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# **South African Mosquitoes.**

**By G. A. H. BEDFORD, F.E.S., Research Officer, Onderstepoort.**

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## INTRODUCTION.

THIS paper has been written with a view to bringing our present knowledge of the mosquitoes found in South Africa together in one paper. Up to the present it has been found impossible to study the mosquitoes of the Union without having to consult numerous scattered works on these insects, many of which deal principally with exotic species. Even to identify a single specimen it is frequently necessary to have several papers in front of one before the species can be accurately determined and named. For instance, to obtain keys to the adults it is necessary to consult one or more papers, keys to the larvae will be found in other papers, and for descriptions and ascertaining the latest names used other works again have to be consulted. Moreover, there have been so many changes in the nomenclature within the last few years that unless one is familiar with the numerous names that have been used for various species one is likely to experience great difficulty in finding the information required when consulting various works.

It is hardly necessary to emphasize the importance of mosquitoes, and the necessity for a mosquito survey in the Union. Mosquitoes are not only transmitting agents of malaria, yellow fever, dengue fever, and *Filaria bancrofti* to man, but they also transmit horsesickness to horses and mules, most probably blue-tongue to sheep, *Filaria immitis* to dogs, and bird malaria to various species of birds, and in addition to these there are, no doubt, other diseases that are also conveyed by mosquitoes to both man and animals. Malaria is transmitted by various species of *Anopheles*, but not all the species belonging to this genus are capable of acting as intermediate hosts for the malarial parasites. Of the 19 species that have been found in the Union only four have been proved to be transmitting agents, namely *A. pharoensis*, *A. gambiae* and *maculipalpis* *A. funestus*. Some of the other species are common, but they are either not carriers, or at the most are very poor carriers, and those that are rare do not play an important rôle in the spread of the disease, even if they are carriers, owing to their scarcity. It does not necessarily follow that because a species is a carrier that others which are closely allied to it are also transmitters. *A. pharoensis* Theo., which is a transmitting agent, is common in most parts of Africa, but has only been found in the Union in northern Zululand, its place being taken by *A. squamosus* Theo., a closely allied species. This insect is not a carrier as it is common throughout the year in the central Transvaal, and is equally prevalent in non-malarial seasons as it is during epizootics of the disease. *A. costalis* is the main malarial carrier here; it is always prevalent when epidemics break out, but has very rarely been found at other times.

Yellow fever is transmitted by the "tiger mosquito," *Aedes argenteus* Poiret, formally known as *Stegomyia fasciata* Fabr. This mosquito is very common in many parts of the east coast, and also

occurs in other parts, but fortunately the disease is not present in this country. Dengue fever, a disease which only occurs, as far as we are aware, in this country in parts of Natal, is transmitted by *Aedes argenteus* and *Culex fatigans* Wied. *Filaria bancrofti*, which fortunately is absent from the Union, is conveyed by *Anopheles gambiae*, *Culex fatigans* and *C. pipiens*, etc. The species which transmit horse-sickness and blue-tongue are not known. *Filaria immitis* is transmitted to dogs by *Aedes argenteus* and a common European species of *Anopheles*, and bird malaria can be conveyed by *Aedes argenteus*, *Culex fatigans* and *Culex pipiens*.

Our present knowledge of the mosquito fauna of the Union is still very imperfect. Practically no collecting has been done in the Cape Province, except at Capetown, and still less is known about the mosquitoes that occur in the Orange Free State, northern, western and eastern Transvaal. In 1901-02 Sir Arnold Theiler made a collection of mosquitoes in Pretoria, and from 1908 to the present time collecting on a large scale has been undertaken practically every year at Onderstepoort. The specimens collected in Pretoria in 1902-03, and the collections made at Onderstepoort from 1908-1911 were reported upon by Theobald (1903, 1911, and 1912) and Gough (1910). In 1907 Hill and Haydon contributed a paper on the larvae of *Anopheles* found in Natal. In 1917-18 a mosquito survey of the Military Hospital areas was undertaken by the S.A.M.C. A very large number of mosquitoes were collected at Capetown, Durban, Potchefstroom and at Roberts' Heights, Pretoria, but the majority of the specimens collected unfortunately proved to be the same species. In 1922-23 the writer made a collection of mosquitoes in Zululand (3). Apart from these records, however, only a few small collections made by various people in different parts of the Union have been reported upon by Theobald and Edwards from time to time.

At the present time it is contemplated carrying out a mosquito survey of the Union, the work to be done by the Union medical authorities in collaboration with the South African Institute for Medical Research and this Division. This survey should, if carried out on a large scale, not only throw much light on the distribution of the malarial carriers and other species in general, but should also considerably extend our present knowledge of the habits, etc., of the mosquitoes. Furthermore, it should also give us some indication as to the species that transmit both horse-sickness and blue-tongue.

When carrying out transmission experiments to ascertain the carrier or carriers of a specific disease, it is a great help to have a knowledge of the distribution of both the disease and of all species of mosquitoes or other insects likely to convey the disease that occur in the areas where the disease is present; also to know the seasonal prevalence of both the disease and the insects. All this information may, however, be misleading if the disease is transmitted by more than one species, especially if the species are not closely related and their distribution is not the same, or should the distribution of the carriers overlap the distribution of the disease.

I wish to express my sincere thanks to Dr. A. Ingram for reading through the proofs of this paper, and for furnishing me with a list of mosquitoes collected by him in various parts of the Union; also for a list of mosquitoes collected by Mr. H. P. Thomasset at Weenen, Natal, and determined by Mr. F. W. Edwards.

## COLLECTING MOSQUITOES.

Mosquitoes may be collected by—

- (i) searching for them in houses, stables, and other buildings in the evenings and early mornings;
- (ii) sweeping grass with a butterfly-net before sunset;
- (iii) catching their larvae and pupae and breeding them out;
- (iv) using a tame horse or cow to attract the flies (if collecting is undertaken at night with an animal a light should only be thrown on to the animal at intervals of a few minutes);
- (v) means of mosquito-traps.

For many years mosquito-traps were used at Onderstepoort for collecting adult mosquitoes, and very satisfactory results were obtained with them. Each trap was a large movable wood and iron erection. At one end was a door, divided into two, the upper half having a large mosquito-proof wire-gauze window. At the other end was a manger, and above it a large wire-gauze window. The sides were made of wood, but the first that were used had roller-blind shutters, and these were protected from damage by the horse by iron rails. The horse was placed in a trap about an hour before sunset and the lower half of the door was left open until sunrise, when the mosquitoes were collected and the animal removed. The roller-blinds were discarded because they were constantly needing repairs, and it was found that as many mosquitoes were collected by leaving the lower half of the door open as by raising the roller-blinds about  $1\frac{1}{2}$ -2 feet from the ground and having the door completely shut.

Adult mosquitoes may be caught either with a killing-bottle, or with a glass lamp chimney closed at one end with mosquito-netting kept in position with an elastic band, and at the other end with a rubber stopper, having a small glass tube passing through it and projecting about half an inch at each end.

A killing-bottle may be made as follows:—Place a few small lumps of potassium cyanide in the bottom of a jar or glass tube; then mix some powdered potassium cyanide with a somewhat larger quantity of boracic acid; place this on top of the lumps and ram it well down. Finally cut two or three pieces of blotting-paper slightly larger than the tube and press them down on the powder to prevent it from shifting. The whole mass should only occupy about a quarter of the tube, and, if a jar is used, even less space. The cork of the tube should fit well, and beforehand placed in liquid paraffin wax.

Some collectors prefer to kill mosquitoes with chloroform vapour. This is done by placing a few drops of chloroform on cotton-wool and placing it in a tube. The larvae and pupae may be collected by searching for them in all types of potential breeding places, such as receptacles containing water, pools, streams, etc. They may be caught with a large spoon, but the best way to collect them is with a net made as follows:—Obtain a piece of thick wire and bend one end the shape of the frame of a tennis-racquet, about 5 inches long by  $2\frac{1}{2}$  inches wide. Round the frame should be sewn some mosquito-netting, which should be tight and of double thickness. When caught, the larvae will lie on the mosquito-netting, and can be placed in a jar containing the same water in which they were found breeding by dipping the net in it. When collecting, it is advisable to keep the jars in the shade as much as possible. As the larvae of some

species remain under water for some considerable time when disturbed care should be taken when approaching the breeding places. They may, however, usually be brought to the surface by stirring up the bottom of the water with the collecting net.

#### PRESERVATION OF MOSQUITOES.

Adult mosquitoes may be mounted either on thin cardboard, or better still on sheet-cellulose. First insert a fine pin (No. 20) with curved forceps through the underside of a small rectangular piece of cardboard near one end; if celluloid is used the hole must first be made with a stronger pin and then sealed up again by pressing it with the forceps. Then place the mosquito on a piece of cork and insert the point of the pin through the thorax, either between the legs or through the side. Finally, invert the mount with the pinned specimen and stick a large entomological pin through the mount behind the mosquito. A small label with the locality, date, collector's name, etc., should be fixed to the large pin beneath the mount. Mounted specimens should be stored in cork-lined wooden boxes, the lids of which should fit tightly. A small bag containing naphthaline should be pinned in one corner of the box.

Larvae and pupae may be preserved by keeping them in tubes containing 70 per cent. alcohol.

#### EXTERNAL ANATOMY.

##### *Adults.*

The head, which is joined to the thorax by a narrow neck, is more or less globular in shape, its upper surface being largely occupied by kidney-shaped compound eyes.

The area behind the eyes is termed the occiput, and other terms that have been applied are:—The nape, which is the basal portion of the head; the genae, the lateral areas behind the eyes; the vertex, the space between the eyes; and the frons, between the antennae. Arising from and projecting in front of the head are the antennae, clypeus, palpi, and the proboscis. The antennae are long and delicate structures consisting of fourteen visible segments, those of the female being pilose, i.e. clothed with short hairs, and those of the male plumose, i.e. clothed with long hairs. The palpi consist of two to four segments; in the female they may be short or long, and the joints are never swollen; in the male they are usually long, and the last two joints are invariably swollen or bent upwards or downwards. The proboscis is long and slender, and composed of the following parts:—The labrum or upper lip; the labium or under lip, which terminates in two labellae; the hypopharynx, a small needle-like structure, a pair of mandibles and a pair of maxillae.

The *thorax*, which is the median portion, is more or less bulky, and attached to it are the wings and legs. It is composed of the following parts:—A pair of prothoracic lobes (these being situated anteriorly), one on each side of the mesothorax. The mesothorax is large and arched, and behind it is the scutellum, which may be either simple or trilobed. Lying behind the scutellum is the postscutellum or metanotum. Situated on the sides of the postscutellum are a pair of club-shaped halteres, these being rudimentary hind-wings. The sides of the thorax are known as the pleurae. They are composed of various parts (see figure), and are frequently clothed with scales and hairs, the position of the latter, as Edwards has recently shown, sometimes being of generic importance.

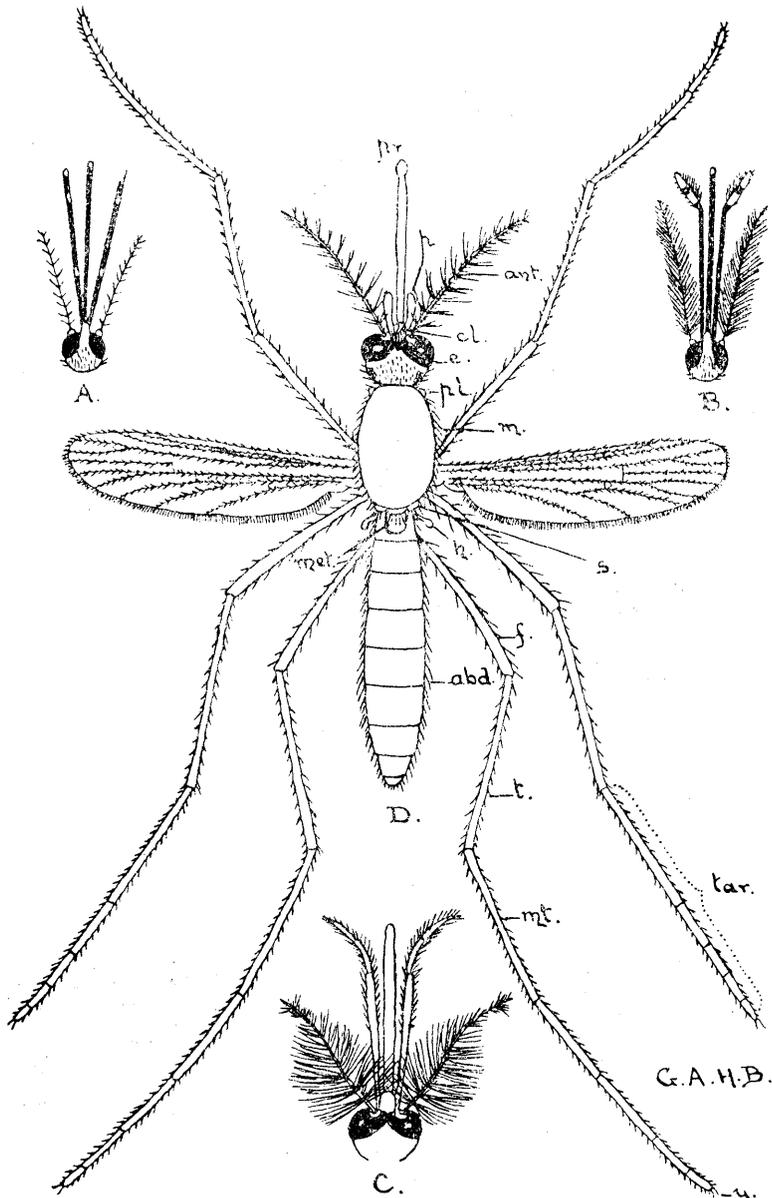


Fig. 1.—DIAGRAMS ILLUSTRATING THE EXTERNAL ANATOMY OF MOSQUITOES.

A. Head of *Anopheles* sp., female; B. Head of *Anopheles* sp., male; C. Head of *Culex* sp., male; D. *Culex* sp., female; pr. Proboscis; p. Palpus; ant. Antennae; cl. Clypeus; e. Eye; pl. Prothoracic lobe; m. Mesothorax; s. Scutellum; met. Metathorax or postscutellum; h. Halter; abd. Abdomen; f. Femur; t. Tibia; mt. Metatarsus; tar. Tarsi; u. Ungues or claws.

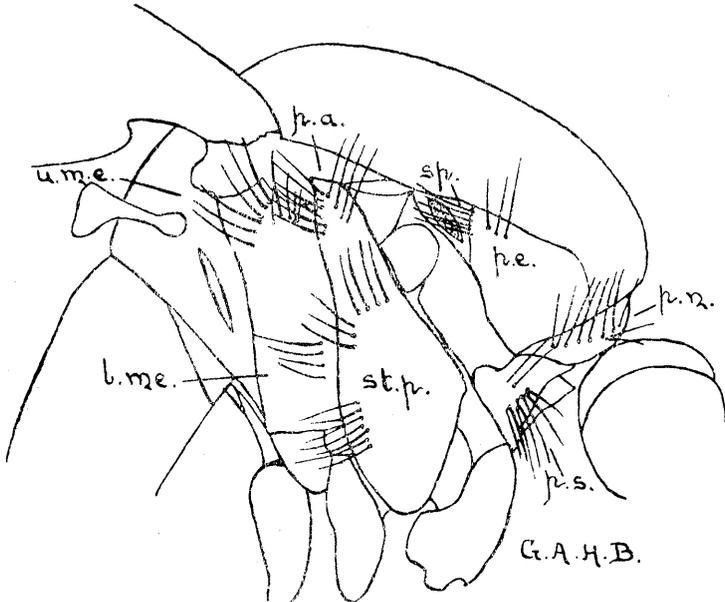


Fig. 2.—SIDE VIEW OF THORAX OF *Lutzia tigripes*, SHOWING THE ARRANGEMENT OF THE PLEURAL BRISTLES (SCALES OMITTED).

Bristles: *p.n.* Pronotal; *p.s.* Prosternal; *p.e.* Proepimeral; *sp.* Spiracular; *p.a.* Pre-alar; *u.m.e.* Upper Mesepimeral; *l.m.e.* Lower mesepimeral; *st.p.* Sternopleural.

The wings are long and narrow, and when at rest are folded flat on the abdomen. There are six or seven longitudinal veins in addition to the costa and subcosta; the second, fourth, and fifth long veins being forked. For details of the venation and cells see figure. The veins are covered with scales, and the wing margin is always fringed with scales.

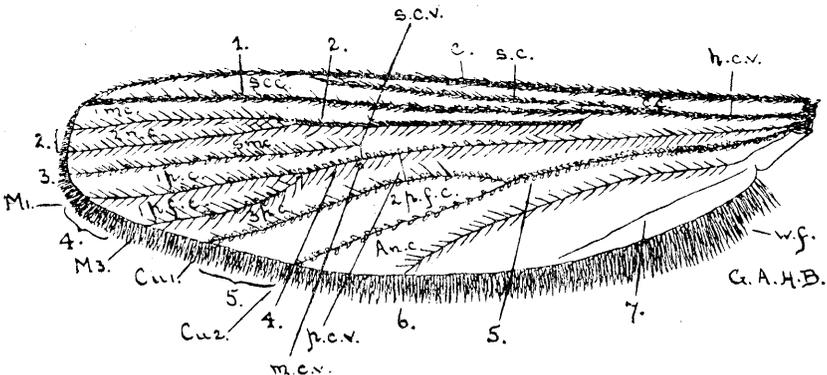


Fig. 3.—WING OF *Culex* sp., TO SHOW THE WING VENATION.

Veins. *c.* Costa.

*s.c.* Sub-costa.

1-3. 1st-3rd longitudinal or R1-R3 (Radial) veins.

4. 4th longitudinal or M (Median) vein.

5. 5th longitudinal or Cu (Cubital) vein.

6. 6th longitudinal or An (Anal) vein.

7. 7th vein.

*h.c.v.* Humeral cross-vein.

*s.c.v.* Supernumerary cross-vein.

*m.c.v.* Middle cross-vein or Radio-median (*r.m.*).

*p.c.v.* Posterior cross-vein or Medio-cubital (*m-cu.*).

*w.f.* Wing fringe.

Cells. *cc.* Costal cell.

*sc.c.* Sub-costal cell.

1 *mc.* 1st marginal cell or R1.

2 *mc.* 2nd marginal cell or R2.

*s.mc.* Submarginal cell or R3.

1 *p.c.* 1st posterior cell or R5.

1 *p.f.c.* 1st posterior fork-cell or M2.

3 *p.c.* 3rd posterior cell or M3.

2 *p.f.c.* 2nd posterior fork or Cu.

*An.c.* Anal cell.

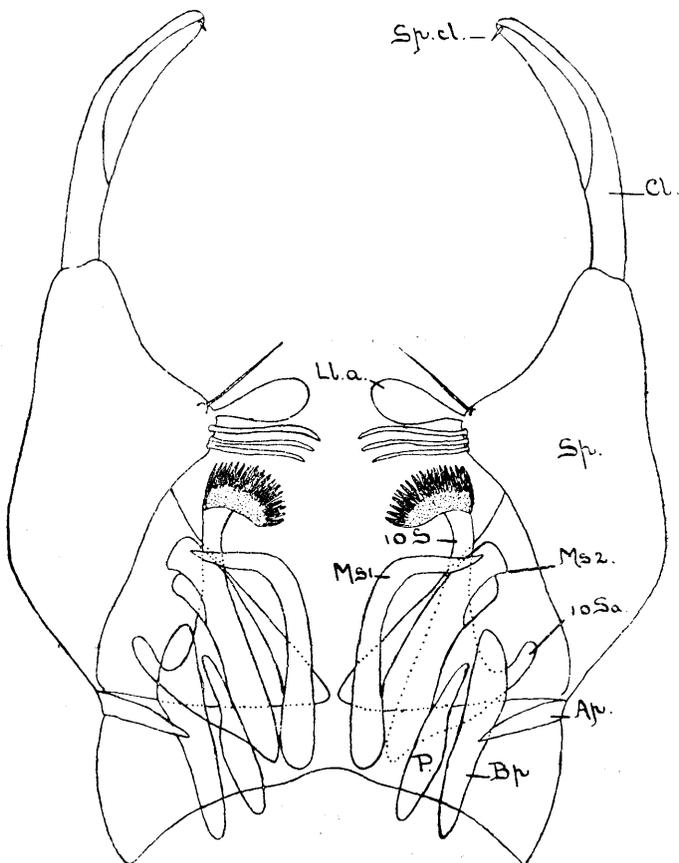


Fig. 4.—DIAGRAM OF MALE HYPOPYGIUM OF A CULEX

*Sp.cl.* Spine of clasper; *Cl.* Clasper; *Sp.* Side-piece; *L.l.a.* Leaf like appendage; *10S.* Tenth sternite; *10Sa.* Basal arm of tenth sternite; *M.s.1* and *2.* Mesosome; *Ap.* Apodeme; *Bp.* Basal plate; *P.* Paramere.

The legs are long and slender, consisting of the following joints: the coxa, trochanter, femur, tibia and tarsi. The tarsi consist of five joints, the first joint frequently being termed the metatarsus. Situated at the end of the fifth tarsal joint is a pair of ungues or claws: these may be equal and either simple or toothed, or unequal and either simple or serrated. Arising near the base of the ungues there may be pulvilli present, these being small elongate pads with glandular hairs and situated between them the empodium.

The *abdomen* which is always long and slender consists of ten segments, the last two being modified and not readily apparent. Each segment is composed of a dorsal plate or tergum and a ventral plate or sternum. At the extremity of the abdomen of the female there are sometimes present a pair of cerci, and in the male the abdomen terminates in the sexual organs, the hypopygium, which will be seen in Fig. 4 to consist of various parts. The apex of the abdomen of all male mosquitoes undergoes torsion shortly after they emerge, as was first pointed out by Christophers, so that the ninth tergite becomes ventral and the ninth sternite dorsal. The terminology of the various parts of the hypopygium used is that adopted by Edwards (*Ann. Trop. Med. & Parasit.*, xiv., pp. 23-40, 1920). The whole chitinous structure of the genital tube opening between the *ninth* and *tenth sternites*, i.e. the *basal plates*, *parameres* and *mesosome*, is termed the *aedoeagus*.

Formally the *tenth sternite* was usually termed the *harpes*, and the *mesosome* the *harpagones*.

*Scales*.—Mosquitoes are usually covered with hairs and scales, the latter varying in size, shape and colour. On the head may be found upright-forked scales, flat scales and narrow-curved scales. On the thorax may be found scales of various shapes, such as narrow-curved, spindle-shaped, flat and long twisted scales. The abdomen is usually covered either with hairs or flat scales. The veins of the wings are covered with a double row of flat scales, which vary in shape in different species. On the wing margin there is a fringe consisting of long and short scales, also small narrow flat border scales. The legs are always covered with flat scales.

#### OVA.

The eggs are usually laid on the surface of water, but may sometimes be deposited upon vegetable matter floating on the surface, or on the sides of receptacles containing water.

The eggs of *Anopheles* are laid separately; they are usually boat-shaped, and surrounded by a small delicate striated rim or frill. Attached to the sides of the eggs of most species are floats; these being small and ribbed, and constructed to contain air. It is by means of the shape and position of the floats and frill that one is able to differentiate the eggs of the various species.

The eggs of *Megarhinus*, *Aedes*, *Eretmopodites*, etc., are also laid singly, being deposited either on water, damp surfaces, or on the sides of tins, etc., containing water. They are variable in shape; those of some species being elongated oval, whilst in others they may be either club- or spindle-shaped. The eggs of *Stegomyia* are surrounded by a frill containing air. Those of some species may remain viable for long periods when kept dry. Probably most species of *Aedes* pass the winter in South Africa in the egg stage. Macfie and Ingram have

found the eggs of *Mansonioides africanus* in West Africa laid on the undersurfaces of the leaves of *Pistia stratiotes*. The eggs of *Culex* and *Lutzia* are laid in regular boat-shaped masses on the surface of water; an egg raft being composed of from about 150 to 400 eggs. Each egg is elongated oval, being broadly rounded at one end; at this end, which lies on the surface of the water, is a small round process termed the micropilar apparatus.

#### LARVAE.

There are two main types of larvae, the Anopheline and Culicine. The former breathe through a pair of sigmata situated on the dorsal surface of the eighth abdominal segment, and when they rise to the surface of the water to breathe they lie in a horizontal position at the surface. The Culicine larvae possess a large chitinous breathing tube, the siphon, on the dorsum of the eighth segment, and lie at the surface with their heads directed downwards.

The body of the larva is long and slender, and bears numerous variously formed hairs; like that of the adult it is divided into three divisions—the head, thorax and abdomen.

The hairs present on the body have been classified by Nuttall and Shipley as follows:—

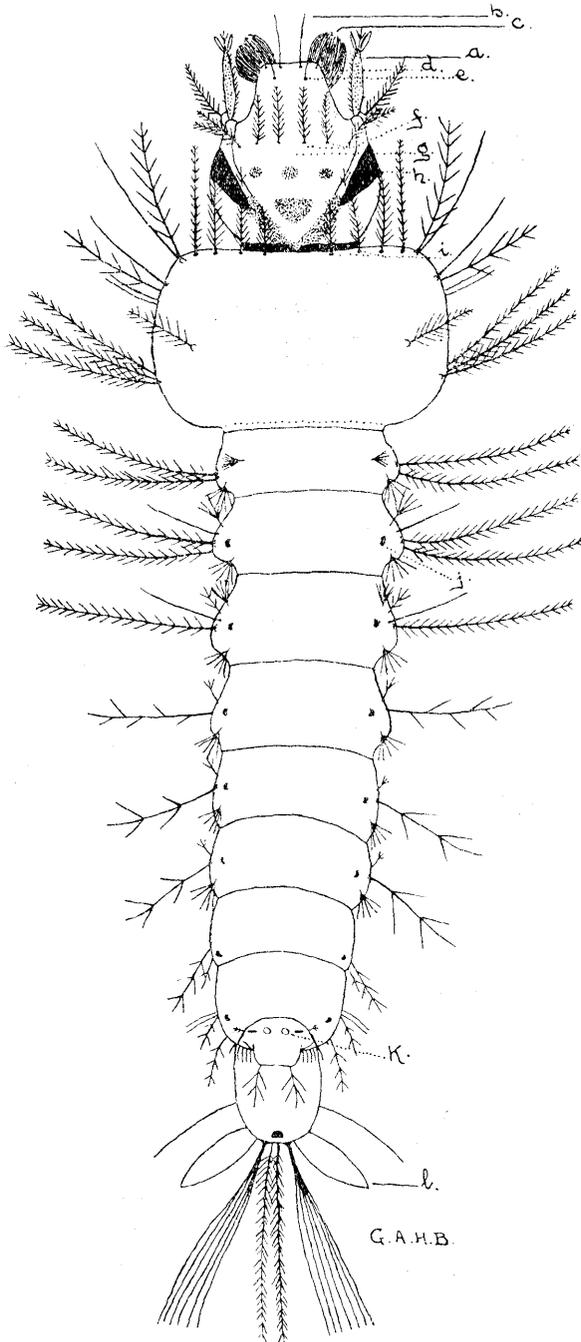


Fig. 5.—LARVA OF *A. pretoriensis* (THEO.)

*a.* Antenna; *b.* Inner anterior clypeal hair; *c.* mouth brush;  
*d.* Outer anterior clypeal hair; *e.* Pre-antennal or posterior clypeal hair;  
*f.* Post-antennal hairs; *g.* Clypeus; *h.* Trans-sutural hair (hairs between  
trans-sutural hairs termed vertical hairs); *i.* Sub-median anterior  
thoracic hairs; *j.* Palmate hair; *k.* Stigma; *l.* Anal gill

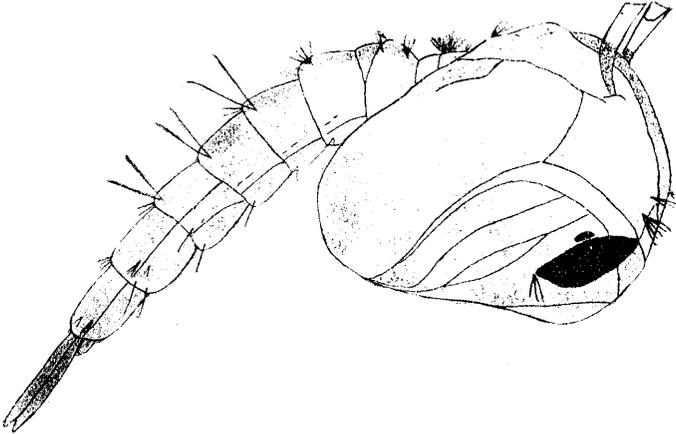


Fig. 7.—PUPA OF A MOSQUITO.

(1) *Simple hairs*.—Hairs without secondary structure.

(2) *Branched hairs*.—Hairs which bifurcate into one or more branches, such as the terminal hairs of some antennae.

(3) *Feathered hairs*.—This term is used when the secondary hairs are all very long and in one plane, such as the thoracic plumes of the *Anopheles*.

(4) *Plumose hairs*.—Those in which the secondary hairs are shorter and are, or are not, in the same plane, such as the antennal plume.

(5) *Subplumose hairs*. Those in which notches can be seen with a magnification of 60 diameters, and having only very short secondary hairs.

(6) *Plumes*.—These may arise from a number of sockets or be the outgrowths of a single hair; consequently their bases may or may not be in the same plane. The hairs may be simple, feathered or plumose.

(7) *Tufts*.—These are short, and the hairs are never in the same plane at the base.

(8) *Stellate hairs*.—Hairs which are simple, arise from a single base, and consist of not less than three or more than five.

(9) *Palmate hairs*.—These are a small fan-like arrangement of flat spines arising from a single hair. They are found in various stages of development on the thorax and abdomen of the larvae of *Anopheles*.

The *head* is more or less spherical and slightly flattened dorso-ventrally; its upper surface being mainly occupied by a chitinous plate termed the clypeus. Situated on each side are the eyes, which

vary in shape; in some stages they are reduced to small round spots and in others they are half-moon shape and frequently have a small pigmented area behind. The antennae are cylindrical and arise from the sides of the head in front of the eyes; on the shaft may be present a plume consisting of simple or branched hairs, and the distal joint has spines and simple or branched hairs at its extremity. Situated in front of the head are a pair of mouth brushes; these being dense masses of long fine hairs except in *Megarhinus*, *Mucidus*, and *Lutzia*, which have brushes composed of chitinized rods. The mouth parts are situated on the ventral surface of the head and consist of a pair of maxillary palpi, mandibles and mental plate connected with the hypopharynx in addition to the mouth brushes and other accessory hairs. The hairs on the head may be classified as shown in Fig. 5.

The *thorax* is unsegmented, rounded and considerably broader than the head and abdomen, usually with numerous plumose hairs present on the anterior and lateral margins.

The *abdomen* consists of nine segments bearing hairs, these being longest and most numerous on the lateral margins. On the dorsum of the eighth segment there is the siphon or respiratory openings, which in *Anopheles* larvae are two small holes surrounded by chitinous plates, and on each side of this segment there is a chitinous toothed plate termed the *comb*. In the Culicini the combs usually consist of a line or triangular patch of minute spines, which vary in shape and number in different species; in addition to these a *siphonal plume* is present on each side near the base of the siphon, a *sub-siphonal* plume behind the comb, and frequently an *anal plume* near the ninth segment. The siphonal tube present in the Culicine larvae is chitinous and cylindrical; it is usually much longer than broad, and the siphonic index obtained by dividing the length of the tube by its width at the base, is often of diagnostic value. At the base there is a highly chitinised ring, and at the apex there are finger-like flaps of chitin, which can be opened when the larva ascends to the surface to breathe. On each side of the venter, usually commencing at the base, there is a row of spines, these being termed the pecten. In addition to these, stellate and other hairs are also frequently present that are of specific importance. The ninth segment is small, mainly chitinous, and directed downwards; at its apex there are four membranous processes—the anal gills or papillae, also numerous long hairs, which on the venter form a brush known as the *anal* or *ventral brush*.

The larva undergoes three moults before finally pupating.

#### PUPAE.

The *pupa* emerges through a slit on the dorsum of the larval skin. It is composed of a rounded or egg-shaped body, the head and thorax, and lying beneath it the abdomen, which is elongated and flattened dorso-ventrally. Compound eyes are present, one on each side of the head, and above each arises a lateral ridge extending backwards—the antenna. On the dorsum of the thorax there are a pair of stout respiratory tubes, the trumpets; these vary in shape and length in various species, but are of little diagnostic value.

The *abdomen* consists of nine segments, the first being very small

and inconspicuous. At the apex of the eighth segment there are a pair of flaps, the fins, anal plates or paddles as they are termed; each has a longitudinal bar running through the middle and ending in one or two short hairs; in addition to these some species possess a fringe or short hairs on the margins. The ninth segment lies beneath the paddles, and in the males is armed with a pair of processes.

#### CLASSIFICATION.

The family Culicidae is divided as follows into three sub-families:—

- (1) Proboscis much longer than the head, well adapted for piercing in the female; head, thorax, abdomen, legs, and wings covered in parts or entirely with scales.—Sub-family *Culicinae*.
- (2) Proboscis not longer than the head, not adapted for piercing; entire insect hairy, especially the wings; scales absent, except on the wing-fringe and on the veins of the wings in *Ramecia*; antennae plumose in the male, pilose in the female.—Sub-family *Chaoborinae*.
- (3) Proboscis projecting somewhat, not adapted for piercing; entire insect almost devoid of hair and scales, especially the antennae in both sexes and the wings.—Sub-family *Dixinae*.

Until recently the Chaoborinae (Coretbrinae) and Dixinae were regarded by the majority of dipterologists, except Williston, as distinct from the Culicidae, and were placed in separate families on the grounds that they are devoid of a biting proboscis, but their separation is not a natural one since, as has been pointed out by Patton and Cragg, the *Stomoxys*, *Lyperosia*, and allied genera, which possess a biting proboscis, are placed in the family Muscidae along with the species of *Musca* and other genera, which have an entirely different proboscis, yet *Stomoxys* and *Musca* unquestionably belong to the same family. No further mention will be made of the Chaoborinae and Dixinae in this paper, since they are non-blood suckers and are therefore of no economic importance.

#### Sub-family CULICINAE.

The Culicinae were divided by Theobald into ten tribes, which were regarded by him of sub-family rank, since he did not recognize the Chaoborinae and Dixinae as belonging to the family Culicidae. More recently Alcock separated this sub-family into four tribes, but at the present time Edwards only recognizes two—the Anophelini and the Culicini, which may be distinguished as follows:—

1. Palpi long in both sexes; wings as a rule (always in all the known African species) with black and white or yellow spots, especially on the costa; head clothed with upright forked scales; dorsal surface of the thorax seldom densely clothed with scales; scutellum simple or trilobed (simple in all known South African species); abdomen clothed with hairs and sometimes a few scales, the latter, if present, usually form lateral tufts or are confined to the last

segment. Larvae without a long chitinous breathing syphon or tube near the extremity of the abdomen, and when at rest they lie in a horizontal position on the surface of the water. ANOPHELINI.

2. Palpi of female short or long, usually short; wings without conspicuous white or yellow spots, but they may be mottled or speckled; proboscis straight or bent, usually the former; scutellum trilobed. Larvae with a large chitinous breathing syphon near the extremity of the abdomen, and when at rest they hang with their heads directed downwards. CULICINI.

The adults of the Anophelini can also be distinguished by the characteristic attitude they assume when at rest; the proboscis and palpi being in the same plane as the thorax and abdomen, the former pointing towards the surface on which the mosquito is resting and the latter away from it, whereby the mosquito appears as if it was standing on its head. In the species of Culicini the proboscis is turned towards the surface on which the mosquito rests, and the abdomen either lies parallel to the surface or is turned slightly towards it.

### Tribe ANOPHELINI.

Small to largish mosquitoes. Head clothed with black and white upright forked scales, a tuft of long white scales projecting in front between the eyes and a few dark outward projecting chaetae on the sides. Palpi as long as the proboscis in both sexes, club-shaped at the apex in the male. Thorax usually grey in the middle, dark at the sides, clothed with hairs and scales, the latter usually confined either to the anterior margin or the grey median area. Scutellum simple in all known South African species. Abdomen clothed with hairs, rarely with scales, and then usually only on the last abdominal segments. Wings spotted with black and white or yellow in all the African species, the position and size of the spots frequently forming useful characters for differentiating the species.

The Anophelina includes a single genus *Anopheles*, which contains about a hundred species distributed throughout the temperate regions of the earth, they being especially abundant in the tropics. Of these, nineteen species have been found in South Africa.

This tribe was divided by Theobald into twenty-one genera, based entirely on the scale characters, but these Edwards has recently sunk as synonyms of the genus *Anopheles* on the grounds that scale characters grade imperceptibly into one another, are sometimes variable within specific limits, and may be confined to one sex only. The following is a table of the old genera represented in South Africa:—

- |   |                                 |
|---|---------------------------------|
| (1) Thorax and abdomen clothed with hairs. . . . .  | <i>Myzomyia</i> Blanchard.      |
| (2) Thorax clothed with narrow-curved scales; abdomen hairy . . . . .   | <i>Pyrethophorus</i> Blanchard. |
| (3) Thorax clothed with hairs, abdomen hairy, except for a tuft of scales on the ventral surface of the last segment. . . . . | <i>Myzorhynchus</i> Blanchard.  |

- (4) Thorax clothed with spindle-shaped scales; abdomen hairy, with a few scales on the last abdominal segment, at least in the male. . . . . *Nyssorhynchus* Blanchard.
- (5) Thorax and abdomen clothed with scales, the latter with distinct lateral tufts on each segment... . . . *Cellia* Theobald.

Of the above "genera," *Myzomyia* and *Pyretophorus* are often very hard to distinguish, and Edwards states that *A. (M.) funestus* Giles may have either hairs or narrow-curved scales on the thorax, but we have never seen specimens with the latter. All the species found in South Africa belonging to both these "genera," have however, a patch of narrow-curved scales on the thorax behind the head. The type of the genus *Nyssorhynchus*, as has been pointed out by Edwards, was a species of *Cellia*. At the present time two sub-genera are recognized, namely, *Anopheles* and *Myzomyia*, the former being represented in South Africa by a single species, *Anopheles mauritanus* Grand. and Char.

#### Genus ANOPHELES Meigen.

Meigen, Syst. Besch. Europ. Zweiflug. Insekten, 1, 10 (1818).  
Theobald, Mon. Culic., Vol. I, p. 115 (1901).

#### TABLE OF SPECIES.

##### A.—ADULTS.

- (1) Costa mainly dark, with only two pale spots (sometimes absent or indistinct); abdomen of female with a tuft of scales on the ventral surface of the last segment... . . . . *A. mauritanus* Grand. and Char.
- Costa with more than two pale spots... . . . . [2]
- (2) Abdomen with scales on all the segments, and with a tuft of black outstanding scales on the apical lateral margins of the segments. . . . . [3]
- Abdomen without scales, or if present, only on the apical segment. . . . . [6]
- (3) Hind tarsi entirely dark . . . . . *A. argenteolobatus* Gough. [4]
- Hind tarsi with white bands. . . . . [4]
- (4) Last joint or hind tarsi entirely dark. . . . . *A. squamosus* Theo.
- Last joint of hind tarsi either entirely white or with pale bands. . . . . [5]

- (5) Last joint of fore and mid tarsi dark. ... .. *A. pharoensis* Theo.  
 Last joint of all the tarsi white at the apex. ... .. *A. jacobi* Hill and Hay.
- (6) Mesonotum clothed with hairs or narrow-curved scales. ... .. [7]  
 Mesonotum clothed with broadish elliptical scales. ... .. [17]
- (7) Last 2-3 hind tarsi all white. ... .. [16]  
 Last 2-3 hind tarsi not all white. ... .. [8]
- (8) Legs spotted and banded. ... .. [15]  
 Legs not spotted, tarsi with or without bands. ... .. [9]
- (9) Palpi of female with 3-4 narrow white bands. ... .. [10]  
 Palpi of female white at the apex only; base of first fork-cell nearer apex of wing than that of the second; small, very dark species. ... .. *A. nili* Theo.
- (10) Palpi of female with four narrow white bands, mesonotum clothed with narrow-curved scales; large species. *A. cinereus* Theo.  
 Palpi of female with three white bands. ... .. [11]
- (11) Mesonotum clothed with hairs only, except for a small patch of narrow-curved scales in front; costa dark at base, pale at apex. ... .. [12]  
 Mesonotum clothed with narrow-curved or hair-like scales. ... .. [13]
- (12) Wings with spots only on the costa; fringe not spotted; tarsi unbanded. ... .. *A. rhodesiensis* Theo.  
 Wings with spots on some of the longitudinal veins; fringe spotted; tarsi with narrow white bands. ... .. *A. funestus* Giles.
- (13) Mesonotum clothed with creamy narrow-curved scales in front and yellow hair-like scales behind; costa pale at base, dark at apex. ... .. *A. pitchfordi* Giles.  
 Mesonotum clothed with pale grey narrow-curved scales. ... .. [14]
- (14) Tarsi with narrow yellowish bands, palpi of female with rather broad middle and apical pale bands. ... .. *A. marshalli* Theo.

- Tarsi dark, palpi of female with the middle pale band rather narrow. ... *A. transvaalensis* Carter.
- (15) Palpi of female with three white bands, the apical one only broad. ... *A. gambiae* Giles.  
Palpi of female with four narrow white bands. ... *A. ardensis* Theo.
- (16) Longitudinal veins with the yellow patches predominating. ... *A. theileri* Edw.
- (17) Mesonotum clothed with golden scales; palpi of female with four narrow white bands; wing-scales lanceolate; legs spotted; last two hind tarsi all white. *A. natalensis* Hill and Haydon.  
Mesonotum clothed with white scales; palpi of female with three white bands; wing-scales much narrower. ... [18]
- (18) Femora and tibiae spotted; last 2-3 hind tarsi all white. ... [19]  
Femora and tibiae not spotted; last three hind tarsi all white. ... *A. rufipes* Gough.
- (19) Palpi of female white spotted; last three hind tarsi all white. ... *A. maculipalpis* Theo.  
Palpi of female not spotted; last two hind tarsi all white. ... *A. pretoriensis* Theo.

B.—KNOWN SPECIES OF LARVAE (after Edwards).

- (1) Shaft of antenna with hair-tuft; no plumose hairs in middle of thorax overlapping occiput... *A. mauritanus* Grand. and Char.  
Shaft of antenna without hair-tuft; plumose hairs present in middle of thorax in front. ... [2]
- (2) Rudimentary palmate hairs on thorax ... [3]  
Palmate hairs of thorax altogether wanting. ... [6]
- (3) External anterior frontal hair much branched, forming a pronounced tuft. ... *A. squamosus* Theo.

- A. pharoensis* Theo.
- External anterior frontal hair simple or slightly branched. [4]
- (4) Posterior and internal anterior frontal hairs simple ... .. *A. funestus* Giles.  
Posterior and internal anterior frontal hairs branched. ... .. [5]
- (5) Dark brown; filaments of palmate hairs longer. ... .. *A. natalensis* Hill and Hay.  
Light brown; filaments of palmate hairs shorter ... .. *A. ardensis* Theo.
- (6) Internal anterior frontal hair branched... .. [7]  
Internal anterior frontal hair simple. ... .. [8]
- (7) Palmate hair of second abdominal segment fully developed, the leaflets with a distinct shoulder; filaments of all palmate hairs about  $\frac{1}{3}$  as long as the whole leaflet. *A. gambiae* Giles.  
Leaflets of palmate hair of second abdominal segment without shoulder; filaments of all other palmate hairs under  $\frac{1}{4}$  as long as the whole leaflet. ... .. *A. jacobi* Hill and Hay.
- (8) Hair at tip of antennae (between the two spines) split into two ... .. *A. cinereus* Theo.  
Hair at tip of antennae split into three ... .. [9]
- (9) Palmate hairs on second abdominal segment well-developed ... .. *A. pretoriensis* Theo.  
Palmate hairs on second abdominal segment rudimentary ... .. *A. rufipes* Gough.  
No palmate hairs on second abdominal segment ... .. *A. marshalli* Theo.

I. ANOPHELES (ANOPHELES) MAURITIANUS Grandpré & Charmoy (1900).

*Anopheles paludis* Theobald (1901).

*Anopheles paludis* var. *similis* Theobald (1901).

*Anopheles tenebrosus* Donitz (1902).

*Myzorrhynchus mauritianus* (Grand. & Char.) Theo. (1903).

Grandpré & Charmoy, Planter's Gaz. Press (1900).

Theobald, Mon. Culic., Vol. I, pp. 128, 129, Pl. 2, f. 5 (1901); Vol. III, pp. 85, 86 (1903); Vol. IV, p. 88 (1907); Vol. V, pp. 53-54 (1910); 1st Rep. Div. Vet.