front of an advancing ant, stops it, thrusts the swollen tip of the proboscis in the opened mouth of the ant and rapidly absorbs the presented food. When not in use the mosquito proboscis is folded backwards under the body.

Malaya leei (Wharton)

Wharton, R. H., 1947. Proc. Linn. Soc. N.S.W. 72, 60 (*Harpagomyia*).

IDENTIFICATION. Patches of silver coloured scales present on apical part of tergites, except for the third and the seventh. In a related species (*M. genurostris* Leicester) patches are lacking on segment III only. In the larva the comb scales are arranged in an irregular patch, there are one or two saddle hairs of about equal size.

DESCRIPTION. Adult. Basal part of proboscis light brown, apical swollen part dark brown to blackish; palpi and clypeus of about the same size, light brown. A median, longitudinal line of silver scales on the mesonotum, remaining part of mesonotum with brownish scales. Patches of silver scales on pleura and scutellum; wings dark scaled; legs dark scaled, silvery patches on coxae only, t. 1 of hind legs distinctly longer than corresponding tibiae. Abdomen blackish with laterally a silver patch on segments I, II, IV, V and VI (small in the latter).

Larva. Clypeal spines are rather long and moderately stout; head hairs A, B and D are approximately equal in size, C is much shorter and finer; A has three to five branches, occasionally six; B is normally trifid, but may be bifid; D has from three to five branches; C is normally bifid, but may be single or trifid. The lateral comb of segment VIII consists of from thirty to sixty fringed scales arranged in a large subtriangular patch. Siphon

weakly chitinized, particularly towards the base, and the siphonal index is about 3; ventrolateral tuft has three or four slightly plumose branches, the following row of tufts consists of from two to four single, frayed hairs, followed by one or two smooth hairs with two to four branches. The dorso-lateral hair tufts consist of from two to four normally single, occasionally bifid, frayed hairs followed by one to three smooth, smaller hairs with six or seven branches on the apex of the siphon; pecten extremely variable; saddle normally covering between one-half and two-thirds of the anal segment, the saddle hair is very long, pilose at its base, and usually with two approximately equal branches, but sometimes it is single (fig. 12).

BIONOMICS. *Malaya leei* is one of the commonest N.G. mosquito species though the adults are hardly if ever collected in nature. They do not suck human blood but they are most probably fed by ants as is verified for oriental relatives. Larvae are almost always present in collections from leaf axils of keladi plants (*Colocasia* and *Alocasia* species).

DISTRIBUTION. New Guinea, where it is wide-spread. Material was seen from Sorong, Manokwari, Homejo (Centr. highlands, 1500 m), Sarmi, Pionier bivak, Janim, Djik, Ifar (400 m), Hollandia, Mandinggei and Mainak (Mandobo, S.N.G.). No specimens seen from Merauke; the highland specimens are aberrant in having reduced silver scaling on the abdomen.

RELATION TO DISEASE. None.

Genus *Topomyia* Leicester

Leicester, G. F. 1908. Stud. Inst. Med. Res. Malaya 3, 18.

The first record of this genus from New Guinea was recently published by Marks (1960). The New Guinea species, *Topomyia papuensis* Marks, is a small mosquito, closely related to the New Guinea *Malaya* species, but immediately distinguished from the latter by the normal proboscis. The species was recorded from the northern district of Papua, Southeast New Guinea.

The larvae were collected from axils of a *Crinum*-like plant in deep shade of secondary forest, in association with larvae of *Aedes kochi* and *Aedes wallacei*.

Genus *Ficalbia* Theobald

Theobald, F. V. 1903. Mon. Cul. 3, 296.

Rather small mosquitoes without very pronounced generic characters. In the male the proboscis is distinctly swollen apically, the palpi are of variable length and the antennae are plumose. In the female the proboscis is slightly swollen in apical third or over, the palpi are not more than $\frac{1}{4}$ of the length of the proboscis. Vertex of head with numerous upright forked scales.

Wings with their scales about equal in shape, usually broad, in some species small and sparse. Thorax without much ornamentation, pleura with few scales.

The species of *Ficalbia* described below fall in two easily recognized subgenera:

Subgenus *Ficalbia* with narrow and often sparse scutellar scaling, flagellar segment 1 in the females almost three times as long as segment 2, anterior forkcell fully as long as its stem vein, wingscales less scanty and palpi in the males quite short.

Subgenus *Mimomyia* with narrow and sparse scutellar scaling, flagellar segment 1 in the females variable, usually elongate, anterior forkcell shorter than its stem vein, wing scales very scanty and palpi in the males as long as the proboscis or longer.

Ficalbia species usually breed in swamps and ponds with much vegetation, frequently among those weeds as are *Pistia*, *Azolla*, *Utricularia* and *Hydrocharis* species. They are frequently associated with *Mansonia* larvae and as such are important as indicators. In one New Guinea species (*F. modesta*) the siphon of the larva and the breathing horns of the pupa have been modified in such a way that plant tissues can be pierced to obtain oxygen (see also under genus *Mansonia*). The females have never been reported to suck human blood.

Ficalbia (Ficalbia) minima (Theobald)

Theobald, F. V., 1901^a. Mon. Cul. 2, 262 (*Uranotaenia*).

Described from Quilon, Travancore, India.

IDENTIFICATION. This species may be distinguished at once from the other species of *Ficalbia* mentioned in this synopsis by the very long antennae (f s. 1 at least three times as long as f s. 2, while in *F. metallica* (Leicester) and *F. modesta* f s. 1 is twice as long as f s. 2) in the female and the minute palpi in the male (in *F. modesta* and *F. metallica* male palpi about as long as antennae); the larva of *F. minima* has the preclypeal spines with fine denticles at base while both other species mentioned here have normal preclypeal spines.

DESCRIPTION. Adult female. Head for the greater part clothed with flat creamy scales, some black upright scales on the nape; proboscis dark, slightly swollen at tip, palpi very small, dark. Mesonotum pale, dark patches on anterior portion of pleura; wings with broad dark scales; a f. and p f. not very short; legs with femora largely pale, darker dorsally on apical half; white knee spots on all legs, largest on hind legs, very small on front legs; tarsi dark with pale subbasal and subapical bands. Abdominal tergites as

follows: T. I entirely dark, T. II mainly dark, other tergites with yellowish basal bands broadening out laterally, narrowing or interrupted medially on succeeding segments; venter pale. ♂ very similar to ♀; proboscis much swollen on distal half. The pupa has extremely long breathing trumpets; for the larva see fig. 13.

BIONOMICS. Larvae have always been found in water collections with *Pistia*.

DISTRIBUTION. From India and Ceylon to New Guinea. Material was seen from Hollandia (Sentani lake) and Teri-Kalwa (Frederik Hendrik Island).

RELATION TO DISEASE. None.

Ficalbia (Mimomyia) modesta King and Hoogstraal

King, W. V. & Hoogstraal, H., 1946. Proc. Ent. Soc. Wash. 48, 186.

Described from the Hollandia area, West New Guinea.

IDENTIFICATION. This species differs from the adult of *F. metallica* in the following characters:

There are no yellowish scales near the wing-root and the abdomen is without a continuous golden median longitudinal dorsal stripe; the anterior forkcell is almost equal in length to its stem; the golden bands on the legs as described for *F. metallica* are absent. The larva is entirely different from that of *F. metallica* as it has a siphon adapted for piercing plant tissue (see *Mansonia* and *Aedomyia*).

DESCRIPTION. Adult male. Apical half of proboscis somewhat swollen, basal two-thirds with brownish-yellow scales, gradually becoming darker on apical third; palpi longer than proboscis by nearly half the length of the apical segments which are swollen, dark scaled, and fused; long segment slightly swollen apically, brownish-yellow scaled; antennae about as long as palpi; vertex and lateral surface of head covered with broad, white to dusky scales with a faint metallic reflection; a small patch of dark, upright, forked scales at nape. Mesonotum and p p n. dark brown, contrasting with the pale, yellowish pleura, mesonotum and scutellum covered with slender, dark scales which have a bronzy reflection in bright light, a few scales over wing base paler, distinctly so on antescutellar space, long bristles arising from the anterior and lateral borders; wing scales rather sparse; a f. almost equal to its stem and arising closer to the apex of the wing than the posterior cell; tip of anal vein abruptly curved to posterior border of wing well beyond fork of vein 5; legs dark scaled with metallic reflection, the undersurface of the femora largely pale. Abdomen: tergites with dark scales with a metallic reflection; tergites II to VII with inconspicuous basal, pale lateral spots;

long golden hairs arising apically from each segment; sternites pale scaled. Female similar to male except in the following characters: proboscis dark scaled except ventrally on basal two-thirds which is mostly brownish-yellow; palpi one-fifth as long as proboscis, dark scaled, very slightly swollen at apex; antenna completely dark with a pale pubescence, a whorl of about five bristles near base of each flagellar segment; scales on front part of vertex appear slightly darker than those on posterior half; eighth abdominal segment short, cerci completely retracted. Larva (fig. 13). Head slightly broader

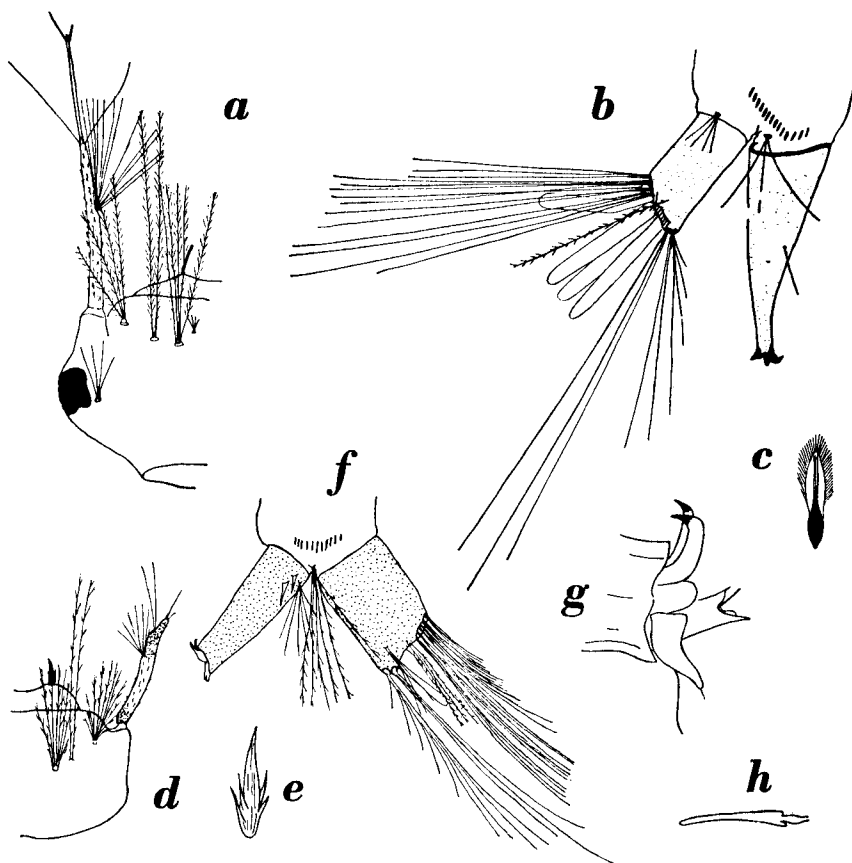


Fig. 13. *Ficalbia modesta* King & Hoogstraal. A. Head of larva. B. Terminal segments. C. Comb spine. *F. minima* (Theobald). D. Head of larva. E. Clypeal spine. F. Terminal segments. G. Apex of siphon. H. Comb spine.

than long; preclypeal spines dark brown, long and prominent; headhairs A, B and C on a straight line, B and C close together, hair A 9-12 branched, frayed, lateral hair about $\frac{3}{4}$ of medial one, B 2-3 branched, much longer

than head, frayed, C 5-6 branched, frayed, slightly shorter than head, hair D small, 4-branched, bare; antenna with smoky basal part, small spines present all over, antennal tuft beyond middle, branches frayed at base, apical elongation $\frac{3}{4}$ of basal part; abdominal segment 8 with 14 teeth in a single, curved row, teeth with lateral, frayed membrane; siphon about $2\frac{1}{2}$ -3 times longer than wide, asymmetrical, cone-shaped, apex black, three small curved spines present at extreme top, halfway two single, long hairs; anal segment two times longer than wide, apically a row of sharp spines is present; i s c. six branches, largely varying in length; o s c. three branches, 2-3 times as long as anal segment; anal papillae slightly blunt at apex, longer than segment; anal fan composed of four, strongly branched tufts, 2-3 times longer than segment; anal hair single, frayed, long. No pecten teeth.

BIONOMICS. This species was found breeding in a very restricted area, with two associated *Mansonia* species. Larvae were collected from a *Pistia-Hydrocharis* field floating in heavily polluted water. Larvae are rootpiercing.

DISTRIBUTION. New Guinea. Material was seen from Ifar Baberonko, Sentani lake.

RELATION TO DISEASE. None.

Genus *Mansonia* Blanchard

Blanchard, R., 1901. C.R. Soc. Biol. 53, 1045.

The adult mosquitoes of this genus are either well characterized by their remarkable, broad and asymmetrical wing scales (fig. 15) or by their conspicuous colour (orange or orange-purple) in combination with following characters:

Proboscis of moderate length and uniform thickness, not swollen at tip in either sex; palpi of the ♂ as long as the proboscis or longer in the known species, of ♀ not more than a quarter as long as the proboscis; antennae of ♂ distinctly plumose, with the last two segments elongate; of ♀ with moderately long verticils, all the flagellar segments about equal in length. Mesonotal bristles always strongly developed; a p n. widely separated; several strong, posterior pronotal bristles; no spiraculars; postspiraculars present or absent; pleura usually with only a few small patches of scales; hind tibiae with a more or less distinct row of fine hairs on inner side at tip.

The larvae of this genus are easily identified by the following characters. Most conspicuous is the peculiarly shaped siphon, adapted to pierce roots of water plants to obtain the necessary oxygen (fig. 14). A similar siphon is found in a few species of the genus *Ficalbia* (e.g. in the New Guinea species

F. modesta). In *Mansonia* the head is short and very broad; the antennae very long with strongly developed subapical hairs which are inserted well below the apex. The lateral comb on the eighth abdominal segment comprises 2-8 teeth; there is no pecten on the siphon.

In spite of the often huge numbers of adults present, the larvae are sometimes difficult to collect. The way to collect them is to find a suitable breeding place (cf. Van den Assem, 1958b), to pick up several host plants and to wash them carefully in a bowl with clean water. In this way the larvae become detached from the roots and can be easily collected.

Mansonia eggs are found in easily detected, rosette-shaped clusters which are glued to the underside of the leaves of their host plants.

Two subgenera occur in New Guinea: *Mansonioides* and *Coquilletidia*.

Subgenus *Coquilletidia* Dyar

Dyar, H. G., 1905. Proc. ent. Soc. Wash. 7, 45.

Wing scales rather narrow, in some species nearly linear. Several species are entirely yellow-orange or yellow-orange with purple (cf. the very different but also orange coloured *Aedes aurantius* and some *Ficalbia* species). Postspiracular bristles absent. Seventh abdominal segment of female large, eighth small but not retracted and without chitinous spines as in *Mansonioides*. Adult specimens are difficult to identify specifically without making use of characters of the terminalia. Larva with extremely elongated antennae and without hair tufts piercing the chitinous ring of the anal segment.

Mansonia (Coquilletidia) crassipes (Van der Wulp)

Van der Wulp, F. M., 1892. Bijdr. Fauna Midden-Sumatra, Dipt. p. 9 (*Culex*).

Described from Soeroelangoen, Sumatra.

IDENTIFICATION. A moderately large mosquito with the integument of the mesonotum orange coloured, or very pale brownish yellow; tibiae, tarsi and wings dark scaled, especially the first with strong metallic shine, no bands. The subgeneric characters in the larvae are striking.

A related New Guinea species, *M. xanthogaster* Edwards is very similar to *M. crassipes* and may only for certain be differentiated by characters of the male terminalia. A third, not uncommon species, *M. ochraceus* Theobald, may be differentiated by its brightly yellow coloration of legs and thorax and by the yellow coloured wing scales.

DESCRIPTION. Head with narrow, curved, small, creamy yellow scales on occiput and scattered, upright, forked, golden yellow scales; clypeus black; antennae with torus and base of flagellar segment 1 yellow brown, remaining

segments very dark, short greyish and long dark hairs present; proboscis and palpi covered with dark scales which have a violet metallic shine; labella black. Thorax, a p.n. bright yellow with golden-yellow, long, stiff hairs; integument of mesonotum bright orange-yellow, somewhat darker anteriorly, laterally and over the wing root, scales on mesonotum not very numerous, curved, narrow, bright golden-yellow; scutellum bright yellow, without scales both with long, stiff, dark hairs; pleura yellow to orange brown with some darker areas; sternopleuron and mesepimeron with a large patch of flat, rather broad, silvery scales; wings with long, rather narrow, outstanding scales on vein 1 and 2, scales on costa and subcosta with metallic purple shine, in certain lights similar scales on basal parts of other veins; legs with violet metallic shine, femora basally with some golden-yellow scales. Abdomen with a variable ornamentation of purple, or violet metallic scales and lighter, lateral patches; ventrally the segments are creamy yellow scaled, in most specimens apically with some bluish metallic scales. Male. Apices of palpal segments and the whole last segment very dark, violet scaled, many stiff, moderately long hairs on last segment on inner surface of subapical segment and inner surface of apex of long segment; antennae with pale brown torus and yellowish brown flagellar segments. The flat, broad scales on sternopleuron and mesepimeron are silvery-white as in the female, but more numerous, especially on the mesepimeron; basal pale areas on femora very distinct. On the abdomen in certain specimens basal, creamy yellow bands on all segments except I, narrow on II, III and IV; ventrally on VII a large bunch of very long hairs.

In the larva the very long antennae are most conspicuous; there are 8 comb scales; the saw-edged apparatus to pierce vegetable tissue is more elongated than in *Mansonioides* species.

BIONOMICS. *M. crassipes*, though common, was never seen as a pest. Adults bite readily and enter houses occasionally. According to Van Dijk (1958) they are greatly impeded by light. In Merauke, adults caught inside were associated with males of *M. xanthogaster*, presumably the females belonged to the same species. Larvae of *M. crassipes* were collected in Hollandia from grass roots in a dirty, water filled pit; there is another record from kankoen (*Ipomoea aquatica*) roots.

DISTRIBUTION. From India to New Caledonia. *M. xanthogaster* occurs in New Guinea and on the Australian mainland. Material was seen from the following localities: *M. crassipes*: Hollandia; *M. xanthogaster*: Koembe, Merauke; Species uncertain: Teminaboean, Tanahmerah, Kali ia, Kimaan, Toerai.

RELATION TO DISEASE. It is improbable that this species is of great im-

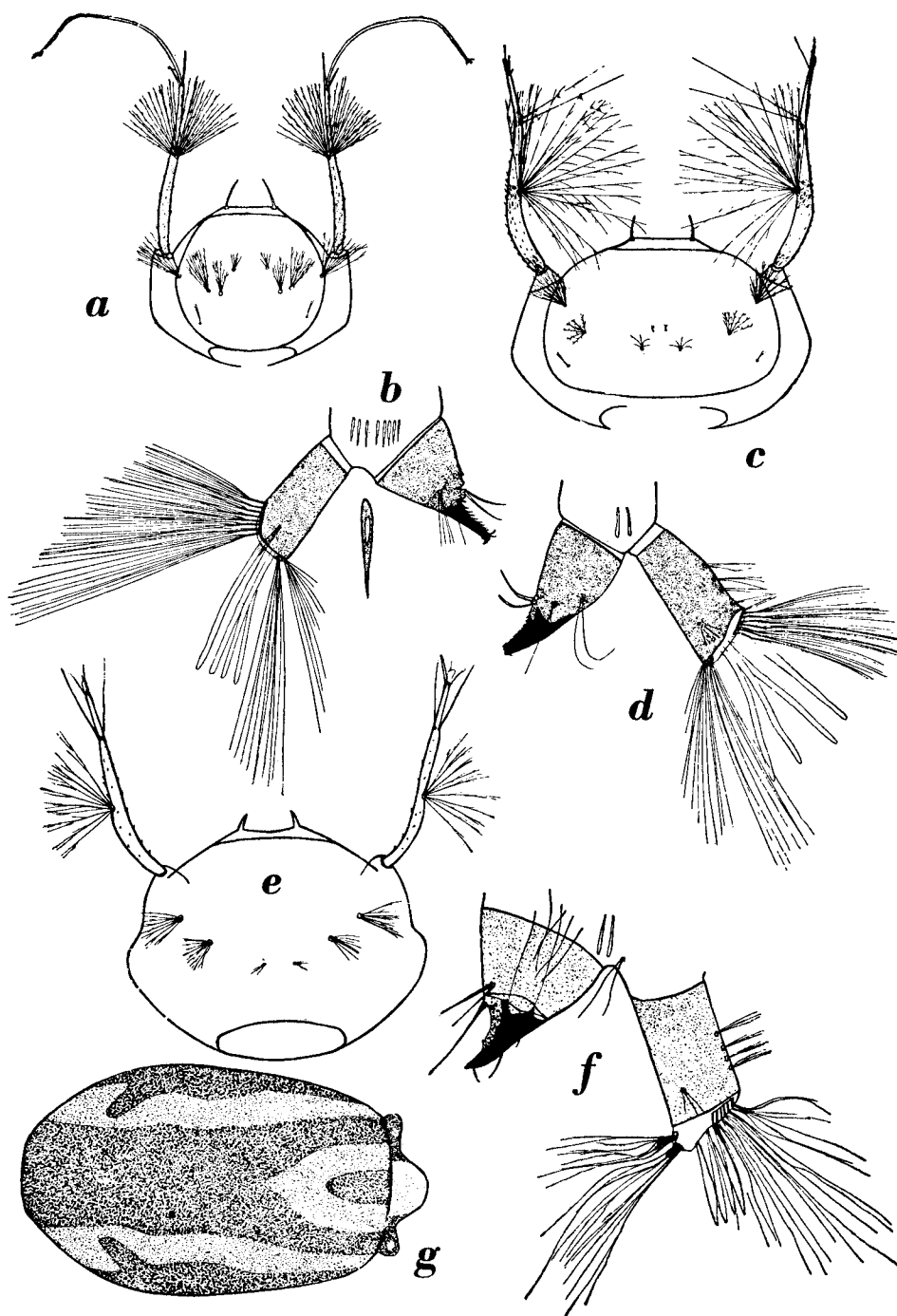


Fig. 14. *Mansonia crassipes* (Van der Wulp). A. Head of larva. B. Terminal segments with separate comb tooth. *M. dives* (Shiner). C. Head of larva. D. Terminal segments. *M. uniformis* (Theobald). E. Head of larva. F. Terminal segments. G. Mesonotal ornamentation.

portance in the transmission of *W. bancrofti*. Van Dijk (1958) records a specimen (*M. xanthogaster*?) with almost infective stages of the parasite in a controlled infection. In Indonesia *M. crassipes* has proved to be susceptible to *W. malayi* infections (Oey, 1942).

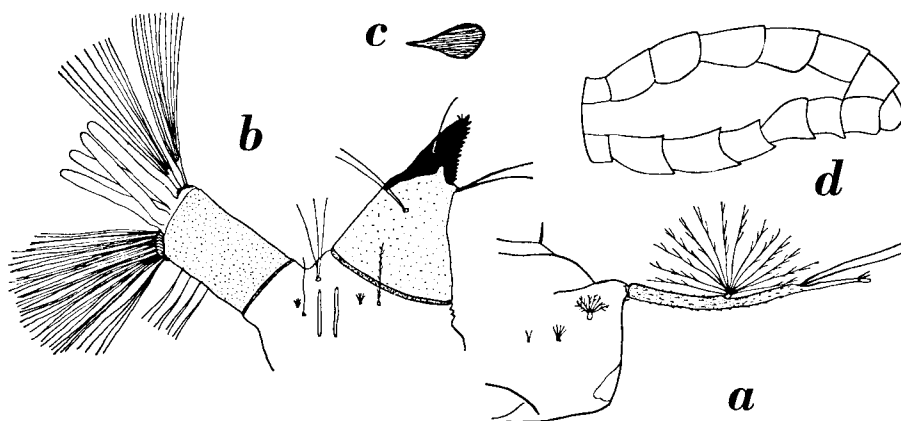


Fig. 15. *Mansonia bonnewepsterae* Van den Assem. A Head of larva. B. Terminal segments. Subgenus *Mansonioides*. C. Asymmetrical wing scale. D. Abdomen of female.

Subgenus *Mansonioides* Theobald

Theobald, F. V., 1907. Mon. Cul. 4, 498.

Wing scales broad and asymmetrical; in all species pale and dark scales mixed, except for *M. papuensis* (for other mosquitoes with speckled wings see under Identification characters of *Aedes kochi* p. 83). Postspiracular hairs present. Palpi of the male about as long as proboscis, not swollen apically and only moderately hairy, penultimate segment rather long upturned, terminal segment minute. Abdomen of the female very blunt at apex, distal segments turned upward. Dorsally only $6\frac{1}{2}$ segments are visible, as the 8th segment is totally retracted and of the seventh only the apical half is visible; apical margin of VIII in ♀ closely set with a row of strong teeth. The number and arrangement of these teeth is different for each species. Legs much ornamented with pale bands and patches. The larva has the antennae of moderate length, the extension not as extreme as in *Coquilletidia*. Ring of anal segment pierced by some ventral hair tufts.

Mansonia (Mansonioides) bonnewepsterae Van den Assem

Assem, J. van den, 1958b. Trop. geog. Med. 10, 205.

Described from Sentani lake, Western New Guinea.

IDENTIFICATION. The female of this species has several characters in common with the closely related species *M. dives* (Schiner), *M. bonneae* Ed-

wards and *M. indiana* Edwards; the identification of wild caught females often remains a problem, only specimens bred from larvae are identified for certain. The males are easily identified, with good mounts of their terminalia. The larval characters in which this species differs from close relatives are the shape of the head which is conspicuously rectangular and slightly over twice as wide as long, head hair A is rather small and the siphon is relatively short (as in *M. uniformis*) and broad at base, the anal segment is short and the dorsal and ventral subcaudal hairs equal in length and 10-11-branched; the anal papillae are shorter than the anal segment.

M. dives is some shades darker than *M. bonnewepsterae*, in the former species the femora of the fore legs are dark scaled with distinct band and patches of white scales, in the hind femora there are no confluent patches.

DESCRIPTION. Adult female. Head clothed on the occiput with numerous dark, erect, forked scales, intermingled with scattered grey narrow-curved scales; along the border of the eyes are flat, white scales, a patch of broad, flat, white scales laterally behind; proboscis dark-scaled at base, towards apex intermixed gradually with more golden scales, apical third again with many dark scales; palpi less than one third of length of proboscis, dark-scaled with white tip. A p n. with narrow-curved white scales; mesonotum with golden brown and greyish white scales, the pale scales arranged in more or less round patches, varying in number, the posterior mesonotal spots are more or less oval and often indistinct; scutellar white scales as those of mesonotum; pleura brown; p p n. with a small patch of white scales; hind border of sternopleuron with a row of similar scales, forming a patch on upper and lower sternopleuron involving part of the mesepimeron, hairs on upper mesepimeron and pre-alar hairs golden-yellow; wings with dark and yellowish broad and asymmetrical scales; front legs: femur with dark and lighter scales intermixed; few white scales at extreme apex; a distinct sub-apical band, a narrow subbasal band more or less distinct, three patches between, sometimes distinct sometimes absent, on posterior surface patches distinct; tibia dark scaled, six distinct white patches present, sometimes additional smaller ones between; at the ventral side a yellow and white-scaled longitudinal line which is distinct at apex and faint towards base; t. 1 with few white scales at base and incomplete white band at the middle; t. 2 and t. 3 with basal, white scaled spot, t. 4 and t. 5 entirely dark; mid legs: femur dark and yellow-scaled, anterior surface with five distinct spots, posterior surface with two extensive white spots basally, a large spot at the middle and two smaller ones apically, few white scales at extreme apex; tibia with numerous white spots of variable size; tarsus as in front legs, basal white spot of t. 1 distinct; hind legs: anterior surface of femur with

five distinct spots, the three most basal ones most extensive and confluent at the caudal border, on posterior surface basal half of femur white scaled, extreme base dark, apical part with one or two distinct white spots, few white scales at apex, remaining part dark and yellow scaled; tibia with numerous white spots, apically at the ventral side with a conspicuous patch of appressed golden hairs, which involves also the base of t. I; tarsal segments with white-scaled base, t. I with a white patch at the middle in addition to the white scaled base. Tergites dark brown, I and II with small, median, yellow patches, II-VII with more or less hook-shaped white, lateral spots, especially in the distal tergites, VIII almost entirely white; sternites with yellow scales basally, white scales in a transverse, broad band in the middle, dark scales apically; comb on eighth abdominal segment consisting of a central group of nine teeth, close to each other, the central one boldest and a lateral group at each side of six to nine hook-shaped teeth, the most distal one smallest, the third lateral one from median group largest. Male. Antennae plumose; palpi one segment longer than proboscis, dark brown scaled, few lighter scales present, long segment with two white bands, subapical segment with basal white band and white, longitudinal line on under-surface, apical segment entirely white.

Larva. Head: twice, or slightly more, broader than long, conspicuously rectangular-shaped; hair A fairly small, 9 to 11 broadbased, frayed branches, implanted on a tubercle; hair B smaller, up to seven branches, bare; hair C very small, two to four branches, bare, about as far caudally as hair B; preclypeal spines large and prominent; antennae distinctly longer than the head, slightly curved inwards, basal half smoky (in some specimens two smoky bands, one at base and one at insertion of antennal hair), covered with spicules up to base of subapical hairs, antennal hair many-branched, distinctly frayed, about $\frac{1}{2}$ to $\frac{3}{4}$ times the length of antenna, subapical hairs long and bare, antennal apex blunt, two tiny hairs and a flat, leaflike structure on top. Comb on eighth abdominal segment with two, $2\frac{1}{2}$ or three, rather long teeth; siphon index smaller than two; siphon broad, cone-shaped, apical part modified for piercing into and attaching to vegetable tissue, apical part completely black, saw-edged, a pair of spine-like long hairs on a protruding base just under saw structure, more apically a pair of long hairs, at extreme apex two inwards-curved short spines; anal segment as long as siphon, about twice as long as wide, laterally four pairs of hairs as long as width of segment, dorsal and ventral subcaudal tufts with 11 branches, bare, about as long as anal segment; lateral hair very small, inserted well away from the apical margin; anal papilla slightly shorter than segment, rather blunt (fig. 15).

BIONOMICS. Locally the adults of this species are pests biting after sunset but also in daytime in wet places in shade. They enter houses to obtain a bloodmeal but do so less freely than e.g. many *Culex* species or several anophelines. The larvae obtain their oxygen supply from the roots of water weeds. In the Sentani lake they were collected from *Pistia stratiotes* and *Hydrocharis asiatica* in a restricted area where the water proved to be heavily polluted with waste from native houses nearby.

DISTRIBUTION. New Guinea. Material was seen from Sentani lake, probably also (no males correlated) from Sabron Samon, Mijoko, Ia river, Bade, Frederik Hendrik Isl., Koerik, Merauke.

RELATION TO DISEASE. No definite records. Van Dijk (1958) did not obtain infective instars in a controlled infection with *W. bancrofti* in this species.

Mansonia (Mansonioides) papuensis (Taylor)

Taylor, F. H., 1914. Trans. ent. Soc. London, p. 201 (*Melanconion*).

Described from Lakekamu, Papua, New Guinea.

IDENTIFICATION. A rather small mosquito with black scaled wings, the wing scales only slightly asymmetrical; mesonotum without ornamentation; legs brown with yellow scales forming indefinite bands and patches.

DESCRIPTION. Adult female. Proboscis with apical third blackish brown, basal $\frac{2}{3}$ pale brown on under surface to near base, upper surface with numerous darker scales in between, apically only few dark scales, in the middle a creamy yellow band; palpi dark brown; occiput with many dark brown and sometimes a few greyish-yellow forked scales, with scattered small, narrow, curved, creamy yellow scales, behind laterally a patch of broad, flat, creamy yellow scales. Mesonotum covered with small, narrow, curved, golden-brown scales; scutellum with mid-lobe scaled as mesonotum, but paler, on lateral lobes there may be one or two hair-like scales; pleura dark, sternopleuron and mesepimeron with creamy yellow, flat scales; wings with but dark scales, the asymmetrical ones not so very much so, and not very broad; legs with front and mid-femora dark above, on undersurface with creamy yellow scales; hind femur dark above with yellow patches and scattered yellow scales, undersurface with basal $\frac{2}{3}$ creamy yellow; tibiae dark above, undersurface with basal $\frac{2}{3}$ creamy yellow; tarsi dark-scaled with indications of basal bands in t. 1 and t. 2 of mid- and hind legs; t. 1 of hind leg also has pale scales in the middle; the ornamentation of the legs is very variable, sometimes rather indefinite; in other specimens, however, more definite than described above. Abdomen with the tergites dark with creamy yellow lateral patches on II-VI, on IV very small. Sternites II-VI creamy yellow.

Male only recently described (Peters, 1958), larva still unknown.

BIONOMICS. *Mansonia papuensis* occurs as very annoying pests in many swampy places of especially southern New Guinea. In spite of the extreme abundance of the adult females, males have been occasionally collected only and larvae still never have been found. Probably they have to be sought on the roots of swamp grasses. This species typically bite in the early evening hours; relatively very few specimens attack after 21.00 h.

DISTRIBUTION. New Guinea. Material was seen from: Misool (Limalas), Inanwatan, Kasoeeri, Berau, Jamoer lake, Fakfak, Meervlakte, Pionier bivak, Vanderwilligen river, Sentani lake, Tami river, Mijoko (Mimika), Uwoes (Asmat), Gemikja, Tanahmerah, Digoel-Kaoh river, Bade, Merauke, Kimaan, Teri-Kalwa (Fred. Hendr. Island).

RELATION TO DISEASE. Van Dijk (1958) records in controlled infections an initial rapid development of *W. bancrofti* in this species but the subsequent development into infective instars seemed a difficult process, though not an impossible one. The biting habits may hamper its effectiveness as a vector.

Mansonia (Mansonioides) uniformis (Theobald)

Theobald, F. V., 1901. Mon. Cul. 2, 180 (*Panoplites*).

Described from Quilon, Travancore, India.

IDENTIFICATION. Wings much speckled, pale scales broad and asymmetrical; longitudinal stripes of greenish-silvery scales on mesonotum (fig. 14). In the larva head hair B is almost similar to A.

Mansonioides larvae are not so easy to identify specifically, the best procedure is to breed them to the adult phase.

DESCRIPTION. Adult female. Proboscis with a dull yellow to greyish brown band just before labella, followed proximally by a dark band often not sharply defined on distal margin, more proximally a bright yellow area as far as the dark brown basal band; palpi slightly less than $\frac{1}{3}$ of length of proboscis, with brown and yellow scales, the latter scattered or forming tiny patches apically, never, however, a well-defined pale patch at apex; occiput with creamy yellow, curved narrow scales, behind also dark-brown forked scales, laterally cream coloured flat scales present. Mesonotum with coppery brown scales and longitudinal stripes of pale green, silvery, curved, narrow scales (fig. 14); there may be also a median pale stripe; scutellum with similar pale scales, on lateral lobes they are sparse or even absent; pleura with patches of white, flat, broad scales on mesepimeron and sternopleuron; p.p.n. with very small, narrow, curved, pale scales; veins speckled with yellow and dark brown scales, the yellow ones broad and asymmetrical;

femora and tibiae with dark brown and creamy yellow scales, the latter scattered or forming small patches, irregularly spread; there is a tendency to form bands on the hind femora and tibiae mainly with white scales; t. 1 of all legs with creamy yellow or white band on middle and basally; t. 2 and t. 3 with creamy yellow or white bands basally; hind legs with t. 4 and t. 5 with similar bands. Male. The part of the proboscis which is bright yellow in the female, is brown with a speckling of yellow scales; palpi exceeding length of proboscis with $1\frac{1}{2}$ segment, dark brown with cream-coloured bands at base and on the middle of long joint, a cream-coloured stripe on under-surface of subapical segment, broadening basally. The stripes on the mesonotum are less distinct than in the female. Abdomen with the tergites dark brown, I with a yellowish grey, large median patch over the whole length; II and III with small, greyish yellow, basal, median, patches; II-III and V-VIII with yellow lateral patches mixed with few brown scales; sternites yellow with white, lateral, apical patches.

Larva. Head hair A and B rather similar in size, 5-7-branched, B is in any case very distinctly more developed than C, D and E very small. Two to three comb teeth present. The siphon is relatively short, index about $1\frac{2}{3}$; 4 or 5 hairtufts pierce the anal segment-ring laterally (fig. 14).

BIONOMICS. This species occurs in pest conditions in many swampy areas of New Guinea; it certainly is one of the most aggressive biters which is ready to attack at any time of day and night provided the humidity is high enough. In spite of the abundance of the adults, the larvae of this species were found in 1957 for the first time in New Guinea; they were collected from the roots of *Hydrocharis* and *Monochoria* species, rather common water weeds (Van den Assem & Metselaar, 1958). Later on *Pistia stratiotes* was also found to be an important host plant in New Guinea (as it is in many tropical countries).

Mansonia larvae are far more restricted in their local distribution than their host plants: a high degree of pollution seems necessary to make a breeding place attractive to these mosquitoes (Van den Assem, 1958^b, cf. Iyengar, 1938). The sessile way of life of the larvae is an advantage in relation to predators and must be understood as an adaptation reducing predation (Van den Assem, 1958^a).

DISTRIBUTION. From Africa via the Orient to Northern Australia. In New Guinea the species is recorded up to high altitudes: 7000 ft in the Baliem valley in the Central highlands. New Guinea material was seen from: Berau area, Fakfak, Jamoer lake, Nabire, Meervlakte, Bernhard camp, Mamberamo river delta, Bakoessa, Sarmi, Hollandia, Sentani lake, Ifar, Tami river, Genjem, Vanderwilligen river, Wanema, Ibèlè camp, Kaimana, Ajam,

Agats, Kepi, Obaa river, Tanahmerah, Bamgi ia district, Mappi-Nambeom district, Wagen Island, Toerai, Merauke, Koerik, Moeting, Kimaan, Teri-Kalwa, Bamol.

RELATION TO DISEASE. *Mansonia uniformis* is a very efficient carrier of *Wuchereria bancrofti* in New Guinea (contrary to other tropical countries where it is not). For more details see Ch. II and III.

Genus *Uranotaenia* Lynch Arribalzaga

Lynch Arribalzaga, F., 1891. Rev. Mus. La Plata 1, 375.

Very small and usually dark species. *Uranotaenia* may be distinguished from all other New Guinea genera by the very short anal vein of the wing which reaches the caudal wing edge still medially of the fork of vein 5 (fig. 3). In fact this genus may be distinguished from all other mosquitoes by the minute microtrichia on the wing membrane, which requires however a magnification of more than 100 to be noticed. In some species there are white-scaled areas on the wingveins. Palpi short in both sexes, male antennae plumose. Male tarsi ornamented with hairy scales in some species. The head hairs B and C of the larva may be modified into thick rodlike structures.

The larvae may be superficially mistaken for *Anopheles* larvae, because their siphon is very short and they have a habit of assuming a horizontal position in the water though not on the surface but close to it. Some species are abundant in rather polluted pools in sago swamps, others in shaded forest pools or water-filled coconut shells or tins. One species (*U. nigerrima*) is very common in cut bamboos.

Many *Uranotaenia* species are difficult to separate. The New Guinea species are still insufficiently known.

Uranotaenia atra Theobald

Theobald, F. V., 1905. Ann. hist. nat. Mus. Hung. 3, 114.

Described from Muina, T.N.G., New Guinea.

IDENTIFICATION. Bright blue markings on head, pleura and mesonotum and pale spots on the abdomen distinguish this small otherwise dark brown species.

DESCRIPTION. Adult female. Head with a border of brilliant blue or bluish white, flat scales along eye-margins, vertex with similar scales, behind these the scales are dark purple and on the nape a few upright forked dark scales; laterally from the vertex the blue scales are continued and form a patch. Palpi only slightly longer than the clypeus and of the same colour, viz. pale yellowish brown. Proboscis about as long as the abdomen, swollen at apex.

A p.n. with flat blue scales which vary from pale bluish white to azure blue in different light. Along the margin of the mesonotum in front of the wingroots is a line of bright blue, longish flat scales; scutellum brown with flat scales with purple iridescence. Integument of pleura dark brown on the part nearest the scutum, lighter on the part near coxae and on lower mesepimeron; a large patch of flat blue scales in middle of sternopleuron.

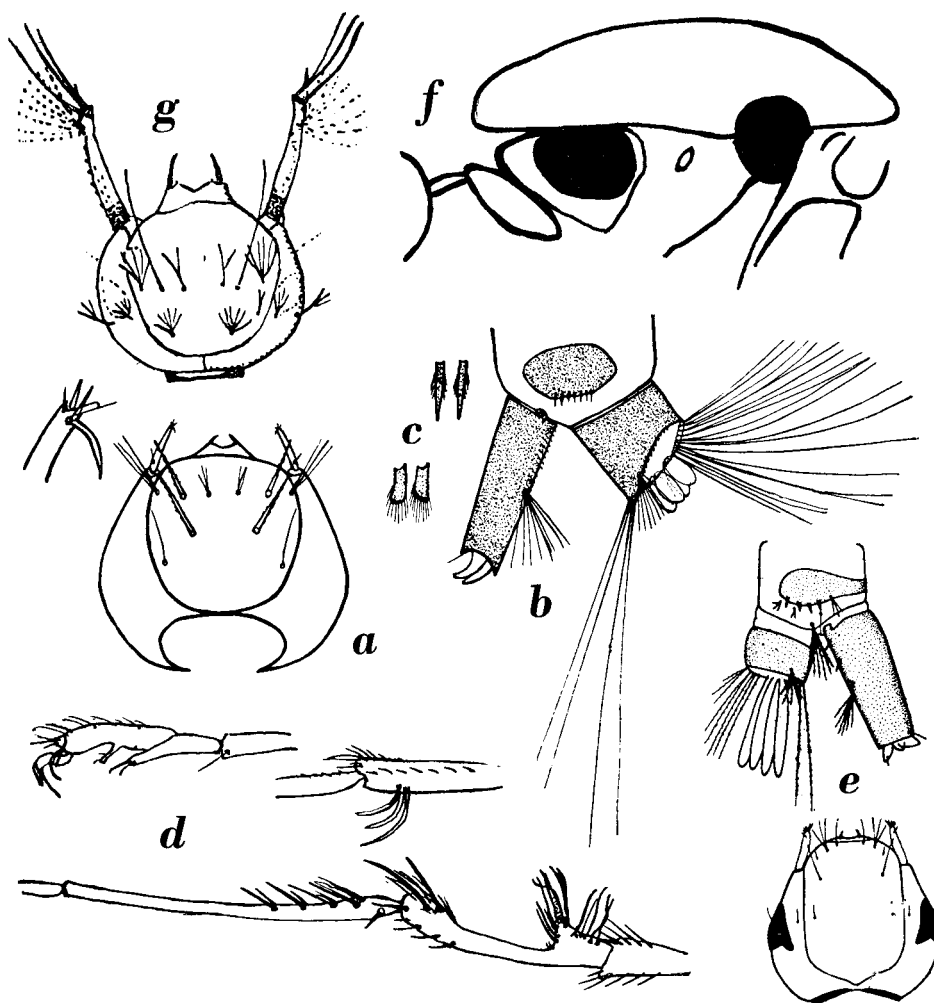


Fig. 16. *Uranotaenia atra* Theobald. A. Head of larva; tip of antenna (left). B. Terminal segments. C. Comb spines (above); pecten spines (below). D. Details of legs of adult male. *U. papua* Brug. E. Head of larva (below); terminal segments (above). *U. nigerrima* Taylor. F. Side view of thorax showing location of black spots on pleura. *Hodgesia quasisanguinae* Leicester. G. Head of larva. (E after Lee; G after Barraud).

Wings with dark scales, a f. very short; vein 6 short, the distal part curved abruptly towards the margin of the wing, which it reaches before origin of vein 2 and bifurcation of vein 5. Abdomen with brownish black tergites which have small lateral, apical, white patches, sternites mainly pale scaled. The ♂ is similar to the ♀ except that the antennae are plumose, the apex of the proboscis is more swollen and some of the tarsi are peculiarly modified (fig. 16). For the larva see fig. 16. Head hairs B and C finely frayed, modified as indicated in genus characters.

BIONOMICS. Breeding places usually earthen lined in fresh as well as in brackish water; also found in crab holes.

DISTRIBUTION. India and Ceylon to Queensland, Australia. New Guinea material was seen from Hollandia, Skou, Merauke.

RELATION TO DISEASE. None.

Uranotaenia nigerrima Taylor

Taylor, F. H., 1914. Trans. ent. Soc. London p. 203.

Described from Milne Bay, Papua, New Guinea.

IDENTIFICATION. Although without any special ornamentation of scales, this species is quite sharply marked off from the other Australasian *Uranotaenia*'s by having two pairs of conspicuous, large, velvet-black spots on the otherwise dark brown thoracic integument (fig. 16).

DESCRIPTION. Adult female. Head with white flat scales and numerous dark, brown, upright forked scales; proboscis black, hairy, apex with a creamy yellow tinge; palpi black. Thorax brown, densely clothed with brown, narrow, curved scales with a small median area in front of the scutellum nude, a row of brown bristles extending from the roots of the wings to the scutellum; prothoracic lobes brown, clothed with flat, pale scales and brown bristles; scutellum pale brown clothed with flat, brown scales; the deep black spots on the integument mentioned under identification stand out distinctly from the dark brown scales and bristles; legs brownish black, coxae and trochanter yellowish, femora pale beneath; wings with dusky brown scales on the veins and in the fringe. Abdomen entirely black, unbanded, truncate. Male similar to the female.

BIONOMICS. In the Hollandia district this species is very common in cut bamboos, coconut shells and rusty tins. Sometimes in small crevices in rocks.

DISTRIBUTION. New Guinea, including New Britain. Material was seen from Fakfak, Biak, Padaido, Pionier bivak, Tablanoesoe, Mamda, Ifar (400 m), Hollandia, Arso, Mainak (Mandobo distr.).

RELATION TO DISEASE. None.

Uranotaenia papua Brug

Brug, S. L., 1924. Bull. ent. Res. 14, 441.

Described from Pionier bivak, West New Guinea.

IDENTIFICATION. This species is mainly characterized by the presence of pale, somewhat bluish, flat scales on the anterior border of the mesonotum or pleura.

DESCRIPTION. Adult female. Head with broad, flat, mouse-grey, somewhat transparent scales, a white rim along border of and between the eyes. Antennae much longer than proboscis, palpi very short, one-ninth of length of proboscis. Abdomen short, truncate, dorsally with dark, bronzy black scales; venter dark brown. Larva, fig. 16. Head hairs normal, C trifid. Lateral chitinous plates of 8th abdominal segment continuous dorsally. Anal papillae at least twice as long as saddle. Siphon practically straight-sided, pecten teeth are smooth spines.

BIONOMICS. The larvae were collected in rusty tins and in a tin helmet, also in an inflorescence of *Curcuma* sp. Females were caught indoors on Upper Digoel.

DISTRIBUTION. New Guinea. Material was seen from Padaido Isl. (Geelvink bay), Pionier bivak, Hollandia, Mainak (Mandobo), Tanahmerah, Kimaan.

RELATION TO DISEASE. None.

Genus *Hodgesia* Theobald

Theobald, F. V., 1904. J. trop. Med. 7, 17.

The outstanding features of this genus are the remarkable wingscales (fig. 12). The species are all very small; if there is ornamentation this is brought about by broad, flat, silvery scales, usually on a p n . and pleura, sometimes on some abdominal tergites. The palpi are very short in both sexes; the antennae never plumose. As far as is known the larvae live in earthen lined, small water collections. The larvae are very small and essentially as those of *Ficalbia*, but on the whole the adults have a great resemblance to *Uranotaenia*.

Hodgesia quasisanguinae Leicester

Leicester, G. F., 1908. Stud. Inst. Med. Res. Malaya 3, 230.

Described from Kuala Lumpur, Selangor, Malaya.

IDENTIFICATION. A very small mosquito with shiny black mesonotum, covered with black scales. It is easily recognized by the large, lateral, silvery spots on abdominal tergites I-III and V-VI; those on V very large spreading on the dorsum, nearly touching medially; the fork cells are moderate, margins of eyes not broadly silvery.

DESCRIPTIONS. Adults. The scales on the occiput are all flat and broad, on the vertex a large silvery white patch and a small silvery spot on either side; a p n. blackish brown, covered with pearl white roundish scales, mesonotum black with black narrow-curved scales; pleura bronzy with a patch of silvery scales; all legs — except hind femora which are mostly all silvery white — dark brown scaled with purple reflections. Abdominal characters see above at Identification. Larval characters as illustrated (fig. 16). We were unable to find larvae in the field in New Guinea.

BIONOMICS. These small mosquitoes are vicious biters in the jungle; locally they can be a pest.

DISTRIBUTION. From Malaya eastwards to Australia. New Guinea material was seen from Inanwatan, ? Pionier bivak, Bernhard camp, Hollandia.

RELATION TO DISEASE. No records.

Genus *Aedomyia* Theobald

Theobald, F. V., 1901^a. Mon. Cul. 2, 218.

This genus is easily recognized by the shape of the antennae: they are $\frac{3}{4}$ the length of the proboscis, the segments are broad and compact in the female, slightly longer in the male. Palpi short in both sexes. Wings densely covered with broad, brown yellow and white scales, the white ones in patches together, the yellow ones scattered. The larva has the same peculiar habit as *Mansonia* and some *Ficalbia* larvae to hook themselves on to the tissue of waterplants. Whether they procure their oxygen that way is doubtful (cf. *Mansonia*).

Aedomyia catasticta Knab

Knab, F., 1909. Ent. News 20, 387.

Described from Bataan, Luzon, Philippines.

IDENTIFICATION. This species is, except by the genus characters as given above, easily recognized by the rather short legs; the dense covering of white, black and yellow scales; tufts of semi-erect scales at tips of mid- and hind femora. The larva has very large flat antennae with the antennal hair composed of frayed long branches; the subapical antennal hairs also very long and frayed. A small lateral plate on 8th abdominal segment to which the single row of comb teeth is attached along the posterior margin.

DESCRIPTION. Adult female. Antennae with very short hairs; palpi about $\frac{1}{4}$ as long as the proboscis, black with some scattered, white scales and a tuft of white scales at apex; clypeus with two rows of white scales along the median line; proboscis black with a white, subapical band, a white band about the middle and a white spot on upper surface between middle band and base of proboscis, some of the scales have a pale brown base which

gives the proboscis a speckled appearance; occiput with dark brown, cream-coloured, and white scales; brown scales on the nape, paler more in front; pale scales between the eyes; along the eyes smaller flat scales, brown and paler ones mixed, all scales on occiput more or less erected which gives it a roughened appearance. Mesonotum with brown, golden yellow, and white scales, the golden scales longer than the others, they produce a median, broad band which is much expanded about the wingroots, the small white and brown scales are scattered all over the mesonotum, many white ones on the prescutellar area; legs dark brown, much mottled and speckled with yellow and white scales, apical and basal pale bands on most of the tarsal joints. Abdominal tergites dark brown with large submedian, yellow spots in many segments and white, lateral patches; sternites brown with many scattered, white scales which may form bands; on the whole very variable.

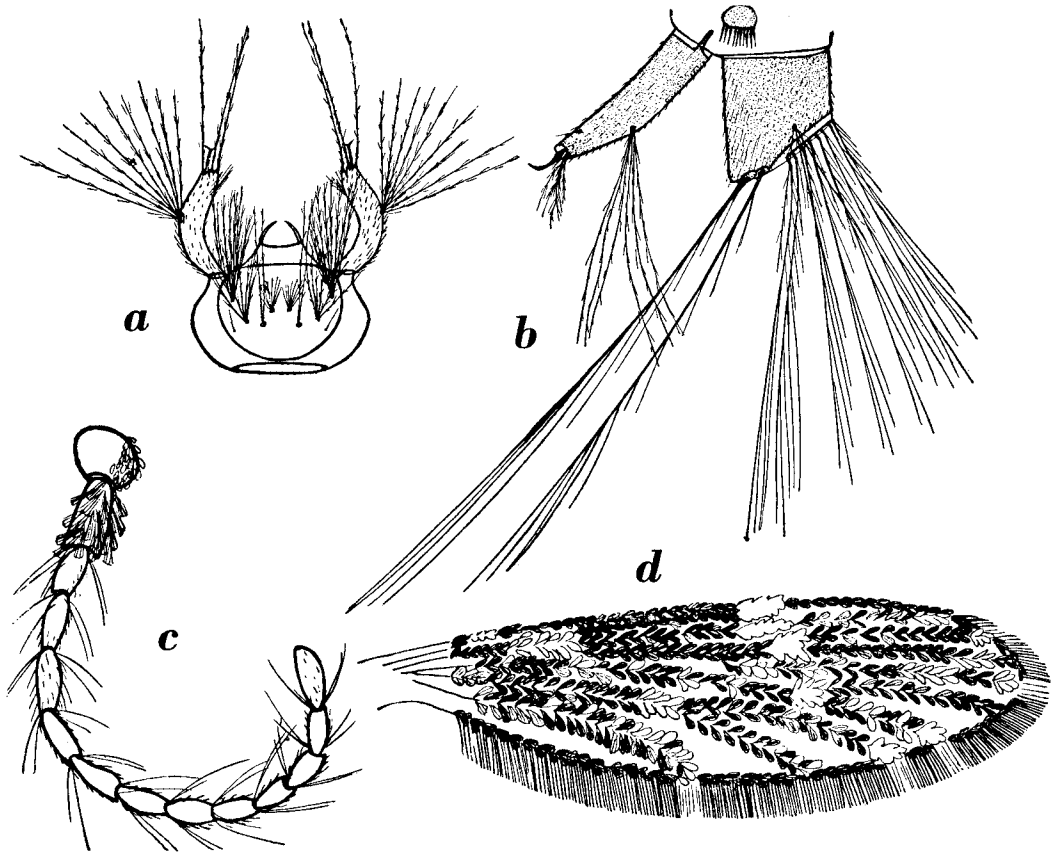


Fig. 17. *Aedomyia catasticta* Knab. A. Head of larva. B. Terminal segments. C. Antenna of male D. Wing.

Male. The antennae plumose, apical and subapical segments not much longer than the others. Larva, fig. 17. Though the siphon of the larva differs entirely from that of a *Mansonia* larva (and also from plant-tissue-piercing *Ficalbia*'s) it apparently has the habit of piercing with the strong curved spine at its tip.

BIONOMICS. Larvae have been found in pools and swamps with much vegetation (*Pistia stratiotes*, *Azolla* spec., *Utricularia* sp. and green filamentous algae). There is also a record of larvae breeding in wheel ruts. This may have been accidental. Adults are easily attracted by lamplight; they apparently do not bite man.

DISTRIBUTION. From India eastwards to New Guinea and continental Australia. Material was seen from Hollandia, Sentani, Demekau (Nimboran), Mamberamo river delta, Rombebai lake, Bakoesa, Homlikja, Koerik, Teri, Kimaan (Frederik Hendrik Island).

RELATION TO DISEASE. None.

Genus *Aedes* Meigen

Meigen, J. W., 1818. Syst. Besch. zweifl. Ins. 1, 13.

This genus is a conglomerate of heterogenous mosquitoes; a differentiation into subgenera is brought about mostly by making use of characters of male and female terminalia. The characters on which it can be decided whether a culicine is an *Aedes* or not are sometimes hard to find and in such cases it may be easier to examine the specimen for absence or presence of defining characters found in other genera.

In all *Aedes* larvae the antennae are relatively small, the antennal hair is implanted at about the middle. The siphon is stout and always bearing pecten spines and a single pair of hair tufts; the anal segment is not completely enclosed by chitin.

In this synopsis representatives of the subgenera *Mucidus*, *Finlaya*, *Ochlerotatus*, *Stegomyia*, *Aedimorphus* and *Aedes* are dealt with.

Subgenus *Mucidus* Theobald

Theobald, F. V., 1901b. J. trop. Med. 4, 235.

Large and conspicuously ornamented mosquitoes. Characteristic in this subgenus is a dark cloud over the cross veins of the wing on the membrane. The female carries the abdomen curved forward beneath the thorax. The larvae are predators, feeding on other mosquito larvae; the mouth-brushes have been modified accordingly.

Aedes (Mucidus) aurantius (Theobald)

Theobald, F. V., 1907. Mon. Cul. 4, 280 (*Pardomyia*).

Described from Kuching, Sarawak, Borneo.

IDENTIFICATION. In this species the characteristic dark spots over the cross veins of the wings are clearly exhibited. *Aedes aurentius* is largely orange coloured, an exceptional colour in mosquitoes. Some species of the subgenus *Coquilletidia* of *Mansonia* are orange as well, but they are smaller and almost always have a distinct purple tinge while the wings are more densely scaled and the clouded spot on the crossveins is lacking. Modified mouthparts in the larvae are also found in *Toxorhynchites* — in this genus pecten spines are absent — and in *Culex* subgenus *Lutzia*, which has a siphon with a row of numerous hairs contrary to *Aedes aurentius* where only one pair of hair tufts is present on the siphon.

DESCRIPTION. Palpi of the female barely a quarter of the length of the proboscis; scales on vertex and scutellum narrow. P p n. with 10-16 bristles, few or none towards the dorsal margin, however; lower mesepimerals present; tarsus 5 of the hind legs whitish. Male similar to the female in most respects.

In the larva the siphon is more or less cylindrical with many pecten spines present from base to well beyond middle; dorsal and ventral sub-caudals both long and single; comb scales on segment VIII in a large patch (fig. 18).

BIONOMICS. Females of this species are fierce biters in the evening and at night. Locally the species can be very common. Larval breeding places are ground pools, frequently rather open grass-grown pools in swamps.

DISTRIBUTION. From Sumatra to New Guinea. New Guinea material was seen from Hollandia, Skou-mabo, Sabron Samon, Manokwari, Inanwatan, Sisir, Koembe, Merauke, Torpedoboot river, Tanahmerah.

RELATION TO DISEASE. De Rook (1960) found that a dense population of this species at Inanwatan played no part in the transmission of *W. bancrofti* locally.

Subgenus *Finlaya* Theobald

Theobald, F. V., 1901b. J. trop. Med. 4, 235.

Adult has the occiput with many flat, broad scales and usually with a median line of narrow curved scales. Scutellum with flat, broad scaling. In the female the eighth abdominal segment is rather large and only slightly retractile; cerci short and broad. Palpi of the male at least half as long as the proboscis, usually longer, last two palpal segments bending towards the proboscis; tip of palpi hairy.

The larval characters are very variable in different species.

Aedes (Finlaya) argenteitarsis Brug

Brug, S. L., 1932. Bull. ent. Res. 23, 76.

Described from the Upper Digoel River, West New Guinea.

IDENTIFICATION. This species belongs to a group of the subgenus *Finlaya* where sexual dimorphism is rather marked in the ornamentation of head, thorax and (or) scutellum. The females of some species (e.g. *A. argenteitarsis*, *subalbitarsis* King & Hoogstraal, *hollandius* King & Hoogstraal)

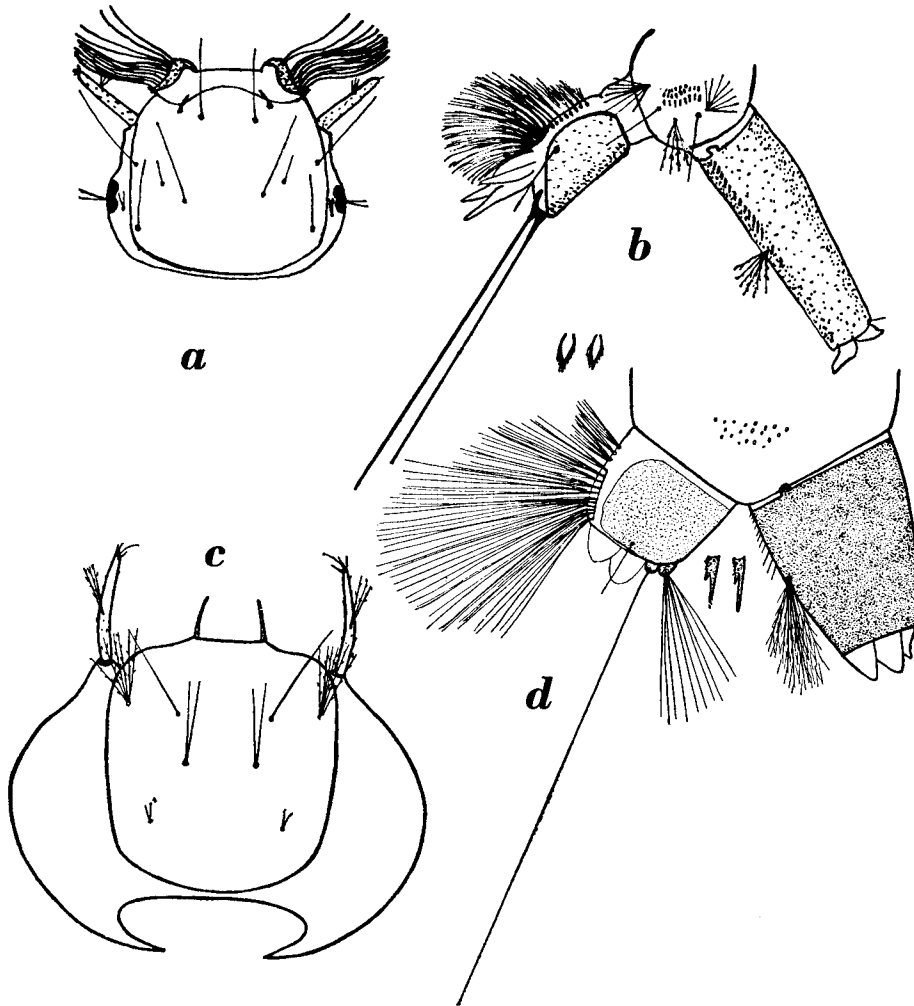


Fig. 18. *Aedes aurantius* (Theobald). A. Head of larva. B. Terminal segments. *A. vigilax* (Skuse). C. Head of larva. D. Terminal segments; comb spines (above); pecten spines (below).

have a rather narrow median scutal stripe and resemble the *scutellaris*-group of the subgenus *Stegomyia* in this respect. These *Stegomyia*'s (*A. scutellaris* and *albolineatus*), however, can always be easily distinguished by the broad, flat scaling on the scutellum. The main differences between *argenteitarsis* and *subalbitalarsis* are: mesonotal stripe tapered caudally, only mid lobe of scutellum white-scaled and most of tarsus 5 of the hind legs white scaled in the former species; stripe broader and gradually rounded caudally, all scutellum lobes with white scales and a narrow, basal band of white scales on tarsus 5 in the latter species. Males of the former species have a big patch of white scales centrally on the mesonotum, in the latter the anterior half of the mesonotum is entirely white scaled.

Aedes hollandius has all three scutellum lobes white scaled and tarsus 5 of hind legs almost entirely white.

The larva of *A. argenteitarsis* has the comb spines arranged in a single row; almost all other related species have a triangular patch of comb spines. Compare the identification notes on *A. novalbitarsis*.

DESCRIPTION. Adult female. Vertex with flat, black scales and a narrow, diamond-shaped patch of white, curved scales extending between the eyes, laterally a patch of flat, white scales; proboscis about as long as the abdomen; palpi short, $\frac{2}{11}$ length of proboscis, both proboscis and palpi dark brown. Mesonotum with small, dark brown, curved scales and a median stripe of small, white, curved scales; the stripe is one fifth as broad as the mesonotum and extending from near the anterior border to a line connecting the wingroots, the stripe ends tapering to a point; scutellum with small, white, curved scales on the midlobe and large black curved ones on the lateral lobes; a p n. with small white flat scales on the posterior surface; p p n. with a small patch of white, flat scales; a line of flat, white scales from the base of the wing extending forward not reaching the border of p p n.; wings with the scales dark brown, erected ones narrow; legs dark brown, t. 1 and t. 2 of front legs with basal white banding; femur of mid leg with an apical white band, a basal white band on t. 1 of mid leg and a white spot at base of t. 2; a white knee spot on hind femur and all tarsal segments with broad, white, basal bands, on t. 3-t. 5 occupying more than half the length of the segment. Abdomen dark brown, with a silvery-white, lateral band on the whole length of T. I and lateral basal spots on T. II-VI; S. II-VII brown with silvery-white lateral spots. Male. This differs from the female, according to King & Hoogstraal, in having a median scutal patch of white about half the width of the thorax and rather oval in shape anteriorly, tapering to a point posteriorly (fig. 21). It differs also in having white scales on the side lobes as well as on the mid lobe of the

scutellum. The larva is indistinguishable from that of *A. dobodorus* King & Hoogstraal, a related species not treated in this synopsis.

BIONOMICS. Adults of this species were never found to bite man. *Aedes argenteitarsis* seems to be the only New Guinea species that consistently prefers breeding in the small amounts of water, staying behind in leaves and bracts fallen to the forest floor. Larvae were collected from this type of breeding places in sago swamps and rain forest.

DISTRIBUTION. New Guinea. Material was seen from Ifar, Hollandia, Tanahmerah.

Aedes (Finlaya) josephinae Marks

Marks, E. N., 1958. Proc. R. Soc. Queensland 69, 58.

Described from Cape York Peninsula, N. Queensland, Australia.

IDENTIFICATION. This species belongs, together with *A. wallacei* Edwards, with another common, still undescribed species and several only partly known species, to the *kochi*-group of *Finlaya*. These are, like *A. kochi* itself, mosquitoes of a profusely spotted appearance. Unlike *kochi*, the markings on wings, legs and abdomen are largely creamy, yellowish or golden in these mosquitoes. The species differ in the adults, besides in important characters to be found in the terminalia, in the arrangement of spots and bands on wings and legs. In *A. josephinae* the segments 2 and 3 of the tarsi of the hind legs have only basal pale bands combined with the lack of an apical pale spot on tarsal segment 3 of the mid legs. In *A. wallacei* the apical pale patch is present.

The complicated taxonomic position of these species will be dealt with by Dr. Marks in a forthcoming paper.

DESCRIPTION. Adult female. Palpi about $\frac{1}{4}$ of the length of the proboscis, dark scaled with few pale scales at tip; proboscis with a light band medially and some light scaling at apex. Center of mesonotum dark scaled, an indefinite pattern of light scales laterally, over the wing roots, near the anterior border and towards scutellum; white-scaled patches on pleura; legs and wings with dark and light scaling. Abdomen with black, golden and white scales on tergites, sternites black scaled with outstanding scale tufts in S. VI and VII. Larva, fig. 19. Arrangement of head hairs as illustrated. Comb multi-spined; d s c. hair on anal segment 3-branched, v s c. bifid.

BIONOMICS. In some places on Frederik Hendrik Island and probably also in the Asmat district this species occurs as a terrific biting pest, together with the still undescribed related species. Females become active just after sunset and remain so all night and into the morning hours. Larvae are to be found in axils though we ourselves were unable to find them locally. Axils of sago palms are suspected harbouring them. Larvae of related spe-

cies were collected from *Pandanus* and keladi (mainly *Colocasia* and *Alocasia* species) and from a *Crinum*-like plant.

DISTRIBUTION. Since several species have proved to be included in what was earlier called *A. wallacei* the distribution records can not all be specified. *A. josephinae* is known to occur in New Guinea and N. Queensland. Material was seen from Teri-Kalwa, Jeobi and Koembe; probably also in the Asmat distr. (Uwoes). The wide-spread undescribed species was found in Teri-Kalwa, Jeobi, Hollandia and Sarmi. Other records of this group are Wandamen Bay, Kokonao, Hollandia.

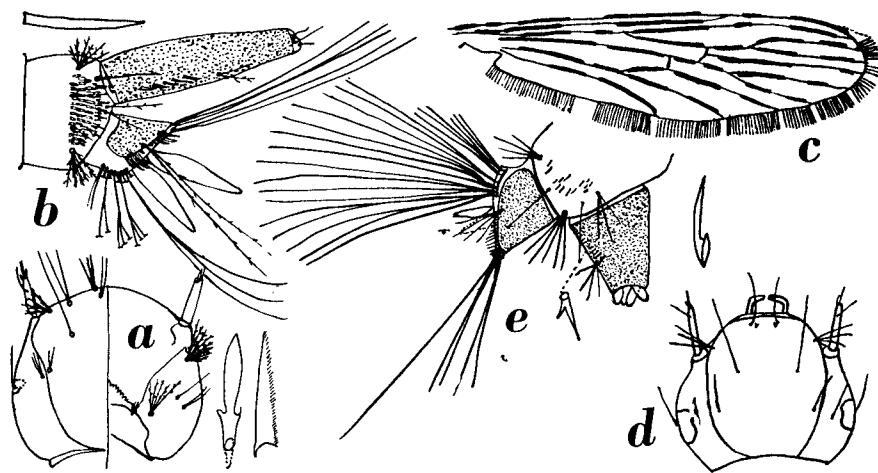


Fig. 19. *Aedes josephinae* Marks. A. Head of larva. B. Terminal segments. *A. kochi* (Dönitz). C. Wing. *A. notoscriptus* (Skuse). D. Head of larva. E. Terminal segments. (A, B after Marks).

RELATION TO DISEASE. No definite records; the group has to be observed closely since it may transmit *W. bancrofti* in Southern New Guinea localities.

Aedes (Finlaya) kochi (Dönitz)

Dönitz, W., 1901. Insekten Börse 5, 38 (*Culex*).

Described from Dreyer Hafen, T.N.G., New Guinea.

IDENTIFICATION. This species falls within the *Finlaya*-group with spotted wings, together with *A. josephinae* and a few other species not treated here. Proboscis with a distinct white band about the middle, wings with white to pale yellow speckling (fig. 19), femora and tibiae with many white rings; tarsi banded; abdomen with a pair of small white or yellowish patches on each tergite.

The speckled *kochi*-group species can be quite easily separated from other species with speckled wings, occurring in the territory, by the following characters:

Anophelines are slender and straight mosquitoes with a much greyer appearance and are speckled all over, not so much banded; palpi in the female long.

Mansonia species have broad and asymmetrical wing scales.

Aedomyia catasticta is smaller, speckled all over and has very particular antennae which readily characterize this genus.

Speckled-wing *Culex* species have their wings never so densely speckled; light bands on the legs, if present, are only to be found at the joints and a single light band on the proboscis, if present, at the middle.

DESCRIPTION. Adult female. Except the white band on the middle of proboscis there is also a narrow white band at apex; palpi black with white tip; narrow scales on occiput white, laterally from these are flat broad, black scales followed by flat broad, white scales; a black and white patch down the sides; on the nape scattered, black forked scales spreading a little in front. Mesonotum with pale, narrow scales forming more or less the following pattern: an indefinite band of narrow, curved scales along anterior and lateral borders, curving inward before implantation of wing and meeting a submedian pale line which runs parallel with a median white line from about the front margin to a patch of white scales in front of the scutellum; there are also patches of white scales laterally above the wing-root; a p.n. and p.p.n. with flat scales; p.p.n. with a few additional narrow, curved, white scales on the dorsal anterior area. Legs with all femora and front and mid tibiae with pale scales at apex and about six white bands; hind tibiae with four bands; tarsi of all legs with t. 1 apically and basally banded and with white scales in the middle part, t. 2 with band or patch, t. 4 entirely dark, t. 5 white; t. 3 of hind leg with apical band; on mid legs this band may be present or missing; t. 3 of front legs black. Larva, see fig. 20. Thorax and abdomen with prominent stellate setae. Preclypeal spines with two branches.

BIONOMICS. Adults of this species are fierce biters, especially in the evening and morning hours. *Aedes kochi* is a rather common pest in several places. Larvae can be found in leaf axils of several plants, e.g. *Colocasia* or keladi and sagopalm; also frequently in coconut shells. *Aedes kochi* has been recorded up to 3000 feet thus far in the Central highlands.

DISTRIBUTION. Molucca's to Queensland (Australia). New Guinea material was seen from: Salawati (Jefljo), P. Pam, Sorong, Fuog, Lake Ajamaroe, Berau, Poeragi, Manokwari, Mnoepisen (Padaido), Varami, Noem-

ba valley (Centr. highlands), Pionier bivak, Tablanoesoe, Janim, Sabron Samon, Hollandia, Ifar, Tami river, Arso, Kimaan, Teri-Kalwa, Selil, Merauke.

RELATION TO DISEASE. A vector of *Wuchereria bancrofti*; see Chapter III.

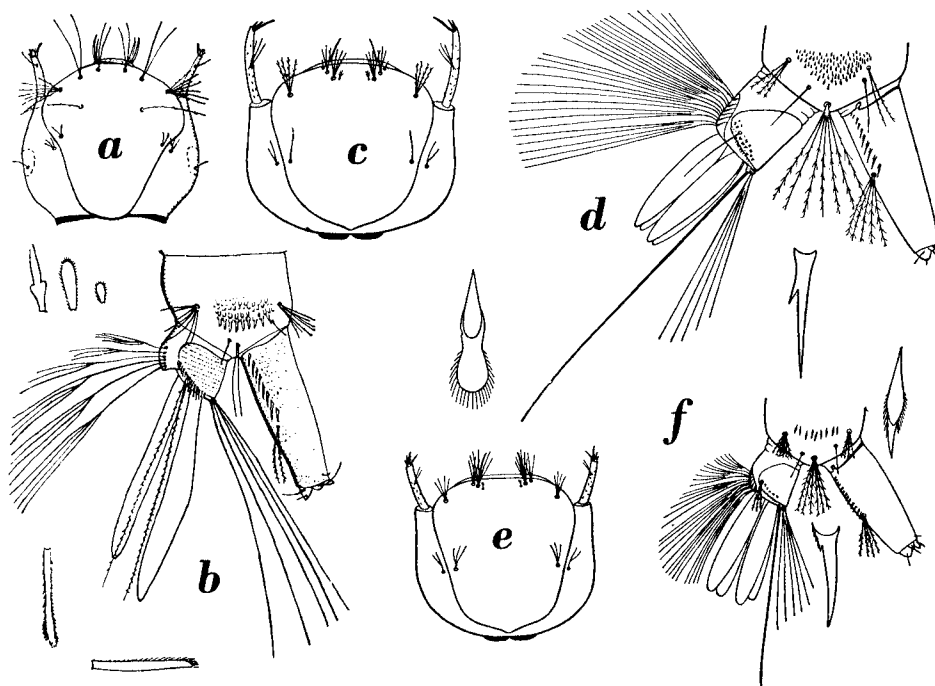


Fig. 20. *Aedes kochi* (Dönitz). A. Head of larva. B. Terminal segments; comb spines (above); pecten spines (below). *A. novalbitarsis* King & Hoogstraal. C. Head of larva. D. Terminal segments; comb spine (left); pecten spine (right). *A. subalbitarsis* King & Hoogstraal. E. Head of larva. F. Terminal segments; comb spine (above); pecten spine (below). (A, B after Marks; C-F after King & Hoogstraal).

Aedes (Finlaya) notoscriptus (Skuse)

Skuse, F. A. A., 1889. Proc. Linn. Soc. N.S.W. 3, 1738 (*Culex*).

Described from Sydney, Australia.

IDENTIFICATION. This black and white mosquito can be identified by the scutal markings: an ornamentation of distinct, narrow, longitudinal lines of pale scales (fig. 23). There is some reminiscence of the ornamentation of *Aedes aegypti*. In the last species however, the lateral lines are much broader and more regularly curved and the submedian lines much more distinct (cf. fig. 24).

DESCRIPTION. Vertex of head with a patch of silvery scales; there is a

white band present at about the middle of the proboscis. Scutal markings see fig. 23; scales on scutellum all broad and silvery-white; p p n. with broad scales only; no scales present on the postspiracular area; wings not spotted; femora, tibiae and tarsi dark, a silvery-white line along the anterior surface of femora and tibiae and silvery-white basal bands on all hind tarsal joints; t. 5 may be entirely white. In the larva the large, curved clypeal spines are very distinct. Siphon rather short, comb scales in an irregular patch, see also fig. 19.

BIONOMICS. This species is common and widespread in New Guinea but was met in pest quantities only once (in a small village on the south coast where an abundance of breeding places was available in bamboo fences). Larvae can be found frequently in rockpools, tree holes, bamboos, and tins.

DISTRIBUTION. From the Molucca's to Australia and New Zealand. New Guinea specimens were seen from Sorong, Fuog, Ajamaroe lake, Biak, Korkanao, Tablanoesoe, Ifar, Hollandia, Selil, Koembe, Merauke, Toerai.

RELATION TO DISEASE. Reported as a transmitter of MVE-virus in Australia.

Aedes (Finlaya) novalbitarsis King & Hoogstraal

King, W. V. & Hoogstraal, H., 1946b. Proc. ent. Soc. Wash. 48, 146.

Described from Lakekamu, Papua, New Guinea.

IDENTIFICATION. This species comes near *A. subalbitarsis*, *A. argenteitarsis* and a few more rare species not treated here. The main differences with *A. subalbitarsis* are as follows. The median silvery stripe on the scutum is anteriorly about a third the width of the thorax; posteriorly it is distinctly wider and bulbous and the scales along the sides of the stripe may be golden. In *A. subalbitarsis* the median silvery stripe on the scutum has the sides about parallel and it is rounded distally. Tarsal segment 5 of hind legs has a narrow basal band whereas in *novalbitarsis* this segment is entirely dark. For differences of these species with *A. argenteitarsis* and with some species of the subgenus *Stegomyia* with which they may be confused, see the identification of *Aedes argenteitarsis*. The scutal ornamentation of the males is similar in *A. subalbitarsis* and *novalbitarsis*.

DESCRIPTION. Adult female. Proboscis entirely black scaled; palpi almost one fourth of the length of the proboscis, black scaled; median area of vertex with narrow, silvery scales extending between the eyes, some golden scales at the margin. Scutal ornamentation as described above; scales of scutellum all white except for a few dark ones at base of mid lobe; some golden scales present on upper part of p p n. Abdominal tergites either with complete, narrow, basal bands on segments II to IV or V, or with long, narrow, basal, median spots on these segments. In the male the scutum is

largely pale scaled on the anterior half. Occasionally a specimen of this species may show a few white scales at the base of the fifth hind tarsal segment. Larva. Head: antenna about half as long as head, with scattered spicules; shaft hair long, arising near middle, with 2 to 4 branches; head hair A lightly plumose, with 3, rarely with 4 to 6, branches; B and C near front of clypeus, non-plumose, B with 3 branches, C with 4 to 6; D minute, about 4-branched; inner sutural hair single, outer double or triple. Abdomen: upper lateral hair of segment I with 2 or 3 branches, lower single, lateral hairs on II double or triple; III to VI with 2 to 5 branches; VIII with a dense, triangular lateral comb of about 50 elongate scales apically rounded and fringed; pentad hair 1 single or double; 2 and 4 single; 3 with 7 or 8 plumose branches; 5 with 2 or 3 broad branches. Siphon ratio about 2.5 : 1, the sides tapered, a prominent acus present; from 7 to 11 long, spine-like pecten teeth extending to about the middle of siphon, each with one large, and sometimes with one or two smaller, denticles; hair tuft arising about level with apical pecten tooth, with 6 to 8 plumose branches. Anal segment more than half covered by saddle, saddle covered with short rows of spicules that become much larger posteriorly; scattered setae also near posteroventral border; lateral hair single, rarely double; dorsal subcaudal hair tuft 5- or 6-branched, the ventral one single; anal gills equal, tapered to a blunt point apically, about 2 times length of saddle (fig. 20).

BIONOMICS. *Aedes novalbitarsis* is a rather common species in the Hollandia area. Most of the collections were from low elevations but the species was also taken a number of times by American entomologists from high altitudes in the Cyclops Mountains, up to the peak of Mt. Dafonsero (about 2200 m). No definite biting records were obtained; we never found females biting in localities where larvae were numerous. The species is a container breeder, most often present in small water collections as are tree holes, rock crevices, coconut husks, fallen bracts etc.

DISTRIBUTION. New Guinea. Material was seen from Tablanoesoe, Ifar, Hollandia.

RELATION TO DISEASE. No records.

Aedes (Finlaya) papuensis (Taylor)

Taylor, F. H., 1914. Trans. R. ent. Soc. Lond., 193 (*Leucomyia*).

Described from Milne Bay, Papua, New Guinea.

IDENTIFICATION. A black *Aedes* with the anterior half of the mesonotum almost completely white scaled; additional pale markings on head, tarsi and abdomen. *Aedes papuensis* belongs to a group of many closely related New Guinea species of which only *A. novalbitarsis* is dealt with in more details (for diagnostic differences see p. 86).

DESCRIPTION. Head of male entirely white scaled, in female medially white with black sublateral patches. Anterior half of mesonotum white scaled, flat, white scales on dorsal part of pronotal lobes; pale and black scales on scutellar lobes. All tarsal segments in the hind legs with broad, basal, white rings. Abdomen with basal, white bands on segments II-V. Larva, fig. 22.

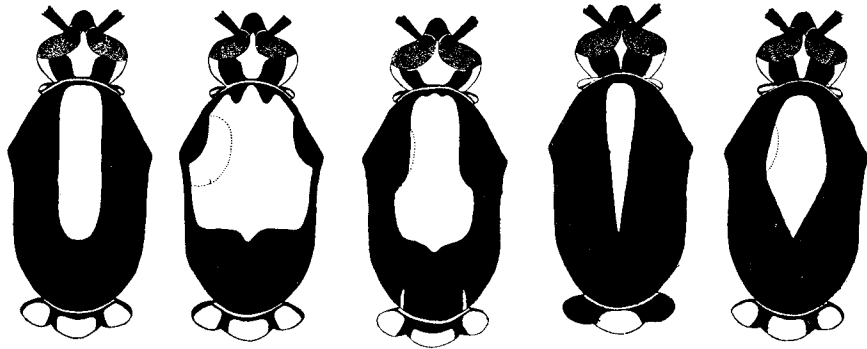


Fig. 21. Mesonotal ornamentation of (from left to right): *Aedes subalbipennis* ♀; *A. subalbipennis* ♂; *A. novalbipennis* ♀; *A. argenteipennis* ♀; *A. argenteipennis* ♂. (After King & Hoogstraal).

BIONOMICS. Females of this species were found biting occasionally. Larvae were collected from different types of containers: tree holes, bamboos, tins and rock pools. They were invariably present in dirty flower bowls on the municipal cemetery at Hollandia.

DISTRIBUTION. New Guinea. Specimens were seen from Hollandia, Ifar, Tami river, Tablanoesoe and Albatros bivak.

RELATION TO DISEASE. No records.

Subgenus *Stegomyia* Theobald

Theobald, F. V., 1901b. J. trop. Med. 4, 235.

Mesonotum with black and white ornamentation; tarsi with white bands; proboscis black; wings dark scaled; occiput and scutellum with mainly broad, flat scales except in *Aedes (Stegomyia) albolineatus* which has a patch of narrow scales between the eyes. Palpi of the female short, in the male about as long as the proboscis, curved upwards and not hairy. In *A. albolineatus* the palpi of the male are less than half the length of the proboscis. The general characteristics of the larvae are: antennae usually smooth, with a simple hair on the shaft, and rather short; hairs B and C placed in front of the others. Meso- and metapleural plates usually carry a spine. Comb teeth usually in a single straight row. Siphon short, no acus; pecten without

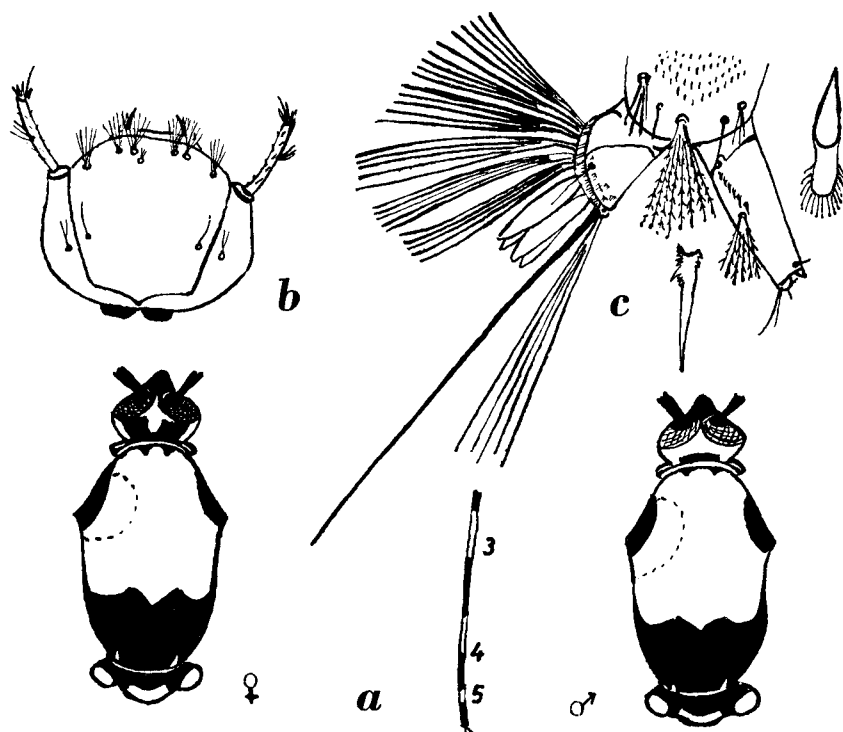


Fig. 22. *Aedes papuensis* (Taylor). A. Dorsal view of head and thorax; distal hind tarsal segments. B. Head of larva. C. Terminal segments; comb scale (above); pecten spine (below).

detached teeth apically, tuft well before tip of siphon; anal saddle usually rather small; ventral brush of anal segment often much reduced.

Most *Stegomyia* species are day-biters. The breeding places usually are containers of one type or another, less often earthen lined. The eggs are resistant to dessication as soon as the larva has developed inside the shell.

Aedes (Stegomyia) aegypti (L.)

Linnaeus, C., 1762. In Hasselquist's *Reise nach Palästina*, p. 470 (*Culex*).

Described from Egypt.

IDENTIFICATION. An easily distinguished species with a lyre-shaped ornament on the mesonotum (fig. 24), basally banded legs and in the female broad, white scales on the clypeus.

Adults of *Aedes (Finlaya) notoscriptus* have sometimes been mistaken for *Aedes aegypti* because of their thoracic ornamentation.

DESCRIPTION. Proboscis black; palpi black, about one fifth the length of the proboscis, tip very broadly white scaled. A p n. with a large patch of

silvery white scales, many black bristles present; mesonotum clothed with narrow curved, golden scales, bronze or brassy brown scales, silvery white rather broad, flat lying scales and somewhat narrower curved, white scales; all these scales together form a lyre-shaped pattern as in fig. 24, the strings of the lyre are pale golden, the curved lines silvery white; ante-scutellar space edged with white, a short median, very light, yellowish stripe before ante-scutellar space; a white patch at roots of wings; scutellum densely clothed with silvery white scales, except apex of mid lobe, which is brown scaled; pleura brown, clothed with patches of silvery white, flat scales; wings with brown scales; legs: femora black, more than basal half of hind legs whitish beneath, of front and mid femora about basal half, the white scales on hind femora also in front and rear; hind tarsi with rather broad, white rings at base of joints, very broad on t. 4 and t. 5, last joint entirely white or almost so; front and mid tarsi with white incomplete rings at bases of first two joints only, last joints with coppery reflection. Abdomen black with dorsally a slight greenish reflection and white markings; ventrally mostly yellowish to silvery-white.

Male. Antennae plumose, palpi exceeding the length of the proboscis by half the last joint, slender, uniform, black with four white incomplete bands situated at base and middle of long joint and at bases of last two joints, the one at middle of long joint broad, those on long joint mostly on upper surface, those on subapical joints on lower surface. Colouration otherwise similar to that of the female.

Larva. Head rounded, wider than long, widest at eyes; antennae small, cylindrical, slightly curved, smooth, a single hair at middle; a very long hair, a spine, a flattened appendage and a small digit at apex. For head hairs see fig. 23. Lateral comb of the eighth segment (fig. 23) of eight to eleven scales in a single row; the scales elongate, a long apical spine and curved stout ones more basally, decreasing in length. Siphon stout, strongly tapering on outer half, less than twice as long as wide at base; pecten of about 14 teeth running nearly half way from base to apex, followed by a single tuft of three hairs; single pecten tooth a rather long spine with small denticles at the basal part; anal segment about as long as wide, not ringed by the plate, i s c. with a long hair and a shorter one, o s c. long, single; 1 h. almost as long as segment, double; ventral brush moderate; anal papillae long, the tips rounded.

BIONOMICS. This mosquito has attained a high grade of domestication. It is the easiest mosquito to breed; for experimental purposes any desired number can be cultivated. Its breeding places are only exceptionally earthen-bound, rarely vegetable, and mostly artificial. The latter may be very small,

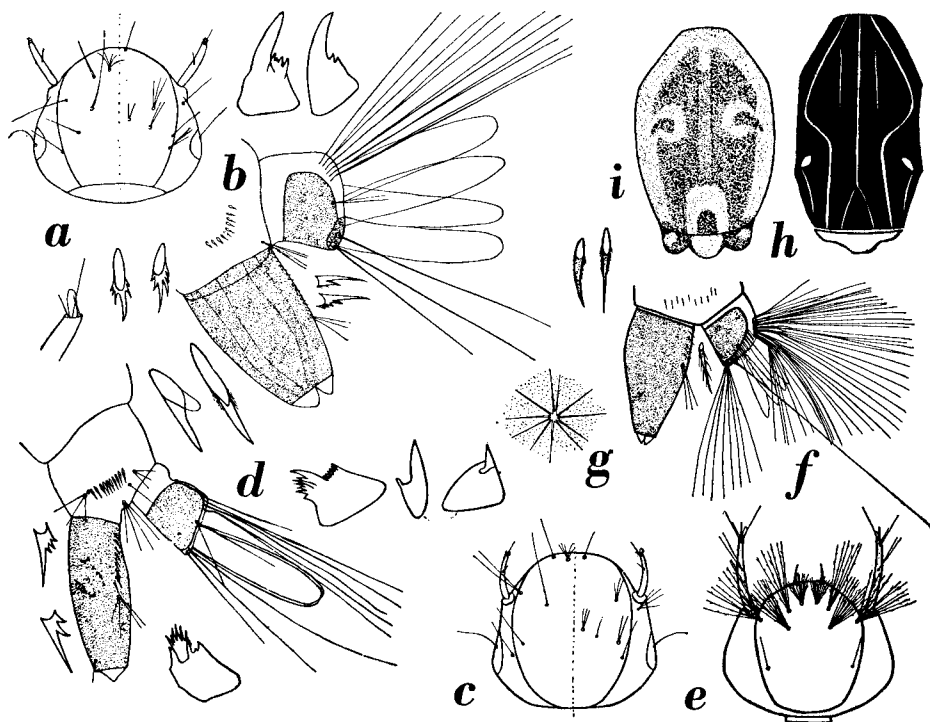


Fig. 23. *Aedes aegypti* (L.) A. Head of larva; dorsal half left, ventral half right. B. Terminal segments; comb spines (left); pecten spines (right). *A. scutellaris* (Walker). C. Head of larva; dorsal half left, ventral half right. D. Terminal segments; comb spines (above); pecten spines (below). *A. albolineatus* (Theobald). E. Head of larva. F. Terminal segments. G. Stellate hair of body. *A. notoscriptus* (Skuse). H. Mesonotal ornamentation. *A. lineatus* (Taylor). I. Idem. (I after King & Hoogstraal).

containing only some ml of water. Any container may serve, no matter it is of wood, concrete, cement, brick, tin or any other metal, porcelain, glass, earthenware, etc. Larger breeding places are roof-gutters, cisterns, water-tanks, bathroom tanks, etc. The food for the larvae is often furnished by leaves or other organic matter. To the vegetable breeding places of *A. aegypti* belong bamboo stumps, but larvae in this position are exceptional. They have been repeatedly demonstrated in rotholes in trees, but they have never been recorded from tree holes in the region under consideration. Whether the breeding place be artificial or natural a certain amount of contamination is needed to make it attractive for egg-laying. Breeding places are usually situated very near inhabited houses. Eggs can be kept dry for a long period and may be sent by mail without precautions. It is rare that anyone is bitten by *A. aegypti* outside a house; man is mostly preferred as a source of blood, but animals (birds, mammals) are not rejected. It is

mainly a daytime feeder, but in lamplit rooms and even in dark rooms it has been observed to bite man.

DISTRIBUTION. In the tropics all over the world. In the Western part of New Guinea of a very restricted distribution. Material was seen from Teminaboean, Saga, Poeragi, Inanwatan (Vogelkop), Soesoenoë and Kaimana (Kaimana distr.). So far it is absent from all larger settlements.

RELATION TO DISEASE. One of the most efficient carriers of yellow fever (not endemic in New Guinea) and dengue.

Aedes (Stegomyia) albolineatus (Theobald)

Theobald, F. V., 1904^a. Entomologist 37, 77 (*Scutomyia*).

Described from Kuala Lumpur, Malaya.

IDENTIFICATION. A black and white mosquito with a distinct median white line on the mesonotum (fig. 24), a very large white patch on the pleura, and the last two hind tarsal joints dark throughout (cf. *A. (S.) scutellaris*).

DESCRIPTION. Adult female. Occiput medially clothed with a broad, perfectly straight line of broad, flat, silvery-white scales which have a distinct blue shine in certain lights; in front the median white line continues as a triangular patch of narrow silvery-white scales; antennae densely scaled on inner surface; proboscis dark, as long as or longer than the abdomen, very slender; palpi short, dark scaled throughout. A p n. black with narrow, long, and broad, dusky brownish scales; mesonotum clothed with narrow, curved, brownish-black scales, except for a broad line of silvery-white scales medially (fig. 24); scutellum covered with broad, flat scales, black on lateral lobes and on extreme tip of mid lobe, remaining part of mid lobe silvery-white scaled; pleura blackish with a large elongated patch of silvery-white, broad, flat scales near margin of mesonotum and a much smaller patch on hind margin of lower sternopleuron; scales on wing veins dark; hind leg: tarsi dark scaled, t. 2-t. 3 with a silvery-white basal spot above. Abdomen black scaled with bronzy lustre; tergite V with a few scattered silvery-white scales basally; VI and VII with a rather narrow, silvery white, basal band; on I-IV large lateral, silvery-white, basal patches, the patch on VII (if present) very small; as far as visible all segments ventrally with basal white bands.

Male. Antennae with last two joints long, no conspicuous whorls present on these segments. Palpi shorter than half the length of the proboscis, very slender, black scaled. Colouration similar to that of the female. Larva. Head hairs see fig. 23. Siphon cone-shaped, few pecten spines present; d s c. 8-branched, v s c. single, very long; the entire larval body is covered with multiple tufts of short, stout spines.

BIONOMICS. In New Guinea a jungle mosquito which does not seem to feed on man. Larvae were collected from container breeding places such as cut bamboos, tree holes, small rock crevices. Locally it is a quite common species.

DISTRIBUTION. From Formosa and India to the Solomons. New Guinea material was seen from Sorong, Biak, Pionier bivak, Genjem, Hollandia.

RELATION TO DISEASE. None.

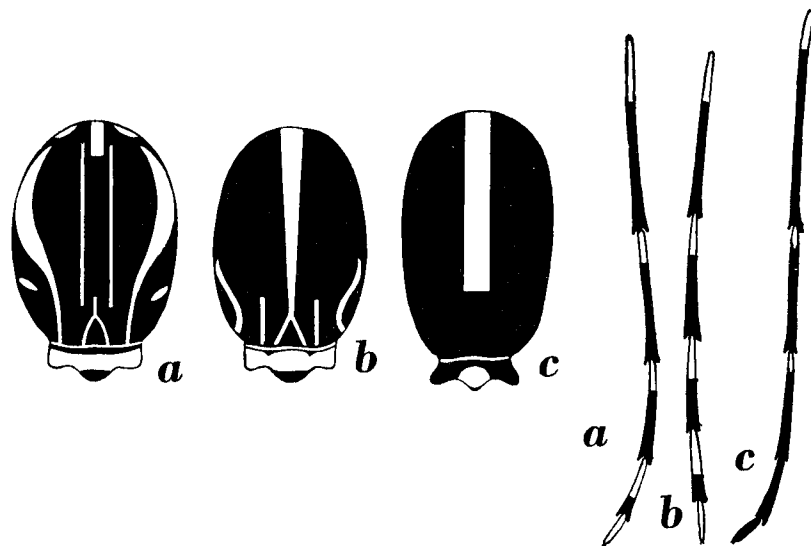


Fig. 24. Mesonotal ornamentation and hind tarsi of A. *Aedes aegypti*. B. *A. scutellaris*. C. *A. albolineatus*.

Aedes (Stegomyia) scutellaris (Walker)

Walker, F., 1859. Proc. Linn. Soc. London, 3, 77 (*Culex*).

Described from the Aru Islands.

IDENTIFICATION. A well-marked species with silvery-white stripe on the mesonotum (fig. 24) and sharply defined, silvery white lines on the pleura. Head, abdomen and legs with silvery ornamentation.

The related *Aedes albolineatus* is differentiated by missing the white lines on the pleura but having a large white spot instead. Some *Aedes (Finlaya)* species (e.g. *novalbitarsis*, *argenteitarsis*) have a more or less similar mesonotal ornamentation. These species are differentiated by missing the distinct, flat scales on the scutellum; their males always have the anterior part of the mesonotum largely white scaled.

DESCRIPTION. Adult female. Palpi dark brown, about half the palpi silvery-white scaled, above apically, beneath very little white scaling apically. A p n. with a conspicuous line of silvery white, rather broad, slightly elon-

gated scales, running more or less diagonally from front margin backwards where it is continued as one of the white lines on the side of the thorax; mesonotum covered with dark, golden brown, narrow curved scales, adorned with light markings as in fig. 24; pleura greyish black with definite lines of silvery white scales: wings dark brown scaled: legs with apical parts of hind tarsi white, t. 5 entirely white. Abdomen covered with brown scales and white markings.

Male. Palpi with two silvery white patches on long segment above, viz. a larger one on basal fourth, partly going all round, a smaller beyond middle, a tiny spot on base of next joint below, a small one on base of last joint below. Abdomen as in the female, but VII dorsally dark scaled, lateral white ornamentation present; VIII dorsally entirely white scaled. Ventrally II-VI dark with a white basal band; VII dark, with some white scales at apex; VIII dark throughout. Larva. Antennae curved, small; head hairs A bifid, B and C single (fig. 23). Comb scales on 8th abdominal segment in a single row, comb comprising about 10 scales with sharply pointed apex. Siphon cylindrical, about $2\frac{1}{2}$ -3 times as long as wide; pecten inserted from base to about halfway; d s c. single, v s c. bifid.

BIONOMICS. This species is one of the day-biting pests of New Guinea villages in the lowlands. *Aedes scutellaris* is a typical container breeder using the most different objects, such as bottles, tins, shells, cement drains, beached canoes, tree holes, rock pools, cut bamboos, hollow coconuts, etc. The larva is able to survive in very little water indeed. An interesting population on Ceram was observed by one of us (B.-W.), it did not feed on man.

DISTRIBUTION. From Hainan, the Philippines and Moluccas to Australia and the New Hebrides. New Guinea material was seen from P. Pam, Sorong, Manokwari, Teminaboean, Inanwatan, Fakfak, Argoeni bay, Kaimana, Wandamen bay, Weinami, Seroei, Padaido, Sarmi, Genjem, Hollandia, Tami river, Pionierbivak, Kokanao, Tanahmerah, Kimaan, Selil, Koembe, Merauke.

RELATION TO DISEASE. In New Guinea the species has been discriminated as a vector of dengue. Related forms on Pacific Islands are vectors of *W. bancrofti*.

Subgenus *Ochlerotatus* Lynch Arribalzaga

Lynch Arribalzaga, F., 1891^a. Rev. Mus. La Plata, 2. 143.

This subgenus is difficult to separate from the subgenus *Aedimorphus*. They have many characters in common: numerous narrow, curved, and forked scales on occiput; palpi of the male long with hairy apex and both last segments curved downwards (towards proboscis). In *Ochlerotatus* the eighth abdominal segment of the ♀ is wholly retractile, the cerci are long and

narrow, in *Aedimorphus* the eighth abdominal segment of the ♀ is either partly or wholly retractile; the cerci are variable.

Aedes (Ochlerotatus) vigilax (Skuse)

Skuse, F. A. A., 1889. Proc. Linn. Soc. N.S.W. 3, 1731 (*Culex*).

Described from Gosford, N.S.W., Australia.

IDENTIFICATION. Femora and tibiae speckled, abdomen with basal bands; mesonotum without definite ornamentation; tarsi of hind legs banded; palpi of male turned slightly downwards; undersurface of proboscis cream coloured from near base to just beyond middle, apical part very dark. No pale scales present on the dark apex; the separation between the pale and dark part is very definite (fig. 28). This is the most important ornamental character by which this mosquito can be distinguished from *Aedes vexans*. The character of the shorter female palpi in *A. vigilax* is unreliable as in both species (*vexans* and *vigilax*) the female palpi have a variable length.

DESCRIPTION. Adult female. Proboscis on underside as in fig. 28 where it is compared with that of *A. vexans*, on upper surface there are yellow and dark brown scales very variably distributed; palpi dark brown with pale yellow apex; occiput with small cream-coloured and dark brown forked scales in the centre, laterally alternating bands of cream-coloured, black and again cream-coloured, flat scales. Mesonotum with brown, shining, curved, narrow scales; these scales become gradually paler towards anterior margin and towards scutellum until there are golden coloured scales; pleura dark brown with patches of cream coloured, flat scales; wingveins dull brown scaled, often with dirty yellow and pale brown speckling, which, however, may be entirely absent; legs dark brown with cream coloured ornamentation, femora and tibiae speckled on outer surface, femora pale on inner surface, tarsi with basal bands on front legs on t. 3, on mid legs on t. 4 and on hind legs on all the joints. Abdominal tergites with cream-coloured, basal bands on II-V (or II-IV, or II-VI) and cream-coloured, apical bands on V-VII or VI-VII; sometimes these segments entirely dark; white, lateral patches at equal distances from base and apex of each segments; sternites white. Male. Proboscis and palpi as in *A. vexans* (see p. 99). T. VIII either completely dark or with incomplete basal, pale bands. Otherwise as in the ♀. Larva as in fig. 18. The saddle of the anal segment only slightly chitinized.

BIONOMICS. Usually in salt or brackish water, but not uncommon in fresh water. Usually in earthen-lined breeding places; but they have also been found in a hole in mangrove trees, in large stone jugs; in tidal swamps, which had no surface connection with the sea and from which all visible water disappeared during low tide. Apparently the larva can live without water for

a number of hours in a moist soil. The adult female is a good flyer, she attacks man and may be very troublesome.

DISTRIBUTION. Along coasts from Formosa and Siam to Australia and New Caledonia. Material was seen from Sorong, Wamal and Merauke.

RELATION TO DISEASE. In New Guinea presumably of no importance. It is reported as a good carrier of *W. bancrofti* in New Caledonia.

Subgenus *Aedimorphus* Theobald

Theobald, F. V., 1903. Mon. Cul. 3, 290.

The species in this subgenus have various ornamentation, but the scales on the posterior pronotal lobes are never broad and flat. Proboscis usually distinctly longer than the front femora; palpi of the male about as long as proboscis, last two segments more or less swollen and hairy, turned downwards; last segment often shorter than penultimate and sometimes much reduced. Lower mesepimeral bristles absent. Eighth segment of ♀ abdomen partially or wholly retractile, cerci variable. The larvae have the antennae usually with spicules on the shaft and the hair branched. Frontal hairs B and C variable in position, sometimes placed almost side by side, usually branched. Comb-teeth usually numerous, in a triangular patch. Siphon usually longer than in *Stegomyia*, index often 3 or more; pecten usually with detached teeth outwardly. Ventral brush well developed. Siphonal tuft usually distinctly beyond middle.

Nearly all the species breed in temporary ground-pools, a few in crabholes or in treeholes. Many are active bloodsuckers, *A. vexans* is a serious pest in many parts of the world.

Aedes (Aedimorphus) alboscuteUatus (Theobald)

Theobald, F. V., 1905. Ann. hist. nat. Mus. Hung. 3, 80 (*Lepidotomyia*).

Described from Simbang, T.N.G., New Guinea.

IDENTIFICATION. Scutellum very conspicuous by its complete silvery-white scaling. Proboscis, palpi, mesonotum and tarsi brown, mesonotum frequently with four small, yellow spots. Abdomen dorsally unbanded or sometimes with very narrow bands.

DESCRIPTION. Adult female. Palpi and proboscis brown, occiput with narrow, curved, golden brown scales, laterally small, flat, cream-coloured scales; delicate forked scales on the nape. Mesonotum with dark coppery scales; often four small golden yellow patches, two near the anterior margin and two more caudally, the latter are sometimes missing; the scales on the mesonotum are small, narrow and curved; scutellum closely set with flat, silvery white scales; pleura bright brown with three spots of silvery white,

flat scales; wings with brown scales, a white area at base of costa; legs brown, apices of tibiae and femora of mid and hind legs silvery white. Abdomen: tergites black with white, basal, lateral patches, sometimes visible from above; occasionally there may be narrow, pale basal bands; sternites with broad, basal creamy bands. Male with the palpi exceeding the length of the proboscis with nearly two segments, otherwise as the female. Larva. (Description after Penn, 1949). Head (fig. 25) about two-thirds as long as wide, lightly pigmented; antennae simple, slightly curved shafts, about three-quarters as long as the head, with number of small spinules scattered along their lateral sides from base to apex; antennal tuft consisting of seven to nine frayed branches which reach about three-quarters of the way to the apex of the shaft, inserted about middle; hair A with six to nine frayed branches, B with three or four frayed branches. C sub-

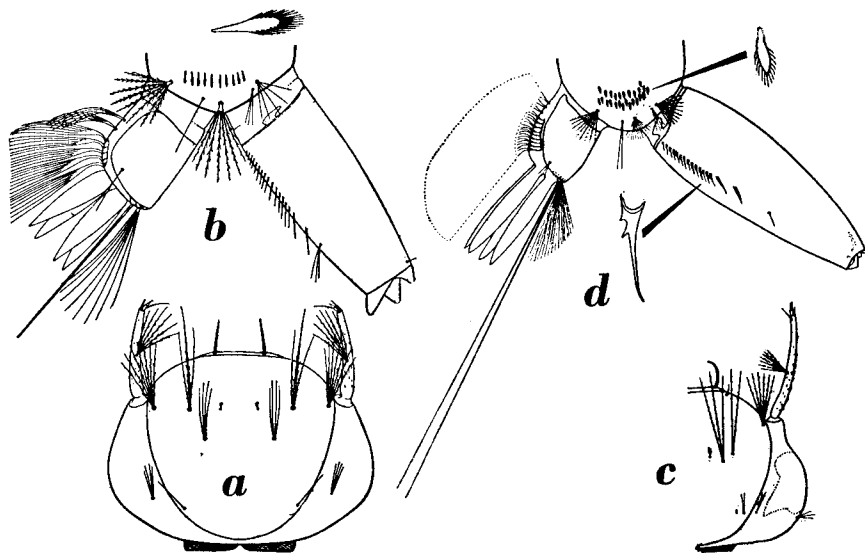


Fig. 25. *Aedes lineatus* (Taylor). A. Head of larva. B. Terminal segments; comb spine (above). *A. alboscutellatus* (Theobald). C. Head of larva. D. Terminal segments; comb spine (above); pecten spine (below). (A, B after King & Hoogstraal; C, D after Penn).

equal to B in length, two to four frayed branches, most often three-branched; D very short, four or five-branched; preclypeal spine stout, simple, curved inwards; E small, two to four-branched; F small, two to five-branched above base. Abdominal comb of eighth segment with the teeth in a triangular patch of two to three rows, and consisting of about 25 teeth, each tooth blunt tipped, with a fringe of short, fine hairs. Siphon lightly pigmented,

index averaging 3.6; pecten of 16 to 23 teeth, most commonly of 18 or 19 teeth, situated on basal half of siphon, with distalmost two or three teeth somewhat detached from the others, each pecten tooth consists of a long, narrow spine with one or two small, basal teeth on the ventral side; siphonal tuft situated just beyond the last pecten tooth and consisting of a very small simple hair; anal segment with dorsal plate incomplete ventrally; ventral fan about 12 branched hairs, three detached from bar; 1 h small, three or four-branched; d s c. 14 to 17-branched, v s c. single, both hairs not frayed, v s c. more than four times the length of d s c.

BIONOMICS. Adults of this species are annoying biters in the evening hours; locally they may be quite common. Larvae were collected from shallow pools at the border of jungle, and in the open; also from wheel-ruts.

DISTRIBUTION. From India to Australia and Japan. New Guinea material was seen from P. Pam, Inanwatan, Hollandia and Sokori plain (Southern shore of Sentani lake).

RELATION TO DISEASE. No records.

Aedes (Aedimorphus) imprimens (Walker) *)

Walker, F., 1861. Proc. Linn. Soc. London 5, 144. (*Culex*).

Described from Amboina Isl., Moluccas, Indonesia.

IDENTIFICATION. This species has several characters in common with *Aedes vexans*, as e.g. the speckling of the anterior surface of the mid femora. The species differs from *A. vexans* in having the pale scales of the scutellum and abdomen golden (in *A. vexans* silvery to white); the scutum has dark brown to golden scales but no silvery or white ones (in *A. vexans* these brown and golden scales are mixed with scattered white ones); the palpi are entirely dark (in *A. vexans* dark, but tipped with white or yellow scales).

DESCRIPTION. Adult female. Proboscis and palpi brown, the latter less than $\frac{1}{4}$ the length of the proboscis; occiput with narrow, curved, creamy yellow scales and scattered, forked, dark scales; laterally down the sides a patch of flat, creamy yellow scales. A p n. with narrow, curved, creamy yellow scales; mesonotum with brown-golden scales, around the prescutellar area the scales are creamy yellow; scutellum with narrow, curved, creamy yellow scales; pleura with patches of flat, oval, pale scales, integument brown; wings dark brown scaled; femora with speckling as in *A. vexans*, tarsi with basal bands, narrow on t. 1 and t. 2 of front legs and mid legs, on t. 3 of mid legs a small basal patch, on hind legs broad bands on t. 1-

* Stone et al. (1959) transferred this species to another subgenus of *Aedes*: subg. *Neomelanoconion* Newstead.

t. 3 and narrow ones on t. 4-t. 5. Abdominal tergites dark, indefinite basal bands on T. II-V, pale, basal, lateral patches on all segments; sternites cream-coloured with apical dark bands on S. I-III. Male similar to female in most respects. Length of palpi exceeding that of proboscis by half the length of the terminal segment. Larva. Antennae covered with thin spines; head hairs A, B and C in about a straight line, A multi-branched. Comb on 8th abdominal segment comprises about 10 spines arranged in an irregular row. Siphon more or less cylindrical, index 3-3.5, acus distinct; pecten spines 20-25, crowded in basal part, more spaced out towards the apex, utmost apical spine at about $\frac{2}{3}$ from base; d s c. with about 10, v s c. with 3-5 branches; anal papillae tapered (fig. 26).

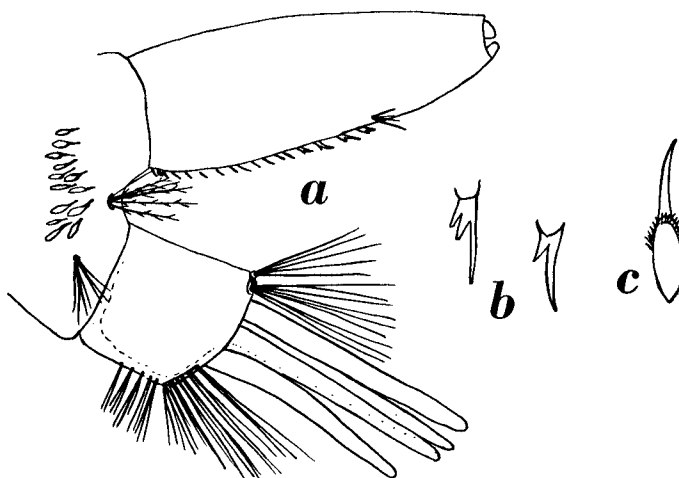


Fig. 26. *Aedes imprimens* (Walker). A. Terminal segments of larva. B. Pecten spines. C. Comb spine.

BIONOMICS. Females were found to be annoying biters. In Kaimana found in pest quantities around houses; sometimes numerous in wet jungle. Larvae were collected from temporary shallow pools in half shade at the border of rain forest.

DISTRIBUTION. From Sumatra to the Solomons. New Guinea material was seen from Manokwari, Kaimana, Hollandia.

RELATION TO DISEASE. No records.

Aedes (Aedimorphus) vexans (Meigen)

Meigen, J. W., 1830. Syst. Besch. zweifl. Ins. 6, 241 (*Culex*).

Described from Berlin, Germany.

IDENTIFICATION. This species can be easily confused with *Aedes vigilax* and *Aedes imprimens*. The proboscis in *A. vexans* has a variable orna-

mentation of yellow and dark scales but the under surface is always different from what is seen in *A. vigilax* (cf. fig. 28). *A. imprimens* has the pale scales on scutellum and abdomen golden, the palpi are entirely dark; *A. vexans* has more cream coloured pale scales and the palpi have some very narrow, pale bands.

DESCRIPTION. Adult female. Proboscis with distal quarter dark brown, on proximal part more or less yellow scaled, especially on undersurface, speckled or forming patches, on the whole very variable; palpi dark brown, apex pale yellow, a very narrow, pale yellow band at base of last segment; the length of the palpi exceeds that of the clypeus by $1\frac{1}{2}$ -2 times the length of the latter; in the centre of the occiput golden to cream coloured, curved, narrow scales and yellow to pale brown, forked scales; more laterally alternating patches of dark brown, cream coloured and dark brown, flat scales; mesonotum with areas of brown and golden yellow, curved, narrow scales which, however, do not form a distinct pattern; scutellum with cream coloured, curved, narrow scales; pleura dark brown with patches of cream-coloured, flat scales; veins of wing with dull brown scales, often with a few speckles of yellow or greyish-brown scales; femora with speckling on outer surface, pale on inner surface, hind femora with outer surface sometimes entirely white; tibiae on outer surface dark or speckled, inner paler, sometimes with apical bands; t. 1-t. 3 of front and mid leg yellow banded, hind leg with t. 1-t. 5 basally banded. Abdominal tergites dark brown, II-VII with creamy yellow, basal bands, sometimes partly or entirely interrupted in the middle, and lateral, large, basal patches; on VI and VII sometimes also indications of apical bands; sternites with brown and yellow scales, usually the pale ones more numerous.

Male. Proboscis brown, paler in the middle; palpi slightly longer than the proboscis, last two segments turned downwards, dark brown with cream-coloured bands, close to the base and on the middle of the long segment; also at bases of last 2 segments, which are very hairy; apical bands on tibiae missing; t. 2-t. 3 of front and mid legs basally banded, t. 1-t. 4 of hind legs also; abdominal tergites dark, II-VII with basal cream-coloured bands, narrow medially, laterally broader, especially on apical segments; on VI and VII apical median patches, which are only indicated on IV and V; sternites cream coloured, otherwise as in the female. Larva. Head much broader than long; head hairs see fig. 27; antennae towards base rather broad, all covered with spines; the 5-7 unfrayed branches of the antennal hair do not reach the tip of antennae. Comb on 8th abdominal segment comprising 8-9 teeth, more or less in a row, the teeth pointed and fringed in basal half. Siphon index over $1\frac{1}{2}$; pecten with 12-16 teeth, occupying about half the length of siphon,

the two apical teeth are largest, more curved and inserted well apart from the others; anal segment broader than long, the saddle nearly encircles the whole segment; d s c. with 6-8 bare branches, a little more than half as long as the siphon; v s c. simple, bare, about as long as siphon; l h. simple and bare, moderately long.

BIONOMICS. Larvae were found in unshaded pools and ditches, in salt and brackish and in fresh water; also in pools in alang-alang. The adult enters houses and feeds on man, but in warm countries is never such a pest to man and cattle as it is in temperate zones where it may occur in immense numbers.

DISTRIBUTION. A world wide species. New Guinea material was seen from Sorong, Tjof Isl., Manokwari, Kaimana, Hollandia, Merauke.

RELATION TO DISEASE. No records. Outside New Guinea reported as a virus-vector (Ch. III).

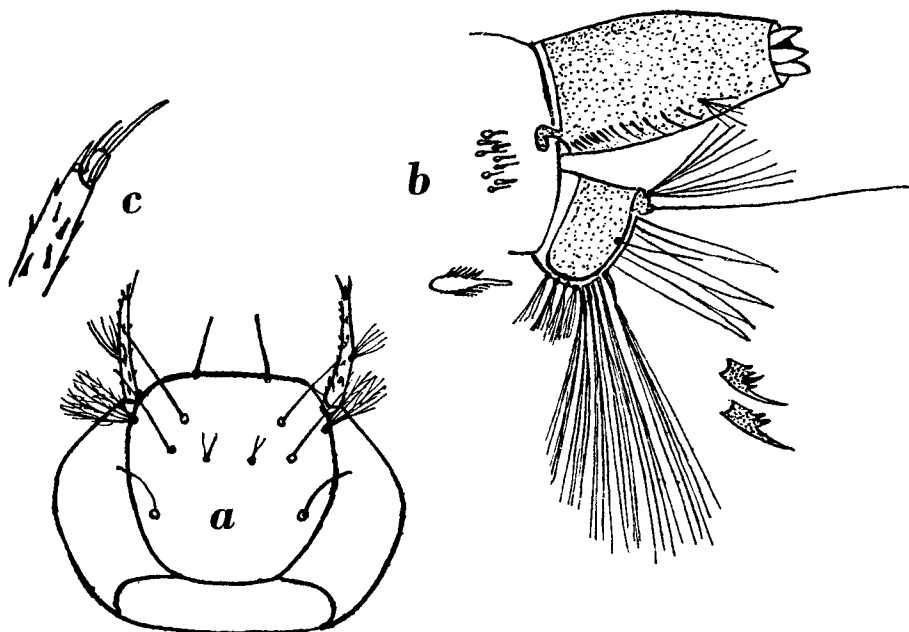


Fig. 27. *Aedes vexans* (Meigen). A. Head of larva. B. Terminal segments; comb spine (above); pecten spines (below). C. Tip of antenna.

Subgenus *Aedes* Meigen

Only one common species belonging to this subgenus is easily identified by its characteristic mesonotal ornamentation (*A. lineatus*). Others however, more or less uniform blackish mosquitoes of medium size which

belong to the most noxious biting pests of the territory, are very difficult to be separated. The only accurate characters are to be found in the male terminalia. At least two of these species are widespread in the territory (*A. carmentis* and *A. parasimilis*), a third one is very common locally in southern New Guinea (*A. funereus*). Some general characters of the subgenus are:

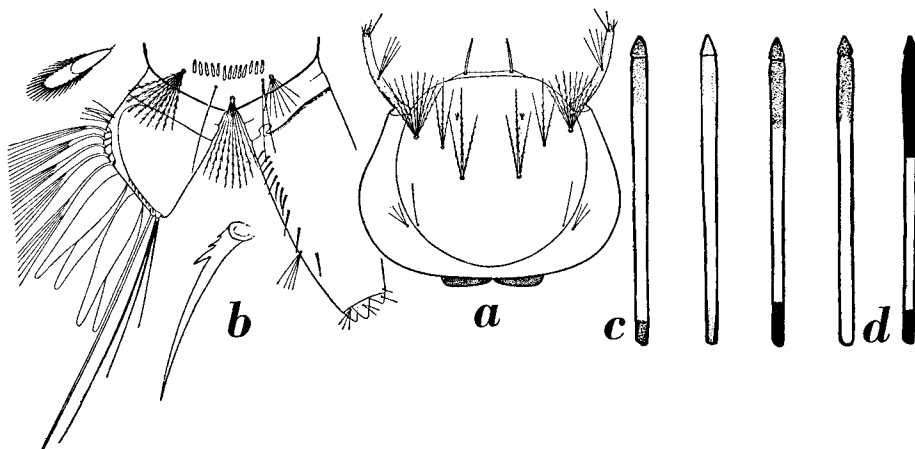


Fig. 28. *Aedes parasimilis* King & Hoogstraal. A. Head of larva. B. Terminal segments; comb scale (above); pecten spine (below). C. Ventral side of proboscis of *A. vexans*. D. Same in *A. vigilax*. (A, B after King & Hoogstraal).

Palpi very short in both sexes; proboscis, wings and tarsi uniformly dark; male antenna mostly densely plumose; recumbent scales of head mostly broad and flat; scutellar scales narrow; lower anterior mesepimeral bristle lacking but usually a group of fine hairs posteriorly; tarsal claws either simple or toothed; eighth segment of female abdomen retractile, the cerci moderately long and slender.

Aedes (Aedes) carmentis Edwards.

Edwards, F. W., 1924. Bull. ent. Res. 14, 388; described from Guadalcanal, Solomon Is.

Aedes (Aedes) parasimilis King & Hoogstraal.

King, W. V. & Hoogstraal, H., 1947. Jl. Wash. Ac. Sc. 37, 125; described from Hollandia, Western New Guinea.

Aedes (Aedes) funereus (Theobald).

Theobald, F. V., 1903. Mon. Cul. 3, 292; described from Queensland, Australia.

PROVISIONAL IDENTIFICATION OF THE ADULTS. *Aedes carmentis* has vertical scales on vertex of head all black, a patch of fine hairs in front of the bristles on p p n. and sternopleuron, pale scales around ante-scutellar space and incomplete dorsal abdominal bands. *A. parasimilis* has all vertical scales

on vertex dark, p p n. bare of scales or hairs, upper sternopleural scales distinctly pale, abdominal lateral spots on tergites rather large, their tips distinctly removed from base of tergites. A very similar species, *A. similis* (Theobald), may be absent from New Guinea, but this is uncertain. Vertical scales on vertex in this species show a light patch in certain lights and the scales around the eyes may appear pale also. *Aedes funereus* has black vertical scales on vertex, p p n. with narrow scales on upper third, abdomen with complete bands on tergites III-VI.

DESCRIPTION OF THE LARVA. *A. carmentis*. Antennal hair 4-branched; head hair B 3-branched, C 5- or 6-branched; comb of about 14 scales (teeth) each round and fringed; air-tube long, index nearly 3.0; pecten with about fourteen spines, the distal two longer and more widely spaced, the others with a single lateral tooth at basal third or fourth; tuft 2- or 3-branched; dorsal subcaudal hair of anal segment with three branches, one very long (two-thirds as long as the ventral hair), the other two short.

A. parasimilis (fig. 28). Antennal spiculate tuft about at middle, with four or five lightly plumose branches. Preclypeal spines long and slender; headhair A about 10-branched, B and C with three lightly plumose branches; comb of about 13 scales each rounded and fringed; air-tube index about 2.5; acus present; pecten of 12-15 spines, the distal two longer and more widely spaced than the others, with one or two small denticles; other spines with one strong and one or two small subbasal denticles; tuft 4-branched and inserted before the last spine; anal segment not completely ringed by the plate; lateral tuft single; dorsal subcaudal hair with 3 very unequal branches, the longest about two-thirds of the length of the single ventral subcaudal hair; two small tufts in front of ventral bar; anal gills moderate, equal, a little longer than saddle.

A. funereus (fig. 29, after Lee, 1944). Headhair B three-branched, the middle branch being longer and stouter than the side branches (as with headhairs B and C in *A. parasimilis*), hair C six-branched; comb of 8th abdominal segment of about 14 rounded and fringed teeth in a curved row, siphon rather long, index about 3.5; pecten with the distal three teeth widely spaced, long and simple, the others with a stout subbasal denticle and some smaller teeth; tuft placed beyond last pecten tooth at about the apical fourth, with three branches; dorsal subcaudal hair of anal segment with three unequal branches; precratal tufts at most two.

BIONOMICS. *Aedes* (*Aedes*) species are extremely abundant biting pests, preferably in lowland wet forest and mangrove swamps. Females bite mainly in day-time but they may be active in the evening hours as well, as is *A. funereus* in Merauke. Larvae are to be found in ground pools, in potholes

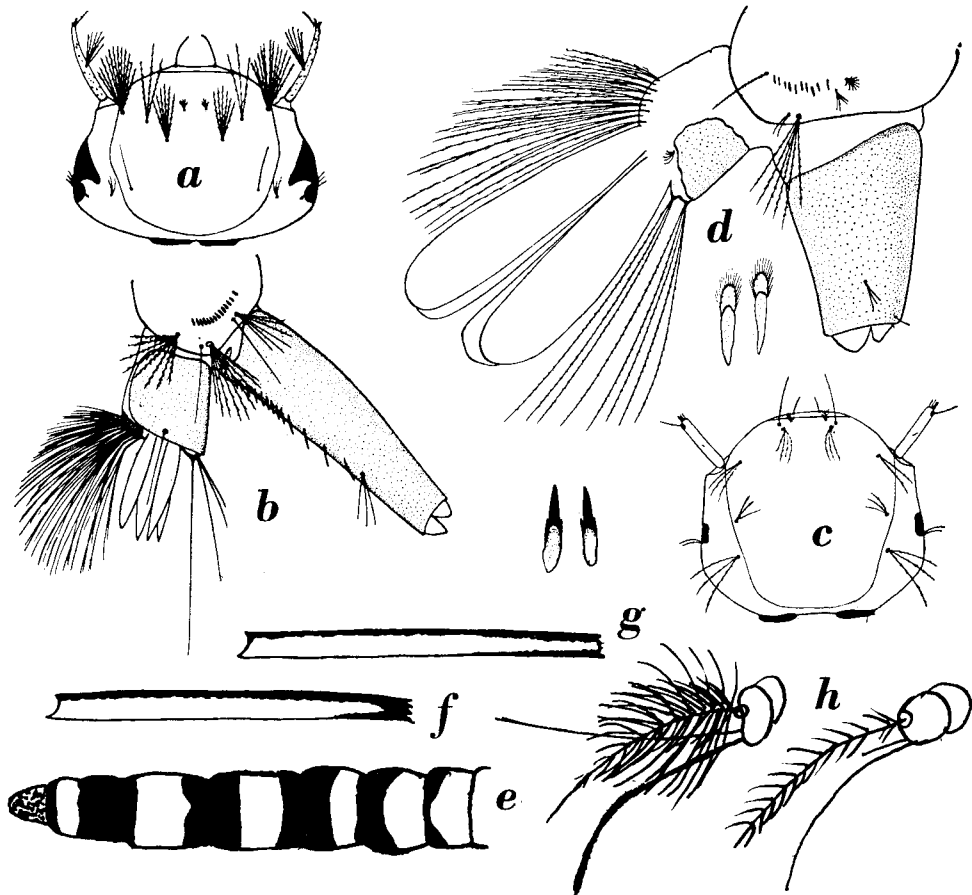


Fig. 29. *Aedes funereus* (Theobald). A. Head of larva. B. Terminal segments. *Armigeres milnensis* Lee. C. Head of larva. D. Terminal segments. E. Abdominal venter. F. Femur. *A. breinli* (Taylor). G. Femur. H. *Armigeres*, head of ♂ (left), head of ♀ (right). (A, B after Lee).

and crabholes in wet jungle and in mangrove swamps. It is usually very tiresome to collect them due to the relatively inaccessibility of the terrain.

Aedes parasimilis has been collected in some numbers from road-side ditches in fair sunlight.

DISTRIBUTION. *A. carmentis*: Moluccas to the Solomons and Australia. *A. parasimilis*: New Guinea, and *A. funereus*: New Guinea to the Solomons and especially the Australian continent.

New Guinea material was seen from the following localities (only those records containing male specimens are reliable): *A. carmentis*: Manokwari,

Wandamen bay, Kaimana, Sisir, Pionier bivak ♂, Sarmi ♂, Djik, Hollandia ♂; *A. parasimilis*: Boemi, Mamda ♂, Hollandia ♂, Pionier bivak ♂, Meer-vlakte, Djik, Tanahmerah, Mandobo, Toerai, Wamal; *A. funereus*: Kimaan, Wamal, Merauke ♂.

Aedes (Aedes) lineatus (Taylor)

Taylor, F. H., 1914. Trans. ent. Soc. London, p. 191 (*Lepidotomyia*).

Described from Lakekamu, Papua, New Guinea.

IDENTIFICATION. An easily recognized species with an ornamentation of yellowish or golden scales on the mesonotum as illustrated in fig. 23. Abdominal tergites with subbasal bands. Proboscis and legs dark. In the larva the siphon is relatively short and the branches of the dorsal subcaudal hair are subequal.

DESCRIPTION. Adult female. Palpi very short; occiput with broad, flat scales, pale along median line; submedially there are black scales and more laterally again pale ones, eyes pale rimmed. A p n. with curved, pale scales, the width of the scales somewhat varying; p p n. with narrow dark scales on the upper part and usually a few broad, pale ones posteriorly; golden scales on the scutellum; pleural bristles mostly pale yellowish; scale patches large, white; mesepimeron with a few hairs posterior to and just below the scale patch. Abdominal tergites with complete pale bands somewhat variable in position, usually at about equal distance from base and apex. Male. Similar to the ♀ in colouration and length of palpi; scales on a p n. not particularly narrow, the abdominal bands often incomplete on some segments. Larva, fig. 25. Head hair B with 3 branches, the middle one longer and stouter than the others; hair C 4-branched, set well back and inside B; D minute; E single. Abdominal comb of about 10 scales in a row, scales rounded and fringed; siphon comparatively short, index a little over 2; pecten comprises about 15 spines, the apical one or two more widely spaced and simple, the others usually with one large and one smaller basal denticle; tuft 3-branched, short; d s c. of anal segment with about 8 subequal branches.

BIONOMICS. Adults are very common and prove to be annoying biters in day-time in wet places, e.g. sago swamps and swampy forest. Larvae can be found in partly shaded pools in mostly open country; also in pools at the border of jungle or in and near sago swamps.

DISTRIBUTION. Lesser Sundas and Moluccas to the New Hebrides. New Guinea material was seen from Sorong, Sarmi, Genjem, Sentani villages, Hollandia, Arso, Tanahmerah, Mindiptanah, Toerai, Selil, Merauke.

RELATION TO DISEASE. No records.

Genus *Armigeres* Theobald

Theobald, F. V., 1901b. J. trop. Med. 4, 235.

Moderately sized to rather large mosquitoes without distinctive ornamental characters. Flat, broad scales on occiput and scutellum. Proboscis and legs and the dorsum of abdomen unbanded. Proboscis somewhat curved downwards at about apical third, from there onward towards tip slightly flattened laterally. Palpi of male a little longer than proboscis, turned upwards, sparsely hairy or even bare on last two segments; palpi of female variable in length from $\frac{1}{5}$ - $\frac{2}{3}$ as long as proboscis. The larva has no pecten on the siphon, the conspicuous anal papillae are very large and sausage-shaped. The breeding places are usually containers like tree holes, hollow logs, barrels, rain-water receptacles, fallen coconuts, bamboos; seldom groundpools. The water in the breeding places is often extremely dirty and frequently thick with decomposing organic matter (e.g. privies). To a certain extent the larva is carnivorous and even cannibalistic. The female attacks out of doors at about sunset, she usually disappears before 19.00 h. The bite is very painful but as the mosquito is rather 'careless' in her attacks and flies very slowly, she may easily be killed before the bite.

Armigeres breinli (Taylor)

Taylor, F. H., 1914. Trans ent. Soc. London, p. 18 (*Neosquamomyia*).

Described from Milne Bay, Papua, New Guinea.

IDENTIFICATION. The clypeus has distinct lateral patches of silvery scales dorsally, the hind femur is white to apex on outer lateral surface; venter of abdomen with broad, apical, dark band on segment III. Dorsally segment VII is pale basally.

DESCRIPTION. Adult female. Head clothed with dark scales with steel blue lustre, a fringe of large, flat, white scales round the eyes, expanding laterally into a patch; a short narrow line of white ones on the occiput and black upright forked ones on the nape; proboscis and palpi dark. Thorax brown, clothed with dark brown, narrow, curved scales, anterior margin with a thin border of pure white, narrow, curved scales and dusky brown bristles, a patch of white, spindle shaped scales above the roots of the wings; a p.n. prominent, brown, clothed with brown, narrow, curved scales and white, flat ones with a few dusky brown bristles; scutellum brown, clothed with flat, dusky scales and a few narrow, curved ones at the base of the lobes; legs steel black with a blue reflection in some lights; hind femora white to apex at outer side. Abdominal segments III-VII dorsolaterally with white spots, VIII with a basal band of white scales; ventrally segments I and II white scaled, III with a broad apical dark band; IV, V and VII with narrow,

basal, dark band, broad, central, pale band and apical, dark band, VIII is rather indistinctly mottled or dark. Male essentially as the female but dorsally segment VII is usually dark at base or only few pale scales present. The larva differs from *A. milnensis* larvae mainly in characters of the terminal segments: the lateral comb comprises about nine pointed teeth which may bear a few minute spines at the base of the main central tooth, but they are never fringed.

BIONOMICS. Adults bite man readily in the evening hours, locally almost in pest quantities. Larvae were frequently collected from rotting banana stumps in gardens near houses; also from pools and log holes.

DISTRIBUTION. New Guinea to the Solomon Isl. Material was seen from Fakfak, Biak, Padaido, Djik, Tablanoesoe, Hollandia, Arso.

RELATION TO DISEASE. This species has been discriminated as a vector of dengue. Cf. Chapter III.

Armigeres milnensis Lee

Lee, D. J., 1944^b. Proc. Linn. Soc. N.S.W., 69, 215.

Described from Milne Bay, Papua, New Guinea.

IDENTIFICATION. This species has distinct broad bands of pale scales on the venter of the abdomen, though none of the segments II-VIII is entirely white. The clypeus is bare of scales. A related species, *A. obturbans* (Walker), may be separated by having the white area on outer surface of the hind femora running as far as the knee joint and having sternite VII nearly all white; in *A. milnensis* the white area on hind femora does not reach as far and there is more black scaling on sternite VII (fig. 29). *Armigeres breinli* can be separated by the conspicuous scaling on the clypeus *). There are no striking differences between the larvae of the *Armigeres* species mentioned here.

DESCRIPTION. Adult female. A dark scaled area on middle of vertex, except for a varying number of pale scales on either side of the median dorsal line, flat pale scales on the border of the eyes, laterally the pale scales form distinct patches; clypeus dark brown; palpi hardly $\frac{1}{4}$ of the length of the proboscis, dark scaled. Scutum very dark brown dorsally and clothed with bronzy-brown scales, a narrow white margin around the anterior border of the scutum; scutellum may have pale scaling but this is often absent; no

*) Peters (1963) detected another, widespread species, *A. papuensis*, previously confused with *A. milnensis*. The male may be distinguished by the presence of brown scales on the anterior part of p p n. (all scales white in *A. milnensis*), and by the white S. II (with apical black band in *A. milnensis*); the female by the broad white scales of ventral part of p p n. (narrow and intermixed with hair-like scales in *A. milnensis*). Peters saw material from the Hollandia and Nimboran areas.

bristles on scutum dorso-centrally; laterally a p n. and p p n. clothed with rather loose, white scales; pleura clothed with a dense layer of white scales over most of its surface; legs without pale patches on coxae anteriorly, femora dark scaled above and pale beneath, femora of hind legs pale on the outer surface from base, nearly to apex which is always dark scaled; tibiae and tarsi of all legs entirely dark scaled; wings with costa, subcosta and vein 1 with broad, dark scales, rest of the wing veins far more sparsely scaled. Abdomen dark scaled; except for a broad band of white scales basally on T. VIII, all tergites have triangular lateral patches of pale scales, seldom visible from above; on the venter S. I pale, S. II largely pale with an irregular scattering of dark scales mostly distally, S. III and IV pale basally and dark distally, S. V, VI and VII dark with a central pale band, S. VIII pale basally and dark distally. Male except for sexual differences about similar to the female; the palpi are longer than the proboscis and as the latter covered with dark scales, the broad pale band on T. VIII as present in the female is rather a patch than a band. Larva. Head rounded, with short, stout antennae; the antennal shaft hair minute and situated at about the middle of antenna; head hair A bifid or trifid, B simple, C with 1-4 branches, A and C finely frayed. Lateral comb on eighth abdominal segment comprises ten or eleven, fringed scales. Siphon short and stout with a minute, 3- or 4-branched, latero-dorsal hair; no ventro-lateral tufts or pecten spines present; saddle of the anal segment scarcely covers the dorsal half of the segment; a minute branched saddle hair present; anal papillae very large, between 3 or 4 times the length of the anal segment, sausage-shaped; d s c. with 5 minute branches, v s c. with 3 similar branches (fig. 29).

BIONOMICS. A wide spread and locally very common mosquito species. Females bite man readily. It can be extremely noxious as it attacks at about sunset, the usual time for sitting outside as the day is getting cooler. Larval breeding places conform to particulars noted under the genus.

DISTRIBUTION. New Guinea. Material was seen from Watopi (240-1000 m), Kali Memeska (750 m), Inanwatan, Seroei, Sarmi, Genjem, Mamda, Sobejab, Ifar, Hollandia, Arso, Baliem valley (1600 m), Kokonao, Tanahmerah, Ambigit, Sabkahang, Kali Ia, Merauke.

RELATION TO DISEASE. This species has been discriminated as a vector of dengue. Cf. Chapter III.

Genus *Culex* L.

Linnaeus, C., 1758. Syst. Nat., ed. 10, 602.

The most striking characters of this genus is the presence of pulvilli on

the legs, in the female most distinct on the front and mid legs, in the male small pulvilli only (fig. 30). Palpi in the ♂ long or short, in the ♀ rarely more than $\frac{1}{5}$ as long as the proboscis. The larvae have the siphon ventrally with at least four hairs (usually 8 or more), more or less arranged in pairs.

Subgenus *Lutzia* Theobald

Theobald, F. V., 1903. Mon. Cul. 3, 155.

Very large mosquitoes; femora and tibiae speckled; tarsi without bands; a row of 5 or more bristles on anterior margin of lower part of mesepimeron. The larvae are carnivorous and even cannibalistic; they are immediately recognized as *Culex* larvae by the row of hair tufts on the siphon.

Culex (Lutzia) halifaxi Theobald

Theobald, F. V., 1903. Mon. Cul. 3, 231.

Described from Dindings, Malaya.

IDENTIFICATION. A large mosquito with the subgeneric characters as given above; medially on the mesonotum are three pale areas, abdomen hardly banded or not at all. In the larva the siphon is short and stout with a row of pecten spines from base to apex.

DESCRIPTION. Adult female. Proboscis dark brown, just before the middle somewhat paler; palpi slightly more than $\frac{1}{4}$ of length of proboscis, dark brown with yellowish white scales on inner surface and an incomplete, yellowish white, narrow band near the base; occiput for larger part with cream-coloured curved, narrow scales, mixed with forked scales, pale brown in front and darker more behind; laterally down the sides cream-coloured, flat scales. Mesonotum with shining, darkbrown and cream-coloured, curved, narrow scales, the pale scales towards margins, in front of scutellum and in the center, the latter in 3 more or less distinct groups, forming a triangle with the top pointing towards head; scutellum with cream-coloured, curved, narrow scales; pleura brown with patches of cream-coloured flat scales; wingveins dull brown scaled; cross-vein 4-5.1 close to and in front of cross-vein 3-4; femora and tibiae speckled as mentioned above and tarsi without bands. Tergites of abdomen dark brown, apical segments with narrow, inconspicuous, apical greyish yellow bands and white, lateral, basal patches; sternites apically from bright yellow to white, basally dark brown. The palpi of the ♂ exceed the proboscis by $1\frac{1}{2}$ segments in length, apical and sub-apical segments and apical part of long segment with long closely set hairs, a cream-coloured patch on underside of penultimate segment basally, a line of yellow scales on undersurface of long segment apically; proboscis dark-brown with a narrow, cream-coloured band beyond the middle, distinct on

undersurface. Larva. Instead of mouth brushes there are prehensile hooked lamellae. The larva of *C. halifaxi* differs only in the minutest details from the oriental species *C. fuscus* Wiedemann; moreover it is very doubtful whether these differences are constant. The lateral hair on the siphon of *C. halifaxi* is usually 3-4-branched, in *C. fuscus* simple or bifid; there is no lateral denticle in addition to the main large one in the pecten teeth of *C. halifaxi*, in *C. fuscus* there usually are 2 small such denticles in addition.

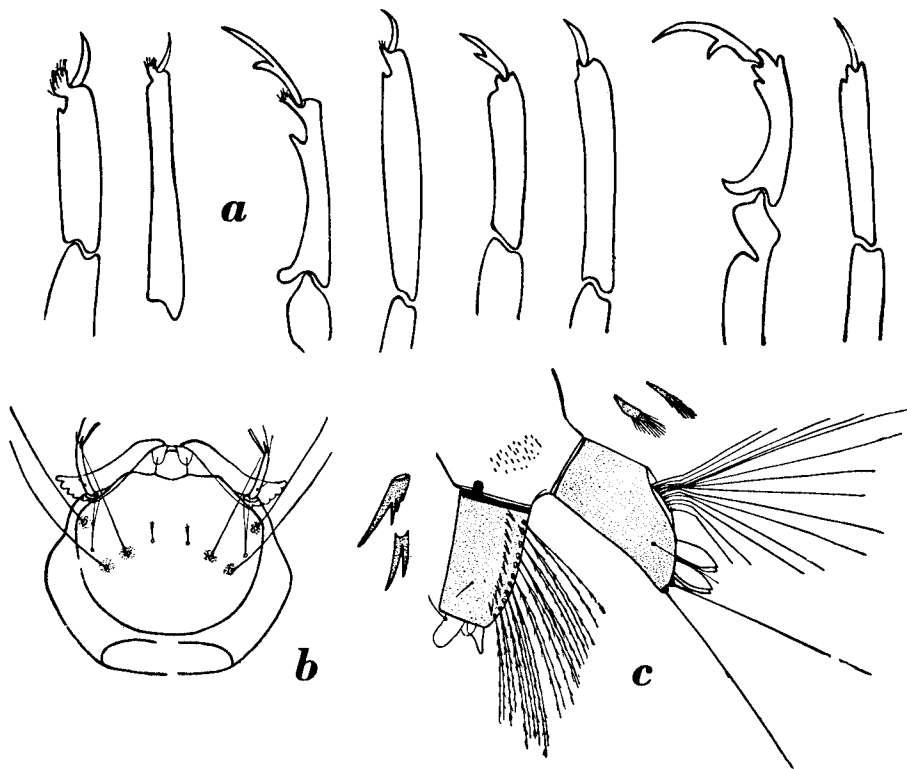


Fig. 30. A. Distal tarsal segments of *Culex* spp., showing pulvilli. *Culex fuscus* Wiedemann. B. Head of larva. C. Terminal segments; pecten spines (left); comb scales (right).

In fig. 30 we illustrate a larva of *C. fuscus* because its mount was better than the ones of *C. halifaxi* available.

BIONOMICS. Larvae of this species are commonly found in semi-permanent water collections in rather open places; it is a frequent companion of *Anopheles koliensis* or *A. farauti*. In New Guinea the adult was never collected while biting man; according to other reports it seems to do so very occasionally.

DISTRIBUTION. From India via the Malay archipelago eastwards to the

Solomons and the Australian continent. New Guinea material was seen from: Hollandia, Tami river, Genjem, Albatros bivak, Homejo (2000 m), Manokwari, Berau, Fakfak, Kaimana, Garumtop (Mandobo), Tanahmerah, Merauke.

RELATION TO DISEASE. None.

Subgenus *Lophoceraomyia* Theobald

Theobald, F. V., 1905. Ann. hist. nat. Mus. Hung. 3, 93.

The males have the antennae ornamented with a matted hairtuft on f s. 9. Also with tufts of modified scales on f s. 6-8. There is no pale ring on the proboscis; the palpi are also without pale rings, variable in length. The tarsi are entirely dark. Wingscales dark and usually very scanty except towards tip of wing. Vertex of the head usually with numerous small flat scales in front towards eye margins. Scutellar scales narrow. They are small mosquitoes, brownish or reddish brown. Species of this subgenus are difficult to distinguish from each other. The larvae do not show any marked differences from those of other subgenera.

BIONOMICS. Usually species from forested regions with much rainfall, breeding in tree-holes; also in groundpools and shallow wells. Little is known about the life habits of the adults, but the ♀♀ do not appear to attack man.

Culex (Lophoceraomyia) fraudatrix Theobald

Theobald, F. V., 1905. Ann. hist. nat. Mus. Hung. 3, 94.

Described from Friedrich-Wilhelmshafen, T.N.G., New Guinea.

IDENTIFICATION. *C. fraudatrix* is easily recognized from other species of the subgenus by the large tuft on f s. 9 in the male. Larvae have a dark band across the siphon at about the middle, sometimes some abdominal segments conspicuously dark coloured.

DESCRIPTION. Adult female. Vertex and nape covered with dark brown, narrow and upright scales, a very pale border to the eyes, widening out at sides; antennae, clypeus, palpi and proboscis dark brown; palpi about $\frac{1}{6}$ length of proboscis. Thorax with mesonotal scales dark reddish brown; pleura brown, without scales, one lower mesepimeral bristle; legs dark brown, front and mid femora paler posteriorly, hind pair pale on anterior and posterior surface, but dark dorsally. Abdomen dorsally dark brown; small basal lateral ochreous markings are usually present; sternites pale brown.

Male. Antennae plumose; long scales on f s. 9 forming a dark tuft projecting outwards and upwards, below these, projecting downwards, are some long hairs, which appear white from certain angles; smaller tufts of crumpled scales on f s. 6 and 7, a matted tuft on f s. 8; palpi longer than pro-

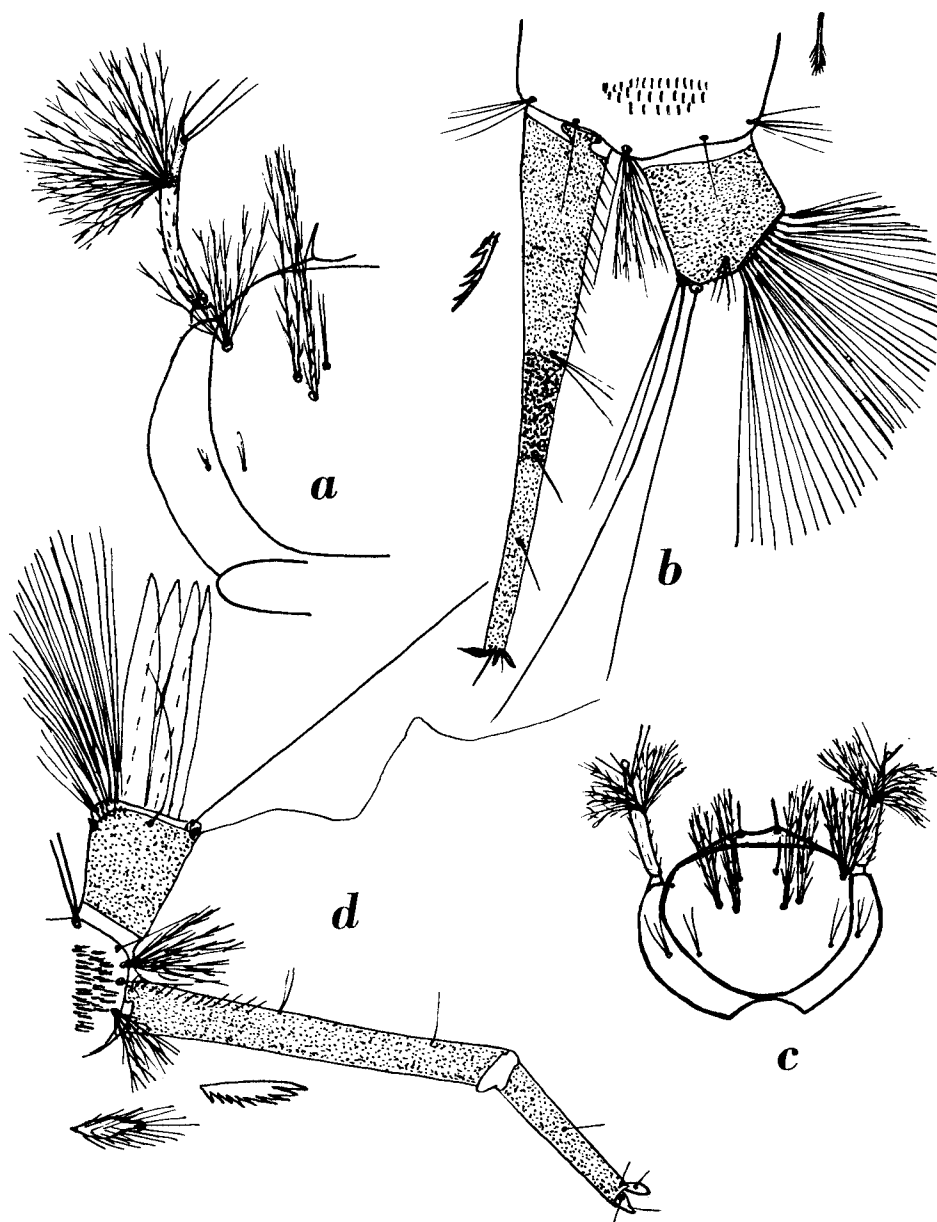


Fig. 31. *Culex fraudatrix* Theobald. A. Head of larva. B. Terminal segments; pecten spine (left); comb scale (right). C. *pullus* Theobald. C. Head of larva. D. Terminal segments; comb scale (left); pecten spine (right).

boscis by $1\frac{1}{2}$ times the length of the apical segment; the terminal segments with numerous outstanding hairs, a small fingerlike process at base of each palp and a transverse row of about six rather long, stiff bristles on under-side of proboscis at base. Otherwise as in ♀ except that the lateral pale markings on the abdomen are sometimes absent. Larva as in fig. 31.

BIONOMICS. The larvae have been found breeding in pot-holes in mangrove tidal areas; also in semipermanent ground pools.

DISTRIBUTION. From India to New Caledonia. New Guinea material was seen from Berau, Hollandia, Sentani lake, Tami river, Upper Digoel river (Madobo dist.),? Kimaan, Merauke.

RELATION TO DISEASE. No records.

Subgenus *Culiciomyia* Theobald

Theobald, F. V., 1907. Mon. Cul. 4, 227.

Moderate sized mosquitoes. No ornamentation on proboscis and tarsi. Head scales narrow and upright except for a single, continuous row of small, flat scales along the eye margins. Wing scales dark. The males are easily recognized by a row of peculiarly shaped, translucent scales on the palpi. The larva is very similar to that of the subgenus *Culex*.

Culiciomyia females do not seem to attack man *), but some species rank among the most numerous New Guinea mosquitoes so one very likely will come across them. Larvae have been collected from a wide variety of breeding places including groundwater pools, stream pools, tree holes, rock crevices and small, artificial water collections.

Culex (Culiciomyia) fragilis Ludlow

Ludlow, C. S., 1903. J. N. Y. ent. Soc., 11, 142.

Described from Samar, Philippines.

IDENTIFICATION. Females of this species are difficult to separate from the related species *C. papuensis*. The latter is larger and darker, with the abdominal tergites completely dark; in *C. fragilis* indefinite lateral pale spots may be present dorsally. Another common relative, *Culex pullus*, has

*) A very remarkable exception to this rule was recently published by Slooff & Van Dijk (Trop. geogr. Med., 13, 287-288, 1961), who found that females of *C. (C.) spathifurca* (Edwards) on P. Pam, a small island west of Sorong, bite man. Moreover they observed well developed larvae of *W. bancrofti* in a specimen which was kept for $7\frac{1}{2}$ days after it had obtained a blood meal on a microfilaria carrier.

Culex spathifurca was never collected east of P. Pam; very probable this New Guinea population represents a distribution border line case or even a population 'in diaspore' (the nearest locality known is in Celebes). One is tempted to attribute the rather aberrant behaviour and possibly also its unsuspected susceptibility for filariasis as due to its peripheral position, a situation paralleled in this territory by *Anopheles karwari*.

As a vector *C. spathifurca* is of no importance, due to local conditions.

distinct basal bands on tergites. The larvae of *C. fragilis* and *C. papuensis* differ very distinctly, the former has a more or less cylindrical siphon with 3 pairs of hair tufts, the latter has the siphon inflated.

DESCRIPTION. Female. Flat scales at the sides of the head are white and the narrow scales on the vertex pale ochreous, the upright scales on the vertex are dark; palpi black and about $\frac{1}{6}$ the length of the proboscis. Thorax with mesonotal scales dark brown; pleura greenish without dark markings; wings

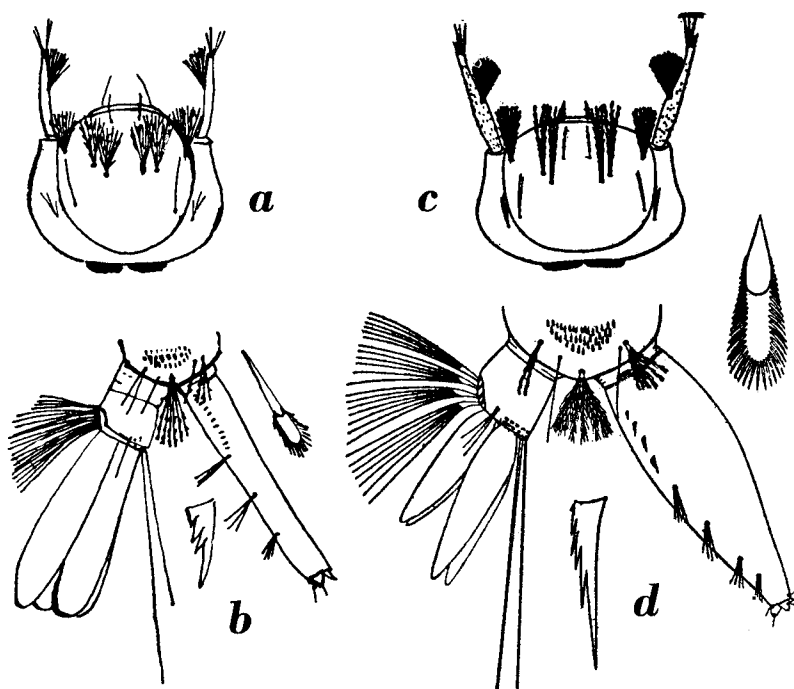


Fig. 32. *Culex fragilis* Ludlow. A. Head of larva. B. Terminal segments. *C. papuensis* (Taylor). C. Head of larva. D. Terminal segments. (A-D after King & Hoogstraal).

with outstanding scales rather broad; legs dark brown, femora pale underneath. Abdomen with venter pale, dorsally brownish black with indistinct, pale lateral spots. Male. Palpi exceeding the proboscis in length by about the last segment, the last two segments with a moderate number of outstanding hairs. Larva. Head hairs A, B and C multi-branched and about equal in length; comb-spines on the 8th abdominal segment frayed in apical part and arranged in a regular patch; siphon with distinct acus, more or less cylindrical, index 5-6, three pairs of siphonal hair tufts present; dorsal and ventral subcaudals both single (fig. 32).

BIONOMICS. One of the most common mosquitoes; females do not bite

man. Larvae were collected from temporary and semi-permanent ground pools with stagnant, more or less foul water in all degrees of shade; also from tree-holes and artificial containers.

DISTRIBUTION. From India and Ceylon to the Solomons. Material was seen from Sorong, Manokwari, Biak,? Wissel lakes (1800 m), Genjem, Hollandia, Tami river, Tanahmerah, Getenteri, Wageriop.

RELATION TO DISEASE. None.

Culex (Culiciomyia) papuensis (Taylor)

Taylor, F. H., 1914. Trans. ent. Soc. London 1914, p. 201 (*Melanocomion*).

Described from Lakekamu, Papua, New Guinea.

IDENTIFICATION. A rather large and greenish-dark mosquito. Adults may be confused with *Culex fragilis* but the larvae of both species are very different (fig. 32). *Culex papuensis* is definitely larger than *C. fragilis*, they are also darker and there is no trace of apical pale spots on the abdominal tergites which are entirely dark. The wing scales on veins 2 and 4 are distinctly narrower and there are fewer flat scales on the vertex of the head. The larva of *C. papuensis* is very distinct because of its inflated siphon.

DESCRIPTION. For adults compare differences given above with the description of *Culex fragilis*. Larva. Head hair A multi-branched, B and C with three branches. Siphon inflated, tapered towards apex; pecten spines very few in number; dorsal and ventral subcaudal hairs both single (fig. 32).

BIONOMICS. Locally this species can be abundant but the females do not bite man. Larvae can be very numerous; they may be found in groundwater- and container breeding places in shade or half shade, in either clear water or water filled with leaves; sometimes present in putrid water as found in hollowed sago-palm trunks.

DISTRIBUTION. New Guinea to the Solomon Isl. New Guinea material was seen from Misool, Manokwari, Tablanoesoe, Genjem, Hollandia, Arso and Tanahmerah.

RELATION TO DISEASE. None.

Culex (Culiciomyia) pullus Theobald

Theobald, F. V., 1905. Ann. hist. nat. Mus. Hung. 3, 87.

Described from Muina, T.N.G., New Guinea.

IDENTIFICATION. This *Culiciomyia* is even in the female sex easily recognized by its distinctly pale-banded abdomen (on tergites III-VII), combined with the dark markings on the pale pleura, while palpi, proboscis and tarsi are dark throughout. The larva is very distinct because of the broken appearance of the long siphon, caused by a weakly chitinised region in the apical half.

DESCRIPTION. Adult female. A moderately sized, greenish-brown species. Some broad scales on the vertex. Thorax deep brown, densely clothed with brownish scales; pleura pale greenish with two, longitudinal, dark integumental bands, the ventral one ending on the sternopleuron. Male. Proboscis dark, a prominent ventral tuft of bristles medially just before the labial joint, numerous hairs all over the proboscis; palpi longer than proboscis including labella, by approximately the length of the last segment, dark scaled, segment III with a rather sparse, ventral row of long, modified scales from base to apex, these modified scales hair-like except for being broadened or flattened medially, numerous long hairs ventrolaterally and medially along segments IV and V; vertex covered with broad, creamy scales, dorsum covered with dusky, upright, forked scales, the more anterior ones paler, and with a band of narrow, creamy scales on the nape and more sparsely on the longitudinal mid line. Mesonotum with fine, brownish scales; a p n. bare of scales, p p n. with some narrow, brownish scales dorsally; no pleural scale patches; pleural integument pale, marked with a prominent, longitudinal, dark band beginning on p p n. and extending backwards, a second shorter band below, extending to about halfway the medial portion of the sternopleuron; fore coxae with dusky scales anteriorly, mid ones with only a few scales, hind ones bare of scales; fore and mid femora dark scaled, marked with pale scaling posteriorly, hind femur pale scaled, anteriorly with dark scaling dorsally from near base to apex, posteriorly the apical two-fifths are largely dusky; tibiae and tarsi dark; wing dark scaled; base of fork cells approximately even, anterior fork cell noticeably longer than stem; halter knob with greyish scales. Abdomen: tergite I with a median area of dark scales, II dark scaled, III-VII with broad basal creamy or yellowish bands, on the more posterior segments these bands are narrowed medially, all the bands extending into the lateral aspect; sternites II-III pale scaled, IV-VII with pale scales basally and dark scales apically. Larva. Head broader than long; hair A shorter than B and C, about three-quarters as long as B; C slightly longer than B; the headhairs with 8-10, 3 and 3 or 4 frayed branches respectively, A, B and C implanted on a nearly oblique line; D halfway front clypeal margin and C, simple, rather long for a D hair; E with two branches; preclypeal spines slender, antenna straight, half as long as head, with a spiculate shaft; antennal hair inserted just before apical third, with about 15 elongate frayed branches, subapical bristles well before apex. Comb of segment VIII comprises many large spines (over 30), each spine with long lateral and terminal fringe. Siphonal index 10, a transverse unsclerotized band on siphon, $\frac{1}{3}$ from apex; pecten of about 8 or 9 teeth, difficult to find, long, pale, with a long fringe of denticles on one

side; there are 3 delicate siphon hairs, very difficult to find, the hairs single or 2- or 3-branched, one inserted just beyond apical pecten tooth, one just before break and one between apex and break; anal segment slightly broader than long with complete band, anal fan with 9 equal hairs, each hair with 7 branches, lateral hair curved, about twice as long as length of anal segment; short dark spines on lateral margin posteriorly, anal papillae twice as long as anal segment, pointed; d s c. long, bare, single, about as long as siphon, v s c. similar (fig. 31).

BIONOMICS. One of the most common mosquito species of New Guinea. Females do not bite man. Larvae were collected from a variety of ground-water breeding places in both sunlit and shaded places; sometimes in extremely dirty water.

DISTRIBUTION. Moluccas to Australia and the Solomons. New Guinea material was seen from Sorong, P. Pam, Inanwatan, Berau, Manokwari, Fakfak, Homejo (1500 m), Mamberamo delta, Pionierbivak, Albatros bivak, Sarmi, Genjem, Hollandia, Tami river, Arso, Kaimana, Wageriop, Nijop, Tanahmerah, Kimaan, Selil, Toerai, Merauke.

RELATION TO DISEASE. None.

Subgenus *Culex* L.

There are at most 2 bristles on lower half of mesepimeron, no postspiracular bristles; palpi of the male longer than proboscis, turned upward and strongly hairy apically. Occiput mainly with narrow curved and forked scales, no broad scales around the eye margin; scutellum with narrow curved scales. Tarsi either dark or with narrow pale rings, usually embracing both ends of the segments. Wing-scales nearly always dense, more or less linear.

Culex (Culex) annulirostris Skuse

Skuse, F. A. A., 1889, Proc. Linn. Soc. N.S.W. 3, 1737.

Described from Blue Mountains and Berowna, N.S.W., Australia.

IDENTIFICATION. The adults of this species resemble *C. sitiens* in having no definite ornamentation on the mesonotum, combined with a distinct band at about the middle of the proboscis and basal bands on abdomen and tarsi. The differences between these two species are mainly found in the width of the band on the proboscis which is broader in *C. annulirostris*, in the mesonotum of the latter which is more evenly coloured, in the speckling of the femora which is sometimes less pronounced in *C. sitiens*, in the front tibiae which have many pale scales on the anterior surface in *C. annulirostris* forming distinct small spots and in the dorsal abdominal basal bands which are broadest along the median line and paler than in *C. sitiens* (but this

broadening is very variable in *C. annulirostris*). On the sternites the dark apical bands are incomplete in *C. annulirostris*.

DESCRIPTION. Adult female. Proboscis black except for the pale broad band; palpi about one fifth the length of the proboscis, black with a few pale scales at tip; head scales creamy yellow on occiput, laterally and on the nape the scales are brown, down the sides pale. Mesonotum rather evenly covered with brownish scales; pleura with patches of flat white scales; fe-

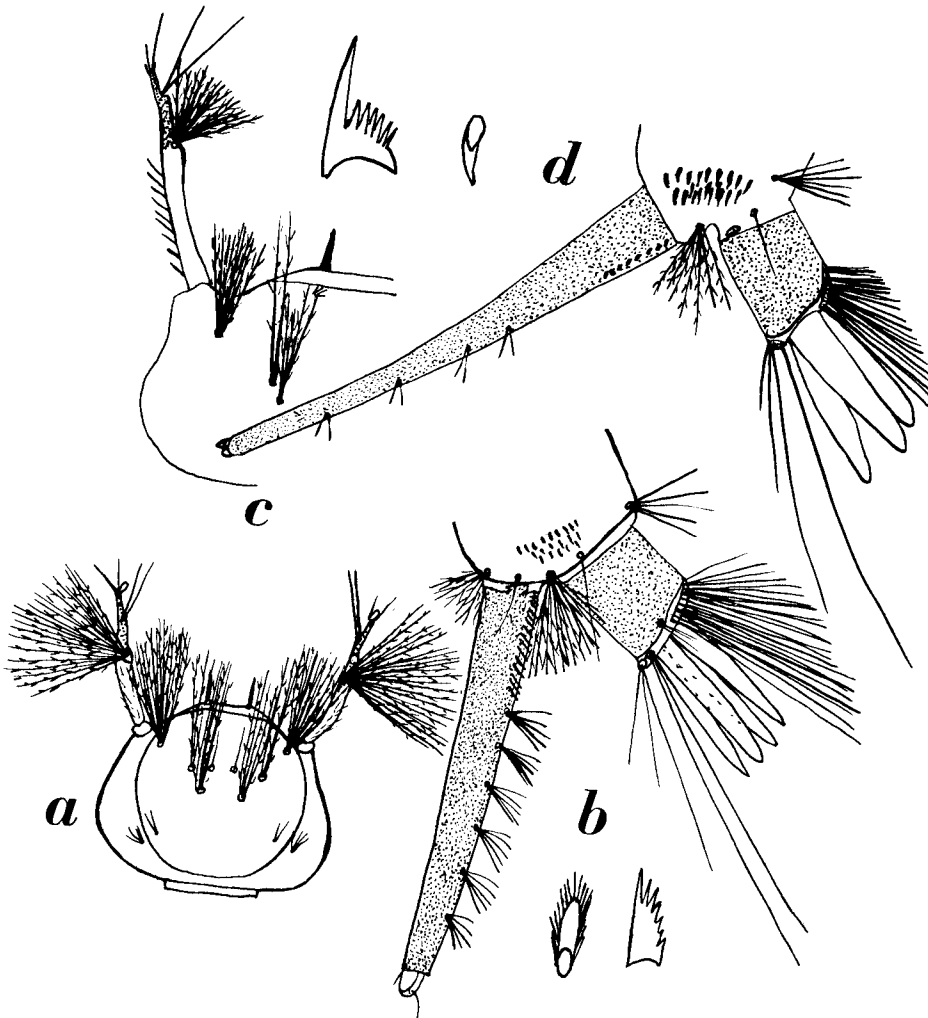


Fig. 33. *Culex annulirostris* Skuse. A. Head of larva. B. Terminal segments; comb scale (left); pecten spine (right). C. *squamosus* (Taylor). C. Head of larva. D. Terminal segments; pecten spine (left); comb scale (right).

mora indefinitely speckled, tibiae of the front legs with a row of small but fairly definite dots on front surface, inner surface of femora and tibiae pale, tarsi pale banded; outstanding wingscales long and narrow, dark. Abdomen with the dorsal pale basal bands usually distinctly broadest in the middle, sternites with incomplete apical, dark bands. Male. The palpi exceed the proboscis in length by about the length of apical and subapical segments, four very pale, though not quite white bands on the palpi, tip of apical segment pale scaled. Femora somewhat more speckled than in the female. Larva. (fig. 33). Head broader than long; hairs A, B and C well developed, with 7-12, 3-4 and 5-6 frayed branches respectively; D simple, bare, rather long; E small, simple or bifid; preclypeal spines long, stout, brown with rough surface; the latter character is typical of this species and *C. sitiens*. Antenna longer than the head, apical third brown, a small pigmented spot at base of antenna, basal $\frac{2}{3}$ broadened and closely covered with spines, a few spines also present on apical $\frac{1}{3}$; antennal hair inserted beyond half the length of antenna with 20-30 frayed about equal branches, the longest branches somewhat shorter than antenna; subapical hairs inserted near tip, these hairs $\frac{2}{3}$ the length of antenna; top hair over half as long as subapical hairs. The comb on segment VIII consists of over 30 teeth, each tooth with a large fringe (fig. 33); siphon cone-shaped, index about 7; a well developed acus present; siphon pecten with 12-14 teeth over more than $\frac{1}{5}$ its length; 6 pairs of rather short siphon hairs, diminishing in length toward apex, the basal hairs with about 9, the apical hairs with 3-6 bare branches, the hairs implanted laterally; anal segment broader than long with chitination all round, no distinct spines at apical margin; d s c. with 4 branches, v s c. simple, no fraying; v s c. about as long as siphon, the longest branch of d s c. slightly shorter; l h. slender, about equal in length with segment, with 3 bare branches; anal fan with about 12 hairs, each hair with 8-9 bare branches; anal papillae as long as segment, tapering from base to a point.

BIONOMICS. Adults of this species are noxious biters in the evening hours and at night. They readily enter houses and they are a pest in many localities. The larva, which is frequently sharing the breeding place with species of the *Anopheles punctulatus*-group, has been found in puddles, ditches and swamps, in brackish and in fresh water.

DISTRIBUTION. From the Lesser Sundas and the Philippines to Australia and Fiji. In New Guinea very common and widespread in the lowlands. Material was seen from Salawati, P. Pam, Sorong, Berau, Manokwari, Seget, Fakfak, Biak, Padaido, Mamberamo delta, Albatros bivak, Pionier bivak, Genjem, Sentani lake, Hollandia, Tami river, Kaimana, Kokonao, Tanahmerah, Wagen, Digoel delta, Ia river, Kimaan, Selil, Moeting, Koembe, Merauke.

RELATION TO DISEASE. *Culex annulirostris* has been discriminated as a vector of *W. bancrofti* locally. Cf. Chapter III.

Culex (Culex) bitaeniorhynchus Giles

Giles, G. M., 1901. J. Bombay Nat. Hist. Soc. 13, 607.

Described from Travancore, India.

IDENTIFICATION. A rather large and variable *Culex*, recognized by the speckled wings, banded proboscis, anterior three quarter part of the mesonotum usually distinctly paler than the posterior quarter, speckled femora and apical yellowish bands on abdominal tergites. This species is most likely to be confused with *C. squamosus* (see p. 127). The larva of *C. bitaeniorhynchus* is easily identified by the very long siphon (index about 8), the sparse (5-7) peculiarly shaped comb scales on the 8th segment and the small number of tiny teeth in the pecten.

DESCRIPTION. Adult female. Except for the characters given above, the proboscis has some pale scaling towards the tip and towards the base, there may be a greyish-yellow, narrow band just behind the labella; the palpi are dark brown with a pale greyish tip, length about $\frac{1}{5}$ of the proboscis; occiput nearly all covered with golden yellow, curved scales, behind and laterally mixed with brownish-black forked scales. Prothoracic lobes and the anterior three quarters of the mesonotum covered with scales of a variable colour from golden to dark brown, mixed with tiny spots of very dark scales, but the whole distinctly paler than the posterior fourth where the scales are brownish black to nearly black (in fact there exists an extreme variation in colour of mesonotal scales; individuals from Frederik Hendrik Island had the mesonotum largely blackish scaled without any difference between anterior and posterior part); scutellum covered with similar dark scales except for the tip of the mid lobe which has dull golden scales; pleura brownish with patches of flat, white scales; first four tarsi of all legs with narrow, basal and apical yellow bands. Tergites of abdomen brownish black on dorsal parts, often with some pale speckling, on one or more of the apical segments a dirty yellow apical band which is concave towards base of segment; tergite VII may be entirely yellow; lateral part of tergites very variable, often there are apical, dirty yellow, patches on two or three distal segments; sternites with mixed, dirty yellow and dark brown scales. Male. The palpi are slightly less than $1\frac{1}{2}$ segments longer than the proboscis; apical segment not quite twice as long as subapical one; long joint with 2 pale rings; narrow pale rings on bases of apical 2 segments; about apical half of apical segment yellow scaled; legs less banded than in the female; t. 1-t. 3 of front legs banded; mid and hind leg with t. 1 apically and basally, t. 2-t. 4 only

basally banded; abdomen with the tergites brown with apical and basal yellow bands on a variable number of segments; sternites yellow; otherwise as in ♀. Larva as in fig. 34. The striking characters are the long narrow siphon, the pecten at extreme base has only 4-6 small, very transparent teeth, which are difficult to detect; comb of eighth segment has 4 to 5 strong sharp teeth without any fringe.

BIONOMICS. New Guinea populations of this species easily bite man, contrary to populations in the oriental region which do not. De Rook (1957b) records this species as a biting pest (and a vector) in the Berau area (Vogelkop). Larval breeding places are all earthen lined fresh water collections, usually associated with filamentous green algae. It was also found breeding in more or less dirty water. De Rook (pers. comm.) holds the opinion that the atypical *C. bitaeniorhynchus* from the Berau area may be an undescribed species).

DISTRIBUTION. West Africa to Australia and New Caledonia; as far north as Korea. Wide spread in New Guinea; material was seen from Sorong, Berau, Teminaboean, Poeragi, Hollandia, Sentani lake, Merauke, Koembe, Selil, Kimaan.

RELATION TO DISEASE. In New Guinea recorded as a vector of bancroftian filariasis (cf. Ch. III). Williamson and Zain (1937) record this mosquito species as an experimental vector of human plasmodia.

Culex (Culex) fatigans Wiedemann

Wiedemann, C. R. W., 1828. Aussereur. zweifl. Ins. 1, 10.

Originally described from Indonesia.

In American literature this species is quoted as *Culex quinquefasciatus* Say. According to Stone, Knight & Starcke (1959) the correct name for this mosquito should be *Culex pipiens quinquefasciatus*.

IDENTIFICATION. This rather drab, medium sized mosquito is easily recognized by its banded abdomen (basal creamcoloured bands and white basal lateral spots on tergites), the unbanded proboscis and legs and the narrow, curved scales on the dorsum of the head. The 4 siphon hairs of the larva are placed in an irregular row.

DESCRIPTION. Adult female. Palpi $\frac{1}{5}$ as long as the dark proboscis, brownish, a few white scales near tip. Mesonotum with golden brown curved narrow scales, paler in front of scutellum, which has pale yellow, curved narrow scales. Wings with the veins dark scaled; legs entirely dark brown, except the inner sides of the femora, which are yellowish and the tip of the hind tibiae, which carry a few paler scales. The tergites of the abdomen are dark brown with very pale yellow bands which are broadest along the

median line and evenly rounded on posterior margin; laterally they broaden again into triangular, basal, pale spots; these spots are broadest at the base and reach to halfway the height of the segment, sternites with white basal

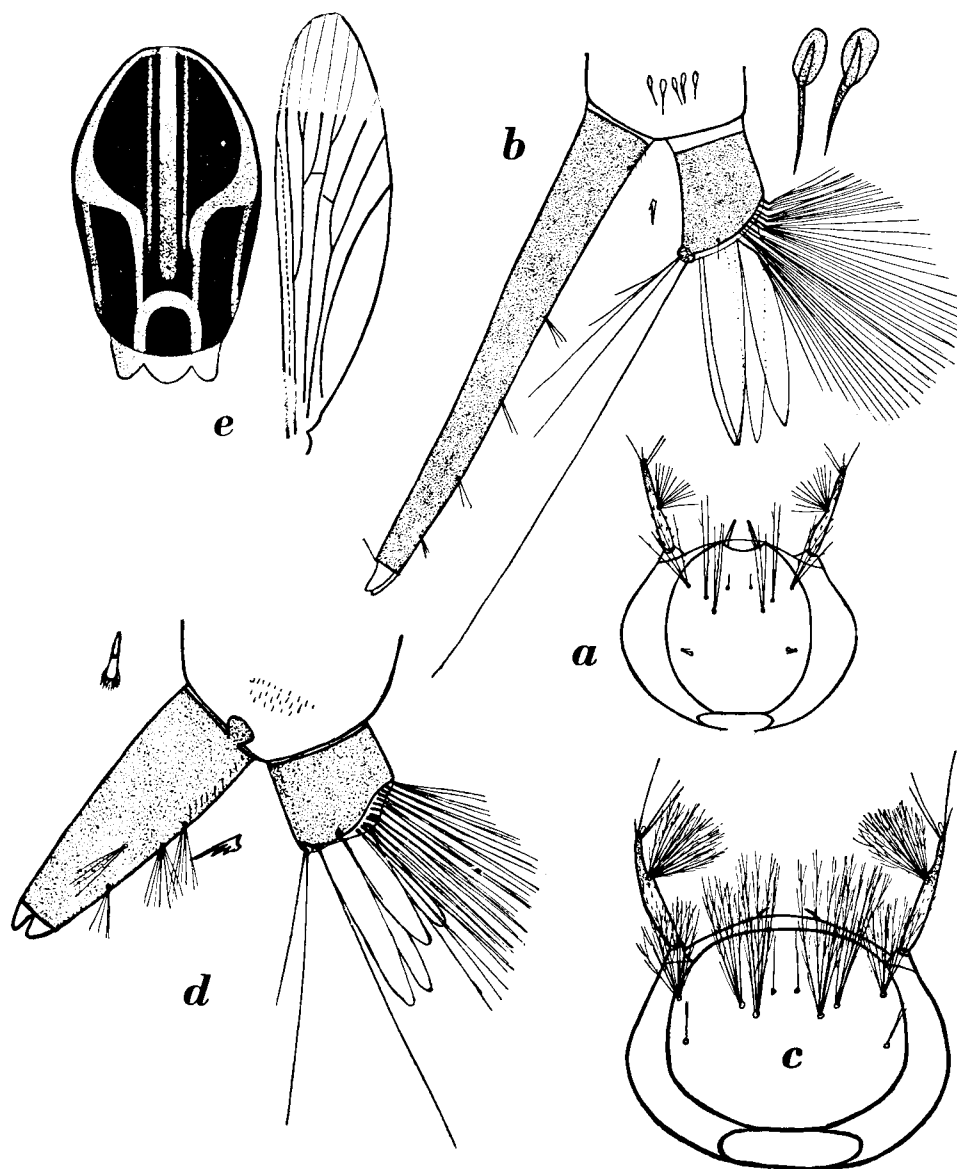


Fig. 34. *Culex bitaeniorhynchus* Giles. A. Head of larva. B. Terminal segments; comb scales (above); minute pecten spine (below). *C. fatigans* Wiedemann. C. Head of larva. D. Terminal segments. *C. miraculosus* Bonne-Wepster. E. Mesonotal ornamentation (left); wing (right).

spots, the apical spots are pale yellowish; there may be a few dark scales between the light ones. In the male the proboscis is paler in the middle than at the base and apex. Palpi projecting beyond the proboscis by about the length of one palpal segment. A bare area on basal part of palpi, simulating a pale band; otherwise dark brown scaled, except for white scales on under-side. Bands on abdominal tergites not medially expanded. All lateral spots well developed and visible from above. The larva is shown in fig. 34. The apical $\frac{1}{3}$ of the antennae is brown, remaining part yellow.

BIONOMICS. This mosquito species is a real pest in many places in the tropics. It is a typically domesticated species, always connected with man and flourishing best in neglected conditions. It breeds in all kinds of artificial breeding places near human habitations: water barrels, wells, tanks, privies, cesspools, fountains, ponds, always provided the water has been sufficiently polluted; also in pools and canals near houses. A salt content of 0.1 per cent is no objection. It usually attacks in and out of doors from 22 hours onward. The bites are very irritating.

DISTRIBUTION. *Culex fatigans* has followed men in all tropical and many semi-tropical countries. Originally it did not occur in New Guinea but has been imported from abroad. Nowadays it is widely distributed in the larger settlements, especially on the coast. Besides, material was seen from Genjem (Nimboran), Napan-Weinami, Bade, Tanahmerah, Enarotali (Wissellakes). The importation of this species into the Nimboran area and in Enarotali (1800 m) is of very recent date.

RELATION TO DISEASE. *Culex fatigans* is in many tropical countries a first rate carrier of *Wuchereria bancrofti*. In New Guinea its role so far has not been of great importance. It has to be watched however very closely.

Culex (Culex) mimulus Edwards

Edwards, F. W., 1915. Bull. ent. Res. 5, 284.

Described from Sarawak, Borneo.

IDENTIFICATION. Two large, pale areas and sometimes a third, less conspicuous one on costa, subcosta and vein 1; pale areas on other veins very variable (fig. 36); mesonotum with an indefinite pattern of paler patches. Proboscis and tarsi banded. *Culex miraculosus*, another species with spotted wings, is easily recognized by its conspicuous ornamentation of the mesonotum.

DESCRIPTION. Adult female. Proboscis brownish black with a broad, cream-coloured band just before the middle; palpi a little over $\frac{1}{5}$ as long as the proboscis, brownish black; occiput with cream-coloured, curved, narrow scales in centre and pale, greyish yellow, forked scales; more laterally the

forked scales are blackish brown; laterally down the sides a patch of cream-coloured flat scales. Mesonotum, a p n. and scutellum with curved, narrow, mostly dull golden scales, slightly paler laterally and on prothoracic margin, also on scutellum; pleura greyish brown with patches of flat, cream-coloured scales; wings (fig. 36) with two large, cream-coloured areas on the costa, involving subcosta and vein 1; often a small pale apical area present; at tip of vein 1 a small, pale area involving the wing fringe as well as the tip of 2.1 and 2.2 (as well as these constant pale areas, there are also pale areas which are very variable and may be altogether absent); legs brownish black with yellow bands; all femora, tibiae and t. 1 with narrow, yellow apical bands; t. 1, 2 and 3 of all the legs and t. 4 of mid and hind legs with basal, greyish yellow bands, most of these bands covering the apex of the preceding segment. Abdominal tergites brownish black with basal, cream-coloured bands, on basal segments more distinct than on apical segments; lateral white basal patches touching apical margins of segments; sternites mainly pale yellow. Male. Palpi about $1\frac{1}{2}$ segment longer than proboscis; brownish black with cream-coloured bands at the base of sub-apical and apical segments and cream-coloured scales on the apical half of apical segment; apex of long segment and next two segments with long hairs. Legs with the basal bands on t. 1 of mid and hind legs missing; abdomen with very definite, basal, pale bands on the tergites; sternites with cream-coloured bases and dark brown apices. Wings with pale areas on costa, subcosta, 2.1 and 6 as in ♀; no other pale areas in the ♂ wing. Larva. Head about $1\frac{1}{2}$ times as long as broad; hair A with 7 branches, B with 3, C with 6 (see fig. 36); preclypeal spines coarse, brown; antennae slightly curved, as long as the head with spines on basal half, apical $\frac{2}{5}$ brown; antennal hair inserted at about the middle of the shaft, with some 20 delicately frayed hairs which reach beyond the tip of the antenna. Comb on 8th abdominal segment with about 35 teeth arranged in an oval group. Siphon long, index 7 (with some variation), base dark brown with a T-shaped acus; pecten comprising 12-14 teeth, inserted on basal third of siphon, beyond pecten 4 or 5 pairs of hairs 2-3 times as long as diameter of siphon at point of insertion; each hair with 2-6 bare branches; towards apex of siphon a two-branched or simple hair. Anal segment about as long as broad, chitination all around, no spines on apical margin; d s c. with 2 branches, one about half as long as the other, the longest as long as the siphon, v s c. single, about as long as siphon.

BIONOMICS. Locally a common species, adults were never collected while biting men; their preferences presumably lay elsewhere. Larvae were collected from a variety of breeding places including rain-filled drums, grass covered ditches, puddles; there also are records from tree-holes and bamboos.

DISTRIBUTION. From Nepal and Ceylon eastwards to Australia. In New Guinea the species is very probably more wide-spread than the present collecting localities suggest. Material was seen from Hollandia, Sentani lake, Mamda and Genjem, all in the Hollandia area.

RELATION TO DISEASE. None as far as known.

Culex (Culex) miraculosus Bonne-Wepster

Bonne-Wepster, J., 1937. Med. D.V.G. Ned. Ind. 26, 92.

Described from the Anggi lakes, Vogelkop Pen., West New Guinea.

IDENTIFICATION. A rather large *Culex* species with a striking ornamentation on the thorax; apical third part of wing very pale.

DESCRIPTION. Adult female. Vertex clothed with narrow, slightly curved, creamy yellow and numerous upright scales; medially the upright scales yellow, more laterally dark brown; palpi with some yellowish scales at tip; proboscis dark brown, with a broad, yellowish band about the middle, nearly one third the length of the proboscis. Mesonotum covered with narrow, slightly curved, dark brown, light golden brown and golden yellow scales, forming a definite pattern (fig. 34); scutellum covered with curved, narrow, whitish scales; pleura with patches of rather broad, white scales on mesepimeron and sternopleuron; a p n. with numerous narrow, curved, creamy yellow scales and many strong, golden brown bristles; on p p n. in front small, narrow, curved, golden scales; wings (fig. 34), scales dark brown except at base of costa and vein 1, where is a bright yellow spot; towards apex of wing scales are pale: yellow on costa and I, white on greater part of fork 2, on apical half of 3, nearly the whole of fork 4 and apex 5.1; pale scales towards apex form a large, distinct pale area, visible to the naked eye; femora slightly mottled with golden scales in front, white on under side and behind, base white ringed, apex golden yellow; tibiae dark brown, a yellow stripe behind, base and apex light scaled all around, broadly so on hind tibiae, narrow on mid and front tibiae; tarsi basally banded on all segments with yellow scales; on t. 1 and t. 2 of mid and hind legs are apical bands. Tergites brown scaled with broad, basal bands, running down all sides, of yellow scales on III-VII; I dark scaled, on II there is a large triangular, yellow, basal patch; VII with a narrow apical band of yellow scales; VIII all yellow scaled. Sternites as far as visible golden yellow scaled. Male. Palpi: a narrow, basal, creamy band and a very broad creamy band on apical half of long joint all white scaled beneath, apical joint with narrow basal band. Larva (description by Marks, 1954). Antenna dark brown, the basal $\frac{2}{3}$ with fine spicules; tuft at $\frac{2}{3}$ from base. Head hairs A, B and C plumose, A 8-10 branched, B 4-5 branched, C 4-7 branched; D and E simple,

D 1-2 branched, fairly strong, reaching almost to anterior margin of head, E 3-5 branched; the base of B posterior to base of A and slightly more than halfway between it and mid-line, C medial and posterior to B, D medial and anterior to B and C. Lateral comb of segment VIII of 40-50 dark, apically fringed scales. Siphon index 6.0-8.0, slender, tapering. Pecten extending over basal $\frac{1}{4}$ - $\frac{1}{3}$ of siphon, of 10-13 spines each with 1-3 pointed, basal denticles; the distal spine may arise beyond the proximal ventral tuft; 4 pairs of 4-10 branched simple ventral tufts and one pair of 3-4 branched lateral tufts. Anal segment with the saddle forming a complete ring, dorsal subcaudal hairs simple, upper (i s c.) 2-branched, lower (o s c.) single; saddle hair (1 h.) 2-branched, simple. Ventral brush (anal fan) of 12 tufts on bar, 6-7 branched. Anal papillae subequal, tapering to blunt point, upper pair $2\frac{1}{2}$ -3 times length of saddle, lower slightly shorter.

BIONOMICS. *Culex miraculosus* is a highland species, in places (Wissel lakes) rather common. Larvae were collected from small artificial ponds and drainage ditches, partly grass-covered and from muddy pools without any vegetation in full sunlight.

DISTRIBUTION. New Guinea. Material was seen from Anggi lakes (Vogelkop, 2300 m), Enarotali, and native villages near Homejo (Central highlands 1800 and 2000 m, respectively).

RELATION TO DISEASE. None.

Culex (Culex) sitiens Wiedemann

Wiedemann, C. R. W., 1828. Aussereur. zweifl. Ins. 1, 542.

Described from Sumatra.

IDENTIFICATION. The adults of this species resemble *C. annulirostris* in having no definite ornamentation of the mesonotum, a distinct band about the middle of the proboscis, basal bands on the abdomen; basal bands on the tarsi. The differences between these two species lie mainly in the width of the band on the proboscis, which is broader in *C. annulirostris*; the mesonotum of *C. annulirostris* is more evenly coloured; the speckling of the femora in *C. sitiens* is more pronounced; the pale scales on the front tibiae of *C. sitiens* do not form distinct small spots; the outstanding wing-scales in *C. sitiens* are not as long and narrow as in *C. annulirostris*; the dorsal abdominal basal bands are not broader along the median line in *C. sitiens* like they are in *C. annulirostris* and they are not so pale; on the sternites the dark apical bands are not interrupted.

DESCRIPTION. Adult female. Compare with *C. annulirostris* and mark differences as given above. Male. Palpi $1\frac{1}{2}$ segments longer than proboscis, a broad, cream-coloured band in the middle of long segment and a narrow

one at its base, last two segments with cream-coloured basal bands, tip of last segment cream-coloured. Mesonotum: the colouration of the scales is more uniform than in the ♀; legs with less speckling on the femora, the basal bands on t. 4 may be absent. Abdomen: on tergites VI and VIII narrow, apical, pale bands present in addition to the basal bands; sternites with the apical half cream-coloured, the basal half black. Larva. Very similar to *C. annulirostris* but differing as follows: the preclypeal spines are stout and short. Siphon index $5\frac{1}{2}$ - $6\frac{1}{2}$; pecten with 8-12 teeth; anal papillae very variable in size and shape, from short and oval to nearly round, but they may be longer than segment and pointed; they appear to be short and round in larvae living in brackish water (fig. 35).

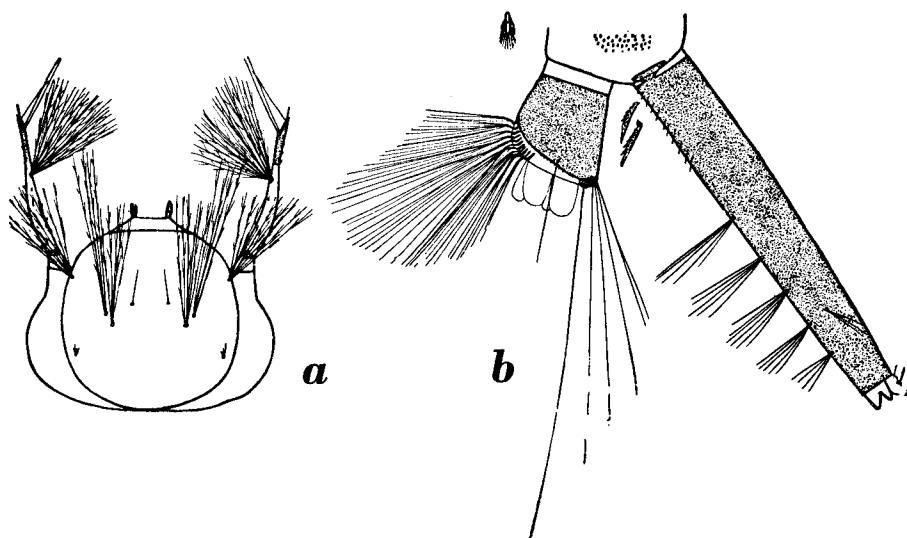


Fig. 35. *Culex sitiens* Wiedemann. A. Head of larva. B. Terminal segments.

BIONOMICS. Adults bite man easily, both in- and outdoors. This species breeds in brackish as well as in fresh water, usually in groundwater breeding places with clear, sometimes dirty water e.g. ponds, flooded lands, pools, swamps, ditches and tidal marshes where at low tide most of the water is drained off. Sometimes found in canoes pulled ashore or in smaller containers. The species is frequently found on coastal localities, but also inland.

DISTRIBUTION. From East Africa to Australia and Pacific Islands. In New Guinea this species has been reported from Sorong, Fakfak, Albatros bivak, Pionier bivak, Hollandia, Tanahmerah, Koembe, Merauke.

RELATION TO DISEASE. No records so far.

Culex (Culex) squamosus (Taylor)

Taylor, F. H., 1913. Trans. ent. Soc. London 1913, 691 (*Culicada*).

Described from Townsville, Queensland, Australia.

IDENTIFICATION. A rather large mosquito with the anterior two-thirds of mesonotum with a cream coloured scaling, which usually contrasts by a fairly sharp line of demarcation from the darker posterior third. Wings with some scattered pale scales. Proboscis and tarsi banded. This species is most likely to be confused with *Culex bitaeniorhynchus* as adults (see pag. 120). *C. squamosus* larvae have the same long siphon as *C. bitaeniorhynchus* but the comb scales on abdominal segment 8 are arranged in a patch and are very small in the former, arranged in a single row and large and sharply pointed in the latter.

DESCRIPTION. Female. Head scales of the usual type, creamy in the centre and dark brown on the sides; the flat scales more down the sides creamy; palpi dark scaled with white apex; proboscis black with a broad median creamy white band. Mesonotum with pale anterior two-thirds with a variable amount of dark scaling towards the front, demarcation between light and dark part on mesonotum usually fairly sharp; scutellum yellowish brown with pale narrow curved scales and black bristly area in front of the wing roots; pleura brown with patches of white flat scales; femora and tibiae conspicuously mottled with pale scales; the pale tarsal rings involve both bases and apices of the segments. Abdomen dark scaled with creamy lateral spots and white banding scarcely if at all widened at the middle; sternites with black and white scales forming a basal banding. Male with the palpi banded with creamy white scales, otherwise similar to the female. Larva. (fig. 33). Head hair A a little over half the length of B, with 7 frayed branches, B 2-branched, C 4-branched, a little longer than A, these three hairs in an oblique line; D very small, 2-branched, inserted at about the same distance as A from the clypeal front margin. Comb on abdominal segment VIII with 18-22 teeth situated in a somewhat elliptical arrangement, teeth rather wide apart, rather thin and sharply pointed, with a short sparse fringe at base. Pecten on siphon with eight teeth, occupying about $\frac{1}{10}$ of the length of the siphon, very transparent and difficult to detect; papillae longer than anal segment, tapering towards apex.

BIONOMICS. A wide spread species which feeds on man but no place known where it occurs in pest quantities. Larvae have been collected from small pools in half shade, fish ponds, stagnant water along the banks of creeks and deep wheel ruts. They were always found to be associated with filamentous green algae.

DISTRIBUTION. From the Moluccas to the Solomons and the Australian

continent. New Guinea material was seen from Sorong, Berau area, Hollandia, Sentani lake, Bamgi ia distr., Tanahmerah, Merauke.

RELATION TO DISEASE. Van Dijk (1958) obtained infective instars of *W. bancrofti* from a specimen which had fed on a microfilaria carrier 15 days before.

Culex (Culex) whitmorei Giles

Giles, G. M., 1904. J. trop. Med. 7, 367.

Described from Camp Stotsenburg, Luzon, Philippines.

IDENTIFICATION. Anterior three fourths of mesonotum snowy white, posterior one fourth with white and dark lines (fig. 36). This species resembles the oriental *C. gelidus* Theobald (not occurring in New Guinea), but is easily distinguished from it by the largely white mid lobe of scutellum, which in *C. gelidus* has only a white tip.

Culex vicinus, a rather rare species, can be differentiated by the anterior white mesonotal area which has no caudal, narrow extensions as in *C. whitmorei*; in *C. vicinus* the basal bands on the tarsi and abdomen are not as distinct as in *C. whitmorei*; the femora and tibiae are not speckled.

Culex bitaeniorhynchus and *Culex squamosus* both have pale scales on the posterior half of the mesonotum but the scales are cream-coloured, not white. Moreover the wings of these species are slightly speckled with pale scales.

DESCRIPTION. Adult female. Proboscis brownish black with a broad creamy yellow band about the middle third of its length; palpi brownish black; about $\frac{1}{5}$ as long as the proboscis; occiput mainly covered with snowy white, curved, narrow and forked scales; laterally down the side a few greyish white, flat scales. Mesonotum and scutellum covered with snowy white and brownish black curved narrow scales; pleura dull brown with small patches of greyish white, flat scales on sternopleuron and mesepimeron; all wingveins with dull brownish narrow and black, spatulate scales on some veins; inner surface of femora greyish yellow, remaining parts dull brownish with basal, dull yellowish bands which expand apically into median triangular patches of half the height of the segments, sometimes only medial basal patches or a median line over the abdomen present; sternites cream coloured with dull brown apical bands. Male. Palpi exceeding proboscis with nearly 2 segments; dull brownish with dirty yellow ornamentation: bands on the middle of long segment, the bases of subapical and apical and the tip of apical segment. Legs as in the female, but the femora less speckled and on the front legs only pale bands on t. 2 and t. 3. Otherwise as in the female. Larva. Head see fig. 36; hairs A, B and C well developed, with 6-8, 2 and 2 frayed hairs respectively, C may be simple; antennae about as

long as the head, S-shaped, spinose, from slightly to strongly pigmented tip; antennal hair inserted on $\frac{3}{5}$ of the length of the antenna with about 20 frayed branches of which the longest is shorter than the antenna. Comb on 8th segment comprises 4-7 teeth with a sharp point and very little fringe at base. Siphon slightly curved, narrow, index $5\frac{1}{2}$ -6; pecten of 9 teeth on basal fourth of siphon or slightly beyond, more apically the teeth increase in size;

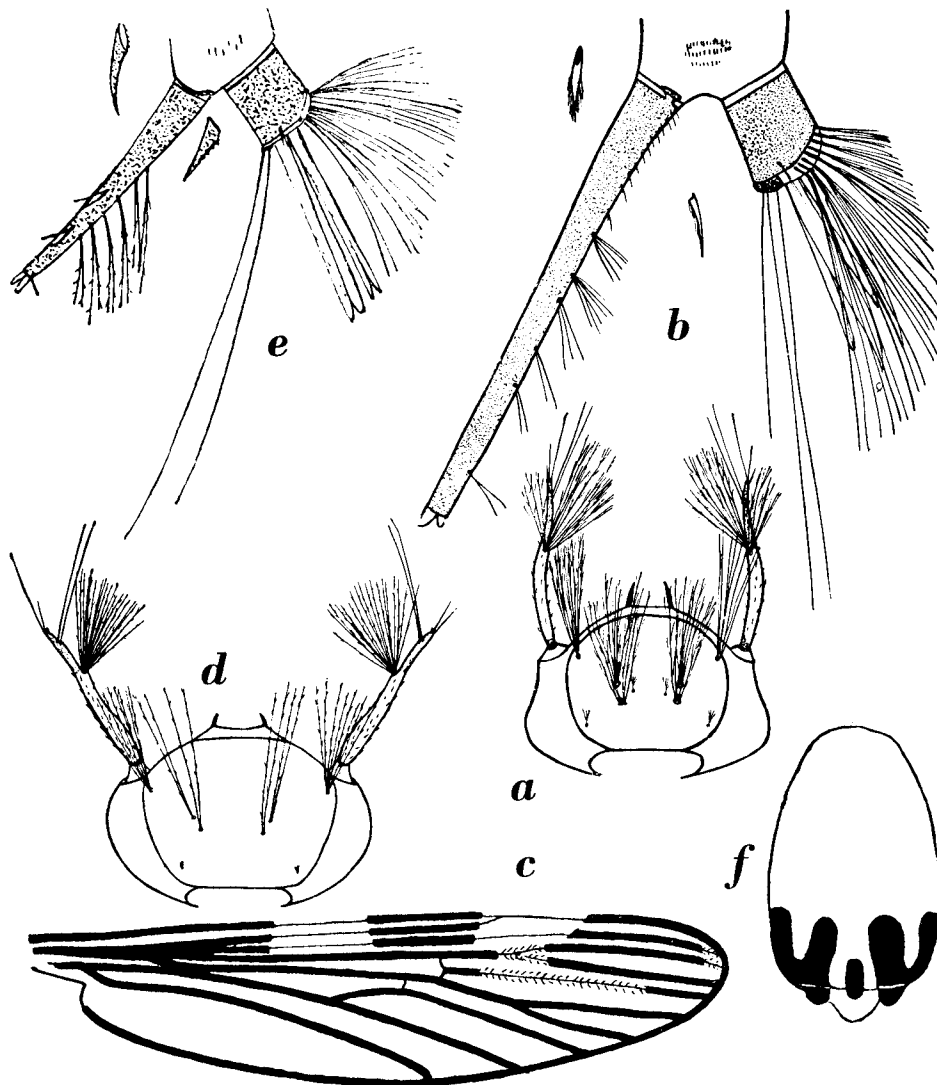


Fig. 36. *Culex mimulus* Edwards. A. Head of larva. B. Terminal segments. C. Wing. *C. whitmorei* Giles. D. Head of larva. E. Terminal segments. F. Mesonotal ornamentation.

5-6 pairs of large siphon hairs inserted on the middle $\frac{2}{5}$ of siphon, hairs half as long as siphon, simple or 2-branched, all of them frayed; two pairs of smaller hairs laterally in addition. Anal segment slightly longer than wide; d s c. and v s c. simple, bare, much longer than siphon (fig. 36).

BIONOMICS. From the rest of Indonesia this species is known as a pest biting indoors at dusk. In New Guinea the species is wide spread both in the low- and highlands but no place is known to us where the species developed into pest quantities. Larvae were collected from the flooded fringe vegetation of swamps and from the vegetation of slow flowing rivulets.

DISTRIBUTION. Throughout the oriental region to New Guinea. Material from New Guinea was seen from Manokwari, Enarotali (1800 m), Homejo (2000 m), Ifar (400 m), Hollandia, Tami river.

RELATION TO DISEASE. In western Indonesia known as a local vector of filariasis; in New Guinea most probably of no importance.

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