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THE CLASSIFICATION OF MOSQUITOES.*

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THE mosquitoes, gnats, or *Culicidæ* were originally all contained in four genera—*Culex* and *Anopheles*, *Ædes* and *Corethra*. Of these even now there are only two groups referred to in medical journals (*Culex* and *Anopheles*). The genus *Culex* has been a sort of harbour of refuge for all *Culicidæ* except *Anopheles* and the large *Megarhinus* and *Ædes*, and contains many forms quite as diverse from one another as *Anopheles* are from *Culex*; some even more so. It is thus very important from a practical point of view in connection with the malarial question to sift and sort out and to arrange these various so-called *Culex*, many of which are generically quite distinct from the typical *Culex*, such as our European *C. pipiens* of Linnæus and the tropical and subtropical *C. fatigans* of Wiedemann.

If there are sufficient differences between these old *Culices* to be of generic importance scientifically, there may be and probably are very important internal structural and physiological deviations.

At present all the blame of malaria-carrying is placed on members of the genus *Anopheles*. It has been said more than once that *Culex* does not do so. What *Culex* have been experimented with? *C. fatigans*, Wiedemann; *C. annulatus*, Meigen; *C. pipiens*, L.; *C. penicillaris*, Rond; *C. pulchritarsis*, Rond; *C. vexans*, Meig.; *C. nemorosus*, Meig.; *C. albopunctatus*, Rond; *C. spathipalpis*, Rond; *C. hortensis*, Fic.; *Tæniorhynchus Richardii*, Fic.; *Stegomyia fasciata*, Fab., and *Ædes*; all these are true *Culex*. But many species that have been considered as such I find are very different. These I have raised to distinct genera, and from what we know of some of these new genera they have very different life-histories to *Culex* proper. Before we can place all the blame on *Anopheles* we must see if any of these new groups can serve a similar obnoxious and posterior cross-veins. But too much reliance *rôle*. Hence to-day I am going to try and point out the characters by which the old and the new genera of the *Culicidæ* can be distinguished.

In formulating the new genera, and in, to some extent, re-modelling the old, I have made most use of the scale structure. The palpi and ungues which have been used as generic characters by Arribalzaga, have had to be discarded. Not until I had examined some thousands of specimens, embracing three hundred odd species from different parts of the world, did I decide upon any general grouping of these pests, but after due consideration I found the scale structure was the only one upon which I could form a satisfactory division of these insects; other characters, such as palpi, ungues, &c., being seen to be of specific but not of generic value.

It is therefore necessary to explain the general structure of a typical mosquito and the scales which cover it, and which give the creatures their often gorgeous colours.

The mosquito, like any other hexapod, can be divided into three main parts—(1) the head, (2) the thorax, and (3) the abdomen.

(1) *The head* bears on its lateral halves a pair of compound eyes, reniform in shape, a pair of jointed antennæ, pilose in the female, plumose in the male, these are not subject to much variation, but a few very important modifications appear upon which two new genera have been formed (*Deinocerites*, Theo., and *Brachiosoma*, Theo.) Of the mouth parts I need only speak of the palpi, as they vary tremendously. In the female they may be long (*Megarhinus* and *Anopheles*), or short (*Culex*, *Ædes*, *Stegomyia*, &c.). In the male also they may be either long (*Culex*, *Anopheles*, &c.) or short (*Ædes*, *Uranotænia*, *Wyeomyia*, &c.). The numbers of joints vary from two in *Ædes* to four in *Anopheles*, or five in *Megarhinus*. These joints are generally difficult

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PLATE I.

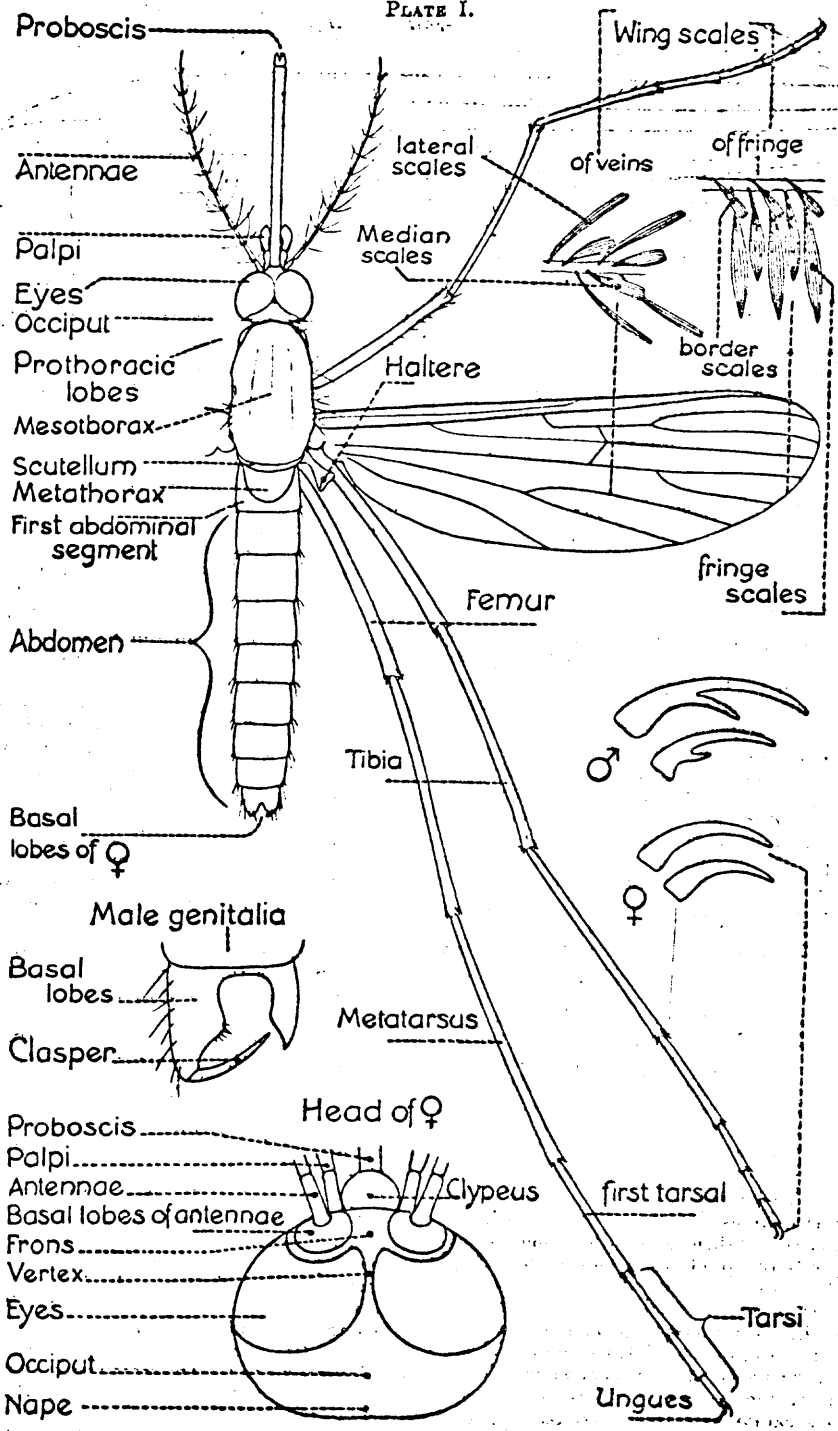
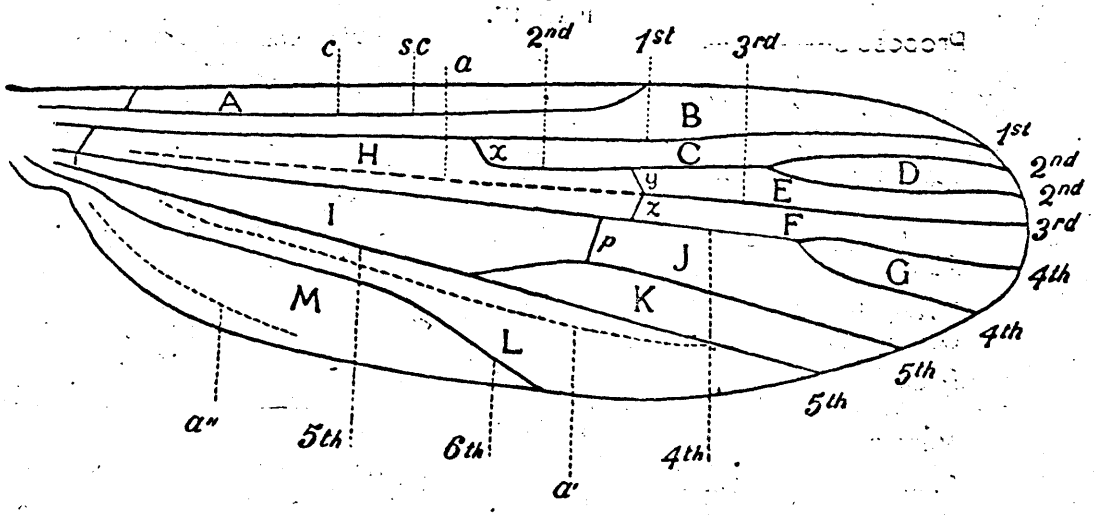

Proboscis
Antennae
Palpi
Eyes
Occiput
Prothoracic lobes
Mesothorax
Scutellum
Metathorax
First abdominal segment
Abdomen
Basal lobes of ♀
Male genitalia
Basal lobes
Clasper
Head of ♀
Proboscis
Palpi
Antennae
Basal lobes of antennae
Frons
Vertex
Eyes
Occiput
Nape
Wing scales
lateral scales
of veins
of fringe
Median scales
Haltere
border scales
fringe scales
Femur
Tibia
Metatarsus
Clypeus
first tarsal
Tarsi
Ungues
♂
♀

PLATE II.



to see in museum specimens. There are also constrictions towards the base of the palpi which have been erroneously taken for joints. Too much importance should not be attributed to joints in palpi, as they are liable to cause grave errors, being covered with scales which hide the segmentation. With regard to the thorax we find all three divisions present, but the main area is the mesothorax, the prothorax being reduced to a pair of lobes, and the metathorax is very small and nearly always nude. Between the meta- and meso-thorax comes a plate, the scutellum, which is usually trilobed (*Culex*, *Stegomyia*, *&c.*), but may be simple (*Anopheles*). The thorax bears a pair of wings and the six jointed legs attached to the lower lateral surfaces, the pleuræ.

The wings have the veins and the whole border covered with scales, which are of generic importance, while the venation is also of great use in classification. On the wing field are six longitudinal veins. There is one surrounding the border of the wing called the costa, the others are spoken of as the first, second, third, and so on, longitudinal veins; the second and fourth longtudinal veins are forked apically, the forks forming respectively the so-called first submarginal cell and the second posterior cell. In some genera the "fork-cells" are very small (*Megarhinus*, *Uranotænia*), in others long (*Culex* and *Anopheles*). Between the long veins we find transverse or cross-veins; those of special classificatory value I find to be the supernumerary, middle, and posterior cross-veins. But too much reliance must not be placed on them as their is some variation in their relative positions even in the same species.

Of the legs I need say but little. The joints are known as the coxa (basal), trochanter, femora, tibia, and tarsi; the latter being five in number, the first being often spoken of as the metartarsus. The relative length of some of these joints may serve as a guide to separate two closely related species. The femora are swollen in some genera (*Uranotænia* and *Anopheles*). The ungues or claws also offer specific distinctions; in the female they are always equal, usually simple, but they may be uniserrated; in the male, the fore and the middle are always unequal, both may be uniserrated, and the larger one bi- or even tri-serrated; in a few they are simple, the posterior pair are always equal and simple, and usually small. I can detect no variation in these in any one species.

The abdomen presents no points of value save the genitalia of the male. The latter differs in most species, and in some cases are peculiarly modified. The so-called hypopygium consists of a pair of basal lobes and two claspers, which vary in form and arrangement.

Such briefly are the chief external structures of a mosquito that are of systematic value.

Scales.—Head, palpi, part of the thorax, abdomen, legs, and wings are covered more or less completely with scales. These scales may assume very various forms (Plate 3, figs. *a* to *k*), but they may be reduced to about six well-marked types on the body and head of the mosquito.

These I have called by the following names:—(1) Narrow curved scales (*e*); (2) spindle-shaped curved scales (*f*); (3) upright forked scales (*h* and *i*); (4) spade-shaped scales or broad flat scales (*a*); (5) long twisted scales (*j*); (6) narrow hair-like curved scales (*d*).

Really all the scaly covering to the head, thorax, abdomen, palpi, and legs can be reduced to one of these six types. On the wings we get other modifications; the scales may be (1) linear and narrow; (2) clongated oval; (3) lanceolate; (4) pyriform (*k*); (5) spatulate; (6) or asymmetrically broadened (*b* and *c*).

The arrangement of the scales on the head in a typical *Culex* (Plate 3, fig. 2) is as follows: Narrow curved scales all over the occiput; upright forked ones, especially thick towards the nape, and flat ones on each side of the head. The thorax is more or less densely clothed with scales; in one type they are all narrow curved scales or hair-like or spindle-shaped scales on both the mesothorax and the

PLATE III.

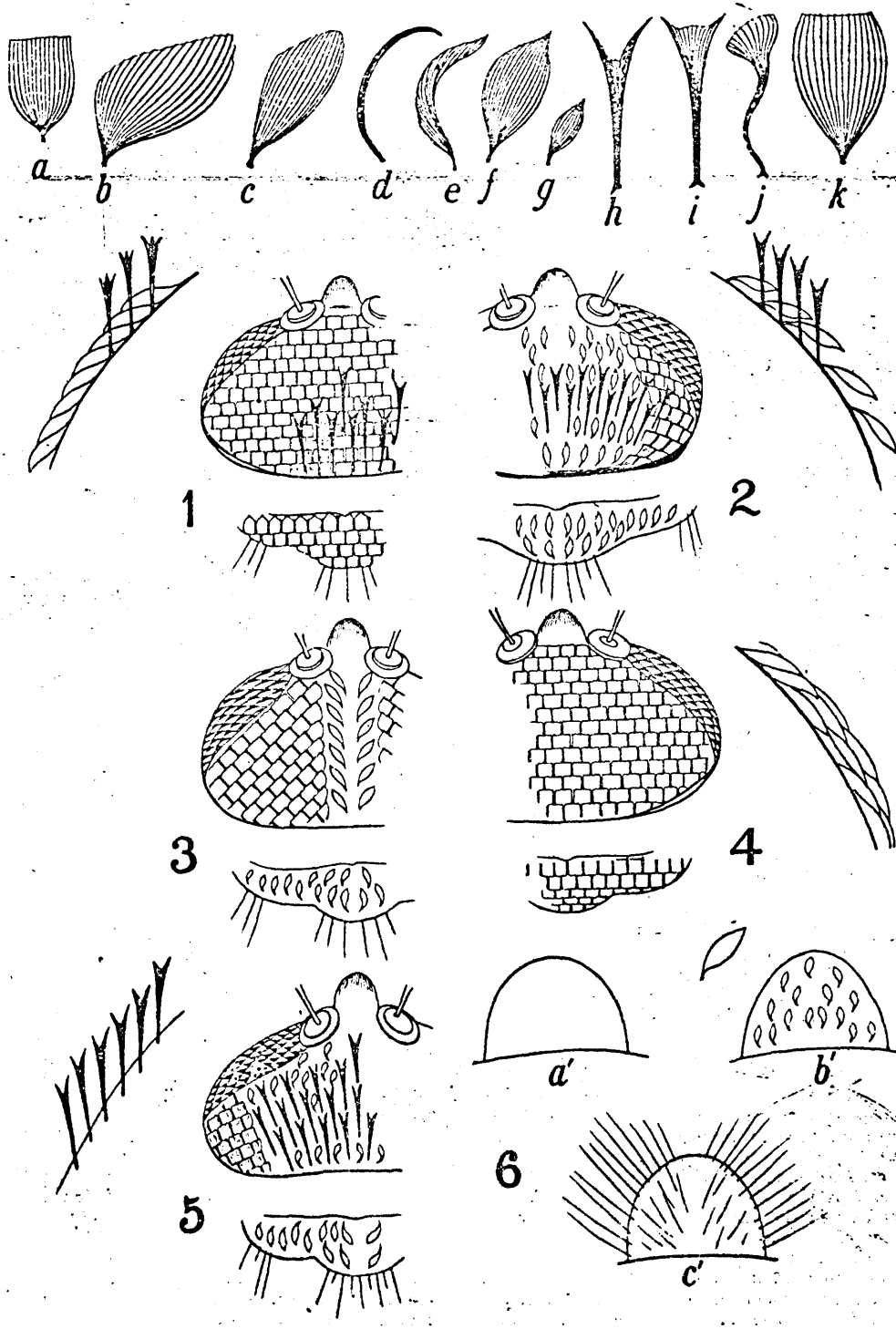
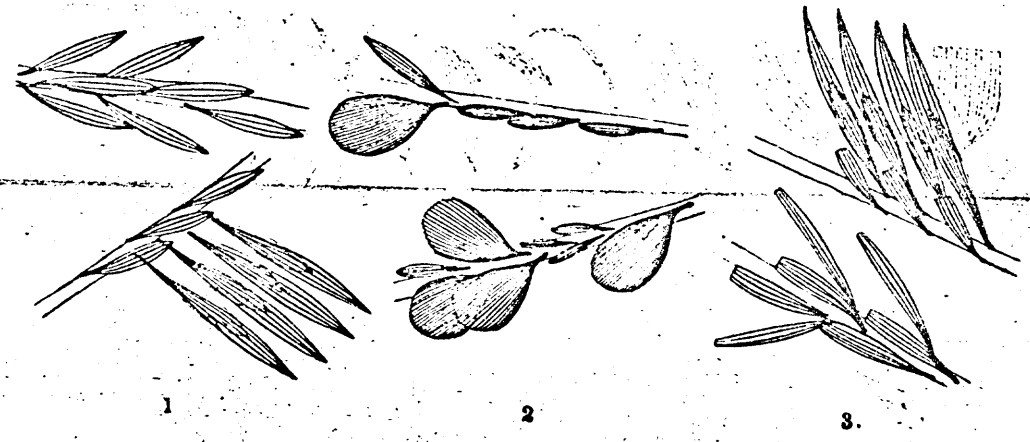


PLATE IV.



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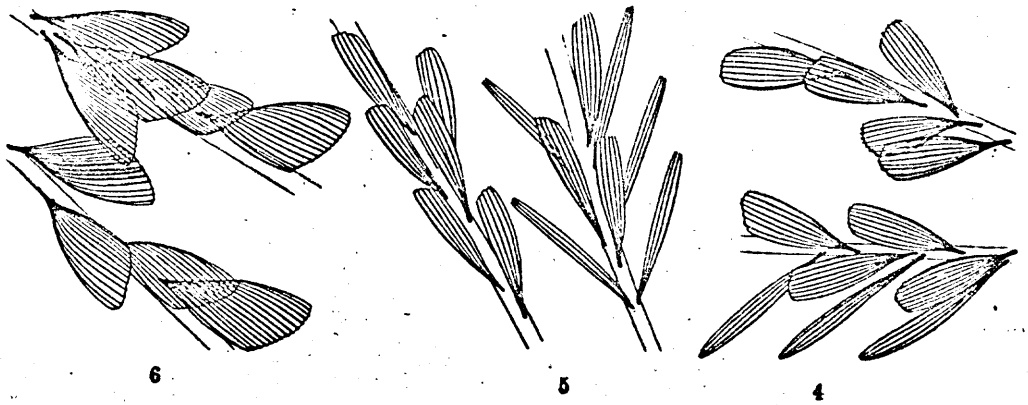

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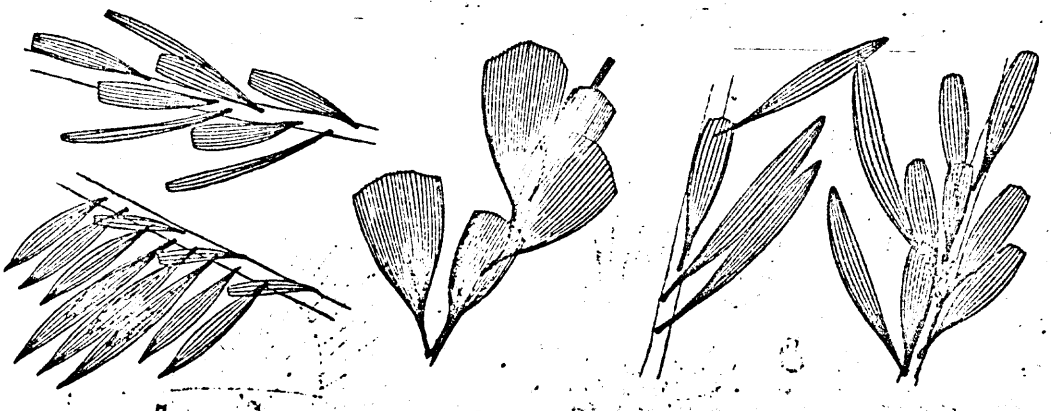
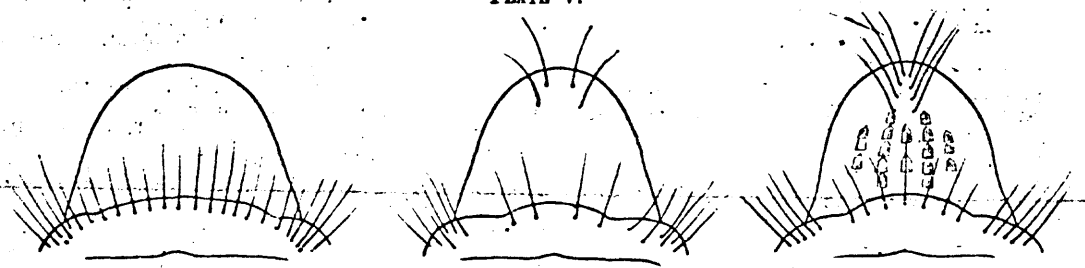


7. 8 9

PLATE V.



1 2 3

scutellum; the metanotum is always nude in typical *Culex* and *Anopheles* (*vide* Plate 5). The legs are also completely covered with scales, which usually lie close together and overlap like the tiles on the roof of a house; they are normally small and spatulate in form and closely applied to the surface, but they may become elongated and erectile, or form dense tufts, giving the legs a thickened appearance (*Janthinosoma*), or even forming dense paddle-like patches (*Sabethes*).

The abdomen in most *Culicidæ*, save *Anopheles*, is covered with flat spatulate scales which form a complete covering. These offer little of systematic value, but in some genera the scales of the abdomen become rather elongated and erectile, and give the body a rough appearance (*Mucidus*), and in others certain parts may be densely scaled with long narrow scales forming a kind of caudal fan (*Megarhinus*, &c.).

On the wings we find scales of quite different form to those of the body. Each vein has two, three, four or more series of scales attached, which vary in form in the different genera. These scales are usually spoken of as (1) median vein scales, (2) lateral vein scales. In *Culex* the former are usually moderately broad, symmetrical, short or elongated scales ending convexly or flat, the lateral vein-scales in *Culex* are thin, linear, straight, or bent squamæ (Plate 4, fig. 7).

The wing fringe is composed of three or four sets of scales, the fringe-scales being long, of three sizes, and lanceolate, and along the border of the wing a third or fourth series of smaller scales, the border-scales of systematic value.

The genera first formed for *Culicidæ* were *Culex* and *Anopheles*, *Ædes* and *Corethra*. The genus *Culex* was instituted by Linnæus in 1790, and was apparently founded on *Culex pipiens*; *Anopheles* by Meigen in 1818, and also *Ædes* and *Corethra*.

In 1827 Robineau Desvoidy, in his "Essai sur les Culicides," instituted three new genera, *Megarhinus*, *Psorophora*, and *Sabethes*. Low, in 1844, placed *Mochlonyx* as a distinct genus.

Not until 1891 was any fresh tabulation of the family attempted. In that year Arribalzaga separated from *Culex* the genera *Janthinosoma*, *Taeniorhynchus*, *Ochlerotatus*, and *Heteronycha*; and from *Ædes* the genus *Uranotænia*. Another genus related to *Ædes* was formed by Williston, *Hæmagogus*, for a single St. Vincent species.

Of these genera I have retained *Culex*, *Anopheles*, *Megarhinus*, *Sabethes*, *Psorophora*, *Janthinosoma*, *Taeniorhynchus*, *Uranotænia*, *Hæmagogus*, *Ædes*, *Corethra*, and *Mochlonyx*. But the characters of the genera have been somewhat modified.

The characters of the genera were mainly based on the proboscis and palpi, but into this old classification I need not now enter.

To these old genera I now add the following:—*Cycloleppteron*, *Toxorhynchites*, *Mucidus*, *Eretmapodites*, *Stegomyia*, *Armigeres*, *Deinocerites*, *Panoplites*, *Wyeomyia*, *Ædeomyia*, *Trichoprosopon*, and *Brachiosoma*.

The characters of these and the old genera are as follows:—

SECTION A.—Proboscis formed for suction; metanotum nude (Plate 5, fig. 1).

(*a*) Palpi long in the male.

Genus 1. *Anopheles* (Meigen).—Palpi long in both sexes, usually clubbed in the male. The head clothed almost entirely with large upright forked scales, a few narrow curved ones, and flat lateral ones (Plate 3, fig. 5). The thorax has usually narrow hair-like curved scales, but in some species they are spindle-shaped, the scutellum round or slightly trilobed with narrow curved scales, the abdomen usually nude of scales, but they may be present in the form of narrow spindle-shaped ones. The wing scales are rather long and lanceolate or narrowly spindle-shaped (Plate 4, fig. 1). The larvæ have no respiratory tube and lie horizontally in the water.

Genus 2. *Cycloleppteron* (Theobald).—Closely related to *Anopheles* and separated from it by the presence of deep inflated wing scales in patches, forming more or less black spots (Plate 4, fig. 2).

(*b*) Palpi long in male, shorter in female; first submarginal cell very small; proboscis bent (*Megarhinina*). Palpi five-jointed in female (*Megarhinus*); three-jointed in female (*Toxorhynchites*).

Genus 3. *Megarhinus* (Rob. Desvoidy).—Scales of the head are all arranged like tiles on a roof, flat (Plate 3, fig. 4); thorax with spindle-shaped and broad scales over the wings; scutellum with broad scales; caudal tuft present on last few apical abdominal segments. Larvæ large with respiratory tube.

Genus 4. *Toxorhynchites* (Theobald).—Venation and scale structure like the above, but the female palpi three-jointed and short.

(*c*) Palpi short in the female, long in the male; first fork-cell long (*Culicina*). In this group the

cross-veins and wing scales form the chief distinctive characters.

(*d*) Legs more or less densely scaled.

Genus 5. *Sabethes* (Rob. Desvoidy).—Mid cross-vein nearer apex of wing than supernumerary; posterior cross-vein nearer apex than midde. Legs with dense paddle-like areas of long scales.

Genus 6. *Janthinosoma* (Arribalzaga).—Cross-veins as in *Culex;* hind legs densely scaly; the scales on the thorax broadly spindle-shaped.

Genus 7. *Psorophora* (Rob. Desvoidy).—Posterior cross-vein nearer the base of wing than the mid cross-vein; wings with thin scales; legs densely scaled. Thorax with lines of small spindle-shaped scales.

Genus 8. *Mucidus* (Theobald).—Posterior cross-vein nearer apex of wing than mid.; wings with large pyriform and large spatulate scales, mostly parti-coloured (Plate 4, fig. 8). Thorax and head with long twisted upright scales giving a mouldy appearance (Plate 3, *j*).

Genus 9. *Eretmapodites* (Theobald).—Posterior cross-vein nearer base of wing than mid cross-vein; wings with rather long thick scales (Plate 4, fig. 4); legs in male with dense apical paddle. Scales of the head flat and also scutellum.

(*e*) Legs uniformly scaled with flat scales.

Genus 10. *Stegomyia* (Theobald).—Head and scutellum with flat scales; head with upright forked ones as well (Plate 3, fig. 1). Wing scales small, both spatulate and linear (Plate 4, fig. 5); fork-cells rather small. Palpi of male with more or less tufts of hairs. Larvæ with short respiratory siphon; eggs often laid separately.

Genus 11. *Armigeres* (Theobald).—Like above, but the male palpi rather long, thin and nude. Large species. Scales on head narrow and curved, upright forked ones, and broad flat lateral ones. Head and scutellum with narrow curved scales.

Genus 12. *Culex* (Linn.)—Wing scales small, lateral ones linear. Head and scutellum with scales as in Plate 3, fig. 2.

Genus 13. *Panoplites* (Theobald).—Wing scales mostly broad and asymmetrical (Plate 4, fig. 6).

Genus 14. *Tæniorhynchus* (Arribalzaga).—Wing scales dense, mostly elongate, oval, or broadly lanceolate.

Genus 15. *Deinocerites* (Theobald).—Second antennal joint very long, nude. In all the other *Culicina* it is rather small.

Genus 16. *Brachiosoma* (Theobald).—Second antennal joint long; the greater part of antennæ densely scaly.

(*f*) Palpi short in both sexes (*Ædeomyina*).

(*g*) Palpi two- or three-jointed, non-metallic.

Genus 17. *Ædeomyia* (Theobald).—Wing scales large and flat (Plate 3, *e*); fork-cells normal.

Genus 18. *Ædes* (Meigen).—Wing scales small, linear like *Culex*; fork-cells normal.

(*h*) Palpi five-jointed.

Genus 19. *Hæmagogus* (Williston).—Metallic; fork-cells normal.

(*i*) Palpi two-jointed.

Genus 20. *Uranotænia* (Arribalzaga).—Fork-cells very small; metallic; flat scales in spots on thorax.

SECTION B.—Proboscis formed for piercing; Metanotum with chætæ; palpi small.

Genus 21. *Wycomyia* (Theobald).—Proboscis moderately or very long.

SECTION C.—Proboscis formed for piercing; metanotum with chætæ and scales.

Genus 22. *Trichoprosopon* (Theobald).—Palpi short in female; long in male.

SECTION D.—Proboscis short; not formed for piercing (*Corethrina*).

Genus 23. *Corethra* (Meigen).—Metatarsus longer than first tarsal joint.

Genus 24. *Mochlonyx* (Low).—Metatarsus shorter than first tarsal.

DESCRIPTION OF PLATES.

PLATE I.

TYPICAL PARTS OF MOSQUITO.

PLATE II.

WING OF CULEX.

c, costal vein; *s.c*, sub-costal; *1st* to *6th*, first to sixth longitudinal veins; *a*, *a'*, and *a"*, incrassations (*a'* called by Austen the *6th* vein, *a"* the *8th*); *y*, supernumerary cross-vein; *z*, mid-cross vein; *p*, posterior cross-vein; A, costal cell; B, sub-costal cell; C, marginal cell; D, first sub-marginal cell; E, second sub-marginal cell; F., first posterior cell; G., second posterior cell; J, third posterior cell; K, anal cell; H, first basal cell; I, second basal cell; L, auxiliary; M, spurious cell.

PLATE III.

HEAD AND SCUTELLAR ORNAMENTATION IN CULICIDÆ.

(1) Head, scutellum, and lateral view of head scales in *Stegomyia* (Theo.).
(2) Head, &c., in *Culex* (Linn.).
(3) " *Ædes* (Meigen).
(4) " *Megarhinus* (R. Desv.).
(5) " *Anopheles* (Meigen).
(6) " Clypeus of *a' Culex*, *b' Stegomyia* (Theo.), and *c' Trichoprosopon* (Theo.).

a to k, Forms of Scales.

(*a*) Spade-shaped scale.
(*b*) Broad asymmetrical winged scale of *Panoplites* (Theo.).
(*c*) The same of *Ædeomyia* (Theo.)
(*d*) Curved hair-like scale.
(*e*) Narrow curved scale.
(*f*) Spindle-shaped scale.
(*g*) Small spindle-shaped scale.
(*h*) and (*i*) Upright forked scale.
(*j*) Upright twisted scale.
(*k*) Inflated parti-coloured scale.

PLATE IV.

FORMS OF WING SCALES.

(1) *Anopheles* (Meigen) vein and fringe scales. → OK
(2) *Cycloleppteron* (Theobald) vein scales. → Anopheles (Anopheles)
(3) *Janthinosoma* (Arribalzaga) vein and fringe scales. → Psorophora (Janthinosoma)
(4) *Eretmapodites* (Theobald) vein scales. → OK
(5) *Stegomyia* (Theobald) vein scales. → OK
(6) *Panoplites* (Theobald) vein scales. → Mansonia (Mansonia)
(7) *Culex* (Linnæus) vein and fringe scales.
(8) *Mucidus* (Theobald) vein scales.
(9) *Psorophora* (Rob. Desvoidy) vein and fringe scales.

PLATE V.

TYPES OF METANOTUM.

(1) *Culex.* (2) *Wycomyia.* (3) *Trichoprosopon.* → OK