A HANDBOOK

OF THE

GNATS OR MOSQUITOES

GIVING

THE ANATOMY AND LIFE HISTORY

OF THE

CULICIDÆ

TOGETHER WITH DESCRIPTIONS OF ALL SPECIES NOTICED UP TO THE PRESENT DATE

BY

LIEUT.-COL. GEO. M. GILES

I.M.S (RETD.), M.B.LOND., F.R.C.S.

Formerly Naturalist to the Indian Marine Survey

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PREFACE TO THE SECOND EDITION.

It is now well-nigh a year ago since my publisher telegraphed to me in India, requesting permission to reprint, on account of the entire first edition being "sold out," and I feel that some explanation is required of what might appear undue delay in meeting the demand for further copies. I felt at once, however, that a mere reprint was out of the question, though I had little idea of the magnitude of the task before me. The first edition had served its purpose in providing workers on the subject with a handy compilation of existing literature, for it neither was, nor professed to be, in any sense original; but a year's work in a very malarious and much mosquito-beridden country had furnished me with material on which to found personal conclusions on many points, and so much had been written by other students of the subject, in all parts of the world, that it was clear that no mere compilation would now serve the purpose. The statements as to the anatomy of the adult insect, reproduced from various authors, in the first issue, I had already found were inaccurate in many points, and the chapter on that subject is now the result of a couple of months of constant work with the microtome, and by dissection. So much had been said and done on the question of malarial prophylaxis, that it was clear that a separate chapter on the subject was absolutely essential, and the net result of these, and other changes, was that when the scattered notes came to be put together, hardly a paragraph of the old matter of the first, or general, portion of the book remained in its original form, and it had been, for all practical purposes, rewritten.

I hoped, however, that the second, or systematic, portion would only require bringing up to date by inserting in their places any new species that might have been described in the interval; but, on reaching England, I found that, in this portion, practically none of the old material could be utilised. By the timely energy of the authorities of the British Museum, and of the Royal Society, an enormous collection of mosquitoes had been brought together; and the work of preparing a monograph of the family, based on the material so collected, had been entrusted to my friend, Mr. Theobald, who met me with the news that, to say nothing of some 160 new species, almost all the old descriptions were hopelessly inadequate, even where they were not positively misleading, and that he had found it necessary to revise the entire classification of the family. To adhere to the original plan of quoting original descriptions *in extenso* was obviously out of the question, as the text of Mr. Theobald's descriptions of new species would alone have filled more than the entire space of my first edition, and the only alternative was to redescribe, as concisely as possible, every member of the family, as illustrated in the splendid collection now at our disposal.

In the case of the genus *Anopheles*, and of some other important genera, and generic types, the course adopted has been to prepare a new description from the actual specimens, but for the rank and file of the still enormous genus *Culex*, it proved more convenient, though I have seen and handled most of the species enumerated, to epitomise the descriptions of the monograph. In both cases the plan followed has been to carefully describe the same structures in all, and to append to each description, in smaller type, a few detailed characters; emphasising those that separate the species from its neighbours; but to save space, the conventional plan of repeating, in the detailed notes on a species, the characters already given in the short description, has been deliberately avoided. With this object, too, certain numbers and signs have been employed in the descriptions, the explanation of which will be found in the introductory remarks to the systematic portion and in those on the genus *Anopheles*.

From what has already been said, it follows that many of the descriptions embody, *verbatim*, entire paragraphs of Mr. Theobald's work, but the necessities of condensation have so frequently involved alterations of verbiage and sequence, that it has been found impracticable to indicate these by inverted commas, and I trust that this acknowledgment will suffice to show how fully I realise my indebtedness to the Monograph for much of the matter of the following pages; and I desire here to express my deep appreciation of the courtesy and kindness with which my work has been in every way facilitated by Professor Ray Lankester and the other authorities of the Museum, and in especial to Mr. Theobald, but for whose exceptional generosity in placing at my disposal early proof sheets, and in personally helping me in every possible way, the appearance of this edition must necessarily have been delayed for several additional months.

There are some hundreds of drawings in the new plates and figures which, with a few exceptions, have been drawn by the writer himself from camera lucida outlines, and it is needless to say that all these changes have taken much time, but were inevitable, if the new issue was not to be rendered almost immediately obsolete by the appearance of the Monograph.

To facilitate comparison of neighbouring species, the figures illustrating them have been, as far as possible, grouped into plates, instead of interspersing them in the text.

As to the question of which of the older names are mere redescriptions of one and the same species—the synonymy of the group—I have followed implicitly the new Monograph, and it must be understood that, in relegating any given name to this category, I merely reproduce, and desire to imply no personal opinion as to the justness or otherwise of the conclusions involved.

Saving only, then, those of some few species, of which no examples have come to hand, all the descriptions in the present edition are drawn up from actual observation, and no attempt has been made to reproduce the original descriptions.

The bibliography of the subject is already so extensive that the inclusion of any at all complete list of publications would add some fifteen or twenty pages to the book, without being of any real use to the majority of my readers, who must needs work far from libraries and museums; while those more favourably situated can easily refer to the very complete lists included in Mr. Theobald's Monograph, as well as those appended to Professor Grassi's "Studi di uno Zoologo sulla Malaria," R. Acad. dei Lincei, Rome, 2nd edit., 1901; to Nuttall and Shipley's "Studies in Relation to Malaria," *Journ. of Hygiene*, vol. i., Nos. 1, 2, 3; and to Dr. Edmonston Charles' "Letters from Rome, with Notes and Postscript by Major Ronald Ross, F.R.S." Liverpool, 1901. Fairly complete systematic references will be found included in the descriptions of each species, in the second part of the book.

My thanks are also due to Professors Celli and Grassi, for placing the resources of their laboratories at my disposal during a short visit to Rome, and to friends and correspondents in all parts of the world, too numerous to mention, who have helped me by sending collections, and by contributing even more valuable observations.

In conclusion, I may mention that I shall always be grateful for specimens of mosquitoes, as well as of ticks, biting insects, and other pests obnoxious to man and animals. The small boxes and materials for collecting, that I used to send to friends good enough to collect, can now be obtained from Messrs. Baker, of 244, High Holborn, but I shall always be glad to do my best to identify specimens sent me, and to help other workers as far as lies in my power.

GEO. M. GILES.

Byfield, Mannamead,
Plymouth, December 26th, 1901.

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PART II.—SYSTEMATIC.

LIST OF ILLUSTRATIONS.

LIST OF ABBREVIATED QUOTATIONS.

The following quotations recur so frequently that it appears more convenient to employ abbreviated references in their case, in place of citing them in full:—

B. M. J. ....British Medical Journal.

C. M. ....Angelo Celli, "Malaria," translated by J. T. Eyre. London, 1900.

Desv. Essai ......Robineau Desvoidy, "Essai sur les Culicides, Mém. de la Soc. d'Hist. Nat. de Paris," III, p. 390, *et seq.* (1827).

D. S. ...."Diptera Saundersiana."

D. Sc...............Zetterstedt, "Diptera Scandinaca."

F. A. ....F. A. Schiner. "Diptera Austeriaca."

Fab. E. S. ....Fabricius, "Entomolog. Syst." IV. (1794).

Fab. S. A. ....Fabricius, "Syst. Antliat." IV. (1805).

F. R. ....Eugenio Ficalbi, "Revisione delle Specie Europei della Fagmilia delle Zanzare," Bull. Soc. Ent. Ital. 1896, p. 239, *et seq.*

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G. S. Z. ...."Studio di uno Zoologo, sulla Malaria." Memoria del Socio Baptista Grassi, R. Acad. dei Lincei. Rome, 1900.

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Macqt. H. D.......Macquart, "Hist. des Dipteres," S. â Buff. I (1834).

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A HANDBOOK

OF THE

GNATS OR MOSQUITOES

PART I.—GENERAL.

CHAPTER I.

On the Position and Terminology of the Culicidæ.

WITHOUT entering into minute detail, it may be well to premise that the *Culicidæ* belong to the Order of *Diptera*, or two-winged insects, in which the hinder of the two pairs of wings of the typical insect are absent as such, and are represented only by a pair of small club-like bodies, the *halteres* or balancers. All the members of this Order undergo a complete metamorphosis, *i.e.*, they are hatched as worm-like *larvæ*, and after attaining, as to size, if not as to form, the dimensions of the adult insect, and undergoing several changes of skin, they cease to eat, undergo profound anatomical changes, and become nymphs or *pupæ*, and, finally, by a last change of skin, they emerge from the pupa case as the externally entirely different *imago*, or adult insect.

The *Diptera* are divided into two Sub-orders, the *Orthorrhapha* and the *Cyclorrhapha*, according to the method by which the pupæ escape from the larval skin. In the former, the rupture is in the form of a T-shaped rent, and the larva is "encephalous," *i.e.*, has a more or less perfectly developed chitinous head; in the latter, the pupæ escape by a circular opening and the larva has no definitely separated anterior division of the body, formed by the blended cephalic somites, and the appendages and jaws are so little specialised, that it is commonly spoken of as being acephalous.

It is obvious that this division, though associated with fundamental structural differences, is of little value to the observer who possesses only the perfect insect, but none of the *Cyclorrhapha* are at all likely to be confused with Mosquitoes, and the sub-divisions of the *Orthorrhapha* are marked by characters of a very obvious sort in the adult insect; the Sub-order being divided in a very natural manner, into two sub-divisions, by the characters of the antennæ. In the *Nematocera*, to which the *Culicidæ* belong, the antennæ are large and prominent organs, consisting of more than six joints, and the palp of four or five joints, while in the *Brachycera* the antennæ are of insignificant dimensions, consisting of but two or three apparent joints, and the palpi are also but one or two jointed. Osten-Sacken further sub-divides the *Nematocera* into the true and the anomalous groups of families. The true *Nematocera*, which include the *Cecidomyidæ*, *Mycetophilidæ*, *Culicidæ*, *Chironomidæ*, *Tipulidæ*, *Psychodidæ*, and possibly the *Dixidæ*, have the following characters:—

(1) The eyes are never blended into a single mass, and there is little or no difference in the size of the head and eyes in the two sexes.
(2) Eyes round, oval or lunate; they may meet but never blend.
(3) Antennæ very large in proportion to the small head.
(4) Legs long and weak, not fitted for walking.
(5) Generally slighter, and more slender.
(6) Inhabit damp, shady places, and prefer twilight.

The anomalous *Nematocera*, which include the *Simulidæ* or sand-flies, the *Bibionidæ*, *&c.*, on the other hand, are characterised as follows:—

(1) Head generally holoptic in both sexes, nearly always so in the male.
(2) Eyes often bisected, the upper facets being the largest.
(3) Legs well adapted for walking and often thick.
(4) The sexes generally differ considerably.

(5) Have a peculiar and often sporadic geographical distribution.

The *Culicidæ*, or fleas, are now included in the anomalous *Nematocera* by the majority of authorities.

Confining our attention to the true *Nematocera*, the *Culicidæ* may, for practical purposes, be easily distinguished from the other families by two very obvious characters. The first of these is the possession of the long, suctorial proboscis, which differs markedly from the mouth parts of any insect likely to be confused with them; and the second is that in all the veins of the wings are fringed with scales like those of butterflies and moths. It is true that the wings of certain genera, such as *Molopheles* and *Ryphacophua* have the veins of the wings scaly, but even in the former the scales are very elongated, while in the latter they are more of the character of hairs, and in both the general arrangement of the scales is of a shaggy and irregular character as compared with that of the *Culicidæ*, apart from which they present unmistakable differences in the venation of the wings.

The family that is most easily confused with the *Culicidæ* is the *Chironomidæ* or midges, which not only frequent very much the same situations, but in general form so closely resemble the gnats that they can scarcely be distinguished by the naked eye; but this family has neither the long proboscis nor the scaly wing veins, and a moment's examination with a lens suffices to distinguish them.

Those who wish to follow more closely the question of the classification of the *Nematocera* are recommended to consult Mr. F. V. Theobald's "Account of British Flies," which is not only very plainly written, but appears more up to date than most of the accessible works on the subject in the English language. Although as yet it is, unfortunately, not completed, it contains a most handy synopsis of the genera of the Order, and will, therefore, be most useful to anyone commencing the study of any group of Diptera, even in tropical regions, for it must be remembered that the Dipterous fauna of India, and most other tropical parts, remains to be written, so that a knowledge of the general principles of the classification can only be gained from European and American works.

Hitherto I have treated the terms *Culicidæ*, Mosquitoes, and gnats as synonymous, and the present work is confined to the consideration of the *Culicidæ* alone, but it must not be supposed that every insect that bites and is annoying to man necessarily belongs to this family. As far as we at present are aware, however, it is the *Culicidæ* alone that are concerned in the transmission of malaria, and as this handbook is mainly intended for the use of those who may be working on this problem, it does not appear worth while to include the *Simulidæ* and other obnoxious insects that attack man in the same way.

The word Mosquito is a diminutive of the Spanish and Portuguese "mosco" fly. A variety of insects of the *Culicidæ* and other families are known under this name in various localities, the only common characteristic being the power of annoying man by their bites. It is not uncommon to see in the press, notices of the occurrence of "Mosquitoes" in England. When investigated by competent entomologists, the insects always turn out to be one of the common indigenous English gnats, generally *C. pipiens, L.*; and in point of fact this species has as good a claim as any other to the name, and is quite capable of inflicting as much annoyance as any other, the tropical species surpassing our English gnat rather in numbers and persistence than in their individual capability of annoyance. Something of the same sort may be noticed in the case of the common fly, which even where fairly common, rarely exhibits in England the same dire determination to sit on one's nose that it does in India and other hot climates, and which it will do, even in England, when the weather is sufficiently hot. In short, the question whether gnats will earn for themselves the dreaded title of Mosquito or not is rather a matter of temperature than locality, or in other words, it is only in hot weather that gnats show any strong tendency to attack human beings in place of being content with their more usual vegetable food. At any rate, no one species is in any way entitled to the name.

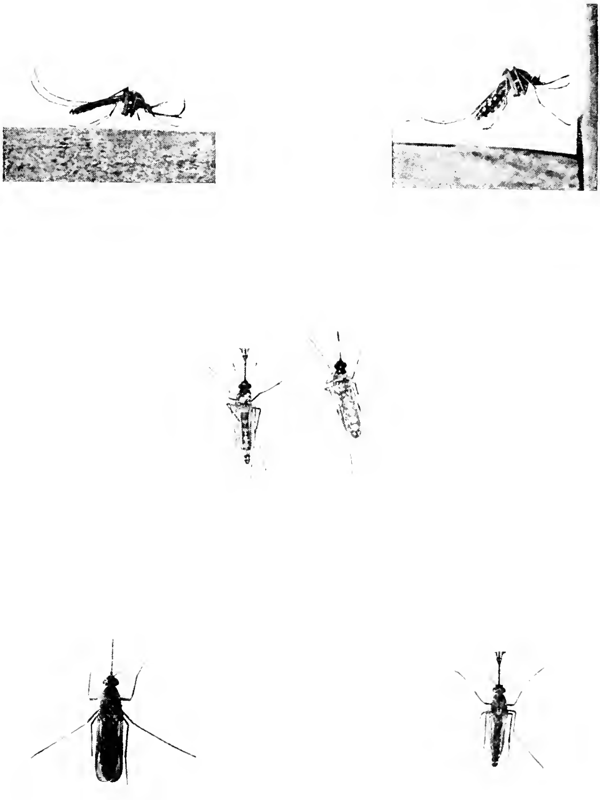

Fig. 1.

Photographs of living mosquitoes (*C. impellens*, Walk.). Above ♂ and ♀ in profile; in the middle ventral aspects of the same; and beneath ♀ and ♂ dorsal views. About twice natural size.

Face p. 4.

On this point, Mr. F. V. Theobald remarks: "Much difference exists between the so-called Mosquitoes of various parts of the world. Some are true gnats, others sand-flies (*Simulidæ*), and yet others midges, or *Chironomidæ*, of the genus *Ceratopogon*, such as the American so-called 'grey gnat.' American Mosquitoes belong to the genera *Culex* and *Simulium;* that of Cuba, according to Desvoidy, is a *Culex*, while in Brazil the Mosquito is a small *Simulium*,

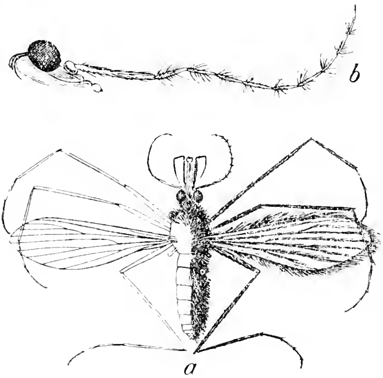

FIG. 2. AN INDIAN "SAND FLY," COMMON IN NAINI TAL. × 15 DIAMS.

a, The left half of the insect is shown denuded of its tomentum, so as to indicate more clearly the details of the venation of the wing; *b*, antennæ of the same, more highly magnified.

sharing the honour with a true gnat (*Psorophora molestus*), according to Pohl and Kollar. From the West Coast of Africa I have had several kinds of Mosquito sent, including one or two *Culicidæ*, but some were midges. It will thus be seen that the term is no guide to the family of insects to which any given 'Mosquito' belongs. In any case, they all belong to families which are found in greatest abundance in swampy places."

The term "sand fly" is, however, at least as loosely applied as the word Mosquito, so that it must not be supposed that all of them are *Simulia*, and some of the most common and vicious of Indian species approach so closely in general structure, and even in the general appearance of the venation of the wing, to the anomalous gnats of the genus *Corethra*, that they are difficult to distinguish without close examination, as may be seen by comparing the figure given on previous page, of a species (probably new) of *Phlebotomus*, most pestilent in its attentions in Himalayan hill stations during the rains, with that given of the wing of *Corethra* in the systematic description of that genus, but it will be seen that what looks like a gnat's hinder fork cell is really not the fourth, but the fifth longitudinal vein, and that the sixth, in place of being simple, is also forked: distinctions that will be better appreciated after a perusal of the following pages on the terminology of the group. The insect, too, is clothed, not with scales but with hairs. A more darkly tinted species of the same genus is equally troublesome in the plains.

In almost all cases it is the female alone that attacks man and animals, an exception being noted in the case of *C. salinus* by Ficalbi in his description of that species; but, however bloodthirsty they may be, it is obvious that they must mainly depend on other nourishment than blood, for these insects are sometimes found in just the places where air-breathing vertebrates are most uncommon.

The males of some Indian species, notably of *Stegomyia fasciatus* (Fabr.), undoubtedly often settle on one, and place themselves in position as if to bite, but I have never seen one actually do so, although afforded every opportunity.

In England, and probably in other parts of the world, gnats may be seen feeding upon the nectar of flowers, and here it is certainly their usual food, a fact I have often verified by personal observation; but Mr. Theobald has also seen *C. ciliaris* sucking the juices of small *Diptera*. The peculiarity of the females alone being addicted to blood-sucking is shared with the *Tabanidæ*, or gad-flies, whose males, too, live entirely on the juices of flowers.

Coming now to the question of terminology, it may first be observed that the terms used by Dipterologists are broadly the same as those used by entomologists generally, with such modifications and additions as are required by the special peculiarities of the Order. Unfortunately, neither among the former nor the latter is there any agreement as to the terms employed. It would be impossible, in any moderate compass, to cover even the practice of the best known authorities, and without expressing any preference for Loew's terminology over that adopted by other authorities, it represents, I think, better than that of any other author what may be called the average practice in the matter, and on this account the definitions given below are, to a great extent, quoted *verbatim* from his "Monographs of the *Diptera* of North America," published by the Smithsonian Institution, Washington, 1862.

In the systematic portion of this book, except where the original descriptions have been transcribed or translated as they stand, Loew's terminology is adopted, except for the wing, for which Skuse's nomenclature is followed.

As in all typical insects the body of the dipterous *imago* is divided into the three regions of the head, thorax and abdomen. In the first two of these the component somites are so soldered together that their limits can hardly be distinguished, but in the abdomen the segments are clearly separated.

The entire external surface is covered with a chitinous investment, which is in all sufficiently dense to afford efficient protection to the internal organs and a firm attachment to the muscles that move the various parts, and in many families forms a veritable coat of armour.

This chitinous coating is always, to a greater or less extent, covered with an armature of chitinous processes in the form of hairs, spines or scales, and where these are so closely arranged as to form a more or less uniform covering, they are spoken of as a *tomentum*.

In the *Culicidæ* all three of these forms of armature are well represented, but its characteristic feature is the abundance of scales, which in most genera thickly cover the entire body, and in almost all cases the decorations of gnats are due to variations in the coloration of this scaly coating; and as these are very easily rubbed off, caution is necessary in comparing them with descriptions.

The tinting of the chitinous body wall itself is spoken of as "ground colouring," and in insects which are provided but scantily with hairs, this may be arranged in sharply defined and brilliant markings, as, for example, in many midges, but in the *Culicidæ* it is usually of a nearly uniform dull tint, and at most shares only in the production of their markings by showing through, between tracts of scales, in the form of symmetrical bare lines and patches.

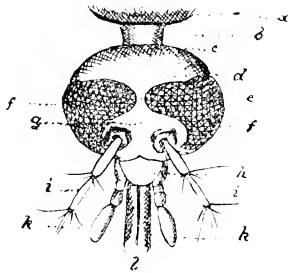

FIG. 3.—HEAD OF FEMALE CULEX.

a, thorax; *b*, neck; *c*, nape; *d*, occiput; *e*, vertex; *f*, eyes; *g*, frons; *h*, clypeus; *i*, antennæ; *k*, palpi; *l*, proboscis.

In descriptions of Mosquitoes it is not uncommon to find the coloration of parts qualified as "when denuded," and where this is the case it must be understood that it is the ground colour that is referred to.

In *Anopheles*, as a rule, there are few or no scales on the abdomen, and its coloration is mainly ground colour. Their appendages, on the other hand, are exceptionally densely scaled. In *Corethra*, again, the appendages, though very hirsute, are so mainly through the abundance of hairs, but in all genera of gnats the armature of the wings is entirely composed of scales.

The head has a hinder plane, opposite the thorax, called the occiput (*occiput*); that region of it lying over the junction of the head is the nape (*cervix*). The part of the head which reaches from the antennæ as far as the occiput, and is limited laterally by the compound eyes, is the front (*frons*), the upper part of which is the crown (*vertex*), the limit between the front and the occiput having the name of the vertical margin (*margo verticalis*). The middle of the front, being often of a more membranous substance, and sometimes differing in colour from its borders, is called the frontal stripe (*vitta frontalis*). On the crown are the simple eyes (*ocelli*), which, however, are absent in the *Culicidæ*, but in the majority of *Diptera* are usually three in number, sometimes on a sharply defined triangular space, the ocellar triangle (*triangulum ocellæ*). Most of those *Diptera* which undergo their metamorphosis within the larval skin possess, immediately above antennæ, an impressed arcuate line, which seems to separate from the front a small, usually crescentic piece, the frontal crescent (*lunula frontalis*). The impressed line itself, which continues over the face nearly as far as the border of the mouth, is called the frontal fissure (*fissura frontalis*). It owes its origin to a large bladder-like expansion, which exists at this place in immature imagines, and which helps them in bursting the pupa case. The frontal fissure is, of course, the true anterior limit of the front, and the frontal crescent in fact belongs to the face; but from its usual situation it is commonly considered as part of the front. In many genera the eyes of the males meet on the front, so as to divide it into two triangles, the upper of which is called the vertical triangle (*triangulum verticale*), the inferior, the anterior frontal triangle (*triangulum frontale anterium*), or simply the frontal triangle. The anterior portion of the head, reaching from the antennæ to the aural margin (*peristomium*) is called the face (*facies*). In most *Diptera* it is divided into three parts adjoining each other, the limits of which depend on the situation which the frontal fissure, continued to the oral margin, occupies in the developed imago. The form and mutual proportion in size of these parts are of the highest value in the classification and distinction of species. Beneath the antennæ there are, in many *Diptera*, longitudinal grooves for their reception, the antennal furrows (*foveæ antennales*). The antennæ lie in these while in the pupa case, and sometimes even after escape. That part of the head which lies on the side beneath the eyes is called the cheek (*gena*). The compound eyes are sometimes encompassed in a greater or less portion of their circumference by a ring, somewhat swollen, and separated, more or less distinctly, from the rest of the surface of the head, and named the orbit, the successive parts of which may be called the anterior (*orbita anterior, sive facialis*), the inferior (*inferior s. genalis*), the posterior (*posterior s. occipitalis*), the superior (*superior s. verticalis*), and the frontal (*frontalis*) orbits. An orbit is also often spoken of when there is no distinct ring; but in this case there is some difference of colour or structure to mark it off.

The oral parts of *Diptera*, destined for sucking, are called the sucker or proboscis. They are either inserted at the end of a more or less prolonged, cylindrical portion of the head called the snout (*rostrum*), or project from a wide aperture, often occupying a great part of the under surface of the head, called the mouth hole (*cantus oris*). The common, fleshy root of the oral parts is connected by a membrane with the border of the mouth. This membrane often has a fold of sometimes quite a horny consistence, and is then called the clypeus (*clypeus s. prælabrum*). It is either entirely concealed by the anterior border of the mouth, and is then usually movable, or it projects over it as a ridge, and is then usually immovable, as in the *Culicidæ*, in which it is usually bare, but is covered with crescentic scales in the genus *Stegomyia*, and is densely hairy in *Trichoprosopon*. The largest of the oral parts in most *Diptera* is the fleshy under lip (*labium*), consisting of the stem (*stipes*) and the knob (*capitulum labii*), formed by the two suctorial flaps (*labella*), and modified in the *Culicidæ* into the membranous, scaly sheath which encloses the other mouth parts. Besides the under lip the palpi are most perceptible, and must be noticed in the description of species. The remaining oral parts are generally rather small and stunted, having the form of bristles or horny lancets. They are considered as being the tongue (*lingua*), under jaws (*maxillæ*), upper jaws (*mandibulæ*), and upper lip (*labrum*), the latter shutting the under lip from above, and certain prolongations of the chitinous pharynx such as an epi- or hypopharynx. These parts are not particularly valuable in the distinction of species.

As in other insects, the thorax of *Diptera* consists of three segments, the prothorax, the mesothorax, and the metathorax: but in this Order the mesothorax is so much more developed than the other segments, that it forms by far the largest part of the thorax, and in the description of *Diptera* is exclusively designated by that name, while other names are given to the pro- and metathorax when some particular part of them has to be characterised. The prothorax, being generally very little developed, sometimes forms a neck-like prolongation which bears the head, and is then called the neck (*collum*). Sometimes the fore-corners of the mesothorax or shoulders (*humeri*) are covered by a lobe of the prothorax (*lobulus prothoracis humeralis*), distinctly separated from the mesothorax; but it is not uncommon for this to be soldered to the mesothorax so that no distinct limit is perceptible, except by differences of colour and armature, in which case it is called the shoulder callosity (*callus humeralis*). Sometimes also the prothorax is closely applied to the anterior border of the mesothorax, and has then the name of the collar (*collare*). The mesothorax frequently also has a transverse furrow (*sutura transversalis*) crossing the middle of its upper side, and ending on each side a little before the base of the wing: its presence or absence, as well as its form, furnishes characters of importance in classification. On each side of the *pleura* or "breast-side" there is, beneath the shoulder, a spiracle belonging to the prothorax (*stigma prothoracis*). To the back of the mesothorax applies the scutcheon (*scutellum*), separated from it by a furrow.

Beneath the scutellum a part of the metathorax is to be seen called the metanotum, generally descending obliquely, often very convex, and on each side a more or less inflated space, called the lateral callosity of the metanotum. In most mosquitoes this portion of the thorax is nude, but in Mr. Theobald's new genera *Wyeomyia* and *Trichoprosopon*, is provided with certain characteristically arranged groups of bristles; and care should be taken not to confuse these metathoracic tufts with somewhat similar but much more uniformly present tufts on the scutellum, which overlie them in the usual position of the parts. The poisers (*halteres*) have their origin beneath this callosity, and before each is placed the stigma of the metathorax. In many *Diptera* these are protected by membranous covers placed above them, and called covering scales (*tegulæ s. squamæ*).

The abdomen is the third of the principal parts of the body, but the word often is applied to the dorsal side only, the under side being called the belly (*venter*). Its segments, as in other Orders, are counted from before back; but the anterior ones are often soldered together, while the posterior ones are stunted and concealed. Much caution therefore is desirable in counting them. The statements as to their number are often rather arbitrary and conventional, and must be taken to refer simply to such as are plainly obvious under a simple lens.

A careful observer will generally find they are really more numerous; and it must also not be assumed that the entomologist's "segment" is necessarily equivalent to the "somite" of the comparative anatomist. In many mosquitoes the scales clothing the abdominal segments are so coloured as to produce a conspicuous alternation of darker and lighter bands; and the presence or absence and relative position of these bands is of the greatest importance in distinguishing the various species.

This banding may be produced in three different ways. Either the lighter coloured scales may be confined to the front of the segment, in which case it is said to be "basally lighter banded"; or they may be located on its hinder portion, when the lighter banding is said to be "apical";

or, lastly, the contiguous portions of consecutive segments may be lighter or darker, and the middle portion of each of the contrasting tint.

Another term, frequently recurring in entomological descriptions, especially in those of earlier date, is to speak of the fore parts of the segments where they are connected with that before them as the *incisuræ abdominis;* and where, as in banded insects, this part of the segments is coloured in contrast, the term "with lighter *incisuræ*" may be taken as equivalent to "basally lighter banded," and the converse; though often the term is loosely employed, and it is therefore preferable to employ the modern equivalent. At the end of the abdomen we see in the male the claspers (*hypopygium*), in the female the *ovipositor.* If the claspers have the form of pincers, and are not bent under the belly, they are called forceps. The *Ovipositor* may be either a borer (*terebra*) or a style (*stylus*), or, as in the family with which we are mainly concerned, may take the form of paired, lobular organs, which, though wanting the hook of the male clasper, resemble it closely in general appearance.

Both organs are very important in the distinction of species in many families, and their structure being generally very complicated and varying much in different families, deserves a most attentive study.

So far the terms employed are in such universal use among systematists that they may be considered as definite as those employed in human anatomy, but it is when we come to the wing that the confounding of confusion commences; for it may almost be said that the systems of nomenclature are as numerous as the authors who employ them.

This has come about from the natural desire to devise a terminology applicable to the entire Order, combined with the widest diversity of opinion as to the correspondence of parts in the various families; so that probably a rigidly numerical system would be really the most convenient, in spite of the names affording no clue to the correspondence of the veins; but an exclusively numerical nomenclature is, as a matter of fact, adopted by no entomologist who has written on the *Culicidæ*, and, for our purposes it will be best to confine ourselves to the wing of the mosquito and the names that have been most commonly used by those who have written on the family.

Commencing with the anterior border of the wing, we find that it is formed of a strong chitinous rib, which is called the *costa*. It tapers off externally, but in the *Culicidæ* is continued round the entire border of the wing, though this is not the case in all *Diptera*.

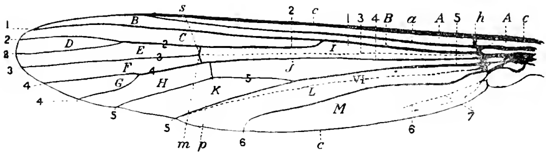

FIG. 4.—WING OF *C. concolor*, R. DESV., ♂ TO ILLUSTRATE THE TERMINOLOGY OF THE WING IN THE CULICIDÆ.

C, costa.
a, auxiliary vein.
1 to 6, first to sixth longitudinal veins and their branches.
7, seventh, or false longitudinal vein (unscaled).
VI, unscaled vein, between fifth and sixth longitudinals.
h, humeral transverse vein.
s, supernumerary transverse vein.
m, middle transverse vein.
p, posterior transverse vein.
A, costal cells.
B, sub-costal cell.
c, marginal cell.
D, anterior fork cell or first sub-marginal.
E, second submarginal cell.
F, first posterior cell.
G, hinder fork cell, or second posterior.
H, third posterior cell.
I, first basal cell.
J, second basal cell.
K, anal cell.
L, axillary cell.
M, spurious cell.

Looking now at the root of the wing, we find that the remaining longitudinal ribs, or veins, spring from three main trunks, which are connected together near their base by a somewhat elaborate arrangement of cross bars. From the anterior of these spring two veins, the front one of which is usually called the auxiliary vein; on account of its being absent in many *Diptera*, though Theobald calls it the sub-costal and by others it is termed the mediastinal.

It runs into the costa considerably before the tip of the wing, and the relative position of this point is useful in distinguishing species. The other of the anterior group of veins is the first longitudinal, which runs, without branching, to join the costa, close to the tip of the wing. From it, well out towards the middle of the wing, springs the second longitudinal, which divides near the tip of the wing into two branches, though in most *Diptera* this vein remains single. Two veins spring also from the second of the vein-trunk. These are the fourth and fifth longitudinal veins and both of them become forked, the fourth near the tip of the wing, and the fifth further in. In the outer part of the wing, between the forked second and fourth, may be seen the third longitudinal vein, which is distinct, and fringed with scales only in this outer part of the wing, and often appears to take its origin from a cross vein; but in many cases, as in *C. concolor*, R. Desv., it can be distinctly traced as an unscaled vein right to the root of the wing, and, in the majority of cases, can be so followed for a considerable distance, while it is not uncommon to find a short length of the vein, internal to the cross veins, provided with scales. From the hindmost of the three root-trunks there springs only a single scaled vein, the sixth longitudinal, which runs without branching to end in the internal margin of the wing beyond the middle. On either side of this, however, is an unscaled vein, one of which joins the tip of the hinder branch of the fifth longitudinal, and is spoken of by Mr. Austen as the sixth longitudinal (the sixth becoming his seventh), and the other being his eighth longitudinal.

As a rule, these unscaled veins are left unnoticed in descriptions and figures of mosquitoes.

We come now to the transverse veins or *venulæ*, of which there are four in the *Culicidæ*.

Between the costa and auxiliary, close to the root of the wing, is the humeral transverse; and the spaces into which it subdivides the interval between those veins are known as the costal cells.

Between the second and third longitudinals lies the supernumerary transverse vein, which is considered by some as merely the angulated origin of the third longitudinal.

Doubtless in some cases, as in *Mucidus*, the third springs from the second longitudinal very far out, but in these cases the supernumerary is absent, and the middle transverse, which in most mosquitoes connects the third and fourth longitudinals, spans the entire space between the second and fourth. The remaining cross vein, or posterior transverse, connects the fourth with the anterior branch of the fifth longitudinal.

The relative length and position of these three last-named cross veins is of great value in distinguishing species. The branched portions of the second and fourth longitudinal veins and their unbranched portions, outside the transverse veins, are often spoken of as the anterior and posterior *fourchettes* and their stems, and the spaces enclosed within the forks are commonly called the fork-cells. The relative proportions of these are also valuable aids in classification.

Some authors entirely eschew the use of numbers in describing the longitudinal veins, and employ in their stead certain special names.

Where such are used, the first is commonly called the "post-costal," the second the cubital, the third the sub-marginal, the fourth the marginal, the fifth the brachial, and the sixth the anal, while Mr. Austen's eighth longitudinal would be spoken of as the axillary.

Ficalbi speaks of the third longitudinal vein as the "*vena interposita*."

The names of the remaining spaces, or "cells," can best be followed by a careful study of fig. 4.

For the rest, the *incisura axillaris*, a retiring angle in the outline of the wing in its axillary border near the base, and the *alula*, a lobe appended to the wing between the axillary incision and its base, alone require special mention. The latter, however, should not be confused with the covering scale that lies above the halteres, as is a not uncommon mistake.

The legs of *Diptera*, like those of other Orders, consists of four principal parts, the hips or *coxæ*, the thighs or *femora*, the shanks or *tibiæ*, and the feet or *tarsi*. Of these, the *Coxæ* consists of two joints, the smaller second joint being called the *trochanter*; the femur and *tibia* each of a single joint; and the feet generally of five joints, of which the first is sometimes called the *metatarsus*. At the tip of the last joint are two claws (*ungues*), and under each of them there is generally a membranous appendage called the pulvillus; many families having, in addition, between the pulvilli, a third appendage of similar structure called the epipodium, while in other families this appendage is bristle-like or altogether wanting. These claws vary greatly in form in the *Culicidæ*, and afford valuable specific characters.

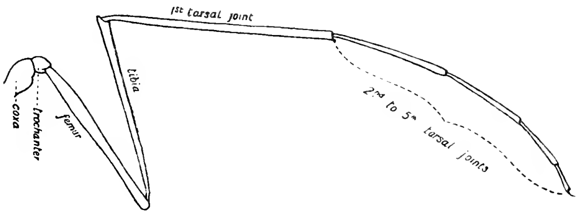

FIG. 5—LEG OF A MOSQUITO.

The only remaining point that requires notice is the meaning of the conventions that are adopted with respect to the names of species. Two names are always employed; the first of these indicates the Genus, always given the complement of a capital initial; the second the species, of which there may be any number in a genus, and, unless the name refers to a person or a place, commences with a small letter.

Like the French Republic, the species is "one and indivisible." Varieties there may be, though the practice of making them is usually regarded with disfavour, except among horticulturists, so that to speak of "a species of *pictus*" is apt to raise a smile on the face of the non-medical naturalist, much as a slip by the latter, in the use of a medical technicality, would amuse a medical man. Practically speaking, a third name, that of the authority who first described the species, is always added; so that the system is really trinomial. Not unfrequently a species is described again and again by different naturalists before it is discovered that all are referring to one and the same animal; and in such cases, however incomplete the description or inappropriate the name, the custom is to employ that adopted in the description which has the priority of date, and the names used in subsequent descriptions are spoken of as "synonyms," *e.g.*, Mr. Theobald finds that the species originally described by Fabricus as *C. fasciatus*, and referred to in the first edition of this handbook as *C. tæniatus*, Meig., has been redescribed under no less than seventeen other names, all of which appear merely as "synonyms" in the present edition. If, however, through error of the original describer, or on account of subsequent rearrangement, the species is referred to a genus other than that used by the original authority, the name of the latter is placed after the specific name in brackets, *e.g.*, *Anopheles bifurcatus* (L.), in which case the species was originally described by Linnæus before the genus *Anopheles* was separated from *Culex*. I devote some space to these points, because the failure to adhere to these conventions is a frequent source of confusion.

CHAPTER II.

On Collecting, Preserving and Appliances for Observation.

In his delightful "On the Prowl," our genial Anglo-Indian naturalist "E. H. A." remarks: "The gun and net I would gladly leave behind, but they cannot altogether be dispensed with. Without a collection a man's knowledge of natural history becomes nebulous, and his pursuit of it *dilettante*. I am sorry it is so, for in spirit I am a Buddhist. But alas! every Buddhist is not a Buddha!" I am glad to say that "E. H. A." has lately decided to go on the "prowl" after Mosquitoes, for there is no one more likely to profitably pry out the secrets of their lives, and then, in quaintly humorous fashion, to hold them up to mingled execration and ridicule.

The training of medical men specially fits them for such work, and although its usefulness may not be at once apparent, sooner or later it becomes of value; and the insignificant worm or insect whose habits of life we have traced, turns out perhaps to be the free stage of a parasite, dangerous to animals or man; or a "pest" destroying crops of incalculable value. It is well nigh on a century ago since Fabricus, Wiedeman, Desvoidy and Meigen laid the foundation of our knowledge of the Mosquitoes, but to-day we reap the fruits of their patient labours, and if the last-named naturalist were alive to-day he could hardly fail to congratulate himself on the rare intuition which led him to denominate his new genus *Anopheles* by the Greek equivalent for noxious, for we now know that the insects of this genus are far more efficient checks on over population than all the armies of the world, armed though they be with all the products of modern science and ingenuity. Fragile though they be, many of Meigen's "types of species of *Culicidæ* are still preserved in very fair condition in the Jarden des Plantes, though some must be seventy or eighty years old. Few realise the enormous field of work open to the collector in all tropical climates, and to say the least, the pursuit forms a most fascinating hobby, and may be recommended as a far better insurance against boredom in old age than the most intricate knowledge of Hoyle and Cavendish.

As regards the *Culicidæ* an infinity of work remains to be done in identifying species with their larvæ, in discovering their habits of life, food, and natural enemies, as well as in discovering how species tide over seasons unfavourable to their free multiplication, for it is only by work of this kind that we can hope to ultimately establish an exact and rational prophylaxis against malaria.

Mosquitoes are rarely found far from water, as during the first two stages of their existence they are aquatic animals, and the imagines rarely fly far from the pool in which they lived as larvæ.

The adult insects are found, not only in houses, but in groves, forests, and in any other situations where shade can be obtained during the day, while the larvæ and pupæ are common in all small collections of water where there is no strong current. In the hills they are common in pools in water-courses. They are to be found in all countries from the Tropics to the Polar regions, and some species have so wide a distribution as to rival that of man. In all countries the adults may be found at all seasons of the year, the maintenance of the species being mainly secured by the survival of impregnated females, which hide, and remain quiescent during seasons unfavourable to the well-being of the larvæ.

In searching for them in houses it should be remembered that it is in the darkest corners that they are most likely to be found, and that their favourite haunts are draperies, clothing hanging up, the corners of cupboards, behind furniture, and such like situations.

A very favourite hiding place, especially of *Anopheles*, is the under surface of tables, and indeed these Mosquitoes seem to have a special liking for suspending themselves from the lower side of horizontal surfaces.

For collecting in the open, the best time is the early dusk, but in shady gardens many species, notably *Stegomyia fasciatus* (Fabr.), and *S. scutellaris* (Walker), are active and vicious during the day, and in the autumn will even venture on short flights across patches of sunshine; but I have never met with an *Anopheles* in the open during the day in India; though like other Mosquitoes, they will always leave the house if they can at sunset, and certain European species are undoubtedly diurnal.

Jungle and garden species, however, commonly harbour during the day in ditches and under bushes, so that it is necessary to disturb them by beating the bushes with a stick.

A number of pill boxes with glass *bottoms* should be taken, as the Mosquitoes must be brought home alive, or else portable setting materials must be carried, as delicate insects such as these can only be satisfactorily set immediately after killing.

In this sort of *shikar* nothing in the way of a call-bird is required, as the method of procedure resembles rather the plan of big-game shooting known as "sitting up over a kill," only the sportsman officiates as his own kill, "in addition to his other duties," as the Gazettes have it.

All that is required is to sit moderately still and the Mosquitoes will come.

Mosquitoes may be captured :—

(*a*) By slipping over them a small wide-mouthed bottle, as they sit on a wall or window, for which purpose a small "killing bottle" is best, provided that each insect can be set at once; or the ingenious trap-bottle, devised by Ficalbi, may be used. This is constructed on the principle of the ordinary lobster pot, and consists of a wide-mouthed phial, through the cork of which is passed the tube of a small glass funnel, so as to project about $\frac{3}{4}$ inch into the interior of the bottle. The funnel should be somewhere about 2 ins. long, and about the same width at the rim, and the narrow part must be fairly wide (about $\frac{1}{2}$ an inch), so that the Mosquito can be driven through it into the bottle without injury. Once inside the insect is very unlikely to find its way out, and the great advantage of the appliance is that a large number of insects may be captured in it without risk of the earlier takes escaping, but one would have to get the funnel specially made.

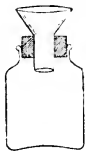

FIG. 6.—FICALBI'S TRAP BOTTLE, ¼ NATURAL SIZE.

The insects can be killed by dropping through the funnel a scrap of blotting paper saturated with dilute hydrocyanic acid, and then covering its mouth with a piece of glass.

(*b*) By means of a net.—Bend 2 yards of stout iron wire so as to form a ring 9 in. in diameter, with a handle about 2 ft. long, formed of the two ends twisted together. The net is a bag 2 ft. deep, secured to the ring, and should be made of fine silk gauze (chiffon); and a strip of cloth should be wound round the twisted wire of the handle to afford a more comfortable grip.

(*c*) By breeding out from larvæ and pupæ.—The larvæ are found in pools, and in domestic collections of water, and when undisturbed generally remain at the surface.

Place a score or so of full-grown larvæ and pupæ, in the water in which they have lived, in a tumbler, and tie over it a covering of gauze supported on a twig or piece of wire bent into an arch.

In the course of a few days the adult insects will escape from the pupæ and be found in the gauze. They should not be killed for a day or two, and it is better to introduce a slice of banana into the net so as to enable them to feed, and so fill out to their full size.

When a sufficient number of specimens have appeared and been pinned the remaining larvæ should be preserved in a small phial, in rectified spirit, or in 4 per cent. formaline solution, and marked with a distinguishing letter or number in order to identify them with the adult pinned insect. If spirit be used it is well to place the larvæ in dilute spirit for twenty-four hours, and then to change them to rectified spirit.

The appliances required for collecting are simple and inexpensive, and, as a matter of fact, are better improvised at home than obtained from a dealer's, as the articles they manufacture are, as a rule, unsuitable for such extremely delicate specimens as those of the *Culicidæ*, their nets in particular being rarely fit to deal with anything less robust than the larger *Coleoptera*, while their cabinets and boxes rarely have sufficient provision for storing the large amount of camphor necessary for the safety of the collection in a tropical climate, unless one is to be continually examining them and replenishing the supply.

The first step in the preservation of collected specimens is to kill the Mosquitoes, and for this the best plan is to employ a "killing bottle," which any one can easily manufacture for himself.

Those supplied by dealers are always far too large for small *Diptera* such as the *Culicidæ*.

Select a wide-mouthed phial about $3\frac{1}{2}$in. high by 2in. wide, fitted with either a well-fitting cork, or preferably, with a metal screw-top. Most chemists store such bottles.

In the latter case the disc of cork in the top of the cap should be removed and replaced with one of thick rubber, which may be secured in position by means of ordinary bicycle tyre-repairing cement. Mix equal bulks coarsely powdered cyanide of potassium and dry plaster of Paris, and put a depth of $\frac{3}{4}$in. in the bottom of the bottle; dust over this a little dry plaster, and then pour over all $\frac{1}{2}$in. in depth of liquid plaster of the consistence of cream—when the plaster has set the bottle is ready for use.

A bottle such as this is very handy for slipping over and catching sitting Mosquitoes, as in a few seconds the insect is stupefied, and drops into the bottle uninjured by attempts to escape. When the insect has been taken by the net the bottle is passed into it, and it is easy to slip the bottle over it as it sits on the gauze. The Mosquito should never be left in the bottle for more than 90 seconds or it will get too stiff to be conveniently set, and it should be pinned immediately.

Another very effectual killing agent is tobacco smoke, which may be applied by holding a lighted cigarette a few inches beneath the net and letting the stream of smoke play over the entangled insect—or by puffing smoke from the lips into the pill box or bottle, if it has been caught in that way.

Chloroform is useless for the purpose, as the insects recover after setting, but a scrap of blotting paper moistened with dilute hydrocyanic acid and slipped into the pill box or bottle answers very well.

Practically speaking, the only satisfactory method of preserving Mosquitoes for identification is to pin them in the method described below.

It is of course very easy to mount Mosquitoes as microscopic specimens in balsam, or to preserve them in bottles in spirit, *but such specimens are absolutely useless for identification*, as their coloration depends entirely on the reflection of light from the scales with which they are clothed, and is lost if they be immersed in balsam or any other fluid; and on this account, although additional specimens preserved in spirit are not without their uses, carefully pinned specimens are the first essential. The following requisites are required for the work.

[1] (1) No. 20 Insect pins: (Obtainable from D. F. Tayler and Co., New Hall Works, Birmingham). A quarter of an ounce, costing about half a crown, will last a long time.

[1] To avoid the difficulty of seeing the point of the pin, with the disc already on it, Dr. Adolf-Eysell, in the *Archiv. für Schiffs-und Tropen-Hygiene*, Nov., 1900, p. 354, recommends the use of pins pointed at both ends. Such pins would have the additional advantage of enabling one to remove the insect from the disc to examine the ventral surface; but, if adopted, it would be necessary to first puncture the disc; as the pin would certainly bend if forced through the disc when held above the mosquito.

(2) Card discs—cut from rather thin cardboard by means of a 16 or 20 bore gun-punch, on a thick plate of lead.

(3) A small flat piece of cork, covered with white paper, on which to place the insects while pinning them.

(4) Ordinary toilet pins of medium size.

(5) An insect box.—Any small wooden box, not less than $1\frac{1}{2}$in. deep, may be utilised for the purpose by covering the inside of the bottom with a sheet of "cork carpet," cork, or solah pith. If intended for transmission by post, they must be very strongly made, and provided this be attended to there is not the least need for enclosing them in an outer box. Those I use are made of wood at least a third of an inch thick. Their internal dimensions are $6\frac{1}{2}$in. $\times$ 3in. $\times$ $1\frac{1}{2}$in. The two end pieces are made of hard wood, the better to hold the nails, but this would not be necessary if one could get them dovetailed together. One of these end pieces is narrower than the other so as to leave a gap of about $\frac{1}{4}$in. wide between it and the top, and before nailing the latter on, a piece of muslin, about 3in. wide, is glued across this end of the box, from side to side and along the upper edge of this shorter end. In this way, after the top has been secured in its place, a sort of pocket is left between it and the muslin, the mouth of which is formed by the gap between the narrower side piece and the top; and the inner end of the pocket is closed by placing over it a thin slip of wood, secured to the inside of the top of the box by a couple of tacks. This pocket is then filled with a mixture of camphor and naphthaline, and its mouth closed by means of a slip of wood forced into the gap, and held only by friction, so that it can be at any time readily prized out and the pocket refilled.

This box portion is made to lift off the bottom, which consists of a simple piece of thin plank, on to which is tacked a piece of "cork carpet" exactly fitting the internal plan of the box. As there are no sides to get in the way, it is far easier to arrange the specimens in position than in insect boxes of the usual plan. The boxes may be made deeper, so that they can be utilised to carry a killing bottle and other materials on the outward voyage, and some have returned from the uttermost ends of the world simply wrapped in brown paper, and have landed their cargoes in good condition, so that the plan can be recommended as having stood the test of rough actual practice.

The insects should be pinned immediately after killing, as if left for more than a few minutes they get so stiff that it is difficult to arrange them nicely in position without damaging the legs. As a rule, it will be found that they die with the wings nicely spread out at right angles with the body, so that the insect when shaken out of the bottle on to the setting cork lies naturally on its back. The process of pinning is conducted as follows :—

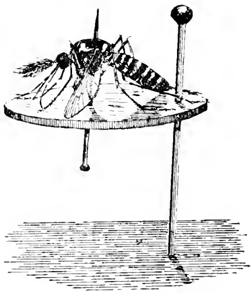

FIG. 7.—TO ILLUSTRATE THE METHOD OF PINNING A MOSQUITO: TWICE NATURAL SIZE.

(1) Take a disc and write on it date and place of collection—"House," "bites," "sylvan"—or other information; also a distinguishing letter if there be several species.

(2) Place the disc, writing upwards, on the piece of cork and then take an insect pin in a pair of forceps close to the point and transfix the disc near the middle.

(3) Place the Mosquito on the cork on its back.

(4) Take the pin, with the disc on it, in a pair of forceps near the head, and holding it so pass the point through the thorax of the insect between the roots of the legs from venter to dorsum.

(5) Pass a common pin through the disc, near the edge, and force the point of this into the cork at the bottom of the box.

(6) Spread out and arrange the legs and wings in suitable position by means of a fine-handled needle.

For handling the pins it is best to obtain a pair of specially-made entomological forceps, but if such be not available the "ciliary" forceps used for extracting eyelashes will serve very well.

In arranging specimens in the box for transmission by post, care should be taken to force the pins well home into the cork, and additional pins should be placed between the contiguous discs so as to prevent their shifting laterally, in the position shown in the figure.

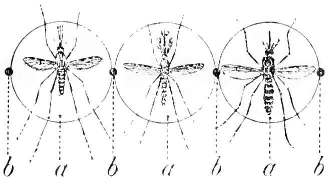

FIG. 8.—TO ILLUSTRATE METHOD OF ARRANGING PINNED INSECTS FOR TRANSMISSION BY POST.

a a a, pins carrying the discs; *b b b b*, extra pins placed between the discs to prevent lateral movement.

Another plan is to thrust the disc pins into the cork obliquely, so that if the disc shift it will rest against the cork instead of the next specimen; but this method is not so efficient as the first.

Insect boxes for keeping a permanent collection are best obtained from regular dealers, as they require to be nearly air tight; but it is well to specify that they should be lined with "cork carpet," as this holds the pins much better than sheet cork, and a space $\frac{1}{4}$in. wide should be partitioned off one end by a slip of wood, to contain a long narrow muslin bag full of naphthaline or camphor.

After a few trials it will be found that pinning an insect in the way above described involves far less trouble than making it into a microscopic specimen; but if materials for pinning be wanting, fairly recognisable specimens may be made by mounting the insect dry in a deep cell, or in one of the slides recommended by the late Dr. Carpenter for mounting *foraminifera.*

These consist of a slip of deal 3in. × 1in. × $\frac{1}{16}$in., with a hole $\frac{3}{4}$in. in the middle. This perforation forms the wall of the cell and is closed on both sides with ordinary cover squares, secured in place by perforated labels, so that the specimen between the covers can be viewed from either side. The sides of the perforation should be brushed with creasote to prevent mildew, and the preparation dried as rapidly as possible in the sun.

Wings mounted dry as microscopic specimens are, however, valuable, but when made, great care should be taken to mark with corresponding letters slide and pinned specimen, without which latter such slides are valueless.

Specimens may also be transmitted fairly safely in short lengths of glass tubing of a size just sufficient to admit the insect, but too small for it to shake about easily. The tubes should be simply tied up in a square of muslin, as if sealed the contents are certain to mildew; but whatever plan you adopt, *ON NO ACCOUNT PACK INSECTS IN COTTON WOOL*, as it is impossible to extricate them from it without breaking them. Tubes may also be made by rolling a piece of gummed paper round a pencil and cutting them to suitable lengths when dry.

Just as mature insects can be obtained from larvæ, so it is generally possible to get larvæ from the former; but a somewhat larger apparatus is necessary. Take an earthenware dish, at least 1ft. in diameter and 4in. deep, and fill it with puddle water which has been strained through muslin to avoid the fallacy of its already containing larvæ. A cover is made for this consisting of a square of thin plank a few inches wider than the dish, with a large hole occupying the greater part of its centre. In the four corners are small holes into which are fixed four small upright sticks about 18in. high, so as to form the supports of a miniature Mosquito net made of gauze or the material known as "leno," which is made close by means of tin tacks to the edges of the plank.

The whole thing can be lifted off and on to the dish, and when in position a Mosquito introduced into the net is securely confined. The triangular corners of the board can be utilised to carry banana or syrup as food, or may be smeared with mud in order to ascertain if the species ever deposit eggs in such situations. It is best to experiment

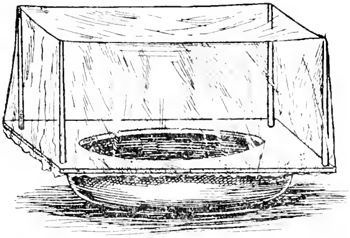

FIG. 9.—APPARATUS FOR BREEDING-OUT INSECTS.

with females that have had a feed of blood; or in the case of sylvan gnats with specimens taken in the open, as unless fully fed they will rarely deposit their eggs. The form of the egg boats, or groups in which the eggs are deposited, should be carefully noted and the larvæ preserved when sufficiently grown.

It is rarely necessary to confine males, as most species couple immediately after escape from the pupa.

The above appliance is also useful for obtaining from larvæ large numbers of individuals for use in observations on malaria, filariasis, &c. A piece of cardboard is slipped under the opening so as to close it, and in this way the contained Mosquitoes can be carried without injury to the subject of experiment, and liberated under his Mosquito net by simply removing the card and inverting the net.

By means of a simple apparatus of this sort the life history of the genus *Culex* can be followed out with great ease, but this is by no means equally the case with *Anopheles*, the species of which are very difficult to maintain in captivity, and I have not yet succeeded in rearing any batch from egg to imago. Very often the females refuse to deposit their eggs, or when they do so the larvæ rapidly die, and the experiences of numerous correspondents have been similar. It is difficult to say why this is so, as I have used vessels holding much more water than many natural collections I have met with containing *Anopheles*' larvæ, have had them partly filled with mud from genuine *Anopheles*' pools, and tried in every way to as nearly as possible imitate natural conditions. At any rate, it is useless to attempt to experiment in test tubes and such-like small receptacles, and I am inclined to think that the best plan will be to have made a frame of wire gauze large enough to cover a natural pool. In the north-western provinces of India, at least, the scale of such an experiment need be neither unwieldy nor costly, as here, perhaps, the commonest natural haunt of *Anopheles*' larvæ are certain small masonry tanks, one or more of which are to be found in the garden of almost every bungalow, and these are often no more than two or three feet square.

For rearing perfect insects from a comparatively limited number of larvæ taken from some natural source, a very handy little apparatus may be improvised from one of the ordinary prune bottles fitted with a screwed metal top. The greater part of the middle of the cap is cut out, taking care to leave at one point of the circumference a tongue-like projection to serve as a support for food. A single loop of wire is soldered on to the sides of the cap, of sufficient height to serve as a support for the bag of gauze or "leno," which when bound with string to the rim of the cap completes the apparatus. All appliances for observing captive *Anopheles* should be well fitted, as they will discover and creep through the smallest interstice, and much of the ordinary Mosquito netting sold is quite valueless as a protection against them.

The study of the habitual resting position of living insects is an interesting one, and has attracted considerable attention lately. With reference to the habitual attitude of *Anopheles* as contrasted with *Culex*, and with the view of more accurately studying this point, I have devised an arrangement for photographing living, resting Mosquitoes in profile. The appliance consists of a frame of thin wood about 1in. deep, and $4\frac{1}{4}$in. × $3\frac{1}{4}$in. in dimensions. This frame is converted into a box with glass top and bottom by means of a couple of the glasses of waste quarter-plate negatives, kept in position by adjustable brass clips. In each of the two vertical sides is an oval opening, closed by a small piece of gauze glued on to the inside of the frame. When a living Mosquito is introduced into the box it generally settles on the gauze, and if the box be then placed in front of a long extension camera so that the edge of the vertical side of the frame crosses the field of view, one can generally obtain a satisfactory picture.

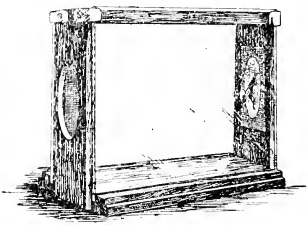

FIG. 10.—BOX WITH GLASS FRONT AND BACK FOR PHOTOGRAPHING LIVING MOSQUITOES IN PROFILE.

Mosquitoes make excellent sitters, and I have obtained negatives showing most minute detail, although the exposure has to be some ten to fifteen seconds, as they are uneasy and restless in too strong a light. It is useless trying to get too great magnification, as with any lens of less than $4\frac{1}{2}$in. focal length, placed so as to enlarge about two and a half times, it is impossible to get all the parts simultaneously in focus. For most purposes a sheet of white paper is the best background, but it is quite possible to get negatives showing much detail by reflected light, in which case a dark background should be substituted.

With the wet collodion process and subsequent enlargement, it would, I believe, be possible to produce useful records of the markings, not only of Mosquitoes, but of other insects.

For certain experiments it may be necessary to transport living Mosquitoes to a distance, and for this purpose Dr. L. Sambon contrived a method, described as below in the *Brit. Med. Journal*, September 29, 1900, p. 949, from which also are copied the subjoined figures.

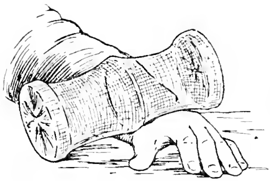

FIG. 11.—Case for Mosquitoes.

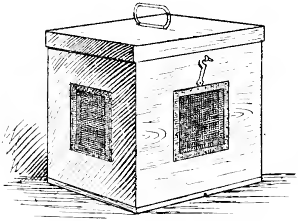

FIG. 12.—Ventilated Box for forwarding Mosquitoes.

"When the insects had fed, Dr. L. Sambon, who had gone to Rome on Experiment No. 2, placed them in small cylindrical cages made of Mosquito netting stretched on a wire frame (fig. 11). Four such cylinders were packed in a well-ventilated box (fig. 12) and forwarded to the London School of Tropical Medicine through the British Embassy in Rome. The box was 9in. in depth and $8\frac{1}{2}$in. on the sides. The wire openings were 3in. square on each side. The cages were each $8\frac{1}{4}$in. in length and $3\frac{1}{2}$in. in diameter. By the courtesy of the Postmaster-General they came forward by the Indian mail, so that they arrived in London some forty-eight hours after leaving Rome. A good many of the Mosquitoes died on the journey or soon after arrival; but a fair proportion survived and appeared to be healthy and vigorous."

With respect to instrumental outfit, a good hand lens magnifying about 10—15 diameters is indispensable; and for dissecting one must have a simple microscope.

Nothing elaborate is required, and indeed a perfectly practical dissecting stand can be improvised from a cigar-box and a scrap of mirror, with a bent wire to hold the lens; but, in choosing an instrument, be careful to select one with broad, gently-sloping wings on which to rest the hands. It is a mistake to fit it with expensive lenses, as all such, work very close to the object in proportion to their power, and room to manipulate is of more importance than excellence of definition. Two simple plano-convex lenses of 1in. and ½in. focus, are all that is required for the actual dissecting, but one modern achromatic lens of high power may be added, not for working under, but for the purpose of examining the preparation at intervals.

As regards the compound microscope, the practitioner in the tropics requires something that he can conveniently take to the bedside of the patient for the diagnosis of malaria.

As myself the designer of a folding microscope, I can with the better grace say, that none of them appear to me sufficiently rigid for use with high powers; and therefore prefer a portable, but not a folding stand, and for the last year have been using that catalogued by Leitz.

Messrs. Smith and Beck also showed me a somewhat similar and equally excellent instrument. Both these stands have sufficient weight and rigidity for use with the highest powers. For diagnostic purposes the 3mm. Zeiss dry apochromatic is a most useful lens, but for critical work on the parasite the highest powers of the best makers are required, though there is no need to spend additional money on lenses of exceptional angular aperture.

I give these details, which may seem somewhat out of place here, as one is often asked what should be recommended as the most convenient outfit for the tropical medical practitioner.

Entire larvæ are best mounted as microscopic objects in 4 per cent. formol solution, to which a very little glycerine has been added, but I should doubt if such mounts would be very permanent, especially in hot climates, so that it will be well to preserve a few slides with Farrant's solution. The slide should be first prepared by forming on it a shallow cell of Hollis' liquid glue, of such size that the edge of the cover rests on the middle of the cell-wall, leaving an edge of the glue outside it. This should be allowed to set, but not to dry hard before using, so that the edge of the cover can be imbedded in the semi-solid material. When all superfluous preservative has been drawn off with blotting-paper, a ring of the glue is run round the edges of the cover and the preparation set aside to dry. The sectionising of perfect insects is even more difficult than that of larvæ, as unless the razor be exceptionally keen, it carries the dense chitinous covering before it instead of cutting, and so crushes the internal parts.

There are, however, many structures alike in the larva and adult insect which can be demonstrated in no other way than by the method of serial sections, and as already mentioned, there are especial difficulties in applying this plan to animals with a chitinous integument. Thin as it is in most of the species with which we have to deal, it yet is apt to resist anything but the sharpest of razors, and what is even worse, is well-nigh impervious to the entry of preservative and other fluids, so that I have found it quite impracticable to adopt the plan of staining *en masse* either in the larva or adult insect, and this must hence be done after the sections have been fixed on the slide. After some experimentation I find that the following method may be relied upon to yield satisfactory and well-preserved preparations. For many of its details I am indebted to suggestions from Mr. Allen, the Director of the Marine Biological Laboratory at Plymouth, who has recently been working on certain copepods, which are not altogether dissimilar organisms, as far as consistence is concerned.

The larva or adult insect, as the case may be, is killed by immersion in a solution consisting of two parts of alcohol (90 per cent.) to one part of aqueous solution of perchloride of mercury (1 per mille.), in a test tube, which is then gently boiled for a minute or two so as to expel the air contained within the trachea. As the fluid cools it is necessarily drawn through the stigmata into the body of the insect, and is thus at once carried to all its tissues. It is left in this fluid for a few hours, and is then placed first in 90 per cent., and finally in absolute alcohol. To imbed it, it is first placed for at least twenty-four hours in oil of turpentine and is then imbedded in the usual manner in paraffin. As the various structures are very loosely connected it is very important to choose a specimen of paraffin with a melting point suitable to the temperature of the air of the place in which one happens to be working, for the least curling of the sections is fatal to the production of really satisfactory sections, so that it is well to try a sample of the paraffin in the microtome before employing it for imbedding. In Europe, a paraffin with a melting point of about 105° is not at all too soft for the ordinary temperature of the laboratory, but in the tropics I have found samples melting from 115° to 125° most generally useful; the former for the cold and the latter for the hot weather. The specimens should be kept for at least six hours in the bath of melted paraffin, and are then, with due attention to orientation, placed in the microtome, which, it is needless to say, should be one of a type constructed to produce ribbands of serial sections, the ordinary pathological instrument being quite useless for this purpose.

As the sections are to be stained on the slide, albumen, and not creasote-shellac, must be used for fixation.

A single drop of Mayer's albumen mixture (equal parts white of egg and glycerin, with 1 per cent. salicylate of soda, well beaten up with an egg whisk and filtered) is added to a watch-glass of water and the slide is prepared by brushing over it a liberal allowance of this very dilute albumen, so that the sections rest on a thin layer of fluid. When as many of the series as the slide will accommodate have been arranged in position, the slide is placed on the warm plate of the imbedding apparatus and warmed just sufficiently to flatten the paraffin and no more. It is then placed aside to dry as far as the presence of the glycerin in the mixture will allow; they are then placed on the warm plate and the paraffin melted for a moment, after which they are successively passed through baths of turpentine, absolute alcohol, and 40 per cent. spirit, and are then ready for staining.

For this purpose I find no dye better than Manson's methylen blue (borax 5 per cent., methylen blue 2 per cent., aqueous solution); this is allowed to act for several minutes and then washed off with water, after which it is well to give a ground staining of watery solution of eosine or fuchsine. After staining the slides are passed successively through baths of 90 per cent. spirit, absolute alcohol, and turpentine; and finally mounted in balsam. Gentian violet also gives good, and Ehrlich's hæmatoxylin fair, staining, but I have not been able to get any result with borax-carmine. Working in England I have not been able to test this plan on infected Mosquitoes, but the perfect way in which the most delicate tissue elements are preserved, and the fact that it is so well suited to the use of Manson's stain, makes it a hopeful method for demonstrating the parasites in the salivary glands. Great care must be taken to lose none of the series of sections, as the salivary glands are so small that they may easily be missed unless the series be fairly complete.

As the majority of workers at tropical medicine must necessarily conduct their investigations in places where there is no gas supply, such as is required for the working of the ordinary imbedding apparatus and other appliances involving the employment of self-regulating appliances for maintaining a constant temperature, it may not be out of place to describe a simple piece of apparatus for the purpose which I have used for many years in India. It consists of a sheet of copper about 15in. long by 3in. broad and at least $\frac{1}{12}$in. thick. This is supported in a horizontal position on two wooden feet sufficiently high to admit of the chimney of a small paraffin lamp being placed under one end.

In addition to the ordinary copper capsules for containing the melted paraffin for imbedding, a special long narrow one is required. This is filled with a sample of the paraffin which is selected for use, and is then placed near the middle of the copper plate, not across, but parallel with the length of the plate. If the lamp be now lighted and placed under one of the projecting ends of the plate, its heat is conducted by the copper to the narrow tray, and it will be found that a greater or less proportion of its length will become melted. At the point where the melted and solid portions meet it is clear that the paraffin is just at its melting point, and opposite this point are placed the small capsules of paraffin in which the structures for imbedding are to be placed. The long narrow tray, in fact, acts as a thermometer, and if the plate be allowed to reach, so to say, a settled condition before placing the capsules of tissues on it, it will be found that the heat of the lamp is quite uniform enough to render little or no close supervision necessary, and that in a still atmosphere it may often be left for hours without touching. I do not, of course, propose such an appliance as a substitute for the self-regulating one where gas is available, but where, as in most tropical countries, there is no gas supply, it will be found to be something more than an inefficient make-shift, and with a small amount of occasional attention will yield as good results as can be desired.

With the exception of the wings, which are best mounted dry, the cover being merely secured by a perforated label, parts of Mosquitoes are best mounted in balsam, after passing through absolute alcohol and clove oil.

The subject of the methods of determining the relation of Mosquitoes to blood parasites is rather outside the scope of a book like the present, but a few words on the subject may not be out of place. To infect a Mosquito all that is necessary is to introduce a few of the species under investigation under a Mosquito netting, beneath which the patient harbouring the hæmatozoa is to sleep. The insects should be females, and to avoid the possible fallacy of their having been previously infected, it is better, if possible, to employ for the purpose only insects that have been reared in captivity from larvæ. Although a certain number of confirmatory experiments of the infection of the vertebrate host by infected insects are desirable, there is no need of such an experiment to establish the biological relation between Mosquito and parasite, for if it is found that the parasites ingested by the Mosquito with the blood of the infected vertebrate undergo developmental changes, it may be taken as proved that the species used is capable of acting as intermediate host, and is therefore dangerous to the vertebrate from which the infected blood was derived. It is well to make use of a fair number of insects in each experiment as all may not bite, and in any case some ten or a dozen will be required for dissection day by day in order to follow out the changes undergone by the parasites within the Mosquito. The method of dissecting out the stomach of the Mosquito is described elsewhere, and it only remains to add that the best medium in which to examine is ordinary "normal saline" solution. If the stomach be very full of blood it is well to puncture it, and shake it to and fro in a watch-glass of saline solution, with the point of a needle, or which is safer, to irrigate it with drops of solution as it lies on the slides.

For permanent preparations Major Ross found nothing so suitable as formol solution, as balsam or glycerin render everything so transparent that all details are lost. Such experiments are, when negative, conclusive only when conducted at the season of the year at which the parasitic disease under investigation is rife, as at any other season it may possibly be merely owing only to unsuitable climatic conditions that the parasites fail to continue their cycle within the Mosquito.

PLATE I.

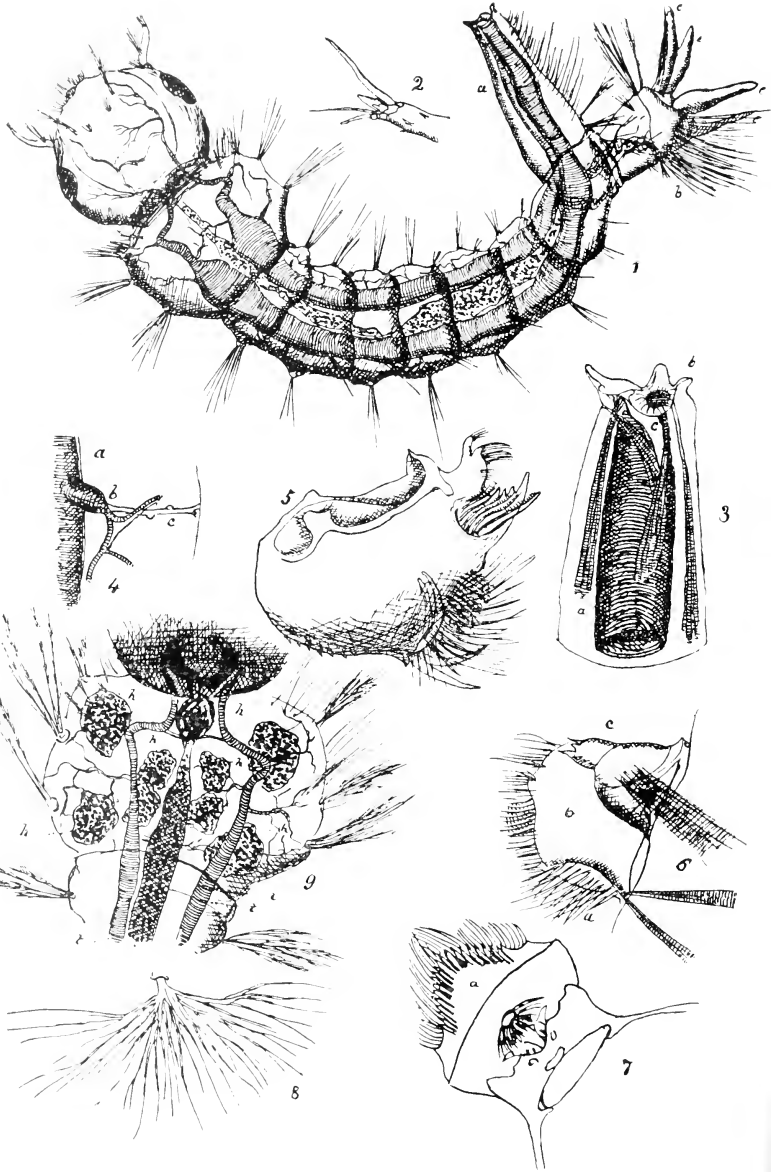

PLATE I.—To Illustrate the Anatomy of the Larva.

Fig. 1.—Full-grown larva of *Culex annulatus* (Schrank): *a*, respiratory syphon; *b*, swimming fan; *c c c c*, anal papillæ.

Fig. 2.—An antenna, more magnified.

Fig. 3.—Respiratory syphon more enlarged, to show: *a*, the muscles; *b*, the valve-like terminal lobes; *c*, the stigma.

Fig. 4.—Segmental respiratory apparatus: *a*, part of the main longitudinal trunk; *b*, lateral branch; *c*, cord by which the cast-off lining of the tubes is withdrawn during ecdysis.

Fig. 5.—Left mandible, seen from below.

Fig. 6.—Right maxilla, seen from below: *a*, internal lobe; *b*, external lobe; *c*, maxillary palp.

Fig. 7.—Labium, with the lower part of the pharynx, seen from above: *a*, the labrum itself.

Fig. 8.—One of the natatory compound bristles, much magnified.

Fig. 9.—Thorax of larva of *C. pipiens*, to show: *h*, the hepatic masses; *i*, intestine; *t*, main longitudinal tracheæ.

It will be noticed that in this species the thoracic dilatations of the main tracheæ are by no means so marked as in *C. annulatus* (Schrank), and the whole respiratory system is less developed.

This plate is partly based on Meinert's figures, and partly original.

CHAPTER III.

The Anatomy of the Larva.

From a purely anatomical point of view a good deal has been written on this subject, but on the descriptive side comparatively little has been recorded, so that except in the case of a few of the commonest species, we are quite without adequate descriptions whereby *Culex* larvæ may be distinguished among themselves. In by far the greater number of recorded species the larvæ have never been recognised, and still less described. It is obvious, however, that as these insects can be much more easily destroyed in large numbers in the larval stage, by insecticides, or by the filling up of pools, than they can be as flying insects, the accurate description of the larvæ of noxious species has become a matter of great importance; but it is unfortunately one that can, as yet, be hardly said to be commenced.

Observations on this subject, by "breeding out" adult insects from larvæ, require much time, and, above all, a settled residence, and the work of the Sanitary Commissioner of an Indian province is of a kind that precludes either requirement, so that my present visit to India has been very unfruitful in results in this direction, and I still can only offer a few general suggestions for future work.

As regards the genus *Culex*, I believe that the proportional length of the breathing tube, as compared with that of some comparatively fixed portion of the body, such as the head or thorax, will be found to yield valuable specific characters.

I was at first inclined to think that this proportion varied greatly with the age of the larvæ, but found subsequently that this was a mistake due to the occurrence of several species in the same pool, and that a ratio of this sort remains fairly constant throughout the growth of the larvæ. It is easy, for example, to distinguish between the larvæ of *C. fatigans* (Wied), and those of the species I identify as *C. impellens* (Walker), which constantly are found associated here in the cold weather, the breathing tube of the former being of medium length, while that of the latter is very short; and I have met with larvæ in which the syphon is so short that they may easily be confused with those of *Anopheles*, the more so as they not unnaturally assume much the same position in the water; but I was unable to delay my departure in order to ascertain the species to which they belonged, but I believe they were those of a *Stegomyia*.

In *Anopheles*, on the other hand, apart from size, the larvæ of different species are most difficult to distinguish. Their coloration is singularly alike, and as yet I could not undertake to distinguish those of any individual species, though they differ considerably in the matter of the size of the anal tubercles.

Quite recently Grassi (*G.S.Z.*, p. 81) has shown that the bristles with which these larvæ are provided, in various situations, differ sufficiently in the various species to be made use of to afford definite indications of the species to which a larva belongs. These bristles are often of very complex structure, and this is especially the case with those on the dorsum of the thorax and head. Confining his attention to those of the latter region, he finds that the characters of two special bristles, viz., the sub-median pair, in the middle of the fore border of the head, and those placed at its external angles, suffice to easily distinguish the four European species of *Anopheles* larvæ known to him, and on comparing his figures with the corresponding bristles of the larvæ of *An. Rossii*, I find that in that species too these bristles again differ from any of those. It will be observed that the difference between the bristles of *An. Rossii*, as compared with those of *An. superpictus*, is very marked, and is alone quite sufficient to set at rest any doubts as to the absolute distinctness of the species in question.

In addition to the above, there are a variety of other compound bristles, notably those of the swimming fans, which might be made use of in distinguishing species, but, with the above exception, we can go no further than the recognition of genera, and of some even of these we are quite ignorant of the characters of the larvæ.

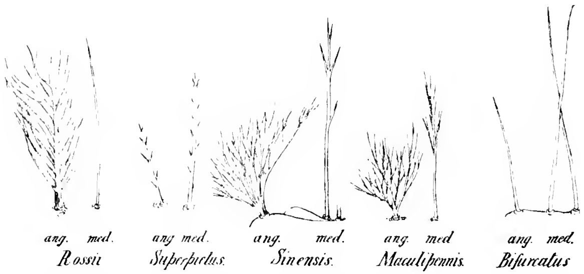

FIG. 13.—The median and angular bristles of the fore margin of the clypeus of five species of *Anopheles*. Copied from Grassi, with the exception of the figure of the bristles of *An. Rossii*. (Original.)

Of the larvæ of *Megarhina*, *Psorophora*, and *Mucidus* we know nothing. Those of *Uranotænia* are said by Dr. Lutz to have a very short syphon, and to look much like those of *Anopheles*, resting in the water in an oblique position. In Mr. Theobald's new genus *Stegomyia*, *S. pseudotæniatus* and *S. fasciatus* certainly have very short syphons, and the same was the case in a larva I met with in Allahabad in August, and which, though I was unable to breed out, was almost certainly that of *S. gubernatoris;* so that probably the larvæ of this genus are characterised by the possession of short breathing tubes. The same, however, is the case with certain Culices, notably of *C. pulchriventer*, the syphon of which is no larger than one of its anal tubercles.

The larvæ of all the *Culicidæ* are aquatic, and are encephalous, *i.e.*, have a well-developed head. When just hatched, the larvæ are of just sufficient size to be easily seen by the naked eye, and are at this stage so transparent, that almost all details of their anatomy can be made out in the living larva placed under the microscope in a little water. If all superfluous water be carefully removed from beneath the cover, by means of a strip of absorbent paper, so as to slightly press upon without crushing the larva, its naturally vivacious movements will be sufficiently restrained to admit of its being observed at leisure.

The larvæ are easily recognised by their vivacious wriggling movements, as minute worm-like bodies, with a disproportionately large head with a pair of prominent black eyes, and at first sight what appears to be a vertically bifurcated tail. Being quite unprovided with legs, they swim by means of the strokes of a tail armed with large expansions of bristles. When more closely examined, it is seen that, like the adult insect, it consists of three well-defined regions, the head, thorax, and abdomen. Commencing with the head, it is seen to be not quite so wide as the thorax, but considerably wider than the abdomen, and forms a truncated cone, wider than it is long, and separated from the thorax by a distinct sulcus. It is ornamented on the dorsum with several patches and lines of pigment, the arrangement of which, however, is not very constant; and at the broadest part laterally are placed the two large eyes. It is further ornamented in various places with tufts of strong bristles, the structure of which is often very complex.

From two slight prominences a little in front of the eyes spring the antennæ, and projecting from the middle of the anterior border of the head may be seen a complex arrangement of bristles springing from the upper lip and mouth parts.

The greater part of the upper surface of the head is formed by the dorsal surface of the third metamere. In front of this is the clypeus or dorsal plate of the second metamere, a short but broad plate, with a shallow, curved indentation in front, while laterally it is armed with a pair of incurved tufts of bristles which form what Meinert (De Encephale Mygelarver) speaks of as a whorl, or rotatory organ; as he believes that it is by the vibrations of these bristles that nutritive particles are directed into the mouth. Anterior again to the clypeus is a small, rounded, median prominence, the labrum or dorsal plate of the first metamere.

The eyes are large and placed laterally, forming a sector of about 150°, and close behind them may be distinguished a minute ocellus, generally of oval form. The antennæ spring from the antero-external corners of the third metamere, and form a pair of short, curved horns, fairly freely movable on their basal articulation with the head, but elsewhere rather rigid. The greater part of the organ consists of a rather stout basal joint, which is provided at the inner side of its distal extremity with a tuft of strong, compound bristles.

The next joint is less than half the length of the basal, and is distally armed with a few long, stiff bristles, while, like the basal joint, it is beset throughout its length with stiff, short spines. The last portion of the antenna or flagellum is very minute, although there are indications that it is in reality composed of three very short articulations. Besides the flagellum there are also attached to the end of the second joint two peculiarly-formed processes or jointed hairs, which are almost certainly sense organs of some sort, and are most probably olfactory organs.

In general form the thorax forms a sort of six-sided box, and is somewhat larger than the head in all dimensions.

Although no sutures can be distinguished on its surface, its division into its three component segments is sufficiently indicated in its outline, and by three pairs of lateral tufts of bristles, which are longer and stouter than those of any other region of the body. The component hairs of these tufts are all compound, each being clothed throughout its length with filaments of considerable proportional length; and each tuft springs from a nipple-shaped tubercle, which appears to be capable of a certain amount of voluntary movement, though, from its position, it is obviously not the rudiment of a leg. These tufts appear to act by way of lateral keels, whereby the larva is maintained in any position without being made to revolve on its axis under the influence of the strokes of the tail. In addition to these principal tufts, other smaller but also pedunculated tufts spring from the sides of the terga of the segments, the characters of which should be accurately noted in describing species, as it is probable that their form, number and position, may yield good specific characters. The great preponderance of the mesothoracic segment is already well marked, though not to anything like the same extent as in the imago.

Proceeding with the examination of the living larva, the first thing that catches the eye in the thorax are four pairs of what at first sight appear to be pigment spots. A little watching, however, suffices to show that these are not really external markings, but internal organs seen through the transparent carapace, and that their position is constantly altering under the action of the surrounding thoracic muscles, and of the pulsations of the dorsal vessel. Examined with a somewhat higher power, they are seen to be glandular bodies of a sacular form, lined with secretory cells, their cavities being filled with a clear fluid, holding in suspension a quantity of deep brown granular matter. These glands are connected with the upper end of the intestine, and are probably hepatic in function. In the dead, or preserved and mounted larva, they soon become invisible, owing to the discharge of the contained brown matter into the intestine.

These glands are arranged in two sets, an internal and an external, the former of which consists of two glands placed so closely together as often to look like a single mass, and situated nearly in the middle of the thorax, close to the intestinal canal. The other two pairs are placed at a distance from the intestine, in the corners of the pro- and metathorax respectively. In the middle line the dorsal vessel can be seen pulsating, the action being rather that of a peristaltic wave than a true systole, the heart being here a long, valved tube, corresponding rather to an aorta than to a heart in the usual acceptation of the word.

More or less in the middle line, too, its coarser image often obliterating that of the delicate, superjacet dorsal vessel, is the stomach, or chylific ventricle, its opacity varying with the fulness of its contents; and on either side may be seen the dilated thoracic portions of the respiratory tracheæ, which are easily distinguishable by the spiral thickening of their chitinous lining, while branches of the tracheal system to the various organs can be traced in various directions.

The abdomen is between three and four times as long as the thorax, but narrower, and consists of nine segments, each of which is provided with a large tuft of bristles as well as with numerous hairs, either single or grouped, on the dorsal and ventral surfaces. The cardiac, intestinal, and respiratory tubes can all be traced through the greater part of its length, and the Malphigian tubes, and other intestinal appendages, can all be made out, as the larva takes favourable postures. The nervous system, however, is completely hidden, and owing to its transparency during life, cannot be seen even if the animal be placed in the supine position.

In the genera *Culex* and *Mochlonyx*, there springs from the dorsum of the eighth segment a large process, at least as wide and generally about two or three times as long as the remaining segment of the abdomen, and into this the two main respiratory trunks can easily be followed, and are seen to open at its extremity by means of curiously guarded openings. At the root of this breathing horn are a pair of rather short but dense tufts of hairs. The last segment contains the rectum and carries the anal tubercles, the anus being placed almost at the very extremity of the body, but rather towards its ventral aspect. Around the opening are two pairs of delicate, leaf-like expansions, each furnished with a branching twig of trachea, the lower pair being somewhat the larger. They probably act as gills, and subserve respiration during the periods when the larva is completely submerged, which, when the weather is cool, are often somewhat protracted. On either side, too, but originating a little in front of these anal tubercles, are a pair of large dense tufts of compound hairs, which are employed in swimming much in the same way as a fish's tail, and are so arranged as to form an expansion of similar shape.

The internal organs are of typically insect plan, and will be most easily understood by considering each system separately.

Digestive System.—Apart from the gnathites or foot-jaws, which, although of the ordinary masticatory type are rather complex organs, the intestinal canal is of the simplest form, consisting of a narrow œsophagus, which leads into a wide, perfectly straight tube, commonly spoken of as the stomach, which extends to the end of the sixth abdominal segment. Into its thoracic end open the ducts of the hepatic glands, which, when examined in section, are seen to be broad crypts communicating with the stomach by so wide an opening as to almost appear as diverticulæ; and into its distal, where the tube contracts before the commencement of the rectum, open the five Malphigian tubules, which are slender tubular glands, differing in no way from those of the adult. Lying close to the œsophagus in the head are the two salivary glands, but they are not easy to demonstrate, except in section, and the same remark applies to the rectal glands, which lie beside the rectum in the last segment. The mouth parts consist of an upper lip or *labrum*, in the form of a convex crenated plate, armed with numerous hairs, and a longer and narrower lower lip, or *labium*, of somewhat similar structure. Between these are placed the two pairs of foot-jaws, the mandibles above and the maxillæ below. Each mandible consists of a somewhat pyriform plate, the wider end of which forms an articulation with the lateral structures of the mouth; while the narrower end is formed into a rather complex set of dentations divided into two groups, the anterior of which are small and claw-like, and mainly adapted for holding the prey, while the hinder set are better adapted for cutting and crushing. The appendage is further provided with brushes of peculiarly formed hairs, and has, about the middle of the anterior border, two large jointed processes or hairs, which probably are tactile or gustatory in function. The maxilla is a plate of somewhat quadrangular outline, the anterior border being curved and its corners rounded off. It is richly provided with hairs, some of which have a curiously compound structure, and from its inner and posterior corner there projects a short, three-jointed maxillary palp in the form of a truncated cone, the extremity of which is armed with minute spines. The above description should suffice to enable the dissector to recognise the various parts, but it would be wasted labour to enter into minuter detail in a general description, as the form and arrangement of the various parts differ somewhat in the various species, and the minutiæ will best be studied by teazing out the parts from the head of whatever larva happens to be available, with needles, under the simple microscope.

Respiratory System.—This is very highly developed in these larvæ, and presents many peculiarities which differ widely in the different genera; and hence the remarks below must be understood to apply to *Culex* only. The two main longitudinal tracheæ are in all, however, of such large size that they may be considered rather as elongated air sacs than as mere tubes for the conveyance of air to the tissues.

Doubtless they serve a double function; namely, as receptacles for the storage of air for use during periods of complete immersion, and as hydrostatic organs to secure a proper degree of buoyancy. It is only the two main longitudinal trunks that are so largely developed, the remainder of the tracheal system being of no more than the usual complexity in organisms of this sort. Each of these main trunks commences quite abruptly in the prothorax, and, rapidly increasing in diameter, attains its largest dimensions in the mesothorax, where, in some species, *e.g.*, in *C. nemorosus*, there is a marked local dilatation; in *C. pipiens*, however, there is no mesothoracic dilatation, and the tube remains of nearly the same diameter throughout the entire length of the abdomen to its termination at the end of the peculiar dorsal process of the eighth segment. The anastomoses between the two main stems are trifling, there being only two transverse connections placed in the pro- and mesothorax respectively before the tubes have attained their maximum diameter. The anterior of these two cross-branches is considerably the larger, and immediately in front of it, each trunk splits up into a number of branches, which enter the head and are distributed to the various organs contained in it. The large anterior cross branch gives off no branches, but the hinder one supplies some twigs to the wall of the intestinal canal, and to the hepatic glands.

In the larvæ of *An. Rossii*, however, and presumably of other species of that genus, the communication between the two main trunks is extremely free, as not only are they continued beyond the end of the thoracic dilatation to unite with each other in the middle line in the form of an arch of nearly uniform diameter, but a smaller anterior branch unites with its fellows to form a second concentric arch, of

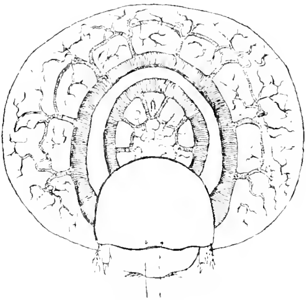

FIG. 14.—Larva of *Anopheles Rossii*, seen from in front, to show the tracheal arches, and their anastomosing loops.

but little less calibre. Moreover, as will be seen in the figure, each arch gives off eight branches, which anastomose with each other to form a series of loops, four on each side, those of the larger arch being directed tangentially, while those of the smaller run forwards; so that, in addition to the transverse branches described above, there are no less than four channels of communication between the main trunks of opposite sides.

From each of the main trunks in the thorax there issue also three rather large branches, one for each segment, which divide up into branches that pass to the contained muscles and viscera. Between these lateral thoracic branches I have not been able to make out any longitudinal communication; but like the lateral abdominal branches they extend as pervious tubes nearly to the skin of the larva, and are continued to the latter as an impervious chitinous cord, surrounded by true dermic tissue, to actually blend with the external chitinous covering of the larva. In the abdominal region the arrangement is essentially the same, only here there is a continuous longitudinal anastomosis between the lateral branches, one of which issues from the main trunk of all but the last segment, and after a short course divides into three main branches—an anterior to anastomose with the posterior branch of the lateral trachea of the segment in front of it, a posterior to communicate with that behind it, and a continuation, which after distributing branches of air supply is continued to the skin, first as a pervious tube and then as an impervious cord, exactly as in the thorax. These cords represent the rudiments of the future segmental stigmatic trunks of the imago, and it is by their agency that the discarded lining of the portion of the tracheal system belonging to the segment is withdrawn from the body whenever the larva undergoes its periodical change of skin. From these three principal segmental branches there issue branchlets which carry air to the various muscles and viscera of the segment. These lateral stigmatic cords can best be studied in the abdominal region; and if a cast skin, such as will be found floating in abundance on the surface of any vessel in which larvæ are kept, be carefully examined, it will be seen that the main longitudinal air sac has broken up into segmental lengths, and that each piece is attached by its cord to the skin of the corresponding segment; for it must be remembered that not only the outer skin but the whole of the lining of the tracheal system is thrown off at each ecdysis. The structure of the peculiar dorsal horn of the eighth segment remains to be described. Each of the two main stems passes up through it separately, to end in a pair of stigmata at its extremity, whose openings are considerably smaller than the diameter of the tube, being placed in the centre of a small circular plate supported by chitinous rays. The mechanism by which these openings are protected from the entry of water is rather complex and consists of a sort of valve, formed by five flap-like lobes at the end of the process. These flaps consist of two pairs and a small unpaired lobe, the larger of the two pairs being placed opposite the small unpaired one. Between the two air tubes and around them are a number of muscular strands, which originate in the eighth segment and extend through the process to be inserted into the bases of the flaps, so that, when they contract, the stigmata are drawn down somewhat within the process, and the valves close over them.

Vascular System.—This consists of a delicate, long, wide tube, which extends along the dorsal aspect of the body, from the hinder part of the head to the very extremity of the abdomen. Its structure is so delicate that, except in the living larva, where its shape and position can be followed by its movements, it is extremely difficult to make out. It consists essentially of a long, thin-walled tube, with valvular constrictions opposite the incisuræ, communicating freely with the perivisceral spaces by means of cribriform apertures, which, however, are anything but easy to demonstrate. There is no system of peripheral vessels at all comparable with those of the higher animals, the function of the organ being to keep in motion the perivisceral fluid, which is thus kept flowing over the tracheæ, which lie free in the perivisceral spaces between the various organs and tissue elements. It acts, in fact, rather as a churn than as a pump. In front of the thorax it extends as a narrower vessel into the head, and this portion is sometimes spoken of as the "aorta," but I look upon this term as a misnomer, as, save in diameter, the extension differs in no way from the rest of the dorsal vessel, is quite unprovided with branches, and appears at its anterior end to lose itself in the general interstitial lymph spaces of the head. The circulating fluid is colourless and contains but few cellular elements, those that are present being of the nature of leucocytes, so that while fulfilling the functions of both, the fluid is rather of the nature of lymph than blood.

Nervous System.—The demonstration of the nervous system can only be made by dissection, as its elements are too delicate to be distinguished from the overlying intestine, even in the supine position, and for this purpose specimens hardened in alcohol are best. Even thus it is not altogether easy to follow out any length of the chain, and for those who will be satisfied to examine a closely-allied larva, it is recommended to dissect the larva of one of the *Ephemeridæ*, in which the nerve cord can be separated with singular ease. These larvæ are very common in grassy pools and small running streams, and may be recognised by their long caudal bristles, which give them the appearance of possessing a long forked tail. When one has become accustomed to what to expect to see by practice on these easier subjects, it will be found easy enough to teaze out the nerve cord in *Culex* larvæ. In the head, however, this is scarcely practicable by the method of teazing, and sectionising must be resorted to. Taking the young larva as a type, a pair of ganglia can be demonstrated for each segment, and on emerging from the thorax the lateral cords separate to pass backwards across the œsophagus, to combine behind it in the large superœsophageal ganglion or brain. From this mass filaments are given off to the eyes and antennæ, and from it, as well as from the ganglia of the segmental chain, fibres pass to the corresponding muscles and to the periphery, sensory filaments having been actually traced into the bases of the hairs. At the time of pupation the location of the ganglia undergoes changes of startling rapidity.

Mr. F. V. Theobald notes that in a few minutes prior to the escape of the pupa from the larval skin the first abdominal ganglia come to lie in the posterior part of the thorax, and during pupal life the changes are equally rapid. In four days the fore-brain increases tenfold in bulk, the first abdominal ganglia fuse with the three thoracic pairs, and about the same period the eighth pair shift forward and fuse with the seventh ganglia, and in the ♀, but not in the ♂, the double mass so formed shifts into the sixth segment. This last alteration is performed with remarkable rapidity during the few minutes the imago takes in emerging from the pupa case.

Organs of Sense.—The eye in the encephalous larva is usually stated to be of the "simple type consisting of a group of ocelli with lens and retinal expansion."

This sort of statement has been copied from one text-book to another till it has become stereotyped, but as a matter of fact, there is neither lens nor retinal expansion, properly so-called, and the eye appears to be rather a transition stage in the development of the compound eye of the imago, than a structure in any way like the ocelli of adult insects, or the eyes of spiders or molluscs.

In full-grown larvæ of *Culex pipiens*, the eyes, although distinctly separated by an unpigmented gap, form for all practical purposes a single visual organ, the thick but perfectly transparent cuticle forming an unbroken spherical curve over both eyes, and although this is somewhat thicker in the middle line opposite the separation between the deeper parts of the eyes, there is nothing whatever in the form of a lens, at any rate in the optical sense of the word, as not only is its internal limit formed by the irregular surface of the pigment, but even taking this as a regular surface there is so little difference in the depths of the anterior and posterior curves that any image formed by it would fall nowhere near the visual nerve endings, but somewhere in the animal's thorax. If we examine a not too thin radial section of the organ it will be seen that it consists of a number of conical masses of pigment, the combined bases of which form the inner boundary of the transparent cuticular layer of the eye, and into the apex of each may be traced a fibre of the optic nerve springing from a bilobed mass of ganglion cells, almost in contact with, but yet distinct from, the large lobes of the cerebral mass.

Selecting a thinner section we find that each nerve fibril, shortly after starting from the optic ganglion, begins to acquire a rapidly thickening covering of pigment granules, and that as soon as this has become sufficiently bulky to merge with the neighbouring sheaths of pigment to form the base of the great pigment mass of the eye, the fibre expands into a spindle-shaped body provided with a distinct nucleus. Beyond this the spindle-shaped body contracts into a rod-like structure, the actual ending of which I have not been able to trace, though I think it simply ends in the midst of the transparent contents of the tubular visual elements to be presently described. A further examination of radial sections shows that the pigment-covered sensory cones each consist of a deep portion enclosing the spindle-shaped bodies, which may or may not be radial in direction, and may even be curved, and an outer portion containing the rod-like nerve end, which is always truly radial. If we now turn to the examination of tangential sections, we find that the superficial layer of the general pigmented mass consists of a number of cylindrical prolongations of the transparent superficial layer of the eye, each enclosed in a layer of pigment, which is very thick at the surface and becomes gradually thinner as the deeper layer containing the spindle-shaped bodies is approached.

In all sections that are sufficiently truly tangential to afford a clear image, the contained terminal rod can clearly be seen as a well-stained dot exactly in the middle of the transparent contents of the tube of pigment; but whether it extends through the entire length of the tube, or ends somewhere during its course, is more than I can say; in any case, however, it extends along it for some considerable portion of its length. From what has been said it is clear that the terminal rods can receive only rays the direction of which is parallel to the radius of the sphere of the eye coinciding with the transparent axis of the pigment-clothed visual element, and that such rays will reach this end-rod and no other, so that although there be no dioptric apparatus, such as is found in each visual element of the facetted eye of the adult insect, for the purpose of concentrating on the contained rod the pencil of rays entering each transparent cylinder, it is, nevertheless, like such eyes, suited only for mosaic vision, and is for such a purpose only less efficient in so far as in that a smaller portion of the entering pencil of rays will actually reach the end-rod placed in the axis of the transparent cylinder. Indeed, to complete the development of the eye of the imago no great alteration of the deeper parts is required, but only the modification of the transparent superficial layer of the eye into the beautiful system of miniature dioptric systems, one for each end-rod, which forms the most striking characteristic of the facetted com-

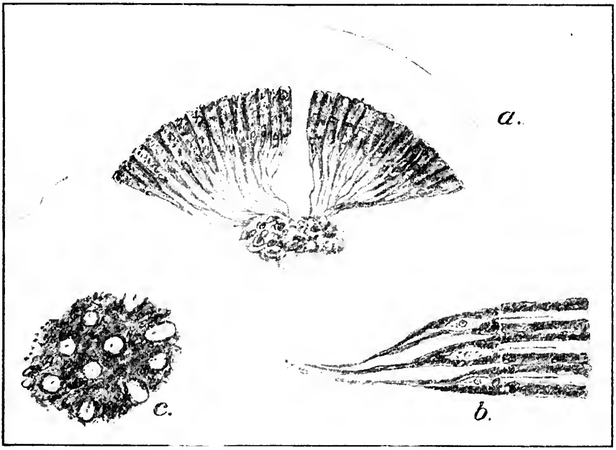

FIG. 15.—TO ILLUSTRATE THE ANATOMY OF THE EYE OF THE LARVA.

a, Radial section through anterior part of the head of the larva of *Culex pipiens*, cutting through both eyes and the optic ganglia; *b*, semi-diagrammatic representation of three of the visual elements of the above more highly magnified; *c*, portion of tangential section of the outer layer of the pigmented portion of the eye.

pound eye. I have gone into somewhat more detail than usual in this point, because I have nowhere met with any account of the visual organs of these larvæ which appears to be based on actual observation of the family, most authors being apparently content to assume that their eyes must needs resemble the visual apparatus of other and often very distant groups of invertebrata. It is clear that in such an eye the mosaic must be a very coarse one, and that, except in the case of very near objects, the impression gained of their form must be extremely fragmentary and ill-defined.

Hearing.—As regards the organ of hearing it happens that in one member of the family, *viz.*, in the larva of *Corethra*, an organ as to the auditory nature of which there can be little doubt has been studied in some detail. In this genus the larvæ are so transparent that they are known as glass larvæ, and hence can be studied with exceptional advantage, and the organ which is situated in the eighth segment is described and figured by Professor Lubbock in his popular work on the "Senses of Animals." In this form the ganglion which is placed in the anterior part of the segment gives off a branch, the auditory nerve, which after a short course outward expands into a small auditory ganglion from which a sheath containing two or three auditory rods passes outwards and backwards to the skin.

The auditory ganglion and end-organ are further supported and kept in a state of uniform tension by a ligament which runs in an opposite direction from the ganglion to the skin at the anterior part of the segment.

The organs of smell and taste are probably situated in the antennæ and maxillary palpi and other parts of the mouth respectively, but I am not aware of any work on this subject bearing on the *Culicidæ* in particular.

PLATE II.

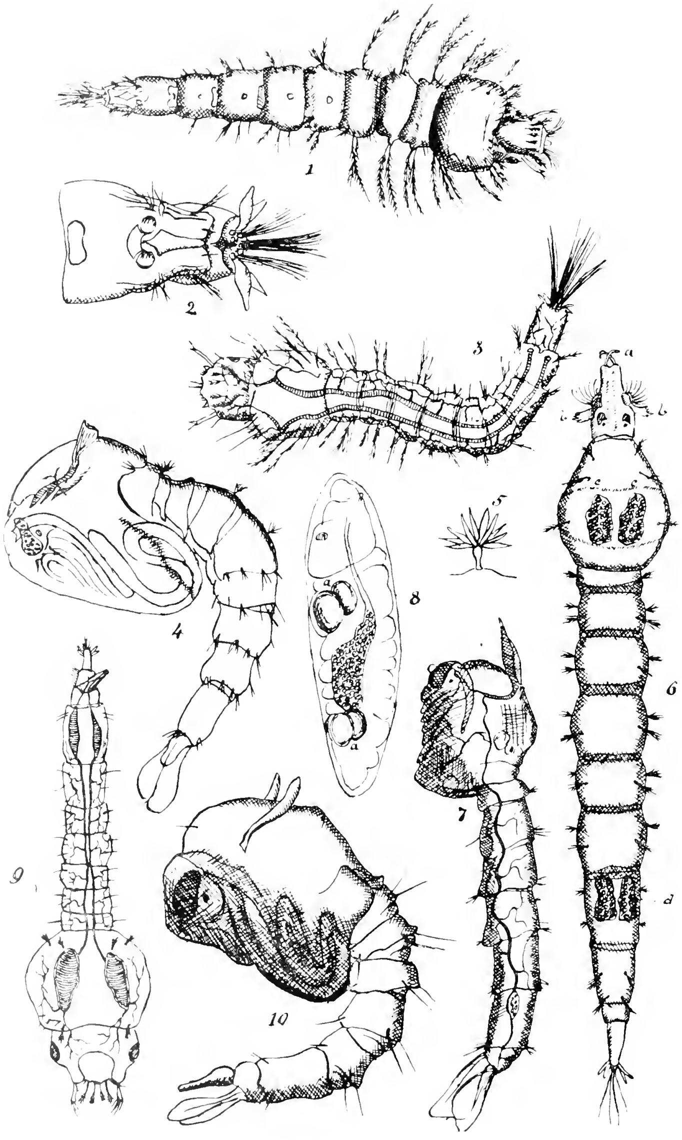

PLATE II.—To Show the Characteristics of the Larvæ of Different Genera.

Fig. 1.—The larva of *Anopheles maculipennis*.

Fig. 2.—Hinder extremity of the same, more enlarged.

Fig. 3.—The larva of *Anopheles nigripes*, to show the arrangement of the respiratory system.

Fig. 4.—Pupa of *Anopheles maculipennis*.

Fig. 5.—One of the natatory bristles.

Fig. 6.—The larva of *Corethra plumicornis*.

Fig. 7.—The pupa of *Corethra plumicornis*.

Fig. 8.—Embryo of *Corethra plumicornis* within the ovum.

Fig. 9.—The larva of *Mochlonyx culiciformis*.

Fig. 10.—The pupa of *Mochlonyx culiciformis*.

CHAPTER IV.

The Generic Characters of the Larvæ of the Culicidæ.

THE number of species which have been followed through their complete metamorphoses is, as already remarked, very small. In the case of the genus *Megarhina*, I can find no record of any observation whatever on this subject, while in *Ædes* the only note met with is one by Osten-Sacken, on *Ædes fuscus*, an American species, and this is of the most cursory description, all that is said being that they exactly resemble the larvæ of *Culex*, except that they are smaller. Putting then aside *Megarhina*, the larvæ of the various genera may be divided into two categories, according as to whether they possess a dorsal respiratory process to the eighth abdominal segment or not. In the first category are *Culex*, *Ædes*, and *Mochlonyx*; in the second *Anopheles*, and *Corethra*. Amongst those possessing the respiratory dorsal process, the larva of *Culex* has already been sufficiently described: of *Ædes* nothing more can be said, and of those sufficiently described, only the larvæ of *Mochlonyx* remain to be described. I have actually handled the larvæ of *Culex*, *Stegomyia*, and *Anopheles* only, and the notes given below are almost entirely a *précis* of Fr. Meinert's paper, "De Encephale Myggelarver" (Vidensk Selsk., 6, Raekke, Naturvidensk, og mathem. Afd. iii., 4).

Genus *Mochlonyx*.—Meinert's remarks apply in especial to *M. culiciformis*, which formed the subject of his investigations. The full-grown larva is of a light brown colour, the tracheæ and air sacs often showing through the skin with a golden lustre. On the dorsum of the thorax are several small, dull white spots, and the pleuræ and venter are whitish. After each change of skin the colour is almost white, and this lighter coloration persists longer on the head and anal tube than elsewhere, so that the newly-dressed larva presents quite a distinctive appearance.

In many points these larvæ are intermediate in form between those of *Culex* and *Corethra*, but the head is most like that of *Anopheles*, forming like it a truncated cone, but differing in being pinched in in front of the eyes, so as to present a pyriform outline; and seen from the side the difference is even greater, as the tergal plate of the second metamere is bent downwards and then backwards, so that the anterior part of the clypeus overhangs the mouth. The tergum of the third metamere is cordate, being deeply incurved in front for the reception of the hinder part of the clypeus. The eyes are placed well back on the broadest part of the head, and are of oval form, with the long diameter transverse. The antennæ consist of a single joint, are moderately long and thick, and when at rest are directed downwards so as to be scarcely visible from above: they are provided with several jointed bristles, some of which are longer than the antennæ itself. The labrum is almost rudimentary.

The mandibles are strong and trenchant, and in addition to their teeth, carry a variety of simple and compound hairs, some of which are of very specialised forms. The maxillæ are short broad plates, with a sinuous anterior border and stumpy, conical palps. They and the lower lip, in addition to ordinary hairs, are provided with several ranks of peculiar flattened bristles with truncated dentate ends.

On the maxilla, the inner face of the external sinuosity is provided with a single row of these peculiar plates, but on the labrum, which is transversely oval, there are three, and on the lateral plate of the metamere, with which the maxilla articulates, no less than five ranks of different lengths. They look as if they were designed to act as a sort of sieve to exclude too coarse materials from the mouth, but, as the larva is predatory and subsists mainly on small crustaceans, they are more probably retentive organs. The thorax is relatively very large, somewhat flattened, and no distinction between its component segments is visible. The lateral tufts of balancing bristles which are so marked in *Culex* and *Anopheles*, are ill-developed. The abdomen is cylindrical, slender, and of nearly uniform diameter as far as the seventh segment, the segments also progressively increasing in length up to this point, while the last two are of insignificant dimensions. The seventh, which contains the two large posterior air sacs, is of very exceptional size, being at least as long as any other two segments. The eighth segment, as in *Culex*, bears on its dorsum the respiratory process, but this is quite small as compared with the organ in most members of that genus, and is of conical form. The ninth segment carries four small, slender anal tubercles, and a pair of swimming fans composed of closely-arranged, multifid bristles. The tracheal system is peculiar, combining many characters of these organs in *Culex* and *Corethra*. The main longitudinal trunks have the same course and general distribution as in the former genus, but are quite small, the hydrostatic function being fulfilled by two large pairs of dilatations or air sacs, which are situated in the thorax and seventh segment respectively. All four, and especially the thoracic sacs, are so large that they quite overshadow the rest of the tracheal system, the main trunks being reduced to the rank of mere communications between them.

The pupa closely resembles that of *Culex*, but the abdomen is relatively shorter and stouter. It may be most easily distinguished by the disproportionately large size of the seventh segment, which retains in the nymph the proportions it holds in the larva. The respiratory trumpets are small and somewhat olive-shaped.

Genus *Anopheles*.—Meinert's description refers in particular to *An. maculipennis*, with shorter references to *An. nigripes*. The ground colour of the larva is a light yellowish green, with a dark brown stripe along the back, which, however, is whitish in the middle line. There are also four small dark spots on the hinder border of the anterior abdominal segment, and six small oblique bands on the sides of the other segments. In all the Indian species the larvæ are of a dirty brown colour; with a few rather ill-defined patches of pigment on the head and thorax. In *Anopheles Rossii mihi* there are two patches of pigment on the dorsum of the head, which, combined with the eyes, give this region of the larva, when regarded from above, a quaint resemblance to a human skull. The head is less rounded than in *Culex*, and the constriction between it and the head is deeper but less obvious than in that genus, as it forms rather a truncated cone, with the broader part behind, than a sphere. The tergum of the third metamere is in the form of a lozenge, with the anterior corner cut off and the point behind, and is ornamented in front with six plumed bristles, the outer of which are the largest. That of the second metamere is broad and short, and carries at each of its outer corners a single plumose bristle. As in *Culex*, it is provided at its outer part with a dense whorl-organ. The labrum, which is tongue-shaped and crenated on either side, is small and hirsute. It is, moreover, overhung by the clypeus, so that it is little in evidence when viewed from above. The eyes form a band of pigment of somewhat pyriform outline, with the narrower end backwards, and on their outer sides are the small ocelli.

The antennæ generally resemble those of *Culex*, but are armed with a row of short, stout spines along the inner border of the basal joint. They carry also certain fan-shaped and other specialised bristles. The mouth parts closely resemble those of *Culex*, but the whorl-organs are larger. The lower lip forms an equilateral triangle, with a few strong dentations on its sides, and is prolonged into a peculiar dentated process, besides which, as seen from below, it is partly covered by two plates which appear to be connected with the ventral plate of the second metamere, which last structures do not appear to be represented in the other genera. The mandibles and maxillæ also closely resemble those of *Culex*, but the latter have a straighter anterior edge, and are less cut off at the corners. They are fringed with bristles, some of which are of a specialised character, and from their outer posterior corner there springs the maxillary palp, which is larger and more acutely conical, and also carries certain specialised bristles. Proportionately to the head the thorax is a good deal larger, and exhibits three rows of bristles besides the large lateral tufts, the posterior of which are the largest in the body, while those of the pro- and mesothorax are of insignificant size. The abdomen is cylindrical, and is very distinctly separated into nine segments, which increase in length while they diminish in breadth from before back. The lateral tufts of bristles of the three anterior segments are exceptionally large, but the hinder ones are very small.

On the dorsal surface of the eighth segment are a pair of simply-formed spiracles, which can be withdrawn beneath a fold of skin when the insect requires to protect their openings. At the same time, if examined in profile, it is evident that the difference between the larvæ of *Culex* and *Anopheles* is really one of degree rather than of kind, and that although rudimentary in the latter, all the parts of the long syphon of *Culex* are really present, and are especially evident in some species; while, on the other hand, as already remarked, in some *Culices* the syphon is very short. The last segment carries the four anal tubercles, which, as well as the tail-fans, are rather less developed than in *Culex*. Although arranged on the same general plan within the body, the tracheal system is much less developed, the main longitudinal trunks being of very ordinary size, and quite without hydrostatic dilatations in any part of their course.

The pupa differs from that of *Culex* only in the respiratory trumpets being shorter and more squarely cut at the end. It may be distinguished from the pupa of *Mochlonyx* by the fact that the eighth instead of the seventh abdominal segment is disproportionately long. In the particular species examined by Meinert the pupa, like the larva, is grass-green, but this coloration is not universal in the genus, and those of Indian species, like the larvæ, are brown. Working in Italy on the same species, Grassi was unable to confirm Meinert's statement as to a green coloration, finding the larva, as we do in India, brown. As a matter of fact, the green colour, when present, depends largely on the nature and stage of digestion of the intestinal contents. Hence, under certain conditions, Meinert's statement is correct, but it cannot be called coloration in the strict sense of the word.

Genus *Corethra.*—The species examined by Meinert were *C. plumicornis*, and *C. pallida.* The larvæ of this genus differ markedly from those that have been already described, and resemble those of the *Chironomidæ* rather than any of the *Culicidæ.* These larvæ are well known as favourite objects for microscopic demonstration of "pond organisms," and are generally known as "glass" or "crystalline" larvæ on account of their extreme transparency, which is broken only by the four darker, but still transparent, air sacs placed in the mesothoracic and seventh abdominal segments respectively. The head is much smaller than in any of the preceding genera, being narrower than any other part of the body, except the last two abdominal segments. Its hinder half is bounded by straight parallel sides, as seen from above, but is contracted in front, so that as a whole it presents the outline of a broad-nibbed pen. The eyes are small and round, and are placed well back on the head, rather on the dorsal aspect of their sides, and behind each of the large eyes is a single separate ocellus.

The antennæ are articulated, as it were, at the point of the pen and are relatively small. Each consists of a single joint with a constriction, followed by a small node just beyond the base, and is armed at the end with five large bristles, which spread out like the claws of a lizard.

The tergum of the third metamere is rudimentary, but its ventral plate forms the greater portion of the under surface of the point of the pen, and is provided about its middle with a sort of tubercle, from which radiate five pairs of large bristles, while behind this are a pair of peculiar fan-like plates, the posterior border of which is fringed with fine hairs. The ventral plate of the second metamere is generally spoken of as the labrum. It forms a sort of ridge in the middle, and is provided with a number of flattened hairs; on either side are a pair of projections carrying a number of strong radiating bristles, the analogue of the whorl-organ of the other genera. The mandibles are very large and trenchant, and being capable of very wide abduction are particularly well adapted for seizing the larva's prey. The maxillæ are two small, very simple plates, and the lower lip can hardly be said to be represented as such.

The thorax, which is much the stoutest part of the body, is of fusiform outline, and shows little or no indications of its component segments; both this and the abdomen are provided with only a few small compound bristles. The abdomen is composed of nine segments, which progressively increase in length to the seventh. These are of nearly equal width to the sixth, after which the body rapidly tapers off. The anal tubercles and swimming fans are small, but round the anus are four bristles of much greater size. Round the anus also are several ranks of peculiarly-shaped hooks.

The respiratory system is peculiar. Apparently the function must be entirely aquatic, as in the very young larvæ there are no signs whatever of tracheæ, and even in the fully-grown creature there are no stigmata or external breathing apertures whatever. In young larvæ all that can be seen are the two pairs of air sacs, which are situated in the same positions as in *Mochlonyx*, but present a very different appearance as they contain no air, but are full of serum and are lined with a large-celled epithelium with prominent nuclei. Gradually with successive changes of skin the main longitudinal trunks and their branches appear piecemeal. At first they are full of serum, but as development proceeds they gradually fill with air, which, however, must be secreted from the blood, as there is at no period of larval life any direct communication with the exterior.

The pupa in this genus is distinguishable by the relatively large size of the abdomen and the small dimensions of the cephalo-thoracic mass. As far as its respiratory arrangements are concerned, however, it closely resembles the pupæ of the other genera, the breathing trumpets being well developed, with very oblique mouths.

PLATE III.

Fig 1

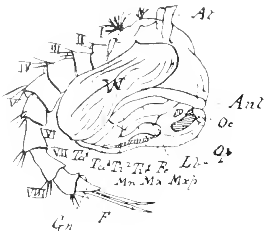

Fig 2

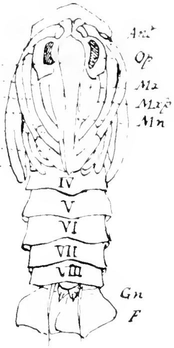

Fig. 3.

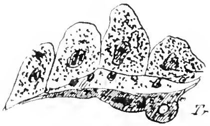

Fig. 4.

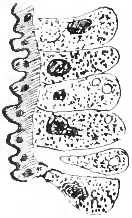

Fig. 5

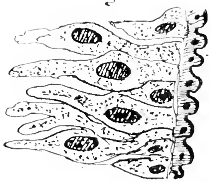

Fig. 6

Fig 7

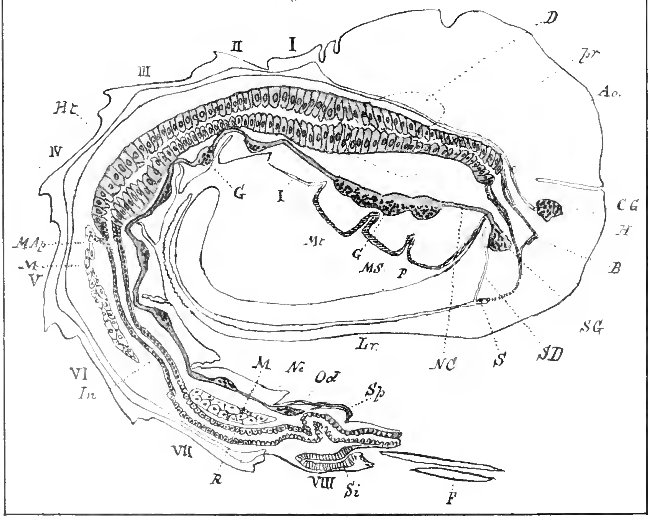

PLATE III.—To Illustrate The Anatomy of the Pupa (after Hurst).

Fig. 1.—Side view of the male pupa.

Fig. 2.—Ventral view of the female pupa, partly extended.

Figs. 3-6.—Successive stages in the metamorphosis of the epithelium of the hinder part of the stomach.

Fig. 7.—Sagittal section of a very young female pupa. *Ant.* antennæ; *Ao.* aorta; *At.* respiratory syphon; *B.* buccal chamber; *CG.* cerebral ganglion; *D.* gastric pouch; *F.* caudal fin; Fe^1. femur of first leg; *G.* ganglia; *Gn.* outgrowth of "ninth" segment, within which the gonapophyses develop; *Hr.* balancer; *H.* head; *Ht.* heart; *In.* intestine; *Lb.* labium; *Lbr.* labrum; *M.* Malphigian tubule; *M.Ap.* its opening into the intestine; *MS.* mesosternum; *Mt.* metasternum; *Mx.* maxilla (first); *Mxp.* its palp; *NC.* nerve commisures and ventral cord; *Oc.* ocellus; *Od.* medium oviduct; *Op.* compound eye; *P.* prosternum; *R.* rectum; *S.* aperture of salivary duct; *SG.* subœsophageal ganglion; *Si.* larval respiratory syphon introverted into the eighth segment; *Sp.* spermatheca; *St.* stomach; Ta^1. Ta^2 proximal joints of the tarsi; Ti^1—^{3} tibiæ; *Tr.* trachea; *W.* wing; I. II. III. &c., first to eighth segments of the abdomen.

After the Plate in the late Mr. Hurst's Paper in the Mem. Owens Col., somewhat reduced.

CHAPTER V.

The Anatomy of the Pupa.

THE following account is derived from the late Dr. C. Herbert Hurst's excellent paper on the subject, published in the "Studies from the Biolog. Lab , Owens College," II., 1890, pp. 47, *et seq*.

The paper is too full to be reproduced in full in an introduction like the present, but is characterised throughout by the most painstaking accuracy, and I have been able to verify most of the statements reproduced.

During the latter stages of larval life, in addition to the visible head appendages, there appear eight other pairs beneath the larval cuticle. Of these six are thoracic and two abdominal. The thoracic pairs are three of them dorsal, the future pupal syphons, the wings, and the halteres; and three pairs ventral, the future legs. The two abdominal pairs belong to the last two segments. Those of the eighth lie in the larval syphon, and are to form the fins of the pupa; the hindmost pair form the outer gonapophyses of the adult, which are accessory organs of copulation.

All these eight pairs arise as foldings of the epidermis ("hypodermis") outwards, and are quite hidden under the larval cuticle. The antennæ, too, are much larger in an advanced larva than they appear to be externally, as the growing basal portion is folded, or even telescoped beneath the unyielding cuticle. Towards the end of larval life the animal becomes sluggish; profound changes in the mouth parts deprive it of the power of eating, and it floats with its breathing tube at the surface. Shortly, the cuticle bursts in the thoracic region, the pupal respiratory trumpets are protruded, the abdominal tracheæ appear to collapse, and the animal floats with the anterior end upwards, the new syphons coming to the surface. The soft parts of the old respiratory syphons are withdrawn from the cuticle and invaginated into the eighth abdominal segments while the lining of the tracheal trunks breaks up into pieces, which in the abdomen correspond to the segments, and is cast off, with the other larval exuviæ, by means of the mechanism that has been already described. The pupa which thus escapes, differs greatly from the larva. It is in the larger species a little under 1 cm. in length when fully extended, and consists of a bulky, laterally compressed mass, made up of the head and thorax with their appendages, and of a slender flexible abdomen, which when at rest is carried curled under the thorax.

In a specimen 9 mm. long the thorax was 2·5 mm. and the abdomen 6·5 mm., but the thorax appears much longer on account of the wings, which extend downwards and backwards from its sides. The head adds nothing to the length, as it is carried tucked down under the thorax. It is broad from side to side, short from back to front, while ventrally it is drawn out into a long process, which extends backwards under the thorax as far as the anterior part of the abdomen, where it curves upwards. This process is made up of the mouth parts, and includes all the parts represented alike in the adult and larva.

On throwing off their larval chitinous covering, the parts retain their larval masticatory type, but during the four days of pupal existence the various parts mould themselves and develop into the basis of the adult condition, so that by the time the chitin of the adult is ready for induration, they have altered their form to that of the adult mouth. From the sides of the epicranial region, the antennæ run outwards to the sides of the thorax, one beneath the anterior margin of each wing. The head and all its appendages are immovable during the pupal stage.

The thorax is rounded, but somewhat compressed from side to side. From the sides of its summit arise the respiratory syphons, a pair of conspicuous organs whose position and form has led to their being termed horns or trumpets.

The wings are nearly flat, oblong plates, arising behind the bases of the syphons, and extending downwards and backwards.

Immediately behind them are a pair of triangular plates, enclosing the halteres of the future gnat. The legs are mostly hidden by the wings, but the femur, tibia and first tarsal joint of the first leg, and the tibia and first tarsal of the second are visible. The respiratory syphons are nearly cylindrical, narrowed at their bases, and curved forwards to be attached by flexible membranes to slight prominences on the sides of the prothorax. Above, they are obliquely truncate and open, and the margin is slightly notched on the inner side. The outer surface is marked so as to resemble imbricated scales, each with a minute spine at its apex. The cavity of the syphon communicates directly with the tracheal trunk at its base. Palmén ("Zur Morphologie des Tracheen systems," Helsingfors, 1877) has denied the communication of the syphons with the tracheæ, and imputed to them the function of "tracheal gills"; but apart from the fact that their dense chitinous structure renders them entirely unsuitable for the performance of any such function, the reality of their communication with the tracheæ can easily be proved by watching the imbibition of suitable fluids through the syphons into them. All these appendages originate as protrusions of the epidermic layer, enclosing mesoblastic tissue. Those of the dorsum are all at first flat, wing-like plates, but those of the mesothorax alone retain this form as the wings of the adult, while the halteres become club-shaped, and the anterior appendages become rolled up to form the syphons of the pupa, only to disappear on attaining the adult form. The legs, on the other hand, appear from the first as cylindrical processes. They are at first unjointed, but by the end of the pupal period have segmented themselves into the various joints of the adult.

The abdomen is flattened dorso-ventrally, and when at rest is curved under the thorax. It is jointed and flexible, and forms with the pair of large fins, borne by the eighth segment, the only locomotor organ of the pupa, the wings and legs lying immovable, and even adhering to each other, though they are easily separated in specimens preserved in alcohol.

Nine segments are easily recognised in the abdomen, and the last one, though it is probably composed of no less than three condensed and highly modified segments, is the smallest. Each segment has a chitinous tergum and sternum, and setæ are sparingly distributed over them, those present being mostly on the hinder part of the terga. Of these a pair placed on the hinder part of the first segment alone require mention. Each consists of a triangular basal plate, articulated to the tergum by a soft membrane, and distally divided into a number of bars, which by repeated sub-division give rise to about a hundred setæ, all lying in one plane parallel with that of the median, of the body. When at rest the pupa floats with the tips of these setæ and those of the respiratory syphons at the surface of the water, and the setæ probably assist in maintaining equilibrium, as well as serving as sensory organs for the perception of disturbances of the water.

The eighth segment bears the fins, a large pair of thin oval plates about 1·2 mm. in length, each of which is strengthened by a midrib, which projects as a spine beyond its hinder border. Beneath and behind them is the ninth segment, a small though probably composite segment, which contains the anus, and is provided on either side and in front of it with a pair of blunt processes, larger in the male than in the female.

The digestive canal differs but little in any stage of the insect, the main change being the casting off of the thick large-celled lining of the stomach and the substitution of the more delicate mucosa of the adult. The cast-off larval mucous membrane appears to be disposed of by digestion. During this period also is developed the peculiar chitinous dilatation of the anterior part of the thorax, already described in the adult. Mr. Hurst describes it as triangular in section with incurved sides, to the concavities of whose sides are attached muscular fibres originating from the sides of the head, the mechanism being specially well developed in the female. The peculiar air-containing sac already described is also developed at this time. It is obvious enough that the former mechanism is capable of being actively dilated by muscular action, and may therefore assist in suction, but it is difficult to understand how any one can have fallen into the error of ascribing such a function to the latter organ.

The circulatory system consists of a long dorsal vessel, which is broad and actively contractile in the abdomen and contracts into an "aorta" in the head and thorax. From its sides membranes, the *alæ cordis*, which serve to suspend it, run out between the extensor muscles and the stomach, to attach themselves to the tracheal trunks. Each ala consists of a dorsal and ventral lamina, and the space between them has been called the pericardium. It contains the pericardial cells and communicates freely with the body cavity by the spaces between the alæ. There is no distinct constriction of the heart into chambers, and the paired ostia or slits, which put it in communication with the "pericardium," open backwards in the first segment, and forwards and inwards in segments three to seven.

In the space between the *alæ cordis* are also the pericardial cells, which are brown in colour and arranged in ovoid masses, of which there are four pairs in each abdominal segment, two of which are in its anterior and two in its posterior portion. The protoplasm of these cells is extraordinarily spongy and contains numerous granules which stain deeply with borax carmine. The nuclei vary in number from 3 or 4 to 10 in each mass, but the boundaries between the cells cannot be made out. The glandular character of these cells has been shown by Kowalevsky ("Biolog. Centralblatt," ix., 1889), their function being probably somewhat analogous to that of the lymphatic and other ductless glands of the higher animals. I reproduce more fully the histological characteristics of these masses, as, alike from their position close to the walls of the stomach, from which they are separated only by the ventral layer of the *ala cordis*, and from their general appearance they might easily be confused with the parasitic "coccidia" of malaria recently described by Major Ross, I.M.S., by an observer not personally conversant with the appearances of the two structures; and I shall not be at all surprised to find descriptions of these bodies appearing in the form of notices of the occurrence of the parasites in the pupal stage. The possibility of the communication of the disease among Mosquitoes through infected ova has already been mooted, and investigators working upon this line should be on guard against this fallacy.

The so-called aorta runs from the anterior end of the dorsal vessel forwards, above the stomach and œsophagus to the head, where it terminates in an open end. In transverse sections of the thorax the aorta appears as a laterally compressed tube, and does not appear to give off any branches.

The *respiratory system*, during pupal life, undergoes the changes which prepare the rudimentary stigmatic trunks of the thorax and abdomen to take on functional characters in the adult. With the exception of the first abdominal pair, however, none of the stigmata are open except the prothoracic openings which form the respiratory syphons. These first abdominal stigmata open into the air space which exists under the pupal skin beneath the thorax, and in which the legs are undergoing development. This cavity must exercise a hydrostatic function, and the patency of these stigmata must be in this case necessary for the conveyance of air to the cavity. From the base of each syphon tracheæ run to various parts of the body and head. Among these may be mentioned specially one transverse trunk running across the thorax between the alimentary canal and the nerve chain, which puts the two syphons in direct communication with each other; and a pair of longitudinal trunks running back to the hinder end of the body, and giving off branches to the various organs, and also a branch to each of the future stigmata.

The cuticular lining or intima of the chief trunks and their branches is well developed even at the beginning of pupal life, and has the usual spiral thickening. The trunks connecting the stigmata with the main trunks are the only ones that undergo any marked change. These widen round their separated and collapsed intima, and a new and strongly thickened intima is developed. In the main trunks no new intima is formed, and when the imago escapes no portion of the intima is shed, saving the portions connecting the syphons and the first abdominal stigmata with the main trunks. These fragments are, in the case of the syphons, well developed, and have a fully-developed spiral thickening. The portions connected with the first abdominal stigmata, though better developed than the other abdominal branches, have the spiral thickening only slightly developed. The terminal portion is beset with very numerous small spines.

The *nervous system* is particularly interesting. Within the short space of four days, certain ganglia increase enormously in size by the addition of cells, apparently derived directly from the epidermis; and other ganglia shift their positions bodily and sometimes fuse with others.

In the larva each of the first eight abdominal segments has a pair of ganglia; and yet a pupa, only half escaped from the larval cuticle, has four in the thorax and none in the first segment of the abdomen. During pupal life these four ganglia fuse into one compact mass. During the first two days of pupal life the eighth ganglia migrate into and fuse with those of the sixth segment. In the female the change goes further. A pupa almost ready to burst and give exit to the imago has still the arrangement already described; but an imago killed immediately after its escape is found to have no ganglia in the seventh or eighth segment, but in the sixth segment are two masses; the first the pair properly belonging to the segment, lying at its anterior end; the other a double mass, formed of the seventh and eighth ganglia, lying in the hinder end of the segment.

In the male imago the arrangement is the same as in the advanced pupa. In the head the supra-œsophageal ganglion increases enormously in size. The epidermal ("hypodermal") cells, especially those near the borders of the eyes, proliferate freely, and the cells budded off from their inner surfaces migrate inwards and form the new cells of the ganglia. By this process the ganglia, which at the commencement of pupal life were comparatively inconspicuous, grow till they almost fill the head, and there are places in the advanced pupa where ganglia and epidermis appear continuous.

Dr. Hurst's paper also contains some very interesting details as to the development of the sense organs, especially of the eyes and antennæ ; but for these the reader is referred to the original paper, as their interest is mainly that of the development of these organs in insects in general than that of the *Culicidæ* in particular.

Reproductive System.—The male generative organs of the adult consist of testes, vasa deferentia, "prostatic glands," copulatory organ, with a common pouch at its base and two pairs of gonapophyses. Of these last, the outer ones are a pair of large forceps for holding the female. Both pairs originate in the larva and are probably the appendages of two segments now fused and indistinguishable. The testes are a pair of cylindrical bodies, already present in the larva, at the sides of the intestine in the sixth segment. They are chambered and the spermatic elements in the hinder chambers are more advanced than those in front. The length of each segment is that of the segment in which they lie. The vas deferens of each side is a direct continuation of the wall of the testis, and is a very narrow tube running directly backwards, quite distinct from its fellow of the opposite side, but the two are closely bound together in their hinder parts and they open behind into the common pouch. The prostatic glands are a pair of elongated glandular tubes, apparently simple, but seen in sections to be double, though the cavities communicate behind before opening into the common pouch. This latter is a dilatation of the ejaculatory duct at the base of the copulatory organ, which last is perhaps derived from one of the component somites of the last abdominal segment, and represents its appendages. The hinder part of each vas deferens is, in some *Culicidæ*, expanded to form a vesicula seminalis of considerable size, but this is not the case in *Culex nemoralis*.

The female generative organs are a pair of ovaries, the oviducts uniting behind to form a median oviduct, a median copulatory pouch, and three spermathecæ opening into the last. They correspond in size and position to the testes. The median oviduct is formed by the invagination of a region which Dr. Hurst takes to be the ninth sternum, while the anus opens at the posterior end of what he takes to be the eleventh abdominal somite, so that there is no common cloaca. This invagination is already far advanced at the beginning of pupal life, and during it it grows forwards, keeping pace with the forward shifting of the last pair of ganglia, and at all stages lying just behind it till the final ecdysis, when the rapid shifting of the ganglia leaves it behind. Its anterior end is, in the adult, near the front of the seventh segment. In the youngest pupæ three flattened invaginations, the future spermathecæ, lie on the dorsal wall of this median oviduct. During the pupal period the anterior end of each becomes spherical and acquires a strong chitinous lining. The anterior ends of these organs remain stationary in the eight segment throughout. The bursa copulatrix is a dorsal outgrowth of the invagination which gives rise to the median oviduct, and is a small pouch lying just behind and above the median aperture.

The pupa does not eat. It breathes air through the apertures at the end of its syphons. It floats, thorax upward, by virtue of the large air cavity lying under the hinder part of the thorax and front of the abdomen. This cavity is bounded in front by the legs, at the sides by the wings, and in front by the mouth parts. It extends up at each side of the abdomen, where it is covered by the halteres, and into it opens the patent first abdominal stigmata. The pupa is sensitive to light, and immediately darts backwards when a shadow falls upon it suddenly. The movements, however, though very rapid, are devoid of anything like steering.

The larva has to search for food, but the pupa has simply to get out of the way of danger, and the direction of its flight is of little importance, though since the movement is always backward with reference to the pupa, it is chiefly downward with reference to the outer world. A sudden loud noise or a very gentle tap upon the vessel containing the pupæ causes those at the surface to dart downwards, but as slight sounds produce no effect upon them, Dr. Hurst concludes that the tremor of the surface of the water and not the sound itself is recognised by them. The setæ on the first segment of the abdomen are probably the organs by which this movement is felt.

CHAPTER VI.

The Anatomy of the Adult Mosquito.

In its anatomy, the Mosquito conforms to the usual insect type, the body being divided into the three sharply separated regions of the head, thorax and abdomen; the first accommodating mainly the organs of sense, the second those of locomotion, and the third the digestive and reproductive organs.

The entire body is covered with a chitinous integument, which is thick and rigid on the dorsum, and over the entire head, and thin and elastic where it connects together the various rigid portions.

This chitinous "exoskeleton," besides covering the exterior of the body, sends inwards plates and trabeculæ which form a beautifully intricate framework supporting the bases of the legs and other appendages; and in addition to this, the entire intracephalic portion of the intestinal canal, and the ducts of the salivary glands are lined with the same material; while in the form of the tracheæ, tubular involutions of this outer covering ramify minutely throughout every tissue, much in the same way as the blood vessels do in vertebrates.

The whole of the outer armour is covered with appendages of various forms, the most characteristic of which take the form of scales.

These scales consist of flat plates springing from a narrow pedicle, and differ a good deal in outline, not only in different species, but on different regions of the same insect; though in any given species and situation their form is very constant, and affords valuable characters in classification. Each scale consists of an anterior and posterior membrane separated by an almost imperceptible interval, and is minutely ribbed and striated in a manner that requires the best lenses to properly resolve. Perhaps the commonest outline is that of a racquet, but as will be seen from the

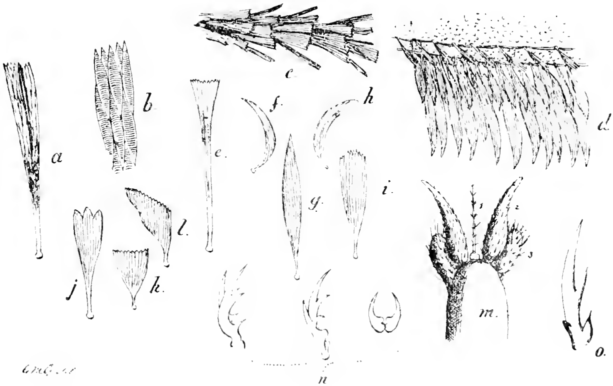

FIG. 16.—SCALES AND OTHER CHITINOUS APPENDAGES OF MOSQUITOES.

a, Scale of frontal tuft of *Anopheles Rossii*, × 375 diams.; *b*, detail of membrane of the same scale, × about 1,000 diams.; *c*, to show form and arrangement of the scales on one of the veins of the wing of *Culex fatigans* (Wied.), × 75 diams.; *d*, to show form and arrangement of scales on margin of wing of *C. fatigans* (Wied.), × 75 diams.; *e*, scale of nuchal corona of *C. hortensis*, × 185 diams., after Ficalbi; *f*, scale of thoracic tomentum of *C. pipiens*, × 185 diams., after Ficalbi; *g*, scale of alar margin of *C. pipiens*, × 208 diams., after Ficalbi; *h*, scale of thoracic tomentum of *C. spathipalpis*, × 185 diams., after Ficalbi; *i*, scale from the leg of *C. pipiens*, × 208 diams., after Ficalbi; *j*, *k*, *l*, various forms of wing scale, after Arribálzaga; amplification not stated; *m*, last tarsal joint of *C. pipiens*, ♀ showing 1, empodium, 2, tarsal claws, and 3, Pulvilli, after Ficalbi; *n*, fore, mid, and hind tarsal claws of *C. pulchriventer* sp. n. ♂; *o*, single claw of fore leg of *An. Rossii*, ♂.

above figure, they vary in shape almost as greatly as the leaves of plants, and some are so long and narrow as to be almost indistinguishable from the hairs, which are found everywhere, either interspersed among the scales, or, as in the abdomen of many *Anophéletes*, constituting the entire tomentum. The third class of chitinous appendages are the tarsal claws and epipodium, the latter of which is essentially a compound hair, while the former vary in form almost as much as do the scales. In the females these claws are usually of simple form, and of no great size; but in the male, those of the fore and middle legs and more rarely those also of the hind pair, are usually proportionally large and armed with one or more accessory teeth, and the two claws of the same leg may differ in size and form. Those of the fore legs are generally the largest, and the difference in size and form in the sexes is suggestive of the function of those of the male being to grasp the female. In many species, at any rate of *Anopheles*, there is only a single compound claw on the fore leg, the missing claw being apparently represented only by a small projection at one side of its base. Varying as they thus do, there can be no doubt but that the form of the claws would, if generally noted, be capable of furnishing valuable specific indications; but though valuable notes on this point have been made by Ficalbi, and also by Arribálzaga, information on this point is wanting in the great majority of species, and the circumstance that it is impossible to properly make them out without mutilating a specimen by mounting the legs, for the compound microscope tends to render these characters not so useful as others for the practical purposes of classification. The legs are always thickly clothed with scales, and in the one or two species of the genus *Sabethes* of Desvoidy, and of Mr. Theobald's new genus *Conchyliates*, the sides of the tibiæ or tarsi of certain legs are provided with lateral fringes of long scales so as to form a sort of paddle-shaped expansion; while in *Psorophora* and *Mucidus* the entire legs are shaggy.

The head is rounded, but wider than long, and bears the usual appendages, all of these being represented, although those forming the mouth parts, being modified to form the style-like proboscis, differ markedly from the ordinary insect foot-jaws, and present perhaps an even wider divergence from the simpler forms than the suctorial mouths of most other *Diptera*.

In this region of the body no sign of segmentation can be made out, nor is there any visible separation between the dorsal and ventral chitinous shields, such as is found in the other regions of the body.

The greater part of the sides and front of the head are occupied by the facetted eyes. These are always large and well developed and in certain species may even touch each other in front and nearly so below. Their anterior border is usually somewhat hollowed back to lodge the bases of the antennæ, so that they tend to a reniform outline. There are no ocelli, or simple eyes, such as are found in the majority of *Diptera*, and though some authorities assert that they are present in a rudimentary form, I have not been able to satisfy myself as to the existence of any trace of them in the adult insect, and for practical purposes, at any rate, they may be considered as absent.

Immediately in front of the eyes will be seen the antennæ. These are of the moniliform type, and although of fundamentally similar construction, differ greatly in appearance in the two sexes, owing to the organ in the male being so richly provided with long, silky hairs as to form a pair of singularly beautiful plumes; while in the female these hairs are less numerous and down-like, so that the joints of the antennæ itself are plainly visible, and are the portion of the organ that catches the eye. In both sexes the antennæ is typically formed of fourteen joints, the basal one of which is much the largest and of globular form, the constriction at its base being almost fused with the cephalic shield so as to be capable of little motion. The greater part of the front of this large basal joint is occupied by a soft but tightly stretched membrane, and into the centre of this is articulated the base of the second joint, which, like those that follow it, though but little shorter, is not one-fifth of the diameter of the basal joint. The chitinous wall of the latter is grooved on its interior for a richly-developed system of nerve threads, which are symmetrically arranged in its lining membrane like the wires of a birdcage. The structure of this joint has been described in great detail by Dr. Christopher Johnstone of Baltimore (*U.S. Quart. Journ.*

Micros. Science, iii., pp. 97-102), and he contends that the entire antennæ serves as an auditory organ, the atmospheric vibrations being received by the long hairs of the antennæ, and so transmitted to the drum-like membrane which, as already described, closes the front of the basal joint, and thence through its contained fluid to the nerves lining its cavity. According to this theory, the anterior membrane is an actual *membrana tympani*, and the fluid within corresponds in function to the endolymph, contained in the cavities of the internal ear of the higher animals. It has been further pointed out that the hairs of the verticils of the male Mosquito respond to the musical note given by the vibrations of the wings of the female insect. Professor Lubbock ("The Senses of Animals," p. 115) seems to regard with some favour Johnstone's idea on this point, but antennæ having this form of basal joint are not very common in insects, and if it be really a tympanum it is certainly a very exceptional arrangement. The articulation between the first and second antennal joints is capable of very free motion, so that at this point the entire organ can be moved to considerable angle in any direction, while the extent of mobility between the latter and the succeeding ten joints is much more limited. Except in the very aberrant *Deinokerides cancer*, in which the second is as long as several of the succeeding ones, from the second to the twelfth pieces inclusive, the joints closely resemble each other, forming a moniliform series of short cylindrical pieces of a length but little exceeding their thickness. From the base of each springs a verticil of hairs, numerous (about forty) and long in the ♂, and shorter and fewer in the ♀. It is more than probable that these hairs in the ♂ are really chordotonal, auditory organs, as there is no doubt that they respond to the note of the female wings, and it is the function of the male in these insects to seek out the female, but the acceptance of this does not involve that of Johnstone's theory of a tympanic function for the basal joint. The last two joints greatly exceed the others in length, forming in the male, together, much more than a third of the entire length of the organ. The basal verticil of the penultimate is well developed, but that of the last is ill developed, and both are closely covered with short, downy hairs, and exhibit also certain pits and specialised hairs, which probably are sense organs, olfactory, tactile, &c. For further details on the sense organs of insects, the reader is referred to Lubbock's work, already quoted. Projecting from the middle of the head (*vide* fig. 13), below the antennæ, is the characteristic proboscis which, although it at first sight appears to be merely a cylindrical, trunk-like projection, is really a very complex organ, being composed of no less than nine separate pieces. The organ springs from a sort of groove on the lower aspect of the head, through the intervention of a flexible membrane, which admits of a certain amount of protrusion and retraction as well as of flexion and extension in the vertical direction; the bases of both the upper and lower lips being furnished with sets of longitudinal and vertical transverse muscular fibres to effect these motions.

In all the *Diptera* the mouth parts of the adult insect are modified, almost beyond recognition, from the obviously trenchant jaws which have been already described in the larva, and which persist, with but little alteration, throughout life in some orders, such as the beetles. During the three or four days of pupal life a marvellous series of changes takes place, whereby the masticatory mouth of the larva is transformed into the suctorial apparatus of the adult.

To understand the dipterous mouth it must be remembered that, in most of the order, all that is visible to the eye is the lower lip, the other parts being hidden, wrapped up within it. Everyone who has handled a microscope is familiar with the stock popular object of the "blow fly's tongue." This "tongue" is the labium, and with the exception of the maxillary palps, little else of the mouth parts is in evidence, the other foot-jaws being but little developed, as the fly licks rather than sucks its food, and the "tongue" is provided with an armature of chitinous rasps, not unlike those that stud the lingual rib, and of gasteropod molluscs. If now we examine a horse fly, we find that the upper lip is developed into a strong spine; and that, hidden between it and the lower lip are four short, stout blades, each of which has exactly the form of a Roman sword. These blades are the mandibles and maxillæ, and are capable of inflicting a sharp bite or rather puncture, but the lower lip remains practically identical with that of the blow fly.

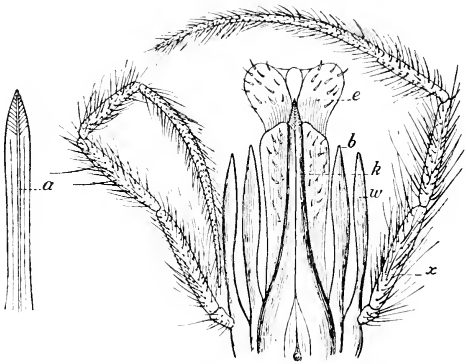

FIG 17.—MOUTH PARTS OF AN INDIAN SAND FLY (*Phlebotomus*), THE LABRUM HAVING BEEN REMOVED AND PLACED SEPARATELY TO THE LEFT.

a, labrum; *b*, mandible; *c*, labium; *k*, "hypopharynx"; *w*, maxilla; *x*, maxillary palp, that of the left side being shown bent; as habitually held during life when at rest.

If we now examine the further modified mouth of a sand fly, we find that the lower lip, though obviously approaching in form to that of the Mosquito, is still recognisably the same organ as the "tongue" of flies. The four miniature, sword-like blades of the mandibles and maxillæ are present, and almost identical in shape with those of the horse fly. There is, however, now an additional median organ lying in the midst of this bundle of weapons, in the shape of a conical tube, sharp at the point and very broad at the base, prolonged from the mouth cavity. This organ is the hypopharynx, and with this addition, we have now represented all the parts of the highly evolved, suctorial mouth of the gnats; the only difference being that on the latter the parts are attenuated and elongated into the far more efficient, though more delicate, suctorial organ represented below.

In the Mosquito the labium is a long, narrow, grooved spine ending in a pen-like point, and the lower lip, though bearing some likeness to that of the sand fly, has become a

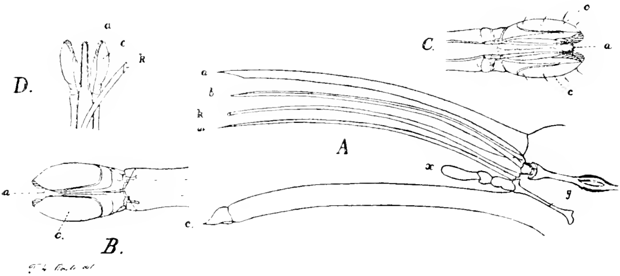

FIG 18.—DIAGRAM TO ILLUSTRATE THE MOUTH PARTS OF A FEMALE MOSQUITO.

A, median mouth parts, and gnathites of the left side (their relative position at the base is indicated in a purely arbitrary way); *B*, end of proboscis seen from below; *C*, end of proboscis seen from above; *D*, the same with the hypopharynx drawn away to the left—with the exception of fig. *A*, after Ficalbi. In the above, *a*, labrum; *b*, mandible; *c*, labium; *k*, hypopharynx; *w*, maxilla; *x*, maxillary palp; *y*, basal joint of maxillæ.

mere sheath for the other organs and no longer bears any resemblance whatever to a fly's tongue; the mandibles and maxillæ have become simple slender lancets, formed on the plan of the mediæval rapier, with a comparatively thick rod-like back, and a broader edged and pointed lamina; a mere golden-coloured wire of chitine supporting a narrow blade of the same material, so thin as to be absolutely colourless. The hypopharynx has undergone a similar change and has taken the form of a delicate plate, pierced throughout its entire length by a minute canal; the whole of the mouth parts, except the lower lip, being so delicately fashioned as to practically defy draughtsmanship, so that they can only be represented in diagrammatic form.

The upper lip, or labrum, springs from a bulbar enlargement of the front of the face, placed between the bases of the antennæ. This bulb is flexible and elastic, and the

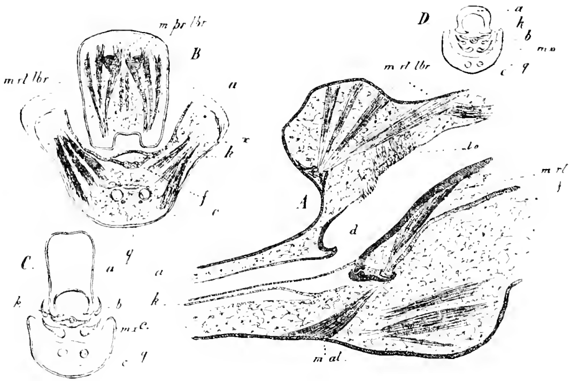

FIG. 19.—SEMI-DIAGRAMMATIC REPRESENTATION OF SERIAL PREPARATIONS OF THE ANTERIOR PART OF THE HEAD AND PROBOSCIS. × 150 diams.

A, median sagittal section of root of proboscis, showing the entry of the salivary duct into the floor of the base of the hypopharynx, with the valvular fold and its muscles, by which the duct is opened and closed. *B*, transverse section opposite the point of entry of the salivary duct, and the roots of the palpi. *C*, transverse section of the proboscis, near its base. *D*, transverse section of the middle of the proboscis. In the above figures:—*a*, labrum; *b*, mandible; *c*, labium; *d*, buccal bulb; *f*, salivary duct; *k*, hypopharynx; *mx*, maxilla; *m.at.*, muscle opening the salivary valve; *m.rt.*, muscle closing salivary valve; *m.pr. lbr.*, protrusor muscle of labrum; *m. rt. lbr.*, retractor muscle of labrum; *t.o.*, taste organ (?); *q*, tracheæ; *x*, root of palp.

whole of its median plane is occupied by a fan-shaped muscle, taking origin from its upper surface; the fibres converging to be inserted into a thickening of the chitine at the base of the actual labium; while, on either side of this retractor, a number of antero-posterior transverse fibres fill up most of the remaining space. By the action of the retractor muscle, the base of the labium can be invaginated within the bulb, so that its point is withdrawn behind those of the other mouth parts, while by that of the transverse fibres, it can be forced out and extended once more to their level, or beyond them.

Firmness is imparted to this arrangement by a pair of strong spines, which project from the lateral trabeculæ of the front of the head into the bulb. Beyond the bulb, the labrum becomes a strong, rigid style of a form not unlike that of a surgeon's "director," but with a more complete groove; the transverse section forming at least three parts of a circle; and this incomplete canal is converted into a tube by the hypopharynx, which, throughout its length, lies in contact with its lower surface. It is through this channel that blood or other food reaches the mouth cavity. The hypopharnyx springs from the anterior part of the floor of the buccal bulb, and is a tubular organ with, at first, a very broad but shallow lumen. This, however, rapidly contracts to a minute tube, of about the same diameter as the salivary duct, of which it is virtually a continuation, and on either side of the tube are developed the membranous wings, which serve to convert the groove of the labrum into a tube. Into the floor of the broad *cul-de-sac* of the commencement of this tube opens the salivary duct, the mouth of the latter being guarded by a remarkable arrangement, which serves as a valve. The floor of the buccal valve at this point is strengthened by a strong chitinous plate; and this, though of course continuous with the thinner membrane near it, forms a veritable articulation with a separate plate in the floor of the base of the hypopharynx, in which is placed the termination of the salivary duct. As the rest of the lining of the *cul-de-sac* is delicate and flexible, this plate can be moved forward and back, and is provided with two special muscles for the purpose. In the latter position the mouth of the duct is effectually closed, while it is freely open when drawn forward by the anterior muscle, which springs from the chitine of the ventral wall of the labium. Grouped round the lower surface of the hypopharynx and the sides of the labrum are the four lancets, which are simple, rapier-like blades, simply pointed, and unprovided with teeth or serrations of any kind, though a false appearance of the sort is lent to the points of the maxillæ by the plate of their blades being fibrillated. The maxillæ are usually stated to be the smaller and more delicate, but, as a matter of fact, they are considerably the stouter, and except in this the mandibles and maxillæ closely resemble each other. Neither pair of lancets appears to be provided with any special musculature, and they are probably forced into the skin simply by the thrust of the head; the labrum being drawn back while they make their puncture, and then forced into the wound they have made. Lastly, the labium is a comparatively stout, fleshy organ, soft, flexible, and clothed with scales on its outer surface, which is wrapped round the other parts so as to form a sheath, open only above. Between its scaly ventral surface and its delicate dorsal lining is interposed a considerable amount of loose connective tissue, in which lie a pair of tracheæ, and immediately beneath them two large nerves. The labium ends in a pair of valve-shaped, articulated lobes, capable of being moved by certain special muscles. The function of these lobular organs, which are said to represent the labial palps of certain other arthropods, is probably to grasp the styles as they pierce the skin, while the stem of the labium is being looped down out of the way.

The above account differs, it may be noticed, from previous descriptions, inasmuch that it has hitherto been assumed that both food and saliva passed through the proboscis by the same channel; but there can be no doubt of its correctness, which I have verified by several series of sections, in both *Culex* and *Anopheles;* and I gather from Professor Grassi that he holds the same view of the functions of the various structures, who I trust will understand that his priority in the matter is herein fully recognised; though he must not be held responsible for the existence of the salivary valve, and the other structural details of the above description.

A little reflection will, moreover, show that an arrangement of the sort is a physiological necessity, as it would be quite impossible for the saliva to be forced down a tube while the food is being drawn up through it.

When the Mosquito brings the proboscis into action to pierce the cuticle of the plant or animal from which it seeks its food, all these parts, except the sheathing labium, are forced into it, while the labium is bent down into a sort of loop which progressively narrows as the piercing organs penetrate more and more deeply. On either side of the base of the proboscis may be seen a pair of jointed appendages, the maxillary palpi. These organs have been described by several authorities as labial palps, but a closer examination shows that they are really connected with the base of the maxillary lancets through the intermediation of a piece which, in the usual position of the parts, is hidden within the base of the labium. In most cases the palpi consist of five visible joints, but they present great sexual and generic differences within the family, and require especial notice in systematic work, as the classification of these insects is largely based on their characteristics.

In some species they greatly exceed the proboscis in length, while in the genus *Ædes* they are quite rudimentary in both sexes and appear to consist of only a single short joint.

The head is connected with the thorax by a soft flexible neck corresponding in function to the intersegmental membranes of the abdomen, though by some authorities it is considered as a part of the prothorax, which allows of a considerable freedom of movement between these two divisions of the body.

The thorax is the most bulky portion of the body, as, though but little broader than the head, it is more than twice as deep. It is composed of three segments, but the great preponderance of the middle of the three, or mesothorax, and the fact that the three are fused together into a single rigid mass, makes it not altogether easy to make out the lines of division between the component parts. Viewed from above, almost all that is visible is the tergum of the mesothorax, but in some mosquitoes, as in *Psorophora*, a portion of the prothorax projects in the form of a pair of lateral protuberances, the shoulder callosities; and on either side of the scutellum, which appertains to the mesothorax, can be seen, even in the extended insect, a portion of the better-developed metathorax, while in flexion the whole width of its tergum can be easily seen. Laterally, however, the three component segments are easily distinguishable by the fact that each gives origin to a pair of legs, the coxæ of which guide the eye to the corresponding

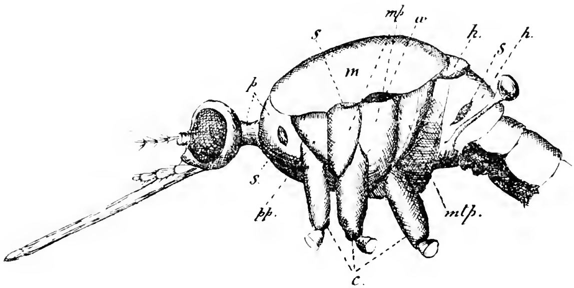

FIG. 20.—*p*, prothorax; *m*, mesonotum; *h*, metanotum; *k*, scutellum *pp*, propleura; *mp*, lobes of metapleura; *mtp*, metapleura; *s*, *s*, *s*, thoracic stigmata; *w*, root of wing (after Arribálzaga).

portion of the thorax. Just in front of the root of the coxa of the front leg can be seen, in the great majority of species, an oblong or oval scale, which covers the stigma of the prothorax.

The stigma of the mesothorax is also well developed, and can easily be seen just in front of the origin of the wings; but those of the metathorax, on the other hand, are small or not recognisable. From the propleura springs the coxa of the front leg, and between it and that of the middle leg is a comparatively large area of mesopleura. This latter is more or less divisible into three areas, one of which carries the stigma, the second the middle leg, and the third and hindmost the wings. From the metapleura springs the coxa of the hind legs, and above it may be seen the halteres or poisers, a pair of small, club-like organs, consisting of a delicate stem terminating in a pear-shaped head, which represents the rudiment of the hinder wings of other insects.

There appears to be good reason for regarding these modified wings as sense organs, for although mere rudiments, as far as their original functions are concerned, they are supplied by one of the largest nerves in the body, and have been regarded by Keller, Hicks, and Bolles Lee as auditory organs.

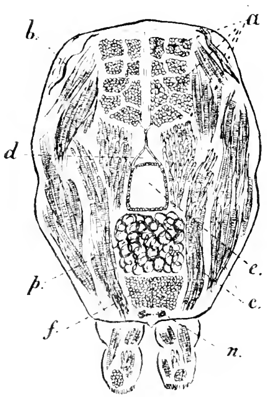

FIG. 21.—SEMIDIAGRAMMATIC DRAWING OF A TRANSVERSE SECTION OF THE THORAX OF *C. pipiens* (L).

a, alar muscles; *b*, portion of chitinous framework supporting the wing; *c*, coxal muscles; *d*, dorsal vessel; *e*, œsophagus; *f*, flexor of abdomen; *n*, nerve cords; *p*, pneumatic vesicles.

According to the last-named authority ("Les Balanciers des Diptères," *Recueil Zool. Suisse*, 1885), the organ consists of a varying number of rows of minute vesicles placed at the base of the organ, each vesicle being perforated and containing a minute hair. Sense organs have been discovered in a variety of very unexpected situations in insects, and it is quite possible that, while the verticillary hairs of the antennæ of male gnats may serve as chordotonal organs, whereby they are enabled to localise the whereabouts of the female, ordinary hearing may be subserved by these peculiar structures at the base of the halteres.

Almost the whole of the interior of the thorax is occupied with the powerful muscles that actuate the wings, legs, and halteres, but the detailed consideration of their arrangement hardly lies within the scope of a work like the present.

The general structure of the Dipterous leg and wing have already been sufficiently alluded to in the remarks on the terminology of the Order, but as regards their special characteristics in the *Culicidæ*, it may be noted that the former are always proportionally long and slender, and that the hips, or upper sections of the coxæ, take the form of obconical processes, immovably connected with the corresponding pleuræ; while the trochanters are much smaller, and take the form of short, globular, or oviform pieces. Of the remaining joints, the femur, tibia, and first tarsal joint are long and linear, and, as a rule, differ but little in length, though their relative proportions furnish valuable specific indications. Not unfrequently the first tarsal is the longest of the three. The remaining four tarsal joints taken together do not, as a rule, equal either of the above linear joints, and generally progressively diminish in length, the last being often scarcely wider than long, and carrying a well-developed epipodium and pulvillus, and a pair of claws, the characters of which have already been sufficiently noticed.

The third division of the body or abdomen is the longest of the three, but is much more slender than the thorax. It is more or less cylindrical, but depressed, being broader than deep, and is composed of nine segments, none of which are provided with locomotor appendages, although the last, bears a pair of jointed appendages which serve as external organs of generation. Each segment is composed of a dorsal and a ventral, rather rigid, chitinous plate, united at the sides by a softer membrane, in which are placed the stigmata or external respiratory apertures. The anterior segments closely resemble each other, except the first, which is a good deal shorter than the rest, and has its ventral aspect devoid of any rigid sternal plate, being composed entirely of elastic flexible membrane. The last three, however, are shorter and diminish rapidly in width; and the last two are specially modified to accommodate the apertures of the digestive and reproductive systems, the anus being placed on the ventral aspect of the eighth segment, while the tergum of the ninth is quite invisible in the usual position of the insect, and all that can be seen

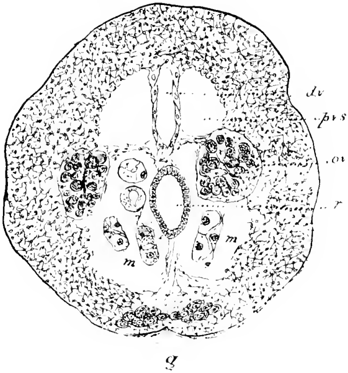

FIG. 22.—TRANSVERSE SECTION THROUGH THE POSTERIOR PART OF THE ABDOMEN OF A HIBERNATING FEMALE.

dv, dorsal vessel; *prs*, perivascular space; *ov*, ovary; *r*, rectum; *m*, Malphigian tubes; *g*, last abdominal ganglion. × about 100 diams.

of it are two lobed appendages, thickly clothed with hairs and scales, and not showing any very prominent difference in the two sexes. In both they consist of a pair of olive-shaped protuberances, but in the male, instead of ending in a simply rounded, bristly extremity, they have articulated to each a strong incurved claw, by which the female is grasped during copulation, the whole organ forming a clasper. In the female they are somewhat spatulate and act as an ovipositor, being held together to form a sort of channel along which the ova are passed on to the upper surface of the similarly held together hind tarsi, by which they are guided to the surface of the water on which they are to be launched.

If we dissect the abdomen by teazing with needles or by sectionising, we find that immediately beneath the chitinous exoskeleton there is a soft, cellular layer, the true dermis; and beneath this again, a very scanty and interrupted layer of longitudinal muscular fibres, which not only serve as flexors, extensors and abductors, but can also, when simultaneously contracted, shorten longitudinally and therefore transversely widen the entire region, an action which cannot fail to have an effect in keeping in motion the air contained within the tracheal system. For although there is no continuous, rhythmic action of the body comparable with the respiratory movements of the higher air-breathing animals, movements of this kind are sufficiently frequent and habitual to exercise a powerful action in preventing stagnation of the air contained in the respiratory tubes. These longitudinal muscles are arranged in sets, each set corresponding to an intersegmental membrane and serving to connect two adjacent segments. There are also a few transverse fibres, arranged mainly in two lateral groups, placed near the middle of the segments, but they are less easily made out.

The best way to exhibit them is to carefully remove all the scales from the abdomen, a preparatory step which should be taken as a routine matter in all dissections, by gentle brushing with a camel hair pencil. Dip the specimen for a moment in spirit, and then by a stroke of a pair of fine scissors split the abdomen into lateral halves. Examined in salt solution, such a preparation, after cleaning away the viscera by means of the needles, shows well the stigmata and parietal tracheæ, and subsequently, after appropriate staining in borax-carmine, will give a good view of these parietal muscles. The precaution of dipping the specimen into spirit for an instant, before placing in salt solution, is a necessary preliminary to all dissection of these insects, as otherwise, however carefully one may have brushed, one is sure to be embarrassed by air bubbles, obstinately entangled in the remaining tomentum.

Having now sketched the external configuration of these insects, their internal organisation remains to be considered, and will probably be best dealt with by taking separately the various systems, digestive, respiratory and reproductive, in their turn.

The Anatomy of the Digestive System.—In the first edition of this book I had perforce to rely mainly, alike for facts and illustrations, on the work of previous writers. My supply of fresh material for verification was very limited, and hence numerous inaccuracies were reproduced. A notable example of this was Arribálzaga's illustration of the general relations of the digestive organs. In this figure the salivary glands are shown protruding from the back of the head, which, as a matter of fact, is just where they are seen in the ordinary course of dissection: as they are drawn out from their natural position in the soft neck connecting the head and thorax by the act of pulling away the œsophagus from the thorax. He appears to have then hastily sketched in an outline of the insect, and hence these glands are made to appear as if placed in the anterior part of the thorax.

The present chapter is, however, the outcome of personal observation, and the illustrations, with a few duly noted exceptions, are reproductions of pen and ink drawings from camera lucida outlines, and so may at least be trusted as to the relative size and position of the parts represented.

The digestive tube may be said to commence at the extremity of the proboscis. By the alternate retraction and protrusion of the labrum; as regards its relative position to the lancets, the whole of the styles of the proboscis are gradually worked into the wound inflicted, slightly in advance, by the mandibles and maxillæ; the hypopharynx, which is a delicate, flexible tube, far too yielding to be forced unsupported into any substance, lying along the groove of the labrum. Imagine a surgeon's "director," with a piece of thin drainage tube carried against its groove, and with four slender bistouries grouped round it, and you will have a fair working model of the malaria-inoculating apparatus of the mosquito.

From this it follows that it is only through the tube of the hypopharynx that the salivary secretion, with its contained malarial germs, can be injected into the tissues of the vertebrate alternative host.

In the case of filariasis the route of infection is different. Taken as a family, the *filariæ* are essentially parasites of the intercellular lymph spaces, and hence are most commonly found in such situations as the cellular tissues, and the great serous sacs, such as the cavities of the peritoneum and pleura, and that stage of the parasite life-cycle of the *filaria* inhabiting as an adult the human cellular tissue, which is passed in the mosquito, forms no exception to this general rule.

Necessarily it is along the groove of the labrum that the embryonic *filariæ* find their way, along with the ingested blood into the mosquito's stomach; but once there, they hasten to reach a more congenial situation, by boring through the walls of the organ into the cellular tissue around it, and are then free to wander in its interstices all over the body, including that of the sheath of the proboscis or labium, which is a comparatively thick fleshy organ, containing between its inner and outer walls a considerable amount of cellular tissue supporting the tracheæ, muscles, and nerves, with which it is liberally supplied. Now, as Grassi has recently pointed out, *filariæ*, though not usually very destructive parasites, do cause a certain amount of irritation and effusion; and the result of the intrusion of *filariæ* into the substance of the labium will be to raise a tense swelling of the delicate inner covering of the organ.

As already pointed out, when the mosquito bites, the labium is sharply doubled into a loop, and if the organ be swelled, owing to the presence in its substance of *filariæ*, the result of this doubling up will be to rupture its delicate integument, and so set free the contained *filariæ*. Once free they can scarcely fail to be carried by capillarity among the blades of the lancets, and so introduced with them into the cellular tissues of the new victim in which they propose to grow to maturity.

Passing through an opening between the trabeculæ which form the framework of the head, and to which it is

PLATE IV.

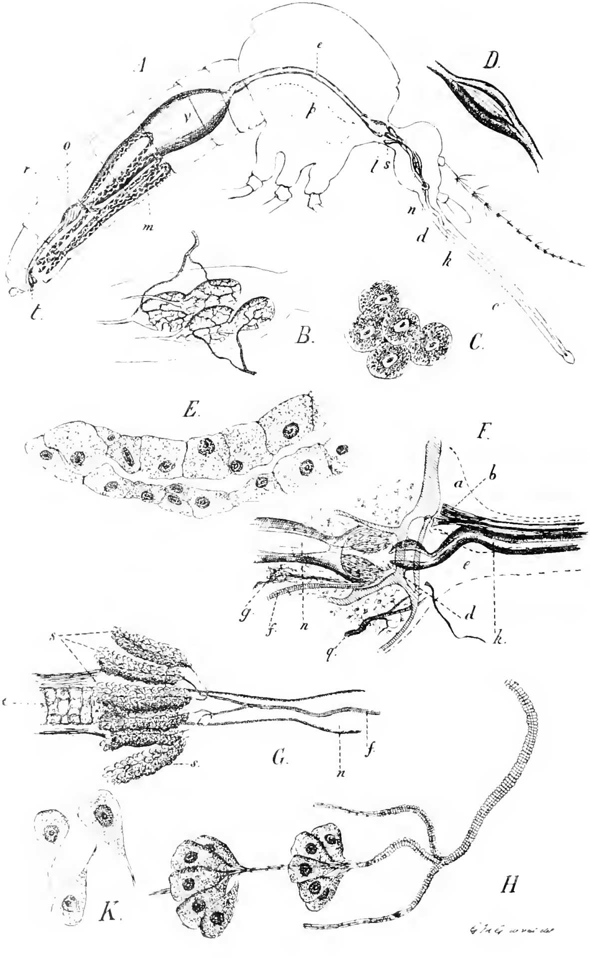

PLATE IV.—To Illustrate the Anatomy of the Digestive System of the Imago.

A. Outline figure of a female *Culex*, to show the relations of the intestinal canal and its appendages. × 15 diams.

B. The rectal glands lying *in situ* on the large intestine, with their tracheal supply. × 75 diams.

C. Isolated cells of rectal glands. × 300 diams.

D. Chitinous pharyngeal bulb. × 75 diams.

E. Blind extremity of a Malphigian tube. × about 200 diams.

F. Semi-diagrammatic representation of the parts about the mouth. × about 75 diams.

G. The salivary glands and their ducts lying *in situ* on the pharynx and œsophagus. × 75 diams.

H. Salivary duct of one side and its branches, the middle one of which, though mainly denuded, has attached to it two clusters of salivary cells. × 430 diams.

K. Normal salivary cells somewhat more highly magnified.

In the above figures: *a*, labrum; *b*, mandible; *c*, labium; *d*, buccal bulb; *e*, œsophagus; *f*, salivary duct; *g*, nerve; *k*, "hypopharynx"; *m*, Malphigian tubes; *n*, chitinous pharyngeal bulb; *o*, spiral valve of large intestine; *p*, pneumatic vesicle (dotted outline of); *q*, trachea supplying the cellular tissue of the labium; *r*, rectum; *s*, salivary glands; *t*, rectal glands; *v*, stomach.

The chitinous framework of the head is indicated by coarse oblique shading; the outline of labrum in dotted, and that of the labium in broken dotted lines.

connected by a delicate membrane, reflected on to them, and thence to the floor of chitinous pharynx, the hypopharynx, as already described, ends as a blind sac lying in the root of the labium, just in front of the buccal cavity. The anatomy of the latter is by no means simple, and so far as I know, has hitherto remained unnoticed.

As I have endeavoured to indicate in fig. F, plate IV., the framework of the mouth springs from the strong tergal plate running along the middle line of the head, and from which springs the base of the labrum. From this, on either side, runs down a strong lateral piece, which shortly divides into two rods, enclosing an oval space, the anterior of which appears to be really the basal piece of the mandible. Reuniting below, these lateral pieces are continued downwards to join with the strong but narrow sternal plate that lies in the ventral middle line. This sternal plate, however, is only single and median for a short distance; after which it divides into lateral rods, united by a delicate membrane, which run back between the lower borders of the eyes. Through this transparent membrane, if we can successfully clear away the opaque mass of structures lying above them, may be distinctly traced the single median common duct of the salivary glands, running forward to open into the fundus of the hypopharynx. The pharynx, or intracephalic portion of the digestive tube, is entirely chitinous and terminates in a cup-shaped expansion, which forms the back of the roughly spherical frame of the buccal cavity. This, as already described, is in no way rigidly connected with either the framework of the head, or the end of the hypopharynx, continuity of the tubes being maintained only by a very delicate membrane, and into the space between the two structures a mass of mesoblastic tissue is pushed forwards, especially below, and expands between the cupped end of the pharynx and the delicate connecting membrane into a thick mass composed mainly of peculiar spindle-shaped cells. It is along with this mesoblastic intrusion that the salivary duct and two large nerves are conducted to the interior of the buccal bulb, and the presence and large size of the latter make it probable that the function of this thickening which fills up the greater part of the chitinous sphere, is connected with the sense of taste. The anterior part of the lining membrane, especially below, is closely armed with minute spines, the back of the cavity being lined with the soft tissues of what is evidently a nervous end organ, and is probably that of taste.

At the point where it springs from the cup-like expansion, the pharyngeal tube is somewhat constricted, but after this

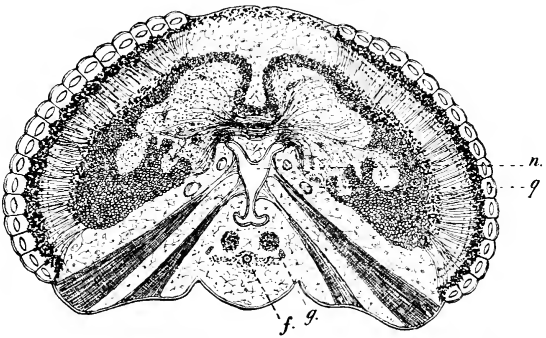

FIG. 23.—Transverse Section of the Head of *An. Culicifacies*, sp. n. x 120 diams., showing the pharyngeal bulb, with its dilator muscles. Immediately above is seen the mass of the brain, or supra-œsophageal ganglia; *f*, salivary duct; *g*, ventral nerve cords; *n*, pharyngeal bulb; *q*, tracheæ.

it runs for a short distance as a tube of uniform thickness, through the mass of the œsophageal nerve collar, and then expands into a fusiform dilatation of considerable size. As usually seen (in fig. D) it is longitudinally furrowed so that its transverse section would have the outline of a wallflower, but when filled by imbibition of glycerine these infoldings disappear.

This bulb unquestionably serves as the pump, by means of which the insect draws up the fluids of the tissues into which its proboscis is plunged; as it is provided with a

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special set of muscles, by the action of which it can be actively dilated. Above, it is fixed by the connective tissue around it being intimately connected with that of the supra-œsophageal ganglia; and on either side are inserted bands of muscular fibre, which pass obliquely forwards and outwards, to their origin from the chitinous wall of the ventral aspect of the occiput, and a glance at the figure above will make it clear that they must necessarily exercise a powerful suctorial action.

Behind this, the pharynx once more contracts to its previous diameter and just beyond the back of the head, where it enters the neck of the insect; it ends in the soft œsophagus or true fore-gut, the walls of which are greatly thickened at this point so as to form a bulb, rather broader than that of the pharynx, and mainly composed of a muscular thickening, which probably acts by way of a valve, by means of which the contents of the mid gut are prevented from entering the pharyngeal bulb while the latter is exercising its suctorial function. It is on the ventral aspect of this junction, but mainly on the œsophageal bulb, that are placed the salivary glands which are therefore contained *within the narrow neck connecting the head with the thorax*.

In the fresh insect, they extend but a little way into the front of the thorax; but in serial sections, as a result of the shrinking action of the various processes to which the preparation has been subjected, they are squeezed out of the soft and yielding neck, back into the cellular tissue filling the more rigid box of the thorax, and so are made to appear to extend backwards for a considerable distance into it; and the erroneous representations that have found currency have no doubt resulted from a too complete reliance on the method of serial sections, unchecked by dissection of the fresh insect.

I can find no previous description of the salivary glands, including that quoted in my first edition, which is not, as I now find, full of inaccuracies. This has arisen from the fact that their extreme delicacy renders their demonstration by far the most difficult piece of minute dissection that it has fallen to my lot to attempt. It is comparatively easy to obtain a portion of them for microscopical examination, but to lay them bare intact, and still more to follow out the course of their ducts, is a task that will try the most patient. For often, as Dr. Daniels remarks, all one has to show for one's pains is the intra-glandular portion of a duct, denuded of its cells. As however, it appears probable that it is through the infection of these glands and their secretion that the germs of malaria are carried to man, their structure and relations require to be carefully studied. Although their duct passes forward to open into the fundus of the hypopharynx, these glands are rather closely bound down to the œsophageal bulb on which they lie by means of connective bands, and hence are occasionally brought away with the rest of the digestive viscera in the dissection of the stomach; but such an occurrence is merely accidental and cannot be relied on; and where the glands are required for investigation, the following is the best method I can suggest for exposing them :—

Place the insect in some salt solution on a slide, and then, with the point of an edged needle, lay open the narrow neck connecting the head and thorax, keeping well to the dorsal side. Next pass the needle into the midst of the thorax, so that it must divide the œsophagus about the middle; then by a few gentle strokes, tear through the integuments of the neck here and there, where it joins with the thorax, still keeping away from the ventral side; and finally, keeping the left hand needle entangled in the thorax, gently tear off the head with that held in the right and clear away the rest of the insect.

It is well at this stage to wash well with fresh salt solution from a pipette, and it facilitates the recognition of the various structures to just colour the solution with methylene blue.

If the separated head be now carefully examined there will be seen, protruding from the torn neck, the tag of œsophagus which has been drawn out from the thorax, and round it several minute glistening lobular bodies, which, under a sufficiently powerful lens, look much like tiny bunches of grapes.

These are the blind ends of the lobes of the salivary glands, of which there are six in all; each gland consisting of three sausage-shaped lobes of nearly equal size; but as a rule only two or three of their number will come into view at this stage and their subsequent separation from the structures surrounding them is purely a matter of manipulation, for which I can offer no better receipt than patience and steady hands. Once one has learned to recognise their very characteristic appearance, there is little difficulty in getting piecemeal preparations, but I was well nigh in despair ere I had cleared up my last doubts as to their exact form and connections.

In structure these glands differ entirely from any with which the student of vertebrate histology is familiar, as, strictly speaking, each cell is a separate gland, there being no true duct formed by a lumen bounded by contiguous gland cells and supported by a fibrous layer, such as is typical of vertebrate glands, as well as those that appertain to the intestine proper in arthropods. Instead of this, the salivary cells are arranged, like the flowers of a "spike," on a chitinous tube prolonged from the lining of the buccal cavity, and the singularly sharp outline and appearance of rigidity of this tube, form a marked contrast with the indeterminate appearance of the lumen of an ordinary tubular gland. Apart from the fact that it is quite straight, the intraglandular portion of this chitinous duct resembles nothing so much as an elastic fibre from the *ligamentum nuchæ*, but is of much less diameter. The external diameter of even the main duct is only 3 or 4 μ, and the lumen of its intraglandular branches can hardly exceed 0·5μ. Each lobe of the gland consists of a single branch of the duct with the salivary cells closely clustered round it, but in no other way connected with each other, so that the least touch or the pressure of a cover glass, at once separates them from each other and from the duct, to which each cell is connected only by a delicate thread of cell substance prolonged from their smaller ends. Each is a typical gland cell of considerable size and pear-shaped form, with large nucleus and nucleolus, the smaller end tapering off to a delicate thread which connects the broad-ended cell-mass with the duct; and if the latter be examined under a good apochromatic lens, it can be distinctly made out that, minute though it be, this chitinous wall of the tube is pierced by spirally arranged minute perforations, each corresponding to the point of origin of a cell.

In connection with the search for parasitic elements it is well to remember that, there being no connective or other elements to confuse the issue, any other structure than these very characteristic gland cells must necessarily be abnormal.

Each gland consists of three lobes about three times as long as they are wide, and the three ducts unite at the same point into the right and left salivary ducts; but these have only a short separate course, and at a point near the base of the pharyngeal bulb, they, in their turn, unite into a common median duct which terminates in the manner already described. The six lobes lie close together on the œsophageal bulb, and together cover the whole of its ventral surface and the greater part of its sides. The only other point requiring notice is that the extra-glandular portion of these ducts is strengthened by a spiral or annular thickening of the chitine, so that they present a close resemblance to a trachea emptied of air; but there is this difference, that whereas in the trachea the thickening is on the inside of the tube, in the salivary ducts it is distinctly placed on its outer surface. There is no separation or distinction whatever between the salivary and poison glands, which hence are now commonly referred to as the "veneno-salivary" glands.

Behind the bubar thickening in which it commences, the œsophagus is continued as a simple transparent tube, through the whole length of the thorax, and the only point that requires special notice is that it is not uncommon, in dissecting, to bring away attached to it a pair of delicate bags of air bubbles, the true nature of which will be referred to in the description of the respiratory organs.

The dissection of the remainder of the digestive apparatus is a simple matter, and the structures that compose it may be easily demonstrated in the following manner:—Take a specimen, and place it on a slide with a little salt solution, and carefully remove the legs and wings. Next tear open the thorax, so as to loosen the anterior attachment of the tube, and then carefully partially detach the last two abdominal segments by separating the delicate intersegmental membrane. Now place one needle so as to fix the last two segments, and with the other entangled in the thorax pull steadily on the anterior portion, when the alimentary canal and its appendages will be drawn out intact attached to the hinder fragment. If the operation be successful even the œsophagus and salivary glands may be included in the preparation, but as a rule, the tube is torn just behind the latter, so that they and the so-called aspiratory vesicle are left behind.

Assuming, however, that, as is usually the case, only a portion of the œsophagus is brought away, we find that, immediately after entering the abdomen the digestive canal expands into the chylific ventricle or stomach, which forms by far the largest part of the intestinal canal. It is of considerable width throughout, but especially so at its hinder end. Throughout its entire length it is thrown into deep transverse folds, which recall somewhat the *valvulæ conniventes* of the higher animals, and probably serve the same purpose of increasing the secretory area. In insects that have but recently emerged from the pupal stage some remnants of the last meal of the larva may occasionally be seen, but in the well-established imago plant juice, pollen, or blood will alone be found. Lastly, succeeding the broad, hinder part of the stomach, comes the hind gut, and running into the junction of the two are seen opening five long, convoluted, dark-tinted glandular bodies, the Malphigian tubes. These are supposed to have an excretory function, and as uric acid and other renal products have been found in them, the balance of opinion regards them as renal organs. They are lined with a series of large nucleated cells, the protoplasm of which is exceptionally rich in pigment and granules. These cells are arranged in a somewhat peculiar fashion, for as they are too large to admit of their forming a complete lining, the cell of one side projects into the depression formed between two consecutive cells of the other, so that in a tube that has been a little flattened out by pressure, the lumen appears zigzag, and the individual cells roughly triangular.

The last part of the digestive canal is much narrower than the stomach, its lining epithelium smaller celled and of a less glandular character, and its wall thick and muscular, while around it may be distinguished some strands of voluntary muscular fibre springing from the wall of the penultimate segment.

By a little judicious teazing of the last two abdominal segments, there may be made out, lying on the ventral aspect of the hind part of the intestine, four pear-shaped follicular glands, richly supplied with a close net-work of air tubes, and connected with the intestine by short ducts. These are lined with large gland cells, and probably secrete some fluid accessory to digestion. In the natural position they are arranged not symmetrically in pairs, but are "échelonned" in obliquely placed couples.

The respiratory system is, for the most part, quite of the usual type, the main trunks from the stigmata giving off communicating branches to those in front and behind them, and ending in a tuft of branches for the supply of the muscles and other organs contained within the segment. There are no distinct stigmata in the head or in the last abdominal segment, though I have observed certain tracheæ undoubtedly communicating with the exterior near the base of the proboscis; and the two anterior thoracic stigmata are by far the largest and most important in the body, the abdominal openings being individually small and difficult to make out, as they are completely hidden by the scales fringing the edges of the sterna and terga. They are placed rather nearer the front than the back of the segments, and are best demonstrated by first carefully removing all scales by brushing, and then crushing the insect as it lies on its side between cover and slide, so as to pinch the abdomen from side to side and bring the lateral surface into view beneath the microscope.

There is, however, in this connection, one structure that calls for especial notice; the "aspiratory vesicle," or, as I prefer to speak of them, the pneumatic sacs. This structure is not, as has been stated, in any way peculiar to the gnats, but is, I find, often even better developed in the midges, and other allied insects; moreover it is not a median, but a paired structure and I believe that its size, which has hitherto

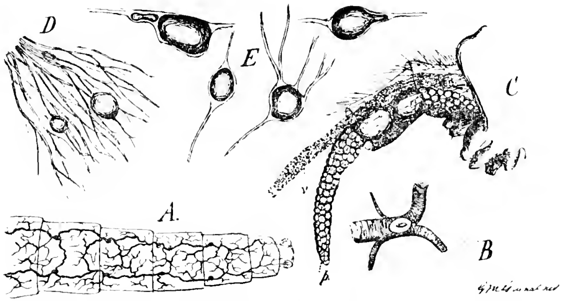


FIG. 24.—TO ILLUSTRATE CERTAIN POINTS IN THE ANATOMY OF THE RESPIRATORY SYSTEM, AND OF THE PNEUMATIC VESICLE.

A, camera lucida tracing of the distribution of the main tracheæ in the abdomen of *C. fatigans* (Wied.) × 15 diams; *B*, one of the abdominal stigmata and the tracheæ springing from it, × 75 diams; *C*, dissection of a midge, to show the relations of the pneumatic vesicle; *p*, pneumatic vesicle; *v*, mid-gut, × 15 diams; *D*, base of one of the pneumatic vesicles nearly emptied of air, × 200 diams; *E*, air bubbles contained in fibres of the pneumatic vesicles as seen under $\frac{1}{12}$th apochromat. objective, × about 1,000 diams. It will be observed that the air bubbles are of irregular and varied forms, and not uniformly spherical, as they would be if simply suspended in a mucilaginous fluid.

been absurdly understated, is inversely proportional to the size and power of the wings in the different species in which it is found.

The reason it has been hitherto mistaken for a single median sac is that, owing to the pressure of the contained air, the two sacs come to lie one behind the other. They have no true organic connection with the œsophagus and the only reason why they have been supposed to be diverticula of the digestive canal is that they are often brought away attached to it, owing to the fact that the fibrous base of the sacs, which connects them together across the middle line, is divided into two bands, leaving between them an opening through which passes the œsophagus, a little behind the valve in which the latter commences. To the naked eye they look like clusters of minute air-bubbles, and when intact, their walls rival in tenuity those of a soap-bubble. At the least touch they collapse into a bundle of fibres amongst which a few residual bubbles remain entangled.

Instead of being as they have usually been figured, barely larger than the salivary glands, they occupy, during life, as much or more space than the digestive canal when at its utmost distension. Moreover, the more gorged the insect or the heavier it be with eggs, the larger will these sacs be found, as together they occupy a large space and fill out the entire ventral portion of the body cavity from the front part of the thorax to the end of the fourth or fifth abdominal segment.

It is difficult to understand how any one could ascribe to such a structure as this any active suctorial function, and so describe it as "aspiratory," and there can be no doubt that its function is identical with that of the air spaces in the bones of birds, namely, to lighten the work of the wings by increasing the bulk of the body; and further, I have now no hesitation in affirming that, as too, is the case in birds, these sacs are mere extensions of the respiratory passages. Into the base of the sacs may be traced large tracheæ and these split up and become continuous with a brush of dichotomously dividing fibres of which the base of each sac is composed. These fibres, like the intra-glandular part of the salivary ducts, look much like those of elastic tissue, and are undoubtedly composed of chitine. Moreover, if we examine the collapsed "sac" under a sufficiently high power, a number of minute air bubbles will be found to remain, and close examination shows clearly that these bubbles are not entangled between the fibres, but contained in dilatations of their continuity. In other words, these fibres are neither more nor less than extremely elastic and distensible tracheæ, which swell out into bubble-containing dilatations, wherever their mutual pressure permits of their doing so. Apart from a few loose connective elements, the sacs consist of nothing else than these curiously modified tracheæ.

The circulatory and nervous systems also present no peculiarities beyond the few points that will be found noted in the section on the anatomy of the larva and its metamorphoses. In the imago, however, the fused cephalic

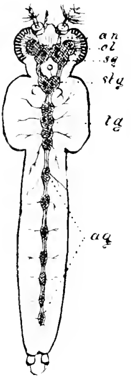


FIG 25.—DIAGRAM OF THE NERVOUS SYSTEM.

a n, antennal nerve; *o l*, ophthalmic lobes; *s g*, supra-œsophageal ganglion, or brain; *s b g*, sub-œsophageal ganglion; *t g*, mass consisting of the third thoracic and first dorsal ganglion; *a g*, abdominal ganglia.

ganglia, or brain, is very large, and although they do not appear to possess any specially great amount of insect intelligence, its relative weight as compared with that of the body, cannot fall far short of that of even the human subject. One striking point, however, is the manner in which almost the whole of the branches of the last abdominal ganglion are supplied to the internal generative organs. So much is this the case, that a successful preparation of either the ovaries or testes almost always carries away with it this ganglion.

The genital organs of the female consist of a pair of more or less spindle-shaped bodies, which, in the unimpregnated insect, are contained mainly in the last abdominal segment, and lie obliquely in it on either side of the middle line, their distal extremities being supported by a sort of ligament springing from the common fibrous lining of the segment. They contain a large number of soft closely packed ova in various stages of development, those nearest the opening of the oviduct being the most advanced. They

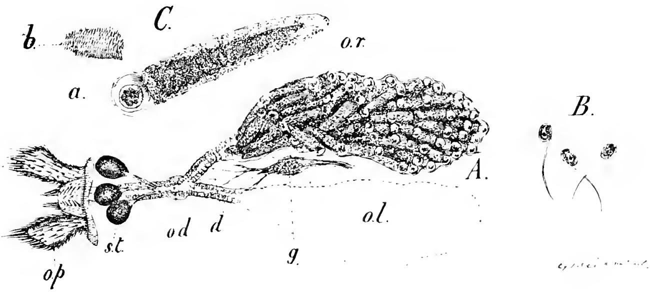


FIG. 26.—GENERATIVE ORGANS OF A GRAVID FEMALE MOSQUITO.

A. Generative organs of *C. fatigans*, ♀ × 18 diams.; *or*, right ovary and oviduct full of mature ova; *ol*, outline of left ovary; *g*, last ganglion of abdominal chain; *d*, ovarian ducts; *od*, common oviduct; *st*, spermothecæ; *op*, ovipositor; *B*, spermatozoa from the spermotheca, × 450 diams.; *C*, a mature ovum, × 45 diams.; *b*, portion of coat of ovum proper, showing its spinous structure.

are richly supplied with tracheæ, supplied from the stigmata of the penultimate segment, as well as with large nerve threads from the last abdominal ganglion.

When further advanced, the ovaries and their ducts take up a large share of the cavity of the abdomen; forming a pair of large, lobulated masses. At this stage, very little of the true ovarian tissue can be distinguished, almost all that can be seen being the enormously dilated funnels of the oviducts. Each egg consists of the ovum proper, clothed in a chitinous envelope closely covered with minute spines, within which may be distinguished an elongated embryo, and a peculiar sac at one pole containing a single large polynucleated cell, which appears to be in some way concerned in the bursting of the egg membranes; the whole being enclosed in a delicate, structureless, external membrane, the total length of the whole egg being 0·71 mm. Their width is but a fifth of their length, and they are much broader at the end provided with the polar capsule, the base of which is marked with fine radiating striæ. In the oviduct this broad end always lies forward, so that the narrow pointed end is that which appears first in delivery. The ovaries communicate with the common oviduct by means of a short, transparent, funnel-shaped tube; and this latter is a short transparent canal, which commencing in the junction of the funnels of the ovarian ducts, runs straight backwards without convolution or deviation from the middle line, to open between, and at the base of, the ovipositors. Just before its external termination, it receives on either side the ducts of three small glandular bodies, each consisting of a spherical glandular portion about 0·5 mm. in diameter and a short neck or duct. They are filled with an opaline white fluid, which consists of a material identical with that found in the *receptaculæ seminales* of the male, the peculiar fibrous matrix as well as the spermatic elements being undoubtedly transferred *en masse* from the receptacles of the male to those of the female, their contents differing only in the fact that, whereas in the male only the earlier stages of spermatogenesis are represented, in the female, the contents consist of more advanced spermatic elements and of fully developed spermatozoa, so that the later stages of the process take place in the body, not of the male, but of the female.

The spermatozoa are minute comma-shaped bodies with a rather stiff one-sided tail, and a pear-shaped nucleus, the long diameter of the head being about 7 μ. I see no reason for thinking that these bodies serve any other function than that of spermothecæ, and their dull colour is due, not to any opacity of their contents, but to the sooty pigmentation of the sac-wall. They contain absolutely no glandular elements, and therefore cannot also as Arribálzaga supposed, secrete the gelatinous fluid that cements together the eggs in the "egg-boats."

The ducts of the spermothecæ are strengthened by a spiral fibre of chitine, just as in those of the salivary glands; and just behind their entry into the common oviduct will be seen that of a special accessory gland which secretes a mucilaginous fluid which can hardly have any other function than to furnish a protective coating to the eggs, and to cement them together in those genera which deposit them in boat-shaped masses.

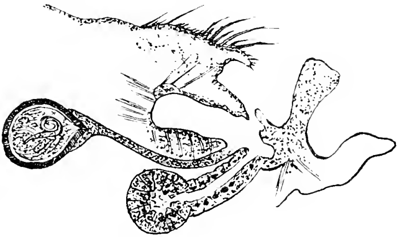


Fig. 27.—Sagittal Section of last Abdominal Segment of a ♀ Culex, showing the Entry of the Spermotheca and Cement Gland into the Oviduct. (After Kulagnin.)

The male generative organs consist of a pair of small yellowish bodies, the testicles, from which the sperm is carried by the vasa deferentia, which are simple straight tubes, to the ejaculatory duct which originates in their union. Just before the termination of the vasa deferentia, they receive the ducts of the receptacula seminales.

The function of these vesicles requires further investigation, as their contents do not, as one would expect, consist of spermatozoa floating in a simple fluid, but of spermatic elements in various stages of the process of spermatogenesis, anterior to the appearance of completely developed spermatozoa; and what is more remarkable, these are not floating in fluid, but are entangled in a fibrous mesh. Presumably not only the spermatic elements, but detached portions of the fibrous basis of the testicle are carried down the vas deferens and stored in the receptacula, but the manner in which this is effected is difficult to understand. The ejaculatory duct is short, simple and straight, and ends in a short, fleshy penis, which is unprovided with any chitinous armature.

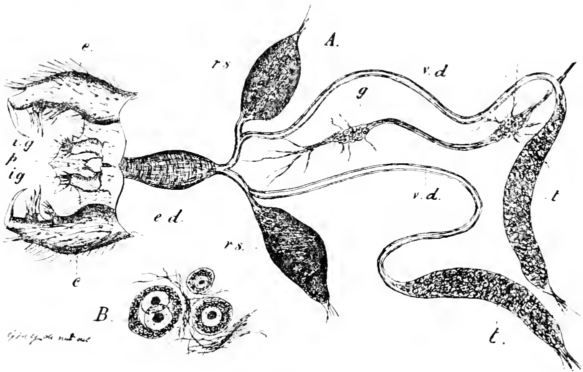


FIG. 28.—MALE GENERATIVE ORGANS OF *C. fatigans.*

A, The male organs, the *vasa deferentia* being represented as curved to save space (they actually pursue a perfectly straight course) × 18 diams.; *t*, testicles; *v d*, *vasa deferentia*; *r s*, *receptaculæ seminales*; *e d*, ejaculatory duct; *c*, claspers or external gonapophyses; *i g*, internal gonapophyses; *p*, penis; *B*, contents of *receptacula seminales*, × 450 diams.

All these points can be made out, if not at the first attempt, at least after examining a few carefully made, teazed preparations, and the reader is strongly recommended to follow the preceding descriptions with such preparations before him rather than to trust to illustrations, which, owing to the extreme delicacy of the objects which it is attempted to represent, are at best mere diagrammatic representations, and can do no more than serve as a guide to the recognition of the parts sought for.

Apart from the fact that the ova differ markedly from the above description, which applies only to *Culex*, there is no noticeable difference between the internal anatomy of the different genera; and, putting aside of course the generative system, the two sexes closely resemble each other, so that I cannot confirm Prof. R. Blanchard's statement (*Bull. Acad. de Médecine*, 3e. Sér., t. xliv., p. 21.) that the buccal apparatus of the ♀, is much the more developed; for I find that, for all purposes of anatomical investigation, one may use either the ♂, or the ♀, as interchangeable material.

The above account will, I think, be found sufficiently detailed to serve as an introduction to those engaging in work on the subject, but is necessarily a mere sketch of the subject, for so many points force themselves on one's notice that it is difficult to avoid being tempted into too great detail. It would indeed be easy to fill as large a work as the late Prof. Huxley's wonderful work on the cray-fish if not to copy the luminousness and charm of the author, but anything beyond an outline of the subject would be out of place in a book like the present.

CHAPTER VII.

On the Life History and Seasonal Prevalence of Mosquitoes.

THE life history of any species is necessarily mainly determined by the nature of its food; and in these insects this differs entirely at different stages of their career; for while the larva is a purely aquatic animal, feeding on pond organisms, vegetable and animal, the adult flying insect, from the structure of its mouth, can subsist only on fluid, or at most, emulsified forms of nourishment; and as naturalists are generally agreed that gnats cannot travel to any considerable distance, it follows that food both for adult and larva must be obtainable within a limited area, for mosquitoes cannot and do not fly far. It is impossible to fix any absolute limit to their powers in this respect, but it may be safely asserted that few individuals ever stray much more than a quarter of a mile from the pool in which their larval youth was passed, and the great majority never travel further than the nearest shady spot. Nor, in spite of popular beliefs to the contrary, can they be carried far by the wind. Mosquitoes, indeed, exhibit a well-founded, instinctive dread of boisterous weather, and will not leave shelter in a high wind. Those accidentally carried away are, I am inclined to think, rapidly disabled.

When serving as Naturalist to the Indian Marine Survey I was necessarily at sea for months together, and though butterflies, dragon flies, and other strong flying insects often boarded us far out at sea, I found no evidence of small and delicate species being transported in this way.

A run up the Hooghly for coal would fill our cabins with these unwelcome shipmates; but, once fairly at sea, their numbers rapidly diminished, though a certain number remained long enough to make it certain that the dissemination of species through the agency of steamships is by no means impossible, and may be of not infrequent occurrence. It was only, however, when the ship chanced to lie close to the shore that she was invaded in this way. The myriads of Mosquitoes that invade a ship moored alongside the bank in Garden Reach must be seen and felt to be believed, but when moored "in the stream" one is left comparatively at peace; and in open ports, ships anchored at the usual distance from the land remain practically free from these pests.

Another reason that makes it impossible for Mosquitoes to be carried overseas any considerable distance by the wind is that, whatever may be the rate of travel that they can bear without injury, the entire journey must be made at night, for in tropical regions shelter from the sun during the day is a matter of life and death to a Mosquito, as is proved by the following observation.

In Oudh, during April, it is difficult to sleep in comfort except in the open. My servant one night was careless in the tucking in of the mosquito net, and when I woke in the morning I found I should have done well to have imitated the Irishman of the story and "crept out under the bottom bar," for the net was alive with happy, satiated dames of the gnat community.

My bed, as a matter of fact, had no bottom bar, but doing my best to imitate the astute Hibernian, I crept out with infinite precaution, tucked in the curtains, and gave directions that the bed should be left where it was. The day turned out somewhat cloudy, the temperature inside the net never exceeding 105° F., but by noon every Mosquito was not only dead, but bone-dry.

For these reasons, we may I think reject, as having no foundation in fact, such popular beliefs as that the swarms of Mosquitoes that sometimes appear on the Persian coast, have been carried by the wind 200 miles across the Gulf from the Arabian shore; albeit you must be prepared to hear this belief quoted as an established fact, even by European residents.

Food then, alike for larval and adult insect must be obtainable in close proximity. The pupa does not eat. In the adult stage, the usual food of probably all species of both sexes is the juices of plants, and although the females of many attack and suck the blood of vertebrates, food of this sort does not seem to be in any way essential to their welfare, as most species will lay their eggs equally well on a purely vegetable diet. Moreover, even in the case of notoriously troublesome species, it is often difficult to induce them to bite animals, although they will still feed on their more usual vegetable food. A high atmospheric temperature appears to be the main determining condition of these outbursts of sanguinary instinct, and this is probably the reason why, in spite of gnats being quite common, we are so rarely troubled by their attacks in England, for it is noticeable that whenever there occurs a spell of exceptionally hot weather, we find in the press notices of an invasion of England by Mosquitoes, which, however, always turn out to be common indigenous species when submitted to a competent entomologist. The same thing may be observed in Northern India, where it will be found that Mosquitoes cease to be troublesome, some time before they have finally hidden themselves for their cold weather rest. Speaking generally, only the females bite, and it is noticeable that different persons differ greatly in their reaction to the stings of these insects. When Mosquitoes are unable or unwilling to obtain blood they suck the juices of plants. They are frequently found on flowers, and especially in England on the catkins of the willow. On hot days and in places exposed to sunshine they remain at rest until the evening, but especially in wooded localities they often are active in the middle of the day, and may often be observed perched on leaves and making a sort of balancing movement of the body, by alternately bending and extending their legs in the same way as do many of the *Tipulidæ*.

In India too, the most usual recognisable constituent of the contents of the stomach, of all species I have examined, in both sexes is pollen. Now some pollen grains look not unlike the printed representations of zygotes, and I have met with an instance when they were mistaken for them. No fairly expert microscopist is of course likely to be misled in this way; but it will be at least a harmless precaution, for anyone who has to depend for guidance on figures, to make himself familiar with a few of the commoner pollens before starting zygote hunting.

In addition to the juices of living plants and animals, many species will also feed on such articles of human food as are suitable to the structure of their mouth parts and they show a marked preference for sweet things. Hence mosquitoes may often be seen clustered on the moist sticky sugar exposed for sale in the shops of an Indian bazaar, and a few will generally be found feasting on the preserved fruit and sweets laid out for desert on an Anglo-Indian dining-table, or on puddings put aside in the larder. Not indeed that they confine themselves to such articles; they are not adverse to milk, and will also attack raw meat, or indeed, any article of food out of which anything can be got by suction. On one occasion I found some Mosquitoes unmistakably feeding on filth, but believe such a habit is adopted only as a last resource, for at the time I observed this, all plants were dried up and juiceless. As is well known, many butterflies which also normally feed on plant juices, exhibit the same incongruous taste.

Although one of our commonest Indian species is reputed to do so, I have never actually seen a male mosquito bite, and believe that when they do so it is only an exceptional indulgence. There is, however, no doubt that some few species do so occasionally.

On this point Mr. Austen remarks: "While it is certain that in a natural state only an infinitesimally small proportion of all the Mosquitoes that come into existence can possibly taste the blood of a warm-blooded animal, it is reasonable to suppose that primitively all *Culicidæ* fed upon the juices of plants. Indeed it has been stated that at the present day some species are still exclusively vegetarian in both sexes; that in others, while the males are vegetarian, the females suck animal blood—in some species only exceptionally, in others habitually; and, finally, that there are species in which *both* sexes suck animal blood (this is said to be the case in an Egyptian species and in two Italian ones; it has also been observed in two species found in Madagascar, and has been noticed at Bannu (N. India)."

When in the humour to attack, it is not only man, but also other mammals as well as birds that are laid under contribution; and it is propable that they do not even confine their attention to warm-blooded animals, for if, as is most likely the case, they are the habitual intermediate hosts for the majority of the class of protozoal blood-parasites, of which that of human malaria is the best known example, it seems likely that tortoises and frogs are the chosen victims of certain species, as hæmatozoa closely allied to Laverans parasite are well known to occur in animals of these classes.

Bovine malaria has been shown by Smith and Kilborne to be carried by a tick (*Ripicephalus annulatus*), but owing to the amphibious habits of the former animals it is unlikely that the alternative host of their malaria can be any wingless arthropod.

The staple food of the larvæ of all the well-known genera is undoubtedly of a vegetable character, such as monocellular and filamentous algæ, and in dissecting larvæ I have never met with anything else in the contents of their stomachs. There can be no doubt, however, that they feed also on animal matter, and may be not only predatory, but actually cannibalistic. The larvæ of *Corethra* are said to be especially remarkable for proclivities of this sort, but I have no personal experience of this genus, and otherwise there seems but little difference in the habits of food of the different genera. The Indian species of *Anopheles* are no exception to this. Quoting from a communication to the Bombay Natural History Society, advance proofs of which have been kindly sent me by the author, Mr. E. H. Aitken, one of our best field naturalists, I extract the following graphic description of their habits:—

"The favourite vegetable food is a soft *fucus*, very like cotton wool dyed green, which is found in clear running water; or that thick spongy growth which clothes the sides of fountains in which there are no fishes, and gets detached and floats like a thick, dark green scum. The principal animal food is the cast-off skins and pupa cases of water larvæ, including those of its own kind, and the remains of dead mosquitoes and other small insects. These often collect in patches on the surface of a pond, and one dip under such a patch will secure hundreds of larvæ after you have searched the rest of the pond in vain. Now the larva of *Anopheles*, unlike that of *Culex*, floats flat on the surface of the water, and it is much more unwilling to go down than *Culex*. If green food is to be had not more than two or three inches deep, it will go down and feed, but it comes up again very soon, and would evidently rather not go down at all. As it floats you will see two little organs on the front of its head incessantly stirring the water. These are the "whorl-organs." They are crowned with little brushes of bristles, and their function is to keep up an eddy, by which every little floating particle which passes by is sucked in towards the insect's mouth. With a lens you can see this quite plainly and observe it seizing the little particles with its jaws, sometimes eating them and sometimes throwing them away with an angry toss of its head. I do not think that even living objects, if small enough, are refused, and, in fact, I am almost sure that the larger larvæ sometimes eat the little ones. They are all very ill-natured and bite savagely at each other when they get the chance. This way of feeding explains why *Anopheles* likes a certain amount of motion in the water, for it brings food, and why it must starve in deep water unless there chances to be a great deal of food, animal or vegetable, floating on the surface. The larvæ of *Culex* dive much more freely and are more promiscuous in their diet, and, since they float with their heads down, they do not care much for floating matter. Hence they dislike any motion. The more stagnant the water is and the more dirty, the better it pleases them. Lastly, *Anopheles* larvæ must have sunlight, though they will hate it more cordially than other mosquitoes when they come to mosquitos' estate."

The necessity of sunlight is mentioned by Meinert, and is also noted in a letter I had received from Dr. St. George Gray, of St. Lucia, in the West Indies, and furnishes an explanation of the failure of all our efforts to keep these larvæ in health in captivity. In speaking of the habits of *Culices*, Mr. Aitken refers to the specially domestic species, for those of many sylvan gnats are less tolerant of dirty water than any *Anopheles* of my acquaintance, and those of Mr. Theobald's new genus *Stegomyia*, are the most dainty larvæ I know of in this respect, which probably accounts for the fact that they are all essentially insects of the rains. Species, such as *C. fatigans*, which live in really foul water, subsist largely on the *vibriones* with which it swarms.

Waterless tracts, or such as are desert owing to the character of the soil, are necessarily free from Mosquitoes, except through the indirect agency of man, but in by far the majority of situations, food for both their stages of existence is obtainable, and gnats of some sort are included in the fauna; though the species harboured will vary with the sort of accommodation offered.

In searching for larvæ, it is little use attempting to do so by a mere inspection, as owing to their universally protective colouring, it is easy to overlook them, even when present in large numbers, if one merely stoop down and peer into the puddle. The examination should be made by dipping up some of the water from the surface of the puddle in an ordinary tumbler, and examining it by transmitted light. If care be taken not to disturb the mud at the bottom, it will usually be easy to do this at once, but should the water get stirred up, the specimen must be put aside till it settles.

The habits of the larvæ, not only of the different genera, but also of individual species of the same genus differ greatly, and much misconception has arisen from hasty attempts to generalise; for, as a matter of fact, it is impossible to say that you will find the larvæ of Anopheles in certain situations, or in water of a given degree of purity or otherwise, as those of some species frequent only fairly pure collections, while others are hardly less particular than many, even domestic species of Culices.

Lynch Arribálzaga (L. A., p. 23) classified Mosquitoes, as regards their habits, into domestic, field, marsh and wood Mosquitoes; and Ficalbi (F. V. S., p. 62) into "foveal," which I take it, may be translated as domestic, paludal, and sub-paludal species.

The word paludal, however, appears to be a misnomer based on an unconscious remembrance of bygone notions of the etiology of malaria, for all marshes of dimensions worthy of the name, shelter too many of the greatest enemies of the larvæ to be regarded as the typical habitat of any species; and for practical purposes, it is more convenient to divide them into domestic and field Mosquitoes; though the true forest gnats, such as the genera *Megarhina*, *Sabethes*, *Ædes*, *Ædomyia*, and *Ceranotænia* mostly, which inhabit the depths of tropical jungles, far from the haunts of man, form a class by themselves. *Psorophora* and *Mucidus* are field rather than jungle gnats, and *Stegomyia* and *Armigeres*, are rather field than domestic, and are never, so far as I know, found in dirty water. I know of no really jungle species of *Anopheles*, all species being either field or domestic, but *Culices* are found in all possible situations.

It would be a mistake to attempt to attach too rigid a signification to terms of this sort, and I would particularly caution against premature attempts at generalisation, but broadly speaking, the domestic gnats are those which infest habitations, while their larvæ are mostly found in small artificial collections of water, such as garden tanks, broken crockery filled by rain, waste water puddles and so on; while the field species, though often found in and about habitations, pass their larval stage in fairly clean, natural pools, or at any rate in such as afford conditions similar to those found in the open.

Some typically domestic gnats, such as *C. fatigans*, will deposit their eggs in the foulest of water, and I have found its larvæ in apparently flourishing condition, in the small cemented tanks, for the temporary storage of sullage water in Indian towns, known as *nabhdán*, the contents of which are filth, far more concentrated than the sewage of any

European town. On the other hand, unless my suspicion that however close their resemblance, they are really distinct forms be correct, the same larvæ will be found during the rains, alone or in company with *Stegomyia* larvæ, in almost drinkable water. *Culex pipiens* is of course another typically domestic gnat, and *C. annulatus, spathipalpis, nemorosus, viridiventer* and *pulchriventer* may be cited as examples of field species, though the last is perhaps, strictly speaking, a forest form.

The habits of the different species of *Anopheles* larvæ also vary greatly *An. Rossii* is certainly essentially a domestic species, and so too, I think, is *An. Sinensis* with us, but *An. Jamesii*, which appears to be the species that swarms in the Madras paddy fields, is probably a field species, and so too, it may be, is *An. culicifacies*, sp. n., which is probably the species referred to by Mr. Aitken, in his above-quoted note.

During the past year I have observed the larvæ of *An. Rossii* in a variety of situations, but all essentially "domestic." In the spring months, in upper India, none are in evidence, and I first found them towards the end of April, breeding in a pool beside one of the piers of the old bridge across the Goomti, which flowed just beneath my house in Lucknow. The pool was but a few yards long by not more than six feet wide, and though it did contain a certain amount of green filamentous vegetation, was extremely foul. Still it is the nearest approach to the "*Anopheles* pool" of the West African Malaria Commission that I have met with inhabited by the larvæ. Typical pools of the sort I have indeed come across by the dozen, but in no case have I met with them in such pools.

The horizontal posture of the larvæ was, however, very noticeable, and when placed in a tray under lens, I could also verify their peculiar trick of screwing round their heads so as to look upward. During the dry, hot weather, however, their appearance is with us exceptional, though in the damp eastern and southern parts of India they may be found at any time of the year; and it is not until the rains are fairly established that one can expect to find them in any numbers.

In July and August last, my duties involved an extensive tour through the province during the rainy season. In the early part of the period it was evident that though *Anopheles* larvæ were common, they had not long been so, as even in places where they were plentiful, I could find no adults. It was not indeed till the end of the month that I began to find them at all commonly in bungalows. The situations, however, in which I found the larvæ entirely upset all the notions I had gathered from recent writings on the subject. I began, of course, by looking for the typical *Anopheles* pool of Ross, but such as I found never held any of the expected larvæ, and the first place I met with them was in the garden of the Meerut Club, in the small irrigation tanks described in the next chapter Here they were present in enormous numbers, sometimes alone, but more frequently in company, and apparently on excellent terms with the larvæ of *C. fatigans*. It was, however, noticeable that while the *Culex* larvæ for the most part remained in the middle of the tanks, those of *Anopheles* generally kept themselves floating with their tails touching its side walls, and so might easily be overlooked. In my subsequent wanderings, I met with *Anopheles* larvæ in a variety of situations, but always these small irrigation tanks were the "surest find," and further I never met with them at any distance from human habitations, so that I am inclined to suspect that females are unable to mature and deposit their eggs until they have had a feed of blood. I have also met with *Anopheles* larvæ in muddy pools of some size in brick-fields, in the overflow from stand-posts in large cities supplied with a regular filtered water supply, and even in a very shallow depression in the concrete surface of the platform of a bustling railway junction, also fed by a stand-post.

In Hong Kong, Dr. J. C. Thomson writes, in *The Government Gazette* of November 24th, 1900. "The usual *habitat* of the larvæ of the *Anopheles* Mosquito is the natural water courses, and their favourite locations little breaks in the rocky surface by the side of the stream, where the merest trickle from the stream itself prevents entire stagnation, and where there is no through-wash." This, it will be noted, is exactly the same sort of situation in which they were found by Drs. Stephens and Christophers, in Sierra Leone, and there, both these gentlemen and Ross never found them in really dirty water, so that presumably, both *An. costalis* and *funestus*, the species concerned, confine themselves to fairly clean water; but, as we have seen, several species can adapt themselves to less nice conditions, so that no generalisation as to the sort of water in which *Anopheles* larvæ will or will not be found is possible, and all attempts to formulate such are simply misleading for the genus, and where recorded, should be accepted exclusively for the species to which the observations refer, and to no other.

How difficult it is to make any definite statement as to the habits of even a single species, may be judged by the fact that even in Italy, where more attention has been devoted to such points than anywhere else, the larvæ of one and the same species are stated to be "paludal" in habit by one authority, while the imagines are said to be domestic by another observer. The fact is that it is impossible to lay down any hard and fast rule, and all that can be done at present is to point out the desirability of always recording the exact species referred to, and in noting the habits of either larvæ or adults, so that materials for a more complete statement of the case may accumulate in the future.

The females of, I think I may say, *all* genera of Mosquitoes lay their eggs in water. During the past year, a large number of observers have been noting these and kindred points, and no one records any fact that in any way confirms Ross's suggestion that they may sometimes deposit them on the dried-up ground where puddles have previously existed. A gravid gnat must deposit her eggs somewhere, and in such surroundings as the interior of a test tube, which is about the most unsuitable vessel I know of wherein to confine gnats with the view to observe points in their life history; there is nothing really suggestive of usual habits in her being driven to deposit them on the walls of the tube.

The attitude of the females in depositing their eggs is peculiar. Thanks to the air entangled in the pulvilli, with which the feet are provided, they can rest on the surface of still water, as easily as upon dry ground, and are able to alight upon or take flight from its surface at will. When they have settled themselves in this way on the surface of

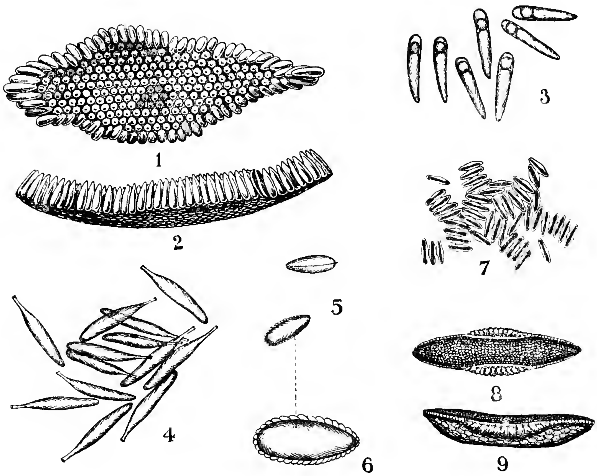


FIG. 29.—Various forms of Mosquito Eggs.—(1) Egg-boat of *Culex*, seen from above; (2) the same, side view (after Sambon); (3) separate *Culex* eggs; (4) eggs of *Panoplites* (after Daniels); (5) eggs of *Stegomyia*; (6) the same more highly magnified (after Theobald); (7) groups of *Anopheles* eggs, as they float on the water (after Sambon); (8) egg of *Anopheles maculipennis*, showing lateral floats, seen from above, × 30 diams.; (9) the same, viewed laterally, (after Nuttall).

the water chosen for the purpose, they spread out the four anterior legs as a support, while the posterior legs are crossed behind them so as to form an acute angle, and it is into this angle that the eggs are dropped side by side, until an elongated, boat-shaped mass is formed, somewhat raised at each extremity. The hind legs which carry them are extended little by little until the boat is finished, when the insect allows it to drop into the water at the mercy of the wind.

In speaking thus of "boat-shaped masses," it must be understood that *Culices* only are referred to, as *Anopheles*, *Mucidus*, *Panoplites*, *Stegomyia*, and some drop their eggs separately, and in these genera the eggs are provided with separate arrangements to secure flotation.

In Culex, the eggs are glued together, as they are laid, into canoe-shaped masses, which, in size and colour look, as they float on the water, not unlike caraway seeds. Each boat consists of from 250 to 300 eggs, which latter are oblong, more pointed at their upper extremity as they lie in the boat, larger and more rounded below, and ending abruptly in a bordered edge, much like that of certain liqueur flasks; the opening of which may be said to be closed by a thin membrane, by the rupture of which the larvæ escapes. The lower or immersed end is furnished with a curious opening, or rather thinning of the egg-shell, and is surrounded with some curious radiated markings. The object of this arrangement is probably to enable the embryo to obtain oxygen from the water in which the little raft floats.

The egg-boats must needs float on the surface of the water, as the embryos perish if they become submerged. Only their neck comes in contact with the water. When just hatched the eggs are entirely white, but they soon become shaded green, and in less than half a day they become grey. Usually they are laid between five and six in the morning, but in England Mr. Theobald finds that the evening is also chosen for the purpose, and the larvæ escape in two or three days, but the interval varies a great deal, according to the temperature, and the particular species. Those of *Mucidus* apparently take a long time, as Major Close, I.M.S., at Moradabad, kept some, laid by a confined female for a month without the larvæ appearing. As, however, the experiment was conducted in a test tube, and it is possible the embryos may have perished for lack of oxygen, this observation must be taken with reservation. As soon as the larvæ of *Culex* have escaped from the eggs, the egg-boats break up, and the empty shells form very pretty microscopic objects, their surface being closely set with minute spines, the form of which varies in different species, and so might possibly be made to serve as a means of identifying the species to which they belong.

C. pipiens ova measure 0·9 mm. in length, *C. nigritulus* 0·6, and according to Howard those of *C. pungens* (= *C. fatigans*, Wiedemann) 0·7 in length and 0·16 in diameter.

Anopheles eggs are quite different in form and are deposited separately. Sometimes, they lie on the surface of the water in stars or groups of other forms, but as they are in no way connected together, I regard this as quite accidental, and of no moment. As regards the form of the egg, the following excellent description, extracted from Dr. G. H. F. Nuttall and A. E. Shipley's paper "On the Structures and Biology of *Anopheles*" (*maculipennis*) in the *Journal of Hygiene*, I., p. 49, may be quoted:—

"When first deposited the eggs are white, but they soon darken. Each ovum measures 0·7 to 1·0 mm. in length and is at its greatest breadth about 0·16 broad. The egg is boat-shaped and one end is slightly deeper and fuller than the other. The surface which, were the egg a boat, would be the upper, is flattened but slightly convex. It is marked by minute reticulations (fig. 2). The under surface of the boat is characterised by much larger and more regular reticulations, which divide the surface into fairly equal hexagonal areas. The rim (*a*) of the boat is thickened and very regularly ribbed. Along the centre of each side, extending over a space of rather more than one-third the total length, this rim is much thickened, the ribbing is more marked and the whole forms a very conspicuous and characteristic feature of the egg. This thickening recalls the rounded float which runs along the edge of a life-boat (fig. 29; 7, 8, 9). It serves the same purpose, being composed of air chambers and is used to keep the boat-shaped egg with its flat surface uppermost. Howard refers to the membrane we are about to describe as the 'clasping membrane,' notes the reticulated surface exhibited by the eggs, as also the presence of 5—7 minute dark circular spots at the ends. His measurement of the egg is given as only 0·57 mm. As in other insects the egg doubtless varies in size.

"The colour of the egg soon after it is laid is greyish black. If the eggs are subject to much attrition a delicate membrane splits off which gives the surface of the intact egg its reticulated appearance. Stripped of this membrane, which desquamates in irregular whitish fragments, the egg appears with a glistening black surface comparable to that of patent leather. One end of the egg is slightly blunter and more rounded than the other, and this contains the head end of the embryo. It is an interesting point that when the egg, as frequently happens, is drawn by capillary action a little way up from the water on to a leaf or some other half-submerged object the head or blunt end always points downwards, and thus should the hatching take place whilst the egg is in this position the larva emerges into the water, and not into the air."

I doubt if these ova can resist more than a very temporary dessication, but it is very difficult to judge of this point by laboratory experiments, as not unfrequently, they refuse to hatch out at all. The ova of some *Stegomyiæ*, however, which resemble them a good deal, being laid separately, and having also similar lateral floats, are certainly much more resistant, and may apparently be uninjured by being left high and dry for a month.

Carroll, Agramonte, and Lazear (*Philadelphia Med. Journ.*, October 27, 1900, p. 291), state that in experimenting on conveyance of yellow fever by Mosquitoes (*Stegomyia, fasciata*, Fabr.), they obtained a supply of this species from Dr. Finlay. Thirty days previously, *vide* Finlay, ova had been deposited by a female just at the edge of the water in a small basin, whose contents had been allowed to slightly evaporate, so that these ova, at the time of their visit, were entirely above contact with the water. Notwithstanding this long interval, they were promptly converted into the larval stage, after a short period, by simply raising the level of the water in the basin.

The separately-laid eggs of *Panoplites* have a very peculiar shape, like a long, narrow pear, one end being prolonged into a sort of neck exactly like that of a Florence flask.

According to Meinert, the ova of *Corethra* are laid in flat, round, jelly-like masses, each containing from 100 to 150 eggs, but Miall describes them as arranged in spiral lines, so as to form a gelatinous sheet. We have no information as to the eggs of the other genera, and as a matter of fact, our knowledge on this point is very scanty, and further observations are much required.

The insects pair towards evening. The males assemble in large numbers, flying hither and thither without travelling far, and the females appear among them in smaller numbers, so that the moment one appears she is clasped by a male, allowing themselves to float in the air, or flying together. The coupling only lasts a few moments, and when it is completed the pair separate, and the fertilised female proceeds to deposit her eggs.

As already remarked, the time taken by the ova to hatch out depends upon the species and on the circumstances of its environment, but, in most, may be said to be about three or four days. Even when newly escaped, they can be easily distinguished by the naked eye, if favourably lighted, as black dots with a transparent, wriggling tail. Being mainly air-breathing animals, though it is possible that the anal papillæ may aid in respiration, by acting as gills, they cannot remain under water for any length of time, and all species pass the greater part of their time at the surface, lying so that the respiratory opening is open to the air. The larvæ of *Culex*, especially those species which possess a long respiratory syphon, pose themselves in a nearly vertical position, as if hung from the surface of the water, as is well shown in the following illustration, which was photographed from living larvæ and pupæ by my friend, Mr. Royle, of Rosa, N.W.P.

The larvæ of *Stegomyia*, whose breathing tubes are very short, lie much more obliquely, their position approaching that of *Anopheles*, but this cannot be looked upon as a generic peculiarity, as those of *C. pulchriventer*, which have an equally short syphon, take up the same position, which is presumably simply necessitated by the shortness of the tube. The species figured by Christie in his useful little book, "Mosquitoes and Malaria," is probably a *Stegomyia* (pl. v., figs. 9, 10).

The larvæ of *Anopheles* on the other hand, lie absolutely horizontally, with the respiratory orifices, which are almost

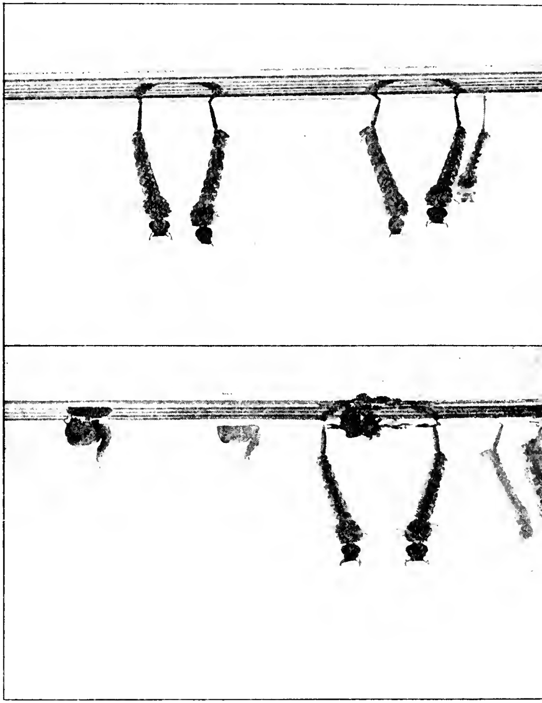
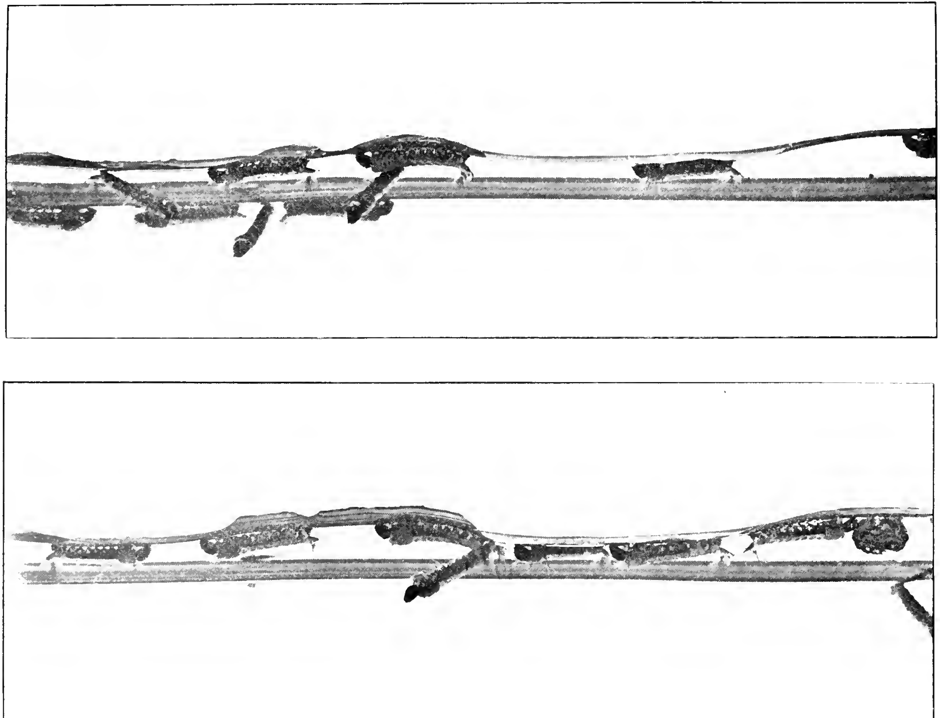


FIG. 30.—Larvæ and pupæ of *C. fatigans*, Wied., photographed from life, about twice natural size.

flush with the rest of the dorsum, just emerged, and the head barely submerged.

Lying in this position, they look just like scraps of straw-blackened by long immersion, and as they often lie motion-

PLATE V.



Living *Anopheles* larvæ. Photographed by Mr. T. H. Royle, of Rosa.

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less for a quarter of an hour or more, would be taken to be such by any one not specially looking for them. As already noted, they exhibit a great preference for the sides of the tank or pool in which they may be, and may also be found along floating sticks, leaves, or other such objects, lying at right angles to, and with their tails touching it, as if moored by the stern. When lying thus at the surface, they have a quaint custom of screwing their heads completely round, so that its ventral surface looks right upwards, and, though otherwise motionless, if closely watched it will be seen that the head is being slowly rotated and swept to and fro, while by the rapid vibrations of the bristles of the "whorl organs," a current of water with its suspended nutritive particles is kept flowing to it.

It is perhaps rather a misnomer to speak thus of the moustache-like bunches of bristles that project from a pair of plates hinged on to the fore corners of the clypeus, as the bristles all work together, and do not bend, one by one in a wave, like the cilia of the *Rotatoria*, from a fancied resemblance to which they have got the name. Although capable of being moved separately, the two brushes when in action are brought together, as if grasping at something, and then open out again, and repeating this movement with great rapidity; according to Nuttall (*loc. cit.*), three times a second.

He describes, too, how they employ the peculiar bristles on their mandibles to comb off, into the mouth, the nutritive particles that have collected on the brushes. The mouth-organs of *Culices* are used in exactly the same way, only instead of sweeping the surface, for floating particles, they depend on such as are suspended in the water beneath. When disturbed the larvæ dart backwards into the depths of their puddle, and hide themselves among the loose particles at the bottom, and then, after a few minutes, float slowly back to the surface when the coast is clear. A good deal has been written about these movements, and those of the pupæ, but as they are obviously purposive, they naturally vary, and hardly merit detailed description.

The nymphs, as may be seen in Fig. 31, float in much the same position as those of *Culex*, but perhaps the breathing horns are held, sloped somewhat more forewards. *Ædes* larvæ are said, by Dr. Lutz, to lie in the water in a sloping position, intermediate between that of *Anopheles* and *Culex*, in other words, much as do those of *Stegomyia*. According to Meinert, *Corethra* larvæ are much less restricted as to the character of the collections of water in which their larvæ are reared being often found in deep still water containing but little vegetation, as well as in very foul pools. Their position in the water is even more absolutely horizontal than that of *Anopheles*, whose position is slightly oblique, and they retain this horizontal posture even during their excursions below the surface. They are very voracious, devouring not only *Daphniæ* and

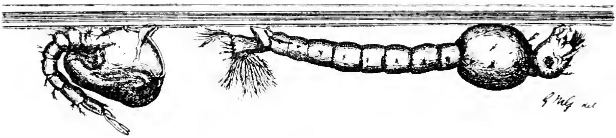


FIG. 31.—Larva and Nymph of *Anopheles*, to show habitual resting position. The head of the larva is shown looking up, as when feeding.

other small crustaceans, but also *Dixa* larvæ and even young fish and molluscous embryos; nor do they even shrink from cannibalism, smaller specimens of their own species being devoured with gusto if they come within the reach of their jaws. It is only the very young larvæ that are so absolutely transparent, as when older they develop a number of patches of pigment, and the contents of the intestinal canal obscure the complete transparency of the body. Still, it is doubtless owing to this transparency that they are the only gnats whose larvæ live, as a rule, among fishes. All their ecdyses are performed with singular rapidity, even the final emergence of the imago taking only a few minutes to accomplish. Their pupæ assume a nearly vertical position in the water, but otherwise do not differ greatly from those of other genera.

Meinert states that the larvæ of *Mochlonyx* affect the waters of fields and woods, and that they are especially often found in such places as ditches, where the water is clear, but without any particular current. The larvæ do not survive the winter, but he considers it probable that the eggs do, as he has found newly-hatched larvæ so early in the year as to make it highly improbable that any of the perfect insects could have emerged from their hybernation, even assuming that the adults do hybernate. In a warm room, in captivity, all the changes from egg to imago were gone through in three weeks. Unlike *Culex* there appears to be only a single generation of larvæ developed in the year. The position taken up by the larvæ is very like that of *Corethra*, but they are more in the habit of remaining under water, They are voraciously carnivorous, and appear to be even more arrant cannibals than the larvæ of that genus. The pupa also behaves much like that of *Corethra*, but it is not quite so rapid in its changes of skin.

The larvæ of the *Culicidæ* swarm in spring and summer in the stagnant water of tanks and other domestic collections of water, where they may be found in abundance in Europe from the time the ice is melted. Usually they keep at the surface of the water or a little below it, in an inverted position, the head being lowest, breathing by means of the tube placed at the extremity of the abdomen. They are extremely lively and easily disturbed by any movement of the water, but soon resume their old position. Their body is elongated and has no legs. At first greenish, they soon become greyish and transparent. The larva undergoes several moults, three taking place in the first two or three weeks. In order to get rid of the old skin it places itself horizontally on the surface of the water with the back upwards. As a rule the change takes place through a rent on the thorax, and extends after to the abdominal segments. Like the larva the nymph is capable of swimming but can take no nourishment. When in repose it is contracted into a lenticular form, its abdomen being bent under the thorax and kept closely applied to it. It lies vertically in the water but in a different sense from the larva, as the humped-up thorax forms the highest part, and it is from the dorsal surface of that part of the body that the respiratory syphons spring, being in the form of two horns or asses' ears. Their upper extremity is cut obliquely, and when the pupa is at rest is always kept above water. The eyes are distinct, and beneath the thorax is found a large mass consisting of the antennæ, mouth parts and legs. The abdomen is elongated, segmented, and terminated by two oval plates. If the nymph desires to go beneath the surface of the water it straightens itself and gives a few strokes of the tail, but is soon carried back to the surface, as soon as this has ceased to act, by its own buoyancy. After passing five or ten days in this state, the insect is ready for its last metamorphosis, but this is a most critical period of its life, as if the nymph case upsets during the process of the imago's freeing itself, the insect perishes by drowning, as it is now entirely unable to survive contact with the element in which, up to now, it has passed its life. The moult that frees the imago from the nymph integuments takes place in the same manner as the preceding ones; a rent appearing in the upper surface of the thorax through which the gnat protrudes first the head and thorax as much as possible above the aperture. The posterior extremity of the body now contracts a little, and extending itself immediately after, is gradually drawn out in a perpendicular plane. Meanwhile, the old skin of the nymph serves as a sort of boat of which its own body serves as the mast, only a very small portion of the hinder extremity touching it. Next, having drawn from their sheaths the four anterior legs and then the hinder ones, it carries them forward. Soon after it bends towards the water and arranges its limbs, and thus assured of safety, it unfolds its wings and flies off. When first it escapes it is whitish with the thorax greenish, but it very quickly after assumes the proper colours of the adult insect.

Both larvæ and pupæ show a remarkable degree of resisting power to physical, and even chemical agencies, especially those of *Culices*, though those of *Anopheles* appear to bear cold better. In Celli's experiments on them, it was found that freezing for a couple of days, killed all the larvæ, while no pupæ survived more than twenty-four hours. Desiccation, on the other hand, was better borne by the nymphs, which in a few days, were transformed into very active Mosquitoes, in spite of being placed in dry river sand, so that the drying up of a pool does not stop the development of such insects as have reached this stage, while the larvæ were all dead in two days if dried at 20° C., and both stages were killed by two minutes' exposure to a temperature of 40°. Experimenting in India, I found that larvæ were usually dead and decomposed before the mud of the pool in which they had lived had dried up by ordinary evaporation. Nearly all species can live only in fresh water, but Bancroft found a species, which has been named *marinus*, by Mr. Theobald, living in sea water, and Ficalbi collected the larvæ of *C. nemorosus* (*salinus*) in a salt marsh.

Celli found that *Anopheles* larvæ died within thirteen hours in sea water, and could not live in mixtures stronger than two parts of fresh to one of sea water, which agrees with the results of Ficalbi's recent observations on the salt marshes of Cervia, where he found that though they abounded in neighbouring sweet water pools, they were never present in the actual salt pools, and were only exceptionally found in even slightly brackish water. Stephens and Christophers found that mangrove swamps never contained *Anopheles* larvæ, so that the idea that these salt-water shallows are a cause of malaria is erroneous, though one can well understand that a saturated atmosphere, reeking with the emanations of vegetable putrefraction, may be extremely unhealthy for other reasons. Moreover, although they speak of them as being found in fresh water marshes, it is evident from what they write that, strictly speaking, they are no more to be found in such situations in Africa than they are in India, as they proceed to explain that they found them, not in the main marsh, but in the pools around it. In running water, unless the current be very slow, they cannot exist, and hence they are never found in rivers, except in extremely sluggish streams, such as the Cam, where Theobald mentions having once found them.

The length of time required to develop from egg to imago varies greatly; about a month in Italy, according to Celli, in the case of *Anopheles*, but usually much more rapidly in India.

In Mr. Aitken's paper, already quoted, he says: "I was anxious to ascertain next the length of the larva life, but found that it varied indefinitely with the conditions. Given warmth and plenty of food a larva will come to maturity in eight days, or perhaps less, but I have had one for more than a fortnight, and then it died before becoming a pupa. The time spent in the pupa state in all my specimens was more than twenty-four, but less than forty-eight hours. So I think we may put down the time which it takes to produce a Mosquito at something between ten days and a fortnight, from the laying of the egg; and water, treated with kerosine oil once a fortnight, should be perfectly safe. It is very difficult to ascertain the normal life of the adult Mosquito, because we cannot keep them in natural conditions. Some of mine lived for ten days, but, as I have said, they would not lay their eggs, and that alone could not but affect the length of life. . . . To my astonishment I found *Anopheles* larvæ swarming in a dirty drain filled with rotting straw, which gave the water the colour of beer. In May, Colonel Weir sent me two or three bottles of water from other places in Bandora, with *Anopheles* larvæ in them. The breaking of the monsoon, of course, upsets the haunts of all Mosquitoes for a time, but on the 2nd of July I went out to Chinchpoogly and explored the quarries at the foot of the hill, where Dr. Christy told me he had found larvæ some time before. I found larvæ in many of the pools and one specimen in a little puddle, not more than four inches deep, which must, I am sure, have been as dry as bone ten days before, for we had a long period of hot, sunny weather, as you will remember, in the middle of June."

This agrees with such scanty observations as I was personally able to make in India, but, owing to the peripatetic nature of my duties, breeding-out observations were rarely practicable.

In England, and also in the somewhat similar temperature of Indian hill stations, *Culicidæ* larvæ develop even more slowly than in Italy.

In Northern Europe all larvæ and pupæ that may not be ripe for their remaining metamorphoses, perish during the winter, but in Italy, according to Celli, the larvæ of *Anopheles* "hybernate" (C.M., p. 78 and 166) and some, at any rate, of the adult insects that appear early in the spring are furnished by larvæ that have passed the winter in that stage.

I am nearly sure that the same is the case in Northern India, though in a tank in my garden at Shahjahanpur, where I had found them present in swarms on my arrival, and which I had always kept supplied with water, so as to keep them under observation, they suddenly disappeared about January 11th, without any apparent reason, as the severest part of the "cold weather" was already past. Unfortunately I was unable to find any other pool, in which to continue observations, as a long spell of drought during the last three months of 1900, had completely dried all such pools as had remained under natural conditions. I have on one or two occasions noticed the larvæ, though abundant a few days before in all stages, disappear from a pool in the same unaccountable manner, and strongly suspect that this must have been due to the outbreak among them of some epidemic disease.

Although they were thus capable of maintaining themselves as larvæ, no imagines were being produced, and for six whole weeks not a single pupa could be found, though carefully sought for; nor, so far as I could judge, did the individual larvæ grow to any extent, as all sizes were present from the first, and the large ones did not appear to become more numerous.

The lowest temperature ever observed in this tank was 56° F. in the early morning, but the margin of temperature inimical to pupiation must be a very narrow one as, after a fall of rain accompanied by cloudy nights, during which the night temperature could not fall to the usual minimum, the higher temperature sufficed to bring about the appearance of a few pupæ.

Now the rain had not perceptibly altered the depth of the tank, which was indeed filled periodically from the well —and so fluctuated more from this cause than it could do from any shower,—so that the occurrence has evidently no connection with the rain *per se*. Brought into the house, these pupæ gave issue to their imagines, but I cannot say if this is also the case with those in the open—at any rate, none appeared in the bungalow.

Celli's observation may, however, be considered to practically settle the question, as it is little likely that the larvæ are unable to survive the mild cold weather of Upper India, if they can do so in the comparatively severe winter of Italy, and hence it may be accepted that in subtropical and the warmer parts of temperate climates, the survival of larvæ is one method whereby the permanence of the species is secured, not only in *Anopheles*, but also in other gnats, as the same thing was undoubtedly the case with both *C. fatigans*, Wied., and *C. impellens*, Walk., although, in their case, the imagines were more or less in evidence through the entire period, and were, I believe, even breeding in a leisurable fashion whenever the weather turned a trifle warmer.

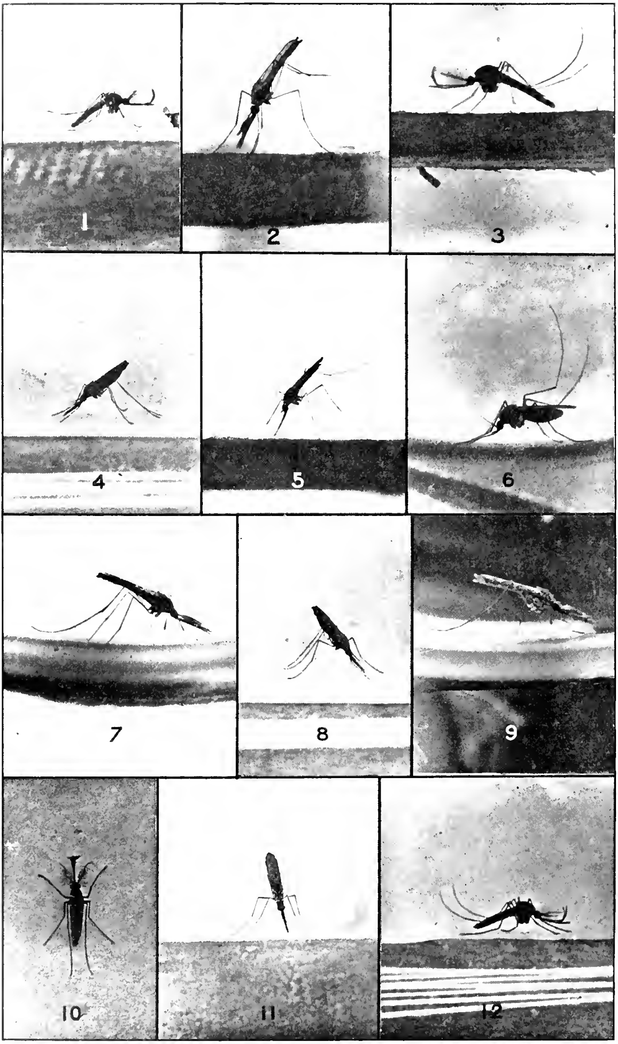
During the short Danish summer, Meinert finds that *Anopheles* can find time for the rearing of but a couple of broods, and it is natural that in a limited period such as this, there should be more or less definite seasons of appearance of larvæ, and that the flying insects should appear in periodical swarms; but in Italy the process goes on more or less irregularly throughout the much longer summer, and the same is the case in Northern India.

In Italy, Celli says that the hybernating larvæ pupate and turn into Mosquitoes in April, and the first generations of new larvæ are found in the first half of May. With us, in Oudh, as we have seen, the new Mosquitoes put in an earlier appearance, though they rarely can find many opportunities to deposit their eggs till the advent of the rains, as even their own winter quarters must usually be dried up during the fierce heat of the months that intervene. Just as the process commences earlier with us, so it continues into the later months of the year, so that active *Anopheles* Mosquitoes are to be met with till quite the end of October, though neither they nor the two persistent species of *Culex*, above noted, exhibit any tendency to bite, so that there is no longer any need for the use of Mosquito nets, whether on the score of comfort or safety, for in India, just as is the case in England, we find that the question as to whether or not Mosquitoes will attack human beings is entirely one of air temperature. Celli says that the adult *Anopheles* will bite as soon as it is out of the pupa case, and after they have digested their meal, bite every two days or so, and ovulate several times. As far as I can judge by the rather desultory experiences of correspondents and myself, I fancy this conveys rather too high an idea of the gastronomic and reproductive capabilities of individual insects: that they generally take some four days to renew their appetite after a full feed, and that the laying of a couple of batches of eggs is about the limit of the reproductive capabilities of most of them; but doubtless they vary in this, and their intolerance of captivity makes such matters difficult of determination. However this may be, there can be no doubt of the enormous capabilities of multiplication possessed by the entire family, and this strongly tends to neutralise any check that can be imposed upon it by natural enemies.

Like the larvæ, the adult insects may be roughly classified as domestic, field, and jungle species; and they generally agree in these respects with the corresponding larvæ, though Celli emphatically states than *An. maculipennis* is domestic, while *An. bifurcatus* is a field insect; whereas Ficalbi regards the habits of their larvæ as the reverse. It is impossible, however, to make distinctions of a rigid character in such matters, and the looser our conceptions of their signification, the better, though they are very useful for general purposes if employed with such reservations. Although some few species are active throughout the day, *e.g.*, *An. bifurcatus*, in Italy, taken as a family, gnats are essentially nocturnal, and especially crepuscular insects. Speaking generally, Mosquitoes start the day's work just after sundown, and are very busy among the plants and animal victims that furnish their food, till it falls dark, by which time, though many continue in evidence throughout the night, most of them have satisfied their needs, so that there is a sort of lull in their activity till dawn, when those that have failed to secure a breakfast reappear, in vicious earnest to secure a supper. Once, however, is the tropical sun above the horizon, and they may be seen taking immediate measures to escape from the power of his rays.

The window-door of my last little Indian work-room was closed by means of Mosquito netting stretched over the frame, so that it was possible to use the microscope with it open, without being tormented with flies; and I was often much diverted by watching the persistent efforts, not only of *Anopheles*, but of all the other domestic species about, to get out to feed in the evening, and to return to shelter in the morning. Shelter, as we have seen, they must have during daylight, and speaking generally, an observer who confined his observations to those hours might report that no such insects existed in the tropics, so sluggish are they during the heat of the day and so cunningly do they hide themselves in dark corners. During the rains, however, the *Stegomyiæ*, which are common at that season, may be seen flying about such places as orchards, and will occasionally even venture upon short flights across patches of sunshine. Within the bungalow, too, they will often bite viciously, even in the middle of the day; but as they are rather field than domestic in their habits, they give less trouble in this way than would otherwise be the case.

When settled on some surface, the position of these insects is very characteristic. As a rule, they support themselves entirely on the four anterior legs, the hind pair not being brought into requisition, but kept held up well above them, so as to serve as extra feelers. During the active hours of their existence they are kept slowly waving about in the air, as if feeling for something; but when quiescent, though the hind legs are still rarely placed to ground, they are kept quite still, so much so that I found little difficulty in photographing the living insects, placed in the glass box described in the first chapter, with even an entire minute's



Photographs of living *Anopheles* and *Culex*.

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exposure. The *Culices* sit humped up, with the abdomen drooping, or at most horizontal, and the proboscis held out in front of them, so that even when they are looking at the surface on which they are standing, it is at least kept off the ground. The palpi are kept arched backwards and upwards, and usually slightly separated from the proboscis, and the antennæ usually sloped well behind its line. In *Anopheles*, on the other hand, there is a strong tendency to keep all the appendages of the head in the same plane, and in both sexes, the four basal joints of the palpi are kept closely held against the proboscis. In the female the whole organ is so held, but the clubbed terminal joints of those of the males are kept spread out at an angle of about 45 degrees. On this account the trunk of this genus of gnat looks almost as thick as the rest of the body. In addition to this, instead of bunching themselves up as the *Culices* do, they keep the whole body and cephalic appendages nearly in one straight line, obliquely, or it may be, almost vertically to the surface on which they are resting, with the abdomen held up, and the proboscis pointing at the surface on which they rest, as if they contemplated boring themselves into it. This attitude is so characteristic that it affords a ready means of recognising the genus, when found settled. In the case of *An. sinensis*, *An. Rossii*, *An. Jamesii*, *An. argyrotarsis*, *An. albipes*, and also, to judge even from Sambon's own figures, in those of *An. superpictus* and *An. maculipennis*, there can be no doubt that the habitual resting attitude is such as has been described; but I do not for a moment suppose that it can be taken as an absolute rule for all species, either of *Anopheles* or *Culex*; and just before I left India I met with a new species of *Anopheles* which entirely deviated from the common rule in this respect, as every one of some dozen living specimens of both sexes was found resting in a position exactly such as is regarded as characteristic of *Culex*. The resemblance is further aided by the fact that in the fresh state the abdomen is conspicuously banded in a manner most exceptional in the genus, so that when I arrived in the rest-house in which I found them, late one night, I was completely taken in by the counterfeit, mistaking them for

C. impellens, to which they present a close resemblance. On this account I have named the species *An. culicifacies sp. n.* On the other hand, I suspect that *C. mimeticus*, Noè simulates *Anopheles*, not only in costume, but in its habitual position when at rest, though I have seen too few living specimens to be sure. It must be remembered that these remarks refer to *habitual* attitudes only, and that there is nothing absolute in the application of any natural history rule of the kind, so that there is nothing noteworthy, as some writers appear to have imagined, in finding an individual *Culex* with its tail cocked in the air, or an *Anopheles* with the abdomen drooping; for being living animals, they may be occasionally found in any possible position, however characteristic certain particular poses may be of their usual ways.

When the season favourable for active existence and breeding is over, the majority, at any rate of species, proceed to find some suitable shelter, in which they may lay up, protected from cold and injury, till the return of spring, or, at the least, the surviving impregnated females do so. In Northern Europe and similar climates this appears to be the sole provision for the maintenance of the species through the winter, and the males rarely or never hybernate; but in the south, as we have seen, this means is supplemented by the hybernating of the larvæ as well; while in really tropical regions there is no interval of inactivity, at any rate from cold.

There can be no doubt, however, that not only cold, but other climatic conditions unfavourable to the free multiplication of a species, such as intense heat with drought, cause Mosquitoes to retire into a similar condition of inactivity, as the truth of the suggestion advanced in the first edition of this book to that effect has been amply verified by my observations during the past year in India. There can, in fact, be no other way of accounting for the absolute disappearance from public ken, for long periods, of certain species, such as the *Stegomyiæ*, which are active only for certain limited seasons. The larvæ are certainly not concerned in the matter, as none of the kind are to be found, and water of a character suitable to their needs is nowhere available, so that it is certain, that though nowhere in evidence, they must undoubtedly exist somewhere in hiding; and though I cannot say I have actually traced them to their lairs, the unlimited accommodation for secreting themselves afforded by the structural imperfections of an Indian house make this in no way astonishing, and the same is the case in the cold season with *Anopheles*, which appear to have vanished from the earth, so well are their hiding places chosen.

During the cold weather, of the twenty or thirty members of the family that form the gnat family of the North-west Provinces, the imagines of but two, with their larvæ, and the latter stage of a couple or so more, are alone to be found; and one of the former, I believe, also disappears into seclusion when the fierce heat of the dry season commences, leaving *C. fatigans* as the only adult Mosquito in evidence. Now, as the insects are in no sense migratory, it is an obvious conclusion that a sufficient number of adults, either impregnated females only, or representatives of both sexes, to maintain the breed, must be lying by somewhere. In countries such as England, where buildings are carefully finished and their ceilings fairly accessible, it is generally possible to obtain living gnats at any period of the year, provided one knows the kind of situations wherein to search for them; but in India, the ample space between the ceiling cloth and the thatched roof, and the innumerable gaping fissures in the rough mud plaster, that is all that covers the carelessly laid bricks leave so many crannies and corners, that it is by no means surprising that one may fail to unearth the insects from their hiding places without pretty well pulling down the house, an operation by no means unattended with risk, as one is apt to disturb other skulkers of a larger and more immediately dangerous character.

This habit is spoken of as hybernation, and in Northern Europe, where the males apparently all die before winter has fairly set in, only impregnated females survive the winter, and it is through their agency alone that the continuity of the species is maintained. In more moderate climates, where water rarely freezes during the winter, this expedient may be assisted by the survival of larvæ also, as we have seen is the case with certainly some species of *Anopheles*, and in that genus also, at least in India, it is not the females alone, but the surviving members of both sexes that seclude themselves in this way, for towards the end of the season of activity, males are to be met with in houses, in far larger numbers than their spouses, and are obviously sinking into the same lethargic state. Mosquitoes, when hybernating, creep into any hiding place that will afford warmth and darkness, and prefer to utilise for the purpose narrow crevices, into which one would hardly expect so delicate a winged insect to creep.

When in this state they are extremely sluggish, and may often be found stationary in the same place for long periods, without having, to all appearance, moved for days together; and provided one can find them, it is naturally not difficult to catch them; but they nevertheless retain sufficient strength and alertness to escape from careless or clumsy attempts to capture them, though, with such exceptions, they neither feed nor perform any of the other active functions of life. All Mosquitoes are greatly affected by cold, and refuse to move or feed on a cold morning, even on their more habitual vegetable food, while the most troublesome species never attack animals, except in warm weather, so that although a couple of species are fairly common in houses throughout the cold weather in Oudh, Mosquito curtains can be safely laid aside.

It is only during the times of the year that they are actively breeding that Mosquitoes attack animals, and the habit is probably indulged in to supply the large amount of nourishment required to supply material for the relatively enormous bulk of eggs laid by them. Many species are, it seems likely, unable to mature their eggs without having first obtained a feed of blood. In Southern India, and doubtless in similar climates elsewhere, it is never cold enough to drive Mosquitoes into hybernation, and in places within the equatorial belt of uniform climatic conditions, the heat is rarely so extreme, or drought so prolonged, as to force them into retirement on the opposite account ; so that in such places, all correspondents tell me that they are present, in greater or less numbers, throughout the year ; though even with them, the degree of prevalence is a good deal influenced by such climatic variations as occur. Thus there exists for many species, what may be called a southern limit of hybernation, to the north of which it is compelled to retire into seclusion during the winter ; whereas, further south, they are able to remain in activity to a greater or less extent throughout the year. In the case of our local species in India of *Anopheles*, this line lies somewhere about the 26th parallel of latitude, for while they were certainly still hybernating in Agra, in the middle of February, I found them numerous and fairly active some hundred miles further south, at Hoshangabad, in the Central Provinces. It should, however, be needless to remark that it is impossible to lay down any rigid limits in a case of this sort, and that it must needs vary from year to year with temporary variations of the character of the seasons.

Our knowledge of the seasonal prevalence of individual species is very limited, and in any case, can only be stated for areas of small extent, but it may be broadly stated that in each locality it may be fairly predicated from an inspection of the annual weather reports, as while some are tolerant of the greatest heat, others are confined to seasons of abundant rainfall. Were we even much better informed than we are, it is therefore obvious that no general account could be afforded within any moderate limits of space, so I confine myself, as an example of what may be observed in some one region, to the following sketch of a year's experience on this point in the North-west Provinces of India, and Oudh. Presuming a visitor to arrive in January, he would find about houses and in gardens, but two species, *C. fatigans*, Wied, and *C. impellens*, Walker, and even these, neither troublesome, nor numerous.

In the garden tanks he would find the larvæ of these species and also those of *Anopheles Rossii*, *Mihi*, and *sinensis*, Wied, but, owing to almost all natural collections of stagnant water of moderate size being already dried up, he will find it difficult to find them away from the neighbourhood of habitations.

These larvæ may almost be said to be in a sort of resting condition, or in other words, they are not growing, and, as a rule, no pupæ will be found, though the occurrence of a day or two of warmer weather, will lead to their appearance, especially in the case of the *Culices.* Towards the middle of February, these two hardy species commence to renew breeding operations in a leisurable way, but as far as I can make out, it is only *C. fatigans* that dares to brave the fierce heat of the dry season, *C. impellens* retiring into obscurity in March, until the advent of the rain makes climatic conditions more tolerable, alike for Mosquitoes and men. At the end of March, *C. fatigans* was absolutely the only species I could find, but it made up for the want of its kindred by its enormous numbers, as the small, constantly replenished tanks in the gardens, which afforded the only possible nurseries for Mosquitoes of any sort, were well-nigh solid with their larvæ and pupæ, and they so swarmed in the bungalows, as to make the evening and night intolerable. In the open, or anywhere away from houses, it is needless to remark that no Mosquitoes of any kind were to be found, and they continued to be the only species present in at all noticeable numbers, until the break of the rains, in the end of June, or beginning of July.

In the middle of April, however, the *Anopheles* larvæ that have tided through the winter, pupate, and give birth to a spring brood of adults, but as the climatic conditions are unfavourable at this time to its breeding operations, on account, I fancy, of the available collections of water being too hot for the taste of the larvæ ; which will swarm in the very same situations a couple of months later, and hence no fresh broods appear, and the imagines that made a short appearance on the scene hide themselves for the rest of the dry season : as none of my correspondents make any mention of having met with them in our part of the country at this time of the year. With the advent of the rains, however, a renewed period of activity commences. *Anopheles* larvæ make their appearance in every available pool, and soon strange Culiciform larvæ, with short breathing tubes will be found in the pools of fairly clean rain water that form in every depression of the ground. Before long *C. fatigans*, though still taking a considerable share in the business of rendering human existence less endurable, is thrown into the shade by numbers of small Mosquitoes "brindled" with intensely contrasted black and white, while the unobtrusive *Anopheles*, though really present in large numbers are less importunate in their attentions, and will not so readily be found by the unpractised searcher. On this account, and because they are more purely nocturnal than the *Culices*, those who do not know where and when to look for them may be led to report them as scarce or absent, though in reality they may be present in large numbers. I suspect too that the elevation of an upper storey affords a more secure haven from their attacks than is the case with *Culex*.

Mr. Aitken, in the paper already quoted, remarks :—

"As regards the mature *Anopheles*, the most remarkable fact in my notes is that I have not seen one during these last twelve months, excepting those that I reared. This fact will give the best idea of what an insidious enemy we have to deal with. I lived most of the year at the Bombay Club, within a stone's throw of the Frere Fountain, in which *Anopheles* was being produced by the thousand, but I never saw one, though I was often tormented by *Culex*, the larvæ of which were comparatively scarce. *Anopheles* is a small, slim Mosquito, of a pale, ashy-grey colour, difficult to see at any time, and it appears to fly only by night, so it is rarely seen. Add to this that its bite appears to be almost painless, and you will see that one may have malaria injected into him night after night while he is sleeping without curtains, under the belief that there are no Mosquitoes. I say that its bite is almost painless on the authority of my own experiments only. I kept mine in a bottle with thin muslin tied over the mouth, and if I laid my arm on the muslin the females attacked me at once and did not leave off till they were bloated with blood. I sometimes felt a slight prick at the moment when they punctured the skin, but there was little or no irritation afterwards and no swelling. Of course, others might have been affected differently. The males never attempted to suck my blood, but they fed freely, as did the females also, on a slice of apple, fig, mango, or any juicy fruit. In default of fruit I gave them jam, or even sugar and water. After a meal of blood they seemed to feel heavy and indisposed for active exercise, but were quite ready again in twenty-four hours. It has been stated that *Anopheles* is mute. This is certainly a mistake. It has a very shrill pipe."

The brindled Mosquitoes above alluded to are *Stegomyiæ*, but, in addition to these, *Tæniorhynchus ager*, *Mihi*, *Mucidus scataphagoides*, *Mihi*, and a number of *Culices*, such as *C. concolor*, R. Desv., which are entirely absent to all appearance at other times of the year, may be found in greater or less numbers. In October, I took at Shahjahanpur, a solitary specimen of *C. mimeticus*, Noe, but I suspect that this is rarely found during the rains in the plains, as it was not included in any of the collections sent me for identification from this part of India. I also took at this period, the single specimen from which *Corethra Asiatica*, *sp. n.* is described, but this species is so small and inconspicuous that it is easily overlooked, and it is probable that the example I captured was a late specimen of a species that may be common enough during the rainy season. With the drying up of the rains, these species, peculiar to that season of the year, cease to be seen, and retire into a seclusion that cannot fall far short of seven or eight months; but the *Anopheletes* linger longer, and may be found, though in rapidly diminishing numbers, till late in November. Towards the end of the period *An. sinensis*, previously the less common, is far more often met with than *An. Rossii*, but the very last specimen I was able to find during the year was one of the latter species (on November 22nd). In a note dated two days previously, I find that a male *sinensis* was so sluggish in the early morning (temperature 56° F.) that he refused to fly, though he revived somewhat during the day, when taken into the sunny verandah to pose for his photograph. After this, no others than the two species mentioned as still present in January could be found, and it is again not until April that any were observed by my friend, Mr. Royle, who then found them again in evidence in Shahjahanpur.

Such is roughly the seasonal prevalence of the family in the Province to which my own observations have been almost confined, but those who are not familiar with the wide range of climatic conditions found within the peninsula must not be misled into supposing that the account can be accepted for the entire country, or that it is even typical of any large proportion of its area. In illustration of this, I quote a further extract from Mr. Aitken's paper and a few of the replies published in the *Indian Medical Gazette*, in response to a circular of queries issued by Major Buchanan, I.M.S., the editor of that journal. Mr. Aitken says: "In the first place, you will note that I have found *Anopheles* larvæ in every month of the year, except February, when I did not look for them. But I had plenty in captivity during that month, which I had brought home in January. So it appears that, in a place with a moist climate, in which there is always some water to be found, Mosquitoes can survive without hybernation and may be found at all seasons. But as with other insects generally in this Presidency, the time when they are most abundant is the close of the rains."

Captain Giffard, I.M.S., notes that on the Coromandel coast the malaria-bearing Mosquitoes were extraordinarily prevalent, even at the end of the cold season, and existed in thousands in every pool, well, and casuarina pool examined.

Captain Cornwall, I.M.S., states that in Madras, Mosquitoes are never entirely absent, but they are most common, when a sufficiency of water is lying about, *i.e.*, in January, February and March, after the rains. They decrease in the hot weather and increase again in the showery months of July, August and September. In the last three months of the year, when the heavy rains have swamped the breeding places, the Mosquitoes, both adult and larval, are most difficult to find.

Captain C. J. Fearnside, I.M.S., writes that in Rajahmundri, Mosquitoes seem to exist all the year round, and that he finds that *Anopheles* breeds anywhere, in a beaker of water as well as in a puddle. He has also seen *Anopheles* feed greedily in the daytime. With regard to the evolution of the malarial parasite, Captain Fearnside notes that in some species of *Anopheles* crescents and spring tertian parasites will not develop at all, the crescents may be "old and impotent" (Grassi), but this will not explain the non-development of the spring tertians. He also noted that he had frequently found crescents in cases known to have suffered from only mild attacks of fever.

Major J. Smyth, I.M.S., writes from Bangalore that Mosquitoes are present throughout the year, but in diminished numbers in January and December. Last year *Anopheles* were present in certain localities in large numbers, especially in July. The following note is of special interest: last year at Bangalore some new plots of land were opened out for the extension of the town, and one of the new extensions became so malarious that it had to be abandoned, all the children suffered from ague, and most of them developed enlarged spleens. In this part of the extensions Major Smyth found *Anopheles* larvæ very prevalent in some low-lying pools; in two other extensions no malaria prevailed and no *Anopheles* larvæ could be found.

This observation at Bangalore is very interesting in connection with the much discussed question of malarial outbreaks among men employed in engineering and building operations.

From Berhampur, Bengal, Major J. H. T. Walsh, I.M.S., writes that *Anopheles* is present in small numbers all the year, but only a few in the dry hot months. They appear in large numbers during breaks in the rains, and after the heavy floods of last September none were seen for several days. Though Berhampur is a very "malarious" district, very few cases of true "ague" were seen in the jail and asylum. *Anopheles* larvæ seem to breed everywhere he says, in tanks, or even in a bathroom.

Major C. R. M. Green, I.M.S., F.R.C.S., writes from

Mozufferpore that Mosquitoes are present all the year, but most common in September, October and November. The adult *Anopheles* is most easily found in October and November.

Captain Maddox writes from Chapra that August, September and October are the worst months for Mosquitoes. He has found *Anopheles* larvæ in small pools and ditches near habitations.

Writing from Benguela, in Portuguese West Africa, Dr. A. Yale Massey says that the hot, wet season lasts from October to April, and that Mosquitoes appear in November. There is comparatively little fever before December, and cases occur as late as June, but January and February are the worst months.

Speaking generally then, it may be safely asserted that, for any given locality, the seasonal prevalence of Mosquitoes may be accurately predicated from an inspection of its tables of rainfall and temperature; and that, provided *Anopheletes* be included in its fauna, malaria will make its appearance, in all warm climates, within a few weeks of the breaking of the rains.

It only remains to add a few words on the natural enemies of Mosquitoes in their various stages. Unfortunately, as Celli remarks, these are not numerous, and are rarely sufficiently numerous to perceptibly diminish the numbers of so prolific a family of insects. In the adult stage, birds, reptiles, frogs and certain insects devour them whenever they have the chance, and are not tempted by the superior attractions of larger game. The bright little gecko lizard, which is so commonly found in our Indian bungalows, should be always treated as an honoured guest for his services in this direction, especially as he does not strike work and go to sleep just when he is most wanted, as most birds do. Each of these quaint, half-tame little beasts may be looked upon as at least equal, in Mosquito-destroying efficiency to a fly-paper of the largest size, and their company should be encouraged accordingly. In the larval stage there can be no doubt of the efficiency of certain species of fish, and the apparent contradictions that appear in the communications one reads from various parts are simply due to the fact that the tastes of different species of fish as to their food differ like those of other orders of animals. That fish and Mosquitoes are constantly found in company in the Madras rice swamps simply shows that the species found there do not happen to be larvivorous, and in no way discredits the accuracy of other observers, who find that gnat larvæ are unable to exist in water that contains fish of probably entirely different sorts. Personally I have never found fish in the same pool with larvæ

FIG. 32.—Caudal extremity of *Anopheles Rosii* infested by a parasitic stalked infusorian.

though, like Mr. Aitken, I find that they and tadpoles, and I may add frogs, seem to be able to live together as excellent friends. Mr. Aitken says: "From my experience I should say that, of all larvicides, the most effectual, in the case of *Anopheles*, is little fishes. I have never found larvæ and fishes in the same pool. Once I put a large number of larvæ into two glass vessels and introduced a few gold fish into each. Next morning there was not one larva in either. They have many insect enemies, too, especially the larvæ of dragonflies, but one fish will do more than a hundred of these. Tadpoles do not eat them."

On the other hand, there is a general concensus of evidence that the larvæ of dragonflies are most efficient in this respect, and I believe that their universal presence in all collections of water of any size in upper India is the explanation of the fact that we so rarely find gnat larvæ in such situations. The only parasite I have ever met with infesting the larvæ is the small stalked infusorian represented in the accompanying illustration. I have repeatedly found every larva in a pool simply covered by these parasites, which lie crowded together in enormous numbers, attaching themselves especially to the softer parts of the integments, such as the angles between the anal tubercles, and the soft membranes between the segments.

Larvæ affected in this way have a peculiar, slimy appearance, and seldom appear healthy, though it is difficult to see how these ecto-parasites can be harmful, unless it may be that being, at the very least, greedy mess-mates, they may appropriate to themselves an undue share of the food that would otherwise fall to the share of their hosts. Nevertheless, I strongly suspect that they may be the cause of the inexplicable disappearance of larvæ, already alluded to, from situations where they were just before present in abundance.

Since the above went to press, I have received from Dr. J. Cropper, of Chepstow, a slide containing some immature *Acari* which he found upon *An. maculipennis*, in Palestine.

They are of cordate outline, nearly as wide as they are long, and are provided with a formidable suctorial mouth. From their comparatively large size, they must be formidable parasites to so small an insect, but only three specimens were observed to be infested in this way. They much resemble the hexapod larvæ of certain bird-ticks.

CHAPTER VIII.

On the Conditions Influencing the Prevalence of Mosquitoes, and on the Prophylaxis of Malaria.

In the previous issue of this handbook, but little space was devoted to this subject; but though no more than a year has elapsed, so much has been observed and written on the subject, that it is impossible to give any adequate idea of the present state of our knowledge in a few paragraphs, incidental to the life history of the *Culicidæ*, so that it has become necessary to devote a special chapter to the subject. To-day it may be fairly asserted that the question of the connection between malaria and Mosquitoes has passed beyond the tentative stage, and is indeed no longer a "question," but an ascertained fact.

Not only has the casual connection between the Mosquito-carried parasite and malaria been proved beyond question of reasonable cavil, but experiments on a large scale in the practical application of our present knowledge to the prevention of malarial disease have shown that, given sufficient intelligent co-operation of the affected population, and sufficient earnestness on the part of the governing authorities, it is quite possible to so avail ourselves of this newly gained knowledge as to greatly diminish if not to actually "stamp out" the disease. Without this co-operation, however, we are helpless, for science can only help those who will consent to help themselves. The primary discovery of Laveran has gradually been so followed up by Marchiafava, Golgi, Plehn, Celli, Grassi, and many other distinguished observers in Europe, as to place Laveran's "epoch making" discovery on the soundest basis; establishing the fact that we have to deal with not one only, but at least three distinct species of blood parasite and elaborating and systematising our knowledge of their life history within the blood-vessels of the human subject.

Following on these we have the undoubtedly pioneering observations of Major Ross, I.M.S., on the life history of the stage of the parasite which is passed within the mosquito, which are all the more remarkable when the conditions under which he worked are understood. Conditions under which those accustomed only to the luxurious ease of a European laboratory with dozens of assistants well-nigh as able as themselves to lighten the work, would probably find so untenable that it may be doubted if they would succeed in observing at all. But even under the most favourable conditions, initial observations of the sort must needs be always more or less incomplete and that some inaccuracies should be discoverable in Ross's work is merely equivalent to stating that the work was of an initial and pioneering character. Ross's observations have been now confirmed and elaborated by the admirable work of Grassi, but there still remain some points to be elucidated before our knowledge of the life history of the parasite within the mosquito can be considered as complete. Finally, it has been clearly demonstrated in Italy that man can be inoculated with malaria by the bite of infected Mosquitoes of the Genus *Anopheles* and quite recently Major Andrew Buchanan, I.M.S., has recorded in the April issue of the *Indian Medical Gazette*, a number of carefully conducted experiments which establish the same fact for India.

The Italian observers, having the advantage of working in a country, highly malarious, and yet provided with fully equipped laboratories, and all the resources of an advanced civilisation have been able to conduct their experiments with an exactness of precaution quite unattainable in the semi-civilised haunts of tropical malaria, and to the unprejudiced critic, leave no really fair ground for objection; but they still leave it open for the superficial objector to suggest that, being inhabitants of a notoriously malarious country, the subjects of experiment may have been infected in some other way than through the agency of the experimental Mosquito bite. The standpoint of these last objectors is, however, entirely cut away by the truly crucial experiments conducted in the London School of Tropical Medicine under the direction of Dr. Manson which conclusively demonstrate that malaria *can* be transmitted to man through the agency of Mosquitoes. A number of *Anopheles* were allowed to bite a patient suffering from tertian ague in Italy. They were then transported to England and made to bite two healthy young English students. Both these gentlemen developed tertian malarial fever, and the characteristic parasites of the disease were found in their blood.

It is difficult to find in this experiment any possible source of fallacy. It is absolutely conclusive of the fact that this is at the very least one of the methods of the transmission and propagation of the disease; and a very little consideration will show any one conversant with the data of parasitism that it is also necessarily the only one, saving only by the intravenous injection of the blood of a patient suffering from malaria into the vessels of a healthy subject; a method hardly likely to occur in nature.

The reason for our assurance of this is that the malarial parasite requires two successive hosts—a human being and a Mosquito—to attain sexual maturity and propagation. In the blood of the fever patient it multiplies non-sexually; in the tissues of the Mosquito it does so sexually. Now there are a large number of parasites which have an exactly parallel history, the most familiar being that of the tape-worm, which lives and multiplies asexually in *herbivora* and other *eaten* animals, and passes its sexually mature life in the carnivora, and other *animal-eating* animals. Just as it is possible to introduce asexually multiplying malarial protozoa mechanically into the veins of a healthy man, so would it, doubtless, be practicable, in these days of abdominal surgery, to lay open the intestine and introduce into it a living tape-worm, which would, doubtless, continue to thrive in its new host. But in the ordinary plan of nature, the eggs discharged from the bowel of the *eating*-animal are discharged in situations when they are likely to be swallowed by the eaten animal, and in the latter produce the asexually multiplying bladder worm. This, when swallowed with its eaten host, developes, in the flesh-eating animal, once more into the sexually multiplying tape-worm.

Now, although we are acquainted with a large number of parasitic life histories of this character, we know of no instance in which a parasite with such a history is capable of maintaining the continuity of the species in any other manner, and it will be indeed astonishing if the malarial parasite should prove an exception to what has been hitherto found to be an unvarying law of parasitism; though of course, however intrinsically improbable, it is within the range of biological possibility, that besides finding its way to its intermediate host along with the venom of the Mosquito, the parasite may also be capable of assuming the form of a resting spore, or some kindred reproductive mechanism, and being in this way conveyed to water, food, &c., through the agency of the living or dead Mosquito. There is not, however, a single recorded fact in the natural history of the disease that suggests the probability of such an occurrence, and practically speaking, everyone possessing any special knowledge of helminthology will be convinced that either the idea that the Mosquito is the alternative host of the malarial parasite is a huge mistake; or it is, under natural circumstances, the one and only method of infection. There is in reality no tenable middle position.

Most of the apparent exceptions depend on the fact that like most other two-host life-history parasites, the host carrying the asexual phase of the malarial parasite may do so for years without any perceptible inconvenience. A bladder worm may have to lie imbedded in the tissues of an ox for years before the animal is turned into beef and devoured by a man.

Then its opportunity has come and it developes into a tape-worm each sexually mature, *proglottis* of which is a complete, hermaphrodite, sexually mature animal.

So with the malarial parasite. An infected person may have no visible symptoms, but lurking in his tissues are the parasites ready to start again on their course of asexual multiplication should any accident bring the resisting power of the host sufficiently low.

Hence, persons who have had no recent opportunity of being bitten by Mosquitoes often do develop a typical ague, but the fact remains that they must have been bitten at some time, and as a matter of fact the interval is a concern of but little moment to the parasite. The patient in fact, though apparently well, has latent malaria; in other words, he harbours but a harmless number of quiescent parasites, and the exception is only apparent. The fact of the possibility of the transmission of malaria in this way having thus been now conclusively demonstrated, we may take it as certain that every malarial patient has at some time been bitten by an infected Mosquito. Further, it appears probable that only Mosquitoes of the genus *Anopheles* are capable of acting as the host of the sexual stage of the parasite, but this is not certain.

Now the malarial parasite is responsible for by far the greatest proportion of all sickness and death in the tropics. Cholera and plague are the insignificant enemies that perhaps kill a few thousands a year—in an impressive way it is true; but the quiet, insidious malaria sweeps off its millions, and so habituated have we, native and European alike, become to the danger, that we have come to look upon the inconvenience of one or more "touches of fever" during the year, as a necessary evil, inseparable from the conditions of tropical residence, and no more to be escaped than the occasional "cold" of more temperate climates. Unfortunately there can, I fear, be no doubt that this fatalistic frame of mind will, for a long time to come, constitute one of the greatest obstacles to sanitary improvement; for such preconceptions are hard to eradicate, and hence it comes that, while large sums are freely expended in fighting in the dark against the unfamiliar terror of plague, in the case of malaria, where we have already a large basis of solid facts to work upon, our total expenditure on the prevention of malaria appears to be comprised in the vote of the absurd sum of Rs. 30 *per mensem* to provide the salary of a man to destroy Mosquito-larvæ with kerosine, by the City fathers of Calcutta. I doubt if India will ever be a pleasant residence for the white man for the greater part of the year, but nevertheless it would not compare very unfavourably with the temperate zone from a health point of view, could we but do away with malaria. While proposing, in the main, to treat the interdependence of malaria and Mosquitoes as an established fact, it may be well to devote a few words to certain objections that have lately been, in various forms, advanced. The first is that malaria may exist in places or at seasons when Mosquitoes are rare or absent. Now in the first place, putting aside certain little visited islands, gnats or Mosquitoes are to be found practically everywhere, from Greenland to the Equator, and it may be taken as certain that abundance of these insects or their larvæ would be found by any one accustomed to the search in every one of the cited cases of their absence. Moreover, it will be generally found that such objections are raised by persons who, however intelligent and highly educated they may be, have had no practice in observations of the kind required for the record of facts bearing on natural history, and they are apt to forget that, in this, as in any other special business, long training, much patience, and a certain aptitude, are required for the work. A writer, for example, in a well-known Indian lay journal, *a propos* this question, gravely propounded the astounding statement that Mosquitoes were extinct in India in the rains, and specially troublesome in the cold weather, whereas, without for a moment questioning the good faith of the writer, it is needless to say that exactly the reverse is the case. In all probability he had never made a single definite note on the subject, or troubled himself as to whether few or many Mosquitoes were about, since the time when they made themselves painfully obvious to the newly landed journalist during the time he was acquiring that indifference to their bites which all of us sooner or later develop; and under such circumstances memory is naturally treacherous.

Another argument that has been used is that, whereas the presence of malaria is dependent on that of man, and should therefore be worst where population is thickest, the reverse is the case, as towns enjoy a practical immunity, while some of the most deadly spots in the world have but a scanty population. The reason why the conditions of urban life are unfavourable to the spread of malaria will be dealt with further on, and it is sufficient to point out that the reason why such tracts of country as the notorious Indian Terai are so deserted is that they are too malarious for human occupation. In other words, the local conditions are so favourable to the multiplication of the species of mosquito concerned in the transmission of the disease that the presence of a very small number of infected persons suffices to infect an enormous number of Mosquitoes, and to render well nigh certain the infection of any visitor who exposes himself to the same conditions. Moreover, every place of the sort that I have heard of has always been a tract of close jungle or swamp, in which it is impossible for the traveller to stray from certain beaten tracks, or to make his camp elsewhere than at certain definite halting places, where, however small may be its number, there is always a permanent population, or at the least, passers through are sufficiently numerous to maintain the infection. That in such deserted tracts these foci of intense malaria are purely local I do not entertain a doubt, and that a healthy man who landed from a balloon a mile or two away from them would, though equally pestered by Mosquitoes, take no other harm; but in such country man can push his way but slowly, and there is always time for those who attempt to open it up to carry the infection with them.

Moreover, in comparing the relative salubrity of neighbouring places, it must be remembered that a certain temperature is essential to the development of the parasite in the body of the Mosquito, and that on this account a difference of a few thousand feet above the level of the sea is quite sufficient to account for a place being quite healthy, though but a few miles of horizontal distance from foci of intense virulence. It is this factor that is overlooked by Mr. Guy Marshall, in his paper on "Mosquitoes and Malaria," in the *Entomologist*, August, 1900, p. 218, who points out that Salisbury, in Mashonaland, though comparatively thickly populated, is much less malarious than the sparsely populated Umfuli district. Being a skilled entomologist, Mr. Marshall found several species of *Anopheles* in both localities, and asks why the more populated district should not be the more malarious. He forgets that Salisbury lies nearly 5,000 feet above the sea, more than 2,000 feet above the malarious regions, and that, though elevation *per se* is no absolute bar to malaria, the temperature of places so elevated, in that latitude south, is always too low for the development of really serious malaria. Curiously enough, we find that almost simultaneously another writer from Mashonaland, Dr. Ch. Todd, demonstrating (*Journ. Trop. Med.* 1900, p. 92.) that there, as elsewhere, the curve of malaria prevalence follows that of rainfall and therefore of Mosquitoes; the most rainy months being January and February, and the most feverish, March and April.

Before proceeding to the consideration of the prophylaxis of malaria, it will be necessary to examine in detail how far the prevalence of Mosquitoes and therefore of that disease are influenced by climate, cultivation, and the other incidents of everyday human environment. Working as I have in India, it is natural that most of the examples cited should be based on observations made in that country; but communications, personal and published, from observers in other tropical regions, most of which cannot, however, be quoted in any moderate space, convince me that our experience in that country may be taken as fairly typical of the conditions present in other hot climates.

It will be seen too that, with modifications arising from the differences of oriental surroundings, I come to practically the same conclusions as Professor Celli, in his admirable work on "Malaria in Italy," and if I quote less than might be expected from that work, it is partly because most of the notes on which the present chapter is based were written before I had an opportunity of reading it, but mainly because I think that everyone interested in the subject should make a point of reading his book *in extenso*.

In certain cases, however, it is hardly practicable to separate the consideration of the conditions favouring malaria from the practical outcome of the facts noted, and, where thus more convenient, points of prophylaxis will be dealt with in their own connection.

The necessarily frequent allusions to climatic conditions in India will be more easily understood by occasional reference to the table on pp. 162—163, the materials of which were kindly supplied me by Mr. J. Eliot, the Meterological Reporter to the Indian Government.

The range of climate within the peninsula is very wide, almost every variety of tropical and subtropical condition being represented, from the intense drought of the western Punjab and Rajput desert, with their wide range of annual temperature, to the uniform moist heat of Cochin and the Burman littoral; and it is obviously impossible to give any complete account within the limits of a page or so of tabulation. The references to the relative salubrity or otherwise of the various places must, moreover, not be taken to apply specially to the town mentioned in the table, but rather to the region of which its climate is representative; and in speaking of the local malaria as "mild," "virulent," and so forth, I do not refer to the species of parasite (for little else than the æstivo-autumnal fever is to be met with in India), but to the malignancy or otherwise of the type of the disease, which varies greatly in different places, and indeed, from year to year, in the same place.

The places included in the list, being selected as fair average examples of the climates or the regions in which they are situate, by no means illustrate the extreme range of variation within the limits of Indian jurisdiction; and hence do not include such situations as Cherra Punji (said to be the wettest place in the world) where the rain gauge has literally to be graduated to feet; or Sibi, where, as the tale has it, the sun has such power that the European residents must needs assemble in the club, to sit beneath the billiard table, still wearing their pith hats.

Influence of Climate.—There can be no doubt that climate is the most important of all the factors that together contribute to render a given place malarious or otherwise. The genus *Anopheles* has a world-wide distribution, extending much further north than malaria, which is unknown in really cold countries, while, given the presence of the malarial blood parasite, no hot climate is free from the disease. If this be absent, there can of course be no malaria, as the disease is no necessary concomitant of a tropical climate, as is shown by the case of the Island of Mauritius, which, previously healthy, suddenly became intensely malarious. In this case there can be little doubt that Mosquitoes of the suitable species were already present, for the endemic developed with a rapidity quite inconsistent with the idea of the establishment of the necessary species from a few chance emigrants. All that was required was the importation of the infected man; and of this, before the introduction of steam navigation, there was but a precarious chance.

It has usually been suggested that the disease was in this instance imported from India, but the type of the disease seen there is very different. Never in India have I met with cases exhibiting the absolutely classical malarial paroxysm such as I have witnessed in soldiers sent to Natal for change of air from Mauritius.

In other cases the immunity of places where every condition of climate is favourable is due to the absence of Mosquitoes.

In a letter to the *Lancet*, dated January 18th, 1901, by Mr. H. D. O'Neill, an interesting observation by Robert Louis Stevenson is referred to on the subject of Mosquitoes and their association with filaria and malaria: "In Atuona (Marquesas Islands), a village planted in a shore-side marsh, the houses standing everywhere intermingled with the pools of a taro-garden, we find every condition of tropical danger and discomfort, and yet there are not even Mosquitoes, nor even the hateful day-fly of Wuka-Niva, and fever and its concomitant, the island fe'efe'e, are unknown."

It is a long-established fact that the northern limit of malaria corresponds roughly with the summer maximum isotherm of 76° F., or, according to Hirsch, to a mean summer temperature of 15°—16° C. (60° F.), which is much the same thing. Recent Italian researches show that the development of the hæmosporidia within the Mosquito

Table Showing the Monthly Rainfall and

No.	Station		January Rainfall	January Mean temperature	February Rainfall	February Mean temperature	March Rainfall	March Mean temperature	April Rainfall	April Mean temperature	May Rainfall	May Mean temperature	June Rainfall	June Mean temperature	July Rainfall	July Mean temperature
1	Simla	Sub-Tropical India.	2·35	41·5°	2·68	41·5°	2·24	50·7°	1·90	59·7°	3·64	64·5°	6·79	68·0°	17·55	65·0°
2	Peshawar (N.)		1·77	51·7	0·98	53·6	1·70	64·2	1·84	73·7	0·75	83·6	0·35	91·0	1·79	90·9
	Lahore (Mid.)		1·06	54·4	1·10	57·1	0·73	69·2	0·46	80·7	1·03	87·4	1·84	92·7	6·67	89·5
	Multan (S.) ..		0·48	56·3	0·38	59·5	0·38	72·1	0·07	82·7	0·42	90·3	0·59	94·5	2·94	93·1
3	Meerut ..		1·27	57·4	0·79	61·0	0·77	72·4	0·24	83·2	0·69	88·5	2·44	91·1	9·54	86·3
	Agra		0·53	61·0	0·21	65·0	0·31	77·2	0·14	88·2	0·60	93·7	2·54	94·8	11·50	86·6
	Allahabad ..		0·85	60·8	0·28	65·3	0·32	77·8	0·11	88·1	0·39	22·4	5·69	92·6	12·33	85·4
	Benares ..		0·79	61·2	0·37	65·9	0·28	77·8	0.08	87·9	0·72	91·6	5·13	91·6	10·74	85·5
	Jhansi		0·59	63·3	0 33	67·3	0·35	79·3	0·13	89·9	0·49	94·9	4·89	93·5	12·60	84·5
4	Patna		0·65	61·3	0·53	65·3	0·38	77·4	0·26	87·0	1·97	88·6	7·34	88·4	11·75	85.1
	Hazaribagh ..		0·56	61·7	0·82	65·8	0·75	76·3	0·41	85·2	2·26	86·3	7·63	84·2	14·16	79·0
5	Calcutta ..		0·60	66·2	1·38	70·7	1·57	80·0	1·74	85·5	7·62	85·2	10·74	85·0	12·46	83·2
	Dhubri ..		0·40	63·5	0·53	66·0	1·93	75·6	4·83	79·4	13·97	79·4	24·53	81·0	16·17	83·1
	Sibsagar ..		1·47	59·9	1·96	62·9	5·07	69·7	9·37	74·6	12·63	78·9	13·69	83·2	17·10	84·5
6	Jaipur		0·69	61·1	0·19	63·9	0·39	75·4	0·09	84·9	0·45	90·9	2·49	91·4	9·37	84·4
7	Kurrachi ..		0·72	66·8	0·31	69·4	0·23	76·8	0·33	82·2	0·00	86·3	0·52	88·5	3·47	86·1
8	Deesa		0·17	67·1	0·10	70·2	0·05	79·9	0·01	86·9	0·25	91·8	2·16	91·1	10·99	84·4
9	Khandwa ..	Tropical India.	0·31	67·6	0·06	71·7	0·13	81·3	0·17	89·3	0·45	93·1	6·05	87·7	8·82	81·0
	Jubulpur ..		0·76	62·8	0·47	66·8	0·51	77·2	0·18	86·2	0·71	91·6	9·10	87·4	20·80	80·1
	Nagpur ..		0·55	69.2	0·27	74·2	0·61	83·1	0·34	90·8	0·80	94·9	8·74	87·9	14·73	80·9
10	Bombay ..		0·13	75·1	0·01	75·5	0·03	79·6	0·01	82·7	0·94	85·2	19·37	83·3	27·17	80·7
11	Hyderabad ..		0·09	71·0	0·04	76·8	0·75	83·6	0·67	88·7	1·15	90·4	4·85	83·7	6·90	78·6
	Poona		0·06	70·0	0·04	74·2	0·05	80·7	0·54	85·5	1·65	85·3	4·73	80·6	6·87	76·3
	Belgaum ..		0·06	70·3	0·02	74·0	0·35	78·9	1·72	81·8	2·62	80·5	6·59	74·3	15·37	71·2
	Bellary ..		0·13	76·0	0·04	79·5	0·22	86·1	0·58	90·4	1·70	89·8	1·85	85·1	1·93	82·6
	Bangalore ..		0·19	67·9	0·11	72·0	0·54	77·3	1·15	81·2	4·02	80·1	3·45	75·6	4·59	73·7
	Trichinopoly ..		0·26	77·0	0·90	80·0	0·55	85·1	1·53	89·2	3·04	89·7	1·62	88·3	1·50	87·1
12	Cochin (West Coast)		0·59	80·0	0·62	81·2	2·44	83·7	4·37	84·7	13·30	83·2	28·41	79·5	21·51	78·6
	Madras (East Coast)		0·89	76·0	0·28	77·2	0·39	80·6	0·62	85·1	2·12	89·3	2·11	89·3	3·87	87·0
13	Rangoon ..		0·17	76·3	0·34	78·9	0·28	83·6	1·83	87·0	9·42	84·9	17·51	81·3	21·68	80·3
14	Mandalay ..		0·08	69·7	0·07	74·8	0·21	82·4	1·37	89·4	5·56	89·0	6·21	86·5	3·17	86·1

MEAN TEMPERATURE OF THIRTY-ONE INDIAN STATIONS.

No.	August		September		October		November		December		Remarks
	Rainfall	Mean temperature	Rainfall	Mean temperature	Rainfall	Mean temperature	Rainfall	Mean temperature	Rainfall	Mean temperature	
1	17·98	63·5°	6·56	62·4°	1·22	56·8°	0·54	49·7°	0·74	45·8°	Hill station, with practically temperate climate. Not malarious.
2	2·70 5·83 1·58	88·4 87·4 91·1	0·64 2·49 0·42	82·8 84·9 88·5	0·11 0·26 0·00	72·9 76·6 79·9	0·57 0·10 0·10	60·6 63·7 67·8	0·34 0·38 0·20	53·0 56·1 58·6	Punjab stations.—Intensely hot in summer, quite cold in winter; rainfall scanty. Malaria rife from August to November; sometimes of a very virulent type.
3	10·59 7·07 11·10 11·83 12·50	84·5 84·5 84·1 84·3 82·6	5·74 4·91 6·05 6·59 6·80	83·2 84·3 83·8 84·2 83·1	0·42 0·47 1·83 2·30 0·70	76·4 80·4 78·8 79·3 80·5	0·08 0·05 0·17 0·36 0·12	65·3 69·5 68·2 68·7 70·4	0·32 0·19 0·32 0·24 0·13	58·6 62·1 61·2 61·4 64·3	North-West Provinces.—Hot and dry from April to mid-June; then to September, moderate rain; cool with bright sun, November to March. Malarious from August to November, but seldom of a severe type.
4	11·30 13·11	84·4 78·3	7·40 8·76	84·7 78·3	3·25 3·41	80·5 75·0	0·17 0·29	70·7 67·2	0·13 0·22	62·6 60·9	Upper Bengal.—Intermediate in climate and salubrity between N.W.P. and Lower Bengal.
5	12·95 13·76 16·19	82·6 82·3 83·8	9·33 13·35 12·22	82·6 81·4 82·6	4·39 3·50 4·84	80·5 79·0 78·0	0·66 0·26 0·98	72·9 71·8 69·1	0·24 0·10 0.57	66·1 65·3 61·1	Lower Bengal and Assam.—Moist, except for a few weeks in March and April; heavy and prolonged rains, but seldom with intense heat. Malaria prolonged, and often of a severe type.
6	10·07	85·0	4·40	82·7	0·30	78·9	0·24	68·8	0·08	62·8	Rajputana.—Closely resembles the Southern Punjab.
7	1·55	83·8	0·54	83·6	0·00	82·2	0·09	75·0	0·16	69·0	Seaport of Sind.—Waterless and desert; but climate modified by proximity to sea. Exceptionally little malaria previously to the introduction of a regular water supply.
8	7·60	81·8	4·83	83·1	0·35	81·5	0·16	75·6	0·06	68·6	Gujarat.—Scanty rainfall, July, August; heat of prolonged drought modified by proximity to sea. Malaria moderate, more or less throughout the year, with two maxima: in February and October respectively.
9	7·14 16·12 10·25	79·8 79·3 81·0	7·56 8·77 10·13	80·2 79·9 81·2	1·73 2·07 2·95	78·0 75·6 78·9	0·31 0·50 0·90	70·4 66·6 71·8	0·56 0·38 0·64	65·3 65·6 66·8	Central India.—Prolonged dry season, intensely hot in May and June; rainfall moderate. Malaria autumnal, prolonged far into cold weather, but seldom particularly virulent.
10	11·43	80·3	11·81	80·2	2·47	81·8	0·66	79·7	0·09	76·8	Considerable rainfall, almost confined to three months. Not very malarious.
11	8·17 3·22 8·74 2·58 5·80 4·67	78·4 75·7 71·2 82·1 73·6 86·2	5·99 5·21 4·64 4·09 4·72 3·21	78·4 76·3 71·9 81·7 73·5 85·4	3·08 4·80 6·39 4·29 7·15 7·49	77·3 77·5 73·7 80·1 72·9 82·4	1·76 1·31 2·11 2·13 3·59 5·37	72·5 72·4 71·6 76·0 70·3 79·1	0·27 0·26 0·13 0·14 0·55 2·55	69·1 68·6 69·6 73·0 68·1 76·7	Southern plateau.—Scanty rainfall, but no great annual variation of temperature; intense heat of central region modified by sea breeze as ghauts are approached. Malaria worst in August, prolonged far into cool season, but rarely of virulent type.
12	13·31 4·56	78·7 85·5	9·38 4·69	79·2 85·2	14·01 11·00	80·1 82·1	6·77 13·21	80·6 78·7	1·81 5·28	80·3 76·7	Southern litoral.—Climate uniform and moist. No marked malaria-free season, but disease seldom specially severe.
13	18·19	80·3	16·04	80·7	6·74	81·4	2·98	80·1	0·09	77·5	Lower Burmah.—Resembles Indian Southern litoral in climate, but disease often of severe type.
14	3·88	85·3	6·54	84·8	5·08	83·1	1·28	76·9	0·28	70·5	Climate resembles that of Southern Indian plateau. Malaria from June to December, worst in August; disease often of virulent type.

cannot take place at a lower temperature than 20° C. (68° F.), or at a higher than 30° C. (86° F.), and in the existence of this upper limit we find an explanation of the fact that the hot dry weather in northern India, where for months together the temperature rarely falls as low as this, is, in spite of the unbearable heat, by far the healthiest season of the year, and that during it, primary cases of malaria are practically unknown.

As in these parts of the Peninsula the winter temperature, for considerable periods falls considerably below the lower limit, extreme climates such as we have there, are blessed with two consecutive periods of immunity, malaria being confined to the season of the "rains" and early autumn. Strictly speaking, however, Northern India is sub-tropical. In the Tropics, and especially in the Equatorial region the lower limit is practically never reached and the existence of the higher is of far greater practical importance, as during the drier portions of the year it is, except in certain specially favoured localities, always surpassed for considerable periods. As, however, in the truly Equatorial regions there are two dry and two rainy reasons in each year, the periods of immunity are too short to bring about any very distinct diminution in the amount of sickness due to malaria, as their occurrence is masked by recurrent attacks which always continue to vitiate the statistics of any period of immunity for a longer period than the entire duration of these short intervals.

While then in temperate climates the duration of the winter is the most important climatic factor in securing a prolonged period of immunity, in tropical and sub-tropical regions it is the hot dry weather that exercises a sanitary influence.

Second only to temperature is the amount and distribution of rainfall. It is needless, however, to go into any lengthened considerations of its effects, as these naturally follow from the premise that malaria is dependent on the Mosquito for transmission from man to man; beyond pointing out that besides being the main natural puddle-producing agency it has the additional effect of keeping down the temperature, and so shortening or abrogating the period of immunity due to heat, and that the more evenly it be distributed the more serious will be its effects on public health.

So greatly is malaria favoured by a copious rainfall that in the majority of places *the monthly incidence of new infections of malaria may be roughly said to be directly proportional to the rainfall of the preceding month.* The only apparent exceptions to this rule occur in places where a heavy rainfall occurs during months too hot or too cold for the development of the parasite; but of course in such places the rule must be taken to apply only to those months during which the air temperature permits of the maturation of the parasite within the Mosquito. Without encumbering these pages with needless statistics, the two following examples may be taken as fairly typical, remembering always that the figures given probably include a much larger number of recurrent than of primary attacks.

Table Showing the Relation of Rainfall to Admissions to Hospital for Malarial Fever (including Recurrent Cases) in Two Indian Prisons.

	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	
Admissions to hospital for malaria	31	27	28	12	15	14	31	38	56	56	50	37	Nagpur Central Jail.
Rainfall during the preceding month	0	0	0	0	0	0	7	14	12	9	1	0	
Admissions to hospital for malaria	11·7	8·1	11·6	10	14·2	11·2	8·8	13·9	23·1	23·6	14·9	15·9	Shahjahanpur District Jail.
Rainfall during the preceding month	1·4	2·6	2·5	0·9	0·7	1·4	6·4	12·6	14·1	6·3	0·9	0·4	

The figures referring to the Nagpur Central Jail are derived from a paper by Major A. Buchanan, I.M.S., published in the *Indian Medical Gazette*, and both series represent the averages of ten years. In the case of the Shahjahanpur Jail the average strength of prisoners during the period was 378·7.

Conditions of atmospheric pressure can, *per se*, have no influence on the incidence of malaria.

Hill stations are, of course, as a rule free from malaria, but the reason of this is not that because the barometer stands some inches below the instrument in the plains, but because they are cool and well drained. Given other favourable conditions, and malaria will develop at any elevation, and as a matter of fact, the writer has observed and treated undoubted malaria in Wakham in the upper Oxus Valley, at an elevation of 9,000 feet above the sea, among the Tajik tribesmen who rarely or never visit places at a lower level.

The Influence of Water.—In a certain sense, the malariousness or otherwise of any locality is intimately connected with its water supply; but the question is one of its relative abundance and distribution, and not of its quality. As has already been pointed out, it is, for biological reasons, in the last degree improbable that there can exist any alternative route of malarial infection than that through the Mosquito, and it was not proposed to enter here into the question on the possibility of drinking water forming a vehicle of infection; but old fallacies die hard, and as an attempt has recently been made by Captain Leonard Rogers, I.M.S., to resuscitate this one, it may be well to devote some space to the consideration of the arguments brought forward by him. Captain Rogers attempts to show that those parts of Calcutta and neighbourhood which receive a filtered water supply are less malarious than neighbouring suburbs which draw their supply from the river, from tanks, or from wells. He estimates the relative malariousness of the compared localities by what he terms their spleen ratio, a factor which he determines by counting the number of enlarged spleens in a given number of persons whom he regards as fairly representative of the general population.

Now such a method of estimation is obviously open to a variety of sources of fallacy, and is, at least, misleading. As pointed out by Drs. Christophers and Stephens, and confirmed by Koch, the true index of the malariousness of a place, is the average length of time required for the infection of new comers; and the most convenient class of immigrant, because always ready to hand, are the young children. Further, as will be pointed out further on, the mere fact that Calcutta is a great city, in which municipalisation on European lines has been carried much further than in the "up-country" towns mentioned below, is alone sufficient to account for the more crowded portions of the towns which have been provided with a filtered water supply being less malarious than the suburbs, even assuming that Captain Rogers' researches may be taken as conclusive that such is really the case. As a matter of fact, experiments on a very large scale have been of late years conducted in certain Indian prisons, where the entire drinking water supply of the prisoners was carefully and systematically boiled in the hope of diminishing malarial disease, but without producing the least effect in the hoped for direction.

But apart from this, our experience in Northern India strongly suggests that, so far from diminishing malaria, the introduction of a piped and filtered water supply, has commonly quite the opposite effect. It is unfortunate that before venturing on generalisation from what appears to be such scanty data, Captain Rogers was not at the pains to avail himself of the tabulated information on this point readily available to him in the annual reports of the Sanitary Commissioners of the Northern Provinces, where the effect of the introduction of filtered water supplies has been a matter of anxious observation for a considerable series of years, for it is impossible to imagine that any diminution in malarial fevers and splenic enlargement could fail to show itself in a diminution of the general death-rate.

For the benefit of those to whom the above reports may not be readily accessible, the figures bearing on the question are extracted on next page :—

The addition of this table to the Sanitary Reports was probably initiated with the view of illustrating the benefits conferred by modern sanitation; but if this be the case the compilers must have been most disagreeably surprised, for with hardly an exception a rise, and not a fall, of mortality has followed. There are, of course, absolutely no statistics extant of any value whatever as to the absolute number of deaths referable to malaria in any Indian town, but it will not, I presume, be denied that the disease is everywhere in India accountable for a considerable proportion of the total mortality, or that any perceptible diminution in the prevalence of malaria could fail to make itself evident in the total death-rate.

Town	Average annual death-rate since introduction of a filtered water-supply	Average annual death-rate for the five years' period preceding its introduction	Remarks
Cawnpore	47·83	41·15	Only the data referring to towns provided with a filtered supply are included here; places supplied with unfiltered water have been excluded, as also have cantonments and hill stations.
Allahabad	28·70	25·77	
Lucknow	43·79	44·68	
Benares	48·81	39·99	
Meerut	35·06	32·13	
Agra..	35·46	32·23	

It is inconceivable that the introduction of a pure water supply should raise the death-rate from cholera and bowel complaints, and as a matter of fact the figures of such of the towns as I have examined show improvement in this respect.

Nor can the enhancement of the death-rate be fairly ascribed to improved registration, as during the entire period this has been admittedly fairly accurate as to total mortality however worthless it may be as to detailed causes, nor is there any evidence to show that there has been any general improvement in this respect. Moreover it must be remembered that the dates of introduction of the regular water-supply differ widely in different places, and that the increased mortality has followed immediately in by far the majority of cases. Further, the increase though immediate is not progressive, as may be seen by running through the series of tables published up to the present date.

It is therefore undeniable that in the North West provinces at least, municipal malaria has increased and not diminished coincidentally with the introduction of filtered water-supplies.

For those who believe in the agency of the Mosquito in the propagation of malaria, the explanation of this unexpected and undesired result of modern sanitary enterprise is not difficult.

In by far the majority of cases no attempt at improved surface drainage has accompanied the spread of the water-pipe.

Financial tightness has necessitated that the essentials of sanitary reform should be taken in hand one by one; and the effort to introduce a pure water-supply has so exhausted the resources of each municipality in which it has been carried out, that the proportion of cases in which the engineers have been able to so place their hydrants as to secure a ready flowing away of waste water has been perforce a very small one, and the result has been that often, each hydrant is the source of a string of puddles of constantly renewed, fresh cool water, and not unfrequently so placed as to be the greater part of the day in the shadow of tall buildings. In pools so fed and situated *Anopheles* larvæ may be found at times of the year, when but for the hydrants, they would be rare as the dodo; for these larvæ do not appear to be able to develop in water as hot as that of the ordinary stagnant pool or tank in the hot dry weather. At any rate it is only in such exceptionally conditioned water that *Anopheles* larvæ can be found in the N.W. provinces in March and April, for the ordinary garden tanks, which in the rains will harbour large numbers, are then full of *Culex* larvæ only. In this way a piped water-supply extends the period of possible infections over several months, which ordinarily yield but few fresh cases.

As even when confined to its normal times and seasons malaria is responsible for a larger share of the total mortality than any other disease, the above explanation appears to me to adequately explain the apparent failure of pure water-supplies to improve the general health.

It is obvious, however, that the increased sickliness and therefore presumably malariousness of these places are an indirect result only of the introduction of a water-supply; as to the direct connection of which with malaria there exists no tittle of proof.

The case too of the French transport "Argo," which has so often been quoted as an example of malarial infection through the agency of water, has been conclusively shown by Celli (C.M., p. 95) to have been probably an outbreak of acute poisoning, but certainly not malaria. Putting aside then the possibility of water acting as the direct vehicle of infection, let us see how far the prevalence of malaria is indirectly influenced by its agency.

The presence of water is absolutely essential to the multiplication of Mosquitoes, and further, it is now fully recognised that it is not large bodies of water, such as marshes, lakes and rivers, that form their favourite nurseries, but small stagnant collections such as puddles and pools of no great size that are favoured by them.

Further, these puddles must be sufficiently permanent to persist for at least ten days. It is therefore the surface distribution of water that is primarily of importance; but as this is largely influenced by the disposition of the ground water the study of the depth and movements of the latter is of the greatest importance, and the prevalence of malaria is therefore influenced by this in exactly the same way as if it were a truly water-borne disease. Of the older generalisations on the subject, perhaps the only one that can be said to have stood the test of recent knowledge is the often demonstrated fact that localities where the ground water lies close to the surface are generally malarious. The reason of this is that in such places the surface is easily saturated and badly drained; because, wherever the ground water lies high, it is usually also either sluggish or stagnant.

Now a marsh is usually a place where the ground water comes to the surface, the level of the soil being below that of the ground water of the higher land around it; but the marsh itself, *per se*, is rarely concerned in favouring the multiplication of Mosquitoes, the larvæ of which are only very rarely to be found in such situations. It is the stretch of country immediately surrounding the marsh, where the ground water level is not below, but almost coincides with that of the soil, that is the true focus of "marsh miasmata," for in such places the smallest depression must needs remain a puddle, in spite of the most rapid evaporation.

It is obvious therefore that hydraulic sanitation can do much to diminish malaria, though in some cases, as in the Roman Campagna, the works required may, as pointed out by Celli (C.M., p. 126), be of such magnitude as to be beyond our present financial and engineering resources; but there are many cases where much good can be effected. The level of the true subsoil water can as a rule be modified only by works of a public character, as the necessary works must usually be undertaken at a considerable distance from the properties they are intended to benefit. What is usually spoken of by agriculturalists as "subsoil drainage" only indirectly affects the ground water level, as the pipes or rubble drains, &c., employed are placed at but a little depth from the surface and nearly always much above the true subsoil water level. The only works that can directly affect the ground water level are the straightening and regrading of the channels which form its natural outlets.

Harbour works for example, which involve the removal of tidal bars, may have an important influence of this kind, and there are other cases in which locks shutting off the flood tide from estuaries may have an equally good effect.

It must be remembered in this connection that as a rule the surface of a river is the lowest point of a section of the ground water level across its basin at any given point of its course. Now, whatever may be the fall of a river bed, the main obstacle to its efficiency as a ground water effluent is friction, and the more tortuous and therefore longer its course, the flatter will be its gradient and the greater the total friction, which may also be greatly increased by the presence of "snags," boulders and similar obstructions, or by water plants, as in the instance of the "sudd" of the upper Nile. Fortunately, in many cases, works of this sort are not only of sanitary, but also of obviously commercially economic importance, and it is very possible that the desire to make "trade follow the flag" which actuates our attempts to cut a way through the "sudd" may result in a really far more economically important improvement in the health of the Soudan, whereby spots like Fashoda may become valuable possessions, instead of merely affording worthless incitement to international strife and jealousy, and early graves for the Englishmen or Frenchmen who secure the pestiferous bone of contention.

Surface drainage on the other hand is more usually a matter of detailed small works, the collective effect of which, however, as in the case of our own Fen country, may have a most beneficial effect on the public health. Apart from mere gutters, the most effective means of drying the surface of the soil is the well-known agricultural system of "subsoil drainage." Somewhat similar to this, but less effective as a measure of malarial prophylaxis, is the system of drainage employed on Assamese tea gardens, in which the cultivation is divided into plots by straight drainage cuts some five or six feet deep, and these in their turn are divided and subdivided by progressively shallower cuttings. As a measure for drying the soil to suit the needs of the tea bush they are doubtless all that is required, but owing to the impossibility of accurately grading simple cuttings in the soil, they are a fruitful source of puddles. Still they on the whole appear to be beneficial, as they have undoubtedly diminished the malariousness of certain estates.

Influence of the Air.—On this point little need be said as its effects are always rather those of climate than composition. Its chemical composition, the relative proportion present of carbonic acid or ozone, &c., have nothing to do with the case; but still the word malaria can hardly be said to be a complete misnomer, for it is the air that carries the Mosquito which is the actual vehicle of the malarial germ. The limits of distance to which they can be conveyed are, however, as we have seen very limited, and for practical purposes the quality of the air of a place may be left out of consideration.

Influence of Soil.—The comparative freedom of certain sites from malarial disease has been well known from the earliest times, though owing to ignorance of the actual underlying causes, all attempts at generalisation were rendered futile by the constant cropping up of perplexing exceptions.

Always assuming that there be no water-logging of the soil, it is obvious that the more porous it be, the less the probability of the formation of puddles of sufficient permanence to admit of the rearing of a brood of Mosquitoes. Sand for example, holds water so badly that short of complete water-logging the formation of puddles is an absolute impossibility; but the deposition of a very thin layer of fine silt by flood water will suffice to render such soils sufficiently retentive. In the same way, rocky soils are usually healthy, because they are generally found in hilly regions, and are therefore associated with good surface drainage; but if the peculiarities of the rock are such as to lead to the formation of basin-like depressions during the process of weathering, such a soil may be highly favourable to the development of malaria, always provided that the rock be of uniform and impervious texture, so that the water cannot soak away. For this reason the malariousness of Hong Kong was, in our older books on hygiene, ascribed to some mysterious influence of a soil consisting of decomposed granite.

In a certain sense, of course, it really is the decomposition of granite that is at the root of the mischief, but this is not because granite, whether intact or decomposed, can have anything to do with the effect ascribed to it, but because the denudation of such rocks leaves the undecomposed portion hollowed out into basins as watertight as the best porcelain, and moreover, where such rocks form the beds of water courses, they are particularly liable to be worn into "pot-holes" by the action of pebbles retained in some chance depression.

According to Drs. Stephens and Christophers, (*R.S.M.C.*, July, 1900, p. 43), the persistence of *Anopheles* during the drier portions of the year in Freetown, Sierra Leone, is due to puddles retained in rock basins of this description, and similar conditions have been noted in Southern India, in addition to which I have myself met with *Anopheles* pools of this description at Jhansi.

Speaking generally, it is the character of the surface soil that is of the greatest importance, as however deep the subsoil water may lie, puddles will necessarily form, provided only the surface layer be sufficiently retentive. Hence sites having a clayey surface are necessarily favourable to the development of malaria, and even if the actual surface be not of this character, it is quite possible for a thin intermediate stratum of such material to so hold up the surface water as to admit of the surface being practically waterlogged, in spite of the subsoil being quite pervious and the ground water deep. An impervious stratum of this sort is to be found in many parts of the Gangetic alluvium some four or five feet below the surface, as is shown by the fact that in such districts any attempt to increase water storage by the deepening of existing tanks merely results in their drying up.

In the Sitapur district (Oudh) for example, several tracts of country of this description are to be found, and though the subsoil water lies some thirty or forty feet from the surface they are notoriously malarious.

I am not aware that such an experiment has ever been tried, but in the case of limited areas, such as inhabited sites, it seems possible that their sanitary condition might in such cases be improved by the construction of a number of blind wells carried through the impervious layer so as to open up the porous subsoil beneath.

It would be impossible within any moderate limits to give any account of the various kinds of soil that are to be met with in India, as it is needless to say that in so vast a country almost every possible combination of soil and contour formation is to be met with, and malaria is rife more or less throughout ; but a few words with respect to the commoner formations may not be out of place.

Between the foot of the Himalayas and the old island India of past geological times stretches an immense level plain reclaimed from the sea by the silt deposited by the mountain streams that now fall into the Ganges and Indus. After this old narrow sea had completely silted up, the rivers continued to raise their beds, wandering from side to side whenever the detritus deposited in their shoals accumulated sufficiently to raise them above the level of the land hard by.

This process has been going on ever since, and is still in progress; till to-day, this enormous area of alluvium forms an apparently level plain, stretching from sea to sea, and in most places some hundred miles wide. Though apparently as level as the ocean the imperceptible watershed between the Ganges and Jumna flowing east and the westward bound rivers of the Punjab is really some 700 to 800 feet above the sea, and the depth of the alluvium is in some situations enormous. The whole of this area consists of sand and silt of various degrees of fineness, modified at the surface with a variable amount of decomposed organic matter. Saving where waters, rich with lime in solution, have matted together vegetable fibre and sand into "kunkar," nothing of the nature of a stone is to be found.

At both the eastern and western limits of this wide alluvial area, the ground water is necessarily close to the surface, as hundreds of square miles of country are but a few feet above the level of the sea; but speaking generally, as one travels further inland the level of the subsoil water gets deeper and deeper, and on the watersheds between the rivers may at times be as much as a hundred feet from the surface.

The eastern or Gangetic half of this area is for the most part naturally fertile, the natural rainfall being, in normal years, sufficient to water a sufficient crop to support a large population. In the easternmost portion indeed the normal rainfall may be said to be excessive, and malaria is necessarily rife and long continued.

On the other hand, once the country drained by the Indus is reached the rainfall becomes scanty and precarious. Whether, however, we start from the Gangetic or Indus delta, the subsoil water becomes deeper and deeper as we travel inland so that in Oudh and the North-west Provinces, forty or fifty feet is no uncommon depth for a well, and in parts of the Punjab, the water may not be reached for twice that depth. On the western side the rainfall progressively diminishes, so that the country, even where the ground water is at no great depth, is a waterless desert; and cultivation, apart from irrigation, an impossibility.

Now, except when its natural permeability is destroyed by a layer of fine silt, as is the case with the cement-like surface of the Punjab "put," this alluvium is considered merely as a soil, by no means favourable to the development of malaria, as it is for the most part so pervious that it holds water badly. Owing, however, to its unbroken levels the natural surface drainage is everywhere bad, and its artificial improvement difficult or impracticable.

In spite, however, of these disadvantages, it may almost be said that the haunts of *Anopheles* larva are throughout its entire area mainly the work of man, and are therefore to a great extent removable; always provided that sufficient funds and intelligence be available.

Passing south, the transition from the alluvium to the broken and rocky ground of central India is often well-nigh as abrupt as that from sea to land.

In place of the monotonous plains of Northern India, the surface, at very least undulates and is often mountainous; and the soil, which is seldom of very great depth, is derived from the decomposition of rocks in the immediate neighbourhood which belong mostly to primary or metamorphic formations. In the northern part of this area much of the cultivable land consists of what is known as the black "cotton soil," which possesses certain characters which have an important influence on the local seasonal incidence of malaria. It absorbs water like a sponge or like so much "black cotton," and once thoroughly saturated holds it well enough to favour the formation of puddles, which are fairly permanent as long as the air remains damp. With the return, however, of the dry weather it dries rapidly, splitting up into a network of deep fissures which render the existence of puddles, whether of domestic or natural origin, well nigh an impossibility.

The greater part of this region is, however, to the south of the line of hybernation for *Anopheles*, so that adult insects may be taken at all times of the year; but the presence of larvæ is practically limited to the season of the rains, or from the middle of June to the end of September.

As, however, the closure of the fissures by the swelling of the spongy soil as it drinks in the rains still leaves the surface irregular, this soil is peculiarly favourable to the multiplication of the species as long as the wet season lasts, so that the physical characteristics of this sort of soil necessarily are such as to favour greatly the development of malaria for this short and limited period; and as a matter of fact, the seasonal incidence of malaria corresponds well with these facts, as taken altogether, such sites are fairly healthy, though malaria is rife and wide-spread while it lasts.

Owing to the instability of such a foundation the construction of permanent works of all kinds is a matter of the greatest difficulty, and hence the surface drainage of towns is always costly, and even when most carefully designed requires continual regrading.

Below the black soil there is commonly, especially in Kathiawar, a stratum of limestone, locally known as *moram* (miliolite) intervening between it and the subsoil water, which, though not very dense, is yet sufficiently effective in holding up the surface moisture.

It is doubtful if even subsoil drainage would be of any great use in combating malaria in land of this description, as the peculiarity of this soil is that it dries rather by evaporation from above than by the draining away of its moisture from below, and it is obvious that under such circumstances works of this sort would be not only expensive, but probably ineffective.

With a highly civilised population it is possible that some good might be effected by the systematic destruction of the adult insects during the dry season, as the climate and general characters of the country are such as to render the shelter of houses almost indispensable to the maintenance of the species; but under existing circumstances this appears one of those cases in which the free distribution of quinine and the popularisation of its use can alone effect much benefit, and is therefore the more fortunate that the same physical peculiarities that so favour the development of malaria for three or four months of the year also limit its duration.

It is needless to remark that besides the above almost every variety of soil is to be met with in so large a country as the Indian peninsula, but the above are the only two cases with which I have any personal familiarity which are sufficiently extensive and peculiar to require any special mention. In all probability what has been remarked with regard to the Gangetic alluvium will apply also to other tropical and subtropical alluvia, such as those of the Nile and Mississippi, but I have not been able to obtain any special information on such points, except as regards India.

Influence of Vegetation.—As the three essentials to the well-being of all species of Mosquitoes, vegetable food, shelter from the sun during the heat of the day, and the presence of puddles wherein to rear their young, are all either dependent upon or greatly favoured by the presence of vegetation, it is obvious that its amount and character is a factor that must always be considered in estimating the potentialities of malaria in any given place.

Open grassy plains have long been known to be unfavourable to malaria. In such situations gnats can find no sufficient shade, and such puddles as form are hidden from them by the closely crowded stems. I am inclined to believe that the hiding of the surface of pools by close vegetation tends to prevent Mosquitoes from using them as breeding places, and that this fact might often be made use of as a cheap and effective means of sanitation.

There can be no doubt *e.g.*, that the presence of certain water plants in some way prevents the appearance of Mosquito larvæ in the water covered by them, and the only reason I can suggest for this is that the plants act in this way because they hide the water from the female gnat searching for a suitable place in which to deposit her eggs. At any rate it is difficult to otherwise account for the curious fact that in the Benares public gardens, where there are some scores of the small irrigation tanks described below, *Culex* and *Anopheles* larvæ, alone or in company, were present in every tank save those that were covered with a peculiar floating water plant, looking much like a young lettuce, which is spoken of by the natives as the *jalkumi*.

In the tanks so planted, the water was alive with young leeches and nematodes, but in none of them could be discovered a single Mosquito larva, while the others swarmed with them. Introduced into a tank already containing Mosquito larvæ, however, the plants appeared to exercise no hostile influence whatever on their development, and for this reason, I conclude that the plants act mechanically in the same way as an artificial cover. The *jalkumi* floats on the surface of the water and so forms a most effective screen; but another plant resembling the Canadian duckwood, which grows completely submerged appeared almost as effectual, though in this case the surface of the water was certainly not hidden in the ordinary sense of the word, though the green coloration may have masked its presence to the defective and short ranged vision of a Mosquito. Whether the presence of such plants would be equally effective in places where no alternative pools are accessible is of course open to doubt, and the vagrant nature of my employment as Sanitary Commissioner prevented my being able to follow the point up, but the matter is certainly worthy of investigation, as if confirmed, it would afford an extremely simple and inexpensive means of diminishing the number of available nurseries for larvæ.

A variety of plants, such as the castor oil and eucalyptus have enjoyed the reputation of being protective against either Mosquitoes and malaria, and it is possible that the scent of certain strong smelling species may be obnoxious to the insects; but the observations of Celli (C. M., p. 143) show that so far from being destructive to them such plants may form an excellent refuge for Mosquitoes. Our experience in India is similar, as may be judged by the following extract from the *Pioneer* (April 4, 1901):—

To the Editor.

"SIR,—Some short time back, there appeared, in the correspondence columns of your paper, I think, a recommendation to use the castor oil plant to keep a bungalow free from Mosquitoes. I being a sufferer had six plants placed in pots in my rooms. I fancy we must breed a different variety of Mosquitoes than your correspondent, for the castor oil plants are thickly covered with the insects by day, who, at night time, seem to be actually invigorated by the apparently stimulating effect of their new quarters.—D."

The influence of trees in especial has hitherto been greatly misunderstood. A screen of trees was supposed, in some occult way, to be capable of filtering out malarial germs from the air; and it is just possible that the presence of a convenient shelter of this sort might in certain cases prevent Mosquitoes wandering further to dwellings which might otherwise have been their nearest convenient refuge; but it would obviously be bad policy to multiply such shelters. Speaking generally indeed there can be no doubt, that trees greatly favour the multiplication of Mosquitoes.

This they do in four ways: they afford shelter during the day; their shade prevents the drying up of puddles; their flowers often afford the staple food of the insects; and lastly, they prevent the growth of grass.

In 1884, the Italian authorities instituted an enquiry as to the influence of disforesting on public health (C. M. p. 141), and the result of their investigations was that they were unable to find any proof that disforesting was injurious to health, but that some facts indicated an opposite effect.

Popular and professional opinion in India as to the influence of trees on malaria has oscillated, but has generally been in favour of open sites, though no one doubts that trees greatly favour the prevalence of Mosquitoes.

The history of the large military station of Meean Meer is both curious and instructive in this respect. After the annexation of the Punjab, the large force quartered close to the great native city of Lahore suffered so terribly from malaria that it became absolutely necessary to remove them to some more healthy site. At that time the, as we can now see, perfectly defensible view that open sites are least malarious was that in vogue and the General and his advisers therefore selected Meean Meer, a barren plain, almost uncultivated owing to the thinness of the soil.

The extensive building operations necessary for the housing of the troops, however, soon honeycombed the level surface with excavations of all sizes and the rising barracks and bungalows soon afforded abundant shelter of the effective sort dearest to the Indian *Anopheles* ; and hence, like all new places, before long occupation has gradually ameliorated the untidiness inseparable from new and growing places ; the change proved no better than from "frying pan to fire." Changing opinion led to the unhealthiness of the place being ascribed to the absence of trees, and at great trouble and expense, a separate shaft, filled in with soil, having to be sunk through the limestone for each sapling, large numbers of trees were planted, with no very perceptible result. The cantonment still bears an evil reputation for malaria, but half a century of occupation has wrought great improvement in surface drainage and other kindred ameliorations, and though still decidedly malarious, it is to day neither markedly better nor worse than other stations in the Province. In India, as elsewhere, especially during the rains, many species of Mosquitoes certainly habitually harbour in trees during the day, and there can be no doubt that the proximity of trees, however pleasant to the eye, is most undesirable if one wishes to keep a house free from these pests. Celli (C. M., p. 141) states that *An. bifurcatus*, in Italy, lives preferably in thickets, and that persons sleeping in such places, even during the day, are frequently bitten ; though the experience of Dr. Sambon and Low (*B.M.J.* Dec. 8, 1900, p. 162) were contradictory in this respect.

The explanation of this is probably that the observations were made in different months, for in India at any rate our local species of *Anopheles* do not apparently find that the shelter of trees is sufficient during the fierce heat of the day, and prefer the deeper shade of buildings ; and, as far as my somewhat limited experience extends, are not to be found amongst trees during the day, though it is likely enough that they may do so in parts of India where the summer heat is less fierce than in the North West Provinces.

All considered, I fear that great as is the solace of a shady garden to the eye jaded with the fierce glare of a tropical sun, it is a most undesirable adjunct to a residence, alike for health and comfort, for besides sheltering and in every way fostering the multiplication of Mosquitoes, whether simply irritating or noxious, the trees, which practically never shield the house from the direct rays of the sun, cut off the breeze and so interfere with that free ventilation, which is a *sine qua non* of tolerable existence.

Finally, it must be remembered that trees are in some way capable of modifying the climate of a locality by increasing the rainfall. How or why they are capable of doing so is by no means clear, but the connection is generally admitted, and some recent observations in India appear to show that such an effect may be produced within the limits of a comparatively restricted area. While they, however, generally favour malaria, Celli justly points out, (C. M., p. 142) that trees should be respected on hilly ground, as by retarding the rapidity of drainage they tend to prevent the flooding of the plains below by heavy rainfalls on the hills.

Assuming then it to be possible to chose the site of a tropical residence, it should certainly be placed on open ground, and coolness and rest for the eye should be aimed at by surrounding it with a stretch of well-watered grass, the watering being conducted on some plan that does not involve the use of tanks and other collections of standing water; but such a plan is always difficult and expensive, and is in many parts of India, impossible.

The presence of thickets and undergrowth has long been recognised as favourable to malaria. Growths of this sort sufficiently luxuriant to be unmanageable, in and about inhabited sites, presuppose a moist climate, free from the extreme heat of the drier parts of the tropics, and in which the habitations alike of Europeans and natives are constructed with an eye rather to the freest possible ventilation than to keeping out the heat; so that as far as that is concerned, there is little to choose between the shade of a tree and the best built of bungalows.

In such climates, *e.g.*, in Assam and Burmah, the multiplication of all species of Mosquitoes, *Anopheles* included, can hardly be otherwise than greatly favoured by growth of this sort, and as a matter of fact, the clearing of jungle from village sites is one of the few measures that come within the range of practical politics in village sanitation of the provinces in question. Costing as it does nothing more than a little official persuasion, it is pretty generally carried into effect, and is undoubtedly most beneficial.

When the District Officer in Assam has induced his villagers to clear away the jungle from their huts and to give their wells the annual cleaning, he justly feels that he has done all that is humanly possible for the sanitation of the unpromising human material he has to deal with; for the Government resolution that converts the Assamese peasant to sanitary decency will have to be framed with a stringency far beyond the ingenuity of any legislator, past or present.

The consideration of the *rôle* played by plants in the propagation of malaria leads naturally to the effects of cultivation. As far as India is concerned the question of the influence of cultivation on malaria resolves itself mainly into that of the effects of irrigation. At any rate it is the only one in which remedial measures on a large scale can be attempted by Government, as the methods of the indigenous cultivator are too ingrained and detailed to be capable of modification by legislative measures, to say nothing of the fact that agricultural experts are agreed that in the main his system is but little capable of improvement, and can therefore be hardly profitably meddled with.

The total area under irrigation in India is about 29,000 square miles, rather more than the area of Greece, or just over 2 per cent. of the entire country; but as the irrigated areas are also very densely populated, their influence on public health is much greater than such a proportion would suggest, to say nothing of the fact that such areas serve as foci from which the disease is constantly spread abroad by human agency.

It is needless for me to quote here any evidence as to the untoward influence of canal irrigation on the public health through the concomitant increase of malarial disease. The matter has been the subject of several special investigations, and as a matter of fact has been fully admitted alike by the profession and the Indian Government long before we had any exact knowledge of the way in which irrigation is responsible for such evil effects.

In some cases these effects have been so serious as to raise the question of the advisability of abandoning the system; but these have occurred mainly in situations where old native canals have been utilised, and in which the alignment contravenes the principles that will be explained below; but it may be at once admitted that no suggestion involving the prohibition, or even restriction of irrigation will be considered worthy of serious consideration by practical men.

Starvation is a worse disease to bear than malarial fever, and over much of the irrigated area, the very existence of the population is dependent upon irrigated crops. In much of the Punjab and Rajputana, and the whole of Sind, the natural rainfall is so small that, but for irrigation from canals or wells, the whole country would be an uninhabitable desert; and the entire prosperity of the country and the prevention of famine depend entirely on the energetic extension of canals.

Though admittedly, as we have seen, no unmixed blessing, irrigation is in such places a necessary postulate to the existence of any population at all, whether fever stricken or healthy, and the question resolves itself merely into how the malarious influences of canals can best be prevented, or at least minimised.

Irrigation is so little needed in Europe, that in order to convey to those who have not seen it in practice, why and how far it favours the spread of malarial disease, some few words of explanation as to how this form of cultivation is carried out are necessary. In the greater part of Europe, the natural surface soil is rather too wet than too dry for the farmer's purposes, and his efforts at improvement naturally take the form of surface and subsoil drainage, and so are distinctly anti-malarial. In subtropical regions on the contrary, especially far inland, the problem the cultivator has to solve is how to keep the surface soil damp enough to keep his crops alive.

Subsoil drainage would double the labours of his well bullocks, and to prevent the escape of the share of the scanty showers that fall on his patch of ground he subdivides his holding into small, carefully levelled patches, each but a few yards square, surrounding each patch with a low ridge of earth a few inches high.

Naturally in such regions cultivation favours malaria.

Irrigation may be divided into two kinds: (*a*) Where the water is raised to the surface by water lifts of various kinds; and (*b*) where it is brought on to the land by gravitation, or in other words, by canals.

The first is always a domestic operation; the second can only be successfully carried out by large and expensive engineering works. Whichever plan be adopted, the method of applying the water to the land is the same. The cultivator having levelled and subdivided his land in the manner described above, the water is made to flow in turn into each little square until the ground within its boundaries is covered to a depth suitable to the particular crop. In practice (except for rice) the amount given is usually absorbed in a few hours, and the careful levelling of each patch is distinctly unfavourable to the formation of puddles.

In domestic irrigation the water is raised from wells by bullock or human labour, or it may be scooped up in adroitly swung baskets from rivers or swamps, but whatever its source, the water is too laboriously gained to be wasted, either in leakage or puddles. The quantity raised is usually too small to perceptibly affect the level of the ground water; but so far as it goes the tendency must be to lower the spring levels, and on the whole I believe that the influences of domestic irrigation are rather unfavourable to malaria than otherwise.

In the case of canal irrigation the results are quite different, as the enormous quantity of water used usually seriously raises the level of the ground water and may even cause water-logging, while the freedom of the supply, and especially its independence of the individual efforts of the user, leads to carelessness in its use, and hence to leakages and puddles; but it must be distinctly understood that, for all crops except rice, the puddles are the result of the abuse and not of the use of irrigation, and that the reason why these puddles are sufficiently permanent to be harmful is that the water is not absorbed on account of the saturation of the soil with canal water, nearly three-quarters of which, as will be seen, represents waste of some sort. In recording my beliefs as to the harmlessness of domestic irrigation, it must be understood that I refer only to field irrigation. Gardening as carried on in the parts of India with which I am familiar is conducted in a way that makes each garden a paradise for Mosquitoes.

In considering the influence of canals in favouring the production of puddles, and therefore of malaria, it must be remembered that but a comparatively small proportion of the water entering the canal at its head works ever reaches the fields. In a departmental note "On the Irrigating Duty of Bari Doab Canal," Mr. R. G. Kennedy, of the Indian Public Works Department, states that out of every 100 cubic feet of water entering the canal during the winter months of 1881-82, twenty were lost in the canal proper, six in the larger distributories, twenty-one in water-courses, twenty-five by waste in various ways, so that only twenty-eight was left to do all the useful work of irrigation. That is to say, that considering the canal as a machine, its efficiency was but 28 per cent.

Now in this canal alone, which is by no means the largest of our Indian irrigation works, the average flow of water is over thirteen millions of gallons per minute, and this enormous amount of water is distributed, in work and waste, over 1,200 square miles, or, in other words, is equivalent to a rainfall of about 40 inches per annum. But this gives no adequate idea of what may be the local effects of the system. In the case of the canal in question, for example, the distribution of the water is very different at different seasons of the year.

During the dry weather some 26 inches are spread over a very large area, the security of the spring crops in the Punjab being almost entirely dependent on irrigation (either from canals or wells). For the autumn crops, however, the cultivator relies mainly on the natural rainfall, and it is mainly in the case of certain valuable crops, such as rice and sugar, that he requires to supplement it by irrigation.

Hence, for the cultivation of the autumn crops, which commences in the dry weather and is continued through the rains, some 56 inches of water are given, although the area so treated is much smaller than that irrigated for the spring crops; and this, it must be remembered, is in addition to a natural rainfall of some 20 inches, which is mainly concentrated in the same season of the year. Except in the case of rice, however, the water never lies long enough on the ground to admit of the development of a generation of Mosquitoes, as for most crops only a few waterings and those at long intervals are given, as may be seen from the table given below, taken from Mr. Kennedy's above-quoted paper.

MINIMUM AMOUNT OF WATER REQUIRED TO IRRIGATE DIFFERENT CROPS.

Name of Crop	Number of Waterings	Total Depth of Watering in inches
Grain and fallow land	1	3·4
Millets	2	6·4
Wheat, barley, poppy, cotton, Indian corn ..	4	10·6
Sugar cane	11	25·3
Rice	..	96·0
Senji (a fodder plant)	5	10·5

Mr. H. Frost, the present executive engineer of the same canal, tells me that except in the case of rice it is rare for the water given to the land to remain visible on the surface for more than a day, and my own casual observation of irrigated land has given me the same impression. It will be observed in the above table that the number of waterings given to rice is not stated. In other words, during the earlier and more critical stages of the crop, it is kept continuously under water. The water is fairly clean, though rich in vegetable growths, and the stems protect the surface from the wind, so that we have here absolutely ideal conditions for the development of the larvæ of *Anopheletes.*

Personally I have seen but little of rice cultivation, as irrigated rice is not greatly cultivated in the parts of India in which I have served, but Captains James and Cornwall, of the Madras branch of our service tell me that there, the rice fields absolutely swarm with *Anopheles* larvæ, and this in spite of the presence of numbers of small fish, though the latter do not appear to be often seen in the irrigated rice of the Punjab. Rice is therefore the only irrigated crop in which the *used* water is instrumental in the propagation of Mosquitoes.

Putting aside the quantity lost by evaporation, which must form a considerable proportion of the *used* water, the whole of the canal intake, whether used or wasted, must ultimately find its way to the subsoil and so raise the level of the subterranean waters.

This raising of the spring level, with its attendant increase of malaria, does not take place at once, but is gradual and progressive for many years after the introduction of canals, until the subsoil waters are raised to a level at which canal supply and drainage are at an equilibrium, but this may mean the absolute water-logging of the soil and the progress of these changes has been made the subject of careful observation by the irrigation branch of the Indian Public Works Department. As an example I may quote a note by Mr. T. Higham, Chief Engineer for irrigation in the Punjab, on the "Spring Levels in the Dari Doab Circle," dated March 19th, 1896.

Summary of Results, Upper Sutley Canals Division.

"(*a*) On the upper two-thirds of the Katora canal, the spring level is rising at the rate of 0.81 feet *per annum*, the average depth from the surface being 16.2 feet in 1890-94. After a lapse of fourteen years, the spring level may be expected to average but five feet.

"(*b*) In the lower third of the same canal the spring level is rising at the rate of 6.32 feet *per annum*, but as it is still on the average, about 20 feet from the surface, water-logging is not likely to occur until a lapse of forty-seven years and probably not even then.

"(c) There has been on the whole, during the last ten years a general rise of spring level on the other canals of the division but water-logging need not be apprehended even in the remote future."

The departmental literature on this subject, would alone more than fill the present book, and indisputably establish that everywhere the introduction of canal irrigation has brought about a serious raising of the spring level, but the above quotation shows sufficiently for our purpose the amount and considerable variation in extent of the changes within a given small area.

The European engineer endeavours as far as possible, to take his canals along the lines of the water-sheds, but the reverse plan was followed as a rule by our native predecessors, and when the old canals made by them have been utilised the results on the health of the population have often been so serious as to necessitate heavy expenditure in altering their alignment; as the untoward effects, of canal irrigation in intensifying malarial diseases, has been thoroughly recognised by the Indian Government for many years, and the prevention of water-logging has been the subject of anxious consideration by their canal engineers.

As regards the direct production of puddles, I suspect that most of the 25 per cent. of waste "in various ways" is spent in their production, as a very large proportion of this item results from leakages due to carelessness on the part of the cultivators. The water is allowed to flow on to the land from the ultimate distribution channels by simply breaching the bank, and is stopped by repairing the opening by means of a few handfuls of mud. Although when carefully done the plan is much more efficient than one would expect, leakages, which necessarily result in the production of puddles are certainly very common, and owing to the water-logged condition of the soil resulting from the high spring level, such puddles are likely to last for a considerable time.

Of course the canal authorities do their best to lessen such wastage of the precious fluid, and a cultivator may be charged double rates if detected in permitting any considerable waste, but the areas administered are so large, that numbers of such cases must pass undetected, and a leakage promptly repaired, would probably not be punished, though it may easily have lasted long enough to produce a considerable puddle.

The means proposed by the Canal Department to prevent water-logging of the land they irrigate are :—

(*a*) To carry their canals along the line of water-shed.

(*b*) To so arrange the minor channels as to avoid their being carried across the natural lines of drainage.

(*c*) To limit the supply both as to quantity and time to the amount absolutely required for the success of the crops.

(*d*) The making of drainage cuts along the natural lines of outfall.

Of these the last is probably by far the most efficient, but the attempts that have been made in this direction have hitherto been of a tentative character and on no very large scale.

With the water brought so near the surface as it often is, it is obvious that it would be quite possible to use it over again by raising it by pumping ; but under the present conditions of Indian agriculture the cost of such a system would obviously be prohibitory.

It will be observed that none of the above propositions can have any influence in preventing loss of water from the main canal and its permanent branches.

This loss, as we have seen, amounts to over a quarter of the entire intake, and as the amount of water that can be taken from the supplying river is limited, cannot be met by increasing the speed of the flow, so that the water thus wasted has a large and definite money value ; and the stoppage of this loss becomes an object in which considerable capital might profitably be expended. It is needless to say this aspect of the question can hardly have escaped the consideration of the administration of so successful a "productive" department as that of our Indian canals, and I understand that the question is not so much as to the desirability of taking measures to stop the waste, as of how to do it. At first sight the remedy seems obvious, namely, to "revet" the channels with a layer of masonry or concrete, but unless the work is of a very solid description it has been found that such a lining soon cracks and becomes pervious. Doubtless, however, the ingenuity of our engineers will ere long find a method of meeting the difficulty, and whoever answers the question will not only have solved an important economic problem, but will have done much to diminish the untoward effect of canals in water-logging the soil, with its inevitable concomitant of intensification of malaria.

An occasional way in which canals may directly produce breeding places for Mosquitoes is their being left empty for a period long enough to admit of the rearing of a generation of imagines from the egg. Necessarily a temporarily disused canal is really a chain of pools; and I have met with an instance where a small canal supplying a tract of thin loam lying on boulder alluvium, furnished the only situation in which I could discover any *Anopheles* larvæ, in the form of pools in the beds of canal channels not in use. Moreover the village in question was notoriously malarious.

It is obvious that the flushing of each empty channel every week or ten days would prevent their serving as Mosquito nurseries.

The above remarks apply exclusively to the large perennial canals, but in many places another system is in use, viz., irrigation by "inundation canals." There are channels carried from the river bank to any portions of the country which may happen to lie lower than the flood level of the river, and are so graded that they are filled only during times of flood. Their object is in fact, exactly the opposite of the system of protecting low-lying lands by dykes that have been so efficient in diminishing malaria in Holland and in the English fen country, and as neither the time nor quantity of the supply can be controlled, their effect on health can hardly be otherwise than disastrous.

Another reason why inundation canals specially favour malaria is that they carry and distribute over the surface of the land an enormous amount of fine silt, the deposition of which renders the surface of the soil impervious to water, and so favours the permanence of puddles. The proportion of solid matter suspended in the water at the intake of some inundation canals may reach $\frac{1}{300}$ of its weight, but so high a proportion indicates a high velocity in the supplying river, and therefore a coarser deposit, most of which will fall in the earlier reaches of the canal before the water is distributed on the land. In spite of this, however, the amount of fine deposit may be very large, especially in rivers such as the Indus, which flood mainly owing to the melting of the snows supplying the glaciers of the far distant mountains in which they take their source; and this really dangerously fine, clogging silt, is naturally the most difficult to get rid of. Col. Tremenhern, R.E. ("Roorkee Professional Papers," first series, vol. iii., p. 25), states that "Those inundation canals in Sind which draw their supply from branches separated from the main river by islands covered with brushwood and long grass, contain a comparatively small amount of material in suspension. The brushwood and grass impede the velocity of the water and clarify it," and the selection of a swampy tract of this sort, at a distance from dwellings and cultivation, as the site for the intake of a canal of this sort, could hardly fail to be useful in diminishing its malarious tendencies.

I do not think that the importance of this waterproofing effect of fine silt deposited by floods is sufficiently appreciated as a malaria favouring agency; but it appears to me to be the true explanation of the way in which a previously healthy place may be rendered permanently malarious by a flood of but short duration. Anyone who has been concerned in the management of large municipal filter beds knows well how rapid and efficient is this "staunching" action of fine silt. In the Calcutta waterworks, for example, after about a fortnight, the filters at certain seasons become practically watertight to a head of 24 inches or so of water.

All canals, of course, carry more or less silt, but the amount brought down by perennial canals is comparatively insignificant.

It is, I believe, this staunching action of silt that renders places liable to flooding so notoriously malarious. The actual floodings are too occasional and temporary to exercise much direct influence; but the waterproofing of the surface enormously favours the production of fairly permanent puddles. The obvious remedy lies in the digging into the soil of some more coarsely grained material, and in many cases this would be not only practicable, but actually beneficial to cultivation, for soil of this kind is necessarily impervious not only to water but to air, and is therefore unfavourable to the growth of plants. Not unfrequently the thickness of this silt-choked layer of soil is but small, and is immediately underlaid by coarse, pervious sand, so that there is no need to bring material from a distance, and that all that is required is digging, or even ploughing, to a sufficient depth to break up the thin impervious superficial layer, and to mix with it the abundant more coarsely grained substratum.

Whatever the system employed, however, the extent to which cultivation, whether irrigated or otherwise, favours malaria depends almost entirely on the habits of the cultivators. Where the agriculturist is neat and systematic in his operations, and especially when he is anxious to utilise every available foot of land, cultivation is harmless because the waste of space and of water implied by the presence of puddles is carefully avoided, while on the other hand untidy cultivation necessarily spells opportunity for the entire race of Mosquitoes.

It is for this reason that garden cultivation is as a rule harmless, unless there be some special feature in the plan of operations that provides the necessary collections of water in some other way, and such is unfortunately the case with the gardens that commonly surround our bungalows in Northern India.

For the greater part of the year artificial watering is an absolute necessity, and the plan employed is usually not irrigation in the usual sense of the word, but watering by

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hand in the same way as is done in England. The water is usually raised from a well by the agency of bullocks, and as the gardens are generally tolerably large, is generally, to save labour, distributed by masonry channels to a number of small cemented tanks, such as that illustrated below, from which the water is dipped up by the gardeners.

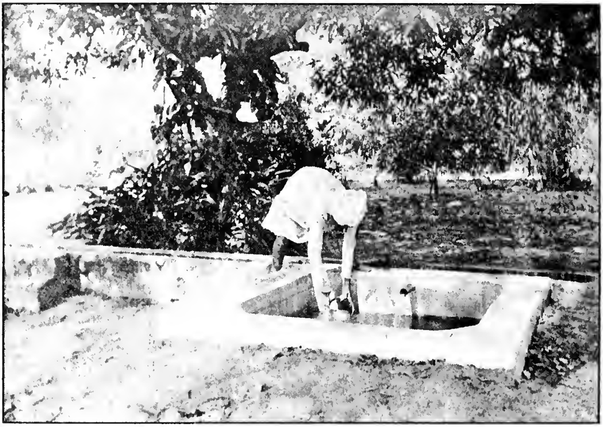


FIG. 33.—Typical garden tank (one of a dozen) in the garden of an European residence in Shahjahanpur, N.W.P., India.

Now as far as the Anglo-Indian resident of upper India is concerned these tanks are *par excellence* the most fruitful of breeding places for Mosquitoes of all kinds. During the hot dry weather, they teem with the larvæ of *Culex fatigans*, whose imagines render life in the attached bungalow well nigh unbearable; when the rains come this species is associated with *Stegomyia fasciata*, *Anopheletes*, and other Mosquitoes appertaining to the season; and all through the cold weather they serve as the last vantage ground of the few Mosquitoes that remain active at that time of the year.

To those who have lived only in Europe the remedy appears simple and obvious :—Construct a single covered tank at the well head, and distribute the water by means of pipes provided with taps. But in practice the expense, and the difficulty of obtaining sufficiently skilled workmen to construct such an installation and keep it in order are prohibitory. What might, however, be done, would be to insist on each tank being carefully cleaned out and left dry for a few hours once in every week; but it is difficult to persuade even Europeans to do this, and though in smaller stations, where the houses are scattered, a good deal of personal immunity might be secured by attention to this point, in the larger places one would gain but little unless one's neighbours could be induced to do the same. In such places, however, the weekly cleaning out of all such tanks should be made compulsory by municipal bye-law, for in view of our present knowledge it is no more justifiable to foster the multiplication of Mosquitoes than to permit the maintenance of the germs of cholera or other zymotic disease.

How far care and neatness in cultivation can go to diminish malaria is well shown in the case of Egypt. The climate is well suited to the spread of malaria, the ground water nowhere far from the surface, and the annual inundation of the entire inhabited area would, one would think, render the country a perfect hot-bed of the disease.

During the actual rise of the Nile, when the whole country becomes a shallow sea, the conditions are no doubt not really favourable to the multiplication of Mosquitoes, but as the waters recede; but for the fact that the restricted area available for cultivation renders every square foot of value, the conditions are naturally ideally favourable to the spread of the disease. Nevertheless, Dr. Sandwith, of Cairo, assures me that, although present, malarial disease is neither common nor serious in the Delta, and a few walks among the fields near Cairo, showed me that the entire cultivation was really of the best garden type, and that land and water were alike regarded by the fellaheen as far too precious to be wasted as sites and material for puddles.

Celli regards meadow land as unfavourable to the development of malaria. In the European sense of the word cultivation of this description is so exceptional in the East that it can have but little influence, but in Europe level pieces of land with a high ground water level are commonly chosen for pastoral purposes, and the careful levelling of the fields, together with the thick covering of grass, must necessarily go far to prevent the formation of permanent puddles; and the disappearance of malaria from England is probably largely due to the substitution of pastoral for arable agriculture throughout the country.

This disappearance, it will be noticed, dates from the time when the improvement of means of transport so cheapened imported corn as to render the cultivation of cereals in England unprofitable. At that time quinine was so expensive, and its proper administration so little understood, that it was administered in doses so small that it could have had but little effect in checking the disease which, nevertheless, had practically disappeared from the country before the great fall in the price of the drug rendered its full administration practicable.

I have been told by a druggist who was in business in the fen country while it was still malarious, that the popular remedy was then the prophylactic use of opium.

It was quite common for a farmer's wife to carry home along with her other weekly market day purchases, a half pint of laudanum; but he was but rarely asked for quinine. Now while there is a certain amount of evidence tending to show that the habitual use of opium has some protective influence against malaria, it is certainly incapable of destroying the parasite, and it appears on the whole unlikely that the use of drugs can have had any appreciable effect in stamping out the disease, which is more probably due entirely to alterations and improvements in agriculture.

The Effects of Human Occupation.—Given the necessary climatic conditions, it is man himself who is the most efficient of all agencies in bringing about the conditions that favour malaria. The human being is essentially a digging animal, and, whether it be the savage, who scoops up a few handfuls of mud wherewith to smear the wattles of his hut or the modern engineer with his steam navy, the result is the same less or more, *viz.*, depressions of the surface, and hence puddles, and it cannot be too often insisted upon that it is the small, unnoticed puddle close to the dwelling, and not the large, but distant marsh or pond, that, for practical purposes, is the real nursery of malaria. The large tank or tanks that are to be found in almost every Indian village are generally far too dirty for the taste of even the none too particular Indian species of *Anopheles*, but with us, as with most semi-civilised communities, mud forms not only the main material of domestic architecture, but also of house decoration. At frequent intervals the careful Indian housewife smears the interior of her home and the little platform before it with a mixture of mud and the dung of the sacred cow, and the result is certainly to give an appearance of cleanliness that could hardly be otherwise obtained for so small an expenditure. In Zululand, and, I believe, generally among African tribes, the same mixture is employed. But though the Hindu lady likes to keep her house neat in this way, both she and the goodman are tolerant of untidy surroundings to an extent that will be scarcely believed in Europe, and the result is that the ground round the house soon becomes honeycombed with small excavations, which in the rains get filled with fairly clean water. Nor is the European one whit less blameworthy.

Apart from the special malaria-brewing tanks already described, with which most of our gardens are furnished, there will be found close to every building, whether it be the cottage of the Eurasian clerk or the imposing barrack or law court, an excavation of corresponding dimensions, from which has been taken the earth for its plinth; and rarely or never is any attempt made to fill up or drain the hollow so formed.

Further, as the surroundings of European dwellings and official buildings are usually kept fairly clean, the results to the inmates, as far as malaria is concerned, are even worse than those of the tanks that have originated in the same way round a native village.

The results of public works are equally disastrous on a

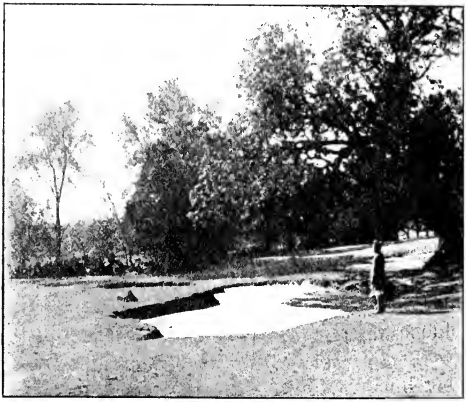


Fig. 34.—View in an Indian cantonment, showing, in the foreground, a pond resulting from the excavation made to furnish the spoil required for the plinth of a bungalow, which lies just behind the trees.

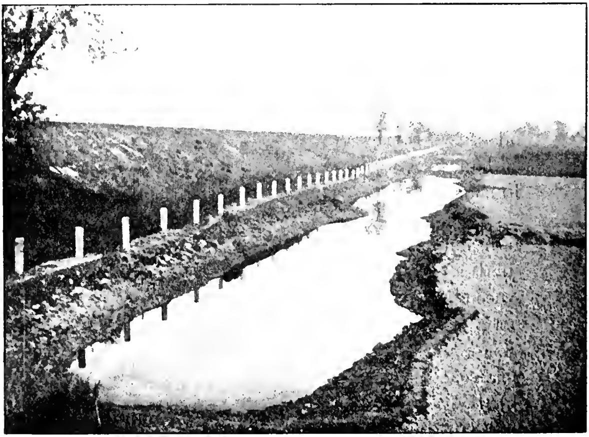


Fig. 35.—"Borrow pits" beside an Indian railway.

larger scale. Every road and railway has, on either side of it, a continuous chain of "borrow pits," which, in rainy weather, form simply ideal nurseries for mosquitoes of all sorts.

It is obvious that, in many cases, these pits might easily be converted into excellent surface drains, but unfortunately, partly to facilitate the measurement of the work done by the excavating gangs, and partly to prevent the scouring effect that might be exercised by a continuous channel, the engineers carefully avoid doing so, and leave them as a chain of pools, which remain continuously full of water for months together. The results, especially where a road or line passes close to habitations, are so serious that, at very least in such situations, the making of such undrained hollows should be prohibited by departmental regulation.

The results even of avowedly sanitary works are unfortunately too often no better. The untoward effects of pure municipal water supplies, on modern lines, have already been adverted to, and very often those of attempts at surface drainage are no more fortunate.

On the next page are four photographs of pools in the course of the local surface-drainage system, all taken within a few hundred yards of my bungalow, and it would have been perfectly easy to fill a large scrap-book with similar prints. In hill stations, such as Naini Tal, the small masonry tanks, such as are shown in the two upper illustrations, form almost the only nurseries for Mosquitoes to be found in such places, as the precipitous lay of the ground is very unfavourable to the formation of natural collections of water.

Celli (C. M., p. 147), also emphasises these undesired effects of otherwise invaluable public works, and is particularly emphatic on those of railways. Railways, and necessarily also ordinary roads, when embanked, may also often increase the malariousness of a locality in another manner; for when, as is often the case, they chance to be carried across the natural lines of drainage, they inevitably bank up the drainage of the land lying above them ; and this, too, in spite of an apparently liberal allowance of culverts.

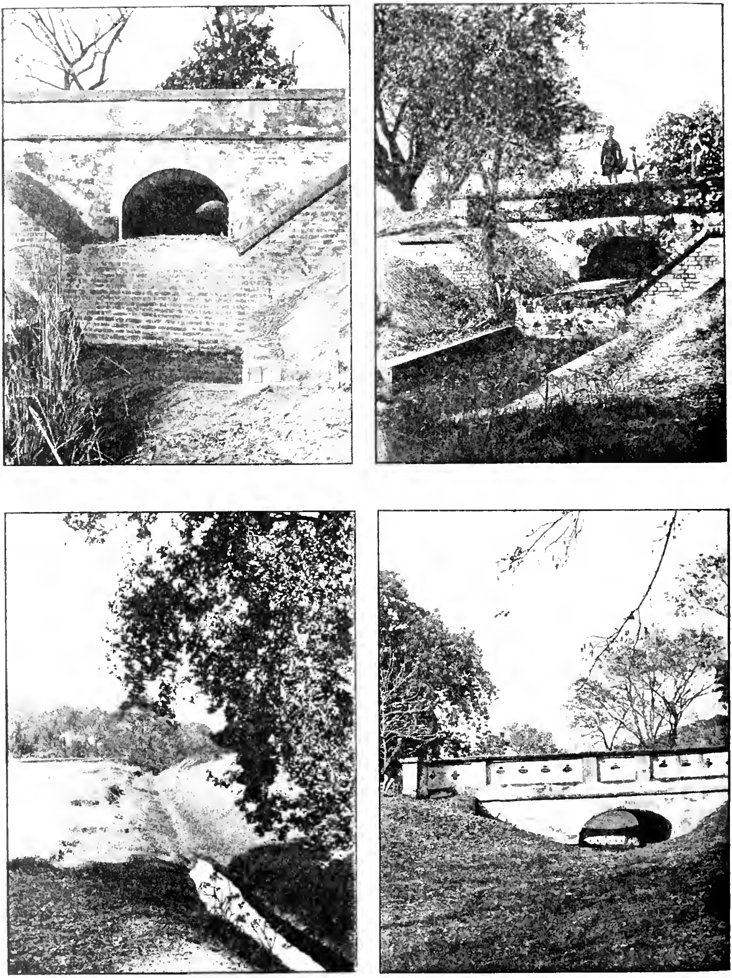


Fig. 36. Collections of water in the surface drains of an Indian cantonment. In the two upper photographs the pools are the result of an engineering expedient to break the fall of the water; in the two lower they are accidental.

When travelling by rail during the rains in India, nothing is more common than to see all the country on one side flooded, while the other is comparatively dry.

On this account railways, like canals, should, as far as possible, be made to follow the water-shed, and where this is out of the question, the provision of drainage openings should be much more liberal than is usually the case. It must be admitted that the European cannot be held entirely blameless in such matters. Putting aside the relationship of puddles to malaria, the presence of such irregular collections of water has long been recognised as unhealthy, and to say the very least they are untidy, and would not be tolerated in any advanced European country on this last score, if on no other. In countries such as India, our public works should be made standing object-lessons of the superiority of European methods and system.

To remedy the results of past carelessness would undoubtedly be extremely costly; but, in the majority of cases, they might have been entirely avoided by the exercise of a little care and foresight, and that with little or no enhancement of the first cost of the work. The mere fact that the excavation of a continuous ditch, in place of a chain of borrow pits, may endanger a railway embankment by "scouring," shows what efficient drainage cuts they might be made, and further conclusively demonstrates how badly they must be needed. Engineers, moreover, admit that for one embankment that succumbs to "scouring," a score collapse from the mere water-logging of their foundations in time of flood, so that the neglect to favour efficient drainage in every possible way can hardly be defensible, even from a strictly technical point of view; and I cannot doubt that the ingenuity of our engineers is fully equal to devising a remedy for the scouring of drainage cuts placed beside embankments, if their provision be once admitted as a necessity. In the case of buildings again, in nine cases out of ten, the earth required for their plinths might be advantageously excavated so as to make drainage cuts to the nearest natural line of outfall and so become a source of improvement, instead of damage, but in practice the matter is mostly left to the native contractor who takes up the job, and all he has to consider is how he may place the required number of cubic feet of soil in the place indicated, with the least possible expenditure of money or thought.

The extent to which this burrowing for building material has been carried, in and about many Indian towns, is incredible, and the haphazard way in which it has been permitted to be carried on has resulted in the absolute wasting of large areas of valuable, culturable land, in a country where it can ill be spared. As a general rule, these "tanks" are far too dirty to favour malaria, for it is not uncommon to find that some zealous amateur sanitarian has deliberately carried the foul bazaar drainage into them; but there are exceptions to this, and there can be no doubt that the taking of earth for building and domestic purposes should be systematised by local bye-law in every Indian municipal area; for there are other tropical diseases than malaria, and the foul emanations of these lakes of putridity cannot fail to be harmful, even where they do not form nurseries for the transporters of malaria. The main obstacle to the removal of these tanks lies in the difficulty of obtaining, within any reasonable distance, sufficient soil to fill them in; but it is not really necessary to fill them up to the level of the ground around them; for, provided that all surface drainage into it be diverted, any given area is quite capable of absorbing all the rain that actually falls within its own limits, and provided it be carefully levelled, no permanent puddles will result, however low-lying it may be, at any rate in Upper India. Now, without exception, these hollows are very irregular, not only in outline, but in depth, and it is only their deepest parts that remain full for any considerable length of time, so that the only practicable way of dealing with them is not to attempt to fill them up, but to level the area they include; obtaining the earth required to fill in the deepest parts by cutting away from the sides so as to bring them to a regular outline, and slope of bank.

A good deal of spoil too can usually be obtained by digging cuttings to cut off the drainage of the neighbouring land, and in a few cases much more can be got by cutting a ditch from the new level of the floor of the old tank site to the nearest *nullah*.

The following photograph shows the progress of an experiment that I made in this direction. At the time of my taking over charge of the local jail, the site of the newly levelled ground in the foreground was occupied by a tank of some size, which had originated in the usual way; in this case to get earth for the building of the jail. Being within

FIG. 37.—Levelling up the site of an actual *Anopheles* tank.

jail limits, although in a waste corner, the contents were quite clean enough for the local Mosquito larva, and the place formed one of the principal breeding places supplying the jail. Some of the deepest parts must have been eight or ten feet below the level at which the prisoners are seen dumping the spoil gained from the banks; and, one way and another, I got about a couple feet more of material, with the result that a plot of valuable garden land was substituted for an injurious collection of water. Moreover, as far as I can judge, the rental of such a plot would have paid well for the amount of labour expended. I was led to try the experiment by noticing a large levelled depression, which had once been an old-standing brick field, and which an enterprising native had converted into profitable garden ground, and finding that, though without any proper outfall, the owner was in no way troubled with flooding.

In many cases in towns, hollows of this sort are grouped together in considerable numbers, with intervening strips of high ground, and, in such cases, these would supply ample material for levelling, and the results could scarcely fail to be remunerative, as cultivable land in such situations always commands a high rental.

The effects of the surroundings that go to make up the conditions of town as contrasted with country life are all in favour of the urban resident. Where indeed could a generation of *Anopheles* find a secure nursery for their larval youth in the heart of such cities as London or Paris?

Nearly forty years ago Dr. Wood, of Philadelphia, pointed out "the extraordinary and very important fact," that "miasmata are neutralised, decomposed, or in some other way rendered innocuous by the air of large cities. Though malarious diseases may rage round a city, and even penetrate the outskirts, yet they are unable to penetrate into the interior; and individuals who never leave the thickly populated parts almost always escape" ("Chambers Encylop.," vi., p. 438, 1868). The true reason for this is, of course, the careful utilisation of every square foot of surface; the grading and paving of the streets, and the resulting impossibility of the existence of puddles sufficiently permanent to rear a brood of larvæ; and it follows from this that it is only in towns in which the resources of civilisation are highly developed that this favourable influence of urban life is very noticeable.

An unpaved, ill-drained town may be as malarious as any country district, and as a matter of fact, few of our Indian cities are sufficiently advanced in these respects to gain any marked advantage over the surrounding country.

Most of them have arisen from the growth and amalgamation of a number of contiguous villages, and strips and islands of the old rural area are commonly left between the more closely packed houses of the old village sites. The only "up country" city, indeed, with which I am personally acquainted which at all approximates to the conditions of our large European towns is Benares, but even there the back streets and lanes are mostly unpaved, and I have found puddles teeming with *Anopheles* larvæ in the very heart of the sacred city, though most of these were fed from the municipal hydrants, the untoward effects of which have already been noticed in connection with the effects of water supply on malaria.

Fortunate indeed it is that such is the case, as, malaria or no malaria, the value of these breathing spaces is incalculable, for a continuous mass of houses such as form our large European towns, inhabited by a population of oriental habits, would be a perfect hot-bed for the breeding of plague and other bacterial infections.

Outside the bazaars, or business quarters, continuous lines of houses are rare. In residential neighbourhoods, owing to the necessity for privacy imposed by their social system, each house is a hollow square of which one or more sides are usually simple walls of no great height. As not only the human inmates, but commonly also cattle and horses, have to be accommodated, the size of this inner court even in modest households is often considerable, and the residences of well-to-do citizens have often considerable gardens. The latter form ideal breeding places for mosquitoes of all sorts, but the domestic puddles of the more usual enclosures are generally far too foul for the larvæ of even the none too fastidious *An. Rossii*, though *C. fatigans* breeds in abundance about them.

The anti-malarial influence, then, of town life is less marked in India than in Europe, but it is nevertheless, I am inclined to think, quite perceptible, for though no reliable statistics are available, most officers who have been engaged in our civil medical administration appear to have a general impression that their towns are less feverish than the districts surrounding them.

Judging from descriptions, this effect should be more marked in Chinese cities than in other types of oriental civilisation; but whatever it may amount to, the advantage must be purchased at too high a price.

When, however, the Indian townsman is driven to overcrowding by special local conditions, he packs with a closeness that puts the Western slum-dweller to shame, and an enormous population may be concentrated in an area too small to be beyond the influence of the nearest breeding places even in its most central parts.

There are, for example, parts of Bombay where the density of population probably exceeds that of the worst European slums, but the dimensions of this "congested area" are not considerable.

As, however, the domestic interiors are usually too unsavoury to furnish nurseries for the really dangerous species, it is certain that the paving and draining of our large towns will do much to diminish municipal malaria.

A good deal indeed has been done, and is in progress in this direction, but as the constantly recurring phrase of conventional Indian self-depreciation has it, "We are very poor folk," and improvements that appear the simplest necessities of urban sanitation to the European expert are quite beyond the pockets of the community, however enlightened the views of the Government may be.

The paving of streets and the introduction of systematic surface drainage are of course large and costly undertakings, which can only be carried out gradually, but it must not be supposed that nothing can be done in the mean time.

Nine-tenths of the nurseries of *Anopheles* larvæ that I have met with within municipal limits are of such small dimensions that they might be put an end to by means of a few shovels-full of earth, and a few men trained to systematically fill up the puddles as they formed might undoubtedly do a good deal to diminish municipal malaria.

Such a measure is of course rather of the category to which belongs chemical disinfection, than to that of radical prevention, for I am perfectly aware that new puddles would form as fast as the old ones were filled up, but these could do no harm if filled up in their turn.

Let it be at once admitted that the extermination of Mosquitoes may be impracticable; but it does not follow that we should fold our hands and make no effort to prevent their fullest multiplication. Every *Anopheles* puddle filled up means one focus the less of infectible material, and the mere fact that without any specially directed sanitary efforts the city of Rome is malaria free, though standing in the midst of most deadly surroundings, shows how much may be effected.

There are millions of unvaccinated persons in India, and everyone of them is a possible focus of variolous infection, but no one can doubt that vaccination has effected an enormous diminution of small-pox in the country, though the impossibility of securing universal vaccination might have served equally well as an argument for attempting nothing in the matter. In the wide expanse of the country in general such detailed measures are certainly impracticable, but in limited areas, such as those of municipalities, much might undoubtedly be done by the intelligent application of our present knowledge, albeit of a "hand-to-mouth" character, and that at but a trifling cost. Much also might be done by the enforcement by municipalities of bye-laws prohibiting the indiscriminate honeycombing of the surface for earth for building and plastering purposes. Such a regulation need not give rise to any real inconvenience, as tanks and other excavations of a size unlikely to serve as nurseries for larvæ are so numerous in most such municipal areas that it would cause no hardship to insist on the earth required for such purposes being taken from their banks. The systematic filling up of small depressions with any hard rubbish that may be available is another measure that obviously suggests itself, and as the most dangerous collections are generally quite small and shallow, need not be beyond the pecuniary resources of even small places.

In the North-west Provinces and Punjab I have rarely met with any large collection of water or "tank" within the limits of a native town which contained *Anopheles* larvæ. Most of them, indeed, are too foul for even the least fastidious of *Culices*, though, within cantonments, where their contents may be little else than rainwater, they occasionally do so. In provinces, on the other hand, where the rainfall is heavy, and especially in such tanks as lie in the line of a natural drainage depression, and are hence scoured out by heavy falls, such tanks may contain larvæ; but I doubt if they are likely to do so for any considerable portion of the year, though it is hazardous to attempt to generalise in such a matter, as exact local knowledge is alone of any value.

It must be remembered in this connection that, in Lower Bengal, tanks are largely used as sources of drinking water, and such tanks are more or less guarded from pollution, for callous as the Indian may be in this matter, there are few who would drink the water of a town tank in Northern India; and any tank containing water that would be regarded as drinkable, even from a native point of view, would certainly form a congenial habitat for *Anopheles* larvæ, and the improvement of municipal sanitation against malaria will be in such places proportionally difficult.

Where not indispensable as sources of drinking-water, such tanks might doubtless be dealt with by the use of larvicides; but in such places these tanks are both large and numerous, so that the expense would be a large and constant one, and we are further met with a difficulty that must be fatal to the success of all temporary, and therefore continuous measures in India—the difficulty of providing adequate intelligent supervision.

Another reason why not only cities but also smaller long-inhabited sites tend to become less malarious is that the ground level is being slowly but continuously raised by the accumulation of the ruins of older buildings on which, from time to time, new buildings are raised. Often, in India, village sites are of an unknown antiquity, and in such the tortuous village streets wind their way always up hill to its centre, where often there still stands the more imposing home of the headman. The older the hamlet, the higher the hill, and some have lasted so long that the site of the hut from which it grew may now be 50 feet or more above the unbroken level of the surrounding plain. Now it is obvious that this self-raising action must have a most beneficial effect by favouring surface drainage, and this affords us a hint that might well be taken advantage of in planning new settlements on ground reclaimed from the desert by canal irrigation; only in place of gaining the earth by honey-combing the plain hard by with a network of foul tanks, the spoil should be taken from carefully planned drainage cuts carried along the natural lines of drainage. Surely, considering the vast outlay involved in the construction of a great canal, it should be a good investment to spend considerable though comparatively trifling sums to secure health for the colonists who come to reap the plenty brought by the fertilising water.

Such being the conditions that influence the prevalence of Mosquitoes, it may be asked whether the seasonal prevalence of these insects really corresponds with the intensity of malarial disease? On this point the figures given by Celli are sufficiently convincing, but for many reasons it is difficult to quote statistics of corresponding value for India, though, speaking generally, no doubt can be entertained as to the fact of the coincidence, or rather consequence.

The connection is, however, of a kind that is much more obvious to the working physician that to the statistician. The former well knows that, in Northern India for instance, his really troublesome malarial cases occur between the middle of August and the end of November, and that those which are admitted between January and August are mostly recurrences, generally lasting only a few days, and of a comparatively mild type.

These relapses, however, go to swell the number of admissions in months during which, in many parts of India *Anopheletes* are, practically speaking, as rare as the dodo; and thus it happens that in spite of the infinite amount of labour that is wasted on the statistics that lumber the record rooms of our offices in India, we are still quite without any really reliable information as to the seasonal prevalence of malaria.

Apart from the fact that hitherto no attempt has been made to distinguish between primary and recurrent attacks, a distinction which, it must be admitted, it would be very difficult to make in practice, the diagnosis between the various forms of pyrexial disturbance, that in India and elsewhere in the tropics are grouped together as "fever," has hitherto been made in a very loose way.

No statistics as to malaria can be considered to be exact and definite in which the diagnosis is not based on the ascertained presence of the parasite in the blood, and as yet such statistics on any considerable scale are entirely wanting. No doubt in the majority of cases the symptomatic diagnosis of malaria is perfectly correct, but we are only now commencing to differentiate exactly between remittent, malarial, typhoid, and Malta fevers, and on the other hand there can be no doubt that numbers of cases of transient pyrexia, due really to digestive disturbance giving rise to the absorption of toxic materials from the bowel, and to various other causes, are returned as malaria. Such cases are very common in the dry, hot season, and in a large proportion of them certainly, the most careful examination fails to demonstrate parasites in the blood.

A certain number of course are really malarial, but are recurrent attacks which, as far as my limited experience extends, appear in this part of India to be usually characterised by the presence of the small, round, unpigmented forms unaccompanied by crescents in the peripheral blood.

In spite, however, of these sources of fallacy the figures at our disposal are really sufficiently conclusive for all but the most exacting.

Taking the returns of intermittent fever as the least open to diagnostic errors, we find that the last available report of the Sanitary Commissioner with the Government of India shows that in the European army the monthly admissions were as follows :—

	Jan.	Feb.	Mar.	Apl.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Bengal ..	368	181	203	316	493	236	387	899	666	754	446	323	5,272
Punjab ..	344	178	206	357	585	414	530	437	526	517	223	150	4,467
Madras ..	245	146	150	162	152	175	217	316	262	352	430	224	2,831
Bombay ..	296	235	197	216	427	355	317	360	270	306	212	162	3,353
All India ..	1,253	740	756	1,051	1,657	1,180	1,451	2,012	1,724	1,929	1,311	859	15,923

These admissions took place on a strength of 67,697, so that roughly speaking about a quarter of the entire force suffered from malarial fever during the year.

In the native army the seasonal prevalence of the disease follows a closely similar course.

	Jan.	Feb.	Mar.	Apl.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Bengal ..	491	265	276	309	369	260	374	933	1,167	1,596	1,339	868	8,247
Punjab ..	668	514	399	409	676	722	983	1,704	1,532	2,112	1,038	590	11,347
Madras ..	442	385	262	241	382	358	538	644	489	696	658	476	5,571
Bombay ..	516	399	387	320	615	417	367	556	601	802	543	359	5,882
Hyderabad Contingent	147	84	107	56	88	73	63	81	66	124	94	94	1,077
All India ..	2,408	1,760	1,630	1,480	2,417	1,992	2,446	3,988	3,871	5,330	3,682	2,419	33,434

This on a strength of 128,529, and again it will be seen that roughly a quarter of the strength suffered from malaria.

Our European and native armies in India are not strictly comparable, as the latter is a long service force, necessarily composed of men, older and more seasoned to soldiering than their European comrades; but in spite of this, while rather *less* than a quarter of the former suffered, the latter did so in the proportion of rather *more* than a quarter. Something of the difference is doubtless due to the more sanitary tendencies of European personal habits; but making all such allowances, it must be admitted that if the native has acquired any immunity he has done so to so small an extent that it is a factor of too trivial importance to be worthy of practical consideration.

It is further noteworthy that in specially malarious districts, such as the Bengal and Orissa group of stations, where the relatively greater preponderance of genuinely malarious cases tends to minimise the fallacy of included cases of diseases simulating malaria, the seasonal variations in the intensity of malaria are much better shown than in less malarious places.

In all stations where the seasonal prevalence of Mosquitoes has been made the subject of careful investigation, the period of greatest intensity of malaria has been found to coincide with that of the greatest prevalence of *Anopheletes*.

As a striking example of this I may instance that writing to one of my numerous correspondents, Lieut. Glen Liston, I.M.S., who is quartered at Ellichpur in the Berars, to ask him if there was any reason to believe that one of the methods of securing permanence of the species might be the survival of retarded larvæ, he replied that there, *Anopheles* was breeding already at the date of writing (January), and sent me numbers of specimens including some in tubes, one of which actually reached me alive. Now it is a curious fact that in the above-quoted table, Ellichpur is one of the few stations in which the largest number of malarial admissions takes place in January, the monthly admissions being 31, 12, 10, 3, 7, 2, 8, 14, 9, 29, 21, 15; total 161.

In Indian jails the figures are closely similar. Out of an average strength of 110,016, there were 37,776 admissions for intermittent and 734 for remittent fever, the largest number of admissions being in the months of July, August, September and October. The proportion of admissions to strength, about one-third, is somewhat higher than among the troops, but this is only to be expected when the inferior physical condition of the class of inmate is remembered. The interiors of most Indian jails are models of cleanliness and good sanitation; but the boundaries of the hygienic oasis are abruptly limited by the jail walls, and immediately outside, the excavations that have yielded the material for their construction, brick pits, and ill-contrived drains, too often furnish breeding places in abundance for the malaria-carrying Mosquito.

Moreover, the strict prohibition against the extra-mural employment of convict labour greatly ties the hands of the Superintendent in his efforts to improve the sanitary conditions of any spot beyond the four walls.

Having now considered, as far as space will allow, the conditions that influence the prevalence or otherwise of Mosquitoes, it remains to be considered what can be done to diminish the pest. The malarial parasite has, it must be remembered, two distinct stages of parasitic life, each with its special host: Mosquitoes of the genus *Anopheles* during its period of sexual life and multiplication; the human subject during its non-sexual stage: and it is obvious that the parasite may be attacked in either, or both of these stages.

The stage of the parasite that is passed within the human subject may be dismissed with a few words. As the end of all our efforts is the preservation of the host, all that can be done is to poison the parasite with quinine, or to isolate cases of malaria in such a manner that they cannot infect a relay of Mosquitoes. As regards the first method, a good deal is being done by the Indian authorities to popularise the use of quinine by distributing it through the agency of the Post office at cost price through the length and breadth of the land. At every Post office in India one can buy for a farthing five grains of excellent quinine, and though the amount so distributed, when stated as so much *per* head of the population, is insignificant, the amount sold is already much more considerable than most of us expected would be the case among a people so slow to avail themselves of new advantages as that of India. Within the present year a new effort in the same direction has been made by enlisting the agency of land-owners to distribute the drug in the same semi-gratuitous fashion to their tenants; and almost the last official duty it fell to the writer's lot to perform was to compile an indent for something like a hundred-weight of quinine for distribution in this way in a single district, a quantity which would have made his earlier administrative chiefs aghast with astonishment. Added to this, the invaluable services of Sir William King, F.R.S., late of our service, in establishing the cultivation of the cinchona plant in India, have revolutionised the price of the drug, and thereby conferred an incalculable boon not only on India but on all malaria-stricken humanity. The absolutely gratuitous distribution of quinine has been suggested, but personally I doubt if the cost to the consumer would be perceptibly less, for State benefits of this sort are woefully liable to be lost in lubricating the smaller administrative channels through which they must needs pass after flowing beyond the ken of the large European distributory. In advanced countries, such as Italy, it is quite possible that the isolation of malarious patients might become practicable, especially as the large towns afford places free from the harmful species of Mosquitoes in which patients could be treated in the ordinary hospitals, without any special precautions for keeping out the insects; but apart from the stupendous number of cases to be dealt with, such measures are out of the question in any malarious British dependency, and most emphatically so in India, where any attempt at enforcing isolation would infallibly result in political disturbance of the most serious character. To anyone who has passed a few months in the East such a statement will seem a superfluous truism, but so astounding and scathing are the comments on Indian administrative matters that are made by confident critics, as conversant with our social and climatic conditions as they are of those of the planet Mars, that it may not be out of place to record it.

Turning now to the stage passed within the Mosquito, it is obvious that as we have no means of distinguishing infected from healthy insects, the solution of the problem lies either in the destruction of mosquitoes, or by avoiding being bitten by them. The consideration of the second class of precaution comes under the heading of personal prophylaxis, while the first must depend mainly on communal action. Measures designed to diminish the multiplication of Mosquitoes are of two classes, viz., those designed to check their increase by doing away with the conditions that favour their breeding, and secondly, those that aim at the extermination of the race while leaving them to multiply at their own sweet will. Of the two, the first is, without question, the more efficient, but the practical sanitarian will not disdain to avail himself of the other class of expedient whenever it is practicable. It will be years before much can, however, be accomplished in the way of the really radical measures of the first class, and for the present we must content ourselves mainly with temporary expedients.

And here it may not be out of place to comment on the attitude of those who have been heaping cheap ridicule on those who have been working on this subject. The favourite expedient of this class of humorist is to impute to a man opinions he has never expressed and then to demonstrate how silly he must be to hold such doctrines. Applied to their own persons and profession they would be the first to resent the assumption that the shoemaker is, *ex officio*, incapable of using a last; and yet they will have it that the fact of a man making a life-long study of sanitary problems renders him absolutely incapable of forming a rational judgment on the subject. The stock gibe of these good folks is to accuse Major Ronald Ross, and others associated with him, with proposing to "exterminate Mosquitoes." Now I can assure them that though he labours under what they regard the incurable disability of being a scientific investigator, and a most distinguished one at that, he is, even outside his laboratory, no simpleton; and no one but a fool would propose so impossible an undertaking, least of all a naturalist who has made a close study of the life-history of these insects. Between this and asserting that it is possible to diminish their numbers there is a very wide gap, though even on this score he has been singularly moderate, for the utmost that he has ever suggested as practicable is to check their free multiplication in certain special localities; and of the practicability of this there can be no possible doubt.

While, however, none of us see any immediate prospect of being able to "stamp out malaria" or of wiping out the entire family of gnats, we find in that no reason for sitting with fatalistically folded hands, or of neglecting to utilise every possible method of keeping down their numbers, whether by doing away with every removable breeding place, or by directly destroying the insects in any stage of their existence. The fact is that there still remain numbers of people who regard disease as an inevitable infliction, which can only be dealt with by drugging, and to whom the conviction is strange that every disease must necessarily have a definite cause, which, sooner or later, will be discovered in all, and is in a number of instances already known. The older frame of mind saved all trouble in thinking, and therefore, quite unconsciously, the modern standpoint is repugnant to them, and they resent being told that if they plan their gardens so as to be perfect incubators for Mosquitoes and refuse to adopt the most simple precautions against being bitten, they have only themselves to thank if they get fever. That though now and again the insect may have been reared elsewhere, the chances are nine to one that the gnat that inoculated them would never have seen the light had not they themselves provided his parents with every possible convenience for rearing their family.

As a matter of fact, every naturalist would scout the idea that we can hope to perceptibly diminish the number of Mosquitoes in tropical regions; and can probably advance better grounds for the faith that is in him than those who picture him as proposing to root out the race; but he does not share in popular notions as to these insects "appearing" from no ascertainable origin, or that they can migrate or be carried long distances by the wind. He knows on the contrary that for all practical purposes every locality breeds its own Mosquitoes, and that whenever he sees one of these insects he may be sure that the water it was reared in is not a quarter of a mile off. Given that a place be destitute of collections of water suitable for rearing the larvæ and it will be necessarily free from Mosquitoes, even if there be places that swarm with them within a mile's walk. From this it follows that to secure a local immunity from them is almost always within the range of possibility, and may in a few cases be a quite simple matter, and resolves itself essentially into a question of expense. Given that we have free access to the entire area, and liberty to deal with every breeding pool we discover as we think best, there are very few collections of water that cannot be drained, filled in, or in some other way rendered unfit for the rearing of Mosquito larvæ; but in many cases the cost would be prohibitory, as for example where the insects larvate in rice fields, and if we desire to prevent the multiplication of *Anopheles*, we must make up our minds to prohibit the cultivation of the staple food of the population—too high a price to pay, even for immunity from fever. On the other hand there are many places where the number of possible breeding places are small in number and limited in extent, and where accordingly immunity can be secured at very trifling trouble or expense. The instance of the successful use of kerosine as a larvicide thirty years ago, in America, quoted in the first edition, must have been an extreme example of this. In this case, L. O. Howard ("Insect Life," vi, p. 90) describes how a residence was freed from Mosquitoes by killing the larvæ in a single pool some 4,000 feet square. In by far the majority of places the experiment would, at best, have proved but partially successful, owing to the existence of alternative, but unsuspected breeding places.

To mention another instance: There is, I have no hesitation in stating, no good reason why the European residents of most stations in Upper India should be much troubled by Mosquitoes in the hot weather. The fierce, dry heat has dried up every possible natural breeding place, and the swarms of Mosquitoes that render life a burden are bred exclusively in the garden tanks described above, and in other easily discoverable domestic collections of water. If each resident would devote a few minutes once a week to seeing that his servants emptied these and carefully cleaned them out, the nuisance would be reduced to a minimum. Moreover, in many places the individual houses are so scattered that a considerable degree of personal immunity may be secured by attention to one's own bungalow alone.

As the quarter in which they reside is usually quite isolated from the houses of natives other than their own domestic servants, the area is entirely under their own control, and all that is required is a little friendly co-operation.

From what has been said it will, I think, be clear that it is impossible to prescribe any generally applicable method of dealing with malaria by radical measures intended to diminish the prevalence of Mosquitoes, and success can only be hoped for by a careful study of local conditions, guided by a clear understanding of the conditions that favour the multiplication of these troublesome insects.

The first step is to discover the pools where they breed and the seasons at which they do so. This done, we have to consider why these pools exist, and if possible to remove the cause. Unfortunately in many cases the breeding places, although small, are so numerous that the task of dealing with them in detail is almost hopeless, and would involve heavy and continuous expense. This may be due to the character of the soil or to waterlogging, and in such cases only extensive drainage works, surface and deep, can be expected to afford any permanent benefit. As a rule it is too costly to attempt anything but surface drainage, and even this is by no means an easy matter, for unless the drains be most carefully levelled and paved, they generally during the rains become chains of small puddles, which form the favourite nurseries for the noxious "dapple-wing" Mosquitoes. But the paving of drains on any adequate scale is a most costly business, and except in closely populated municipal areas out of the question on the score of expense. In most cases, therefore, they are better restricted to a few deep cuttings, and to straightening and clearing the natural outfalls, for I am convinced that the multiplication of what are called in India "kachcha" drains, *i.e.*, shallow unpaved gutters, does more harm than good, and that in cantonments and in other places where sickliness is so costly to the tax-payer as to justify any reasonable expense on sanitation, it would be better to systematically drain the area by means of agricultural "subsoil" drains. As already pointed out, it is a misnomer to speak of these by their usual name, as they are placed immediately beneath the surface, and so cannot directly affect the level of the subsoil water, and they really drain only the surface; but as its contour remains unaltered they cannot lead to the production of puddles in the same way as mere open cuttings in the soil. Deep cuttings, on the other hand, though equally irregular, do not for some reason so often harbour *Anopheles* larvæ. It may be that this is because the water is hidden from the female Mosquitoes when seeking for a place wherein to lay their eggs, but a more probable suggestion, for which I am indebted to Dr. St. George Gray, of St. Lucia, is that the larvæ require plenty of light.

It is in level country such as the Indian alluvia that conditions such as the above are generally found. On undulating ground surface drainage may usually mainly be left to care for itself, and in such a place as Freetown, Sierra Leone, to judge from the reports of the two Malaria Commissions, no extensive drainage measures can be expected to be of any proportionate value. Here the breeding pools are basins of solid rock which necessarily cannot be drained, and as far as one can judge, the measures that suggest themselves are the regrading of the banks of the rocky watercourses, and the improvement of the roads and other places where the rock lies bare, and the formation of these peculiar puddles thereby becomes possible. Possibly, where not exposed to traffic, many of these pools might be rendered innocuous for a considerable period by filling them with sand; but this aside, the main reliance must be placed on larvicides, and I hardly understand why Drs. Stephens and Christophers should be disappointed in the results of their employment (R.S.M.C., p. 43) on the ground that the larvæ reappeared as soon as the use of the larvicides was discontinued. The effect of such agents is at most a matter of days, and there is no possible reason for the Mosquitoes not returning to pools so treated the moment their effects have disappeared. The main objection to the use of these agents is not that they are wanting in efficiency, but that success can only be obtained by continuous trouble and expense, but where the breeding pools are in manageable numbers, and they cannot be done away with except at prohibitory expense, it is as reasonable to keep up a staff of puddle oilers as of scavengers, for the result of the labours of the street sweepers is no more permanent than that of the larvæ destroyers, and it is as fair to object on this score to the continuous employment of the one municipal servant as the other. I feel perfectly sure that Ross never expected to obtain any advantage from the use of such agents without their employment being continuously and systematically kept up, and for the purposes of an initial experiment such as his, or in any case where immediate results are demanded, no other plan is applicable. Sanitation against malaria on radical lines will everywhere require years of continuous and progressive effort, and as long as it remains uncompleted we must necessarily depend upon hand to mouth expedients, such as the use of larvicides. But whatever plan be adopted those who hold the purse strings must reconcile themselves to the fact that the prevention of malaria is impossible without considerable outlay, and they must further be prepared to see a great deal of it expended, though not really wasted, in futile attempts, for we shall no more immediately hit upon the best method of dealing with this difficulty than we have in the deodorisation of sewage or any other sanitary problem. For the present, while radical measures should always be kept in view and undertaken as funds and opportunity permit, we must content ourselves with temporary methods, and it is well to remember that though we may not be able even locally to "exterminate" the carriers of disease, it is always worth while to diminish their numbers. Every breeding pool filled in or otherwise dealt with, means one possible focus for dissemination the less, and a great deal might be soon accomplished by the systematic attention to the immediate neighbourhood of barracks and other dwellings.

Turning then to measures of this class, it is clear that the insects might be attacked either in the aquatic or the ærial stage of their existence, but that they may be far more easily got at in the former. During their adult life, the only period during which much advantage is likely to be gained by attempts to destroy them is that of hybernation, and it has been shown that, in uniformly warm climates, they cannot really be said to hybernate at all. Where, however, they do so, their destruction is of the first importance, and, owing to the sluggish condition of the insects, not so impracticable as might be imagined. The impregnated hybernating females are, it must be remembered, the main hope of the race for the generation of the coming year, and their destruction means that of their posterity. Their numbers, moreover, are comparatively small, and the situations in which they are likely to be found can be predicated with tolerable certainty. I do not, however, propose that one should actually search for them, for the insects understand too well their business to make any search profitable; but it may be taken as certain that the nooks and corners of every room and native hut harbour numbers of them, and it is perfectly easy to destroy them by fumigation with sulphur employed in the same way as in ordinary disinfecting operations. The room to be dealt with should of course be closed up as closely as possible, but no elaborate arrangements for closing all crannies are necessary, as they succumb to a proportion of the vapour in the air that would be perfectly harmless to bacteria. It is very little use to fumigate with pure sulphur, as it burns so uncertainly that it generally goes out before half the material is consumed, and it is even more futile to burn the sulphur by throwing it on a charcoal brazier as is often done, because the result is mainly vaporised sulphur, which is quite useless. A very short exposure to the fumes suffices to kill the stoutest Mosquito that ever buzzed, but as the buildings to be dealt with are mostly extremely pervious, it is of the first importance that the sulphur should be burned very quickly, so as to produce a volume of sulphurous anhydride large enough to be lethal before the product of the portion first burned has time to escape. What is wanted, in fact, is a mild firework which will burn out in a very short time, but yet will not flare up to a dangerous extent. About one part each of nitre and charcoal to eight of sulphur answers well, the mixture being made up into pastilles weighing 4 oz. each, by means of a little gum-water, and dried in the sun. Pastilles of this description were made up for me by Messrs. Waldie, of Cawnpore, and I found that even in thatched buildings not a single insect was left alive. The floor of a bath-room, in which hardly any Mosquitoes could be found by any ordinary search, was found after fumigating in this way covered with dead Mosquitoes, a circumstance which gives a good idea of the effectual way in which they hide themselves. One pastille should be allowed for every thousand cubic feet of space. Merely for the sake of personal comfort, it is well worth while occasionally burning these pastilles in the hot season in bath-rooms and other favourite lurking places, as to do so costs but little either in cash or trouble, and the smell of the fumes disappears as soon as the place has been aired; but it is absolutely useless to do so if active breeding places are allowed to exist close by. To be effectual, fumigating should be done towards the close of the hybernating season, and should be performed during the heat of the day, when even the least sluggish are sure to be under shelter. I trust that no playful critic will indulge us with an arithmetical dissertation on the number of tons of sulphur required for the annual fumigation of every native home in India, on the gratuitous assumption that I propose to enforce some such measure at the point of the bayonet, for rudimentary statistical exercises of this sort are within the powers of the most modest mathematician, and it is needless to say that everyone who has served in the sanitary department in India knows far better than any others that it is quite useless to try to force or even persuade the native to adopt sanitary precautions of any sort within the precincts of his own house. The caution is hardly needless, as, if I remember rightly, some wit went to the pains of calculating the annual enhancement of taxation per household necessary to provide all native babies with a mosquito net, on no better grounds than because some one of us had been emphasising the importance of Europeans protecting themselves by their use. But though we cannot fumigate the Indian continent, there is no reason why the plan should not be adopted in the case of all barracks and other quarters provided by Government, and in cantonments where such natives as are permitted to reside within their limits, do so on the distinct understanding that their status is more or less one of sufferance, and on the understanding that they are willing to submit to the sanitary whims of those for whose use the area has been set aside, however unreasonable they may appear to people in their particular stage of civilisation; it would be not only justifiable, but feasible to insist on such a measure being carried out.

As each pastille costs no more than a Lee-Metford cartridge, the cost would not be prohibitory, and the annual bill for invaliding the men who have been educated to use the latter is so heavy that it would pay well to adopt any measure likely to diminish it; for the lessening of the annual invaliding roll by one or two names would more than meet the cost. In most parts of India the month of February would be the best time to apply such a measure. With this exception we possess no means likely to be of service in destroying the adult insect, and therefore must in the main confine our efforts to attacking the more vulnerable larvæ. In attempting this the species found in a pool, or even their presence or absence, is a matter of little importance, for almost any collection of water is a possible breeding place; and the rule should be to leave as few as possible available. All small pools are certainly best dealt with by filling them up; care being of course taken not to obtain the necessary material by excavating a new hollow.

In most cases sand from the nearest river bed will be the best thing to employ, as it refuses to hold water, and no harm is likely to result from digging it. A large proportion of *Anopheles* pools are, however, so small that a dozen or so may be done away with with a single cart-load of sand, and as the results would be fairly permanent this would be far more economical than the use of larvicides. For larger collections of water, pending the adoption of more radical measures, the use of the latter is the only feasible plan, and the only question is as to what is the best material to employ. Unfortunately the larvæ are singularly resistant to ordinary poisons, and are capable of disporting themselves for hours in such energetic fluids as the Liq. hyd. bichlor. B.P., or in Fowler's solution.

Celli (C. M., p. 196, *et. seq.*) gives the results of an extensive series of experiments as to the quantity required to kill the larvæ of a large number of agents, which may be consulted by those who desire more detailed information on the subject; but their practical outcome is that with the exception of paraffin, and an aniline product called "larvicide," prepared by Weiler-ter-Meer, of Uerdingen, none are sufficiently powerful, in proportion to their cost, to be of any use on a practical scale. To these may be added tar, but the reports I have received as to the efficacy of this latter are so contradictory that there can be no doubt that it is very uncertain in its action, and it is hardly cheaper than paraffin, as to the efficiency of which, when properly applied there can be no doubt. Paraffin, it must be remembered, kills the larvæ, not by acting as a poison, but by choking them, the thin film which it forms on the surface preventing their getting access to the air; and therefore to use it with success, care must be taken that it is made to spread over the entire surface. No very large quantity is required, but it is better to err on the side of liberality; and according to my experience, the best and easiest way is to sprinkle it over the surface by one or two rapid sweeps from a fine-rosed watering pot. So employed, I have never known it fail, the larvæ being all found dead in the course of a few hours.

"Larvicide" on the other hand acts as a poison, killing all larvæ within twenty-four hours, in a strength of about one in 7,000. The consignment I sent for had not come to hand when I left India, so that I know nothing of its powers from personal experiment; but Celli appears to regard it as the only agent of the poisonous class that is cheap enough for use out of the laboratory. He appears to consider it as the most promising agent we have as yet at our disposal, and states that the cost of disinfection per cubic metre of water varies from lire 0·0056 to 0·0012, which is equivalent to saying that a shillingsworth is sufficient for from 7,350 to 34,300 cubic feet of water. It is said to be not in the least injurious to plants, and that the water containing it may be drunk with impunity by men and cattle, but nevertheless to be lethal to most insects which are injurious to crops, so that it is particularly suitable for the treatment of such portions of rice swamps as are dangerously near habitations.

It has the further advantage over paraffin in the fact that, not being volatile, its action is much more permanent, lasting for as long as two months, and there can be no doubt that it should be at least given a thorough trial. Assuming it to stand the test of practical work in the open, the question whether this or kerosine will be the cheaper agent to employ will depend on the depth of the water to be dealt with, as the entire bulk of the water must be rendered lethal; whereas with kerosine depth need not be considered, and superficies is all that need be taken count of; so that where the water is shallow in proportion to its surface, paraffin will certainly be the cheaper; while deep pools will be more economically dealt with by the new agent, the more so as the chemical would probably remain unaltered in the surface mud when it dried up, and more or less of it would be still available when redissolved on the reformation of the pool after fresh rain.

It may be freely admitted taht in many places larvæ-bearing pools are so omnipresent that it may be practically impossible to deal with them in this, or any other detailed fashion, but it is equally true that many limited areas might be dealt with at but little cost or trouble; and it is to be hoped that some of our Colonial Governments may see their way to giving a fair trial to the methods above indicated in some selected localities.

Such being the state of our knowledge as to the sanitation of malaria on a large scale, it remains to be seen what can be done in the way of personal hygiene; and here I believe it may be confidently asserted that much may be accomplished, though not of course absolutely without trouble, expense or other effort on the part of those who wish to protect themselves against this disease. Putting aside the prophylactic use of drugs, which may be better left to purely medical treatises, personal hygiene resolves itself into two classes of precautions, viz., by as far as possible preventing Mosquitoes from breeding in the immediate neighbourhood of our houses, and secondly, as private efforts of the first category can be only partially successful, to endeavour to avoid being bitten.

Precautions of the first class have already been sufficiently noticed, as they are merely such as have been suggested as corporate operations, but on a smaller scale; but as the tropical resident usually lives in houses surrounded by a considerable area under his own control, a good deal more might be affected in this way than is usually the case in Europe. By a very little personal trouble and superintendence there should be no difficulty whatever in doing away with all breeding places within one's own compound, and an occasional round, followed by a coolie armed with a can of kerosine, would do much to keep them down in our immediate neighbourhood, while occasional fumigation with sulphur, especially of one's servants' houses, during the hybernating season would help to minimise the number of immigrants from the quarters of less careful folks. But our main reliance must be placed on precautions against being bitten, the principal of these being to endeavour to keep Mosquitoes out of our houses; and the wonderful success obtained by Professor A. Celli in the case of certain railway employés on the line from Rome to Solmona shows that this is by no means as difficult as one would have expected.

No one can read his recent pamphlet "Sulla nuova profilassi della malaria," in which he gives an account of these results, without being convinced of this; unless they prefer to regard the account as an effort of the imagination, a supposition which no one who has had the pleasure of talking with that distinguished hygienist would for a moment countenance. Selecting a notoriously malarious portion of the line, he had about half the cottages in which the railway men with their families live made roughly Mosquito-proof by protecting all the windows with fixed screens of wire gauze, and by providing all entrances with double spring doors of the same material, as shown in the accompanying illustration, reproduced by Professor Celli's courteous permission, while the other moiety were left in their original condition. The experiments have been now in progress for nearly three years, and counting each year as a separate observation, the results may be epitomised roughly as follows: In 25 protected cottages with a population of 173 persons, only 8 were attacked with fever; whereas in 30 unprotected, having a population of 220, only 17 escaped the disease.

In several instances the compared cottages are the same building, unprotected in one year and protected in the following, and it must be admitted that a much smaller degree of success would warrant any reasonable person in giving the plan a thorough trial. All the same, I know well that what is comparatively easy in a small Italian cottage will be by no means so easy in our rambling Indian bungalows, with several doors to every room, and none of the joinery made to fit with any approach to accuracy. House

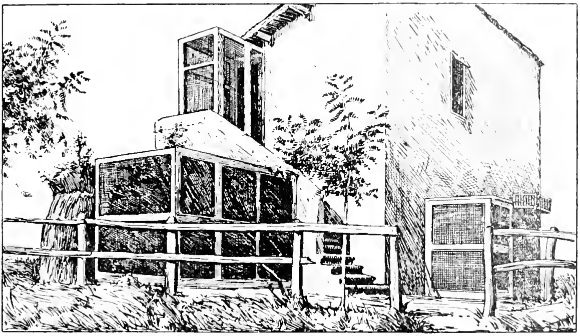


Fig. 37A.—Railway servant's cottage in the Roman Campagna, protected against the entry of Mosquitoes by Professor Celli's method.

building is as excellent in Italy as it is bad in India, and the careless finishing of most of our bungalows, especially of the roofs, would make it extremely difficult to keep out so importunate an intruder as the Indian *Anopheles* without extensive structural alterations. Then, too, I can easily picture how systematically Gunga Din and Nabbi Baksh would "forget" and carefully prop open the spring doors to save the trouble of shouldering them open; but that might be got over by a little drilling. In the type of bungalow common in the Punjab, especially those which are what we speak of as "pacca" built, there would be no great difficulty, but in the ordinary thatched houses of the North-West and lower India, it would tax the best ingenuity, and is practically impossible, unless we can substitute something better for the abominable "ceiling-cloth."

These vile dirt and vermin traps are, however, I am glad to say, rapidly disappearing. For the Burmese bungalow, it is difficult to suggest any plan of applying the method short of reconstruction.

I found that the cost of protecting the last bungalow I occupied would be, at present prices in India, about 300 rupees (£20), but Celli tells me that suitable wire gauze (about 12 strands to the inch) of American manufacture is obtainable in Italy at much cheaper rates than we have to pay in India, and probably the price would lessen if there were a sufficient demand. Presuming the house to be adaptable, I believe the simplest plan will be to completely enclose the verandahs with gauze, providing each with a single set of doors. All the other openings would of course require fixed gauze frames, and doors opening elsewhere than on the verandahs would require to be separately fitted up. Possibly the bath-room doors might be left unaltered, their use being prohibited between dawn and 8 a.m., but it would certainly be preferable to fit them up also. The first cost would be of course considerable, but a considerable annual expenditure for "chiks" would be done away with.

In this, however, as in the case of every essential of health and comfort, the main obstacle as far as officials are concerned, is that we are so constantly moved about from one station to another, that any attempts at improvements of a permanent character are ruinous, as the houses are rented from native landlords, who often are with difficulty persuaded to keep the roof over our heads weather-tight. In the case of permanent residents, however, I believe in the long run a distinct saving would result. "Chiks" are at the best a lame defence against either flies or mosquitoes, but if nothing better be obtainable must be made the best of, and this means that we must absolutely reverse our present customs as to the times of opening and closing them, as we now plan these so as to keep out, not mosquitoes, but flies, the habits of which are the very antithesis of those of mosquitoes.

At present they are kept more or less carefully closed during the day, and are rolled up at night. From an hour or two after sunrise till sunset, it little matters as regards Mosquitoes what is done with them, as the insects settle themselves down for their day's rest as soon as the sun is well up, and will not leave the shelter they have chosen unless they are obliged; but at night every aperture must be carefully guarded and especially the period from 4 to 6 a.m. In the early evening dusk it is better to have everything opened, as just then Mosquitoes, if they can, leave the house to obtain vegetable food, but for all the rest of the darkness and dusk the more thoroughly a house can be kept Mosquito-proof the better.

It will be a long time, however, before Mosquito-proof houses become at all common in India, and for the present most of us will have to be content with Mosquito curtains. A compromise between the two would, however, be well within most people's resources, and far better than the stuffy old nets, which, in spite of my firm conviction of their necessity, are well nigh intolerable during "a break in the rains." For this reason no plan will ever be generally adopted in India which cannot be combined with the use of the punkah, and with the old-fashioned forms of the latter this is most difficult, though the handy little electric fans can be worked in almost any position. Unfortunately, power of this sort can be obtained in very few places, but it might be possible to employ the punkah coolies in working a small dynamo instead of pulling the rope; though the difficulty of getting any small defect remedied would still remain in all but the largest stations. A settled resident would find it simplest to make his sleeping apartment insect proof, but the vagabond official requires some contrivance that he can carry about with him with his other furniture when "transferred." For this I would suggest a portable miniature room formed of light wooden frames filled with wire gauze, and hinged together into panels of convenient size, two of which should, however, be filled with thin planking, so as to protect the rest when packed up for transport. About 8 ft. square would be a convenient size, as to plan, but to carry a punkah, the panels would have to be at least 10 ft. high, and even then the bed must be made as low as possible. Some contrivance to prevent it being shifted by the pull of the punkah would of course be required, and probably the best plan would be to secure the solid panels to the wall through which it is usually pulled; but details may best be left to individual ingenuity. Whether the room be temporary or permanent, however, it is absolutely essential that all furniture and hangings should be absolutely excluded, excepting the beds, chair and small table, so that I fear the plan will hardly meet the æsthetic tastes of the "Memsahib."

When "in camp," or on other temporary absences, we must still be content with the old curtains, and there is a right and a wrong way of hanging these, the latter of which is almost universally adopted, because it looks neater to spread them over the iron or wooden frame, and thereby leave gaps at the corners, which cannot be securely tucked in on account of the poles, than to suspend them *inside* the latter, so that these cannot obstruct complete security. The weak point of the curtains, however, is that unless the bed be very large and one can contrive to keep in the middle of it, one is sure to be bitten through them, owing to the limbs coming in contact with the net.

Many people have an idea that the punkah is an efficient protection against Mosquitoes, but this is entirely erroneous, and I have watched one filling herself, quite undisturbed by the towel pinned to the punkah-frill, which flicked my knee within a couple of inches of the spot she had selected, at every swing; but those who blame us for sacrificing security to the comfort of a long-roped punkah, or for not swathing our limbs in thick woollen putties with the thermometer at 98° in the shade, can know nothing of the climatic conditions under which we must contrive to exist, and forget that a restless night is a bad preparation for a tropical day, and that most of us have other concerns to attend to, so that it is unreasonable to expect us to devote our lives to the prophylaxis of a single tropical disease; though this is no argument against the adoption of such reasonable precautions as may be practicable. In the "hot weather" of the Punjab and North-West, though *Culices*, owing to our own carelessness, are usually in swarms, *Anopheletes* are sc scarce that there is no real need of special precautions; but as soon as the rains break curtains are indispensable to safety.

This brings me to the question of clothing, which may be made to afford considerable protection without being otherwise unsuitable to the climate. I do not think our Indian species of *Anopheles* ever bite during the day, and the same seems to be true for West Africa, so that practically it is only during the evening that there is much chance of being bitten while awake, and not even then while moving about. The really dangerous time is during and after dinner, and the favourite point of attack the ankles, which are bitten through the thin socks that are usually worn. Unfortunately of late years, the sensible and cleanly custom of dressing for dinner in white drill jacket and pants is yielding to an absurd desire to assimilate our customs to those of Europe; though how men of refined habits can reconcile themselves to wearing a garment which is nightly saturated with perspiration till it is worn out, passes my comprehension, and those who will sacrifice so much are hardly likely to adopt trowser-straps, which would not be correct "form" in the black habiliments whereby the Indian Memsahib loves to keep green the ideals of the old country, though they formed a customary adjunct of the supplanted white costume, and would, applied to either, afford complete protection.

It is dangerous for a mere man to venture on the subject of ladies' dress, and in any case absolutely bootless; but as fashion ordains that their evening costumes must sweep the ground, they can obviously protect themselves without straps, if they happen to think of it, and care to deny us the pleasure of glancing at the neat contour of a pointed shoe with an impossible heel; but the "low neck," which is murderous enough in Europe, is clearly no better in India, as it leaves a large surface unprotected just at the time when Mosquitoes are most persistent in their attacks. As regards children, mothers should deny themselves the pleasure of exhibiting their chubby limbs, at any rate in the evening; but as little boys really look "sweet" in absolutely correct "sailor suits," with nautically cut but long pantaloons, there is no real difficulty in their case. The poor little girls, however, are again in a different case, as long stockings thick enough to be any good would cause unbearable irritation of the skin, and probably afford staphylococci the opportunity to start a most debilitating crop of boils; and I fear it is no use pointing out that the "pantalettes" portrayed in Leach's drawings, in which their grandmothers disported themseves, would solve the difficulty; unless indeed we can contrive to initiate a sort of Chippendale reaction for infantile millinery in their favour.

As a rule the Anglo-Indian has no alternative in the selection of his bungalow and must accept that occupied by his predecessor, or camp out. The better class of native gentlemen are beginning to see the superiority of the European plan of villa to such an extent that it is often difficult to find accommodation in what were once purely European quarters. So much is this the case that the provision of quarters built by Government is seriously mooted; but I should be sorry to serve in India, even if housed in them gratuitously instead of compelled to rent them, as, owing to the high standard of work demanded by the department, the largest proportion of the money allotted for their construction will be required to secure technically perfect masonry, and a cramped heat trap, with no proper plinth or adequate through ventilation, but of beautifully pointed red brick, will necessarily result. There is a rule, perfectly reasonable, were it not rigid, that in such cases the rent must bear a certain proportion to the outlay, and that the former must be no more than a certain percentage of the average income of the occupants; and probably a sufficiently healthy and commodious building, durable enough for practical purposes, might be built for the sum, but the executive engineer would have no choice than to reject it if tendered him by a contractor.

There can be no doubt, however, that the provision of really healthy quarters for officials, as commodious as the large but ill-planned bungalows now obtainable, would be really a most remunerative investment even if the direct returns fell short of the requirements of the Accountant-General. Every station has its "Fever Hall," most several, with generally no alternative accommodation; and in one year I have seen three consecutive officers invalided from a fever trap of this sort, none of whom had the least desire to take leave, while the sum disbursed to them as ineffective pay would have easily rebuilt the pestilential hovel. Where, however, any choice can be exercised, a house with an upper story should be selected, as Mosquitoes never fly high, and even this amount of elevation affords considerable protection.

The writer once built, on the flat concrete roof of the house he occupied, a large grass hut, which was used by himself and family right through the rainy season as a sleeping apartment. Although fitted with punkahs, they were never used, as while our neighbours were sweltering through the night under them in the steamy, but sun-baked houses, we were able to obtain refreshing rest in spite of our Mosquito nets. This was long before the etiology of malaria had been solved, and the fact that we not only escaped fever but were all singularly healthy was a matter of constant wonder to them, as to sleep in such a situation in the wet weather was looked upon as a certain invitation to fever. As a matter of fact, however, a hut of this sort, or a verandah, if deep enough to shelter from the drift of a shower, is not a bit damper than the inside of a house, and the only reason why to sleep in the latter is so notoriously dangerous is that they swarm with Mosquitoes more thickly than either within the house or in the open.

Given adequate protection from the bites of infected Mosquitoes, it is far more healthy to sleep in such situations, and so gain refreshing sleep with comparative coolness and the freest ventilation. Makeshift erections of this sort cost so little in India that it is well worth making one, even if one can use it during but a short stay; and I believe that a portable Mosquito room of the sort suggested, sheltered in a hut of this sort built on the roof where this is terraced, is the most practical plan of availing oneself of our new knowledge that I can offer. On several occasions we dined in our airy quarters, but though singularly free from Mosquitoes, the lights attracted such numbers of other members of the insect tribes as to ill compensate for the gain in coolness.

Mosquitoes exhibit a repugnance to almost all strong-scented bodies, and almost every country has its own specific for warding off their attacks by their use. I have tried several of these reputed culicifuges and find that the most efficient are bodies such as kerosine and turpentine, which are as objectionable to the human nose as to the gnats. Celli (C. M., p. 207) gives the results of a long series of experiments with bodies of this kind, which clearly show that none of them are sufficiently powerful to be of any practical use for killing Mosquitoes, and I regard their value when employed about the person with the view of keeping them off as so small that it would be waste of space to further consider the question.

Relied on in place of a Mosquito net, they are worse than useless, as while they enable the user to get to sleep, their action is so evanescent that they leave him unprotected as soon as he has fairly landed in the land of dreams. For practical prophylaxis, the only use that can be made of them is to sprinkle them near persons sitting at table, and probably it very little matters what scent is used for the purpose, the ordinary cosmetics being as good as any.

A good deal of protection, on the other hand, is undoubtedly afforded by smearing the skin with greasy substances, such as vaseline or oil, and I fancy that most of the culicifuge salves and ointments that are sold owe their value not to the scents, but to the fatty matter they contain. As a remedy for the smarting of gnat bites, I find nothing better than hazeline, and a mixture of eau de Cologne and water also affords considerable relief. As a rule, the direct effect of the bites are too trifling to require treatment of any kind, but in some people they swell so much and cause irritation for so long a period that it might be worth while to try the use of weak tincture of iodine, which has recently been stated to abort the effects of the bites.

One more point requires notice, viz., the suggestion thrown out by Drs. Stephens and Christophers that the European tropical resident should seek immunity from malaria by isolating himself from the native.

The proposal to isolate the healthy instead of the sick is a novel one, and I must confess that it is difficult to understand how it is to be carried out, especially as in all such places the climate makes it impossible for the European to undertake his own domestic work, even if he possessed the leisure to do so, which is rarely the case, as his time is generally fully occupied in some occupation of a supervisory character. European and native alike reside in these insalubrious localities for the transaction of the everyday business of life, and it is useless to ask either to subordinate every business and social concern to the avoidance of one only of the numerous tropical risks that he has decided to brave. The native doubtless believes he could spare the company of the European, but the latter is absolutely dependent on the native for every necessity of comfortable existence, and would be in a miserable plight if deprived of his servants for even a few hours in the day. In India there is little to choose in degree of malarial infection between the two races, so that logically most of us would have to throw in our lot with our "Aryan brethren," and few but the last-joined "griffs" would be left to inhabit the sanitary oasis. Apart from this, in India at any rate, the declared acceptance by Government of the duty of bearing what Kipling calls "the White man's burden" would put the adoption of any policy, sanitary or otherwise, intended for the sole benefit of Europeans, entirely out of court, and I cannot believe that the authorities of any of our other tropical dependencies would care to avow a different policy.

It is impossible to enter into a really exhaustive treatment of the prophylaxis of malaria within the limits of a chapter like the present, or to notice all that has been written on the subject, even within the last twelve months, but it is hoped that the above sketch will suffice to give a general idea of the present position of the subject. In bringing it to a close, the writer trusts he may be absolved from the charge of holding extravagant views as to what can or should be done, and to avoid all misconception, would repeat that while he neither thinks it possible to exterminate Mosquitoes, or to do away with all malarial disease, he is convinced that, even with our present knowledge, it would be practicable to enormously diminish the number of cases in any given limited area taken in hand; and further, though it is of course impossible to ensure safety, that anyone who will avail himself of a few by no means onerous precautions may greatly diminish his chances of becoming infected.

Since the above went to press, we have received good accounts of the practical work of the last expedition sent out by the Liverpool School of Tropical Medicine to West Africa; and I have also received an interesting letter from Dr. Yale Massey, from Portuguese West Africa, in which he attributes a diminution of fever in his station to the filling up of pits left by building operations, and to the liberal use of quinine among the children.

CHAPTER IX.

On the Distribution of the Culicidæ.

The *Culicidæ* are a truly cosmopolitan family, and may be found everywhere from the tropics to well within the polar circle. Their commonness indeed depends rather on the state of civilisation of a region than upon its geographical position. In new countries, in regions where the severity of the climate is such that they cannot support a sufficient population to undertake the complete drainage of the area, and amongst people whose civilisation, however old, has not reached the stage of "tidiness" and order, gnats and Mosquitoes will be found to be numerous and troublesome. As examples of this may be mentioned the cases of Lapland and the north-western portions of British America, where, during the short summer, they constitute a veritable pest; so that, in the former country, the nomadic inhabitants are obliged to frequently change their grazing grounds to enable themselves and their herds to escape from their insect tormentors; while in Manitoba, it is not uncommon for horses and cattle to be "stampeded" from the unbearable pertinacity of the indigenous species. In tropical countries again, the commonness of Mosquitoes is due far more to the difficulties of securing efficient surface drainage, and to the careless domestic habits of the people, than to any special favourableness of the climate. On the other hand, in countries such as England, Northern France and Germany, where centuries of human inhabitation have perfected drainage, and domestic neatness has reached almost to the position of a religious duty, gnats are so rare that, when they appear in any numbers, they are commonly suspected of being a recent importation.

Even in Holland, where the nature of the country appears to be entirely in their favour, they are by no means so common as in many apparently less favourable localities; for in Holland drainage is a primary necessity of occupation, and the domestic neatness of the people is proverbial.

With the exception of a few rarely visited islands, there are few parts of the world whence the *Culicidæ* have not been recorded, and indeed their constant association with man makes it almost impossible for any country that is much frequented to long escape their importation, as apart from their being carried in the larval state in ships' tanks, their habit of hybernation, and of harbouring in draperies while in that condition, makes their introduction a very easy matter.

Mr. R. M'Lachlan, in his notes on the insects of Captain Fielden's Arctic Expedition, mentions a species of *Culex*, which, he says, may be *C. caspius*, Pallas, as identified by Curtis in the insects of Ross's Voyage (p. 66). Schiödle identifies the same species with *C. nigripes*, Zett. The latter, according to Staegel, occurs also in Greenland, and is the same as *C. pipiens O. Fabricius, nec Linné* ("Fauna Greenland," p. 201).

The late Professor H. N. Moseley, during the "Challenger" Expedition, described a species of "wingless *Culex*" from Kerguelen's Island ("Proc. Linn. Soc.," XII., p. 578), but it is almost needless to say that the identification was a wrong one, as a wingless insect would not be a gnat.

In the beginning of the century, the "Nouveau Dictionnaire d'Histoire Naturelle," Tome VIII., Paris, 1817, states that only some fifteen species, mostly European, of the family were known, but since then the number has steadily increased.

Schiner, "Reise der Novara," notes that 132 species of the family had been described (up to 1868). Of these 30 are European, 61 American, 21 Asiatic, 10 African, and 9 Australian, with one of unknown origin.

In 1889, Skuse estimated the number of described species at 160, including no less than 21 new Australian forms included in his paper ("S. A. C.," p. 1,717); and subsequent additions and the unearthing of many descriptions which had not been accessible to him, brought the number of descriptions collated in the first edition of this handbook to a total of 242 species, of which 18 belong to the genus *Megarhina*, 30 to *Anopheles*, 3 to *Psorophora*, 3 to *Sabethes*, 160 to *Culex*, 13 to *Ædes*, 12 to *Corethra*, and 3 to *Mochlonyx*.

Of these 72 were European, out of which 24 were recorded from England; 20 from continental, and 29 from the islands of Asia; 41 from North, and 36 from South America; and 29 Australian. No better illustration of the small attention that had hitherto been devoted to the group can be given than the fact that but one species had been originally described from India, and that but four were recorded as having been found within its limits, putting aside the species and records appearing for the first time. It was obvious on comparing the various original descriptions then brought together for the first time, that on the one hand, many of the descriptions were so inadequate that they might easily correspond in the few particulars mentioned to a whole series of perfectly distinct species, while on the other, it was equally clear that many must be mere synonyms. It is, however, most dangerous to dabble in questions of synonymy unless one can compare the actual types, or at the least has available a large collection of locally-taken specimens, and in reality, no collection of the family worthy of the name existed; and I therefore, with one or two exceptions, confined myself to a guarded acceptance of the efforts of others in this direction, most of which I may remark, would, it appears, have better been left unnoticed, as they have generally turned out to be wide of the mark, and to have merely added to the existing confusion.

While I strongly suspected that many of the names enumerated in the systematic portion of the book were nothing more than redescriptions of species already known, it was equally obvious that the determination of the gnat fauna of vast regions of the globe was practically untouched, and that, as a necessary corollary, a large number of unknown species must remain to be discovered and described. During the year that has elapsed since the appearance of the first edition, the attention that has been drawn to the family by the establishment of their instrumentality in the transmission of at least three of the most serious of the maladies peculiar to tropical regions has drawn minute attention to the group in all parts of the world, and the timely activity of the authorities of the British Museum and of our Royal Society, has resulted in the acquisition by the Museum of perhaps the largest collection of insects of any one family that has ever been brought together, and this has been further increased by the loan of collections sent for comparison by naturalists from all parts of the world. The examination of this enormous mass of material has been entrusted to Mr. F. V. Theobald, whose reputation as one of our most thorough dipterologists cannot fail to be enhanced by the encyclopædic Monograph, now in the press, which has resulted from his labours.

As the result of his examination of the family, Mr. Theobald summarises the outcome of his labours as follows:—

"Total previously described *good* species, 164.

"Species recognised and redescribed, 116.

"Other descriptions, probably invalid owing to their shortness and the apparent absence of types, 25.

"Described as distinct, but found to be synonymous with other species, 80.

"New species described, 136.

"Therefore the number identified and redescribed and the new species described in these volumes *number* 252. If to this we add the 48 species not yet identified, we get the total known number of *Culicidæ*, 300."

It must not, however, be supposed that this represents more than the total of species examined at the time of the earlier sheets of his monograph going to press, nor must the reader expect to find it correspond exactly to the number given in the present edition, as the simultaneous passage of both our tasks through the press has been continually retarded by the receipt of fresh material, which not unfrequently has necessitated the reconsideration of the position of an entire group. I understand from Mr. Theobald, that already some thirty or forty more new forms have turned up, which will necessitate the early issue of a considerable appendix to the two heavy volumes already in the press; so that in place of the 242 species, good, bad, and indifferent, of the first edition, we have at least 300, whose validity is hardly likely to be questioned. Moreover, as there remain large areas from which no collections have been received, a total of 500 species as the actual total is certainly an underestimate, and I should not be surprised were it found to rival that of the butterflies.

The remarkably wide distribution attained by certain species such as *Steg. fasciata*, Fabr. (*C. tæniata*, Meig.) has been found to be further illustrated in a most striking way by those of many other species, certain of which have reached the British Museum from the most widely distant parts of the globe. A notable instance of this is *C. cantans*, Meig., a well-known European species, which is now known to be common in Northern America, from the "States" to Manitoba, though this would hardly prepare one to find it in the Nehilgerri hills of Southern India, from which unexpected habitat specimens were sent me by Dr. Price, of Conoor. Another curious example is that of *C. tigripes*, De Grandpré et De Charmoy, Bancroft's "long-lived" Mosquito, which occurs not only in Australia, but in Southern and Central Africa; and what is even more curious, this is by no means the only case of Africa and Australia being coupled together as the sole residences of a single species.

While, however, many species of Mosquitoes have a very wide distribution in longitude, their range in latitude is always much more limited; the only apparent exceptions to this rule being cases such as that of *C. cantans*, in Southern India, where colonies of forms peculiar to the temperate zone are found at considerable elevations above the sea; Conoor, where the specimens were taken by Dr. Price, being some 2,000 metres above the sea level, and enjoying a climate exactly similar to that of the other localities in which the species has been found. *C. mime-*

ticus, Noé, again, belongs doubtless, to a rather warmer climatic band than *C. cantans*, its northern limit being probably Italy; but here again the species, though I have received it from most parts of India, does not appear to be really at home except in the hills, and such stray specimens as have come to hand from the plains have been taken at seasons when the climate has lost its tropical character; whereas in the Nehilgerri Mountains, it appears to be one of the commonest local gnats.

Where, as in the case of *C. annulatus*, Schrank, and *C. spathipalpis*, Rond., which I have taken in the Himalayas, there is, at some season of the year, continuous temperate land connection between the scattered *habitat* of any one species, distributions of this sort are easily understood; but it is hard to see how *C. cantans* can have reached the mountains of Southern India at any period more recent than the glacial epoch, and the fact of certain species being common to Africa and the island-continent of Australia is even more difficult to explain, unless they have been carried overseas by human agency; and in this connection it is interesting to note that in at least one instance the species is one that has an exceptional power of enduring captivity, Dr. Bancroft having kept specimens for as long as five months in confinement.

As a rule then, we must not expect to find species as closely confined to certain localities as is the case with many other insect families, but to this, as to all rules of the sort, there are exceptions in which species have undergone differentiation to meet the exigencies of a peculiar environment. A notable instance of this is afforded by a late arrival at the British Museum, recently examined by Mr. Theobald, of a most aberrant form, generically distinct from any previously received, which has chosen as its home the burrows of certain crabs that live on the shore of some of the West Indian islands. This extraordinary gnat has, he tells me, antennæ twice as long as its body, and but for the last two joints, clothed with scales from the scaphus to the tip. It must be left to field naturalists on the spot to ascertain how or why this queer Mosquito should require antennæ of so unusual a size and character, but there can be little doubt that it will be found to be in some way necessitated by its peculiar domicile.

The tables given below, which are based on those that appeared in the first edition, are reproduced, with a few additions, from Mr. Theobald's monograph.

LIST OF SPECIES ARRANGED ACCORDING TO COUNTRIES.

Europe—53 Species.

Anopheles Sinensis, Wiedemann.
sub-species pseudopictus, Grassi, Italy.
— superpictus, Grassi, Italy.
— maculipennis, Meigen, general.
— bifurcatus, Linn., general.
— nigripes, Staeger, Scandinavia to Italy.
— pictus, Loew (?).
Stegomyia fasciata, Fabricius, Italy, Spain, Portugal, England (?), Gibraltar.
— sugens, Wiedemann, Corsica.
Culex mimeticus, Noé, Italy.
— annulatus, Schrank, general.
— Ficalbii, Noé, Italy.
— spathipalpis, Rondani, Italy, Gibraltar.
— glaphyropterus, Schiner, Austria, Italy.
(?)— penetrans, R. Desvoidy, France.
— cantans, Meigen, Europe generally.
— bipunctatus, R. Desvoidy, France.
— pulcripalpis, Rondani, Italy, England.
— dorsalis, Meigen, Europe generally.
— pencillaris, Rondani, Italy.
— pulcritarsis, Rondani, Italy.
— leucacanthus, Loew, Kasan, Russia.
— ornatus, Meigen, generally.
— nemorosus, Meigen, generally.
— nigripes, Zetterstedt, Scandinavia, Arctic Circle.
— silvæ, Theob., England.
— pipiens, Linnæus, Europe.
— nigritulus, Zetterstedt, Scandinavia, England.
— annulipes, Meigen, general.
— articulatus, Rondani, Italy.
— impudicus, Ficalbi, Italy.
— punctatus, Meigen, Germany, Russia, Italy.
— guttatus, Curtis, England.
— hortensis, Ficalbi, Italy.
— domesticus, Germar, Dalmatia.
— lutescens, Fabricius, generally.

Culex fusculus, Zetterstedt, Scandinavia, England.
— modestus, Ficalbi, Italy.
— vexans, Meigen, general.
— diversus, Theob., England.
Tæniorhynchus Richardii, Ficalbi, Italy, England.
Ædes obscurus, Meigen, England.
— cinereus, Meigen, general.
Corethra pallida, Fabricius, England.
— Nyblæi, Zetterstedt, Scandinavia.
— pilipes, Gimmerthal, Riga.
— plumicornis, Fabricius, generally.
— culiciformis, De Geer, generally.
— flavicans, Meigen, Germany.
— rufa, Zetterstedt, Lapland.
— obscuripes, V. d. Wulp, Holland.
— fusca, Staeger, Denmark.
Mochlonyx velutinus, Ruthe.
(?)— culiciformis, De Geer.

NORTH AMERICA AND CANADA—36 SPECIES.

Anopheles maculipennis, Meigen, Canada and United States.
(?)— nigripes, Staeger (?).
— Walkeri, Theob., Canada.
— punctipennis, Say, United States and Canada.
— crucians, Wiedemann, Mississippi and Pennsylvania.
Megarhina Portoricensis, Von Röder, Georgia, Miss.
— rutilla, Coquillett, N. Carolina, Georgia, Florida.
— ferox, Wiedemann, Columbia and Georgia.
Psorophora ciliata, R. Desvoidy, Texas, Atlantic coast, Georgia, &c.
— tæniorhynchus Richardii, Ficalbi, Ontario.
Stegomyia fasciata, Meigen, New Orleans, Savannah, &c.
— (?) signifer, Coquillett, Columbia, B. N. America, &c.
— (?) tarsalis, Coquillett, California.
Culex Bigotii, Bellardi, Mexico.
— tæniorhynchus, Wiedemann, Florida, Pennsylvania, Texas, Virginia, &c.
— solicitans, Walker, United States, Atlantic seaboard.
— cantans, Meigen, Ontario, Manitoba, United States, Nova Scotia.
=C. conterrens, Walker. =stimulans, Walker.
— sylvestris, Theob., Ontario, Manitoba.
— testaceus, V. der Wulp, Ontario.
— Canadensis, Theob., Ontario.
— æstuans, Walker, Toronto.
— consobrinus, R. Desvoidy, United States and Canada.
— nigripes, Zetterstedt, United States and Canada.
— memorosus, Meigen, Toronto.
=C. provocans, Walker.
— Spencerii, Theob., Manitoba.

Culex fatigans, Wiedemann, United States.
= C. pungens, Wiedemann.
— excrucians, Walker, Nova Scotia.
— impatiens, Walker, Hudson's Bay.
— territans, Walker.
— annulatus, Meigen.
— pipiens, Linnæus, United States and Canada.
Janthinosoma musica, Say, Indiana.
Ædes fuscus, O.-Sacken, Ontario.
Uranotænia saphirina, O.-Sacken, Ithaca.
Hæmagogus cyaneus, Fabricius, Pennsylvania.

Central America—2 Species.

Psorophora ciliata, R. Desvoidy, Honduras.
Stegomyia fasciata, Fabricius, Honduras.

West Indian Islands—28 Species.

Anopheles argyrotarsis, R. Desvoidy, St. Lucia, Jamaica.
(?)— albimanus, Wiedemann, Hayti and Porto Rico.
Cycloleppteron Grabhamii, Theob., Jamaica.
Megarhina Portoricensis, Von Röder, Porto Rico and St. Vincent.
Psorophora ciliata, R. Desvoidy.
Stegomyia fasciata, Meigen, Grenada, St. Lucia, Jamaica, St. Vincent, Montserrat.
— — var. mosquito, R. Desvoidy, St. Lucia, Jamaica.
— — sub-species Luciensis, n. v., St. Lucia, Demerara.
— sexlineata, Theob., Trinidad.
Culex Jamaicensis, Theob., Jamaica, Antigua.
— tæniorhynchus, Wiedemann, St. Lucia.
— confirmatus, Arribálzaga, Jamaica, Trinidad.
— scholasticus, Theob., St. Vincent, Grenada, St. Lucia.
— fatigans, Wiedemann, general.
— atratus, and C. secutor, Theob., Jamaica.
— inflictus, and An. pseudopunctipennis, Theob., Grenada.
Janthinosoma posticata, Saint Lucia.
— Lutzii, Theob., Trinidad.
Thrichoprosopon nivipes, Theob., Trinidad.
Deinokerites cancer, Theob., Jamaica, St. Lucia.
Wyeomyia Grayii, Theob., St. Lucia, Grenada.
— longirostris, Theob., Brazil.
— pertinans, Williston, St. Vincent.
Ædes, perturbans, Williston, St. Vincent.
Hæmagogus cyaneus, Fabricius, St. Vincent.
Corethra punctipennis, Say, Porto Rico.

South America—44 Species.

Anopheles argyrotarsis, R. Desvoidy, Rio de Janeiro, Argentine, British Guiana.

Anopheles Bigotii, Theob., Chili.
= A. punctipennis, Bigot MS.
Anopheles Lutzii, Theob., Sao Paolo, Rio de Janeiro.
— annulipalpis, Arribálzaga, Argentine.
Megarhina hæmorrhoidalis, Fabricius, Brazil, Argentine, Cayenne.
— Portoricensis, Von Röder, Para.
— ferox, Wiedemann, Brazil.
— longipes, Theob., Mexico.
— separata, Arribálzaga, Argentine.
— trichopyga, Wiedemann, Brazil.
Janthinosoma discrucians, Walker, Argentine and Brazil.
— Arribálzagæ, Giles, Argentine and Brazil.
— posticata, Wiedemann, Brazil, Argentine.
— musica, Say, Brazil, British Guiana.
— Lutzii, Theob., Brazil.
— oblita, Arribálzaga, Argentine.
Psorophora ciliata, R. Desvoidy, Argentine and Brazil.
— Holmbergii, Arribálzaga, Brazil and Argentine.
— scintillans, Walker, Amazon region.
Sabethes remipes, Wiedemann, Amazon region.
— longipes, R. Desvoidy, Guiana.
Stegomyia fasciata, Fabricius, Brazil, Argentine, British Guiana Demerara, Panama.
Culex Bigotti, Bellardi, Rio de Janeiro.
(?)— fulvus, Wiedemann, Brazil.
— tæniorhynchus, Wiedemann, British Guiana.
(?)— confinnis, Arribálzaga, Argentine.
— tibialis, R. Desvoidy, Brazil.
— serratus, Theob., Rio de Janeiro, British Guiana.
— confirmatus, Arribálzaga, Brazil, British Guiana.
— albifasciatus, Macquart, Brazil, Chili.
— terrens, Walker, Argentine, South America.
— virgultus, Theob., Brazil.
— fatigans, Wiedemann, Argentine, Brazil, Demerara, Panama, British Guiana, &c.
— cingulatus, Fabricius, South America.
— flavicosta, Walker, Amazon region.
— flavipes, Macquart, Chili, Uruguay, Brazil, Argentine.
— cyaneus, Fabricius.
Tæniorhynchus fasciolatus, Arribálzaga, Argentine, Brazil.
Panoplites titillans, Walker, Brazil, Argentine, British Guiana, Mexico.
— Amazonensis, Theob., Lower Amazons.
— quasititillans, Theob., Lower Amazons.
— Sp. n., resembling Ochlerotatus confirmatus, Argentine.
Ædeomyia squammipennis, Arribálzaga, Brazil, British Guiana, Argentine.
Uranotænia pulcherrima, Arribálzaga, Argentine, Brazil.
— geometrica, Theob. (Lutz MSS.), Brazil.
— Nataliæ, Arribálzaga, Argentine.

West Africa and Islands—33 Species.

Anopheles paludis, Theob., Sierra Leone.
— costalis, Loew, Sierra Leone, Lagos, Bonny, &c.
— funestus, Giles, Freetown.
— cinereus, Theob.
— barbirostris, Van der Wulp.
Mucidus Africanus, Theob.
— mucidus, Karsch, Whydah.
Stegomyia fasciata, Fabricius, Sierra Leone, Lagos.
— sugens, Walker, Sierra Leone.
— Nigeria, and S. irritans, Theob., Bonny.
— Africana, Theob., Freetown.
Culex dissimilis, Theob., Sierra Leone.
— impellens, Walker, Sierra Leone.
— Freetownensis, Theob., Sierra Leone.
— cinereus, and C. decens, Theob.
— fatigans, Wiedemann; and C. nebulosus, Theob.
— masculus, and C. pruinosus, Theob., Sierra Leone.
— metallicus, and C. Duttoni, Theob.
— Annettii, and C. invidiosus, Theob.
— aurites, and C. nimosus, Theob.
— albitarsis, and C. invenustus, Theob.
(?)— bimaculatus, Theob., Sierra Leone.
Panoplites Africanus, Theob.
Eretmapodites quinquevittatus, Theob., Sierra Leone.
Ædes bimaculatus, Theob., Sierra Leone.

East Africa and Islands—6 Species.

Mucidus mucidus, Karsch, Delagoa Bay.
Stegomyia fasciata, Meigen, Mombasa, Pemba Island.
— Grantii, Theob., Socotra.
Culex fatigans, Wiedemann, Pemba Island, Mombasa.
— Mombasaensis, Theob., Mombasa.
Ædes Pembaensis, Theob., Pemba Island.

South Africa—9 Species.

Anopheles mauritianus, De Grandpré.
Toxorhynchites violaceus, Theob., Natal.
Stegomyia fasciata, Meigen, Natal.
Mucidus laniger, Wiedemann, Natal.
Culex impellens, Walker, Durban, Natal.
— luteolateralis, Theob., Durban.
— fatigans, Wiedemann, Durban.
— univittatus, Theob., Durban.
— tigripes, De Grandpré et De Charmoy, Durban.

North Africa—5 Species.

Anopheles Pharœnsis, Theob., Cairo.
Stegomyia sugens, Weidemann, Nubia.

Culex maculiventris, Macquart, Algeria.
— pusillus, Bigot, Egypt.
— pipiens, Linnæus, Algeria.

Central Africa—15 Species.

Anopheles funestus, Giles, Mashonaland.
— paludis, Theob., and An. Mauritianus. De Grandpré, Mashonaland.
— Rhodesiensis, Theob.
— squamatus, Theob.
— cinereus, Theob.
— superpictus, Grassi.
— costalis, Loew.
— Pharœnsis, Theob.
Megarhina lutescens, Theob., Mashonaland.
Stegomyia sugens, Wiedemann, Mashonaland.
— Africana, Theob.
— argenteopunctata, Theob.
Panoplites Africanus, Theob.
Ædes Mashonaensis.

India—49 Species.

Anopheles nigerrimus, Giles, Madras, Punjab, Calcutta. Quilon.
— Jamesii, Theob., Quilon.
— Sinensis, Wiedemann.
— sub-species fuliginosus, Giles, Calcutta.
— sub-species Indiensis, Theob., Madras.
— sub-species annularis, Van der Wulp, Madras.
— barbirostris, N.W. Provinces.
— Indicus, Theob., Madras.
— Rossii, Giles, Madras, Quilon, Calcutta, &c.
— Lindesayii, Giles, Lower Himalayas, 6,000 to 7,000 ft.
— culicifacies, Giles, Central Provinces, Bombay and Madras.
— gigas, sp. n., Nehilgerri Hills.
— Listoni sp. n., Berars.
— Theobaldi, sp. n., Berars.
Megarhina Gilesii, Theob., Sikkim.
— immisericors, South India.
Mucidus scataphagoides, Giles, Burmah, N.W. Provinces.
Stegomyia fasciata, Quilon, Calcutta.
— var. mosquito, R. Desvoidy, Calcutta.
— scutellaris, Walker, Madras, Naini Tal. Calcutta. Ceylon.
— gubernatoris, Theob. (Giles MS.).
— pseudotæniata, Giles, Naini Tal.
— brevipalpis, Giles, N.W. Provinces.
— periskelata, sp. n., N.W. Provinces.
— pipersalata, sp. n., N.W. Provinces.
Armigeres ventralis, Walker, Quilon, Madras, Calcutta.
— panalectoros, sp. n., Calcutta.

Culex mimeticus, Noé, Himalayas, N.W. Provinces, Nehilgerri Hills.
— annulatus, Schrank, Himalayas, Bakloh, Naini Tal.
— spathipalpis, Rondani, Naini Tal, Himalayas.
— microannulatus, Theob., Quilon, N.W. Provinces, &c.
— Vishnui, Theob., Quilon, Madras, Ceylon.
— minimus, Theob., Quilon.
— gelidus, Theob., Quilon, and C. tipuliformis, Theob., Bakloh.
— cantans, Meig., Conoor, Nehilgerri Hills.
— viridiventer, Giles, Naini Tal.
— pulcriventer, Giles, Naini Tal.
— nigripes, Zetterstedt, Himalayas.
— concolor, R. Desvoidy, Quilon, Naini Tal, Madras.
— fatigans, Wiedemann, general.
— fuscanus, Weidemann, Kandy and Indian Continent.
(?)— circumvolens, Walker, Ceylon.
(?) — contrahens, Walker, Ceylon.
Tæniorhynchus ager, Theob., Madras.
Panoplites uniformis, Theob., Quilon.
— annulifera, Walker, Quilon, Lower Bengal.
Æcles nigricorpus.
Ædeomyia squammipennis, Arribálzaga, Madras.
Corethra Asiatica, Giles.

Malay Peninsula and Eastern Archipelago—37 Species.

Anopheles sinensis, Wiedemann.
— sub-species annularis, Van der Wulp, Perak.
— barbirostris, Van der Wulp, Selangor.
— Rossii, Giles, Singapore, Perak.
— ocellatus, Theob., Perak.
— tessellatus, Theob., Perak.
Megarhina immisericors, Walker, Celebes.
— inornata, Walker, New Guinea.
— splendens, Wiedemann, Java, Sumatra, Batavia, Singapore.
— subulifer, Doleschall, Amboina.
— Amboinensis, Doleschall, Amboina.
Mucidus scataphagoides, sp. n., Burma.
— laniger, Wiedemann, Java.
Stegomyia scutellaris, Walker, Singapore, Selangor, Siam, Perak, Celebes.
— crassipes, Van der Wulp, Sumatra and Malayia.
Armigeres ventralis, Walker, Singapore, Selangor, &c., &c.
Culex sitiens, Wiedemann, Perak.
— infulus, Theob., Perak.
— impellens, Walker, Perak.
— longipalpis, Van der Wulp, Sumatra.
— cæcus, Theob., Selangor.
— imprimiens, Walker, Amboina.
— gelidus, Theob., Perak, Selangor.

Culex fuligens, Theob., Singapore.
— bicolor, Walker, Perak.
— fatigans, Wiedemann, Singapore.
— flavidus, Bigot, Perak, Selangor.
— aureostriatus, Doleschall, Amboina.
— setulosus, Doleschall, Java.
— luridus, Doleschall, Middle Java.
— uneus, Theob.. Selangor.
— longipes, Theob., Singapore.
Tæniorhynchus tenax, Theob., Perak, &c.
Panoplites uniformis, Theob., Perak.
— dives, Schiner, Selangor, Singapore.
Ædeomyia squammipennis, Arribálzaga, Perak.
Ædes Malayi, Theob , Selangor.
Corethra Maniliensis, Schiner, Manila.

China and Formosa—11 Species.

Anopheles Sinensis, Wiedemann, Formosa, Shanghai.
— maculatus, Theob., Hong Kong.
— minimus, Theob., Hong Kong.
Mucidus scataphagoides, sp. n., Hong Kong.
Stegomyia scutellaris, Walker, Hong Kong, Formosa.
— fasciata, Fabr., Shanghai.
Armigeres ventralis, Walker, Hong Kong, Formosa.
(?)Culex solicitans, Walker, Formosa. (?)
— vagans, Wiedemann, Foo Chow and Shanghai.
— fatigans, Wiedemann, Hong Kong.
Tæniorhynchus conopas, Frauenfeld.

Japan—5 Species.

Stegomyia fasciata, Fabricius, Tokiyo.
— scutellaris, Walker, Tokiyo.
— Japonica, Theob, Tokiyo.
Culex subalbatus, Coquillett.
— pallens, Coquillett.

Central Asia—2 Species.

Megarhina Christophii, Portschinsky, Amur.
(?)Culex Caspius, Pallas, Caspian Sea.

Australia—29 Species.

Anopheles annulipes, Walker, Queensland and N. S. Wales.
— Mastersi, Skuse, Queensland and N. S. Wales.
— atripes, Skuse, N. S. Wales.
— stigmaticus, Skuse, N. S. Wales.
Megarhina speciosa, Skuse, Queensland.
Mucidus alternans. Westwood, Queensland and N. S. Wales.

Stegomyia notoscripta, Skuse, Queensland, N. S. Wales, Adelaide.
— fasciata, Fabricius, Queensland, N. S. Wales, Victoria.
var. Queenslandensis, n. v. S. Queensland.
Culex annulirostris, Skuse, Queensland, N. S. Wales.
— oceaneus, Theob., Queensland.
— alboannulatus, Macquart, Queensland, Sydney, N. S. Wales, &c.
— vigilax, Skuse, Queensland, N. S. Wales.
— rubithorax, Macquart, S. Queensland, Tasmania.
— procax, Skuse, Queensland and N. S. Wales.
— marinus, Theob., Queensland.
— occidentalis, Skuse, Victoria, W. Australia.
— flavifrons, Skuse, Brisbane, Australia, N. S. Wales.
— camptorhynchus, Thomson, Sydney.
— sagax, Skuse, Queensland.
— Frenchii, Theob., Victoria.
— fatigans, Wiedemann.
var. Skusii, Giles.
var. Macleayi, Skuse.
— acer, Walker, Queensland.
— vittager, Skuse, Queensland and N. S. Wales.
— linealis, Skuse, N. S. Wales.
— atripes, Skuse, N. S. Wales.
— australis, Erichson, Tasmania.
— tigripes, De Grandpré et De Charmoy, Queensland.
Ædeomyia venustipes, Skuse, Sydney.
Uranotænia pygmæa, Theob., Queensland.

New Zealand—7 Species.

Culex albirostris, Macquart.
— acer, Walker.
— pervigilans, Bergcoth.
Culex iracundus, Walker.
Uranotaenia argyropa, Walker.
Corethra antarctica, Hudson.

Oceanic Islands—7 Species.

Bermuda.

Stegomyia fasciata, Fabricius.
Culex fatigans, Wiedemann.

Fiji.

Anopheles, sp. ? (remains).
Stegomyia scutellaris, Walker.
Culex fatigans, Wiedemann.

Mauritius.

Anopheles paludis, Theob.
Stegomyia scutellaris, Walker.
Culex annulitarsis, Macquart.
— fatigans, Wiedemann.

Madeira.

Culex longioareolatus, Macquart.

Anyone who is at the pains to compare closely the above faunistic lists will find no difficulty in discovering numerous other instances of wide as well as of scattered distribution, but as regards the latter character, it must be remembered that wide gaps between the recorded haunts of certain species may be often merely due to our lack of information as to the fauna of the intervening countries, which will be filled up as our knowledge increases. It must not be forgotten, too, that the closest morphological resemblance does not necessarily imply specific identity, and that some of the eccentric distributions that may be noticed may be referable to a close external resemblance of really distinct species; in illustration of which, it may be instanced that cases have been met with by both Mr. Theobald and myself in which specimens have been sent by well-known naturalists as of one species, and which were certainly well-nigh identical, marking for marking, were yet found, on close examination of the form of their scales, to belong to quite different genera.

It will be also seen that, speaking generally, the species of *Anopheles* have seldom so wide a distribution as that of many *Culices*, while the *Stegomyiæ* are the most widely distributed of all, *S. fasciata* (Fabr.) actually belting the world, but not, it will be noticed, extending northward of about lat. 40°, or south of the corresponding isotherm. In the north *C. pipiens* is possibly as widely spread, though there is at present a wide gap in Asia, from whence we have little or no information. I doubt, however, if this species extends much south of Italy, as although typical specimens have been obtained from the northern part of that country, I suspect that its place is taken in the south by *C. fatigans*, Wied., which certainly also occurs there. I am aware that Professor Grassi regards these two species as identical, but believe that he has been led to that conclusion by having to deal with *C. fatigans*, as to judge by the figure in his recent work ("G. S. Z.," Tav. iv., fig. 30) it is really that species, and not *C. pipiens*, to which he refers, as the drawing clearly shows the comparatively short male palpi, which afford one of the readiest means of distinguishing between them. It must be remembered that besides these two there is a whole group of other species as closely allied, but which are, nevertheless, universally admitted as distinct. In cases of this sort, as in that of *An. superpictus* and *An. Rossii,* it is probable that larval characters, when we come to sufficiently know them, may enable us to distinguish between species whose imagines may be puzzlingly alike; and when these have been thoroughly examined, it is quite possible that the very variable *C. fatigans* will have to be split up into several distinct types.

PART II.—SYSTEMATIC.

CHAPTER X.

On the Classification of the Family.

The genus *Culex* was founded by Linnæus, in 1790, and in 1818, Meigen adopted in addition, those of *Anopheles*, *Ædes*, and *Corethra ;* which four genera have been universally accepted ever since. To these in 1827, Rob. Desvoidy added *Megarhina*, *Psorophora*, and *Sabethes*, the distinctness of which can no longer be doubted; and *Mochlonyx*, separated in 1844 by Loew, has always been regarded as a good genus.

Such has, however, not been the case with a number of genera proposed by Lynch Arribálzaga, in 1891, as though some have been found to be worthy of retention, as representing more or less distinct types, their limits and definitions have required modification.

These eleven or twelve genera served well enough as long as the number of species known was but small, but as more and more forms were described, the genus *Culex* in particular came to include so unmanageable a number of species, that further subdivision became urgently necessary, the only difficulty being to discover some class of character which might serve as the basis of a more minute classification. Unfortunately, the family is extremely uniform in character, and it was only after the examination of an enormous mass of material that Mr. Theobald found, in the character and arrangement of the scales that clothe the body and wings, a working basis on which to found new generic distinctions. Speaking generally, I entirely agree with the classification he now proposes, and though its adoption makes it necessary to resort to the compound microscope for the determination of the generic position of a species, this is less of a drawback than might be imagined, as after a little practice, it will be found that examination by reflected light, under a low power, such as a one-inch focus objective, suffices for all purposes; and it is quite unnecessary to destroy the specimen for the purpose, as all that is required can be seen by placing the pin on which the insect is set at various angles so as to give the various points of view required. The simplest way is to stick the disc pin at the required angle into a small piece of cork, and to handle the latter in the same way as one does a slide. A great many microscopes, however, will not rack up sufficiently to admit of an object raised a pin's length above the stage being focussed, and on this account a portable stand in which the stage is detachable is a great convenience, as instead of the latter one can place a small plank of wood on the foot and so obtain ample room. With ordinary stands, if they will not rack up enough, the same difficulty may be generally got over by contriving a sort of miniature stool of wood, which can be placed over the foot and mirror, and using this as a stage, the objective being made to, so to say, peep through the aperture of the ordinary stage.

In the new classification, the five old-established genera form the types of the sub-families *Anophelina*, *Megarhinina*, *Culicina*, *Ædomina*, and *Corethrina*, and each of these is subdivided into one or more genera, the total number of which becomes twenty-four, though it is already certain that two or three more will require to be added. Even, however, with this increased subdivision, the influx of new species has left the genus *Culex*, though its limits have been much restricted, still overloaded with more species than ever, over 150 forms being included within it, so that its further subdivision is much needed; but it is by no means easy to hit upon any character likely to prove serviceable for the purpose, though it is possible that the structure of the male palpi, which vary greatly in the genus, might possibly be used for the purposes of a further subdivision. Of these five sub-families, the last, or *Corethrina*, which form a link between the gnats and midges, differ so markedly that there can be no doubt that they should be placed in a family by themselves, as though they closely resemble other Mosquitoes in the venation of their wings and in other general characters, their mouth-parts are formed like those of midges, so that *they have no proboscis* in the sense of the word as applied to other Mosquitoes, and have in place a short, bilobed organ, ending in a pair of blunt knobs not unlike that of the Indian "sand-fly," figured on page 82.

The remaining four sub-families are distinguished by the old characters of their type genera, viz., by the relative length of their palpi, so that the five sub-families may be tabulated as follows:—

Section A.—Proboscis formed for piercing.

I.—Brilliantly coloured insects, with a very long, curved proboscis.

(α) Palpi about as long as the proboscis in both sexes (*Megarhina*); or long in ♂, shorter in ♀ (*Toxorhynchites*).
MEGARHININA.

II.—Dull-tinted insects, with straight proboscis.

(β) Palpi about as long as the proboscis in both sexes, those of the ♂ clubbed at the end, those of the ♀ linear.
ANOPHELINA.

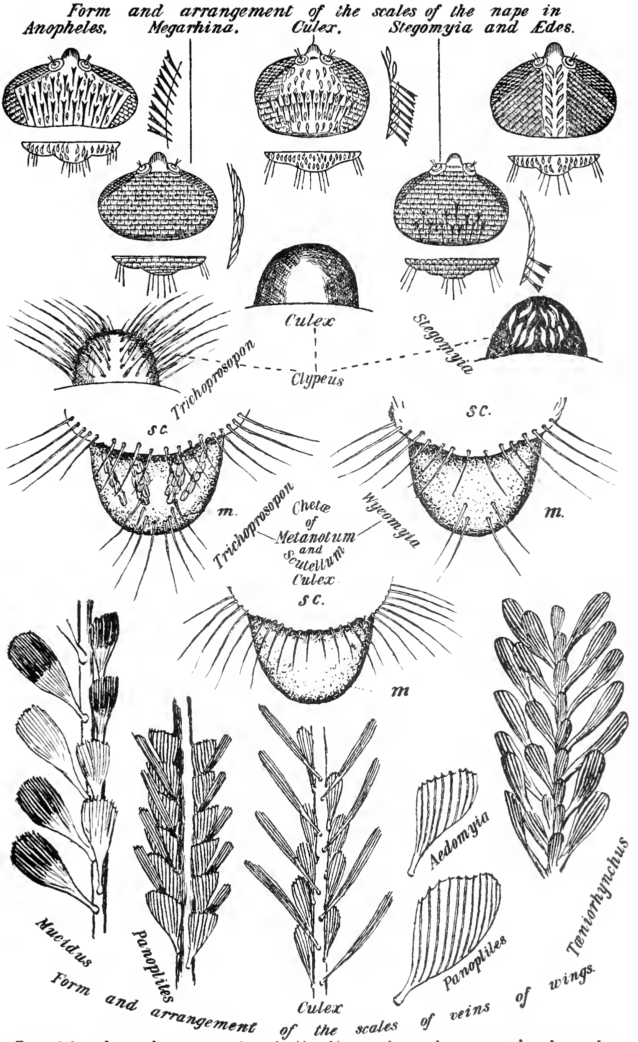
(γ) Palpi about the length of the proboscis in the ♂, but much shorter in the ♀, being in her usually very short.
CULICINA.

(δ) Palpi very short in both sexes.
ÆDOMINA.

Section B.—Mouth-parts not formed for piercing, there being no true proboscis. Palpi small.
CORETHRINA.

The detailed characters of the various genera appertaining to each separate sub-family will be tabulated in their systematic order, but it will be well here to explain the peculiarities of the form and arrangement of the scales and bristles on which Mr. Theobald's new classification is mainly based.

On the opposite page, characters of this sort which have been found by him to be available for the purposes of generic distinction, are collected together in graphic form for ready



Graphic key to generic distinctions based on scale-characters.

Fig. 38.

reference, though many of the figures are, as a matter of fact, realistic. The figures placed in the middle line of the figure are all those of the type genus of the family *Culex*, and on either side are placed figures of the structures of such genera as diverge from the type genus; it being understood that in each instance, the corresponding regions of genera not figured conform more or less to the *Culex* type. For example, the clypeus is nude in all Mosquitoes except those belonging to the genera *Stegomyia*, *Ædomyia*, and *Trichoprosopon*, in the two former of which it is scaly, those of the first genus being provided with a pair of tufts of scales of a peculiar sigmoid form; while in the latter, it is clothed with a rather dense brush of hairs.

Commencing at the top of the illustration, the figures arranged in the first two lines will be found to refer to the arrangement of the scales of the nape. In this region, the clothing scales will be found to belong generally to one of three types, namely, (*a*) flat, spade-shaped scales, arranged overlapping each other in regular order, like the tiles of a roof, so as to form a smooth imbricated armour, which usually displays to the best advantage the peculiar "metallic" interference tints exhibited by scales of this sort when illuminated at certain angles; or (*b*) narrow curved scales, such as those shown in fig. 16*f*, which always give a characteristically woolly appearance to parts clothed by them, and owe such tints as they may possess to their natural coloration, independent of the point of view; and (*c*) upright forked scales, narrow, stiff, bifid structures, usually black, which bristle out usually at an opposite angle to that taken by the associated scales of the other two types. In all Mosquitoes the sides of the head are covered with a pavement of scales of the first-mentioned sort, but in all except those of the *Megarhinina* sub-family and in *Toxorhynchites*, in which they uniformly cover the whole of the back of the head, they are associated with one or both of the other types of scale. In the type-genus *Culex* the flat scales are confined to narrow patches, quite away at the sides, while the whole of the middle portion is covered with narrow curved scales, which constitute the entire tomentum on the vertex and back of the nape, but alternate with upright forked scales on the band between. In *Anopheles* we have again the small lateral patches of imbricated flat scales, but the entire vertex and nape is covered with alternate ranks of narrow, curved, and upright forked scales. such as are found on the limited band across the *Culex* head. In *Ædes*, the lateral patches of flat scales are so large as to leave only a narrow band between them, which is occupied by a stripe of narrow curved scales, no upright forked scales being present. Lastly, in *Stegomyia*, just as in *Megarhina*, the whole vertex and nape are covered with imbricated flat scales, but instead of forming the entire tomentum, as in the latter genus, the back of the *Stegomyia* head is additionally provided with a band of scales of the upright forked type. Below the figure of each head will be found one of the corresponding type of scutellum, an examination of which will show that in *Culex* and all other Mosquitoes it is covered with long narrow scales, except in the sub-family *Megarhinina*, and the genus *Stegomyia*, in both of which this portion of the thorax is wholly covered with flat scales. Below these figures will be found the types of clypei already sufficiently described, and next beneath them three figures illustrating the nude metanotum of *Culex*, and of all other Mosquitoes, except the two small genera *Trichoprosopon* and *Wyeomyia*. In the latter of these, placed to the left, it will be seen that the usually bare surface is armed with a few stout bristles, while in the former, in addition to similar bristles, there are also patches of scales. In searching for the bristles peculiar to these genera, it is well to remember that they are easily knocked off, but that in such case the minute black specks, showing the spot from which they have been detached, can usually be made out. *Mucidus* has certain peculiar head scales.

It should be added that in the above remarks, what has been said of *Stegomyia* applies equally to the closely-allied genus *Armigeres*, as to the distinctness of which Mr. Theobald himself expresses some doubt.

At the bottom are given drawings showing the form and arrangement of the scales of the veins of typical *Culex*, and of those genera which have been separated on account of differences of this kind. In examining the wing for these characters, it is best to choose the middle portion, as they are often less well marked in other parts, and it may be added that occasionally, as in *Panoplites uniformis*, the characters are not equally well marked in both sexes, so that it is well, if possible, to examine both sexes.

If we examine the wing-veins of a typical *Culex*, it will be found that they carry two sorts of scales, which alternate with each other. On each side of the vein, placed close against the membrane, is a row of short, racquet-shaped scales; while between each of these, but springing more from the free convexity of the vein, are rows of long narrow linear scales, which give to the wing its characteristic shaggy appearance. In all but four genera the veins, though differing sometimes in the density of their armature, and in various other details, conform generally to this type, but in *Panoplites*, the short lateral rows of scales of the veins of *Culex*, in place of being small and of symmetrical outline, are so large that, when one is accustomed to their appearance, the genus can be recognised by means of a simple lens. These peculiar scales are bracket-shaped, forming a nearly right-angled, round-cornered triangle, whose base is formed by the free end of the scale, a much magnified figure of which is given on the right of the figure of the *Culex* vein, while to its left is represented the arrangement along a vein of the two sorts of scales, the linear scales being in shape and length much as in *Culex*, but owing to the comparatively larger size of the lateral rows of scales, do not show so much beyond them; so that the wing, viewed with a hand lens, looks characteristically scaly instead of woolly. The only other genus that has scales at all like these is *Ædomyia*, which has been separated from the other *Ædomina* on this account.

Another type of leptotaxis is exhibited by the wing-veins of the genus *Tæniorhynchus* (as modified), illustrated by the figure on the extreme right. Here the distinction between lateral and linear scales is hardly to be made out, as the ranks of scales are disposed in half spirals, along and across the veins, and there are at least three sets as to length, all of which, however, are of essentially the same outline, viz., symmetrical and obovate. The large proportion of long scales and their rounded ends, gives a peculiar velvety appearance to the wings of this genus. Although separated from *Psorophora* on other grounds, the veins in the genus *Mucidus* are equally peculiar, being provided with large, thick, obovate scales, with relatively long stems, all of which are of the same form and size. They also present the additional peculiarity of some of these being parti-coloured, the basal half of the scale being yellowish, and the distal black; the all-yellow and the parti-coloured scales being disposed in alternate groups along the veins, so as to give a characteristically brindled and rough appearance to the wing.

It is interesting to be able to note that the soundness of Mr. Theobald's judgment in selecting characters of this description as the basis of his new generic scheme is receiving early confirmation from the notes that are coming to hand as to the habits of the species of the new genera. Thus, the eggs of some at least of the *Stegomyia* are deposited separately, like those of *Anopheles*, and much resemble them in structure and form. Those of *Panoplites*, too, and *Mucidus* are also deposited separately, a circumstance which alone should suffice to establish their generic distinctness from the *Culices*, with which they have been hitherto associated.

One of the new genera, *Deinokerides*, has been constituted on the peculiar character of the antennæ, which have their second joints as long as three or four of those that succeed it, instead of being of about the same length, as in all other gnats, except the queer little Mosquito already mentioned, that inhabits the domiciles of West Indian shore-crabs.

Certain other genera are also distinguished from neighbouring forms by peculiarities of the venation of the wings, but the consideration of these points will be better left to be taken in connection with the grouping of genera in each sub-family.

In endeavouring, then, to make out the sub-family to which any specimen under examination should be referred, the points to be first noted are :—

(1) The structure of the proboscis, whether formed for piercing or otherwise, and whether strongly curved or quite or nearly straight.

(2) The relative length of the palpi in both sexes and its form, where specimens of one sex only are available. This being determined, species may be referred to their genera in many cases by noting the following points :—

(*a*) The character of the clypeus, whether nude or armed with bristles or scales.

(*b*) The form and arrangement of the scales on the vertex and nape, and also on the scutellum.

(*c*) The character of the metanotum, whether nude or provided with bristles, or with bristles and scales.

(*d*) The relative length of the second antennal joint.

It is a labour-saving plan to in each case note down these points in pencil before proceeding to the more detailed examination of other characters.

In each genus the series of descriptions will be found to be preceded by a table, intended to serve as a key to the ready identification of the species belonging to it; and the species will be found to be arranged in the same order as they fall in the table.

The plan of these tables is based on that adopted by Ficalbi for the European species, but has been somewhat modified owing to the much larger number of species that have to be accounted for.

It must be, however, distinctly understood that tables of this sort can only be employed as a sort of convenient index to facilitate the ready identification of species, and neither are nor pretend to be, in any sense, a natural classification. At the same time, as a matter of fact, although occasionally species will be found to be inconveniently separated from their nearest allies, the plan adopted generally places closely allied species in fairly consecutive order.

The general principle of the tables is to place first the most elaborately adorned species, and to relegate those that are uniformly tinted to the end. In the first edition the incompleteness of the original descriptions, which were all that one had to go upon, led to great difficulties in compiling the tables, and large numbers of species had to be relegated to special doubtful groups. In the present, however, very few such instances remain, as with a few exceptions, we have seen and handled all the species now redescribed.

The earlier entomologists framed their descriptions so as to distinguish between the dozen or so of species alone known to them, and probably in no way foresaw the immense number that would be added by subsequent observers.

Hence, in all but a few species that are so common that a sort of tradition as to their identity has been handed down, there must always remain a doubt as to the identity of the specimens subsequently referred to the names they gave, and even in the case of that commonest of all species, *Culex pipiens*, it does not appear to be by any means certain that the species commonly so spoken of in England and Southern Europe is really identical with the Scandinavian species described by Linnæus.

Before proceeding to attempt to trace out a species of the genus *Culex*, for example, the following points should first be noted on a scrap of paper:—

(1) Whether the wings are spotted or unspotted. If spotted, the number and position of the spots, and whether due to difference of colour or merely to local accumulations of scales.

(2) Whether or not the tarsal joints are adorned with lighter bands, and if so adorned, the exact position of the markings.

(3) Whether the thorax is adorned with markings, or not conspicuously adorned.

(4) Whether or not the abdomen is adorned with marks or cross-bands, and if so, their character and position, especially the relative position of lighter cross-marks on the segments.

With these points carefully noted, I hope that even the amateur entomologist may be able to determine the position of any species he may take.

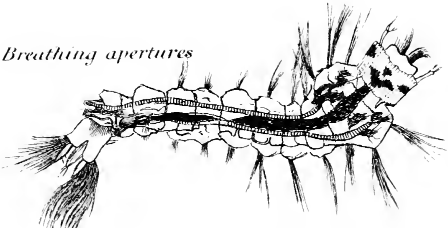
In the following systematic descriptions, to avoid the continual repetition of such long phrases as "first longitudinal vein," "supernumerary transverse vein," and so on, the several long veins are simply indicated by the Roman numerals from I. to VI. respectively; while for the transverse veins, the Arabic figures are employed, 1 meaning the humeral transverse, 2 the supernumerary, 3 the middle, and 4 the posterior transverse veins. It is also convenient to speak of the point at which a vein falls into the costa simply as its "junction," so that the three lines of printing occupied by the statement that the "auxiliary vein joins the costa at a point opposite that at which the anterior branch of the fifth longitudinal vein reaches the margin of the wing," is simply stated thus: "aux. junct. opposite post. V. junct."

In the case of banded, jointed appendages such as the palpi and legs, the statement that the bands are *on* the articulations will be taken to imply that the band of colour involves both the apex of the joint above, and that of the base below, in contradistinction to purely basal and apical banding, where one piece only of the appendage is involved. The use of certain other abbreviations, such as "ant." for anterior, "post." for posterior, and so on, scarcely needs detailed explanation, but their use greatly economises space in the long run, and is almost indispensable in view of the enormously increased volume of facts that must be condensed in the following pages. In addition to these, it is sometimes convenient to use the mathematical signs $=$ for equal to, and $\|$ for parallel to, in a line with, or opposite.

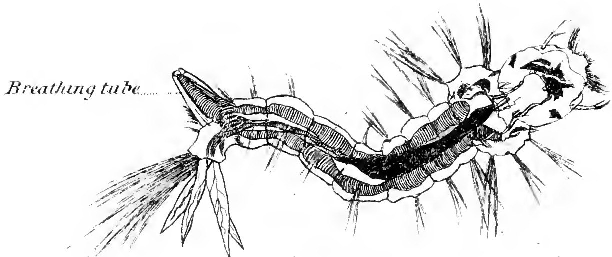
The distinguishing characters of the two principal subfamilies, the *Anophelina* and *Culicina*, in their various stages, are further illustrated in the accompanying plate, reprinted from a short paper by the author, in the Journal of the Nat. Hist. Society of Bombay.

PLATE VII.

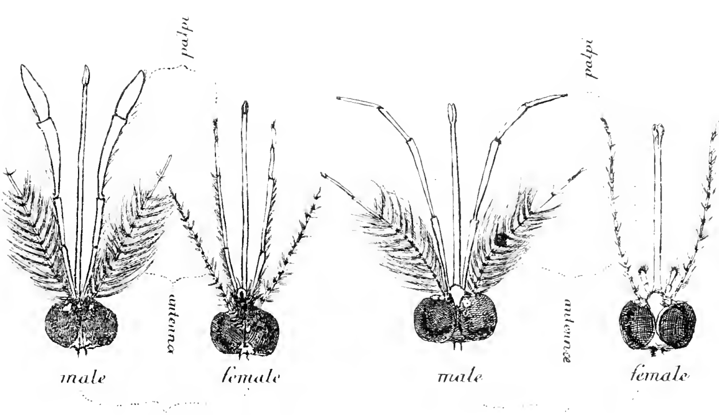
The anterior parts are shown in the prone position and the hinder ends in profile, owing to the body being twisted by the pressure of the cover glass.



(Anopheles Rossii, Giles. larva)



(Culex impellens, Walker, larva)



Anopheles

Culex.

CHAPTER XI.

The Megarhinina Sub-family.

THE members of this sub-family form a very natural group, which, especially in the type genus, present a general appearance which is so characteristic that its members can be recognised at a glance, once one has become familiar with a few species. They are all comparatively large insects, the smallest of them being a good deal over the average size of the family, and are generally conspicuous for their brilliant metallic colouring, of green, gold, and violet, some of them rivalling the well-known "diamond beetles" in their gorgeous reflections. The apex of the abdomen is usually broadened in appearance by a pair of large lateral, subterminal tufts of hairs, which are commonly brilliantly coloured, often in effective contrast with the hairs that fringe the end of the abdomen in the middle. Another peculiarity is that the proboscis, which is always large, is bent downwards, almost into a hook. In length the palpi of the type genus resemble those of *Anopheles*, being as long or longer than the proboscis in both sexes, but they differ in the terminal joint being subulate, instead of club-shaped.

Although the number of species is not large they are widely distributed throughout the tropical and sub-tropical regions, and are essentially forest insects, never being found in houses.

In both genera of the sub-family the nape and vertex is clothed with flat, imbricating scales only. They are distinguished from each other as follows :—

Palpi long in ♂, shorter in ♀ ; first sub-marginal cell very small, much smaller than second posterior cell; proboscis long, bent	Sub-family MEGARHINÆ.
Palpi 5-jointed in ♀ (long)	Genus 1 *Megarhinæ*.
Palpi 3-jointed in ♀ (comparatively short)	Genus 2 *Toxorhynchites*.

Genus I. MEGARHINA.

The original definition of this genus is sufficiently detailed to stand good, but the scale characters of the head and scutellum already mentioned are thoroughly generic, and it may be added that the second joint of ♂ antenna has always an external lateral patch of iridescent scales. The generic characters of the venation of the wing, with its tiny ant. fork cell, are sufficiently indicated in the subjoined figure.

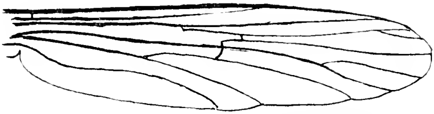


FIG. 39.—Typical Wing of Genus *Megarhina*.

The following is the formal definition of the genus :—

Desvoidy, "Essai sur les Culicides, Mém. Soc. d'Hist. Nat. de Paris," iii, 1827, p. 412; Macquart, "Diptèra Exotica," vol. i, 1838, pl. i, fig. 1. (Extracted from F. A. A. Skuse. "Proc. Linn. Soc.," N.S.W., 1889, p. 1720).

Proboscis bent downwards about the middle of its length; in the male almost the length of the body, in the female a little shorter. Palpi in the male a little longer than the proboscis; the first joint short, second, third and fourth elongate and cylindrical, of equal length, except the second, which is a little shorter; in the female a little shorter than the proboscis with five cylindrical joints of nearly equal length. Antennæ in the male with bushy plumes, the second joint a little elongate; in the female the joints elongate with a few long hairs at the base. Prothorax projecting from each side in the form of a scale; bordered with hairs in the male, naked in the female. Abdomen: the three last segments bordered laterally with hairs in the male; the copulatory organ accompanied by two appendages terminating in a point. Wings: first marginal cell very small; transverse veins very remote from the petiolated cells.

It used to be thought that these giant mosquitoes, in spite of the alarming names of certain species, were harmless, but the information collected by Mr. Theobald during the past year shows that this is a mistake.

"It is erroneously supposed that they are not annoying to man and animals; several occasion severe irritation from their bites. Captain James, I.M.S., sends me the description of one (*M. immisericors*, Wlk.) which is very troublesome in India; another comes in a collection from Mashonaland (*M. lutescens*, mihi), another *M. speciosa*) from Australia, and others have been received from New Amsterdam amongst the collections of mosquitoes sent to the Museum. They are, however, not of much importance as mosquitoes, because they are not troublesome in habitations, being entirely sylvan in habits, and thus only annoying to travellers."—(Monog.)

In the first edition of this hand-book the descriptions of thirteen undoubted species of this genus were included, and two more were placed along with them, because from their scanty descriptions as *Culices*, it appeared on the whole most likely that they should really be placed here. Of the thirteen good species, one which appeared simply as "*Megarhina, sp.*, from Sikim, has been redescribed by Mr. Theobald and reappears under the guise of *M. Gilesii*, Theob.; and four more new species have been received in the museum and described by him, making the present total seventeen.

The members of this genus often present very distinct sexual differences, and this is noticeably the case with the marking of such species as have patches or bands on the tarsi, which generally differ somewhat in detail in the two sexes; and in *M'æ. hæmorrhoidalis*, *separata*, and *inornata*, though present in the females, are quite absent in their consorts, and the same may be the case with some others which have been described from specimens of one sex only. In using the table given below, this point should be borne in mind.

Table of the Species of the Genus MEGARHINA.

A. With the caudal tufts red and black.

II. The tarsi, with some joints marked whitish in the ♀ only.

1. *M. hæmorrhoidalis* (Fabr.) Third joint of the palpi much longer than the fourth.
2. *M. separata*, Arribálzaga. Third joint of the palpi as long as the fourth. Tarsi not specially described.

B. With the caudal tufts more or less yellow and black.

I. The tarsi with certain joints or bands whitish, in one or both sexes.

3. *M. inornata*, Walker. Tarsi banded in the ♀ only. Thorax bronzy-brown, blue at roots of wings and on prothoracic lobes.
4. *M. splendens* (Wied). Tarsi (as in remaining cases of species with yellow and black tufts in which both sexes are known) banded in both sexes. Thorax with metallic green and gold scales. Abdomen green at base, purple behind.
5. *M. purpuræa*, Theob. Thorax chestnut with median azure line; abdomen brilliant purple.
6. *M. lutescens*, Theob. Thorax dull bronze with azure patches over roots of wings; abdomen golden-green scaled.
7. *M. subulifer*, Doleschall. Thorax brown with greenish-gold scales; anterior margin of the wing metallic-blue scaled.
8. *M. speciosa*, Skuse. Thorax brown with greenish scales; margin of wing pale.

9. *M. immisericors*, Walker. Thorax metallic-green; scales on costa blackish.
10. *M. Christophi*, Portschinsky. Thorax black with metallic-blue scales.
11. *M. Gilesii*, Theob. Thorax chocolate-coloured, with a greenish lustre.
12. *M. rutilla*, Coquillett. Thorax brown with golden and violet scales and pale yellow margins.

C. Caudal tufts steel-blue and white.

I. The tarsi with certain joints or bands whitish.

13. *M. Portoricensis*. Von Röder. Thorax bay, with green-gold scales.

D. Caudal tufts showing no contrasted colours, or not obviously present.

I. Tarsi with certain bands or joints whitish.

14. *M. Amboinensis*, Doleschall. Thorax dark with glittering golden scales; abdomen steel-blue.
15. *M. trichopyga* (Wied.) Thorax black with greenish-golden scales; abdomen brown.
16. *M. ferox* (Wied.) Thorax chestnut with azure median line; abdomen steel-grey.

II. With the tarsi uniformly coloured in the ♂, adorned in the ♀.

17. *M. longipes*. No distinct caudal tufts. Thorax bronze and green-scaled. Abdomen pale olive-green.

The characters on which the above table is based, and which should, therefore, be especially noted are:—

(*a*) The colouration of the characteristic "caudal tufts." These consist of dense brushes of hairs on the sides of one or two of the last abd. segs., which are often brilliantly coloured, and may contrast in a striking manner with the similar, but somewhat shorter, hairs that densely fringe the end of the abdomen.

(*b*) The presence and position, or absence of pale tarsal markings. In this genus, the tarsi are rarely banded, so that these usually take the form of patches, and not of complete rings; owing to which, they are apt to be overlooked, unless both sides of the legs are inspected.

(*c*) The colouration of the thorax, in connection with which, as with all colour qualifications of these brilliantly iridescent insects, it must be borne in mind that they are mostly of the sort usually spoken of as "metallic," or in other words, depend, not on pigment, or natural colour, but upon the phenomenon known as the interference of light passing through the thin plates of the scales, and which, therefore,

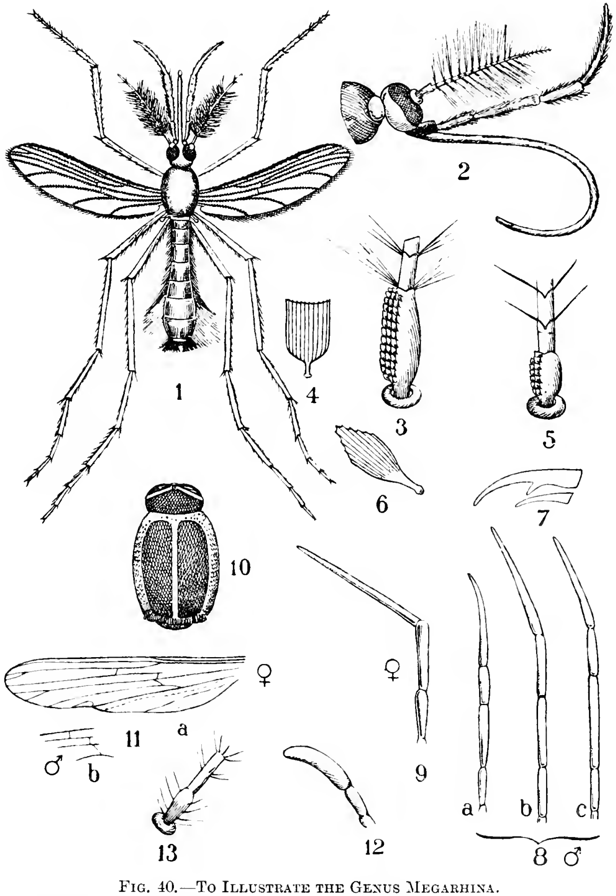


FIG. 40.—TO ILLUSTRATE THE GENUS MEGARHINA.

1, *M. hæmorrhoidalis* (Fabr.); 2, head of a ♂; 3, base of antenna of *M. inornata* ♂, Walker; 4, one of its scales; 5, of *M. ferox* (Wied.); 6, a body scale; 7, fore tarsal claws of ♂; 8, palpi of male—*a*, of *M. ferox* (Wied.); *b*, of *M. hæmorrhoidalis* (Fabr.); *c*, of *M. separata*, Arribál.; 9, palpus of *M. purpurea*, Theob.; 10, *M. ferox*, head and thorax; 11, *a*, venation of ♀ wing of the same; *b*, cross veins of ♂; 12, *toxorhynchites brevipalpis*, Theob., palpus of ♀; 13, base of antenna of the same species.

vary according to the angle at which it falls upon them, so that the reader must be prepared to find a part described as black, appear deep violet, mauve or greenish, just as do the beautiful tail feathers of the domestic fowl :—or *vice versâ*. This character is, of course, often noticeable in the colours of other mosquitoes, but seldom to the same extent as in these, where it is often strongly marked in the entire scaly armature.

1. **MEGARHINA HÆMORRHOIDALIS** (Fabr.)

Culex hæmorrhoïdalis.—Fab., "E. S.," 401, 5 ; and Fab., "S. A.," 25.

Caudal tufts blood-red, with black hairs between them. Fourth joint of palpus between two and three times as long as the third. Tarsi with white markings on hind and middle legs in ♀ but not in ♂. Third joint of palpus longer than the fourth. No fresh material has come to hand of this species, but Fabricius' description is as follows :—

"Fuscous, abdomen at apex, with reddish cilia, very large for this genus (he refers to *Culex*), antennæ very densely verticillate pilose, fuscous with the first joint nude, glistening blue ; head fuscous, glistening blue on the apex ; thorax elevated, fuscous, with anterior margin and a spot in front of the wings glistening blue ; abdomen fuscous, apex strongly rufous-ciliate ; feet blue, metallic, femora testaceous beneath ; antennæ fuscous ; palpi steel-coloured ; frons and vertex glistening emerald-green and copper ; thorax steel-grey and glistening green ; pleuræ ferruginous ; scutellum dull yellow ; abdomen steely with ferruginous spots on either side and forming an interrupted median line, sides with silvery spots, apex with blood-red cilia ; venter silvery with yellowish tomentum ; legs steely, femora silvery below."

Habitat.—South America.

2. **MEGARHINA SEPARATA**, Arribálzaga. "L. A.," p. 33.

Caudal tufts blood-red, with violet-black hairs between them ; legs unbanded in ♂, but with second and part of third tarsal joints white in the ♀. Thorax brown with fusiform metallic bronze scales, azure over the wings. Abdomen violet, purple, and coppery-red. Fourth joint of palpus equal in length to the third, otherwise differs little from preceding. *Length.*—8 to 9 mm. ♀ to 11 ♂, with palpi 19 mm.

Habitat.—Para, Brazil (Walker) ; Cayenne ; Chaco in Formosa ; Argentina ; Rio de Janeiro (Lutz) ; Lower Amazon.

3. **MEGARHINA IMNORNATA**, Walker.

("Proc. Linn. Soc." viii, p. 102.)

Caudal adornment yellow and black. All the tarsal joints of the ♀, with basal white bands, except the first joints of the hind legs; those of ♂ unbanded. Thorax, deep bronzy-brown, azure over the roots of the wings and on the prothoracic lobes.

Head dark bronze, peacock-blue in front, and rather redder at the sides; palpi purplish in the ♂, darker in the ♀, with the apices of second and third joints brilliant violet or blue. Pluræ brown with patches of white scales. Abdomen blue at the base, then purple, then coppery-red, with caudal tuft of black and orange hairs, white tufts anterior to it. Legs of ♂ purple, femora pale below. *Length.*—11 mm.

Habitat.—New Guinea.

In Walker's original description of this most inappropriately named species, his characteristic omission of all its most distinctive characters led to its being placed among the species without contrasted caudal tufts, and hence its altered position in the present issue.

4. **MEGARHINA SPLENDENS** (Wied.).

Culex splendens, Wied., "D. E.," p. 7, and "Zool. Mag." iii, 2, No. 1.

Caudal ornamentation, yellow and black. First and second tarsal joints of fore and mid legs white. Thorax greenish or yellowish-black, whitish on the pleuræ.

"Thorax black, with metallic golden and green scales; pleuræ black, densely white scaled. Abdomen metallic-green at the base, purple posteriorly, with dense golden-orange caudal tuft and white hairs laterally. Legs brilliant golden and green; apices of the joints rich green, metatarsi and tarsi partly white. *Length.*—10·5 mm.

Habitat.—Java, Sumatra, Batavia, Singapore.

5. **MEGARHINA PURPURÆA**, Theob. (Monog., I, p. 230.)

Caudal tufts yellow and black. Fore tarsi unbanded; mid, with white spots on outsides of second and third joints; hind, with similar spots on third joint. Thorax castaneous, with a median azure line. Abdomen, brilliant purple.

Thorax chestnut-brown, with a median azure-blue line and azure-blue scales at the sides, deep blue in front of the scutellum, scutellum with pale blue scales; abdomen metallic-purple, first segment peacock-blue, with apical, lateral golden spots, and golden venter. Legs dark, with some deep purple reflections, no white on fore legs, the mid feet have the second and third tarsi white beneath (hind tarsi missing). Wings with "2," only a short way in advance of the "3," and "4," joining the latter. *Length.*—8 to 8·5 mm.

Habitat.—Amazon (Bates), 1861.

Observations.—"Described from two ♀'s in the Hope Collection at Oxford University. It resembles *M. ferox*, but can at once be told by the abdomen being brilliant purple instead of steel-blue, with apical yellow bands, and by the four, not five, jointed palpi. The venation also differs in regard to the position of the cross-veins."

6. **MEGARHINA LUTESCENS**, Theob. (Monog., I, p. 233).

Caudal adornment yellow and black. Third hind tarsal joints white, except at very apex. Thorax dull bronze, shading to mauve and green laterally, with azure patches over the roots of the wings.

Thorax brown, with small dull bronzy scales above and broader mauve and green ones at the sides, and an azure patch over the roots of the wings; pleuræ yellowish, darker in the middle, with a line of silvery scales. Abdomen covered with golden-green scales, and with golden caudal tufts on the sixth and seventh segments. Legs black, with coppery-green and purple metallic reflection, and golden-yellow bases to femora; second tarsal joint of hind legs white. *Length.*—7·5 mm.

Habitat.—Salisbury, Mashonaland (G. A. K. Marshall, 1879). June.

Observations.—"Described from single ♂ only, in nearly perfect condition. This is a very beautiful species, with a great play of colours, the golden abdominal scales appearing like burnished brass in some lights; the yellow caudal tuft should separate it at once from other species."

7. **MEGARHINA SUBULIFER**, Doleschall.

("Nat. Tijdschr. v. Ned. Indie," xiv, p. 382.)

Caudal ornamentation yellow and black. All the tarsi broadly banded whitish; thorax brown with greenish-gold scales; anterior margin of wing metallic-blue scaled.

Bears much resemblance to *M. Amboinensis*, Dol., but differs as follows:—The black ♀ palpi are short, upturned, and rather hairy; nape partly green; scutellum and first two abdominal segments green, but the remaining segments blue. Wings rather shorter than abdomen, their costa partly green-scaled. *Length.*—2½ Dutch lines.

Habitat.—Amboina.

No specimens referable to this species have reached the Museum.

8. **MEGARHINA SPECIOSA**, Skuse (W. Macleay, M.S.).

("S. A. C.," p. 1722.)

Caudal adornment yellow and black. Fore tarsi, with the first joint all white save at the base, and the second and just the base of third also white; first mid-tarsal with a broad basal white band, and the second, third, and base of fourth joints white; hind entirely dark purple, except a narrow band at the base of the first, and all but the apex of the second joints. Thorax dark brown, with the margins and prothorax densely pale-greenish scaled.

Head pearly-greenish; proboscis and palps deep blue, the third joint of latter with apical golden band; pleuræ with naked brown stripe from origin of the wings; abdomen deep blue, except the first segment which is green, with a pair of lateral patches; coxæ silvery, the remainder of the legs deep violet, except as noted on the tarsi, and on the lower sides of the femora, which are golden. Wings rather longer than the abdomen. *Length.*—About 11 mm.

Habitat.—Queensland.

9. **MEGARHINA IMMESERICORS**, Walker.

(Journ. Proc. Linn. Soc., Lond., iv, p. 91 [1860]; et vii, p. 202).

= *C. Regius*, Thwaites (Hope Collection).

Caudal adornment yellow and black. Legs metallic purple, with second tarsal joints entirely white except just at base and apex; mid. tarsi with two white bands. Thorax clothed with coppery-green, fusiform scales, with an azure patch over the root of the wings.

Head azure blue in front, bronzy-red and green behind, hind border of scutellum whitish; pleuræ black with white scaled patches. Abdomen bright purple and blue with bronzy, black and yellow caudal tufts, and white tufts in front. Palpi, ♂, purple, with some white on the 2 basal joints. Wings purple along the anterior border. *Length.*—11 mm.

Habitat.—Makessar in Celebes, Weigiou, Mysol and North Ceram; Ceylon, Travancore, Malay Peninsula, Nilgherri Hills; Trincomalie, Hot Wells and Ceylon. Neighbourhood of Calcutta.

Captain James writes that it bites very severely in S. India, and that its bite is very poisonous. It is known to the natives as the "Stinging Elephant Mosquito."

10. **MEGARHINA CHRISTOPHI**, Portschinsky.

(Horæ Soc. Ent. Rossicæ, p. 122 [1883]).

Caudal adornment yellow and black. The first and second joints of fore tarsi, the base of the first, and all second and third of the mid., and all the second joint of the hind tarsi white. Thorax black, with metallic blue scales.

From original description :—

Proboscis long and black, but distinctly shorter than the body; antennæ fuscous and barely half the length of the proboscis, provided with scanty black hairs; their first joints, and the circumference of the eyes clothed with glistening, silvery, blue scales; entire body black, closely covered with glistening blue scales. The abdominal segments, from the first to the sixth inclusive, ornamented with a glistening silvery transverse stripe; the sixth segment provided behind with a brush of black hairs, and the last two segments with long, fulvous, marginal hairs on either side. The legs fuscous, with paler bases to the femora. Halteres fuscous. *Length.*—5½ lines (Russian) ♀.

Habitat.—The Amur (Central Asia).

Note.—The climate of the Amur Valley, though hot in summer, is intensely cold for several winter months, so that this is certainly the coldest habitat recorded for any member of the genus.

11. MEGARHINA GILESII, Theob.

(Megarhina sp. from Sikkim, first edition, p. 131).

Caudal adornment yellow and black. Tarsi unbanded in the ♂, but in the ♀ the first and the base of the second tarsals are yellowish-white, and in the hind the whole of the second joint, while the mid legs show no banding, but are rather pale throughout. Thorax chocolate coloured with a greenish lustre.

Antennæ dark brown, with whitish tomentum; palpi metallic violet and purple; proboscis metallic violet, with greenish and golden scales intermixed. Thorax very large, ovoid, with the pointed end forwards, dark chocolate coloured, greenish in certain lights; pleuræ generally lighter than the rest of the thorax, with a few scattered bright blue and green scales. Legs with the femora covered with scales of a more or less metallic violet or deep brown, as also are the tibiæ. Wings hyaline, shorter than the abdomen, with brown veins, the ant. fork-cell very minute. Abdomen with the three anterior segments dorsally bright metallic green, followed by three of a clear metallic blue, with indistinct paler violet, partly denuded bands; all segments more or less fringed laterally with golden hairs, and the last two with a sort of aureole of long golden hairs, relieved by dense, velvety black tufts of long hairs on either side.

In the male the genitalia are scarlet and the ungues of the fore and mid legs unequal, the larger one with a large tooth, the smaller simple; hind ungues equal and simple. *Length.*—11 mm. ♂, 10 mm. ♀.

Habitat.—Upper Burmah; Sikkim 1,800 feet; Ceylon.

Time of capture.—April in Burmah, June in Sikkim.

12. MEGARHINA RUTILLA, Coquillet.

(Canadian Entomologist, p. 43 [1896]).

Caudal adornment yellow and black. Tarsi with the second joint and the base of the third of the fore and middle tarsi, with the fourth joint and the base of the hind tarsi, white. Thorax brown with golden and violet scales, and pale yellow lateral margins.

From original description :—

♂.—Head black, with the occiput blue in centre, white next the eyes; antennæ brown, the first joint covered with blue scales on the outer side, and on the side silvery-white; proboscis and palpi black, covered with blue, gold, and white scales. Humeral angles of thorax and two large spots on the pleuræ gold coloured; scutellum blue-black and golden-scaled. Abdomen black, with blue scales, becoming violet at the tip, that on the lateral margins golden, the venter blue-scaled mixed with a few golden ones. Legs black, with mixed blue, violet and golden scales, the coxæ and apices of the femora entirely golden; one claw of each of the fore and middle legs toothed, the others simple. Wings hyaline, costal margins and veins brown, the scales blue and violet.

♀.—As in the ♂, except that the 1st joint of the antennæ is destitute of the blue and silvery scales; 2nd, 3rd, and base of the 4th joints of the fore and mid tarsi white, claws simple. *Length.*—7 to 10 mm.

Habitat.—North Carolina and Georgia.

13. MEGARHINA PORTORICENSIS, Von Röder.

(Ent. Zeit. Stetin, p. 337 [1885], Von Röder; Trans. Ent. Soc., Lond., p. 271 [1896] Williston.)

Caudal adornment steel-blue and white; penultimate joint of the hind tarsi silver-white. Thorax bay-brown, with green-gold scales. Abdomen, legs and palpi steely brown.

♂.—Head deep brown, with white eye borders and lateral spots, blue spotted in front, and with a yellow frontal tuft; proboscis steely-black; palpi purple. Thorax bronzy-green with an azure patch in front of wings; pleuræ dark brown with a large silvery patch above the coxæ, Abdomen brilliant steel-blue, with creamy lateral patches. Legs steel-blue, the femora golden below. Wings yellowish with violet scales at the base.

♀.—Head bronzy with blue eye borders; palpi intense black, with a few white scales, and the apices of the joints mauve. Abdomen green at the base, purple-blue at the apex, with white, apical, lateral spots. Wings with azure-blue scales towards the base, mauve ones on the costa and on I, and II, towards the middle. *Length.*—8 mm. ♀, 9 mm. ♂.

Habitat.—Georgia, St. Domingo, Para, Porto Rico, St. Vincent. Coquillett also gives Benoit, Mississippi in July.

14. **MEGARHINA AMBOINENSIS,** Doleschall.

(Nat. Tijdschr. v. Ned. Indie, xiv, p. 381).

Caudal adornment showing no contrasted colours. Tarsi with the uppermost joint of the hind tarsi white. Thorax dark green, with glittering golden hairs, and a tuft of long bristles at the origin of the wings.

From original description :—

Head blackish green ; the antennæ black ; those of the ♂ densely plumed up to the last joint ; palpi and proboscis steel-blue, the former white between the second and third joints, and a little hairy ; pleuræ white. Abdomen compressed, steel-blue, with long densely packed darker blue hairs on both sides of the three last segments. Wings longer than abdomen, yellowish with yellow-brown veins. The legs long and thin, almost hairless, blackish-blue. *Length.*—4½ lines (Dutch).

Habitat.—Amboina, during the dry season, in the bush; not uncommon.

15. **MEGARHINA TRICHOPYGUS,** (Wied.).

(*Culex trichopygus*, Wied., "A. Z. I.," p. 4).

The date of the description is antecedent to the establishment of the genus *Megarhina*, but the large size of the insect, its brilliant metallic coloration, the broadening of the hinder abdominal segments by tufts of hairs, and the subulate terminal joint of the palpi, make it pretty certain that the species belongs to this genus.

Caudal tufts showing no contrasted colours. Tarsi with certain bands or joints whitish? Thorax black with greenish-golden scales and the abdomen brown.

Original description :—

Antennæ brown ; palpi yellowish, opalescing blue, with brassy scales below, the end joint subulate deep steel-blue; proboscis blue-black, tapering very much ; head and thorax black with greenish-gold and blue scales ; pleuræ and coxæ brown, with silvery scales. Abdomen polished, brownish, with light steel-blue scales; belly with silvery and steel-blue scales ; the ante-penultimate segment broader, fringed on either side; the penultimate and last segments progressively smaller, and also fringed with brownish-black cilia, which show violet-blue in certain lights. Legs yellowish-brown, with steel-blue, with silvery scales below. (Middle legs wanting in specimen described.) *Length.*—3½ to 4½ lines (German).

Habitat.—Brazil.

16. **MEGARHINA FEROX,** (Wied.).

(*Culex ferox*, Wied., "A. Z. I.," p. 1).

Caudal adornment showing no marked contrast of colour or any very distinct tufts beyond a few yellow hairs. Last two hind tarsals white in both sexes, and those of second and third joints of fore legs in ♀ only. Thorax chestnut with azure adornments.

Head chestnut, with pale blue eye margins; antennæ brown, with frosty tomentum on basal, and brown scales on second joint; palpi and proboscis deep purple to black.

Thorax bright chestnut-brown with a median azure-blue stripe, an azure-blue band laterally and a patch over each wing and on the prothoracic lobes; scutellum deep purple in the middle, pale azure-blue and pale apple-green on the lateral lobes in the ♀; no medium azure-blue band in the ♂, nor is the middle of the scutellum deep purple. Abdomen steel-blue, the basal segment bright bluish-green, some of the apical segments with apical yellow bands; venter and sides partly dull golden yellow; anal segment with numerous yellow hairs. Legs metallic blue and purple, last two tarsi of the hind legs in ♀ and ♂ white and the first two tarsi in the fore legs, but apparently not in the ♂; fore and mid ungues of the ♂ unequal, the larger uniserrated; in the ♀ equal and simple. ("Monog.") *Length*.—5 lines.

Habitat.—Brazil; Georgia.

17. **MEGARHINA LONGIPES,** Theob. (Monog., p. 241).

Apex of abdomen armed with dense yellow hairs, but with no contrasted colouration or distinct caudal tufts.

The second, third, and fourth fore, and middle tarsal joints yellowish-white; the hind tarsi purplish-black, with the apex of the fourth joint white. Thorax bronzy above, green laterally.

♀.—Head green in front, golden brown behind; palpi metallic green; proboscis coppery. Prothoracic lobes pale blue; scutellum pale brown, blue on lateral lobes; pleuræ brown, with pale gold patches. Abdomen bright olive-green, the first segment pale blue, and the apex yellow; venter golden-scaled. Legs deep steely blue, with the bases of the femora yellowish. Wings dusky on the costa, with some purple scales on some of the long veins; halteres pale, with fuscous knob. *Length*.—8 mm. (of mid legs 18 mm., of wings 9 mm.).

Habitat.—Mexico.

This species, and also Walker's *M. inornata*, may possibly belong to Mr. Theobald's new genus *Toxorhynchites*, as in both it is uncertain whether the palpi of the ♀ specimens available are short or broken.

18. MEGARHINA (?) VIOLACEA (Hoffmansegg).

No species referable to the very scanty description given below has come to hand, so the original is, *pro forma*, reproduced.

Culex violaceus, Hoffmansegg.

Caudal tufts yellow and black (?). Tarsi uniformly coloured. Thorax fuscous.

Description from Wied., "D.E.," p. 7.—Steel-coloured, with a fuscous thorax; sides of the abdomen golden-yellow; tarsi without any white markings. Somewhat resembles *M.* (*C.*) *splendens*, Wied., but differs from it in its smaller size.

Genus II. TOXORHYNCHITES, Theobald (1891).

This genus has been constituted by Mr. Theobald for the reception of a single species, aberrant, though obviously allied to *Megarhina*, which he defines as follows:—

Head clothed with flat scales; thorax with small, flat, spindle-shaped scales; abdomen with flat scales. Palpi in the ♀ three-jointed, the last joint long and rounded at the end, slightly curved at the apex; in the ♂ five-jointed. Proboscis long and curved, as in *Megarhina*. Wing venation much as in *Megarhina*, the supernumerary cross-vein nearer the apex of the wing than the mid cross-vein. Ungues of ♀ equal and simple. Abdomen with a caudal tuft.

This genus resembles *Megarhina* on the one hand and *Culex* on the other. From *Megarhina*, however, it differs in the ♀ having short palpi. From *Culex* it differs in the wing venation, which resembles *Megarhina*. ("Monog.")

1. TOXORHYNCHITES BREVIPALPIS, Theob.

(Monog., p. 245).

Thorax brown, covered with olive-brown scales, with a greenish tinge, and pale blue ones on each side. Abdomen deep metallic blue, with lateral white scales, and with white, black, and orange caudal tuft. Legs metallic blue, base of first and most of second tarsal joint, pure white; in the hind legs base of second tarsal only white; fore legs uniform.

♀.—Head bright blue in front, darker behind; palpi three-jointed, rather thick, and about one quarter the length of proboscis, of a bright purple tint; proboscis purple at base, bronzy at apex; antennæ deep brown, the scaphus black, with cinereous reflections. Prothoracic lobes pale blue; scutellum and metathorax deep brown; pleuræ black, with dense white scales. Abdomen brilliant deep metallic blue, with a caudal tuft of white, black, and orange hairs; laterally are numerous white scales and white hairs in patches; venter steel-blue. Legs metallic blue and purple; ungues equal and simple.

Wings with some metallic blue scales to the veins, as long or longer than the body.

CHAPTER XII.

The Anophelina Sub-family.

THIS sub-family consists of but two genera, *Anopheles* and *Cycloleppteron;* the latter of which, containing but one species, *Cy. Grabhamii*, Theob., has been separated from the rest of the sub-family by Mr. Theobald, on account of the peculiar character of its wing scales.

The characters of the sub-family may be briefly stated as follows:—

Soberly tinted *Culicidæ*, having their palpi of about the same length as the proboscis in both sexes; and in which the larvæ are unprovided with a respiratory syphon, the spiracles opening nearly flush with the general surface of the dorsum.

The two genera may be distinguished as below:—

Sub-family **ANOPHELINA.**

Veins of the wings furnished with scales arranged on the same general plan as in *Culex*, or in some cases, more nearly approaching to that of *Tæniorhynchus*.

Genus III. **ANOPHELES**, Meigen.

Veins of the wings ornamented with spots formed by large, round, deeply pigmented scales; the lighter portions being furnished with long, curved scales, of lanceolate outline, and devoid of pigment.

Genus IV. **CYCLOLEPPTERON**, Theobald.

In by far the majority of instances, the insects of this sub-family have spotted wings, and in even the few that are not decorated in this way, some tendency to exhibit this character of the group will be found to exist on close examination. As already mentioned, most of them have also the peculiarity of posing themselves with the head pointing at the surface on which they are resting, and the abdomen elevated.

Speaking generally, the gnats of this group are of moderate size, but one or two are a good deal above the average dimensions of the family.

Possibly a third genus may have to be constituted for the reception of *An. ocellatus*, Theobald, on account of the dense tufts of peculiarly formed scales which fringe the posterior borders of the segments of the venter.

Genus III. **ANOPHELES,** Meigen (1818).

From an etiological point of view, the importance of this genus has been in no way impaired by the researches of the past year, as the number of proved cases in which its members have been convicted of serving as the intermediate host of the parasite of human malaria has steadily increased, and it has been further shown, by Capt. James, I.M.S., and also by Grassi and Noé, to bear a share in the transmission of filariasis.

In the first edition thirty species of this genus were enumerated. Of these the notorious *An. claviger* (Fabr.), reappears as *An. maculipennis*, Meig.; a name previously given as a synonym, as it appears doubtful if the insect referred to by Fabricius existed as a type in his collection. *An. albitarsis*, Arribál., turns out to be but a synonym of the much less appropriately named *An. argyrotarsis*, Desv.; *An. musivus*, Skuse, one of *An. annulipes*, Walker; and *An. quadrimaculatus*, Say, is the same as *An. maculipennis*, Meig. Of the rest, *An.* "*sp. b.*" *mihi*, for which the name "*nigerrimus*" was suggested; *An. annularis*, Wulp, with *An. vanus*, Walker; *An. pseudopictus*, Grassi, and probably *An. pictus*, Loew, are, I am inclined to think, nothing more than synonyms of *An. Sinensis*, Wied.; as, though Mr. Theobald accords them the dignity of ranking as subspecies, they run so much into each other if any considerable series of specimens be examined, that the characters that separate them barely exceed the limits of variation, if at all. As Grassi's *pseudopictus* was treated as a synonym of Loew's *pictus*, this leaves twenty-four species, whose position at present remains unshaken. At the time of Mr. Theobald's monograph going to the press, fourteen new species had been received in the Museum and described by him, and I have found three more, quite distinct from these, in my own collection, which with one added description, the type of which has not been received, and three additional forms received while passing through the press, brings the total number of species enumerated in the present edition up to forty-six.

Besides these, several sub-species and varieties are described in the monograph, some of which appear to be fairly distinct, so that the total number of forms described in the present edition exceeds fifty.

The question as to whether a given form is really a distinct species or a mere variety, can only be settled by careful breeding out experiments, as nothing can fairly be considered a variety unless it can be shown that the eggs laid by a female produce some of the typical, and others of the variant individuals, and it is needless to say that we have no information of this kind whereby to settle the position of the various types of *Anopheletes* described in the following pages.

On this account, the question whether some of those enumerated are or are not distinct, or sub-species, or varieties, is really one of a purely academical character, to which a far too great importance is sometimes attached, as for practical purposes it suffices if workers are supplied with convenient denominations whereby they can indicate the particular kind of insect to which their observations refer.

In the following pages accordingly, descriptions of all the various forms, whether ranked as species or varieties, are included, and the peculiarities of each are, with but one or two exceptions, further indicated by means of camera lucida drawings of the wings and other characteristic portions of the insects. With the exception of figures of scales and tarsal claws, and other obviously much more highly magnified representations, all these figures are drawn at a uniform amplification of ten times the natural size, so that in measuring, centimetres may be read as millimetres; though of course it must be understood that as Mosquitoes vary greatly in size in the same species, they can only be taken to refer to the actual specimen from which the particular figure was drawn.

This gives the great advantage of affording some idea of the relative size of the various species, but has resulted in some few of the smallest species being shown on a rather inconveniently small scale. As, however, the figures were originally drawn more than three times as large as they now appear, the use of a hand lens will be found to obviate this difficulty. The following is the amended definition of the genus according to the new classification.

ANOPHELES, Meigen (as restricted by Theobald).

"CHARACTERS OF THE GENUS.—Head with both flat and narrow curved scales, but mainly covered with large upright forked scales (*vide* fig. 38); palpi long in both sexes, usually about the length of the proboscis, 4-jointed in the ♀, 3-jointed in the ♂, but constrictions at the base apparently make the ♀ 5 or 6-jointed and the ♂ 4 or 5-jointed; in the ♂ the last two joints are short, thick, and often olive-shaped. Antennæ 14-jointed, filiform, pilose in the ♀, plumose in the ♂, and 15-jointed.

"Thorax sometimes nude on the dorsum, usually with narrow curved or small spindle-shaped flat scales. Abdomen generally pilose, but sometimes with a few scales, and rarely with many (*A. Pharœnsis*, *mihi*). Wings covered with small scales of normal form or inflated, with the first sub-marginal cell longer and narrower than the second posterior cell; both the second and third long veins run past the cross-veins into the basal cells, a character which I have noticed very marked in all species examined."—(Monog. I, p. 115.)

Another character, the importance of which was originally pointed out in the first edition, and which the examination of the large accumulation of new material has shown to be of thoroughly generic value, is that both fork-cells appear to be uniformly smaller, and with longer stems in the male than in the female. In the female the anterior fork-cell is usually distinctly longer, though narrower, than the posterior, but in the male the anterior is seldom longer than the posterior, and is in some cases of dimensions almost recalling those of the wing in *Megarhina*.

The arrangement of the scales of the wing-veins, though essentially of the *Culex* type, often recalls that of *Tæniorhynchus* in its general appearance, being much denser than is usually the case in the former genus; for though the linear scales are not broad and round at the end, as in the later, they are usually broader than in *Culex*, and of a lanceolate outline (pl. xi, figs. 5*a*, *b*, *c*, *d*), in place of being narrower and square-ended.

The genus is very widely distributed, though individual species rarely are spread over as wide an area as some *Culices*, and taken generically, they do not extend into as high latitudes as *Culex*. Apart from these limitations, I believe that a map of the world, coloured to show localities in which they are found, would, if the truth were known, show well nigh the entire habitable globe of that tint, and that the many gaps in the existing map of the monograph really show that we know little on this point about these localities.

As already pointed out, malaria is limited not entirely by the existence or otherwise of *Anopheletes*, but also absolutely by conditions of climate outside which the parasite is unable to live; but the large material now to hand shows that where climate is suitable, *Anopheletes* and malaria are generally found together. On this point Mr. Theobald, in the Monograph, writes:—

"Professor Nuttall tells me that in England the distribution of *A. maculipennis* and *A. bifurcatus* compares exactly with the old distribution of ague. At the same time *Anopheles* occur in districts where no ague has existed.

"In those countries where malarial fever is rife the collections of Mosquitoes received by the Museum have always contained many *Anopheles*, with one notable exception, namely Victoria. For instance, they occur in very large numbers on the West Coast of Africa, in Central Africa, in large numbers in the Malay Peninsula, in the West Indies, and in India. On the other hand, in such parts as Brazil and the Argentine, even along the swampy borders of the large rivers, malaria is not very prevalent. *Anopheles* here, as far as observations go, and records that I can find, are far from common, although other Mosquitoes are a great scourge.

"It does not of course follow because *Anopheles* are present that malaria is present, but where the latter occurs *Anopheles* have in all cases but one been shown to exist in numbers. Amongst the small collection of Mosquitoes sent from Victoria no *Anopheles* are included, but a series of *Culex tæniatus* bears a label, 'abundant in the malarious districts of the uplands of Victoria.' Four species of *Anopheles*, however, occur in Australia, and may have been overlooked in this colony, particularly as the collection only contains three species, which number would probably be greatly increased on a further examination of the district. From Mauritius, where malaria is rife, the collection only contained a few poor specimens of *Culex*, but three species of *Anopheles* occur in abundance, one species particularly along the coast, where the fever is most prevalent."

A good deal has been written as to whether the bite of these Mosquitoes is painless or otherwise, and as to whether they "sing" or not, the opinions expressed being most contradictory.

That *Anopheletes* "sing" I think there can be no doubt, for the simple reason that the sound made by Mosquitoes of all sorts is due to no voluntary effort of any sort on the part of the insect, but is an inevitable, though accidental, necessity of the fact, that owing to the peculiar character of their flight, their wings are kept vibrating at a certain number of strokes a second, and hence *must* produce the musical note corresponding to it. Where, as in most of the larger insects, this rate is a low one, we hear the "insects' drowsy hum" of the popular lyricist, while the rapidly vibrating wings of the smaller fry cannot but make a "shrill pipe." That we hear more of this in the case of Mosquitoes than in most other smaller insects, is due to the fact that the affection they entertain for us leads them to hover close to our ears preparatory to imprinting the tokens of their regard that we have such strong reasons for avoiding; reasons which render us particularly alert to the sound.

Personally, I am inclined to think that the bite of *Anopheles* is neither more nor less irritating than that of other Mosquitoes, and that the differences of opinion on this point are due to the varying degree of immunity which all, more or less, acquire; and also to the circumstance that any specially virulent effects are usually due, not to the venom of the Mosquito itself, but to accidental impurities introduced along with it.

I have again and again seen middle-aged Indians, who had long lost all power of reacting to the pure salivary secretion of Mosquitoes, actually apply for treatment an account of their faces being so swollen that they could scarcely open their eyes, and the fact that such cases are specially apt to occur among patients lying in a surgical ward makes it probable that the unusual effect of the bites is in such cases due to the Mosquitoes having indulged in a previous feed from some wound secretion. Occasionally the swelling in such cases has an erysipelatous character, and I have met with suppuration; but as a rule, it subsides in a day or two.

In the same way, it may be doubted if it is safe to generalise on the supposed preference of Mosquitoes for the blood of any particular variety of the human race.

That they should be able to follow up the trail of an adult "buck nigger" more readily than that of the well-groomed European can be easily understood, without assuming that Mosquitoes find Kru-boy tastes nicer than Englishman; and in India, where the personal habits of the indigenous population are more cleanly than those of the West African, one hears nothing of such preference. In any case, however, the number of Mosquitoes of any given species may vary so greatly on consecutive days of the same week, owing probably to differences in the state of the atmosphere, that something more than a few desultory observations are required to justify the expression of any opinion on the point.

The identification of the various species in this genus is rendered none the easier by the fact that most of the most prominent specific characters vary a good deal, so that it is usually possible to find aberrant specimens of any one species which more or less resemble those near it; and an extension of the kind of argument used to deprecate the so-called "multiplication of species" might easily be made to reduce them to absurdity by showing that in this way the whole genus, or family, if it comes to that, is but a single species; but in spite of this, where we find Mosquitoes presenting given characters, which run fairly true through a long series of individuals; it is certainly more convenient to regard them as distinct than to confuse our ideas by the enumeration of the endless catalogue of possible variations that must be appended to specific definitions in any attempt to cut down the nominal number of species.

There is hardly any character relied upon in systematic work that does not vary considerably in Mosquitoes, and the value even of anatomical characters cannot be pushed too far, as the relative positions of the longitudinal junctions of the longitudinal veins, and the distance apart of the transverse veins, which are often recorded at great length in many descriptions, often vary so much that they would better be left unrecorded. The general relative position of the transverse veins with respect to each other indeed does not, so far as can be made out, vary, so that we shall not find the posterior, *e.g.*, sometimes internal, and at others external, to the middle transverse; but their distance apart, as may be seen in the figures of two specimens of Grassi's *pseudopictus*, ♀, plate viii, figs. 11b, 11c, varies so greatly in the same species that it is quite useless to record such points, unless found constant in a long series of specimens; but the position of the cross-veins with respect to each other, though not their proportional length or distance apart, is of considerable value in distinguishing species, and is given, for ready reference, in tabular form on following pages.

In this table, and elsewhere, for the sake of brevity the mathematical sign for parallel, "||," is used to signify "opposite," or "in one line with"; and where 3 (the middle transverse vein) is placed external to the other two venules, the arrangement is stated as "alternate"; where, on the other hand, they are placed like the steps of a stairway, 2 (the supernumerary) being placed outermost, and 4 (the posterior) innermost, it is given as "*seriatim.*"

Coquillett, I understand, doubts if even the form of the tarsal claws is constant, but the larvæ of allied species are so often found associated in one puddle that it may be suspected that the

TABLE SHOWING THE ARRANGEMENT OF THE CROSS-VEINS IN ANOPHELES.

Species.	Female.	Male.
An. Bigotii, Theob. ..	2 ‖ 3, but angulated, 4 much internal	
,, *argyrotarsis*, Desv. ..	2 ‖ 3, 4 widely internal	Alternate, 4 internal.
,, *paludis*, Theob. ..	Widely *seriatim* ..	Widely *seriatim*, 4 internal.
,, *maculipalpis*. Theob.	.. ..	Rather closely *seriatim*.
,, *Mauritianus* de Grandpré et de Charmoy	Widely *seriatim* ..	*Seriatim*.
,, *fuliginosus*, Giles ..	Widely *seriatim*, 4 internal	Widely *seriatim*, 4 internal.
,, *Jamesii*, Theob. ..	Alternate, 4 internal..	*Seriatim*, 4 internal.
,, *Theobaldi*, *sp. n.* ..	2 ‖ 3, 4 internal	
,, *albipes*, Theob. ..	2 ‖ 3, but angulated, 4 much internal	2 ‖ 3, 4 internal.
,, *maculatus*, Theob. ..	Widely *seriatim*, 4 internal	
,, *Pharænsis*, Theob. ..	Closely *seriatim*, 4 internal	Rather widely *seriatim*, 4 internal.
,, *Lutzii*, Theob. ..	Alternate, 2 ‖ 4	
,, *punctulatus*, Donitz	2 ‖ 3, 4 internal	
,, *Sinensis*, Wied. ..	*Seriatim* (rather widely, 4 internal)	*Seriatim*, 4 internal.
,, *annularis*, Wulp. ..	2 ‖ 3, 4 internal ..	Widely *seriatim*, 4 internal.
,, *pseudopictus*, Grassi	*Seriatim*, 4 internal ..	*Seriatim*, 4 internal.
,, *nigerrimus*, Giles ..	Closely *seriatim*, 4 internal	Closely *seriatim* 4 internal.
,, *Indiensis*, Theob. ..	*Seriatim*, 4 internal	
,, *barbirostris*, Wulp ..	2 ‖ 3, 4 internal ..	*Seriatim*, 4 internal.
,, *costalis*, Loew ..	2 ‖ 3 ‖ 4 (slightly internal)	*Seriatim*, 4 widely internal.
,, *cinereus*, Theob. ..	*Seriatim*, but 2 nearly ‖ 3	
,, *superpictus*, Grassi ..	Widely *seriatim*, 4 internal	Widely *seriatim*, 4 internal.
,, *Rossii*, Giles ..	2 ‖ 3, 4 widely internal	Widely *seriatim*, 4 internal.
,, *leucophyrus*, Donitz	Alternate, 4 widely internal	
,, *culicifacies*, *sp. n.* ..	2 ‖ 3 ‖ 4, or closely *seriatim*	Alternate, 3 slightly external.
,, *annulipes*, Walker ..	Alternate, 2 nearly ‖ 4	Alternate, 4 internal.
,, *Mastersi*, Skuse ..	Alternate, 4 much internal	2 ‖ 3, 4 internal.
,, *squamosus*, Theob. ..	*Seriatim*	
,, *Kochi*, Donitz ..	2 ‖ 3, 4 internal	2 ‖ 3 ‖ 4, last slightly internal.
,, *gigas*, *sp. n.* ..	*Seriatim*, but 2 nearly ‖ 3, 4 much internal	Rather widely *seriatim*.
,, *funestus*, Giles ..	2 ‖ 3, 4 internal	2 ‖ 3, but angulate, 4 slightly internal.
,, *Listoni*, *sp. n.* ..	*Seriatim*, but 2 nearly ‖ 3	2 ‖ 3, 4 internal.
,, *Indica*, Theob. ..	*Seriatim*, 4 internal	
,, *Rhodesiensis*, Theob.	Closely *seriatim*, 2 nearly ‖ 3	Alternate, 2 nearly ‖ 3.

Species.	Female.	Male.
An. minimus, Theob. ..	*Seriatim*, 4 internal	
,, *punctipennis*, Say ..	2 ‖ 3 ‖ 4, obliquely inwards	
,, *Lindesayii*, Giles ..	Alternate, 4 internal	
,, *atratipes*, Skuse ..	Alternate, 2 ‖ 4	
,, *maculipennis*, Meig.	Alternate, 4 internal..	Alternate, 4 internal.
,, *stigmaticus*, Skuse...	*Seriatim*, 4 much internal	*Seriatim*, but 3 near ‖ 4.
,, *bifurcatus*, L. ..	Alternate, 4 internal..	Alternate 2 distinctly internal.
,, *Walkeri*, Theob. ..	Closely alternate, 4 internal	
,, *nigripes*, Stæger ..	Alternate, 4 distinctly internal	

observations on which he bases this opinion are explicable on some such ground as that suggested. Still, it must be confessed that amongst the forms described in the following pages, especially in the genus *Culex*, several instances occur in which a difference in the formation of the tarsal claws is the only character distinguishing certain species, and the close resemblance of some of these in all other essential points make it quite possible that Coquillett may after all be right.

For the purposes of identification, the points selected for reference in the succeeding table, are as follows :—

(1) The presence or absence of spots on the wings.

(2) Where the wing is spotted, whether the continuity of colouring of the costa is interrupted or not. Where it it is stated to be so interrupted, it should be understood that purely apical spots, such as that on the tip of *An. Lindesayii*, *mihi*, are not counted. Further, if the lighter coloured portions be in excess the costa is described as light-coloured, with dark interruptions, and *vice versâ*. As a rule, in all species so decorated, the wing-field is spotted as well as the costa.

(3) The presence or absence of light markings on the tarsal joints, and especially if certain joints be light-coloured throughout.

It will be noticed that there is one well-marked group in which one or more of the hind tarsi are all white; a second, in which some or all of the tarsal joints have distinct apical light bands; and a third, in which the tarsi are entirely dark tinted. At the same time, in endeavouring to place a specimen from drawings and descriptions, it is well not to place too implicit a reliance on this character, as nearly all species show a tendency to apical banding of the tarsi, and there are few that will not be found to show some signs of it, if a long series be examined. Several have the tarsi quite distinctly so in one sex, and not in the other, so that, if a specimen agrees well with a given type in other respects, it should not be regarded as distinct on this ground alone.

The various members of these groups are distinguished by the number of the costal markings, the presence or absence of scales on the abdomen and thorax, the relative position of the transverse veins, the markings of the palpi, and other similar characters.

Table of the Species of the Genus Anopheles.

I. Species having the wing spotted.

A. Wings with spots interrupting the continuity of coloration of the costa, in addition to, or without an apical spot.

a. With certain joints of the fore and hind tarsi entirely light coloured.

1. *An. Bigotii*, Theob. Wings with 2 large, external, and a smaller internal white spot. Terminal fore tarsal joints all white. Abdomen black, with yellow scales.
2. *An. albimanus*, Wied ? Wings with yellow spots. Terminal joints of all the tarsi white ? Abdomen with large triangular spots.

b. With certain joints of the hind tarsi only, all white.

α. With the 3 last hind tarsal joints all white.

3. *A. argyrotarsis*, R. Desvoidy. Costa with four more or less pale spots; last joint of fore and mid tarsi dark clay-coloured. Transverse veins of ♂, alternate, 3 external to 2 and 4.
4. *A. paludis*, Theob. Costa with two pale spots; fringe with one pale spot at end of 5th long vein.
5. *An. Mauritianus*, de Grandpré et de Charmoy. Closely resembles *An. paludis*, but only two instead of three of the last hind tarsal joints are all white, and the internal wing fringe is without well defined, paler, interruptions.
6. *An. maculipalpis*, Theob. Tarsi otherwise unbanded, but, together with the remaining leg joints, elaborately maculated with patches of dark and pale scales.

7. *A. fuliginosus*, Giles. Costa black with three small white spots; wings very dark; fringe at apex black.[1]

8. *An. Jamesii*, Theob. Costa black, with 5 obvious white interruptions, besides smaller dots; 3rd and 4th mid tarsi banded; ant. 1st tarsal banded in middle; fringe at apex yellow.

β. With the last 2 hind tarsal joints all white.

9. *An. Theobaldi, sp. n.* Costa black with 5 obvious small white spots and an apical spot. Long veins with less white on them than in *An. Jamesii.*

γ. With 3 last hind tarsal joints white but for a minute black band on the last.

10. *An. ablipes*, Theob. Closely, otherwise resembles *An. argyrotarsis*, Desv., but has cross veins of the ♂, 2 ‖ 3, 4 internal.

δ. With the terminal joint only of the hind tarsi all white.

11. *An. maculatus*, Theob. With 3 small white spots on the black costa, and 2 basal dots. Thorax, black with indistinct lines of white scales. Femora and tibiæ banded and spotted. Abdomen with lateral tufts.

12. *An. Pharœnsis*, Theob. Wings with the yellow costa interrupted by 3 black spots, the middle most conspicuous. Thorax pale, with median dark line and yellow lateral scales. Tibiæ maculated. Abdomen yellow-scaled, with lateral dark tufts.

13. *An. Pharœnsis, var. albofinibriatus, var. n.* Wings with the costa and its apex straw-coloured, with 4 distinct black spots in addition to 2 basal dots, and the entire internal fringe pale.

c. Last hind tarsal joints white tipped, but dark at the base.

14. *An. Lutzii*, Theob. Wings with 3 small white interruptions of the black costa, 2 near the apex, the 3rd close to base. Thorax black, with white-scaled adornment. First fore tarsal joint with basal, apical, and middle white rings. Femora and tibiæ unbanded.

15. *An. tesselatus*, Theob. Wing with the costa black, including the apex, but the absolute base white, with 2 obvious spots far out, and 5 white dots in two groups, more towards the base. Thorax scaly, adorned with curious, tesselated markings. Femora and tibiæ banded and mottled.

d. With some or all the tarsal joints apically lighter banded, but with the last joints dark at the apex.

16. *An. sinensis*, Wied. With 2 small ferruginous spots on the dark costa, one sub-apical, the other a little in front of the

[1] Includes Mr. Theobold's variety *Pallidus*.

cross-veins. Palpi of ♀, with apex, and 2 small rings, white.[1]

17. *An. barbirostris*, Wulp. Much resembles the above, but is blacker, and the palpi are all black in both sexes.
18. *An. costalis*, Loew. Three white spots on the dark costa. Tarsal bands involve both sides of the joints.
19. *An. cinereus*, Theob. Wings with three small white spots on the black costa; fringe brown with yellow patches. Legs long and thin, black; bases very pale.
20. *An. superpictus*, Grassi. Costal spots and dark internals of uniform length; four large yellowish spots. Abdomen with dark brown hind borders to segments. Abdomen without scales.
21. *An. Rossii*, Giles. Costa with 4 large, and an apical yellowish spot, the large one T-shaped. Abdomen without scales. Thorax with a tun-shaped patch of whitish bloom, when fresh.
22. *An. leucophyrus*, Donitz. Costa black, with an apical and 4 small costal yellow spots in addition to 2 basal dots. Tarsal banding not purely apical, but on articulations. Thorax chestnut with dark median line and large reniforn dark lateral spots.
23. *An. Kumasii*, Chalmers. Wings generally light coloured, with 4 black spots on the yellow costa. Thorax slaty, with sub-median and oblique lateral darker lines. Abdomen black, the segments rather darker behind.
24. *An. annulipes*, Walker. Wings with 3 large white spots on black costa, and an apical spot. Basal portion white with 2 black dots; veins elaborately beaded with black. Legs elaborately ringed on all joints. Cross veins alternate, 3 external, 2 ||, 4 ♀; or alternate. 3 external, 4 inside, 2 ♂.
25. *An. Mastersi*, Skuse. Closely resembles above, but all dark portions of the wing larger. Cross veins alternate, but 3 barely outside, 2 and 4 widely internal ♀; or 2 || 3, 4 much internal ♂.
26. *An. squamosus*, Theob. Wing with costa black including its apex, interrupted by 3 small white spots and 2 basal white dots. Hind borders of abdominal segments with prominent lateral tufts of scales.
27. *An. ocellatus*, Theob. Costa white, including apex and base, with 5 uneven-sized black spots and a basal black dot. Long veins mostly white scaled, with a few (about 14) small black dots. Thorax fawn-coloured with a pair of deep brown eye-like spots and a third median one, in front of the scutellum.

[1] In this are included *An. pseudopictus*, Grassi; *An. nigerrimus*, Giles; *An. annularis*, Wulp; and *An. Indiensis*, Theob.

e. With certain of the tarsal joints apically banded in the ♂, but barely perceptibly so in the ♀.

28. *An. gigas, sp. n.* Wing with 2 white spots in the ♀, and 3 in the ♂, as well as an apical spot, and a single basal dot; the fringe all light in the ♂, black at apex and at all but the sixth junction in the ♀. Is considerably the largest of Indian species.

f. Tarsi not obviously banded.

29. *An. culicifacies, sp. n.* Wings with 4 spots on the costa, as in *An. superpictus*, but both thorax and abdomen scaly, and the latter conspicuously basally banded, when fresh.
30. *An. pictus*, Loew. With 2 prominent, and a third indistinct, yellow spots on the dark costa.
31. *An. funestus*, Giles. Wings with the black costa interrupted by 3 white spots, in addition to a large apical spot; fringe interrupted at all but the 6th junction. Last ♀, palp joint all white.
32. *An. Listoni, sp. n.* Wing resembles *An. funestus*, but with a large additional spot near the base, and the ♀, palps minutely white-tipped only.
33. *An. Indicus*, Theob. Wings with the apically black costa interrupted by 4 small yellow spots, and a basal dot; fringe with 3 yellow patches. Otherwise like Grassi's *superpictus.*
33A. *An. sp. aut. var. n.*, near *Indicus.* Having large black costal spot sub-divided on I., and with an additional pale interruption of the internal wing fringe.
34. *An. Rhodesiensis*, Theob. Wings with 3 prominent white spots on the black costa and a yellow apical spot; other long veins and fringe, entirely pale-brown-scaled.
35. *An. minimus*, Theob. Wings with costa black, interrupted by 3 obvious creamy spots, and a fourth on the apex; long veins, dark scaled, saving middle of III; fringe interrupted at all longitudinal junctions, except the sixth. Thorax slaty, with deep brown lateral lines.
36. *An. punctipennis*, Say. Costa black, with a single large yellow spot, opposite the fork-stems, in addition to an apical spot: fringe black, except opposite ant. 5th junct. VI. pale in middle, black at apex and base; knees and apices of tibiæ yellow.
37. *An. pseudopunctipennis*, Theob. Closely resembles the above, but the internal wing fringe is spotted at each longitudinal junction and VI. has basal half pale, and the apical, dark except just at junction.

B. Wings with the costa uniformly coloured, but with an apical spot.

f. With the tarsi not obviously banded.

38. *An. Lindesayii*, Giles. Wings with a large yellowish patch, involving all long veins to III. inclusive, on its apex, and a

few light patches on III, IV, V and VI; fringe dark, except at apex and at post. 5th junct. Hind femora with broad whitish band.

C. Wings with the costa uniformly dark, but with wing-field spotted by tufts of accumulated scales, combined with light patches on some of the long veins.

f. With the tarsi not obviously banded.

39. *An. atratipes*, Skuse. Wings with 6 dark tufts of scales, and white interruptions on all the long veins after post. II; fringe with one yellow interruption behind III.

40. *An. crucians*, Wied. Wings with dusky spots and with VI. white, interrupted by 3 black dots. Palpi marked with white at bases of last 4 joints.

D. Wings with no distinct light interruptions of any vein, but with tufts of long scales, forming spots on the wing-field.

d. With the tarsi obviously banded.

41. *An. annulimanus*, Wulp. Wings with the costa uniformly coloured but with two spots on the wing-field formed by accumulations of scales. Abdomen grey-brown, with darker hinder borders to the segments.

f. With the tarsi not obviously banded.

42. *An. maculipennis*, Meig. Wings with 4 tufts of scales at root of II. on trans. veins, and at forks of II. and IV. Thorax with broad stripes of golden hairs, separated by darker bare lines.

E. Wings unspotted.

a. With the last tarsal joints white.

43. *An. annupipalpis*, Arribál. Costa and its cell densely black scaled, the remaining veins brindled black and gold. Tarsi and palpi white-ringed.

f. With the tarsi not obviously banded.

44. *An. stigmaticus*, Skuse. Wings dark, with the wing membrane yellowish, and an ill-defined patch of darker scales on the stigmatic region.

45. *An. bifurcatus* (L.). Has a creamy central patch on the head and a lighter ring on the base of 1st tarsal joint.

46. *An. ferruginosus*, Wied.? Ferruginous, with fuscous abdomen. Thorax with indistinct linear markings. Bases of palp joints with some white.

47. *An. Walkeri*, Theob. Like *An. bifurcatus*, but with no central creamy scales to the head.

48. *An. nigripes*, Stæger. Head with some white scales on the nape, but with no trace of a band on the 1st tarsal joints. Also smaller and more densely scaled than *An. bifurcatus*.

1. ANOPHELES BIGOTII, Theob. (Monog. I, p. 185).

Plate viii, fig. 5, Wing of Female (diagrammatic).

♀.—Wings with the costa black, including the apex and base, interrupted by two obvious white spots, one near apex, the other‖, the fork-stems with a third small dot a little further in. The subapical spot extends right across the wing, involving both branches of IV, and there are lighter interruptions to the fringe at all the long junctions. Fore legs with the upper three tarsal joints apically white ringed, the fourth all black, and the fifth all white; hind, with the last three tarsals and the apices of the other two, white. Thorax dark brown with four longitudinal lines of rather flat white scales, the two median ones rather close together.

I have not seen this species, as the single type specimen is in a private collection. The decoration of the thorax easily distinguishes it from all the other species with white hind feet. Head brown with white curved scales, and flat ones at the sides; antennæ brown, with second joint nearly as long as the next two, together; palpi brown, with apex and four apical bands to joints white. Abdomen steely-black, rather densely clothed with flat yellow scales on terga, and with white on the venter. *Length.*—6 mm.

Habitat.—Chili.

Observations.—(There is a single specimen in Bigot's collection, labelled by him as "*punctipennis*"; as, however, the name is already used by Say for a quite different species, it cannot stand.)

2. ANOPHELES ALBIMANUS (Wied.) ("A. Z. I.," p. 13).

No specimens exactly referable to the description of this species have reached the British Museum, but it is clear from the name and general context of the description, that the fore tarsi, and probably those of all the legs, had white end-joints. The species most nearly resembling it is *An. Bigotii*, and there seem no very strong reasons why that species should not be regarded as a synonym of Wiedemann's. The specimens from Jamaica, referred to this species in the first edition, were certainly wrongly identified, as in the light of the abundant material now available, there can be no doubt that they are examples of *An. argyrotarsis*, Desvoidy. The following is the original description:—

Fuscous, the abdomen with large, triangular, grey spots; the wings with dusky spots; the apices of the tarsi snow-white. Length, $2\frac{2}{3}$ lines (German), ♀.

Apices of the joints of the palpi snow-white. Each segment of the abdomen with a grey, triangular spot, the apex of which is directed forwards. Costa of the wings dusky brown with yellowish intersections which lie lengthwise. There are spots also on the inner edge and middle part of the wings, but they are much smaller.

Habitat.—St. Domingo, Hayti, and noted as found in the Island of Porto Rico by V. von Röder, in "Entomolog. Zeitung, Stetin," 1885, p. 339.

3. ANOPHELES ARGYROTARSIS, R. Desvoidy.

(Essai, p. 411.) *An. albitarsis*, Arribál. ("L. A.," p. 36.)

Wing with the costa black, interrupted by two small white spots, and a couple of basal white dots, in addition to which there is a large yellowish apical spot, involving all veins back to IV, inclusive. The remaining long veins are mainly white, and the fringe is interrupted at all the longitudinal junctions. Last three hind tarsals, and apices of the two other joints white ; fore legs with the three upper tarsals apically white-banded, the last two all dark ; mid with all joints so banded, but very indistinctly so, especially on the last two. Thorax and abdomen black, thickly clothed with pale ferruginous scales.

The name of this species is somewhat a misnomer, as in most specimens the pale tips of the hind tarsi are of the snowiest white in all ordinary lights. The male palpi are dark grey, with a white patch in the middle of the second joint and a band at its junction with the third, as well as some rather ill-defined markings on the club ; those of the ♀ are black, shaggy at the base, with all the terminal joint and minute bands on the next two articulations pure white. Only the apical white spot and the outer part of the costal interruptions are of any size, and these and the next internal alone affect the contiguous long veins. The greater part of the remaining long veins are pale scaled, but there are numerous short lengths of black on most of them. The anterior wing fringe has large interruptions opposite each longitudinal junction. *Length.*—4 to 5 mm.

Habitat.—St. Lucia, Rio de Janeiro, Jamaica, British Guiana, Antigua, Grenada.

4. ANOPHELES PALUDIS, Theob.

(Monog. I, p. 128 ; Reports to Malarial Com. of R. S. E., p. 75 [1901].)

Plate viii, fig. 3a, Wing of ♀, and 3b, that of ♂.

Wings with the costa black, with two minute white interruptions, one sub-apical, the other ‖ base of forks ; a third spot on the auxiliary long vein, ‖ forking of V, does not involve the costa ; the rest of wing is mainly dark, and there is but one fringe spot, placed at the posterior V junction. Last three hind tarsals and apical half of second, with a broad ring on that of first, all pure white; in the fore and middle legs the upper three tarsals are apically white and the last two dark throughout. Thorax dark brown, with a grey bloom on the metanotum and sparse whitish scales arranged in irregular lines. Abdomen sooty, nude, with golden-brown hairs.

This is a very darkly-tinted species which can hardly be mistaken for the preceding. The ♀ has the last three articulations of the palpi minutely white-ringed, and the hairs at extreme tip also pale. Those of the ♂ can hardly be said to be banded, but like his legs, and in contrast to those of the ♀, are elaborately speckled with white.

The two upper fore tarsal points are minutely apically banded, but the mid pair have none, and the first hind tarsal is also unbanded. *Length.*—5 to 5·5 mm.

Habitat.—Katmiga, Sierra Leone, Central Africa.

Observations.—"With the hind legs destroyed this species looks like *A. Sinensis*, but the white hind tarsi readily distinguish it. From *A. argyrotarsis* it can at once be told by the wings, which have the fringe with only one pale spot at the end of the lower branch of the fifth long vein, whereas in *A. argyrotarsis* there are several pale areas, and there are never more than two costal spots in this species." (Monog. I, p. 129.)

This species has been shown by Christophers to be capable of harbouring the sexual stage of the parasite of human malaria.

5. **ANOPHELES MAURITIANUS**, de Grandpré et de Charmoy.

"Les Moustiques," Port Louis. Planters' Gazette Press, 1900.

= *An. Paludis* sub-species *similis*, Theob. (Monog. I, p. 129.)

Plate viii, fig. 4. Wing of ♀.

Wings almost exactly as in *An. paludis*, but with the fringe entirely dark, or with a lighter patch opposite the second posterior cell. Only two instead of three of the tarsal hind joints are wholly white, and the white-scaled decoration of the thorax is much better defined, recalling that of *An. Lutzii.*

This form closely resembles the above, and Mr. Theobald describes it as a sub-species of that form, under the name of *An. similis, sub. sp. n.* Although dated 1900, MM. de Grandpré et d'Charmoy's publication did not reach us until the sheets of Mr. Theobald's monograph had passed "paged proof," so that his acknowledgment therein of the priority of the above name was impracticable. Apart from the difficulty of defining the status of a species, as compared with sub-species and varieties, the differences, however, appear as well defined, as those between many acknowledged, distinct members of this closely allied series; and hence it appears on the whole preferable to let it stand as distinct under the above name.

Head black, with a very meagre whitish frontal tuft; palpi of ♂ brown, with three whitish patches along the inner border of its club, and a few white scales near the base; those of ♀ black with whitish tip, and very faint white bands on the last three articulations. Coxæ marbled with dark patches surrounded by grey lines. The wing has the exceptional peculiarity of having the minute shortest rank of marginal scales white. Abdomen black, nude, with brownish hairs. *Length.*—Over 5 mm.

Habitat.—Salisbury, Mashonaland; Central Africa; Gold Coast; Mauritius.

6. ANOPHELES MACULIPALPIS, sp. n.

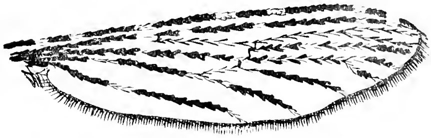


FIG. 41.—Wing of *An. maculipalpis* ♂ (diagrammatic).

Wings with the costa black, interrupted by four minute, almost snowy spots, in addition to a couple of basal dots: of the four outer spots, one is sub-apical; one just outside the base of the anterior fork cell; the third and largest, just inside the cross veins and the fourth well inside the origin of II; there is an additional white spot on I, interrupting the long black area between the two last mentioned spots, and most of the long veins show one or more white spots, but the internal fringe is uniformly dark. Last three hind tarsal joints and apex of the next yellowish-white, but the tarsi otherwise quite unbanded; though, together with all the other leg joints, elaborately spotted with patches of dark and light scales throughout their entire length.

Ground colour of thorax sooty, marked by broad and distinct median and lateral stripes of white tomentum, the former bifurcating behind, besides which there were obviously numerous white scales when fresh. Abdomen black and hirsute throughout, but devoid of scales.

♂.—Head black, with a rather scanty bifid snowy frontal tuft and snowy scales on the nape. Proboscis and antennæ fuscous. Palpi black, considerably longer than the proboscis, unbanded but elaborately maculated with snowy patches throughout their entire length. Pleuræ black with silvery markings. Halteres with pale stem and dark knobs. Venter sooty. *Length.*—About 5 mm.

Habitat.—Salisbury, Mashonaland.

7. **ANOPHELES FULIGINOSUS**, Giles (First Edition, p. 160).

= *An. leucopus*, Donitz; Insect. Borse, 5-18 January, 1901, p. 37.

Plate viii, fig. 7a, Wing ♀; 7b, Palpi ♀; 7c, Palpi ♂; 7d, Scale from lobe of scutellum.

Wing spotted; costa black, except at apex and base, and interrupted by three fairly large yellowish spots, involving the aux. and I. There are also two small black dots on the white basal portion of the costa only, and numerous black dots on the long veins. Last three hind tarsal joints and apex of second wholly white; first, second and third tarsal joints of fore and mid legs apically tawny banded. Thorax black, with whitish yellow scales. Abdomen black, with some (mostly basal) white scales, and numerous golden hairs on the segments.

Head black, with a distinct bifid white tuft; palpi of ♀ black with white tuft, and two narrow but distinct white bands on the articulations next to it; the coxæ have numerous silvery tufts; the large black costal spot next but one to base extends to the corresponding portion of I, but is divided into three by two minute white interruptions. The wing behind I, is mainly pale ferruginous, but there are numerous black portions on the long veins, and the internal fringe shows distinct tawny interruptions opposite each longitudinal junction. Scutellum deep slaty-black, with creamy-white scales, which form two lateral tufts, small black bristles on the mid lobe, long ones at the sides; pleuræ deep slaty-brown; metanotum deep brown to black.

This is Ross's "small dapple wing." *Length.*—3·5 to 4·2 mm.

Habitat.—Chingelput, Madras (common), Quilon, Punjab, Calcutta, Behar, Bengal.

Time of capture.—Madras in March, Punjab in June.

7a. **ANOPHELES PALLIDUS**, Theob. (Monog. I, p. 143.)

A pale form of the above species, the wing of which is figured on plate viii, fig. 8a, is described as a variety, *Anopheles pallidus*, in Mr. Theobald's monograph. It is further distinguished from the darker form by the peculiarity of having the short inner rank of fringing wing scales concave at the end instead of rounded, *vide* plate viii, fig. 7e and 8b.

8. **ANOPHELES JAMESII**, Theob. (Monog. I, p. 134).

Plate viii, fig. 6a, Wing ♀; 6b, Venation of ♂ Wing; 6c, Hind Tarsus.

Wing with costa jetty black, interrupted by five white spots, the three outer and larger of which involve also the aux. and I, while the remaining two are mere dots near base of costa. Under the long black costal area there are two white dots on II. Remaining veins mostly white, but beautifully beaded with black interruptions; fringe black with small white interruptions at each longitudinal junction.

The two last hind tarsal joints with the apex of the third pure white; the remaining joints and those of the other legs are apically white banded; and together with the tibiæ and femora, are elaborately adorned with brilliant white dots on a jetty ground, among which three on the hind first tarsals form complete rings.

♀.—Head black with white nuchal crown and frontal tuft; proboscis black, exactly the same length as the palpi, the apical halves of the two last joints of which are pure white, and the remaining joints spotted in the same fashion as the legs; antennæ black, two-thirds the length of proboscis; with white verticils, and at the base, white scaled. Thorax black, a sharply limited dorsal area covered with a white bloom, ornamented with a median and oblique lateral, nude black lines, the borders of which are fringed with large white scales. Halteres with white stem and black knots. Abdomen sooty with dark brown hairs; ♂ but little paler. The palpi are slightly longer than the proboscis, black, with a large white spot on the inner side of base of the last joint, and dotted white throughout. Claws of ♂ claspers very long. A small but beautifully ornamented insect. *Length.*—3 to 3·5 mm.

Habitat.—Received from Gugranwalla, Shahjahanpur, Punjab, in October; Ellichpur, in Berars, in February; and also recorded by Theobald from Quilon, Travancore. Its most distinctive character is the peculiar banding of the hind first tarsal joints.

9. **ANOPHELES THEOBALDI**, sp. n.

Plate xi, fig. 4, Wing of ♀.

♀.—Wing jetty black, with the costa interrupted by five obvious white spots, the basal dots being almost as large as the spots further out. In addition, there is an apical spot, and the other long veins, though mainly black, are elaborately marked with white lengths, and the fringe is interrupted at the junctions of all the long veins and their branches. The last two hind tarsal joints, with the apices of the other three, are pure white;

the first three joints of the fore and mid tarsi are apically white-banded. The thorax and scutellum are sooty grounded, with broad lines of white scales, two lateral and two sub-median. Abdomen sooty, nude, with brownish hairs.

This species was sent me first by Lieut. Glen. Liston, I.M.S., from Ellichpur, in the Berars, with a note pointing out its distinctness from any species mentioned in the first edition, and though on first sorting my collection, I was inclined to regard it as a dark variety of *An. Jamesii*, its distinctness was at once detected by Mr. Theobald, when we came to compare my collection with the types of that species in the museum. It differs from it in possessing the additional apical white wing-spot, although the wing is generally darker, II. being entirely black; and in but two, instead of three of the last hind tarsals, being all white.

The head is black, with a bifid white frontal tuft, the nuchal crown white, and the nape black scaled; antennæ black with whitish verticils; proboscis sooty; palpi intensely black, with the whole terminal joint and minute apical rings on the next three joints snowy white. Halteres with white stems and black knobs. Legs brindled with white scales throughout, the white preponderating on the lower surfaces, with white knee-spots and a large sub-apical white patch on the femora; the tibiæ and first tarsal joints elaborately white ringed, especially on the mid legs. *Length.*—About 3 mm.

Habitat.—Ellichpur, in the Indian Berars, and also taken in my house at Shahjahanpur, N.W.P., on October 19th, 1900.

10. **ANOPHELES ALBIPES,** Theob. (Monog. I, p. 125).

An. Cubensis, Agramonte (el progresso Medico, X, p. 460, December, 1900.)

Plate viii, fig. 2a, Wing of ♀; 2b, Head of ♀; 2c, Wing of ♂; 2d, Head of ♂; 2e, Hind tarsus; 2f, Tarsal claws of ♂.

Wings with the costa black, spotted with five smaller ferruginous spots, one over middle of fork-cells, the second just in front of mid cross-veins, and three smaller nearer the base, which may not quite involve all the costa; other markings on long veins, and the fringe yellow at the tip and spotted at all but the sixth longitudinal junctions. Last three hind tarsal joints, and nearly half the second pure white, *save for a black band at the base of the terminal joint;* mid tarsi with little indication of banding; anterior with three or four apical yellow bands.

Mr. Theobald originally described this as a distinct species, with which view I am disposed to concur, as in the males the cross-veins are placed 2 || 3, 4 internal, instead of alternate, as in *An. argyrotarsis*, of which he now regards it as a variety.

♀.—Head with white frontal tuft; palpi rather shorter than the proboscis, black, hirsute at base, with all the end joint and apex of third white; antennæ with white verticils. Thorax black grounded, ornamented with a median and a pair of lateral lines bordered with white scales; halteres brownish. Legs deep brown with ferruginous knees and dots on the side of fore and mid femora. Abdomen nearly black, with triangular patches of ferruginous scales on the hind part of the segments. ♂.—The palpi slightly shorter than the proboscis clothed with mixed brown and yellow scales, with a yellowish band on apex of second, and often on the two next joints, with large golden tufts to the club.

This species varies, especially as to palp-banding and fringe spots. It differs from *An. argyrotarsis* in the basal back band on the last hind tarsal joint, in the white spot near the tip of the wing being separated from the apex by a distinct black area, instead of being purely apical, in having but one instead of two rings on the continuity of the ♂ palpi, in the arrangement of the cross-veins in the ♀, and in being altogether a darker species.

The larvæ are found in streams and pools feeding on fibrous green algæ, and vary from grey-brown to greenish, with white patches (T. M.). The adults are rarely found in European houses (Freeland). *Length.*—Of ♂ 3·5 to 4·5 mm.; of ♀ 4 to 4·5 mm.

Habitat.—Jamaica (Dec. to February), Brit. Guiana, Rio Janeiro, Antigua (March).

11. **ANOPHELES MACULATUS,** Theob. (Monog. I, p. 171).

Plate ix, fig. 2a, Wing of ♂; 2a, Head; 2c, Palpi of ♂.

Wing with the costa black, but creamy-yellow just at the apex, with two large outer, two small middle spots, and two large basal dots, six in all, of the same tint; on II, beneath the large black middle area, are two small white interruptions; the rest of the wing is generally pale, but there are prominent black lengths on all the long veins, and the fringe is patched with yellow at each of the long junctions. Last hind tarsal joint all white, and its other joints banded on the articulations, as are those also of the upper tarsals of the fore and middle legs. Thorax dark grey, with brown lines, and a dark patch on either side, clothed with scattered falciform white scales, some long ones of which project from the anterior border. Abdomen black, with golden hairs, very dense towards the apex.

Head black, with black fork-scales except on a triangular patch in front, where they are white, especially large in the ♂: basal joints of the antennæ with some white scales; palpi black, with the last joint and rings on the articulations white in the ♀, less marked in the ♂, in which one side of the club only is white. Legs with pale yellow spots and rings on the femora, tibiæ, and first tarsals. Anterior tarsal claw single, with two accessory teeth. Genitalia of ♂ clothed with black, spade-shaped scales. *Length.*—3·5 to 4 mm.

Habitat.—Hong-Kong (September and October).

12. ANOPHELES PHARŒNSIS, Theob. (Monog. I, p. 169).

Plate ix, fig. 1a, Wing of ♀ ; 1b, Wing of ♂ ; 1c, Abdomen.

Wings with the costa black, interrupted in both sexes by a large white spot commencing just in front of the transverse veins ; between this and a small apical spot there is in the ♂ a fair-sized white spot, and in the ♀ indications of one ; in both sexes there is a third white spot midway between the middle spot and the base of the wing, and there are a couple of basal white dots, but these are much better marked in the female. Almost all the wing field is yellowish, but with scattered black beads on all the long veins ; internal fringe dark, with pale interruptions at the apex and at all the longitudinal junctions. Last hind tarsal joint and apex of next all white ; remaining tarsal joints broadly, apically white-banded, except fourth and fifth, in fore legs. Femora and tibiæ maculated. Thorax grey, with a pair of prominent black, eye-like spots. Abdomen black, with greenish-yellow scales produced into apical lateral tufts in each segment.

Head brown, with mainly white fork-scales. Palpi ♂ rather longer than proboscis, greenish-brown, with indistinct markings produced by the darker bases of the joints ; those of ♀ fawn-coloured with tips and apical white bands of the joints white. Antennæ closely covered with white scales up to the last two joints. The decoration of the thorax is very characteristic, its ground colour being really dark grey, with two intensely black spots, looking like a pair of eyes. Over this grounding is arranged a tomentum of greenish-brown scales, arranged so as to leave a pair of nude ant. sub-median and of post. oblique lateral lines. The tufts at the sides of the abdominal segments also render this species unmistakable. *Length.*—8 mm. ♀ ; 7 mm. ♂.

Habitat.—Cairo (January), Central Africa, Mashonaland, Syria.

13. ANOPHELES PHARŒNSIS, Theob., var. *Albofimbriatus.*

Wings with their costa and apex straw coloured, with 4 large black spots, involving II, of about the same length as the pale intervals, the basal pale spot being unsymmetrically T-shaped, and with two black basal dots on the costa only ; the remaining long veins are clothed with pale yellow scales, with the exception of four or five minute black dots ; VI. being entirely pale, as also is the internal fringe. The last hind tarsal joints are entirely white, and the remaining joints are white for almost their apical halves; in the fore and mid legs the upper three joints have

FIG. 42.—Wing of *An. Pharœnsis* ♀, Theob. var. *Albofimbriatus*, Giles.

broad apical bands, and the last two are all black; all the femora have broad sub-apical garters, and in addition are, together with the tibiæ and first tarsals, marbled with black and white. Ground colour of thorax sooty, clothed with white and yellow scales, the latter preponderating behind.

Although I believe this is merely a variety of *An. Pharœnsis*, it is exceptionally well defined as such, and could not be recognised unless given a separate place in the tabulation of the genus. Ground colour of head sooty, with a double median stripe of white scales, ending in a strong frontal tuft, and with two large white lateral patches; antennæ scaly on all but the two end joints, banded black and white, with scanty verticils; palpi clothed with intermixed black, white, and yellow scales, the proportions varying, so as to form indistinct apical bands to the joints and a tip, paler than the rest of the appendage; proboscis, dark brown. Abdomen, sooty, clothed with golden-brown scales, arranged so as to form broad apical bands, and a median line on the three or four anterior segments, and to almost entirely cover the rest; especially dense at the under corners, so as to form fairly distinct tufts; venter with numerous white scales. *Length.*—About 4 mm.

Habitat.—Tel Zahmul, Palestine. Described from a single ♀ specimen sent me by Dr. J. Cropper. Mr. Theobald, however, tells me that in a considerable series of *An. Pharœnsis* sent him from the same collection, all had the wing fringe striped in the usual way, and in view of the correspondence of the very peculiar arrangement of the scales of the abdomen, I conclude that this is no more than a variety.

14. **ANOPHELES LUTZII**, Theobald (Monog. I, p. 177).

Plate ix, fig. 8.

Wings mainly black; with three minute yellowish spots on the costa; one sub-apical, the second just internal to the base of anterior fork, and the third near the base; there is also a dot on II, midway between the two inner spots, a few white scales about the transverse veins, on the fork of V, and for the middle third of III, and the fringe shows indistinct yellowish

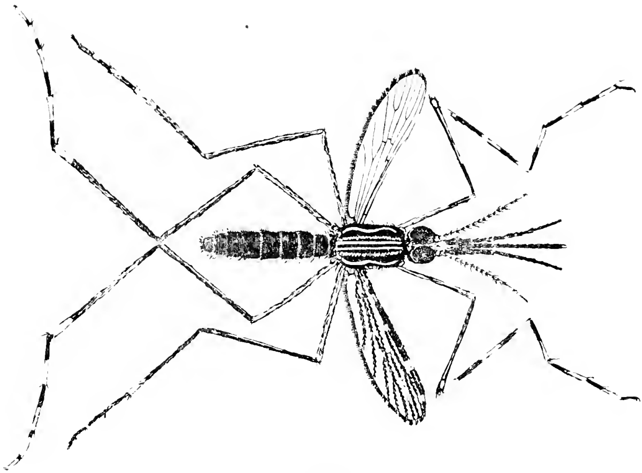


FIG. 43.—*Anopheles Lutzii*, ♀.

interruptions at the longitudinal junctions. Hind tarsi white tipped, and broadly apically white banded on all joints; the first having an additional apical and middle band. Thorax with marked adornment.

♀.—This is the smallest species I have handled, being barely 4 mm. long, and the wing less than 3 mm. The thorax is strikingly adorned, in a way very unusual in the genus, by means of white scaled lines on the fuscous ground colour; of these there is a pair of sub-median and of lateral longitudinal lines and an external lateral pair curved much as are those of *Steg. fasciata*. The proboscis and palps are of equal length and entirely black, save for a few white scales on the tips of the joints of the latter. The eyes have a minute white border and there is a distinct white, bifid frontal tuft. Besides the dorsal thoracic adornment, there are white tufts on the pleuræ and coxæ. The tibiæ have a sub-apical whitish patch. The anterior tarsal joints are broadly apically white banded, saving the last, and the first has in addition two black, alternated with two other white lengths, making five in all. The mid tarsi are dusky throughout, the banding of the joints being obscure or absent. The abdomen is hirsute and fuscous throughout, with the hind borders of the segments somewhat paler.

Habitat.—Received from Dr. Lutz, who writes that it is the wood *Anopheles* of Brazil, breeding in ponds, the adults frequenting woods in mountainous regions, serving as the transmitter of malaria in places where there are no swamps.

15. **ANOPHELES TESSELATUS,** Theobald (Monog. I, p. 175).

Plate ix, fig. 7a, Wing of ♀; 7b, Dorsum of thorax; 7c, Hind tarsus.

♀.—Wing with the black costa white at the apex and at absolute base, with three yellow interruptions large enough to catch the eye, the innermost of which is subdivided by a minute black dot, in addition to which, the generally pale basal fifth of the costa shows three more black dots. Aux. and I. participate in the formation of these spots, but their light portions are further subdivided by additional black dots. The remaining long veins are yellow, minutely beaded with fairly regularly placed black dots. The internal fringe has fairly distinct yellowish interruptions at all but the last longitudinal junction. All the tarsal joints are apically banded, very indistinctly on the hind legs, but quite prominently so on the two anterior pairs, in addition to which the femora and tibiæ are elaborately yellow-speckled. Thorax with two short sub-median brown lines, which with two deep lateral dots and certain other patches give the mesonotum a quaint resemblance to an owl's face.

Head black, with mixed white and black forked scales and a fairly robust frontal tuft. Antennæ clothed with white scales up to the last two joints. Palpi with their apical third white, tinged yellow at the tip, interrupted by two small black bands; the generally black basal two-thirds with three small white rings. Thoracic decoration due to patches of black and white scales. Halteres entirely white. Abdomen sooty, nude, except for some brown hairs. First hind tarsal joint with three pale patches on its distal half. *Length.*—3·5 to 4 mm.

Habitat.—Taiphing, Straits Settlements (May).

16. **ANOPHELES SINENSIS,** Wied. ("A. Z. I.," p. 547).

Plate viii, fig. 9a, Wing of ♀; 9b, Scale of wing-vein; 9c, Scales of wing-fringe with tip of one of long scales more enlarged.

Plate xi, fig. *5a*, Arrangement of scales on wing-vein.

Synonyms or Sub-species?

An. annularis, Van der Wulp = *An. vanus*, Walker.

(Notes, Leyden Museum, vi, p. 249, V. d. Wulp; Journ. Proc. Linn. Soc. Lond. iv, p. 91 (1860), Walker = *vanus*.)

Plate viii, fig. 10, Wing of ♀.

An. pseudopictus, Grassi.

(Venti Specie di Zanzare Ital. (1899), Ficalbi; Reale Accad. dei Lincei. Stud. d. u. Zool. sulla Malaria, p. 78 (1900), Grassi.)

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Plate viii, fig. 11a, Wing of ♀; 11b, Venation of wing of ♂; 11c, Venation of wing of another ♀ (drawn from specimens in Professor Grassi's laboratory).

An. "*sp. b.*, from Calcutta," provisionally named *nigerrimus*, Giles (first edition of present handbook, p. 161. [1900]).

Plate viii, fig, 12a, Wing of ♀: 12b, Head and palpi of ♀.

An. Indiensis, Theobald (Monog. I, p. 145).

= *An. plumiger*, Donitz, Insect. Borse, January, 1901. (Specimens of this supposed new species proved to be partly examples of *An. sinensis* and partly *An. barbirostris*.

Wing with two small ferruginous spots on the black costa, one sub-apical, the other a little in front of the cross-veins; the rest of the wing rather dark, especially towards the tip, the fringe of which is, however, more or less yellow, though it is elsewhere entirely black, or with some more or less pale patches at the longitudinal junctions. There are never any white basal dots on the costa. Tarsi with pale apical bands throughout, though often barely perceptible on fore and middle legs; the last joints generally rather paler at tip. Thorax with a grey bloom, laterally red-brown with scattered golden scales. Abdomen black, nude, with scanty brownish-yellow hairs, a denser fringe of these on the hinder borders of the segments giving an indistinct appearance of banding.

Head black with the exception of a white frontal tuft projecting between the roots of the antennæ, which are black, with pale, downy tomentum between the scanty black verticils, a few of the fork-cells of nape are whitish. Palpi very shaggy, equalling the proboscis in length, with the tips yellowish and the articulations between the next two joints minutely banded whitish. Halteres fuscous. Legs long and slender, yellowish-brown, deepening on the tarsi, the three or four upper joints of which have conspicuous distal ochreous bands, the last joints being all yellow.

In view of the incompleteness of Wiedemann's description and the absence of actual specimens from China, it is by no means surprising that this species should have been repeatedly redescribed. It is impossible to identify the *annularis* form by its original description, as no mention is made of the number of costal spots, and the figures and descriptions of the Italian form leave one in entire doubt as to the position of the transverse veins. I have not seen the *Indiensis* form, as the single specimen from which it is described by Mr. Theobald was a loan from a private collection, but it does not appear to differ much from the rest, and the only one of the group that is at all readily recognisable is Van der Wulp's *annularis*, which has a distinctly lighter wing than the rest and often shows fairly distinct banding of the wing-fringe. In the Museum Monograph, all five forms are separately described as sub-species, and figures of all but *Indiensis* will be found on plate viii; but personally I should prefer to regard them as one moderately variable species. The only species with which it can be confounded is Van der Wulp's *An. barbirostris*, which, however, is easily distinguished by the palpi being uniformly sooty black in both sexes, instead of banded.

Mr. Theobald gives the following table of the differences between these six forms, as follows:—

A. Sinensis.

1. Proboscis longer than palpi.
2. White patch on border of wing below.
3. Wing (costal) spots large.
4. *Scales elongated.*
5. Cross-veins close together.
6. Border scales yellow.
7. Apical fringe all yellow.

Length 4 to 5 mm.

sub.-sp. *annularis.*

1. Palpi and proboscis equal.
2. No white patch on border.
3. Costal spots small.
4. Scales as in type.
5. Cross-veins separate.
6. Border scales yellow.

Length 3·8 to 4·5 ♂., 4 to 5 mm. ♀.

sub-sp. *Indiensis.*

1. 1st sub-marginal cell with base near 2nd costal spot at the junction of the sub-costal and costal veins.
2. Scales as in *annularis.*
3. Cross-veins separate.
4. Border scales yellow.

sub-sp. *pseudopictus.*

1. 1st sub-marginal cell with base near 2nd costal spot at the junction of the sub-costal and costal veins.
2. Cross-veins close.
3. Scales as above.

Length 5 to 6 mm. (often much smaller).

sub-sp. *Nigerrimus.*

1. Base of the sub-marginal cell just in front of the costal spot.
2. Apical fringe black.

Length 4·5 to 5 mm.

A. barbirostris.

1. Bases of the two fork-cells nearly level.
2. Base of 1st sub-marginal cell not near junction of sub-costal and costal.
3. *Scales broader.*
4. No white spot on lower fringe.
5. Black apical patch to fringe.
6. Palpi unbanded.
7. Border scales black.

Length 5 mm.

Habitat.—Sinensis: China, Tamusi, Formosa, Foo Chow, Tai Po, Pokfulam, Lamma (June to October). *Annularis:* Straits Settlements, Taipang, Perak, Madras, Central Provinces, India, Syria. *Nigerrimus:* Calcutta, North-west Provinces, Travancore. *Pseudopictus:* Italy, Egypt, Syria.

17. ANOPHELES BARBIROSTRIS, Van der Wulp.

(Leyden Museum Notes, vi, p. 48.)

= *An. plumiger*, Donitz. Insect. Borse, Jan. 1901. Specimens of this supposed new species proved to be partly examples of *An. barbirostris* and partly of *An. sinensis*.

Plate viii, fig. 13a, Wing of ♀; 13b, Venation of ♂ wing.

Wing intensely black, with a small apical spot, a single tiny interruption of the costa, opposite the middle of the fork stems, and two basal dots of a much clearer white than in the allied species; the fringe is black at the apex and elsewhere, except opposite the junctions of III, and post. V, and over a rather long space about that of ant. V; there are only two or three white spaces on the long veins. Legs sooty, with small, but obvious apical white rings to the tibiæ and tarsi. Thorax black, with a dorsal patch of grey bloom, and some appearance of linear marking, imparted by irregular lines of scattered, golden linear scales. Abdomen black, nude, with brown hairs. Head and appendages entirely black except for a white frontal tuft, and greyish tips to the otherwise black fork-scales of the nape.

There is no need to give any further description of this very distinct species, the differences from the *Sinensis* group having been already sufficiently indicated.

In the North-west Provinces of India it is one of the commonest species of the genus, and may be seen about much later in the year than *An. Rossii*. It is noticeable that males are to be met with in considerable numbers, long after the females have hidden themselves for the winter, and I took one of these on November 20th, in Shahjahanpur, last year. *Length.*—5 to 6 mm.

Habitat.—Straits Settlements, Upper Burmah, Calcutta, North-west Provinces, and Punjab, India.

18. ANOPHELES COSTALIS, Loew.

(Ent. Zeit. Berlin, p. 55 [1866].)

Plate ix, fig. 9a, Wing of ♀; 9b, Palpi of ♀; 9c, Palpi of ♂; 9d, Tarsal claws, *f*, *m*, *h*, of fore, mid and hind legs of ♂.

Wings with the black costa white at the apex, and at all but the very base, with two large spots on the outer half, extending to II, but subdivided in each case on the latter by a black dot; there are also three prominent interruptions on the basal half, but only the outermost of these involves II, the two basal ones, though large, usually affecting the costa only; the remaining long veins are about equally divided into black and white portions, and the dark fringe is white at the tip of the wing and at all the longitudinal junctions. Tarsi with minute but distinct yellowish rings on the articulations. Thorax slaty-brown, with a dusky median line. Abdomen black, nude, and with long golden hairs. Femora and tibiæ curiously mottled.

♀.—Head brown, clothed with upright, rather broad, white scales in front and on the occiput, similarly formed black ones at the sides, and a tuft of white hairs projecting forwards; antennæ pale brown, with pale pubescence, basal joint bright brown, with white scales, which also extend on to the next few joints; palpi black-scaled, apical joint yellowish-white, and the apices of the two preceding also banded white, the bands being narrow; clypeus pale brown; proboscis black, thin, pale at the tip, as long as the palpi. The details of the wing-decoration vary somewhat.

♂.—With the wing much lighter, the white-scaled portions preponderating; antennæ yellowish-brown with darker verticils; palpi dusky, with numerous pale scales, swollen at the last two joints, apical joint chiefly white, the next with a narrow pale apical band; the hair tufts brown, a little longer than the proboscis; proboscis thin, dark brown, yellow at the apex. Abdomen narrower than in the ♀, dark and pale yellowish-brown and silvery-grey, a median brown dorsal line, a paler lateral line on each side, more or less pale basally and with very long hairs; genitalia with yellowish scales. Ungues of fore legs unequal, the larger one twice-toothed. *Length.*—2·5 to 3·5 mm. ♂; 3 to 4·5 mm. ♀.

Habitat. — Freetown, Sierra Leone, Bonny, Lagos. Salisbury Mashonaland, Central Africa, Mauritius, Cafraria.

Appears to be the commonest and most widely distributed of African species, though not so common as *An. funestus* in Central Africa. It has been proved to be capable of transmitting human malaria.

19. ANOPHELES CINEREUS, Theob. (Monog. I, p. 161).

Plate x, fig. 1a, Wing of ♀; 1b, Scutellum; 1c, Basal portion of ♀ antennæ.

Wing with the costa black, with an apical pale spot, but having no basal dots, the intervening portion interrupted by three prominent white spots; the long veins white at the base, but elsewhere made up of alternating black and white lengths, the former preponderating; fringe uniformly brown, except at the tip, where there are two lighter patches. Tarsal joints apically banded with yellow, the end ones paler than the rest. Thorax dorsally grey, with median and lateral reddish-brown lines, and deep brown laterally. Abdominal segments dark brown, darkest on their hind borders, nude, with golden hairs. Second joint of ♀ antennæ longer than the two following it. Scutellum with three exceptionally dense tufts of long golden hairs.

♀.—Head black, except for a scanty yellowish frontal tuft and a pair of lateral patches on the vertex, where the elsewhere black forked scales are white; palpi deep red-brown, with the apex and three rings on the articulations white. Halteres yellowish, with dark knobs. Legs very thin, sooty, but for snowy spots on the apices of the femora and tibiæ. contrasting markedly with the pallid coxæ. *Length.*—5 to 5·2 mm.

Habitat.—Salisbury, Mashonaland; Zomba.

Time of capture.—June, Mashonaland; January, Zomba.

Observations.—Described from three ♀'s. At first sight they look like large *A. funestus*, but the clear pale bases to the legs separate it at once, as well as the large wings and the marked characters of the jet-black legs, with white spots at the knees and apices of the tibiæ.

20. ANOPHELES SUPERPICTUS, Grassi.

(Venti Specie di Zanzare Italianne, p. 87 (1899), Ficalbi; Reale Accad. d. Lincei Stud. d. uno Zool. sulla Malaria, p. 78 (1900), Grassi.)

Plate ix, fig. 10a, Wing of ♀; 10b, Venation of ♂ wing.

Wing with the costa black at the apex and at the base, where there is a single basal dot, the remainder of the costa sub-divided into nearly equal lengths of yellowish and black, so that counting the basal and apical black portions, there are five black and four yellow spots, the remaining long veins show long white and black portions, the former but little preponderating; fringe entirely dark, except at the apex. Legs banded on the tibio-tarsal and tarsal articulations. Thorax with the dorsum browner at the sides. Abdominal segments brownish-yellow, with darker hind borders; very hairy, but absolutely devoid of scales on either the dorsum or venter.

"Proboscis nearly black, but whitish at the tip. Palpi of the ♀, nearly as long as the proboscis, almost black, with white rings at the junction of the second and third, and fourth and fifth, as well as the entire terminal joint white. Nape black, with a median white tuft. Legs with the femora brownish, those of the first pair not proximally dilated. The remainder of the joints brownish-black, with white rings at the tibio-tarsal and tarsal articulations affecting mainly the apices of the proximal joints."—(Extracts from original description.) *Length.*—5 to 8 mm.

Habitat.—Italy, West and Central Africa, India, Madras, and Central Provinces. This species has been shown by Grassi to be the commonest transmitter of human malaria in Italy, and also by Grassi and Noé to be the intermediate host in canine filariasis.

21. **ANOPHELES ROSSII,** Giles (First edition, p. 149).

Plate ix, fig. 11a, Wing of ♀: 11b, Venation of ♂ Wing; 11c, Tarsal claws of ♂.

Wing with the costa pale at the apex and base, but generally black, interrupted by two large yellowish spots opposite the fork-cells, and just in front of the cross-veins respectively; the black area, next internal to these is very large and is T-shaped, owing to the presence of a short length of black upon II, beneath the middle of the thrice longer area on the costa and auxiliary; internal to this there are only three minute white dots; there is a row of sub-ap cal black dots on every one of the long veins, and three or four others, and the fringe is yellow at the tip, and has pale patches at all the longitudinal junctions, except that of VI. Tarsi with yellowish rings on all but the last articulations of the fore and mid legs. Thorax deep brown, with, in the fresh state, a dorsal, tun-shaped patch of velvety, pale cinereous bloom. Abdomen dusky, nude, densely clothed with golden-brown hairs.

♀.—Head blackish, with pale scales in front, and with a tuft of pale hairs projecting forwards, black scales at the top and sides; eyes black; antennæ brown, with pale hairs and pubescence; basal joint ochreous-brown, with a few creamy scales; proboscis dark brown. apex sometimes pale; palpi dark scaled, apically white, and with two other pale bands near the apices of the second and third joints; clypeus pale brown.

♂.—Palpi swollen at the end, yellow, with a broad black band at the base of the second joint, a broad black band at the base of the third, and a small one near the apex of the same joint, and a narrow ring of black at the base of the last two joints; hair tufts short, pale; the base of the palpi densely black-scaled; proboscis dark brown, pale at the tip; antennæ with silky, golden-brown plumes. Wings marked much as the ♀, but in many ♂'s, especially in those from South India, there is a small additional spot beneath the second costal spot, besides the one forming the T, and in a few ♀'s I have noticed the same.

Professor Grassi regards this as identical with his *An. superpictus*, but there are few species more easily distinguished. According to Dr. Daniels it does not carry the tertian crescent stages of the malarial parasite. *Length.*—From 4·6 mm. ♂ to 6 mm. ♀.

Habitat.—Common throughout India.

22. ANOPHELES LEUCOPHYRUS, Donitz.

(Insect. Borse, Jan., 1901, p. 37.)

FIG. 44.—Wing of *An. leucophyrus*, Donitz, ♀ (diagrammatic).

Wings with the costa yellowish at the very apex, but generally black, interrupted by six narrow yellow intervals, the two larger of which are placed opposite the transverse veins and the middle of the anterior fork-cell respectively; of the remaining four, two are large basal dots, and the remaining two take the form of a good sized spot placed opposite the fork of V, subdivided into two by minute black dots on the costa, aux., and I. All the long veins show alternate lengths of ferruginous and dark brown scales; the wing fringe is dark with pale interruptions at the longitudinal junctions, the black patch opposite the anterior fork-cell being specially prominent. Tarsi dark brown with yellow bands on the articulations, including the tibio-tarsal; ground colour of thorax light yellowish-brown, with a narrow median dark line expanding behind into a triangular patch before the scutellum and with an indistinct round expansion a little in front of this, with a pair of irregular double spots well to the sides In the front of the thorax there remain some yellow scales. Abdomen nude in its present condition, rather light grounded, with an indistinct darker median line.

♀.– Head dark brown, with nearly black scales on the nape, and a scanty yellowish frontal tuft; proboscis nearly black with a sharply defined whitish apex. Palpi nearly black, very densely scaled at the base, with yellowish apex and two indistinct yellowish bands. Pleuræ black, indistinctly marbled with grey. Legs mottled with patches of black ferruginous scales, venter fuscous. Halteres light brown, with darker mottling. *Length*.—About 6 mm.

Habitat.—Sumatra.

23. ANOPHELES KUMASII, Chalmers ("Lancet," Nov. 1900).

Wings with the costa black, with three yellowish spots on the outer two thirds of the costa, and with numerous black spots on the otherwise yellow-scaled long veins. Tarsi with yellowish rings on the articulations. Thorax slate-coloured, with two dark lines dorsally and another pair laterally. Abdominal segments dark, nude, blacker on their hinder borders.

Extract from original description :—

"A small black Mosquito. The female is small, 3·5 millimetres in length and having wings three millimetres long. The head is black with light-coloured hairs; the antennæ have light-coloured joints; the palpi are black with three yellow marks; and the proboscis is black except at the apex. The wings have the four black spots on the costal margins separated by yellowish spaces. Of these spots the first is the longest, extending along about one-third of the costal margin, and the other three are much smaller. The legs are in general dark coloured; the femora are not yellowish at the base, and the tibiæ are not yellowish on the outer side. The tarsi are ringed distally and proximally. The male is much the same as the female. Its length is four millimetres, and the length of the wing is three millimetres. Its *habitat* is in dwelling-houses in Kumasi, Ashanti, West Africa."

24. ANOPHELES ANNULIPES, Walker.

= *An. musicus*, Skuse.

(Ins. Saund. i, p. 433 (1850), *annulipes*, Walker; Proc. Linn. Soc. N.S. Wales, p. 1754 (1889), *musicus*, Skuse.)

Plate ix, 3a, Wing of ♀; 3b, Wing of ♂.

Wing with the black costa interrupted by three smaller white spots (the outermost of which is wanting in the ♂), and the pale base marked with two black dots in both sexes. There is also a ferruginous apical spot and all the veins of the wing field are elaborately beaded with black dots. The upper tarsal joints are all more or less apically light banded, but the last two are all dark; all the femora and tibiæ elaborately white banded. Thorax dark with white scales, leaving indistinct, anterior median, and oblique, posterior lateral, bare lines. Abdomen sooty, nude, but for golden-brown hairs.

Head black, with scanty frontal tuft and the fork scales of nape black, but a triangular tuft of those on the vertex white. Palpi of ♀ snowy in front, impure white at the base; the joints with four narrow, but sharply defined basal black bands, a trifle shorter than proboscis in both sexes; those of ♂ brown, with indistinct patches of whitish or grey in corresponding situations to those of ♀. The anterior border of the thorax has a striking tuft of long, white, lanceolate scales, especially well marked in the ♀. Pleuræ and coxæ mainly brown, with some greyish marbling. Halteres with snowy stems and brownish knobs.

The brilliant black and white beading of all parts of this species is very striking. The first tarsal joints of the ♀ fore legs alone have a band in the middle, but the tibia and femora are the most striking part of the legs in this respect. *Length.*—5 to 6 mm.

Habitat.—Bupengary, Queensland; Elizabeth Bay, near Sydney; Mt. Kembla, Illawarra, N.S.W.

Time of appearance.—In Queensland in December (Bancroft); in N.S. Wales in February (Skuse).

25. ANOPHELES MASTERSI, Skuse.

[Proc. Linn. Soc. N.S. Wales, p. 1757 (1889).]

Plate ix, fig. 4a, Wing of ♀; 4b, Wing of ♂.

Wings with the black costa interrupted by two small but obvious spots and by a pair of minute dots midway between the outer and larger spot and a ferruginous apical spot. The absolute base is white and there are also two minute white dots near it. Except in the fore legs the apical banding of the tarsal joints is barely perceptible and in all three legs the first metatarsal as well as the femora and tibia are elaborately spotted. Thorax black with silvery scales. Abdomen nude with golden-brown hairs.

This species closely resembles *An. annulipes*, especially in the head and body, but the light wing spots in the females are much smaller in the present species, the outermost one in the ♀ being represented only by a pair of minute white dots in place of the prominent spot so situated in that species: in the ♂, on the other hand, the outer spot is much the larger in *An. Mastersi*. They are, however, I think, quite distinct. *Length.*—4·5 mm. ♂ and ♀.

Habitat.—Bupengary, Queensland (Bancroft, December 5, and May 8 and 29, 1899); Blue Mountains, N.S.W. (Masters).

"*Observations.*—Very like and closely related to the former, but the ♀ can easily be told from *An. annulipes* by the proboscis being paler at the tip. It is also smaller in size, and Skuse says that the sub-costal transverse vein is placed considerably beyond the middle of the auxiliary vein, whilst in *An. annulipes* it is situated *in* the middle."—(Monog. I, p. 165.)

26. ANOPHELES SQUAMOSUS, Theobald (Monog. I, p. 167).

Plate ix, fig. 6a, Wing of ♀; 6b, Lateral view of thorax; 6c, Portion of the abdomen.

Wing with the costa black, including apex and base, with three small spots involving I. and two large basal dots, nearly as large as the spots, but involving the costa only; II. entirely black, the other long veins about equally divided into white and black lengths; fringe black, except at the apex, and at two or three of the anterior longitudinal junctions. Tarsal joints, with the upper two of the fore and mid and the upper four of the hind legs apically white banded. Thorax black with irregular lines of white scales; the pleuræ with three brilliant white, parallel, longitudinal lines. Abdomen black, densely clothed with scales, which are so dense at the sides of the posterior borders of the segments that they project as conspicuous tufts.

Head black, a few of the anterior forked scales white; palpi deep brown, densely hirsute, with three indistinct whitish bands. Legs with the femora and tibiæ banded and mottled with patches of white scales. The characters of this species are so striking and exceptional, that it can hardly be mistaken for any other except *An. Pharœnsis*, which wants the pleural stripes, or for *An. ocellatus*, in which the lateral tufts of the abdomen are ventral, and not dorsal in origin, and the thoracic spots are too prominent to be easily overlooked. *Length.*—5 to 5·5 mm.

Habitat—Mashonaland, and British Central Africa.

27. **ANOPHELES OCELLATUS**, Theob. (Monog. I, p. 174).

Plate ix, fig. 5a. Wing of ♀; 5b, Dorsum of thorax.

Wings quite hyaline, with the white costa interrupted with four obvious black spots, the largest just inside the transverse veins, and between it and the next an additional black dot. There are only eight or ten long black dots on the long veins, and the internal fringe is cream-white, interrupted by half-a-dozen patches of white scales. Last hind tarsal and apex of next whitish. In the fore legs the last three joints are all dirty white but for a faint darkening of their bases. All other tarsal joints apically banded whitish. Thorax straw-coloured, with a patch of velvety grey bloom on the dorsum and three black spots, one in front of scutellum and the others lateral. Abdomen greyish-brown, with yellowish hairs and dense tufts of long scales projecting from the sides, even when viewed from above, but springing from the ventral surface.

Head with fawn ground and strong white frontal tufts, the fork-scales of vertex white, but those of the nape bluish, while the lateral patches of flat, imbricating scales are of a rich brown; palpi fawn at the base and white for their apical halves, the latter portion showing two distinct but narrow black bands and the basal three, but less sharply defined; proboscis deep brown at the base, fading off to rich ferruginous on its apical half, near the tip of which is a tiny black band. Abdomen deep brown, densely clothed with ferruginous hairs and scales. Venter densely clothed with ferruginous hairs; the posterior borders of the segments clothed with dense tufts of elongated scales, with broad obovate ends, a character which, taken in conjunction with the dense clothing of scales on the terga of the abdominal segments and the fact that the antennal joints are densely clothed with white scales almost to the end of the appendage, may possibly prove to be of generic importance. In such case the new genus, which might perhaps be named *Leptocornis*, would include, in addition to the present species, *An. ocellatus*, and *An. pharœnsis* with its new variety, *An. albofimbriatus*. *Length.*—3 mm.

Habitat.—Taipang, Perak, Straits Settlements (L. Wray, November 22nd and December 21st, 1899).

"*Observations.*—A very distinct and beautiful pale species, easily told by the two clear, dark, eye-like spots on the thorax, the dark area of the scutellum, and the much banded legs and tarsal markings. Described from two ♀'s only."

28. **ANOPHELES GIGAS**, sp. n.

Plate x, fig. 2a, Wing of ♀; 2b, Wing of ♂.

Wing with the costa black, interrupted by a comparatively small, fulvous spot opposite the basal half of the anterior fork-stem, in addition to which there is a large apical spot, and the base of the wing is generally pale, except the actual base of the costa, which has here a black length cut in two by a minute white dot, so that the general appearance is that of two large black, triangular areas, with their bases on the costa, the inner part of the wing being mainly pale, with but few black vein-spots; the internal fringe is pale at the apex and generally towards the base, and the intervening dark portion shows pale patches at the longitudinal junctions. In the ♂, the whole wing is much lighter, there is an additional light spot near the apex, and the entire fringe is yellow. Thorax of a deep chocolate-brown ground colour, the dorsum covered with a velvety, greyish bloom, so arranged as to leave bare a median and a pair of lateral darker lines. Abdomen dark brown, with some lighter hairs, and showing on the terga some lighter tomentum, like that on the thorax.

♀.—General coloration, deep chocolate throughout, the head with the vertex and frontal tuft yellowish; antennæ two-thirds the length of the proboscis, which is distinctly longer than the quite unbanded palpi. Halteres with pale stems and dark knobs.

♂.—Altogether lighter, the palpi golden-brown, with dense terminal tufts of hairs to the joints, about equalling the proboscis in length. Most of the upper tarsal joints show quite distinct lighter yellow apical bands, though they are quite imperceptible in the ♀. His fore ungues, besides the usual accessory tooth, have a strong additional one close to the base, representing probably the other claw, which appears wanting; those of the mid and hind legs are simple and symmetrical. *Length.*—9 to 10 mm.

Habitat.—Sent me by Dr. Price, I.M.S., Retd., of Conoor, Nehilgerri Hills, where the species is fairly common, though it does not appear to occur in the plains, Conoor lying at an elevation of over 6,000 feet above the sea level.

29. ANOPHELES CULICIFACIES, sp. n.

Plate ix. fig. 12a, Wing of ♀; 12b, Wing of ♂.

Wings with the costa black, except at the apex, interrupted by four small straw-coloured spots, which are progressively smaller from base to apex, all involving the second long vein; there is another distinct light spot over the cross-veins, and three more on the principal bifurcations of the long veins, but in the main, the wing is very dark, and the fringe shows no pale patches. Tarsi unbanded, nearly black. Thorax dark grounded, covered with yellow scales so arranged as to show a median and a pair of lateral dark bare lines. Abdominal segments conspicuously basally banded with yellowish, being in the fresh state completely clothed with yellowish and deep brown scales.

Head black, with whitish fork scales on the vertex, but with the frontal tuft ill-marked; antennæ of ♂ dark brown, about three-fourths the length of the proboscis, palpi of ♂ black, about the length of the proboscis, with yellowish rings on the two last articulations, and a lighter tip; of ♀, black, except the whole of the last joint, and two bands on the next two articulations, which are straw-coloured, and as the penultimate jo'nt is long, the second band is well down towards the base. Legs black throughout, except a minute yellow band on the apices of the tibiæ. When seen at rest this mosquito presents a close resemblance to *C. fatigans*, Wied., as apart from the conspicuous abdominal banding, the female habitually sits, humped up, like a *Culex*, while even the males keep the body no more than parallel to the surface they rest on. *Length.*—3·5 to 4 mm.

Habitat.—Hoshangabad, Central Provinces; and the Berars, India.

30. ANOPHELES PICTUS, Loew.

(Dipt. Beitr. (1845), Loew; Bull. Ent. Soc. d. Ital. xxviii, p. 232, Ficalbi.)

Wings with yellow spots, two prominent, and a third indistinct, on the dark costa. Tarsi not perceptibly banded in ordinary lights. Thorax dorsally grey, with five longitudinal black lines, dark brown laterally. Abdomen brownish.

This species is evidently nearer *An. funestus*, *mihi*, than to the *Sinensis* group, but no specimens answering to the subjoined original description have reached the British Museum.

"Thorax dorsally cinereous, with five longitudinal black lines, between which the greyish-white shows; in front of the scutellum which has the form of a transverse line, and is brownish-yellow, is a boat-shaped mark, which combines with the dark median line and reaches well out to the sides; the grey colour of the upper part of the thorax is limited at the sides by a brown longitudinal line. In the middle of the sides of the glabrous thorax are brownish-yellow marks, which show white in certain lights, and are especially brilliant on the anterior and middle coxæ. The head is ash-coloured, the margin of the eyes whitish, and the frons has a tuft of dirty white hairs in front. The antennæ are brownish, with brownish hairs, which vary in colour from brownish to black, according to the direction of the light. The first joint of the palpi is brown and very short; the second longer and densely covered with scales, especially at the base, so that it appears thickened; its colour and that of the scales is brown, although the latter have a whitish lustre on the surface. The third joint is brown, longer than the second, slender at the very base, but thickened at the extremity, where it is furnished with a long tuft of iridescent brown cilia, the scales of which resemble hairs, and have a distinctly whitish lustre, especially on the second half on the internal and upper aspect, as also have the scales which clothe the second halves of both the last joints, which are shorter, nearly equal in length, flattened, brown, fringed on its internal and upper part with brownish hairs, and the fourth joint with a tuft. The abdomen is flattened, brownish, with clear brownish hairs, shining white on the upper surface, and an obsolete, median blackish stripe. The last segment is entirely brown. The wings are hyaline, the veins and margins covered partly with white and partly with black scales, those of the internal fringe form alternate patches of white and brown. On the anterior margin are three large brown spots; the first, which commences not far from the root of the wing, is connected with the second on the costa itself, although separated internally by a point of white; the second brown spot, at its outer end, sends out a bow-shaped band over the transverse veins, concavity backwards, and is separated from the third spot by a small snow-white area, which lies adjoining, and upon the costal margin itself; the third spot is separated by a similar area towards the tip of the wing. In addition to these spots, the veins at the tip of the wing are clothed with brown scales, though the fringe is there whitish. The other longitudinal veins have patches of brown scales, one on the middle of the sixth being especially distinct, but they do not form visible spots. Legs, having the tips of the tibia and of the three first tarsal joints showing, in certain lights, a yellowish lustre, which makes them look ringed; the fore coxæ are exceptional in that they taper towards the end instead of being of uniform width." *Length.*—3 lines.

Habitat.—Coast of Asia Minor, opposite Rhodes.

31. **ANOPHELES FUNESTUS,** Giles.

(Addendum I. Report of Liverpool Malaria Expedition).

Plate x, fig. 3a, Wing of ♂; 3b, Wing of ♀; 3c, ant. tarsal claws ♂ 3d, head and appendages of ♀.

Wing spotted, with a very distinct apical spot, and three large ferruginous interruptions of the intensely black costa, which however, are much shorter than the length of black separating them: the two outer of these involve an equal length of I, but the innermost is nearly twice as long as the costal portion of the spot, being as long as the black interval in front of it, instead of being but half its length as in the costal portion of the spot in front of it; there is an additional yellow dot midway between the innermost distinct spot and the base of the wing, but it does not involve the absolute margin of the costa, which is black. Saving small patches on the three bifurcations, the rest of the wing is mainly black, but the entire tip of the wing fringe and spots opposite all the longitudinal junctions, but that of VI, are yellow. Tarsi entirely black. Thorax and abdomen jetty black with scattered golden hairs.

Head black with distinct snowy frontal tuft, the fork-scales of vertex and occiput all white; palpi, ♀, as long as proboscis, sooty with a longish white tip, and two snowy bands, the outer of which is much the broader; the ♂ has merely irregular grey patches on the club. Antennæ, ♀, black, with silvery verticils and some white scales on some of the basal joints. In certain lights there are some indications of four bare lines on the curious powdery bloom so common on the thorax of Mosquitoes of this genus. Halteres with yellow stems and black tips. The male has the apices of the abdominal segments darker, owing to much powdery bloom on their basal portions. *Length.*—2·5 to 3 mm.

Habitat.—Sierra Leone, Mashonaland, British Central Africa up to 5,600 ft. above the sea, Lake Chilwa, B.C.A., Zomba.

"*Observations.*—This is a small, rather dark species, clearly related to *A. Rhodesiensis* and *A. superpictus*, but it can readily be told by the position of the cross-veins; the fringe is also spotted, and thus can at once be told from *A. Rhodesiensis.*

"Major Giles, who describes this species from Sierra Leona, says he tarsi are not banded; but, even in those that look unbanded to the naked eye, traces of banding may be found on the apices of the tarsi, whilst the Mashonaland specimens show the apical banding much more distinctly.

"Dr. Daniels says (Mal. Rep. R. S. E., 2nd Se. p. 34) that *A. funestus* is the most numerous, the most widely distributed and the most persistent frequenter of houses. In one district, and that the most malarious, it is the only *Anopheles* found, and is more numerous than any of the *Culices* there present." (Monog. p. 180.) This species has been proved to be a vehicle of human malaria.

32. **ANOPHELES LISTONI**, sp. n.

Plate x, fig. 4a, Wing of ♀; 4b, head and appendages of ♀; 4c, Wing of ♂; 4d, head and appendages of ♂.

Wing with the costa black including the actual base, with four yellow spots, distinct but much smaller than the intervening black portions, the largest light area being that quite at the base; there is also an apical spot; the remaining long veins are mainly black, but all of them show short lengths of white scales, and a line of these, over the cross veins, combined with one of the costal spots, forms a distinct light stripe across the wing; the fringe is dark, except at the apex, and indistinct paler patches opposite one or two of the longitudinal junctions. Tarsi dark, unbanded. Thorax and abdomen much as in *An. funestus, mihi.*

Head black, with a robust frontal tuft, forked scales mostly dark in the ♀, but with many white ones behind in the ♂. Palpi of ♀ black, with two narrow rings, and a minute tip of white, slightly shorter than the proboscis; those of the ♂ as long as the proboscis, black tipped, but with two whitish bands.

This species a good deal resembles *An. funestus*, but has an additional white spot close to the base of the costa, and there are no sharply defined interruptions of the internal wing-fringe, as in that species. *Length.*—3·5 to 4 mm.

Habitat.—Sent me from Ellichpur in the Berars (India) by Lieut. Glen Liston, I.M.S., who has evidently a keen "eye for species," as he in his accompanying letter pointed out the distinctness of this form, and of *An. Theobaldi* from other known Indian members of the genus. It was still active in Ellichpur in January.

33. **ANOPHELES INDICUS,** Theob. (Monog. I, p. 183).

♀.—Wings almost exactly as in *An. superpictus*, Grassi, but the internal fringe has three pale patches. Tarsi unbanded. Thorax pale ochreous with pale golden linear scales and black bristles. Abdominal segments dark lustrous brown, some of them with yellowish reflections in the middle.

Head black, with creamy and black-forked scales, the pale ones in the middle; palpi dark brown with the apex and two apical rings on the next joints yellowish. Legs dark brown to black, a small yellow spot on the apices of the femora and tibiæ; coxæ ochreous. Halteres with almost white stems and fuscous knobs.

I have not seen this species, the type being in a private collection, but it appears to be very near Grassi's *superpictus* as to the differences from which Mr. Theobald writes.

"*Observations.*—The above is the description of a ♀ from Madras, and is seemingly related to Grassi's *A. superpictus*, the wings, &c., being almost identical. The chief difference I can detect is, that in the Indian specimen the legs have no traces of tarsal banding, and the fringe has three yellow patches, which are absent in the type of Grassi's *superpictus*. The specimen was taken in a house near Madras, by Captain Cornwall. From *A. funestus* it differs in the position of the cross-vein." *Length.*—3 to 3·5 mm.

Time of capture.—December in Madras.

33a. **ANOPHELES**, Sp., near Indicus.

A new form, possibly a variety of the above, has been recently sent by Dr. Christophers from the Darwars in Central India. It differs, however, in having the third large black costal spot subdivided on I. by a yellow spot near its inner end; in III. being entirely clothed with pale scales and in having an extra pale spot on the internal fringe.

34. **ANOPHELES RHODESIENSIS**, Theob. (Monog. I, p. 184).

Plate x, fig. 5a, Wing of ♀ ; 5b, to show adornment of Thorax.

Costa dark, with three small creamy and a yellow apical spot; fringe apically yellow, but not elsewhere interrupted, being formed of lighter scales than the wingfield, but not obviously spotted. Tarsi dark brown, unbanded. Thorax testaceous, nude. Abdomen brownish.

This species closely resembles *An. funestus*, *mihi*, but differs in the position of the yellow wing-spots, which are all three placed relatively further out and are smaller, as well as in the correspondingly small size of the apical spot, and in the position of the transverse veins, for which see figures; the wing fringe, too, is uninterrupted. The lighter portions of the ♀ palpi also are much narrower. From *An. Listoni*, *mihi*, it is distinguished by the absence of the large yellow spot near the base of the wing and from *An. Costalis*, Loew, by the smaller size and number of its lighter spots. The ♂ palpi are black throughout save for a small yellow tip, and want the greyish indeterminate brindling of the clubs of the neighbouring species. The abdomen is scaly and has distinct basal bands, and the thorax shows a distinct median line forking widely behind, and two lateral lines where the dark ground colour shows through the general velvety greyish bloom of the mesonotum. *Length.* —2·5 to 3 mm. ♂ ; 2·8 to 3·5 mm. ♀ .

Habitat.—Mashonaland; British Central Africa.

Time of appearance.—April, in Mashonaland. This new species has been sent in numbers from Central Africa. It does not appear to occur on the coast.

35. **ANOPHELES MINIMUS**, Theob. (Monog. I, p. 186).

Plate x, fig. 7a, Wing of ♀ (diagrammatic); 7b, to show Decoration of Thorax; 7c, scale from anterior border of thorax.

♀ .—Wings with three, nearly equal, creamy spots on the black costa and an apical spot; fringe with a yellowish spot at the end of each vein except the sixth. Tarsi unbanded, red-brown, without trace of banding. Thorax slaty-grey in the middle with a deep brown line on each side. Abdomen shiny black with yellowish hairs.

I have not seen this species, the type of which has been already returned to Dr. Rees' collection, and the following notes are extracted from Mr. Theobald's original description.

"♀.—Head black, clothed with black upright forked scales behind, and on the sides and over most of the occiput; a few grey and white and creamy ones in front, also some curved white scales and a few white hairs projecting forwards; proboscis deep brown; palpi deep testaceous clothed with black scales, a white ring towards the base (apical portion denuded), longer than the proboscis; antennæ deep brown, testaceous at the base, with dark hairs and grey pubescence.

"Halteres with grey stem and large cup-shaped black knob. *Length.*—3 mm.

"*Habitat.*- Pokfulam, Hong Kong (Rees).

"*Time of capture.*—October.

"*Observations.*—Described from a single ♀ in Dr. Rees' collection. Very like *A. funestus*, *Rhodesiensis* and *superpictus*, but from *funestus* it can be at once told by the disposition of the cross-veins and the darker scaled wings, from *Rhodesiensis* by the ornamented wing fringe and cross-veins, from *superpictus* by its darker hue and ornamented fringe.

"The fork-cells also differ from all three, the stalk of the second posterior cell being relatively much longer. The mesothorax has also numerous spots of a dusky hue. The straightness of the mid ungues is very marked and strongly contrasted with the curved fore ungues. It most nearly approaches *A. funestus* from Africa, but is, I feel sure, a distinct species."

36. **ANOPHELES PUNCTIPENNIS**, Say.

C. hyemalis, Fitch (Journ. Acad. Nat. Sc. Philadelphia, iii, (1823); Ins. N. Amer. ii, p. 39 (1839), Say; Circ. 40, 2nd. se. p. 4, Dep. Agri. U.S.A. 1899), Coquillett).

Plate x, fig. 6, Wing of Female.

Wings with the costa black, interrupted by a single large ferruginous spot a little outside the transverse veins, and involving I. and II. There is also a smaller apical spot, and some yellow spots near the tips of the long veins, but otherwise the wing is very dark, and has no interruptions of the fringe. Legs and tarsi uniformly nearly black. Thorax and abdomen deep brown, nude, but for some yellowish-brown hairs. Wings much longer than abdomen.

Head black, with a scanty whitish frontal tuft. Palpi and proboscis dark yellowish-brown, unbanded but rather lighter at the tips. Halteres brown. This is not likely to be confused with any other species than my *An. gigas*, but may be distinguished by the base of the wing internal to the large spot being uniformly black instead of spotted with yellow, as in *gigas*, as well as by its being altogether a darker species. There appears to be a triangular swelling at the base of the abdominal segments. It may be distinguished from *An. crucians* by the costa of the latter being uniformly dark, and by its having two instead of three dark spots on VI. The middle spot extends much further across the wing than in the *Sinensis* group, and the tarsi are unbanded. *Length.*—5 to 7 mm.

Habitat.—Widely diffused over the North American continent from Ontario to Kansas. Has been recorded from Jamaica. Is known as the "winter mosquito," having been taken when the temperature was but 6° F.

37. ANOPHELES PSEUDOPUNCTIPENNIS, Theobald

(Monog. II., Append. I.).

Closely resembles *An. punctipennis*, Say, but differs in the internal wing fringe being ornamented with yellow interruptions at each longitudinal junction, and in VI. having the basal half pale, and the apical dark, except for a small yellow spot at its junction.

The thorax and abdomen appears brown and hairy, but destitute of scales, and the palpi appear to be banded and yellow at the apex in both sexes. *Length.*—5 mm.

Habitat.—Grenada. Described from specimens in Balsam, in which all but the more strongly-marked characters as to colour and scaly structure are necessarily lost.

38. ANOPHELES LINDESAII, Giles (First Edition, p. 166).

Plate x, fig. 8. Wing of ♀.

Wing with the costa and all the external long veins dark scaled, and the prevailing tint of the entire wing dark except at the tip, where there is a large apical spot involving all the veins outside the tip of ant. br. of IV, behind which all the long veins show short lengths of lighter scales; the internal fringe is dark except round the apical spot, and a patch of pale scales opposite the junction of post. br. of IV. Tarsi without bands. Thorax black, with a large well-defined patch forming the greater part of the dorsum, grey, saving a very fine black median line. Abdomen nearly black, the hinder border of the segments darkest.

Head black, with a patch of whitish tomentum on the vertex, which extends forwards between the bases of the antennæ so as to give the appearance of a rostrum; eyes black: proboscis, palpi, and antennæ uniformly dark brown. Thorax with a large quadrangular patch covered with whitish scales, covering the greater part of the dorsum, on which is a very fine median black line, in front the patch has a rather ferruginous tint; pleuræ black with a few white scaled spots in front. Legs generally brown, darker on the tarsi, which are not banded; the hind femur whitish, with a broad black band at its apex, and a smaller one about its mid length, the other femora black and white scaled, the former preponderating at their tips, the anterior femora slightly thickened near the base. This species can hardly be confused with any other as it is the only one which has a pale apical wing spot combined with an unspotted costa. Length of the body 4·50 mm.; of the wing 3·30 mm.

Habitat.—Sent me by Captain Victor Lindesay, I.M.S., from Bakloh, in the Punjab. I also took a single specimen last July in Naini Tal, both places being situated at over 6,000 feet elevation in the Himalayas, but it appears to be a rare species, as I came across no other example, and could nowhere find the larvæ, in spite of a most careful search.

39. **ANOPHELES ATRATIPES**, Skuse ("S. A. C." p. 1,755).

Plate x, fig. 9, Wing of ♀.

Wing spotted on the wing field, but with the costa uniformly black; the internal fringe is deep ferruginous at the apex, but elsewhere black, as also are all the long veins with the exception of a few white spots on some of the inner ones. There are, however, six distinct spots on the wing field produced by dense tufts of long scales. Legs and tarsi uniformly intense sooty black. Thorax of a red-brown ground colour with a nude, black median line and lateral lines where the brown ground colour is free from the yellowish-white scales and bloom that cover the rest of the mesonotum.

Head black, with white forked scales and a scanty frontal tuft. The clypeus is three-lobed and in front of it the proboscis springs from an exceptionally distinct basal dilatation which is longitudinally striped, alternately intense black and snowy. The palpi and proboscis are absolutely sooty, just a little paler at their tips. There can be no difficulty in recognising this species by the six peculiar wing tufts. The two additional ones to those of the maculipennis being in this species placed on the stem of V. and its bifurcation, the rest of the stem of this vein being white. ♀.—Length of antennæ 1·77 mm.; expanse of wings 4·18 × 0·84 mm.; size of body 4·18 × 0·76 mm.

Habitat.—Berowra, N.S.W. January, and since sent in considerable numbers from Queensland by Dr. Bancroft.

40. **ANOPHELES CRUCIANS**, Wied.

Wings with white spots here and there on the brown veins, uniform along the costa; tarsi unbanded, dusky brown; abdomen uniformly brown, with grey hairs. Thorax red-brown with linear markings.

Description from Wied., "A. Z. I.," p. 12.—Tawny; the thorax with three deeper tinted lines; the abdomen covered with grey hairs; the wings with dusky spots and costa. Length $2\frac{1}{2}$ lines (German).

Coquillett, in his recent synoptic table of North American *Culicidæ*, states that "the scales of the last vein are white, marked with three black spots; palpi marked with white at the bases of the last four joints," and without any spot on the costa, as seen in *A. punctipennis*.

Professor Nuttall sent Mr. Theobald two ♀'s from America in spirit, which, although much damaged, show the two features mentioned by Coquillett very clearly, readily distinguishing the species from the *C. punctipennis* of Say.

Habitat.—United States, at the following places: District of Columbia; Georgia; New Orleans; Richmond, Va. Wiedemann says it is very common on the Mississippi, where it is very troublesome to travellers, and also gives Pennsylvania as a *habitat*.

Time of capture.—April in Columbia; June and November at New Orleans.

41. ANOPHELES ANNULIMANUS, Van der Wulp.

(Tijdschr. voor Ent. p. 127 (1867), Van der Wulp; Circ. 40, 2nd se. U.S.A. Dept. Agri. p. 4 (1889), Coquillet).

Wings with the costa uniformly coloured, but with two spots on the wing field formed by accumulations of scales. Tarsi banded on the fore legs. Thorax dark brown with grey lines near the roots of the wings and golden hairs on the shoulders. Abdomen short, grey-brown, the hind borders of the segments darker, but lighter on the venter.

Extracts from original description.

♂.—Head dark brown; occiput with dense black hairs. Antennæ whitish, with brown rings, the verticils light brown with yellow reflections; proboscis dark brown, one and a half times as long as the head and thorax, with lighter brown reflections above and at the tip; palpi brown, the two first joints deeper coloured, the second joint a little longer than the first, together as long as the antennæ; the two last joints each as long as the second, brownish-yellow, together forming a flattened ellipse, sparingly beset with long hairs. Pleuræ mostly clothed with light grey tomentum. Claspers shorter than the last abdominal segment, with long curved points; abdominal tomentum moderately dense, blonde-coloured. Legs dark brown, the coxæ and roots of the femora brownish-yellow, apex of the latter rather dark, so that the pale yellow or whitish knee spots show out the more distinctly. Close to the base of the mid-femora is a whitish ring, bounded on both sides by a deeper brown than that of the ground colour; the fore tibiæ, except the basal third, whitish, with three darker brown rings, the last just before the tip, which is pale; the white colour appears also at the tips of the other tibiæ; the hind legs are long and slender, especially the tarsi, the first joint of which is a fourth longer than the tibia; halteres dark brown, the stem and base lighter than the knob. Wings longer than the abdomen, with a slightly greyish tint; veins and scales brown; in the middle of the fore part of the wing, under the costa, on the second longitudinal vein, is a spot, and a little further out, above the small transverse vein, a second spot, both formed by accumulations of scales; the upper basal cell is always longer than the lower.

Habitat.—North America.

Coquillet thinks this description applies to *C. consobrinus*, Desv., but Van der Wulp is surely a most unlikely man to be mistaken in a well established dipterous genus.

42. **ANOPHELES MACULIPENNIS**, Meigen [1818].

Plate x, fig. 10a, Wing of ♀; 10b, Palpi of ♂; 10c, the Tarsal claws. ♂ and ♀.

An. quadrimaculatus, Say.
An. claviger, Fabr., of which no type appears to have existed.
C. bifurcatus, Meig. (1804)?

(Syst. Besch. Europ. Zwei. Ins. i, 11, 2 (1818), Meigen; Ins. Lapp. i, 808, Zetterstedt; Hist. Nat. Dipt. i, 32, 2, Macquart; Brit. Ent. 210, 2, Curtis; Bull. Soc. Imp. Nat. Mosc. iii, 294, 2 (1845), Gimmenthal; Dipt. Scand. ix, 3468, 3, Zetterstedt; Ento. Mag. i, 148, Haliday; Dipt. Beitr. i, 4, 2, Löw; Fauna Austr. ii, 265, Schiner; Dipt. Neer. p. 330, Van der Wulp; Ins. Brit. iii, p. 249, Walker; Bull. d. Soc. Ent. Italiana, 1896, p. 228, et 1899, p. 90, Ficalbi; Reale Accad. d. Lincei, S. d. u. Zool. sulla Malaria, p. 77, Grassi.)

Wings with four tufted spots on the wing-field, the costa being uniformly dark, except at the apex, where its colour fades to form a fairly distinct spot; tarsi unbanded, but with an apical yellowish spot to the first joints. Thorax with four broad ferruginous stripes formed of golden hairs, between which the darker ground colour is left bare; with a tuft of large golden scales on the anterior border. Abdominal segments brown with yellowish basal markings; anterior femora not thickened at the base.

"♀.—Head with two patches of creamy scales divided by a central line, the rest of the head with black scales, a small tuft of white hairs in front, borders of the eyes white; eyes deep purplish-black; antennæ dark brown with pale bands and with ferruginous basal joint, pale pubescence and brown hairs; proboscis brown; palpi yellowish-brown, with dense dark scales at the base, which is swollen, shorter than the proboscis. Legs with pale coxæ; femora and tibiæ yellowish-brown below, covered with dark brown scales above: knee spot yellow, apex of the tibiæ paler; tarsi slightly darker than the rest of the leg. ♂.—Antennæ banded, plume hairs brown, last joint darker; proboscis black to dark brown; palpi dark brown: the last two joints, which are clubbed, have a number of short golden hairs internally and are yellow in colour, clothed with thick black scales, through which the yellow underground shows; the last joint is truncated." *Length.*—4 to 7·5 mm. ♂, to 8 or 10 mm. ♀. This species varies greatly in size, the wings shown me in Italy by Professor Grassi being quite small, while some Canadian specimens, in the British Museum, are huge gnats, and to illustrate this, I have superposed on the plate the drawing of one of Grassi's specimens on the outline of a Canadian specimen.

43. ANOPHELES ANNULIPALPIS, Arribálzaga ("L. A." p. 36).

Wings unspotted, the costal vein and cell densely black-scaled, the remaining veins brindled black and gold, so that the wing looks confusedly banded; tarsal joints white ringed, the last joints wholly white; abdomen dusky, with yellowish hairs; thorax with fawn-coloured scales, and three fuscous linear markings.

From original description:—

"Palpi dusky, densely plumed in the ♂, or black with silvery rings in the ♀; the legs and tarsi dusky black with white rings; the tibiæ with silvery spots (♂), or the legs black with silvery rings (♀); head cinereous, with white hairs towards the frons. Antennæ black with dusky hairs (♀); or fuscous with dense verticils (♂); palpi black, straight, with silvery rings (♀), or dusky and densely villous, dilated and divergent at the end (♂); proboscis dusky black, with the apex white; eyes with white margins. Scutellum dusky; metanotum dark red; pleuræ dull testaceous; coxæ yellow; femora black, pale yellow internally and silver banded externally; tibiæ black with white bands (♀), or dusky with numerous silvery dots (♂); tarsi nearly black, with silvery rings and the last joint wholly white." *Length.*—7 mm.

Habitat.—The banks of the Parana in Argentina. A rare species.

44. ANOPHELES STIGMATICUS, Skuse ("S. A. C." p. 1759).

Wings with light brown scales, unspotted, though they are a little darker in the stigmatic region; tarsi violet-brown, unbanded. Thorax red-brown, darker in the ♀, with three double streaks, and dense lateral fringes of golden hairs. Abdomen dark brown, nude? with golden hairs.

Extract from original description:—

"Antennæ in the ♂ about five-sixths the length of the palpi, ochre-brown; first joint nearly black; in the ♀ about four-fifths the length of the palpi, dark brown with whitish pubescence and verticils brown; scapus, except distal half of second joint, red-brown; head ochre-brown, with golden hairs; proboscis scarcely longer than the palpi, brown.

almost black in the ♀, as also are the palpi. Thorax darker in the ♀; pleuræ, ♂, red brown, ♀, fuscous; scutellum, ♂, ochreous, ♀, testaceous fringed with long golden hairs; metanotum, ♂, testaceous, ♀, very deep fuscous. Halteres with the club brown and stem yellow; ♂, forceps testaceous, densely haired. Legs violet-brown scaled, the femora pale yellow for four-fifths of their length in the hind legs, but beneath only, in the other legs; coxæ warm brown; in the hind legs the first tarsal joint is one-seventh longer than the tibia." Wings much longer than the abdomen in the ♀, shorter in the ♂. Length of antennæ ♂ 2·02 mm.; ♀ 1·77 mm.; expanse of wings ♂ 4·06 × 0·88 mm.; ♀ 4·06 × 0·88 mm.; size of body, ♂ 4·56 × 0·76 mm.; ♀ 4·06 × 0·76 mm.

Habitat.—Blue Mountains, N.S.W.

45. ANOPHELES BIFURCATUS (L.).

Plate xi, fig. 1a, Wing of ♀ from specimen (drawn in Prof. Grassi's laboratory); 1b, Wing of another ♀ from Ontario, to show range of variation of size; 1c, Fork scale from head, to show difference from those of *An. Walkeri*, Theobald.

(Fn. Suec. 1791, Linn.; Ins. Austr. 482, 982, Schrank; Spec. Ins. ii, 469, 2, Fabr.; Syst. Beschr. i, 11, 1, et vi, 242, Meigen; Dipt. N. Fr. 163, 1, Macq.; Ins. Lapp. 807, 1, Zett.; Dipt. Scand. ix, 3467, 1, Zett.; Ent. Mag. i, 151, Hal.; Dipt. Beitr. i, 3, 1, Löw; Fn. Austr. ii, 625, Schiner; Ent. Syst. iv, 401, 3 (*C. trifurcatus*), Fabr.; Klass. i, 5, 8, Meigen (= *C. claviger*); Syst. Antl. 35, 6, Fabr.; Dipt. Neer. 330, Van der Wulp; Bull. Soc. Imp. Nat. Mosc. iii, 294, 1 (1845), Gim.; Syst. Nat. v, 2887, 3, Gmel.; Mem. Soc. Imp. Nat. Mosc. iv, 129, Fischer; Bull. Ent. Soc. Ital. p. 225 (1896), Ficalbi; Reale Accad. d. Lincei, S. d. u. Zool. sulla Malaria, p. 81 (1900), Grassi.)

Wings unspotted, dark-scaled throughout, except on the middle of the costa and auxiliary vein, where there are numerous yellow scales intermixed with the black. Tarsi nearly black throughout, with the exception of a faint ring on the base of the first joint. Thorax dark grey, with indistinct median and lateral lines; dark chestnut at the sides. Abdomen brown, some of the segments darker behind. Fork-scales of nape, fimbriate at their free extremities.

"♀.—Head brown, with greyish tomentum, and small pale, creamy, curved scales in front, with a tuft of yellow bristles projecting forwards and pale yellow, upright, forked scales passing backwards as a broad band on each side of the central bare line, the forked scales at the sides black with dusky grey tips; a pale border partially surrounding the eyes; antennæ dark brown, basal joint bright ochreous-brown on one side, dark brown on the other; proboscis nearly black; palpi ochreous, covered with blackish scales, which are densest at the base, a little longer than the proboscis; clypeus brown.

"Legs ochraceous covered with dark scales, coxæ testaceous, also base of femora; knee-spot and base of first tarsal joint pale.

"♂.—Head brown, with upright creamy scales in the middle and upright black scales at the sides, a dense creamy tuft of hairs projecting forwards; antennæ brown with flaxen plumes, basal joint very dark brown; palpi brown, last two joints spatulate, hair-tufts golden-brown; proboscis brown." *Length.*—5 to 5½ mm.; with proboscis 8 to 8½ ♀, 6 mm. ♂.

Habitat.—Europe, from Lapland to Italy and islands in the Mediterranean. This species is said to be mainly sylvan in habits and has been proved to be a vehicle of human malaria by Prof. Grassi.

46. ANOPHELES FERRUGINOSUS, Wied. ("A. Z. I." p. 12).

An. Walkeri, Theobald (?.)

Wings unspotted; tarsi unbanded, nearly black; abdomen unbanded, dusky brown with yellow hairs; thorax deep red-brown with linear markings. Stems of halteres white, with brown knobs.

Original description:—

Antennæ and palpi brown, the latter more dusky with a little white at the joints; thorax intense red-brown, but only in certain lights, if seen from behind whitish, and it then exhibits linear stripes, but looking backwards without stripes; abdomen dusky brown with yellowish hairs; veins of the wings with brown scales; halteres intense white with brown knobs; legs shorter than in *An. crucians*, brownish-black with yellowish femora.

No material exactly answering to this description has been received in the British Museum, but Mr. Theobald suspects it may be the same as his *An. Walkeri*, though he considers it can be neither *C. quinquefasciatus*, Say, or *An. crucians*, Walker.

47. ANOPHELES WALKERI, Theobald (Monog. I, p. 199).

An. ferruginosus, Wied. (?).

Plate xi, fig. 2a, Wing of ♀; 2b, Fork scale from nape.

Closely resembles *An. bifurcatus*, L., differing only in the form of the fork-scales of the nape, which are forked in the present species and fimbriate in *bifurcatus*. The base of the hinder fork-cell is also said to be placed much farther outside that of the anterior than in that species, but the relative position is not very constant in either. Mr. Theobald makes the following observations as to his new species:—

"This species closely resembles the European *A. bifurcatus*, but differs from it in regard to the head ornamentation, the browner appearance of the thorax and the relative positions of the cross-veins, as shown in figure. When viewed under the microscope in some lights there will be seen four grey thoracic stripes which are also characteristic, especially when the thorax is rubbed. No males were unfortunately sent. All the specimens were taken from beds of reeds close to the low marshy shore of Lake Simcoe. I should not be surprised if this proved to be Wiedemann's *An. ferruginosus* from New Orleans." *Length* of body, 5·5 to 6 mm., with proboscis, 10 mm.; of wings, 5·5; of hind legs, 12 mm.

Habitat.—Lake Simcoe, Ontario, Canada (E. M. Walker).

Time of capture.—September.

48. ANOPHELES NIGRIPES, Stæger (1839).

An. plumbeus, Haliday?

(Syst. For. o. d. i. Denmark Nid til fundne Dipt. (1839); Dipt. Neer. ii, 3, p. 331 (1877), V. d. Wulp; Dipt. Beitr. i, 4, 2, Löw; Dipt. Scand. ix, 3467, Zett.; Kröj. Tidskr. ii, 552, Staeg.; Fn. Austr. ii, 625, Schiner; Bull. Soc. Ent. Ital. (1896), p. 227, Ficalbi; Gnats, p. 175, Giles; Zool. Journ. xii. (1828), Haliday (= *plumbeus*).

Plate xi, fig. 3, Wing of ♀.

Wing unspotted, uniformly sooty-scaled. Legs and tarsi uniformly black except the cases of the tibiæ, which are dull yellowish-brown. Thorax with a tun-shaped patch of greyish-brown with two bare sub-median lines. Abdomen sooty, nude, but for some brownish hairs.

Head black, with densely packed yellowish forked scales, and a fairly full frontal tuft. Papi and proboscis uniformly sooty, otherwise is almost indistinguishable from *An. bifurcatus*, but this is a distinctly darker species, with the middle of the mesonotum more frosty-cinereous than it, and the wings are more densely scaled. *Length.*—4 to 5 mm.

Habitat.—Northern Europe and North America. In England it has been taken at Penzance; it also occurs in Scotland, and a few were taken by Mr. Theobald in North Wales.

Note.—Since going to press, descriptions of the following two additional species have been received from Lieut. Glen Liston, I.M.S.:—

22a. An. Turkhudi, Glen Liston. Ind. Med. Gaz., November, 1901. Wings, with three small interruptions on the black costa, in addition to a large apical spot, and two basal dots; bases of the fork-cells, and a spot on III, between them, white, and there is also a large triangular spot on II, III, IV, and V, opposite the cross veins; VI, with one long white interruption; internal fringe dark, with broad white intervals at all but the sixth longitudinal junction. Legs dark brown, with yellowish apical spots on the tibiæ and femora, and on all but the last tarsal joints. Thorax dark-grounded, clothed with white scales, so arranged as to show median, and

Genus IV. **CYCLOLEPPTERON,** Theobald.

This genus has been separated from *Anopheles* for the reception of a single species, at first sent by Dr. Grabham, Jamaica, the characters of which are such as to easily separate it from the rest of the sub-family, the scales of the wings being altogether exceptional and quite different in outline from those of any other Mosquitoes, except those which give the base of the wing of *Uranotænia* its gorgeous metallic sheen; and though somewhat similar in form, they are in reality quite different from these, as they are quite without lustre, and owe their deep coloration to a deposit of an actual pigment, the presence of which has been demonstrated by chemical methods. These scales are exceptionally thick, and are shaped exactly like a child's battledore with the handle cut short off, and are so much larger than those found in any member of the sub-family that they can easily be separately distinguished with an ordinary hand-lens, so that the genus can be perfectly easily recognised without the aid of any more powerful instrument.

The larvæ are said to be much like those of other *Anophelina*, and to assume the same position in the water.

The following may serve as a sufficient definition of the genus.

Cyclolepperon.—Culicidæ with the palpi of about the same

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rather less distinct, lateral bare dark lines. Abdomen olive-green, with yellow hairs.

♀.—Head with vertex and scanty frontal tufts white, but dark on the occiput; palpi black, with three rather broad, white, articular bands; proboscis black, yellowish at the tip. Halteres with pale stems and darker knobs.

Habitat.—Ellichpur, Berars, India.

25a.—An. Stephensi, Glen Liston. Ind. Med. Gaz., November, 1901. Wing with the costa black, interrupted by three smaller white spots, involving aux. and II, and showing, in addition, a large pale apical spot, involving both branches of II, and two big basal dots; the base of I, and the other long veins, mainly, are white, VI, showing only two black dots; and the interior fringe has pale interruptions at each long junction. The three upper joints of the fore, and all but the last of the mid and hind tarsi, with narrow pale apical bands, and there are two additional bands on the first fore tarsals. Thorax black, densely clothed with white scales, so arranged as to leave indistinct median and lateral nude bare lines. Abdomen black, unbanded, thickly covered with yellowish hairs and scales.

♀.—Head with vertex and frontal tufts white, but dark on the occiput; palpi dark, with long white tips and four pale bands, the outermost of which is of considerable width. Halteres with pale stem and dark knob. Legs with white knee-spots, and the femora and tibiæ elaborately speckled silvery.

Habitat.—Ellichpur, Berars, India.

length as the proboscis in both sexes, those of the ♀ subulate, while in the ♂ they are broadly spatulate. Wings with the veins carrying, in addition to scantily arranged lanceolate scales, patches of large thick scales, densely pigmented, and with their free portion of an almost circular outline.

1. **CYCLOLEPPTERON GRABHAMII**, Theobald

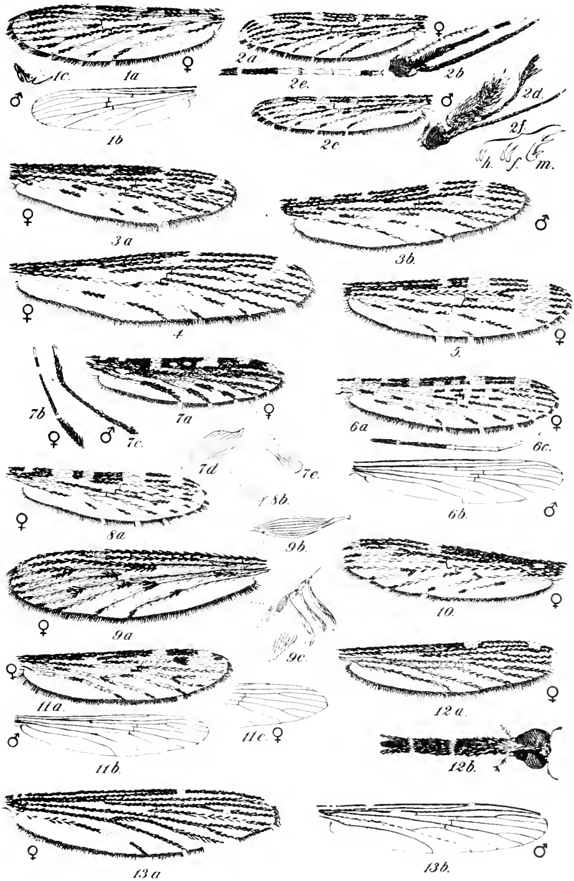
(Monog. p. 205).

Plate xi, fig. 6a, Wing of ♂ ; 6b, Bifurcation of II, to show arrangement of the two sorts of scales; 6c, Generically peculiar scales, more highly magnified; 6d, Probos. and palp of ♂ ; 6e, Ant. tarsal claw of ♂.

Wings with the costa black, except at the apex, and at a single interruption, opposite the middle of the ant. fork-stem; the entire tip of the wing is pale-scaled, much as in *An. Lindesayii, mihi*, and some of the long veins have other pale portions, but is otherwise generally dark, the dark fringe has ferruginous interruptions at each longitudinal juncture, except at the apex, where the light portions preponderate, so that the cells are here marked by only minute black streaks. Tarsi and legs dusky throughout. Thorax and abdomen sooty, nude, but for pale yellow hairs which are so numerous on the middle of the mesothorax as to form an indistinct spot.

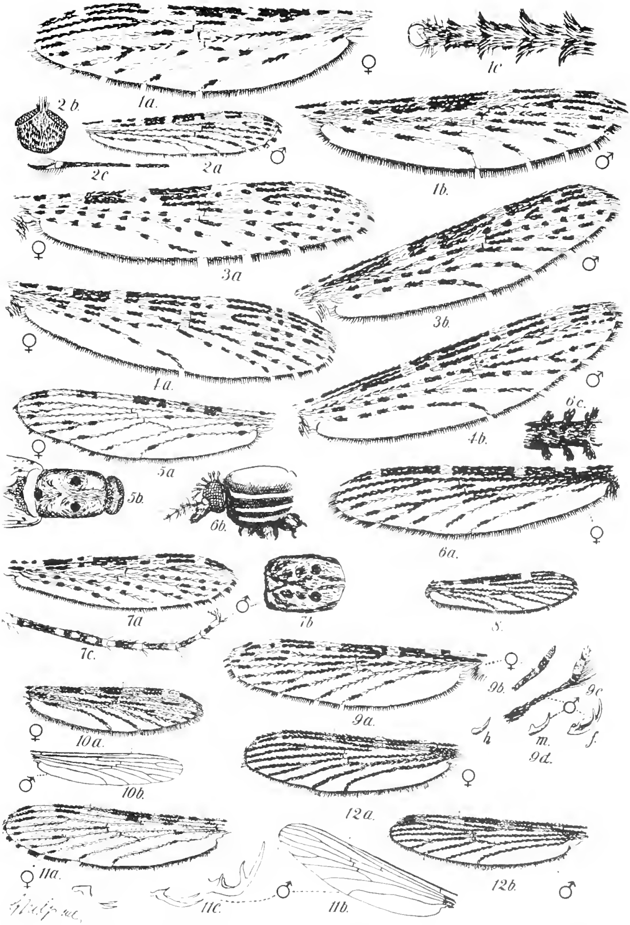
Head and appendages sooty, but for a scanty, whitish frontal tuft which in the ♀ is continued back as a narrower stripe over the nape. Palpi of the ♀ exceptionally hirsute almost to the tips, especially along the borders, so as to almost recall the leg paddles of *Sabethes*. In the ♂ there is a narrow nude yellow band on the second articulation, and the greater part of the last joints are covered with ferruginous scales. In him, too, the frontal tuft and vertex are alone white, the nape being entirely black, and his thorax differs from that of the ♀ in having its anterior border ornamented with a bifid median tuft of long white scales. He has also large lateral patches of yellowish-brown scales at the bases of the abdominal segments. In both sexes, the legs are brindled with alternating patches of ferruginous and dark brown scales, the lighter tint predominating on the femora, and their very apices are light coloured, so that there are some indications of knee spots. The male genitalia are clothed with yellow scales. *Length.*—About 4 mm.

Habitat.—Jamaica (Dr. Grabham, November 24, 1899).



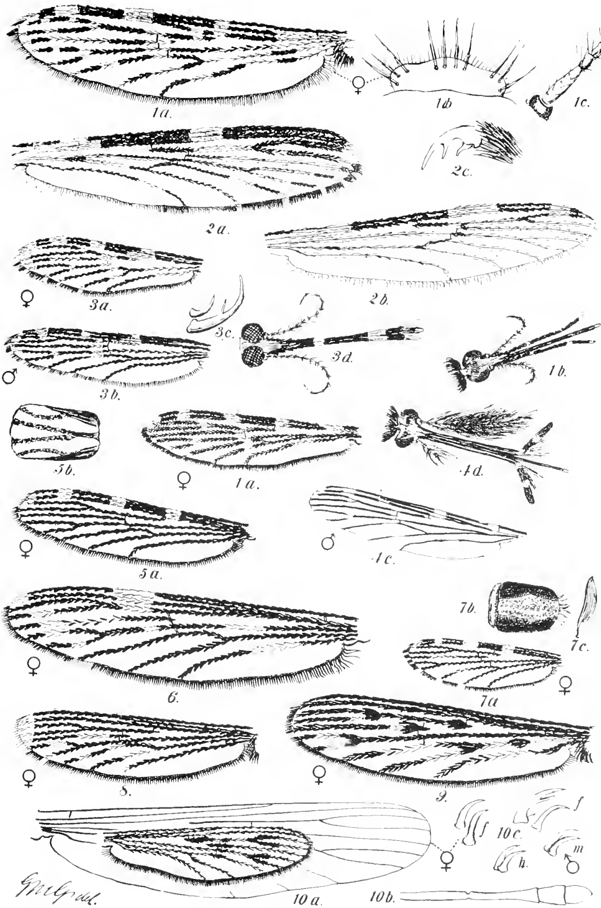
1, *An. argyrotarsis*, Desv.; 2, *An. albipes*, Theob.; 3, *An. paludis*, Theob.; 4, *An. similis*, Theob.; 5, *An. Bigotii*, Theob. (diagrammatic); 6, *An. Jamesii*, Theob.; 7, *An. fuliginosus*, Giles; 8, *An. pallidus*, Theob.; 9, *An. Sinensis*, (Wied.); 10, *An. annularis*, Wulp; 11, *An. pseudopictus*, Grassi; 12, *An. nigerrimus*, Giles; 13, *An. barbirostris*, Wulp.

Face p. 332.



1, *An. Pharoensis*, Theob.; 2, *An. maculatus*, Theob.; 3, *An. annulipes*, Walker; 4, *An. Mastersi*, Skuse; 5, *An. ocellatus*, Theob.; 6, *An. squamosus*, Theob.; 7, *An. tesselatus*, Theob.; 8, *An. Lutzii*; 9, *An. costalis*, Loew.; 10, *An. superpictus*, Grassi; 11, *An. Rossii*, Giles; 12, *An. culicifacies*, Giles.

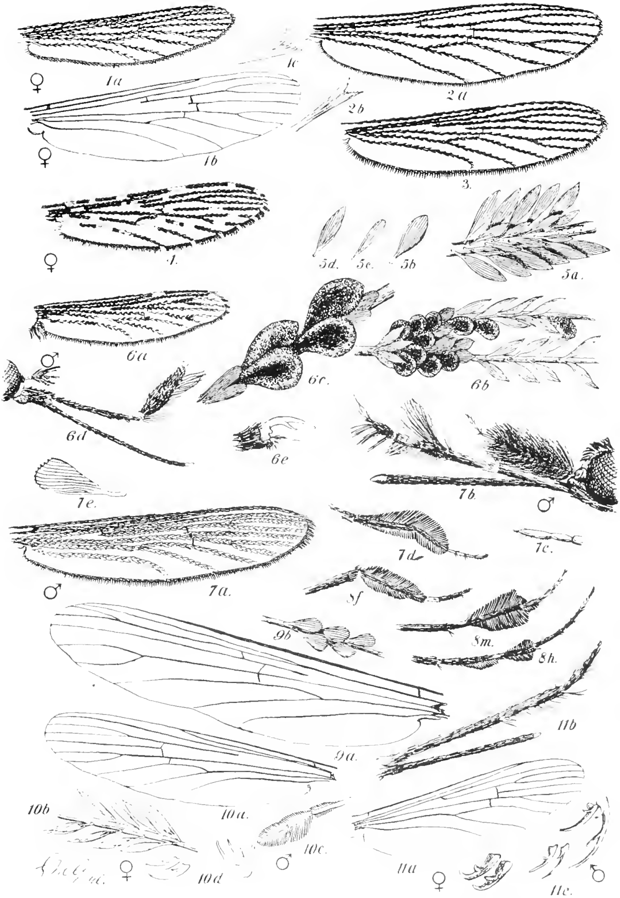
Follow Plate VIII.



1, *An. cinereus*, Theob.; 2, *An. gigas*, sp. n.; 3, *An. funestus*, Giles; 4, *An. Listoni*, sp. n.; 5, *An. Rhodesiensis*, Theob.; 6, *An. punctipennis*, Say.; 7, *An. minimus*, Theob. (diagrammatic); 8, *An. Lindesayii*, Giles; 9, *An. atratipes*, Skuse; 10, *An. maculipennis*, Meig. (detailed figure within an outline to show variation of size).

Follow Plate IX.

PLATE XI.



1, *An. bifurcatus*, L.; 2, *An. Walkeri*, Theob.; 3, *An. nigripes*, Stæger; 4, *An. Theobaldi*, sp. n.; 5, (*a*) wing scales of *An. Sinensis*, (*b*) of *An. barbirostris*, (*c*) of *An. Rossii*, (*d*) of *An. costalis*; 6, *Cycloleppteron Graohomii*, Theob.; 7, *Sabethes remipes* (Wied.); 8, *Sab. longipes*, (Fabr.); 9, *Toxoynchites brevipalpis*, Theob.; 10, *Eretmapodites quinquevittatus*, Theob.; 11, *Janthinosoma musica*, Theob.

Follow Plate X.

CHAPTER XIII.

The Culicina Sub-family.

This is at once the typical, and by far the largest group of the *Culicidæ*, the type genus, *Culex*, including nearly 150 species.

In all, the female palpi are markedly shorter than the proboscis, while those of the male are at the least not much shorter, and may greatly exceed it in length.

Some genera, however, distinctly approach the *Megarhininæ* and *Anophelinæ* even in the length of the ♀ palps, as these are nearly half as long as the proboscis in *Mucidus*, and in *Psorophora*, are fully a third of its length.

In the typical genera, as in *Culex* and *Stegomyia*, they are, however, very short and take the form of a mere pair of blunt projections on each side of the base of the proboscis. The male palpi vary so greatly in relative length and form that no general description of them is possible. Another character that all have in common is that the anterior fork cell is at least as long as the hind one.

The males are easily distinguished from those of the *Anophelina* by the fact that they are never clubbed, at any rate in the same way as those of the *Anopheles*.

One or two species, notably *E. spathipalpis* (Rond.), have the ♂ palps clubbed, but even in these cases the organ is not carried in the same way; as those of the *Anophelina* are held close against the proboscis as far as the commencement of the club and then diverge sharply from it at an angle of about 45°; but are kept straight or nearly so, and never habitually lie along the proboscis, being kept rather away from it, generally arched upwards in a graceful curve.

It is, however, on the other hand, by no means so easy to distinguish the females from those of the *Ædomina*, and here we can rely only on the more detailed, generic characters of the arrangement of the scales and bristles, especially those of the head and of the various regions of the dorsum of the thorax.

The small, but well-defined genus, *Janthinosoma*, resembles the *Megarhinina* in many respects, having the same fine metallic lustre, and the same may be said to some extent of *Armigeres*, which is certainly very closely allied to *Janthinosoma*, having the same long male palps and the same tendency to ornamentation of the venter, while the terga of the abdominal segments are quite dark. *Psorophora* and *Mucidus* form a very natural group of shaggy insects that look more like flies than gnats to a casual glance.

All these aberrant genera that are thus more or less intermediate between the type genera are characterised by possessing shaggy legs, and in uninjured males, *Eretmapodites*, the scales covering them are enormously elongated to form flat, paddle-shaped expansions.

Most of these aberrant Mosquitoes are forest insects, and these peculiar structures probably give them some sort of protective resemblance to parts of the plants and flowers frequented by them; but this is a mere guess, as we know as yet very little of the habits and life history of these forms.

The genera *Stegomyia* and *Armigeres* form another very well defined group, characterised by the smooth curved line of their heads, and a strong tendency to elaborate decoration of the mesonotum with white lines on a jet-black ground. *Panoplites* and *Tæniorhynchus* again are closely allied, while *Deinokerides* may or may not be one of the *Aedomina*, as no males have yet come to hand.

Owing to the separation of new genera, and the consequent modification of the definitions of those already established, the definitions of all are somewhat changed from those quoted in the first edition of this handbook, and as it would occupy much space to enter into any critical disquisition on the newer as contrasted with the older landmarks, it will be understood that those given below follow entirely the classification adopted by Mr. Theobald in the British Museum monograph which is concurrently passing through the press. This tabulation of the genera of the sub-family runs as follows :—

γ. Palpi short in ♀, long in ♂; 1st sub-marginal cell as long or longer than the 2nd posterior cell .... sub-family CULICINA

γγ. Legs more or less densely scaled.

Posterior cross-vein nearer the base than the mid cross-vein; hind legs with tarsi in ♂ densely long scaled; wing scales long and rather thick Genus V. *Eretmapodites*

Cross-vein as in *Culex;* scales of crown and occiput broadly spindle-shaped; 3rd long vein continued as distinct pseudo-vein into the basal cell Genus VI. *Janthinosoma*

Posterior cross-vein nearer base of wing than mid cross-vein; wings with thin scales .... Genus VII. *Psorophora*

Posterior cross-vein nearer apex of wing than mid cross-vein; wings with large pyriform parti-coloured scales ....Genus VIII. *Mucidus*

γγγ. Legs uniformly clothed with flat scales.

Scales of the wings very large, flat, broad, asymmetrical ....Genus IX. *Panoplites*

Scales of wings dense, lateral ones large, elongated oval or lanceolate ....Genus X. *Tæniorhynchus*

Metanotum nude, scales of wings much as in *Tæniorhynchus*, metanotum with a tuft of chetæ and with patches of flat scales Genus XI. *Trichoprosopon*

δ. Head and scutellar scales all flat and broad.

Wings with small scales, both spatulate and linear; 3rd long vein not continued into basal cell ....Genus XII. *Stegomyia*

Third long vein continued as an incrassation into the basal cell ....Genus XIII. *Armigeres*

δδ. Nape clothed with mixed narrow, curved, and upright forked scales, with small lateral patches of flat scales.

1. Second antennal joint small or moderate sized. Scales of the wings small, lateral ones linear Genus XIV. *Culex*
2. Second antennal joint very long, distal joints without scales ....Genus XV. *Deinokerides*
3. Second antennal joint very long, 2nd to 5th joints clothed with scales ....Genus XVI. *Brachiomyia*

Genus V. **ERETMAPODITES,** Theobald

(Monog. p. 280).

This genus has been instituted by Mr. Theobald for the reception of a peculiar species, bred out by Mr. Austen from larvæ found at Sierra Leone in old tins containing rain water. It presents some resemblance to *Sabethes* in having the hind feet provided with a peculiar paddle-shaped expansion formed of long scales, but it is only the males that are so furnished, and even in them, the scales are so deciduous that they are often wanting even in fresh specimens.

Beyond the fact that it must obviously be a domestic species, nothing is known of its life history. The venation is essentially that of a *Culex*, and the arrangement of the scales of the head and scutellum is that of *Stegomyia*, to which genus it is perhaps most nearly allied. He defines the genus as follows :—

"Head clothed with flat and upright forked scales ; antennæ of the ♀ fourteen-jointed, of the ♂ fifteen-jointed, the last two joints long; palpi of ♀ four-jointed, of the ♂ long and thin, five-jointed, basal joint small; third and fourth joints nearly equal; apical joint about two-thirds the length of the penultimate joint; palpi pointed, no hair tufts. Mesothorax clothed with narrow curved hair-like scales; scutellum with flat scales on the mid lobe. Abdomen densely scaled with broad flat scales. Fore and mid ungues of ♀ equal, and each with a small tooth; fore ungues of ♂ unequal, the larger thick, simple, the smaller one thin, and with a single tooth; mid ungues unequal, the larger one stout, the smaller very thin, both untoothed; hind ones equal and simple, small. Last two tarsi of the hind legs in the ♂ densely scaled, forming a distinct 'paddle.' Wings with the first sub-marginal cell longer and narrower than the second posterior cell, stem of the latter considerably longer than the cell; venation practically as in *Culex*.

"A single species only occurs so far. The chief distinguishing features, besides the squamate structure, are the hairy posterior tarsi in the ♂, and the long thin hairless palpi and the ungues.

"Nothing is known of its life-history, except that Mr. Austen bred the gnats from larvæ in old tins and bottles full of water. There is no continuation of the third vein as a pseudo-vein into the basal cell, as in *Armigeres*."

1. ERETMAPODITES QUINQUEVITTATUS, Theob.

(Monog. I, p. 280).

Plate xi, fig. 10a, Venation of wing; 10b, Scales from wing; 10c, "Paddle" of the ♂ hind leg.

Thorax bright ferruginous brown, with six golden-scaled lines, dividing five darker ferruginous lines. Abdomen black, the last two segments with brilliant silvery-metallic scales, five lateral silvery-white patches. Legs black, with a white knee spot, pale bases to the femora, and with the hind tarsi in the ♂ densely scaled, forming a dark broad paddle. Wings transparent, with dark brown scales.

♀.—Head densely scaled with brilliant burnished silvery scales, and with black upright forked scales behind; clypeus, palpi and proboscis black; palpi of moderate size, thickly scaled; antennæ dark brown, with narrow pale bands; basal joint black, with a few small ochraceous scales; second joint testaceous, with black and ochraceous scales.

♂.—Head as in the ♀; proboscis long, thin, black; palpi not as long as the proboscis, black, with purple, and sometimes bronzy reflections, very thin; penultimate and antepenultimate joints about equal; the apical joint two-thirds the length of the penultimate, second short, first very small; the apical joint ends in one long and several smaller bristles. Antennæ banded with broad grey bands and narrow pale brown ones, basal joint black; plumes deep brown, last two joints brown. Fore ungues unequal, one very thick, untoothed, the smaller one thin and serrated; mid unequal, neither toothed, the large one very broad; hind equal, small, simple. *Length.*—5·5 mm.

Habitat.—Sierra Leone (September). Old Calabar (Annett).

2. **ERETMAPODITES (?) ARGYROPUS** (Walker).

Vide *Uranotænia argyropoda.*

It is possible that Walker's *C. argyropus* should be referred to this genus; but for the sake of uniformity I follow Mr. Theobald in placing its description under the genus *Uranotænia.*

Genus VI. **JANTHINOSOMA**, Arribálzaga (modified).

This is a small but very natural group of South American gnats originally separated from *Culex* by Arribálzaga, whose definition, however, seems to miss their real common points of peculiarity, and to insist too much on others that are really found in many other *Culicina.* They are of moderate size, and, seen at a little distance, are very sombre-looking insects, such decoration as they possess being almost confined to their ventral aspects, so that one would hardly suspect that *Sabethes* and *Megarhina* were their nearest relatives. On closer examination, however, it will be found that their dark-toned scaly covering glows with the same brilliant metallic tints as is the case in those genera, and that the scales of the legs, though not disposed in any specially eccentric fashion as in *Sabethes*, are really very long and dense. The thorax is clothed with broad falciform scales, much like those of the same region in *Megarhina*, and exactly similar scales take the place of the narrow curved scales of *Culex* on the head, though here they are mixed with erect forked scales, so that the covering of this region is essentially that of a *Culex.* They may be defined as follows.

Janthinosoma. Culicidæ with the ♂ antenna considerably longer than the proboscis, but very short in the ♀. The abdomen and legs clothed with scales, deeply coloured, but having a distinct metallic lustre. Thorax, including scutellum, clothed with short falciform scales. Head generally as in *Culex*, but with the narrow curved scales of that genus replaced by broader ones exactly like those of the thorax.

Wing scales much as in *Culex*. Fore ungues with an additional tooth in both sexes, those of the ♀ being large and stout.

Arribálzaga gives as characters, which are found to hold good in all the members of the genus with which we are so far acquainted, the following:—Palpi of ♀ short, with the fourth joint subconical, and the fifth oblong and longer and thicker than the fourth. Those of the ♂, much as in his *Tæniorhynchus*, but thinner and less hirsute, obviously longer than the proboscis and somewhat swollen towards the apex, the first and second joints minute; the third very long, nearly three-fourths the length of the proboscis; fourth and fifth subequal and together a little shorter than the third; the fifth oblong and tapering.

He adds that the branches of the anterior fork cell are twice as long as the fork stem, but this is not literally the case even in the type species, *J. discrucians*, and certainly does not hold good with all, though the stem is always much shorter than the cell.

All show a more or less distinct, nude inward extension of III. beyond the transverse veins, a character which they share with *Armigeres*, and, it may be added, with certain members of most other genera. To that genus, indeed, they present a strong general resemblance, especially in coloration, but the scales of the head differ, being arranged as in *Stegomyia*, in *Armigeres*, which wants also the metallic lustre of *Janthinosoma*.

In all but *J. oblita* (Arribál.), which I have not seen, as nothing resembling it has made its appearance at the British Museum, and the description of which reads more like that of an *Armigeres*, all have a portion of the hind tarsi alone pale, and the extent and position of this is alone sufficient to distinguish between the six species with which we are at present acquainted.

All appear to be sylvan insects, and one or two are said to be very vicious and troublesome.

Table of Species of Janthinosoma.

A. With some portion of the hind tarsi white.
  a. With the thorax decorated.
    β. With the last two hind tarsal joints all white and a little of apex of next.

1. *J. Lutzii*, Theob. Mesonotum with a broad median band of metallic purple, bordered by lateral stripes of brilliant yellow scales.

b. With the thorax undecorated.

β. With the last two hind tarsal joints white.

2. *J. discrucians* (Walker). Occiput, scutellum and bases of all the femora bright yellow.

γ. With the last hind tarsal and apex of next white.

3. *J. musica* (Say). Hind femora yellow, fore and middle ones, with but little of that coloration, venter with triangular golden apical spots.

δ. With the last hind tarsal joint only all white.

4. *J. posticata* (Wied.). With a yellow patch on the tergum of the second abdominal segment.

ε. With a white band on the apical half of the fourth hind tarsal joint.

5. *J. Arribálzagæ*, *sp. n.* With only a narrow band of yellow coloration on the hind borders of the segments on the venter.

B. With the hind tarsi entirely black.

6. *J. oblita*, Arribálzaga. The legs lighter coloured than in any other species; pale yellow with testaceous articulations.

1. JANTHINOSOMA LUTZII, Theobald (Monog. I, p. 257).

Plate xiii, fig. 7, Venation of ♀ wing.

Wings unspotted, dusky. Last two joints of hind foot entirely white, but the tarsi otherwise unbanded. Thorax conspicuously adorned by a broad. band of purely deep brown scales, separating large golden-scaled lateral areas. Abdomen deep chocolate-brown, with triangular, lateral bright ferruginous spots, not readily seen when viewed directly from above. Venter with segments deep chocolate at the base and ferruginous on their apical half.

Head black with a small yellow frontal tuft, and the middle of the vertex and nape bright yellow, but deep brown at each side, behind the eyes. Palpi, ♀, very short, deep purple throughout. Those of male very dark; longer than the proboscis by nearly the whole of their last two joints, which are sub-equal, and together much shorter than the very long third joint. Pleuræ and coxæ marbled yellowish and white, bases of all the femora ferruginous below, but not perceptible as seen directly from above. There are minute femoral knee spots to all three pairs of legs, which are of a dark bronzy amethystine tint. Stem of anterior fork less than one third the length of its cell. Halteres with pale stem and fuscous knob. *Length.*—4 to 5 mm.

Habitat.—Itacoatiara, Lower Amazon, Rio de Janeiro, Trinidad, Aqua Santa.

Time of capture.—February (Amazon), December (Trinidad).

Dr. Lutz writes: "It occurs in damp woods and shady river shores. It stings in the daytime. The larva is green. Common in Brazil."

2. JANTHINOSOMA DISCRUCIANS (Walker).

C. discrucians, Walker; "D. S.;" p. 430; *nec J. discrucians*, Arribál.

Wings unspotted, dusky. Last two joints of the hind feet and apex of next white. Thorax dark grounded, clothed with scattered yellow scales. Abdomen deep brown, unbanded, but with yellow lateral spots on the hinder borders of the segments. Occiput, scutellum, and bases of all the femora also bright yellow.

This is a good sized species, the wing length being about 4·4 mm. With the exception of the small yellow points enumerated above, it is of a lustrous, violaceous deep brown almost throughout; but the base of the venter is also yellow, and the two front abdominal segments show either as entirely yellowish, or with apical banding of that tint, according to the position of the insect. The armature of the long veins consists of truncate and of linear scales.

Head black; the vertex and nape clothed with short, falciform, golden scales, and erect forked ones of the same colour. Scales of identical form and colour as the former clothe the mesonotum. Palpi of ♀ very dark and short; those of ♂ much longer than the proboscis, and nearly black throughout. The fore and mid legs have a varying amount of dark coloration at the apices of the femora, but those of the hind are golden-yellow throughout; elsewhere the legs are deep purple. Pleuræ and coxæ marbled whitish.

Habitat.—South America; Argentina, San Paolo, Brazil.

Note.—The above is a description of Walker's type, supplemented by fresh specimens sent by Dr. Lutz, but Mr. Theobald points out that this cannot be Arribálzaga's species, as he clearly figures it with a single white band only on the hind tarsus, the last joint of which is shown as black.

3. JANTHINOSOMA MUSICA (Say)

(Jour. Acad. Nat. Sci. Phil. vi, p. 149).

= *C. Mexicanus*, Bellardi.

Wings unspotted, very dusky. Last two hind tarsal joints and apex of next, wholly white, but tarsi otherwise uniformly dark violaceous purple. Thorax, violet-black-grounded, unadorned, nude but for some scattered golden scales. Abdomen deep amethystine and black, dorsally unadorned, but the segments beautifully marked on the venter with golden triangular apical spots and amethystine basal areas.

A beautifully brilliant insect when in good condition, which may at once be known by its long, thick-scaled, hind legs, with white tarsi as described.

Head with sooty ground colour clothed with deep golden ferruginous short falciform scales, and erect forked ones of a somewhat deeper shade. Palpi, ♀, short, deep purple at apex, with a golden tinge at the base. Antennæ dusky. Legs with all the femora pollen yellow at the base, most extensively so on the hind pair; the joints from the tibia downwards greatly enhanced in apparent breadth by a dense covering of long scales. *Length.*—4·8 to 5 mm.

Habitat.—Rio de Janeiro; British Guiana; Indiana; South Amazon.

Time of capture.—Rio de Janeiro, November (Moreira).

Observations.—This seems to be an abundant South American species, which Dr. Lutz calls the Big Wood Mosquito. It stings, says Dr. Lutz, in the daytime.

4. JANTHINOSOMA POSTICATA (Wied.) ("A. Z. I." p. 9).

Wings unspotted, dusky. Tarsi uniformly dark bronzy, except the last joint of hind legs, which is entirely white. Thorax dark brown, unadorned, but clothed with short falciform, golden scales. Abdomen deep chocolate-brown, unbanded, but adorned with an ill-defined triangular golden spot on the tergum of the second, and with large, triangular lateral spots on the hinder borders of each segment, which latter, however, are scarcely noticeable viewed directly from above, venter entirely yellow but for a row of small, triangular dark basal spots.

♀.—Head black grounded, with forked scales and short falciform scales alike of a golden tint. Antennæ fuscous, about half the length of proboscis. Palpi very short, of a uniformly dark metallic purple.

Pleuræ marbled with white and golden; femora yellow beneath, but seen from above are but little paler at base than at apex; there are no knee-spots beyond a faint paling of their apices. The tibiæ, especially of the hind legs, appear apically dilated owing to their dense covering of long scales. Halteres with pale stem and fuscous knob. *Length.*—5 mm.

Habitat.—Castries, St. Lucia; Argentina.

5. JANTHINOSOMA ARRIBÁLZAGÆ, Sp. n.

Janthinosoma discrucians, Arribál. ("L. A." p. 53).

Plate xiii, fig. 2a, Venation of wing, ♀; 2b, Tarsus of hind leg.

Wings unspotted, densely black-scaled; unusually wide in proportion to their length. Tarsi uniformly black-scaled, with the exception of a broad basal white band on the fourth joint of the hind legs. Thorax sooty, clothed on the mesonotum and scutellum, with short falciform, golden scales with numerous long stiff black bristles on their margins. Abdomen, deep amethystine purple, with triangular apical golden spots on each segment, and some yellow scales and hairs along the hind border of the first; ventrally, the segments show triangular golden apical markings.

There can be little doubt that it was upon this species that Arribálzaga founded his new genus, as it agrees entirely with his description, given below, while specimens, sent to Mr. Theobald by Dr. Lutz, and which correspond to Walker's type of *C. discrucians*, though believed by the latter naturalist to be Arribálzaga's species, were at once seen to fail to correspond with Arribálzaga's description and figure, and it is obviously unlikely that the discrepancies can be due to careless drawing. This difficulty is now set at rest by a specimen I have just received from Dr. Lutz, labelled "*Janthinosoma*, sp. n.," and which was at once recognised by Mr. Theobald as the missing species.

The head and appendages almost black, the vertex and nape clothed with erect forked, and short falciform golden scales. The pleuræ and coxæ show extensive areas of golden scales and the lower surfaces of the femora, and the base also above of those of the hind legs, are bright golden, the apices of the femora showing also a barely noticeable yellow knee-spot.

This species can be easily distinguished from any other of the genus by the single band on the hind tarsi.

Original description :—

"(♀ and ♂).—Blackish, somewhat steely. Head clothed behind and below with pale golden scales; antennæ fuscous; proboscis dark steely; palpi of the ♂ much longer than the proboscis, with an apical brush; those of the ♀ dark steely with the last joint large and oblong. Thorax with dark fawn-coloured scales above, with greyish-golden scales below and on either side. Wings limpid with fuscous scales, which are densely arranged in front and more sparsely behind; first sub-marginal cell longer and narrower than the second posterior, their stems nearly equal, but while that of the first sub-marginal is barely half the length of the cell, the stem of the second posterior is quite as long as its cell. Legs dark steely, but with the femora broadly pale yellowish at the base; hind tarsi with the base of the fourth joint adorned with a pale yellow band. Abdomen steel-coloured above, the first segment with broad silvery fringes, the remainder not fringed but golden on either side; the venter with pale golden arcs. *Length*.—6 mm.

"*Habitat*.—South America (Walker); Argentina (Arribálzaga)."

6. **JANTHINOSOMA OBLITA**, Arribálzaga ("L. A." p. 54).

Wings unspotted; tarsi without obvious bands; thorax unadorned, dark grey; abdomen undescribed, but presumably unbanded. Nothing resembling this has come to hand.

Original description :—

" ♂—Hoary or dark cinereous, with scanty frosty cinereous scales. The first twelve joints of the antennæ with the bases pale and slender, and the apices thickened and piceous, all with not very dense pale fuscous plumes; the last two joints fuscous; eyes black; proboscis pale testaceous, with the base and apex dusky; palpi longer than the proboscis; the two basal joints short and piceous, the remaining two pale yellow, with scanty villosity; the last wanting. Legs pale yellow, with the joints indistinctly testaceous; tibiæ longer than the first tarsal joint; the anterior and middle tarsal claws are wanting, but the hinder are long, the external over twice as long as the inner one, with a very long additional tooth beneath; wings hyaline, slightly yellow, the veins clothed sparsely with long slender fuscous scales; first sub-marginal cell twice as long as its stem, the second posterior of the same length as its stem. *Length.*—4·50 mm.

" *Habitat.*—Navarro, in Argentina."

Genus VII. **PSOROPHORA,** R. Desvoidy

(" Essai," p. 412; " L. A." p. 38).

The genus *Psorophora* was constituted by R. Desvoidy in 1827, and it is difficult to understand why the generic value of so distinct a type should have been denied by all subsequent entomologists, until the genus was revived by Arribálzaga in 1891.

Though not so shaggy as *Mucidus*, it may be fairly said to belong to what may be called the hirsute genera of Mosquitoes, but the wings are not brindled in the same way as is the case in that genus, and the scales of their veins are like those of *Culex* and *Stegomyia*.

Owing probably to the defective character of the lenses available at that date, Desvoidy was led to give as the leading character of his new genus, the presence of peculiar scale-like structures, which he thought he made out, overlying and protecting the prothoracic stigmata. As a matter of fact, nothing of the sort is to be found in these gnats, and the supposed operculum is really nothing more than a tuft of scales covering the shoulder callosities.

In many respects they may be said to be intermediate between *Mucidus* and *Panoplites*, the legs and general appearance being much as in the former, while the arrangement of the scales on the head and thorax resembles that in the latter genus, though there are some stiff linear scales just at the juncture of the nape with the neck. The ♀ palpi too, though certainly proportionally longer than in *Panoplites* and *Culex*, being fully one-third as long as the proboscis, are shorter than *Mucidus*, where they are about half its length. In the ♂ the palps are exceptionally long and strongly tufted. Arribálzaga describes the ♀ palp as 5-jointed, but personally, I can make out but two joints in addition to the short basal piece, though it is possible that the minute bead-like terminal joint which he figures, may have been broken off, as the specimen I examined was badly rubbed. The posterior transverse vein is placed just internal to the middle, instead of being outside it, as in *Mucidus*.

A fair short definition would be: Mosquitoes with shaggy legs, but with smoothly scaled nape and mesonotum; the males with the palpi longer than, and the females with theirs, about one-third the length of the proboscis; with marked humeral callosities, and the posterior venule internal to the middle venule.

All the three known species are from the warmer parts of the American continent.

Mr. Theobald's modified definition runs as follows:—

"Head covered with small broad curved scales and upright forked ones; meso-thorax with curved scales in the middle with short broad scales laterally; abdomen with small flat spatulate scales; antennæ rather short in both sexes, in the ♂ the two last joints elongated as in *Culex;* palpi short in the ♀, long in the ♂, twice as long as the proboscis in the ♂, five-jointed, the first two joints very small, the third nearly as long as the proboscis, slightly enlarged apically; the fourth and fifth joints thick, the two nearly equalling the third in length; in the ♀ the palpi are also five-jointed, but short, never more than one-half the length of the proboscis; the first and fifth joints are very small, the third longer than the second, the fourth longer than the third, according to Desvoidy and Arribálzaga, but I cannot detect the small basal and apical joints myself in either species. The proboscis is short and rather thick. The prothoracic lobes are said to have lateral appendages which protect the stigmata of that segment. Wings with the scales rather long and thin; first sub-marginal cell short, only a little longer than the second posterior cell; the posterior cross-vein close to the mid cross-vein, but always a little nearer the base of the wing than the mid. Legs with the apices of the femora, tibiæ, and to some extent the first tarsals with long scales; ungues of the ♀ all equal, thick, with a large distinct tooth to each, in the ♂ fore and mid claws unequal, the larger one twice as long as the smaller and with two teeth, the smaller with one tooth; hind claws equal and single toothed."

He tabulates the three members of the genus as below:—

Fuscous, clothed with yellowish and pale
scales (7-8 mm.) .... 1 *Ciliata* (Fabricius).

Fuscous, clothed with dark scales, black in general appearance....................	2 *Holmbergii*, Arribálzaga.
Fuscous, clothed with brown scales, apices of hind femora white, very densely scaled..	3 *scintallans*, Walker.

1. PSOROPHORA CILIATA (Fabr.).

C. ciliatus, Fabr.; *C. molestus*, Wied.; *P.S. Boscii*, R. Desv.; *C. perterrens*, Walker; *C. conterreus*, Walker.

(Ent. Syst. iv, p. 401 [1794], Fabr.; Syst. Antl. p. 38 [1804], Fabr. [= *Culex ciliatus*]; Dipt. Exoti. p. 36 [1821], Wied.; Auss. Zwei. Ins. i, 3, 5 [1828] Wied.; Dipt. Exoti. p. 11, Sup. iv. [1838], Macq.; Dipt. Brit. Mus. i, p. 2 [1848], Wlk.; Ins. Saund. p. 431, Wlk. [= *C. perterrens*]; Dipt. N. Amer. Cat. 18, Osten-Sacken; Dipt. Arg. Rev. d. l. Mus. d. l. Plata, p. 40 [1891], Arri.)

Wings unspotted. The three distal tarsal joints with yellowish basal bands. Thorax yellowish-white, with median and lateral fuscous lines, the armature consisting of large overlapping scales, as also is that of the abdomen, which both dorsally and ventrally is almost pure white. Legs testaceous, tufted at the joints.

This is one of the largest species in the family, the abdomen (♀) being over 6 mm. long, and the wing nearly 8 mm. The entire insect has a rich red-brown ground colour, covered with nearly white scales; the proboscis and palps being, however, darker, their scales being mixed yellow and fuscous. Those of the ♀ are exactly one-third the length of the proboscis, while in the ♂, they are nearly twice as long. The legs are deep brown above, and on the whole of the first two tarsal joints. There is a dark median nude line on the nape.

Habitat.—Texas, Atlantic coast of Southern states of America, Georgia, Honduras, Argentine Republic, Brazil. Its bite is said to be unusually painful.

2. PSOROPHORA HOLMBERGII, Arribálzaga ("L. A." p. 40).

Closely resembles the preceding, being nearly as large, and differing only in being of a much darker colour, the body scales being dark grey, instead of yellowish-white, and in its wanting the dark naked line on the nape; but though necessarily less prominent, the thoracic adornment is essentially the same. The coxæ too are pitch-brown instead of having almost snowy tufts of scales. The legs are almost black, and the tarsal banding of the fore legs very indistinct, while on the mid legs, the upper two, and on the hind, the upper four tarsal joints have silvery basal bands.

Habitat.—Brazil, and Argentine republic.

3. **PSOROPHORA SCINTILLANS** (Walker).

Sabethes scintillans, Walker ("Journ. Proc. Linn. Soc." III. [1859], p. 77).

Wings unspotted. Tarsal joints with basal white bands. Thorax dark brown, with a median and two lateral snowy lines. Abdomen black, segments with or without snowy apical patches. Proboscis curved as in *Megarhina*.

This species was originally described as *Sabethes* by Walker, but is certainly a *Psorophora*.

Head black, clothed with small flat white scales, black erect ones and numerous black bristles. Palpi of ♂ five jointed, nearly twice as long as the proboscis, dark metallic purple and blue.

Thorax black, with dusky brown curved hair-like scales in the middle and flat white spindle-shaped ones at the sides. Abdomen black, with brown scales with bright violet-blue reflections, first two segments velvety brown, the apical one tinged with metallic green, sometimes with white apical lateral patches. Legs black, with dense long dusky scales with purple and brassy, &c., reflections, apices of hind femora white, tarsi not so densèly scaled as the femora and tibiæ, except the first joints of the hind legs. Wings dusky yellowish-brown. Ungues of the ♀ equal, very stout with an accessory claw beneath. *Length.*—6·5 to 8 mm. ♂ ; 7 to 9 mm. ♀.

Habitat.—Amazon Region.

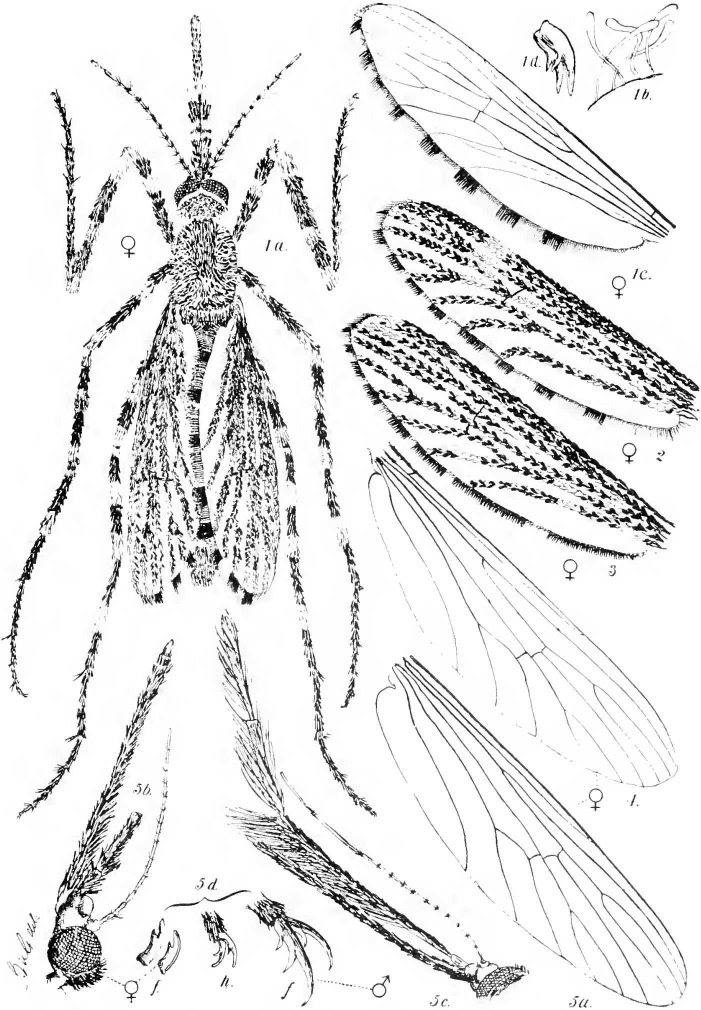
Genus VIII. **MUCIDUS,** Theobald (Monog. I, p. 268).

This new genus has been established by Mr. Theobald, for the accommodation of the curious group of species allied to *Psorophora*, the peculiarities of which were first pointed out in the First Edition of this Handbook (p. 181), one which was partially described under the suggested name of *Ps. Scataphagoides.* They are large hirsute insects which look much more like dung flies than they resemble ordinary gnats. The wings, and, in fact, the entire insect is in all of them elaborately brindled and banded with intermixed fulvous, dark brown and white scales, the tufts of scales on the legs lending a curious dentate appearance to their margins. In all of them, too, the internal fringe of the wing is made up of brilliantly contrasted dark and light lengths. They appear to be confined to the Old World and Australia, just as *Psorophora* is, so far as we at present know, purely American.

Mr. Theobald defines the genus as follows :—

"Head clothed with narrow curved, forked, upright, and long, twisted scales.

"Thorax with narrow curved scales and long twisted, apically expanded scales, as in the head.



1, *Mucidus scataphagoides*, Giles; 2, *M. alternans* (Westwood); 3, *M. mucidus*, Karsch; 4, *Psorophora Holmbergii*, Arribál.; 5, *Ps. ciliata* (Fabr.).

Face p. 346.

"Abdomen with dense scales, which stand out and give it a ragged appearance.

"Wings covered with broad pyriform scales, many of which are particoloured. Palpi of the ♀ half as long as the proboscis; antennæ fourteen jointed, including the basal joint; palpi of the ♂ five-jointed, a little longer than the proboscis. Wings with the venation much as in *Culex*, but the *posterior cross-vein is nearer the apex of the wing than the mid cross-vein.*

"Legs banded, densely scaled with projecting scales; fore and mid ungues of the ♂ unequal, the larger with two, the smaller with one tooth; hind ungues equal, small toothed; in the ♀ all the ungues are small, equal, thick, and with a short thick tooth."

Five species are at present known, which he tabulates as below:—

A. Proboscis with ochreous and yellow scales—no white apieal band.
- α. Wing fringe with 8 pale yellow spots ....
- β. Stem of second posterior cell shorter than the cell .... 1 *alternans*. Westw.
- ββ. Stem of the second posterior cell longer than the cell .... 2 *scataphagoides*. n. sp.
- α. Wing fringe with 7 pale spots.................. 3 *mucidus*. Karsch.
- αα. Wing fringe with 5 pale spots.................. 4 *Africanus*. n. sp.

AA. Proboscis white banded at apex .... 5 *laniger*. Wied.

1. MUCIDUS ALTERNANS (Westwood).

Plate xii, fig. 2. Wing of ♀.

= *C. alternans*, Westwood. = *C. commovens*, Walker. = *C. hispidosus*, Skuse.

(Ann. Soc. Ent. Fr. iv, p. 681, and Trans. Ent. Soc. Lond. iii, p. 384; Ins. Saund, Dipt. p. 432, Walker (= *C. commovens*); Trans. Linn. Soc. N.S. Wales, p. 1726 [1891], Skuse = *C. hispidosus*.)

Wings brindled yellowish and brown, with a not very sharply defined lighter band across the wing at the level of the fork-stems, extending from the costa to V; their internal fringe with eight each, of alternate black and pale yellow lengths of almost equal size. Proboscis deep ochre and pale yellow scaled. Stem of hinder fork shorter than its cell.

Of a general mouldy appearance. Head brown, with median and lateral patches, and the orbits white scaled. Palpi, ♀, nearly half as long as proboscis, brindled so as to be dark at the base and nearly entirely white-scaled at their tips, those of ♂ but little longer than the proboscis, with a tuft of long, silky hairs at the extremity, and a very strong tuft from the side of the third joint, the two basal joints each as long as the last three taken together, and the mixed dark and light scales so disposed as to leave the last joint almost black; the next nearly white, and the two long joints dark at their distal and pale on their basal portions. Thorax yellowish-brown, with white spots as follows: three in front near the head, three in the middle, irregular patches at the sides, and one in front of the scutellum. Abdomen blackish, covered with ochreous, yellow and white, parti-coloured scales, the white forming more or less basal bands, and a spot on the middle of the segments. Legs densely clothed with ochreous, parti-coloured and white scales, banded with white. *Length.*—7·5 mm.

Habitat.—Bupengary, S. Queensland; Hexham Swamp, near Newcastle and Richmond, N.S.W.; Mt. Kembla, Illawarra, N.S.W.; Natal. December and January in Australia.

2. **MUCIDUS SCATAPHAGOIDES,** *sp. n.* (First Edition, p. 182).

Plate xii, fig. 1a, Complete figure of insect, seven times natural size; 2a, Venation of wing at standard amplification of 10 diams.

Wings very broad; not definitely spotted, but with alternating patches of pale and parti-coloured scales on all the veins; its internal fringe pale yellow with eight black interruptions, which are, however, narrower than the intervening pale portions, especially towards the tip. Legs, including tarsi, elaborately banded with alternate brown and yellowish-white rings. Thorax covered with woolly white tomentum, with ill-defined darker patches on the sides at front. Abdomen brindled like the rest of the body, rather paler along the middle line but unbanded. Proboscis brindled so as to be darker at the tip. Stem of hinder fork longer than its cell.

♀.—Head and eyes ochreous, the nape covered with long, forward-directed, pale ochreous scales, almost white in the middle line, and lemon-coloured round the eyes and on a frontal tuft, somewhat like those of *Anophelctes;* antennæ white on basal joint; brownish-yellow, darker at the roots of the verticils elsewhere; palpi more than half the length of the proboscis, ochre and white brindled, nearly pure white at the tips. The venation of the wing is peculiar, "2" being absent, as III. originates from II. external to the transverse veins, and hence "3" connects II. and IV. instead of III. and IV. as usual. Halteres ochreous-brown throughout. *Length.*—8 to 10 mm.

Habitat.—This species is probably widely distributed in India, as the specimens mentioned in the First Edition were from Myingan, Burmah, and during the past year I received a number of specimens from Major Close, I.M.S., who writes:—"They only appeared for about a week in September, and occurred in the Police Hospital at Moradabad, N.W.P., and bit the patients very viciously." Major Close confined a ♀ that had recently bitten in a test tube, placed on the slant, with some water in the bottom. She deposited a number of eggs separately, but when transferred to water they did not hatch out.

3. MUCIDUS MUCIDUS (Karsch).

Culex mucidus, Karsch (Ent. Nachr. p. 25, 1887).

Plate xii, fig. 3, Wing of ♀.

Wing not definitely spotted, but brindled with mainly brown, some ochreous and a few parti-coloured scales with a pale patch at the tip and a couple on V. and VI. each. The internal fringe mainly dark, with seven pale interruptions much narrower than the intervening dark portions. Legs elaborately ornamented with alternating dark and light portions, the latter basal on the tarsi, but these are nowhere very dark. Thorax yellow-brown with woolly white tomentum. Abdomen brindled with brown and white scales, the latter preponderating along the middle and behind. Proboscis rather dark at the tip.

♀.—Head yellowish-brown, with long straggling white scales forming a median line and a few dotted over the whole surface, numerous black and brown upright forked scales, a narrow white border round the eyes, and numerous golden bristles projecting forwards; antennæ yellowish-brown, the basal joint with a tuft of white scales and a few brown scales on the second joint; palpi densely clothed with brown and white scales, the white greatly predominating, especially towards the tip, a few parti-coloured ones also present and a few large black bristles; proboscis covered with golden-yellow squamæ, and with numerous brown ones towards the base; wings with "2" nearly even with "3" and "4," external to them. *Length.*—8 to 8·5 mm.

Habitat.—Whydah, W. Africa; and Delagoa Bay.

4. MUCIDUS AFRICANUS, Theobald (Monog. I, p. 274).

Wings unspotted and less brindled than in the other members of the genus, the majority of the scales being of a single sort (parti-coloured) with a few dark ones on the costa, I. and V. Internal fringe mainly black, with five irregularly disposed pale patches, two near tip, two respectively before and behind ant. br. of V. and a fifth internal to VI. Thorax fuscous grounded with a pair of paler, sub-median ground stripes and white woolly tomentum. Abdomen dark brown, with median and lateral patches of long shaggy white scales on the first few segments, the apical segments being mostly white-scaled; legs with the femora mostly dark-scaled, the tibiæ black on the basal half or more, white on the apical part; metatarsi and tarsi ochreous, scales smaller, making them look nude on the fore and mid legs. Proboscis darker at apex.

♀.—Head brown, with shaggy white twisted scales, some spatulate, especially forming a white median line; upright forked scales numerous, jet black, much wider apically than in other species of this genus; a narrow pale border round the eyes and golden-brown bristles projecting forwards between them; antennæ yellowish-brown, with narrow deep brown bands at the verticils, basal joint with a dense tuft of white scales on the inside; palpi densely clothed with scattered white and jet-black scales; eyes black. Wings with 2, ||, to 3 and 4 well external to them. Tarsal claws equal, thick, serrated. *Length.*—7 to 7·5 mm.

Habitat.—Asaba, W. Africa, in August.

5. MUCIDUS LANIGER (Wied).

C. Laniger, Wied. ("D. E." p. 9).

Wings limpid, the veins with alternate fuscous and white scales; their inner margin alternately banded fuscous and white; tarsal joints banded, and some joints wholly white; tomentum woolly; thorax with a median white line; abdomen white, with a fuscous apical band on each segment.

Although no specimens referable to the above have come to hand, there can be little doubt that the species to which it refers belongs to the genus *Mucidus.* The following is the original description.

Entirely covered with woolly hairs, variegated with white and fuscous. Length 4 lines (German). ♀.—Proboscis yellow, with a white band at the apex; palpi two-thirds the length of the proboscis, the middle joint longer than the apical, the third shortest; all covered with a white and intermixed fuscous lanugo; the bases of the antennæ yellow, the flagella whitish; head covered with fuscous lanugo, with a white middle line; thorax covered with fuscous lanugo, with a median stripe, and two continuous stripes on the pleuræ, white; abdomen white, with a fuscous band on the apex of each segment. Wings limpid, the veins with fuscous and white scales, the internal margin ciliated alternately fuscous and white; halteres whitish. The ground colour of the legs is yellow but is, like the trunk, covered with white and fuscous lanugo; there is no white on the anterior tarsi, but in the hinder their apices are white; the tibiæ of the front legs are white alike at their bases and apices, while those of the middle and hinder, are banded white; the femora of the front legs have three, and of the hinder and middle four white bands.

Genus IX. PANOPLITES, Theobald (Monog. I, p. 276).

This genus is one of the best defined and most easily distinguished of the new genera. Once seen, there is no mistaking the wing with its large regularly placed bracket-shaped scales; and the circumstance that in all the species these are disposed in irregularly-arranged groups of dark and pale scales gives a curiously rough, brindled appearance to the wing. The scales themselves are so large that their peculiar outline can easily be made out with an ordinary hand lens. The internal fringe is usually very long, and the inner rank of short scales are disposed in irregular patches of light and dark colour, just as are those of the veins, though they may be almost all white, as in *P. Australiensis*, or all black, as in *P. Africans*. In very many respects the genus closely resembles *Mucidus*. Not a single ♂ of any species appears to have reached the museum, but in every one the palpi of the ♀ are much larger than in *Culex*, being about one-third the length of the proboscis inmost, and although the scales differ from those of *Mucidus* in shape, their general arrangement on the veins in irregular groups of contrasting colours is very similar in both genera. The dark scales, too, have the same opaque thickened appearance, and the brindling of the whole body by intermixed scales of two or more shades of the same colour, such as white to pale yellow, ferruginous and yellowish-brown of various depths, is exactly similar, and so also is the ornamentation of the body and appendages, produced by the varying preponderance of scales of one or the other shade on various parts. They might almost indeed be said to be small *Mucidi* with asymmetrical wing scales, and though the wing scales present a close resemblance to those of *Ædomyia*, the two genera are easily distinguished, even in the females, by the much greater length of the palpi, which are about one-third the length in *Panopheles* and very short in all the *Ædes group*, and for these reasons I think their natural position is between *Mucidus* and *Culex*.

Of the seven species at present known, only two, *P. dives* (Schiner), and *P. titillans* (Walker), were previously known, but all belong to the warmer parts of the world. The bite is said to be very irritating, and Dr. Lutz has found that the saliva is distinctly acid. Mr. Theobald defines the genus as below:—

Palpi short in the ♀, long in the ♂, in the latter with hair tufts, four-jointed in the ♀ and ♂; in the ♀ the first joint is small, the third long, the fourth small and nipple-like. Head clothed with narrow curved and long upright forked scales; thorax with thin hair-like curved scales and numerous bristles; scutellum with similar squamæ; abdomen with flat scales with very convex apices. The abdomen of the ♀ is usually blunt, and the penultimate segment may have a row of short thick spines. *Wings densely scaled along the veins with broad asymmetrical flat scales on each side of the veins only, no median scales*, and also in some cases with long lateral clavate scales; fork of the second posterior cell usually nearer the base of the wing than that of the first sub-marginal cell. Legs usually more or less mottled and banded with white; ungues of the ♀ equal and simple, of the ♂ unequal, the larger one toothed, the smaller, simple (in *P. titillans*, Walker).

Table of Species of PANOPLITES.

A. Thorax unspotted, and the femora not prominently banded.
- Thorax uniformly dark brown, palpi and proboscis dark, the latter with a trace of banding .... 1. *titillans*, Walker.
- Thorax reddish-brown, with two median pale lines, small pale golden scales in the middle and round the front, abdomen with yellow apical bands................. 2. *pseudotitillans*, Theob.
- Thorax chestnut-brown in the middle, paler at the sides, legs mottled and banded .... 3. *uniformis*, Theob.
- Thorax dark brown, the front two-thirds of the mesonotum golden-brown scaled, tarsi banded white 4. *Amazonensis*, Theob.
- Thorax golden-brown, abdomen unbanded, tarsi broadly basally light banded, proboscis not very obviously banded but dark at tip 5. *Australiensis*, Theob.

AA. Thorax spotted, and the femora elaborately banded or spotted.
- Legs all banded and mottled; yellowish-brown; wings with the posterior border with broad border scales .... 6. *annulifera*, Walker.
- Blackish-brown; wings with the border scales narrow .... 7. *dives*, Schiner.

AAA. Thorax ornamented with broad lines of golden-brown and silvery scales and two pale indistinct spots ... 8. *Africanus*, Theob.

1. PANOPLITES TITILLANS, Walker.

= *Tæniorhynchus tæniorhynchus*, Arribálzaga = *Culex damnosus*, Say.

(Brit. Mus. List. p. 3 [= *Culex titillans*], Walker; Jour. Acad. Phil. iii, 11. 3 [1882] [= *Culex damnosus*], Say; Dipt. Argentina, p. 48 [Arribálzaga] [= *T. tæniorhynchus*].)

Plate xiii, fig. 4a, Venation of ♀ wing; 4b, Leptotaxis of wing vein; 4c, outline figures of ♂ and ♀ palpi (after Monog.).

Wing brindled with dark brown and yellowish scales, the latter somewhat preponderating, except along the costa; the short inner rank scales of the fringe, some black and some white. Tarsi basally white banded. Thorax uniformly dark brown. Abdomen deep purple-black, the segments more or less distinctly apically banded or fringed with yellowish scales. Proboscis with a broad ferruginous band, the ant. limit of which is fairly distinct but which fades off behind gradually. These markings are barely perceptible in the ♂, which is almost uniformly greyish-brown.

Head brown with grey curved and black erect forked scales, paler in the ♂; palpi of ♀ fully one-third the length of the proboscis, brindled yellowish and black, whitish at the tip; those of ♂ brindled yellowish-white to black; fourth joint with a dense tuft of hairs, basal half of end joint white. First hind tarsal joint with a minute band at the juncture of the middle and lower thirds, the other joints all distinctly basally white banded, while in the mid legs, the upper four, and in the hind the upper three tarsal joints are banded. *Length.*—5 mm. ♂, 5·5 ♀.

Habitat.—Rio de Janeiro, New Amsterdam, British Guiana.

2. PANOPLITES PSEUDOTITILLANS, Theob.

(Monog. II, p. 178).

Plate xiii, fig. 7, Fork of IV., to show distribution of dark and light scales.

Closely resembles the above, but the wing is paler, its veins having a rather larger proportion of pale scales than are found in that species, and often four to six white ones lie along one side of a vein, while those on its other are black. There are narrow basal bands on all the tarsal joints of the hind and mid, but only on the upper three of the fore-legs, and the extra band on the hind first tarsal is absent, or at most ill-defined. The proboscis with a very broad and ill-defined ferruginous band in the middle. It may be distinguished from the preceding by the thorax being ornamented by two paler median lines, but the chief difference, however, which is certainly specific, is in the scale ornamentation of the wings. In *P. titillans* there are numerous lateral scales on the veins of an elongated form, similar to those of a *Tæniorhynchus*, whilst in this species the scales are *all* typical *Panoplites* scales. *Length.*—6 mm.

Habitat.—Lower Amazons, *Time of capture.*—March.

3. PANOPLITES UNIFORMIS, Theob. (Monog. II, p. 180).

Plate xiii, fig. 3a, Venation of wing in ♀; 3b, of ♂; 3c, Leptotaxis of wing-vein; 3d, Head and appendages of ♂.

Wings brindled but unspotted. ♂ tarsal joints brown, with ferruginous band, swhich are scarcely perceptible in the ♀, on the articulations. Thorax clothed with golden scales on a dark ground colour, unadorned. Abdomen brown, with marked broad apical ferruginous bands in both sexes. Proboscis with a broad yellowish band beyond the middle. Wing-length 4·5 mm. ♀, 4 mm ♂. This species is remarkable for the fact that, while the long veins of the male carry a quite characteristic armature of bracket-shaped scales, in those of the ♀, it much more resembles that of a *Culex*, only a part of the anterior veins showing a few unsymmetrical scales, and those ill marked.

The head is clothed with yellowish scales; the ♀ palpi are one-third the length of the proboscis, dark, with a faint yellow band at the base of the short end-joint; and those of the ♂ nearly black, with a long yellow tip and four other bands of the same colour, the largest of which is exactly opposite the broad ferruginous band just beyond the middle of the proboscis. The halteres are pale yellow. The venter impure yellow throughout. In the wings the white scales rather preponderate. The thighs are very indistinctly marbled rather than banded. In the female there is a broad pale band on the middle of the first tarsal joints, in addition to its basal band, on the hind, and in its absence, in the other two pairs of legs, the two last joints of these legs not being perceptibly banded. The pale band on the proboscis is sharply defined in front, but shades off behind into the darker base. *Length.*—4·5 to 5 mm.

Habitat.—Appears to occur all over India, and also in the Straits Settlements; I found some in Shahajahanpur, N.W.P., for a few days early in October, after which it disappeared.

4. **PANOPLITES AMAZONENSIS**, Theob. (Monog. II, p. 182).

Wings unspotted, but brindled, the dark scales greatly preponderating, except in the rank of short scales of the inner fringe, where they are about equal in numbers.

Thorax dark brown, the front of the mesonotum covered with bright golden-brown scales. Abdomen dark brown, unbanded, with yellow and grey scales on the lateral borders, and a patch of white scales on the apex of the first segment. Legs brown, bases of the tarsal joints basally pale-banded, yellow on the fore and mid, white on the hind legs; ungues equal and simple.

♀.—Head black, with a few curved dull golden scales, a small white patch on each side, a pale border to the eyes and numerous black upright forked scales; palpi rather shorter than in most members of the genus, being barely a third the length of the proboscis, covered with loose black scales, with a few grey ones dotted about; proboscis brown, with a small white band beyond the middle, and with yellow scales dotted over the basal half; antennæ black, with narrow clear white rings, basal joint black, with yellow scales, second joint black, with black scales.

Thighs and tibiæ very dark, not banded, but brindled with a few pale scales. The basal bands of the first tarsal joints are so narrow as to be barely perceptible, but all the other joints of the hind, the next three of the mid, and the next two of the fore legs show fairly distinct bands. The last two joints of the mid tarsi are much paler than the other feet. *Length.*—4·3 to 5 mm.

Habitat.—Lower Amazon, taken in January.

4a. **PANOPLITES**, *Sp.*, resembling *C.* (*Ochlerotatus*) *confirmatus*, Arribál.

I received from Dr. Lutz, along with specimens of the above-mentioned species, a form much resembling *P. Amazonensis*, but certainly distinct. It is in too rubbed a condition for description, and all that can be said at present is that it so resembles Arribálzaga's species that the two are practically indistinguishable until the wing is placed beneath the microscope. I figure, however, the peculiarities of the wing with the view to its early recognition and the collection of further material (Plate xiii, fig. 5a, Venation of wing; 5b, Leptotaxis of wing vein; 5c, Ungues ♂).

It will be seen that the long scales associated with the characteristic bracket-shaped scales are exactly like those of the *Tæniorhynchi*, so that the species may in a certain sense be said to be intermediate in character.

5. **PANOPLITES AUSTRALIENSIS**, Theob. (MS. name).

Wings unspotted but brindled with dark and light scales, the latter greatly preponderating; the dark ones, however, are numerous on the costa, but the inner rank of fringe scales are all white. Thorax with the mesonotum and scutellum testaceous, thickly beset with golden-yellow narrow curved scales and long bristles. Abdomen deep purple-brown with a large triangular patch of ferruginous scales on the terga of the first two segments, extended as an ill-defined lighter line to the apical segments, the last two of which are mainly dark ferruginous. Legs with the femora and tibiæ obscurely banded with dark brown and ferruginous scales; the tarsi are all wanting in the single, much mutilated type, except those of the fore legs, which have a narrow basal band to the first and very broad yellow ones to the next three joints.

♀.—Head nearly black, covered throughout with golden forked and narrow curved scales; palpi rather pale golden, with a few scattered brown scales, especially numerous at the base, and a small tuft of white ones at the tip, less than one-third the length of the proboscis, which is golden on its basal two-thirds and black on the distal third, the separation of the two tints being sharply defined. Venter dusky, the bases of the segments of a somewhat paler ferruginous brown. Halteres with ferruginous stems and dusky knobs. *Length.*—About 4·5 mm.

Habitat.—Burpengary, Queensland.

6. PANOPLITES ANNULIFERA (MS. name), (Walker).

Culex annulipes, Walker; *Culex annulifera*, Walker (MS.); (Proc. Linn. Soc. Lond. i, p. 5 [1857], Wlk.).

Plate xiii, fig. 8. Hind leg, to show banding.

Wing unspotted, but brindled with dark and light scales, the latter greatly preponderating, the former most numerous in the middle of the wing towards the base. Thorax tawny yellow, with four snow-white round spots, and a dark line running backwards from the posterior border of the two anterior spots; an indistinct fifth white spot may also be present. Abdomen with white scales laterally, and forming bands across the segments, last three segments with many white scales. Legs yellowish-brown, all the joints with many white bands. There being six alternations on each of the femora and an additional band in the middle of each first tarsal joint, all the tarsal joints are basally banded except those of fore and mid legs, which possess only the median band.

♀.—Head clothed with brownish-golden scales and long golden-brown hairs; eyes black, with a silvery border; palpi yellowish-brown, with a few scattered dark brown scales; apex snow-white; antennæ brown, with pale bands; proboscis black for the distal third of its length, changing abruptly to pale ferruginous, except the very base which shades off to a darker tint. Wings with 2 ‖ 3, but angulated, 4 widely internal. This species is much paler than *P. dives*, Schiner, and can hardly be mistaken for any other Indian species, the multiple banding of the whole length of the legs being most characteristic. *Length.*—4 to 4·5 mm.

Habitat.—Madras, Quilon, Travancore, Behar, Dacca, Bengal.

7. PANOPLITES DIVES, Schiner.

Culex dives, Schiner; *Culex nero*, Doleschall (?); (Reise der Novara, p. 31, Schiner; Natuurkundig. Tijdsch. v. Ned. Ind. xiv, 383 [= *nero*], Doleschall ?).

Wings unspotted but brindled with light and dark scales, the latter greatly preponderating, especially along the costa; the short inner rank of fringe scales all black. Thorax very dark brown, with dark coppery scales, with six bright greenish-white spots. Abdomen blackish, the antepenultimate and penultimate segments with white-scaled lateral patches. Legs long, black, banded white, including the femora and tibiæ, the contrast of colouration being much more marked than in *P. annulifera*, though the mid legs are less obviously ornamented. In these and in the hind legs the first tarsal joints have a median as well as a basal ring and the next two joints have also basal white rings, while in the fore only the upper two or three joints have distinguishable basal bands.

♀.—Head blackish, with long black forked scales, with some scattered white ones, and with ten long bristles projecting in front; eyes brilliant purple and pale bronze towards the middle; antennæ with basal joint dark, base of first to fourth joints banded white, remainder brownish-purple; palpi yellowish-brown, thickly clothed with dark scales near the apex and white ones at the extreme tip; proboscis with dusky purple scales at the base, then a yellow band, and then more dusky scales, whilst the tip is yellow scaled and has also some golden hairs. It differs from *C. annulifera* in all the innermost rank of fringe scales being black. *Length.*—3·8 to 4·5 mm. (♀).

Habitat.—Selangor, Straits Settlements (very common); Singapore, Batavia. *Time of capture.*—At Selangor, in September.

8. **PANOPLITES AFRICANUS**, Theobald (Monog. II, p. 187).

Plate xiii, fig. 6, Palpi and proboscis of female.

Wings unspotted, very dark, showing but little brindling, there being but few pale scales, the short inner rank of fringe scales being also all black. Proboscis with a median broad and narrow apical yellow bands. Thorax dark brown, ornamented with narrow golden-brown and silvery scales, the silvery ones forming more or less two spots on the mesonotum and occurring on each side of the posterior half of the thorax. Abdomen dark brown, the basal segments with basal median yellow spots, the apical segments with yellow apical bands; there are also white apical lateral spots; venter pale, with creamy scales, apex often mostly white scaled. Legs dark brown, banded and mottled with white. The femora and tibiæ showing about five or six white spots each. The hind tarsal joints are all usually white banded and the first joints have an additional median ring in all three pairs of legs, though the last two joints are all black in the fore and mid legs.

♀.—Head brown, with narrow curved grey scales and flat white ones at the sides, a white border round the eyes and numerous long upright forked dark brown scales; proboscis dark brown to almost black, with a broad median yellow band and a yellow band at the apex: palpi covered with dark brown scales, apex white scaled, and there is also a band towards the base; antennæ brown, broadly banded with grey, the grey bands involving the base and apex of contiguous joints; basal joint testaceous, second joint pale testaceous, with a few black scales; clypeus deep testaceous. Halteres ochreous, with the knob a little darker. *Length.*—4 to 4·3 mm.

Habitat.—Fort Johnston, British Central Africa; Chiromo, Lower Shire, British Central Africa; Lagos, also British Central Africa; Old Calabar.

8a. **PANOPLITES AFRICANUS**, var. *Reversus* (Theobald).

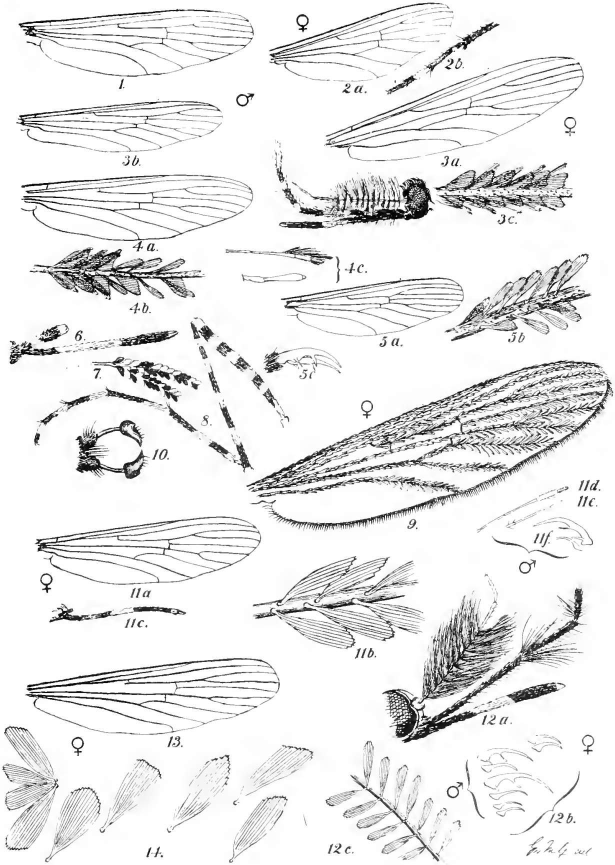
Mr. Theobald separates the above form from the usual type of the species with which it is found associated. The yellowish scales on the wing largely preponderate, and the apical borders of all the abdominal segments are yellow. The thigh and tibiæ are brindled but not distinctly banded, and on the hind legs the first tarsal joints have only a single median band. The dark tip of the proboscis is also shorter. *Length.*—4·5 mm.

Habitat.—Zomba, British Central Africa.

GENUS X. **TÆNIORHYNCHUS**, Arribálzaga (as modified by Theobald).

This genus is closely allied to *Panoplites*, the leptotaxis of the wing veins in certain species of that genus closely approaching that of the present, while in many *Tæniorhynchi* certain of the scales are decidedly unsymmetrical, though they never quite assume the typical bracket-like form. They may usually be easily distinguished by the wings never being brindled in the same way as is the case in all *Panoplites*, for though, in some species, there may be a few pale scales intermixed with the dark ones, they are never sufficiently numerous or sufficiently contrasted to give rise to doubt. The female palpi closely resemble those of *Panoplites* in their general appearance, but are always shorter, seldom exceeding one fourth the length of the proboscis, which is usually, but not necessarily banded. As at present constituted the genus contains but one of the members of Arribálzaga's old group. In distribution they closely resemble *Panoplites*, with which, indeed, they are often found associated. The most typical species are all of a peculiar honey-yellow tint, but two or three are more sombre insects. Mr. Theobald's definition of the genus is as follows, the essential generic character being that the veins of the wings are densely clothed with long obovate scales.

PLATE XIII.



1, *Janthinosoma Lutzii*, Theobald; 2, *J. Arribálzagæ sp. n.*; 3, *Panoplites uniformis*, Theobald; 4, *P. titillans* (Walker); 5, *Panoplites, sp. n.* (*pseudoconfirmatus*); 6, *P. Africanus*, Theobald; 7, *P. pseudo-titillans*, Theobald; 8, *P. annulifera* (Walker); 9, *Tæniorhynchus fulvus*, Wied.; 10, *T. Annettii*, Theobald; 11, *T. fasciolatus*, Arribál.; 12, *T. Richardii*, Ficalbi; 13, *T. Ager*, Theobald; 14, various forms of wing scales in *Tæniorhynchus*.

Face p. 358.

"Palpi long in the ♂, short in the ♀; the fifth joint in the ♀ minute, hidden among the scales of the next joint; ♂ palpi longer than the proboscis, third joint long; head clothed with narrow curved scales and upright forked ones; thorax and scutellum with narrow curved scales; abdomen with flat scales; *wings clothed with elongated oval scales, ending either diagonally and convexly, or more or less bluntly pointed*, no median linear scales to the veins; legs spotted and banded; ungues of female equal and simple, of the male unequal in the fore and mid legs, the larger one with one or two teeth, the smaller simple, the hind claws also simple; wings with similar venation to *Culex*."

Table of the Species of the Genus TÆNIORHYNCHUS.

Yellow and Orange Species.

A. Legs banded.

α. Ungues serrated in ♂ and ♀.

Thorax yellow, with four purple marks on each side; abdomen yellow, with metallic purple apical bands to second to fifth segments; ungues of ♀ equal and serrated; of ♂ unequal, uniserrated .... 1 *conopas*(Frauenfeld).

αα. Ungues simple in ♀.

Thorax brown with creamy-yellow scales, a brown patch on each side in front; abdomen dark with yellow basal bands........................ 2 *Annettii*, n. sp.

Thorax clear yellowish-brown in front, with narrow yellow curved scales in mid line darker behind; abdomen ochreous yellow; ♀ tarsi pale brown with broad yellow apical bands .... 3 *fulvus*(Wiedemann).
flavicosta, Walker.

Thorax golden-yellow, abdomen golden-yellow; hind tarsi dark ... 4 *aurites*, Theob.

AA. Legs unbanded.

Thorax golden-yellow, metallic in front; abdomen orange-yellow, first four segments apically purple 5 *acer* (Walker).

Thorax bright ochreous with two deep purplish patches behind; fork-cells short; abdomen purple with ochreous tarsal bands .... 6 *brevicellula*, Theob.

SOMBRELY-TINTED SPECIES.

a. Thorax ornamented.

β. Legs banded.

Thorax with median paler line covered with golden scales, and two pale-scaled lines in front and behind	7 *fasciolatus* (Arribálzaga).
Thorax chestnut-brown with small golden scales; abdomen dusky yellowish-brown, with scattered yellow scales and pale lateral spots	8 *Richardii* (Ficalbi).
Thorax dark brown, with pale golden scales on the front two-thirds, black on the remainder	9 *tenax*, Theob.
Thorax brown with golden scales, white over roots of wings and a pale line on each side of a bare space in front of scutellum; pale abdominal bands apical	10 *ager*, Theob.

aa. Thorax unadorned.

Thorax very dark, abdomen with pale apical bands	11 *Perturbans*(Walker).

1. TÆNIORHYNCHUS CONOPAS (Frauenfeld).

(Verhand. Zool. Bot. Ges. Wien. xvii, 451 [1867].)

Wings unspotted, very densely clothed with long obovate scales of an uniform yellowish-brown colour, the scales being perhaps the most characteristic of any species. Tarsi dark brown with pale basal bands. Thorax golden-yellow with four dark purple patches on either side. Abdominal segments indistinctly basally pale banded. The 2nd to 5th being metallic purple at the apices. Generally yellow throughout. Tarsal claws serrated in both sexes.

♂.—Head densely covered with curved golden-yellow scales and a very few brown upright forked ones; eyes black below, with silvery sheen above; palpi clothed with yellow scales, a few black hairs; antennæ yellowish at the base, pale brownish towards apex, faintly pale banded; proboscis dark yellow, black at the apex. Scutellum pale yellow in the middle, dark purple laterally. Pleuræ and coxæ pale yellowish with three black lines. Legs bright ferruginous with the apices of the joints darker, especially on the fore pair. Wings longer than abdomen. Venter bright yellow, with dark fringes to the hind borders of the segments. Halteres yellow with dusky knobs. *Length.*—5 mm.

Habitat.—Straits Settlements; Perak, November and December; Selangor, October; Formosa, January and June.

2. **TÆNIORHYNCHUS ANNETTII,** Theob. (Monog. II, p. 205).

Plate xiii, fig. 10, Male genitalia.

Wings unspotted, densely clothed with uniformly brownish-yellow scales, which are of typical form, except on V and VI, where they are linear. Tarsal joints not obviously banded, being too pale generally to render their darker apices conspicuous. Thorax pale yellow with a brown patch on either side in front. Abdominal segments more or less distinctly basally pale banded, rich yellow, with dark hind borders. Ungues of ♀ equal and simple; of the ♂ unequal, the larger uniserrated, the smaller simple.

Head brown, with narrow curved pale yellow scales, almost white round the eyes, and with long thin yellowish and brown upright forked scales; antennæ brown, basal joint yellowish-brown; second joint rather swollen, verticillate hairs brown, placed close to the base of the joints; palpi densely scaled, dark brown at the base and apex; proboscis spatulate, yellow at the base, black at the apex. The very base is black in both sexes, especially in the ♂, but the tints shade off into each other so that the band is ill-defined. Legs yellow, with darker tips to the joints. Halteres pale ferruginous, stems and knobs. The claspers of the male are of very singular form, each consisting of a helmet-shaped apical lobe connected with a stout base by a long thin stem. *Length.*—4·8 mm.

Habitat.—Old Calabar, West Africa.

3. **TÆNIORHYNCHUS FULVUS** (Wiedemann).

= *Culex flavicosta*, Walker.

("A. Z. I." p. 546 [1828], Wiedemann; Ins. Saund. p. 431, Walker.)

Plate xiii, fig. 9. Wing to show venation and variation of length of scales (drawn from Walker's type of *flavicosta*).

Veins of wings densely fringed with uniformly golden scales of typical form. Hind tarsi with yellow apical bands, not very noticeable on other legs owing to general light coloration. Thorax yellowish in front, darker behind, with yellow scales in front and dark behind; abdomen rather hairy, with yellowish-brown scales, the hind borders of the segments lighter. Proboscis darker at apex and base, but not obviously banded. General coloration of insect fulvous.

♀.—Head yellow, with narrow, hair-like, small yellow scales and small black and ochreous forked ones behind; palpi clothed with yellow scales, black at the apex; clypeus yellow; antennæ with basal joint and base of the second joint yellowish, rest dark brown. Femora and tibiæ darker at their apices. The scales of the anterior part of the wing are of typical form, but those on the forks of IV. and V. are almost linear. Tarsal claws small, equal and simple. Halteres ferrugmous. *Length.*—5 to 6 mm.

Habitat.—Amazon Region, Brazil.

4. TÆNIORHYNCHUS AURITES, Theob. (Monog. II, p. 209).

Wings uniformly very densely clothed with honey-yellow scales of typical form. Tarsi black, with basal golden bands to the first two joints. Thorax dusky yellow, with a darker median line clothed with very long and narrow golden scales, and with marginal bristles, the latter specially dense at origin of wings. Abdomen uniformly clothed with flat golden scales. Proboscis darker at apex and tip, but not obviously banded. The whole insect of a beautiful honey-yellow tint.

♀.—Head fawn coloured, with narrow curved orange-yellow scales, and deeper orange, long thin upright forked ones; flat orange scales at the sides of the head; palpi orange scaled, except at the tip, where there are a few brown scales; antennæ orange-yellow at the base, the basal and next five joints being yellow, brown apically, the last few joints being dark brown; proboscis orange-brown, dark at the apex, and with a few brown scales at the base. Legs yellow, the tips of the femora and tibiæ dark. Pleuræ yellow, with an indistinct white longitudinal line. Halteres yellow. *Length.*—5 mm.

Habitat.—Bonny, West Africa (May).

5. TÆNIORHYNCHUS ACER (Walker). ("List", p. 7.)

Wings uniformly very densely clothed with very long brownish-yellow scales. Tarsi uniformly dark metallic purple. Thorax golden-yellow, with traces of brown markings; abdomen orange-yellow, the first four segments apically banded with metallic purple and also traces on the other segments. In general appearance resembles a *Janthinosoma.*

♀.—Head brown, with testaceous scales, a pale border round the eyes above, with some black and yellowish bristles; eyes black; basal joint of the antennæ yellowish, remainder brown; palpi dark yellowish-brown; proboscis covered with black scales with a very dark purplish reflection. Pleuræ pale reddish, dark beneath the wings. Legs with coxæ orange-yellow; femora orange-yellow at the base, apically metallic black, rest of legs clothed with black scales showing purplish and slight golden reflections; general appearance of legs sooty.

♂.—Head with pale greyish scales, a dark line running down the middle; palpi as long as the proboscis, dark brown at the tip, paler basally, with a small pale band about one-third of the length from the base; proboscis dark brown, slightly paler towards the tip; antennæ banded brown and white, with yellowish-brown verticils. *Length.*– 5 to 5·5 mm.

Habitat.—New Zealand; Bupengary, Queensland.

Note.—Personally I should prefer to place this species and the next in *Janthinosoma*, the purple legs with their yellow thighs being most characteristic of that genus, while the wing scales seem of rather intermediate form than characteristic of *Tæniorhynchus*.

6. TÆNIORHYNCHUS BREVICELLULA, Theob.

(Monog. II, p. 212).

Plate xiii, fig. 12a, ♂ Palpi; 12b, End of ♂ antennæ; 12c, ♂ Fore tarsal claws (after B. M. Monograph).

Wings uniformly but rather scantily clothed with yellowish-brown scales. Tarsi uniformly deep metallic purple. Thorax iridescent yellow and purple, two patches at its hinder part appearing of the latter tint in all lights. Abdomen deep yellowish-bronze with narrow yellow basal bands to the segments. Proboscis deep purple unbanded. May be distinguished from preceding species by all, instead of only the first four, abdominal segments being banded, and the fork cells of ♀ being very short.

♀.—Head brown, with long ochreous upright forked scales, a pale border round the eyes, numerous small pale scales over the occiput and pale flat scales at the sides; golden-brown bristles projecting over the eyes; clypeus pale brown; palpi densely clothed with bronzy scales and hirsute; antennæ deep brown, with narrow pale bands at the verticils; proboscis deep brown. Scutellum purple in the middle and yellow laterally; pleuræ marbled with bronze and yellow with two distinct patches of whitish scales. Legs covered with deep metallic purple and bronzy scales all over, except the base and venter of the femora, which are bright ochreous. Ungues equal and simple in the ♀, while the ♂ has those of the fore legs unequal, the larger one with a large and a small basal tooth, mid claws with one tooth, hind equal and simple. *Length.*—4·8 mm.

Habitat.—Selangor, Straits Settlements; Thayetmyo, Upper Burmah (August).

7. TÆNIORHYNCHUS FASCIOLATUS, Arribálzaga.

(Rev. d. Mus. d. l. Plata, p. 50.)

Plate xiii, fig. 11a, Venation of wing; 11b, Form and arrangement of wing scales; 11c, Proboscis of ♀.

Wings with the veins clothed with uniformly black scales of typical form. Tarsi black, with white bands on the tibio-tarsal articulations, and on those between the first and second tarsal joints of the fore and hind legs. Thorax dark brown, with a broad median reddish line, forking behind and with curved lateral lines of pale scales in front. Abdomen dark steel-blue, with six lateral patches of white scales, and with golden hairs on the hind borders of the segments. Proboscis nearly black, with a broad creamy band in the middle, and the apex pale. Whole insect generally deep brown.

♀.—Head dark brown, with white curved scales dotted about and black upright forked ones, a narrow pale border round the eyes, white curved scales at the sides of the head; eyes black; antennæ deep brown, faintly pale banded, basal joint and base of the second joint testaceous; palpi with black scales at the tips of the joints, brown at their bases, the apical joint white scaled, five-jointed; proboscis dark, almost black, with a broad creamy-white band in the middle and with the apex pale. Pleuræ brown with a greyish sheen and a patch of white scales. Legs with femora and tibiæ black, speckled with a few white scales, the former white beneath. Venter yellowish, the segments darker behind. Halteres pallid throughout. *Length.*—5 mm.

Habitat.—Rio de Janeiro (1899); Navarro, in Argentina; Lower Amazon (November).

Although not of the characteristic yellow colour, this may be regarded as the type species of the genus, as it is the only one of Arribálzaga's genus included in the group as now limited.

Dr. Lutz writes concerning this species as follows: "It is a real swamp mosquito, common in the littoral; stings painfully, in preference through the stockings, principally at dusk, or in the shade during the daytime."

8. TÆNIORHYNCHUS RICHARDII (Ficalbi).

= *Culex Richardii*, Ficalbi.

("F. R." p. 261; "V. S." p. 151.)

Veins of the wings clothed with black scales with a few white ones intermixed, the short rank of inner fringe scales all black. Tarsal joints deep brown with yellowish basal bands. Thorax chestnut-brown, with small golden scales, adorned with five or six pale lateral spots. Abdomen black with five or six bright yellowish-white trapezoidal spots along the sides. Proboscis black with a very broad band occupying more than the middle third of its length.

♀.—Head brown, with narrow curved very pale creamy scales, which become almost white at the sides of the head, and with whitish eye-borders; the nape with ochreous and black upright forked scales; antennæ brown, with narrow pale rings, basal joint bright, pale ferruginous, also the base of the second joint; palpi yellowish-brown, densely covered with mixed yellow and dark brownish scales; short, with whitish tip in the ♀; longer than the proboscis by the entire last joint in the ♂; clypeus deep ferruginous yellow; proboscis dull yellow, with scattered black scales, which almost cover it at the apex. Orbits white. Pleuræ dark brown, marbled with white. Legs ochreous, with scattered ochreous, white and dark scales on the femora and tibiæ, the latter dark towards the apices; first tarsal joints with a pale band in the middle and one at the base. Halteres pale ferruginous. *Length.*—7 to 10 mm.

Habitat.—England (at Sutton); Italy; Toronto, Canada; Tel Zahmul, Syria.

In the specimen from Palestine, the pale lateral abdominal spots are very indistinct.

9. **TÆNIORHYNCHUS TENAX**, Theob. (Monog. II, p. 198).

Wing veins densely clothed with black scales intermixed with a few white ones on the costa, and on the long veins near the base, the short rank of inner fringe scales all dark. All but the last tarsal joints basally white banded. Thorax dark grounded, its anterior half clothed with curved golden scales, paler across the middle of the mesonotum, white on the hinder half; the scales are black, but for a pair of whitish lateral lines. Abdominal segments deep brown with a fringe of golden scales on their posterior borders which are broad enough on the hinder segments to be called bands. Proboscis black with a broad pale band just beyond the middle.

♀.—Head brown, with yellowish-brown scales in front and at the sides and a patch of black scales on each side of the back of the crown, eyes purple to black with a border of white scales; antennæ brown, with testaceous basal joints; palpi black, with white scales at the tip, and black hairs. Pleuræ yellow, with black bristles and a few white scales and hairs. Legs densely covered with black scales with a few yellow ones intermixed; knees yellowish; apices of tibiæ pale, combining with the first tarsal band. *Length.*—6·5 to 7 mm.

Habitat.—Straits Settlements, Perak, Freetown, Sierra Leone (bred from roadside puddle).

10. **TÆNIORHYNCHUS AGER**, Sp. n.

Entomologist, 1891, p. 196.=*C. bitæniorhynchus mihi.*, Journ. Bombay Nat. Hist. Soc. vol. xiii, p. 607.

Veins of the wings distinctly brindled with dark and light scales, the latter being almost as numerous as the former on all the long veins (a character found in no other allied species). Tarsi deep brown with ochreous bands on the articulations. Thorax unadorned, black grounded, covered with mingled black and golden scales, paler at the roots of the wings. Abdominal segments black, with distal ochreous bands. Proboscis black, with two narrow ochreous bands at the tip, and in the middle of its length.

Head covered with dull, pale, creamy-white curved scales, with scattered brown, forked, upright ones behind, which are ochreous at the tips, and flat white ones at the sides, forming a pale spot; palpi of ♂ dark brown, with the apical joint yellow, and ending in a brown spine, base of the next two joints banded with yellow, the following with a broad and narrow paler yellow band, hairs almost black; of the ♀, one-fifth the length of the proboscis, black with a minute yellow tip; antennæ banded brown and white, plumes brown; pleuræ brown with a patch of white scales; legs dark-coloured, clothed with a mixture of black and golden scales, the former preponderating except on the under sides of the femora. *Length.*—4·5 mm.; of wing, 4 mm.; of ♂ palpi, 3·3 mm.

Habitat.—Madras, Travancore, Shahjahanpur, N.W.P., India.

NOTE.—Mr. Theobald's description of this species for the Monograph was already in the press when he received the paper containing another description which I sent through him to the "Entomologist," but with characteristic courtesy, he insists on its standing as mine under the name he had adopted for it. It appeared in my Prodromus of Indian *Culicidæ* under the above synonym, but I was careful to note that the names of new species should be regarded as merely provisional, as it was quite possible that, though in correspondence, the same species might be described by Mr. Theobald and myself.

11. TÆNIORHYNCHUS PERTURBANS (Walker).

Insect. Saunders, p. 428.

Wing unspotted, with the veins densely clothed with uniformly dark scales of fairly typical form, but rather squarer than usual at the tip. The first tarsal joints have all barely perceptible basal, and a broad and distinct median yellowish ring. All the other tarsal joints appear to be distinctly basally banded with the same light tint (one or two of the terminal tarsals are wanting in type). Thorax with testaceous ground, clothed with narrow-curved yellow scales in front and laterally, and with a patch of silvery ones behind (probably more or less ornamented in the fresh state). Abdomen chocolate-brown, with narrow golden basal bands. Proboscis pale at tip and in the middle, forming a distinct but not sharply-limited band.

♀.—Head, with chestnut-brown ground, clothed with yellowish-brown, erect forked, and golden narrow-curved scales; antennæ never as long as proboscis, the first two joints very short, verticillate hairs, exceptionally numerous and long; palpi yellow-brown, less than one-fourth the length of the proboscis; pleura and coxæ marbled with golden and dark brown. Legs yellowish-brown, all the femora with a sub-apical spot on their outer sides, especially prominent in the fore legs; hind tibiæ, paler at base, dark at apex, with a distinct white ring in the middle. Wing with "2" || "3," but angulated; "4" placed twice the length of "3" internal to them. Halteres with white stem and golden knobs. *Length.*—About 6 mm.

Habitat.—Honduras.

Genus XI. TRICHOPROSOPON (Monog. II, p. 284).

This genus has been instituted by Mr. Theobald for the reception of a single species. *Tr. nivipes sp. et gen. nov.*, which presents the peculiarity of having the metanotum provided not only with a tuft of bristles but also with patches of scales; in addition to which each antennal joint carries two whorls of hairs, a long set near the base and a shorter, close to the apex. The form and arrangement of the wing scales much resembles *Tæniorhynchus*, but in other respects the species resembles more a *Janthinosoma*, while the proportionally long female palpi recall those of *Psorophora* and *Mucidus*.

Mr. Theobald defines the genus as follows:—

"Head clothed with flat scales and having a ring of upright forked scales across the back; antennæ fourteen-jointed in ♀, the joints with two distinct rows of verticillate hairs, one long and the other short, basal joint of the antennæ bristly. Palpi in the ♀ three-jointed, densely scaled; in the ♂ four-jointed. the joints nearly equal, tapering, apex spinose; clypeus densely bearded with short bristles and long ones in front; proboscis long, scaly, and pubescent at the rather expanded apex. Thorax covered with rather flat spindle-shaped scales; prothoracic lobes distinct, with flat scales; scutellum with dense flat spindle-shaped scales; *metanotum with a tuft of chetæ* and *with flat scales on part of its surface*. Abdomen covered with flat scales, and in the ♀ with the apex very bristly; in the ♂ the basal lobes of the genitalia densely scaled. Tarsal claws of the ♀, small, equal and simple, in the ♂, those of the fore and mid legs unequal and simple, in the hind very small, equal and simple. Wings densely scaled along the veins, with rather broad flat scales, somewhat like those of *Tæniorhynchus*, but shorter; fork-cells rather long, 'II.' extending nearly to the base of the wing, the anal cell very large, and the cross-veins arranged 'alternately.'"

1. TRICHOPROSOPON NIVIPES, Theobald. (Monog. II, p. 285).

Tarsi and legs nearly black, with the last two joints of the hind, and last four of the mid legs all white. Thorax dark brown behind, yellow in front and at the sides. Pleuræ with a silvery spot. Abdominal segments deep metallic purple, unbanded, but with triangular, whitish apical spots. Metanotum brown, with two sub-median rows of small, flat blue scales, and a pair of tufts of bristles at the apex.

Head clothed with brilliant metallic scales, showing golden in most lights. Palpi bronzy, and unadorned in both sexes; those of ♀, about half the length of the proboscis; those of ♂, resembling those of *Janthinosoma*; venter yellowish. *Length.*—7 to 8 mm.

Habitat.—Trinidad; in a cocoa grove near a forest.

Genus XII. **STEGOMYIA**, Theob. (Monog. I, p. 283.)

This is one of the most natural of the new groups of *Culicidæ*, the members of the genus presenting an appearance that once seen is easily recognised, owing to the predominance of regularly arranged flat, imbricated scales on their costume. They have a smooth satin-like appearance, which is most characteristic, and even the wings have a smoother and more velvety look than the true *Culices*. With hardly an exception they present no other coloration than jetty-black, contrasted with the purest white, the latter being disposed in bands and stripes on the legs and in adornments of the thorax, which are often most elaborate. The black, however, always greatly preponderates, and one or two are almost entirely black. The *Stegomyiæ* are essentially tropical and sub-tropical insects and are hardly found north of 40° latitude. One of them, *S. fasciata* (Fabr.), is the most widely-distributed Mosquito with which we are acquainted, its colonies being found all round the world. The reason of this is that the individuals of this species are good sailors, being able, as I know from personal observation, to make a voyage from Kurachi to Suez, now that steam has made communication so much more rapid alike for Mosquitoes and men. All the Indian species I have met with alive are purely wet weather insects, which disappear entirely as soon as the S.W. monsoon is over, in Northern India, though they linger longer in the damper South. Mr. Theobald's definition of the genus is as follows:—

Stegomyia.—" Palpi short in the ♀, long in the ♂, four-jointed in ♀, and five-jointed in the ♂. Head clothed completely with an armour of broad flat scales; mesothorax covered with either narrow-curved or spindle-shaped scales; scutellum *always* with broad flat scales to the middle lobe, and usually with them present on the lateral lobes; abdomen completely covered with flat scales, banded or unbanded, but always with white lateral spots. The ♀ palpi are small, never more than one-third of the length of the proboscis; those of the ♂ are as long, or longer than the proboscis. Wings with similar venation to that of typical *Culex*, but the fork-cells short."

Table of Species of the Genus Stegomyia.

A. The proboscis with a pale band in both sexes.

1. *S. notoscripta*, Skuse. Thorax elaborately adorned with fine white lines, femora with longitudinal white lines.
2. *S. periskelata*, *sp. n.* Thorax unadorned, all the femora with a broad white garter a little above the apex.

B. The proboscis with a pale band in one sex.

3. *S. pipersalata*, *sp. n.* Proboscis banded in the ♂ but not in the ♀. Wings and body brindled throughout, with intermixed black and white scales.

C. The proboscis unbanded.

a. Last hind tarsal joints all white.

α. With some of the other tarsal joints basally light banded.

4. *S. fasciata* (Fabr.). Thorax dark, with prominent white, lyre-shaped adornment.
5. *S. scutellaris*, Walker. Thorax black, with a broad medium white line in front, but without lateral curved lines.
6. *S. sugens* (Wied.). Thorax red-brown, with 2 pairs of silvery lateral spots.
7. *S. nigeria*, Theobald. Thorax nearly black, with 2 short rows of white scales across the front, and a pair of lateral white spots, just visible from above.

β. With some of the other tarsal joints apically light banded.

8. *S. Marshallii*, Theobald. Thorax dark grounded, with chestnut scales, and 2 distinct, and 1 indistinct pair of lateral white spots.

b. With some of the tarsal joints basally banded, but the last joint of hind legs not entirely white.

i. The abdominal segments with pale basal bands and lateral spots.

9. *S. Africana*, Theobald. Thorax dark, with white adornment.
10. *S. sexlineata*, Theobald. Thorax nearly black, with 6 fine, longitudinal white lines, femora spotted, but not striped.

ii. The abdominal segments with basal bands expanding at the sides to form lateral lines.

11. *S. Grantii*, Theobald. Thorax chestnut, with elaborate adornment of fine white lines. Upper leg joints with 3 white longitudinal stripes.

vi. The abdominal segments unbanded, but with lateral white spots.

12. *S. terrens*, Walker. Thorax mouse coloured, with some traces of white adornment.

d. With some of the tarsi pale banded, *on the articulations*, *i.e.*, two joints participating in the band.

i. The abdominal segments, with white basal bands and lateral spots.

13. *S. signifer* (Coquillett)? Evidently much resembles *S. fasciata*. Position uncertain.

iii. Some of the abdominal segments with basal white bands, but without lateral spots.

14. *S. pseudotæniata*, *sp. n.* Thorax black, adorned with fine white lines, much as in *S. notoscripta*.

v. With some of the abdominal segments banded white, alike at base and apex.

15. *S. tarsalis*, Coquillett. Thorax black, with linear white adornment, all abdominal segment with basal white bands, the last 3 white also on the apices.

vi. Abdominal segments unbanded, but some adorned with lateral white spots.

16. *S. gubernatoris*, *sp. n.* Thorax sooty, with a large anterior median and four smaller snowy lateral marks at the corners of the mesonotum.

e. With the tarsi unbanded.

iii. Some of the abdominal segments with basal light bands, but without lateral spots.

17. *S. microptera*, *sp. n.* Thorax unadorned, black grounded with bronzy scales.

iv. Some of the abdominal segments with apical light bands.

18. *S. crassipes* (Van der Wulp). Mesonotum unadorned, bronzy, but with white scales on the scutellum.

19. *S. irritans*. Thorax dark, unadorned; antennæ of ♂ very short.

vi. Abdominal segments unbanded, but some adorned with lateral white spots only.

20. *S. argenteo-punctata*, Theobald. Thorax dark amber-brown, with 6 white spots. Scutellum with 3 white patches.

21. *S. minuta*, Theobald. Thorax black, with irregular white submedian lines and a pair of white spots. Scutellum with a line of white scales.

22. *S. nigricephala*, Theob. Thorax nearly black, quite unadorned on the dorsum, but with two white pleural patches. Head entirely black.

viii. Abdominal segments unadorned.

23. *S. brevipalpis, sp. n.* Thorax unadorned, dark. Palpi of ♂ much shorter than the proboscis, venter pale, unbanded.

1. STEGOMYIA NOTOSCRIPTA, Skuse ("S. A. C." p. 1738).

Plate xiv, fig. 1, To show decoration of thorax and head.

Wing veins uniformly black scaled. Tarsal joints black with four broad basal bands on the hind and two on each of the fore and mid, sometimes a trace of a third on the latter. Thorax black, elaborately adorned with fine snowy lines (*vide* figure). Abdominal segments black with very narrow snowy basal bands and triangular lateral patches and a ferruginous hinder fringe. Proboscis with a broad silvery band a little beyond the middle.

Head black, with the orbits and a triangular occipital patch snowy. Palpi of ♂ black with broad snowy basal bands to the last two segments somewhat ochreous at base; of ♀, black with the apex snowy. Scutellum mouse-coloured with a single basal row of white scales and a few more on the middle lobe; pleuræ and coxæ elaborately marbled with brown lines and snowy patches. Legs intensely black, the femora and tibia ornamented with a brilliant longitudinal silvery line. Anterior tarsal claws of the ♀, unequal and toothed, the others simple, but all unequal; of the ♂ toothed in all three pairs of legs, those of fore and mid legs markedly unequal, those of the hind symmetrical. *Length.*—4·5 mm.

Habitat.—New South Wales, September to January; Adelaide, October; Queensland, January. Appears a widely distributed Australian gnat. Skuse says that the ova are deposited in boat-shaped masses of 300 or more and that the larvæ swarm on water-butts, so that clearly all *Stegomyiæ* do not deposit their eggs separately.

2. STEGOMYIA PERISKELATA, Sp. n.

Plate xiv, fig. 22, Cephalic appendages of ♂.

Wings densely black scaled. Tarsal joints with minute basal yellowish bands to all the joints, the bands being specially narrow on the hind pair. Thorax black grounded with narrow curved golden scales and numerous long black bristles. Abdomen dark brown, sooty behind, with barely perceptible pale basal bands and brilliant triangular snowy lateral spots. Proboscis black, with a broad snowy band.

♂.—Head white with two broad black lateral bands of black, imbricated scales cutting off a large median triangular patch on the nape. Proboscis spatulate black with a broad snowy band beyond the middle. Palpi equalling the proboscis in length, basal joint minute, the next two very long and sub-equal, the last two also sub-equal, but very short; entirely black except the last joint, which is snowy. Antennæ quite as long as the proboscis, the hairs of its verticils exceptionally long and dense. The knee spots are barely perceptible, but each femur shows a distinct broad white garter (περισκελις) about a quarter from its tip. Pleuræ with snowy spots; halteres entirely pale. Scutellum with pale brown scales; venter dark grey, with white basal spots. *Length.*—4 mm.

Habitat.—Shahjahanpur, N.W.P. in October.

3. STEGOMYIA PIPERSALATA, Sp. n.

Plate xvi, fig. 1a, Venation of ♂ wing; 1b, The same, more amplified to show distribution of dark and light scales.

Wings densely clothed with, for the most part, black scales, but on the costa and along the bases of the long veins, are scattered snowy scales. Tarsal joints moderately broadly basally banded with snowy white, on all of the hind, the upper three of the mid, and the upper two of the joints of the fore leg. Thorax, black-grounded, clothed with narrow curved, mouse-coloured scales, with some whitish ones laterally which form indistinct curved markings. Abdomen sooty, with snowy lateral spots on the bases of the segments, which in the ♀, especially on the anterior segments, may be connected to form narrow bands. Proboscis banded in the ♂, but not distinctly so in the ♀.

Head, with black forked scales, and mouse-coloured long narrow ones. Antennæ fuscous, those of the ♂ about equalling the proboscis in length. Palpi of ♀ black, with whitish tips; of the male, very little longer than the proboscis, first joint minute, second and third sub-equal, and together near as long as the proboscis, with an indistinct band on the articulation between them, placed a good deal inside the band on the proboscis; last two joints short and sub-equal, a band between them and the third, and all the end joint, whitish. Proboscis black at the base, testaceous at the tip, with a broad band of white, well beyond the middle, in the ♂, but barely perceptible in the ♀. Legs with a patch of white scales just above the tips of the femora, in the ♂, but not in the ♀. The wings, legs and all other appendages are most curiously brindled with a mixture of snowy and black scales, the latter greatly preponderating, so that the insect looks peppered and salted. No other mosquito at all likely to be mistaken for this species, has this mixture of white with black scales on the wings. *Length.*— About 3 mm.

Habitat.—Jhansi, Gonda, N.W. Provinces, India.

4. STEGOMYIA FASCIATA (Fabr.).

Plate xiv, fig. 2. Venation of wing; fig. 3, To show body adornment.

= *C. tæniatus*, Wied; = *C. calopus*, Meig., Macquart; = *C. frater*, Desv.; = *C. mosquito*, Desv. Ficalbi; = *C. exagitans*, Walker; = *C. inexorabilis*, Walker; =*C. formosus*, Walker; =*C. zonatipes*, Walker; =*C. excitans*, Walker; =*C. viridifrons*, Walker; =*C. impatibilis*, Walker; =*C. Bancroftii*, Skuse; =*C. mosquito*, Arribálzaga; =*C. elegans*, Ficalbi; =*C. Rossii*, Giles.

(Syst. Antl. 36, 13 (1805), Fabr.; Aussereurop. Zweiflüg. Insec. p. 8 (1828), (=*fasciatus*), Wiedemann; Aussereurop. Zweiflüg. Insec. p. 10 (1828), Wiedemann (=*tæniatus*); Bull. Soc. Ent. Ital. p. 251 (1896), Ficalbi (=*C. elegans*); Jour. Trop. Med. p. 64 (1899), Giles (=*C. Rossii*); Dipt. Argent. Revista d. Museo d. l. Plata, p. 60, fig. 2, pl. iii, Arribálzaga (=*C. mosquito*); Proc. Linn. Soc. N. S. Wales, iii, p. 1740, Skuse (=*C. Bancroftii*) (1886); Ins. Saundersiana, p. 430, Walker (=*exagitans*); Dipt. Insects Brit. Mus. pt. 1, p. 4 (1848) (=*inexorabilis*); (*ibid.*) p. 4 (=*formosus*); Proc. Linn. Soc. Lond. v, p. 229, Walker (=*zonatipes*); Brit. Mus. List, i, p. 4 (1848), Walker (=*excitans*); B. M. List, p. 3, Wlk. (=*viridifrons*); Syst. Beschr. Zwei. i, p. 3 (1818), Meigen (=*calopus*); Dipt. Exotica, i, Macq. (=*calopus*) (1838); Bull. Soc. Ent. Ital. p. 251 (1896), Ficalbi (=*calopus*); Journ. Proc. Linn. Soc. iv, p. 91 (1860), Wlk. (=*impatibilis*).)

Wings densely clothed with very long black scales of three grades of length. Last hind tarsal joints and all but apex of next snowy; all the other joints of the hind, the upper three of the mid and the upper two of the fore legs of the otherwise black tarsi basally white banded, very broadly so on the hind. Thorax from a velvety-black with reddish reflections, to a golden-brown in some specimens, elaborately marked with rather broad silvery lines arranged somewhat in the form of a lyre (*vide* fig. 3, Pl. xiv). First abdominal segment creamy-white, the others black with narrow basal bands and brilliant lateral tufts of snowy-white. Proboscis unbanded black.

Head black with narrow white orbits and two faint patches of white on the occiput, divided by delicate median and lateral black lines; palpi black with white tips in the ♀, or in the ♂, with four white basal bands. Pleuræ dark brown with several white patches; scutellum with a thick row of white scales and three strong tufts of bristles; halteres yellowish with darker knobs. Tarsal claws of ♂ unequal on the fore and mid legs, with an accessory tooth on the larger claw of the fore pair only; in the ♀ symmetrical, with accessory teeth in both claws of the fore and mid feet and the hind claws simple. *Length* varies greatly, but is never more than of moderate size, and is often very small. In some very dwarf specimens sent me from Calcutta by Major Alcock, the length of the wing was but 2 mm.

Habitat.—This is the most widely distributed gnat of the entire family, being found throughout the entire tropical and sub-tropical zones, but does not appear to occur north of Italy. In the N.W.P. of India it is purely a rainy weather species, but it appears to be in evidence all the year round in such climates as Bombay, and I also found it in Egypt as early as February.

NOTE.—The original descriptions are not only inadequate but misleading, and owing to this it has been re-described as a distinct species by almost every naturalist who has devoted special attention to the family. Added to this it varies greatly, not only in size but in coloration, but it can always be recognised by the peculiar lyre-shaped decoration of the thorax, drawn in thicker lines than in any similarly decorated species, and by the broad banding of the hind feet. Mr. Theobald describes two varieties in addition to the typical species, viz., *var. Luciensis*, characterised by the last hind tarsal having a black tip—a peculiarity I have seen on occasional Indian specimens, as well as in those from St. Lucia, while from Antigua I have found both mixed in a single consignment of specimens. *C. mosquito*, Desv., *nec* Arribál., is said to have only the lateral curved marks present on the thorax and *var. S. Queenslandiensis* has the mid lobe of the scutellum purple scaled, and the apices as well as the bases of the abdominal segment white. Specimens hatched out, however, from the same tank vary so much *inter se*, that I doubt the advantage of giving special varietal names to individuals exhibiting some one or other peculiarity.

5. STEGOMYIA SCUTELLARIS (Walker.)

= *C. albopictus*, Skuse = *C. variegatus* (Dol.)

Plate xiv, fig. 4, Venation of wing; fig. 5, Head and thorax of ♂.

(Journ. Proc. Linn. Soc. Lond. iii, p. 77 (1859), Wlk.; Indian Museum Notes, iii, 5, p. 20, Skuse (= *C. albopictus*); Natuurkundig, Tijdschr. v. Ned. Ind. xvii, p. 77, Doleschall.)

Veins of wings uniformly, and densely black-scaled. Hind tarsal joints exactly as in *S. fasciata;* fore and mid tarsi with narrow basal bands to the two first joints only. Thorax nearly black with a conspicuous broad median snowy line (which is continued over the head). Abdominal segments sooty, with very narrow, basal snowy bands, broadening externally, especially on fourth and fifth segments, where they form distinct lateral patches. Proboscis, unbanded black.

♀.—Head with two patches of dark scales on each side, separating broad median and lateral patches of silvery scales, which form a bright spot in front, and with silvery orbits; antennæ dark brown, faintly paler banded at the joints, with a tuft of silvery scales on the basal joints, forming two distinct spots; palpi black with a silvery white apical joint; proboscis black. Palpi of ♂ slightly longer than the proboscis, black, with four snowy bands, the two outer of which are incomplete. Scutellum bordered with white scales; pleuræ with numerous snowy patches. Halteres with pale stems and fuscous knobs. Legs intensely black, with white knee-spots as well as the above-mentioned tarsal adornment. Tarsal claws of ♀ untoothed; of ♂ very unsymmetrical, the large outer claws alone with extra tooth on fore and mid legs, simple and equal on hind. *Length.*—About 4·5 mm., varies a good deal in size.

Habitat.—Is one of the commonest Indian S.W. monsoon gnats, commoner than any other *Stegomyia* in the N.W.P. Has also been taken in Amboina, Siam and China.

6. STEGOMYIA SUGENS (Wied.)

= *C. vittatus*, Bigot.

Auss. Zweiflüg. Insec. p. 545 (1828), Wied.; Ann. Soc. Ent. d. Fr. S. 4, t. 1 (1861), Bigot (= *vittatus*); Bull. Soc. Ent. Ital. p. 257 (1886), Ficalbi (= *vittatus*).

Veins of wings with long narrow brown scales. Hind tarsi with the last joint pure white and three white basal rings; fore and mid tarsi each with three basal white bands. Thorax with red-brown scales and two white spots on each side of the mesonotum. Abdominal segments black with white basal bands and lateral spots and a median spot on the last. Proboscis black, unbanded, but with sometimes a few white scales in the middle.

Head black, with orbits, and median and lateral occipital patches white; some of the hinder forked scales are white. Antennæ banded, with a patch of white scales on scaphus; clypeus nearly black with two white spots, palpi black with, in the ♀, the last joint white; those of ♂ black, much longer than the proboscis, with four equidistant white bands, but black at the tip. Thorax of ♂ with four grey longitudinal lines in addition to the four white spots; scutellum with four silvery spots; pleuræ dark with only a few white dots. Legs black with the bases of the hind femora pallid, with white knees and subapical garters on the femora as well as on all the tibiæ at the junction of the upper and middle thirds. Venter black with basal white bands. Halteres pale with dark knobs. Tarsal claws of ♀ equal, those of fore and mid legs with an extra tooth to both claws. Those of hind simple; of the ♂ markedly unequal, both claws with an extra tooth on the fore and mid pairs, small and simple on the hind legs. *Length.*—4·3 mm.

Habitat.—Freetown, Sierra Leone, September, October. Mashonaland, Corsica, Nubia.

7. STEGOMYIA NIGERIA, Theobald (Monog. I, p. 303).

Wing veins with long, brown scales, reddish at the base. Last hind tarsal joints white and all but the apex of the next, and with basal white bands on the other three; fore and mid tarsi all black, but for a couple of basal spots (not bands) on the mid legs. Thorax with a thick covering of nearly black scales, with two narrow rows of white scales across it in front and a patch of the same on either side, rarely visible from above. Abdomen with intensely purple-black scales with brilliant white lateral spots and a narrow row of brownish scales across their hinder borders; on flexion narrow basal white bands become visible. Proboscis uniformly black.

♀.—Head black, with a narrow patch of white scales in the middle; palpi black, with white scales at the tip, and a few long bristles; proboscis black, antennæ dark brown; basal joint black, with a tuft of white scales, forming two white spots just below the eyes, and on each side of a small tuft of white down projecting between the eyes, which are black and reddish, with a very narrow border of white scales. Scutellum dark, with a few white scales; pleuræ with silvery dots. Legs dark brown. Wings with "4" far internal to "3" and I. much curved. *Length.*—4·5 mm.

Habitat.—Bonny, West Africa; November (described from a single ♀).

8. STEGOMYIA MARSHALLII, Theobald (Monog. I, p. 310).

Veins of wings with brown scales, a patch of white at base of costa in ♂ only. Last hind tarsal joints pure white, the other joints with snowy apical bands; mid and fore tarsi with an apical white band on the first joint only. Thorax dark grounded, clothed with narrow curved, chestnut scales, with four distinct white spots in front and two, less conspicuous, behind. Abdominal segments dark brown, ochreous behind with lateral silvery spots in the ♀, or with white basal bands to third, fourth and eighth segments and broad lateral spots on fifth, sixth and seventh. Proboscis unbanded. Differs from *S. vittatus* in the tarsal bands being apical.

♀.—Head black, covered with bronzy-black scales in the middle, two silvery-white patches in front on each side divided by a dull purplish and dusky ochreous mass of flat scales: behind are some grey curved scales and numerous upright black forked ones; palpi short, covered with deep brown scales.

♂.—Palpi brown, with three pale rings, the two apical ones on the bases of the two last joints, the last two joints are short, about equal, and together not much more than half the length of the third joint. Pleuræ marbled with white, ferruginous, and brown scales; scutellum brown with flat silvery scales. Legs dark brown with minute white knee-spots, and subapical white dots on the fore and mid femora. Tibiæ, all with an apical snowy spot in front. All tarsal claws of ♂ with an accessory tooth very unequal on fore and mid feet; of ♀ equal with an accessory tooth to the thick, blunt fore claws only. Halteres yellowish with darker knobs. *Length.*—3·5 to 4 mm.

Habitat.—Salisbury (4,000 feet), Mashonaland.

9. **STEGOMYIA AFRICANA,** Theobald (Monog. I, p. 304).

Veins of the wings with brown scales. Tarsi black with narrow basal white bands on the two upper joints of all the legs; the hind legs only, with the third joint all white except just at the apex, the next with a narrow basal band and the last all black. Thorax (much denuded) with oblique lateral white bars, a spot at the root of the wings and traces of a median white spot in the ♂. Abdominal segments black with fairly broad basal white bands; and brilliant lateral snowy tufts (barely visible from above). Proboscis nearly black, unbanded.

Head black, with a pale spot of scales on the crown, and with long dark bristles; eyes golden-green (in the sun); antennæ pale brown; basal joints large; proboscis deep brown, unbanded; palpi of ♀, dark brown, last joint with large pure white scales, of the ♂, black, its joints with four basal white bands, the two proximal ones much broader than the two apical, scutellum dark with a few white scales; pleuræ ferruginous with several white patches. Legs black. Halteres white with black knobs. Tarsal claws of ♂ simple, but very unequal in the fore and mid legs; of the ♀ subequal with an accessory tooth to each of the fore claws. *Length.*—4·5 mm.

Habitat.—Africa, Sierra Leone, Lagos, Old Calabar, Mashonaland.

10. **STEGOMYIA SEXLINEATA,** Theobald (Monog. I, p. 308).

Veins of wings with long, but rather broad, brown scales. Tarsal joints black, with broad white basal bands to the 3 upper, of the hind, and narrower ones on the 2 upper, of the fore and mid legs. Thorax nearly black, with a pair of complete fine submedian white lines, and two other shorter lateral pairs in front, but wanting on the posterior 3rd of the mesonotum. Abdominal segments steely-black, with narrow pale basal bands on all but the first two; and silvery lateral spots to all, those of the 5th, 6th and 7th extending on to the dorsum; proboscis unbanded, nearly black.

Head black, with a median and two lateral pairs of white patches, clypeus black. Antennæ with white scales on the basal joint; palpi black with white patches at the bases of the last two joints. The thorax, in addition to its six fine lines, has a white spot in front of the roots of the wings; scutellum nearly black, a little lighter on the middle lobe; pleuræ black with snowy patches. Legs black except just at the bases of the femora, a white knee-spot, and a speck on the outer side of the femora. Tarsal claws equal and simple. Halteres yellow with dark knobs. Venter black. *Length.*—4 mm.

Habitat.—Trinidad at Aqua Santa, December.

11. **STEGOMYIA GRANTII,** Theobald (Monog. I, p. 306).

Veins of wings with long, narrow brown scales. Hind tarsi with three, and the fore and middle with one distinct basal band, the other joints merely slightly paler. Thorax chestnut-brown, with a narrow median line of white scales forked in front of the scutellum, then a fine curved lateral pair, and another pure white line below on each side. Abdominal segments purple-black with narrow white basal bands and yellow fringes behind, the basal bands each sloping back to join that behind it, and so form lateral white lines. Proboscis unbanded. Upper leg joints, including first tarsal, with three longitudinal stripes of white scales.

♂.—Head black, with two median lines of white scales meeting in a point in front, expanding backwards; orbits white scaled, and a line of pure white scales between the eyes; antennæ brown, with pale bands; basal joint black, with a border of pure white scales; palpi black, with the tip white, scutellum and pleuræ chestnut, the former with a white border, and the latter with a few patches of white scales. Legs black with three linear white stripes on each of the long joints. Venter pale; fore and mid tarsal claws small and simple. Looks much like *C. spathipalpis*, Rond, but the wing is unspotted and has "4" only a little inside "3." *Length.*—5 mm.

Habitat.—Sokotra.

12. **STEGOMYIA TERRENS,** Walker (Ins. Saund. p. 429).

Veins of wings with long black scales. Tarsi dark brown with three broad basal bands to the upper joints of the fore and mid legs; hind tarsi with three bands, the middle one very wide, formed by a broad basal band on the second, combined with the white apex of the first, the last two black. Thorax with mouse-coloured and white narrow curved scales which look as if they had once formed a definite ornamentation. Abdominal segments clothed with purple-black and scattered golden scales with brilliant lateral spots, specially large and distinct on the anterior segments. Proboscis black, unbanded.

♂.—Head brown; eyes bordered with white scales; proboscis, palpi, and antennæ deep chestnut-brown; plumes deep silky-brown; palpi brown with no trace of banding. Pleuræ brown, with snowy spots. Legs dark, the femora with white garters, specially broad and distinct on the hind legs. *Length.*—6 mm. (described from Walker's type, which is in none too good condition).

Habitat.—"South America."

13. **STEGOMYIA** (?) **SIGNIFER** (Coquillett).

(Canadian Ent. xxviii, p. 43.)

Habitat.—Columbia (British North America).

Time of capture.—June.

"Evidently very similar to *C. fasciatus*, Fabr., but differs in having untoothed ungues in the ♀, and, according to Coquillett, by the silvery lateral stripes not being so curved, and it has the pale tarsal bands on the articulations, each involving two joints."

14. **STEGOMYIA PSEUDOTÆNIATA** (Giles).

Jour. Bombay Nat. Hist. Soc. xiii, p. 607.

Plate xiv, fig. 8, Venation of wing; 9, Decoration of body; 10, Larva ♀ 7.

Veins of wings densely clothed with long and rather wide scales, the costa having a long white basal patch. Tarsi black, banded white on the upper articulations, one ring on the fore, two on the mid and three on the hind foot, the bases of the first joints being also white, but not involving the tibiæ. Thorax black, elaborately decorated with fine white lines (as in figure). Abdomen black, with narrow basal snowy bands, barely visible on the hinder segments. Proboscis black, unbanded.

Head black, with two fine lines in the middle and two broader pairs at the sides, as well as narrow white orbits, but the clypeus is black. Palpi of ♀ black, with the apex and a single indistinct band white; those of ♂, almost exactly as in *S. Marshallii.* A small white patch at the roots of the wings; scutellum with a small median patch of white scales on its anterior border; pleuræ black with short stripes of white scales. Halteres yellowish, with dark knobs. Legs black with longitudinal white lines on the femora. *Length.*—4·8 mm. ♀; 3·1 mm. ♂.

Habitat.—The lower Himalayas, Naini Tal and Bakloh, 7,000 ft. The larvæ are 8 mm., very dark tinted, so that the eyes can hardly be made out. I found them in a small collection of clean rain water, with some green *confervæ* in the cemented gutter round a house. The respiratory syphon is very short.

15. **STEGOMYIA** (?) **TARSALIS** (Coquillett).

(Canadian Ent. xxviii, p. 44.)

Wings unspotted; tarsi dark, with broad white bands on the articulations. Thorax black, with a dorsal spot and lateral undulating white lines. Abdomen black, with basal white bands.

Original description :—

"*Habitat.*—Argus Mountains (California).

"Thorax black, marked with a dorsal grey vitta, its tomentum yellowish, except a white sub-dorsal undulating line on either side, a spot in front of the scutellum above the root of each wing, and on the pleura. Abdomen black, a fascia of white tomentum at the base of each segment, and at the apices of the last three. Both ends of tarsal joints broadly white; fore and mid claws bearing a tooth, hind simple in the ♂, in the ♀ unserrated. *Length.*—4·50 mm.

"Clearly a distinct species, probably coming in the genus *Stegomyia* (F. V. T.)."

16. **STEGOMYIA GUBERNATORIS**, Sp. n.

Jour. Bombay Nat. Hist. Soc. xiii, p. 607.

Plate xiv, fig. 6, Venation of wing; 7, Decoration of head and thorax.

Wings unspotted; tarsi each with two bands, one at the base of the first, the second over articulation between first and second joints; thorax sooty, with a large round anterior median and four lateral spots at the corners of the mesonotum; abdominal segments black with large snowy lateral spots, and a minute terminal median spot on the last; venter sooty.

♀.—Head sooty black, the nape with a minute median line, and a pair of small lateral spots of snowy-white behind the eyes; antennæ, proboscis and palpi entirely black. Scutellum black; pleuræ and coxæ speckled white. Halteres with white stem and black knobs, their roots protected by membranous sequlæ. Legs all black except the white bases of the hind femora, and smaller patches on the under sides of the other thighs, together with large white knee-spots; the apices of the tibiæ are involved in first tarsal bands, and there is a trace of a third band in the fore feet. *Length.*—(Of wing) 3·1 mm.

Habitat.—Allahabad, Government House Garden, July. The single type specimen of this very distinct species was unfortunately damaged after description. It is probably not uncommon, but the collection of further specimens and of its larvæ is a desideratum.

17. **STEGOMYIA MICROPTERA**, Sp. n.

(Journ. Bombay Nat. Hist. Soc. xiii, p. 609 = *Culex micropterus.*)

Plate xiv, fig. 24, Venation of ♀ wing; fig. 25, Head and thorax; fig. 26, Appendages of ♂ head (to show relative length).

Wings densely clothed with uniformly black scales, tarsi unbanded; thorax dorsally unadorned, but with white spots on the pleuræ. Abdominal segments black, with white basal bands expanding into lateral spots, and a distal fringe of yellowish hairs. Wings proportionally very small.

Head black, with a pair of snowy spots on the nape, especially distinct in the male. Antennæ black, the plumes of the male having a very marked silvery reflection in certain lights. Palpi black, longer than the proboscis by rather more than the length of the terminal joint, very minute in the ♀. Proboscis black, with a distinct but minute white or yellowish tip.

Thorax with a black ground, covered with a bronzy tomentum and a number of strong bristles, which become especially marked along the posterior border of the scutellum, which is armed with a median and lateral tufts of strong bristles nearly as long as the first two abdominal segments. There are some snowy spots on the pleuræ, and a tendency to longitudinal ornamentation of the dorsum, but not sufficiently contrasted to catch the eye. Wings markedly shorter than the abdomen. Halteres light yellow with darker knobs. Legs short and stout, almost uniformly black save for the femora below, a minute knee-spot, and a tiny band at junction of tibia with first tarsal joint, yellowish-brown. Hind tibia about the same length as the first tarsal joint. Abdominal segments black, with very narrow basal snowy bands (which often disappear on drying), expanding laterally into distinct spots; and with a fringe of yellowish hairs along the distal borders of the segments; venter black, with broad basal snowy bands to the segments. Male claspers black, proportionally large. *Length*—of wings in ♂ 2·2 mm., of abdomen, 2·5 mm.

Habitat.—Allahabad, Jhansi, and Lucknow in houses during the rains.

Observation.—A small, heavily-built mosquito, nearly black throughout, the abdominal banding often disappearing by shrinkage in drying, with short thick legs and exceptionally small wings."

NOTE.—I originally thought this species came under Mr. Theobald's *Wyeomia*, as to the characters of which I had then but a brief note. Further specimens which have dried with the metanotum better exposed, show that the bristles I supposed to belong to it are really some small ones on the scutellum below the three great tufts of bristles figured.

18. **STEGOMYIA CRASSIPES** (Van der Wulp).

(Dipt. der Midden Sumatra, p. 9.)

Wings with yellowish scales, specially long on I, II and IV; fork of II external to that of IV. Tarsi unbanded, nearly black. Thorax bronzy brown, the mesonotum quite unadorned, though a little whitish at roots of wings. Abdominal segments black, with conspicuous yellow apical bands, which are prolonged backwards in the middle, so as to form an interrupted median line; the middle ones have also triangular side spots. Venter pure white. Proboscis dark, unbanded.

Head black with creamy orbits and median stripe, clypeus black with scattered white scales. Palpi entirely black. Scutellum white-scaled;

pleuræ brown, brindled with white scales. Legs nearly black, except the under sides of the femora. Halteres yellowish. *Length.*—4 to 4·8 mm.

Habitat.—Upper Burmah, Sumatra.

19. **STEGOMYIA IRRITANS,** Theobald.

(Report Liverpool School Tropical Medicine, 1901).

Plate xiv, fig. 21, Head and appendages of ♂.

Wings clothed with uniformly black scales. Tarsi unbanded. Thorax unadorned black. Abdomen black, with minute basal white bands on some of the anterior segments.

Closely resembles *S. brevipalpis mihi*, but the ♂ palpi are at least as long as the proboscis, and his antennæ are proportionally very short, instead of being well nigh as long as the palpi, or proboscis.

♀.—Head covered with flat creamy-grey and black scales, the black ones forming a more or less triangular patch on each side, and a small area in the middle, a few scattered black upright fork scales over the occiput, around the eyes a narrow line of curved golden scales; clypeus black, apparently nude; palpi testaceous, with dark scales; antennæ dark brown, with narrow pale bands, basal joint half testaceous, the inner half darker, base of the second joint testaceous, basal joint with a few small scales on the inner side and minute curved hairs; proboscis deep brown; eyes black and golden. Pleuræ brown, with large creamy patches. Legs nearly black, grey on the coxæ and under-sides of the femora; tarsal claws symmetrical; the fore and mid feet each with an extra tooth, the hind simple. Halteres yellow, with white scales on the knobs. Venter whitish, with narrow black hinder border to the segments. *Length.*—4 mm.

Habitat.—Bonny, West Africa.

20. **STEGOMYIA ARGENTIOPUNCTATA,** Theobald.

(Monog. I, p. 316).

Veins of wings with brown scales. Tarsi unbanded, nearly black. Thorax black-grounded, clothed with very long and narrow, umber-brown scales, decorated with six patches of flat white scales, four in front and two more at the sides behind. Abdominal segments nearly black, with small basal lateral white spots and yellow side bristles, venter dark brown. Proboscis unbanded, brown, but black at tip.

Head black, with numerous small white spots; the clypeus black. Antennæ brown, a few black scales on second joint; palpi of ♀ brown, those of ♂ also brown, and unbanded, exceeding the proboscis in length by more than its last joint, which is equal to the next, both being so small as to be, together, shorter than the third joint. Scutellum nearly black, with three silvery patches; pleuræ paler, with five white dots, three in an upper and two in a lower row. Halteres fuscous. Legs nearly black, the femora paler at the base, and gartered white just above the white knee spots; the apices of the tibiæ also white. Tarsal claws of ♀ equal and uniserrated on fore and mid, simple on hind legs; those of ♂ markedly unequal on fore and mid legs with an additional tooth to both of the fore claws, but on the small claw only of the mid feet. *Length.*—About 4 mm. ♂ and ♀.

Habitat.—Salisbury, Mashonaland, 4,000 feet.

21. STEGOMYIA MINUTA, Theobald (Monog. I, p. 319).

Wing veins with brown scales, black on the costa. Tarsi dark brown, unbanded. Thorax nearly black, with irregular white submedian lines, and a pair of white spots, rather to the front. Abdominal segments black, unbanded, but with white lateral spots. Proboscis black.

♀.—Head dark brown, clothed with flat dark brown scales, with a patch on each side converging to the nape, and another lateral patch lower down; upright black forked scales in the middle, and long black bristles projecting forwards over the eyes; the flat median scales show a brighter brown tint in some lights; palpi and proboscis black, the former densely scaled; antennæ dark brown, basal joint deep ferruginous, base of the second joint ferruginous. Scutellum with a line of white scales; pleuræ dark, with a few white dots. Halteres pale with dark knobs. Legs brown, the mid and hind femora with distinct white apices, absent in the fore legs, tibiæ also with a white apical band, most prominent in the hind legs; ungues small, equal and simple. *Length.*—1·8 to 2 mm.

Habitat.—Salisbury (4,000 ft.), Mashonaland.

22. STEGOMYIA NIGRICEPHALA, Theobald.

(Report Liverpool School Tropical Medicine, 1901).

Wing veins densely clothed with dark brown scales. Tarsi nearly black, unbanded. Abdomen black with small lateral, basal white spots. Thorax, dark brown, with bronzy scales; unadorned. Head, entirely black. Proboscis black, unbanded.

♀.—Head black, entirely covered with flat black scales, clypeus, proboscis and palpi black; antennæ dark brown, basal joint testaceous on one side, dark on the other. Scutellum testaceous in the middle at the base, black at the apex, lateral lobes greyish-brown, mid lobe with flat black and grey scales and six (?) black "border-bristles"; metanotum blackish; pleuræ very dark with three large patches of white scales. Legs nearly black, a little paler on the coxæ; fore and mid tarsal claws equal, but each with accessory tooth; hind simple. Ventrally, the abdomen is black, with white basal bands to the segments. Halteres yellow, with dusky knobs. *Length.*—4·8 mm.

Habitat.—Bonny, West Africa, May.

23. **STEGOMYIA BREVIPALPIS**, Sp. n.

Plate xiv, fig. 17, Venation of wing, ♀ ; fig. 18, Wing of ♂ ; fig. 19, Costa of the same more highly magnified ; fig. 20, Head and appendages of ♂.

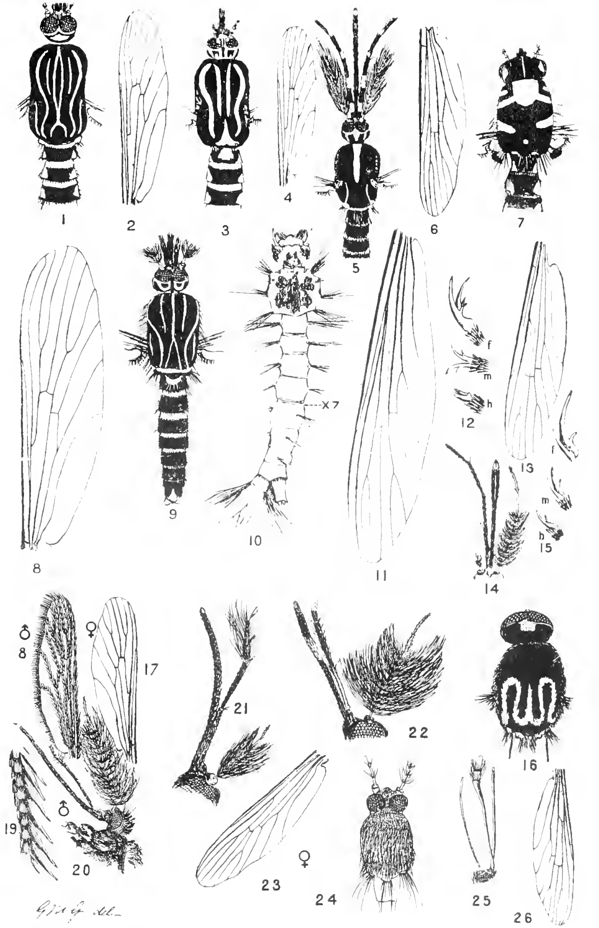
Wing unspotted, black scaled ; those on the costa peculiarly long and thorn-like, especially in the male, distal veins very long and narrow. Tarsi unbanded black. Abdomen black, not noticeably banded. Palpi of ♂ but two-thirds the length of the proboscis, uniformly fuscous.

This curious little mosquito is at once one of the smallest and blackest of the family, and closely resembles a "sandfly," common in the same locality. Some females show signs of lateral white abdominal spots, and of an apical fringe to the segments, and there are white specks on the pleuræ and coxæ in both sexes. The male presents several peculiarities, the curvature of the nape consisting of a broad median area, clothed with yellow upright forked and narrow curved scales, with lateral patches of truncated white overlapping scales. The palpi are exceptionally short, and much resemble those of a female *Anopheles* in form. The antennæ on the other hand are well nigh as long as the proboscis. The abdomen is very narrow in front, gradually widening to the sixth segment, resembling in this respect *C. annulatus*, Schrank. In both sexes the venter is rather pale cinereous. The fore and middle ♂ ungues are unsymmetrical, with each claw provided with a minute basal accessory tooth ; those of the hind legs are small, simple and symmetrical In the ♀, the apices of the femora are light coloured. Taken at Shahjahanpur, N.W.P., in October, in the house. The female bites during the day.

Genus XIII. **ARMIGERES**, Theobald.

This genus may be distinguished from *Stegomyia* by the third long vein being continued inwards, beyond the transverse veins, as an unscaled vein, to the base of the wing, a peculiarity which, however, it shares with many species included within the limits of other genera, and which may even be made out, to some extent in some *Stegomyiæ*, so that personally I should have preferred to have left the species within that genus, for the present.

Although larger than most of the species of that genus, they much resemble the darker forms, such as *S. brevipalpis*, and *S.*



The genera *Stegomyia* and *Armigeres*. 1, *S. notoscripta*, Skuse; 2 and 3, *S. fasciata* (Fabr.); 4 and 5, *S. scutellaris*, Walk.; 6 and 7, *S. Gubernatoris*, sp. n.; 8 and 9, *S. pseudotæniata*, sp. n.; 10, larva of the same species, less amplified; 11, Wing of *Ar. ventralis*, Walk.; 12, Fore, mid and hind tarsal claws of the same; 13, Wing of *Ar. panalectoros*, sp. n.; 14, Head and appendages, and 15, Fore, mid and hind tarsal claws of the same; 16, Head and thorax of the same; 17 to 20, *S. brevipalpis*, sp. n.; 21, *S. irritans*; 22, *S. periskelata*, sp. n.; 23, *Ædes, nigricorpus*, Theob.; 24 to 26, *S. microptera* sp. n.

Face p. 384.

minuta, but they differ in the form of the male palpi which are long and tapering, much as in *Janthinosoma*, from which genus, however, they differ in the form of the head scales.

In the B.M. Monograph, it originally included but one species, *Ar. ventralis* (Walker) = *C. obturbans*, Walker, and both Mr. Theobald and myself have gone through various changes of opinion, as to whether the specimens included in our collections should be regarded as anything from four to one species. We both now, however, think that there are sufficient grounds for distinguishing two forms, which were sent me from Calcutta, sorted roughly into species, by Major Alcock, the Superintendent of the Indian Museum. In ordinary pinned specimens it may be admitted that they are hard to distinguish, but when unrubbed, there is no particular difficulty in doing so. One of these forms, with a dark thorax, paler externally but quite undecorated in the middle, is undoubtedly Walker's *C. ventralis*, which appears to be quite indistinguishable from his *obturbans*. I have carefully examined the rather long series in the museum collection, and though the thorax is in excellent preservation in many of them, I cannot distinguish, in any one of them, the markings which distinguish the other and smaller species described below, which has the thorax rather elaborately, though not very conspicuously, decorated, and differs somewhat in the form of the tarsal claws.

The collection received from Calcutta was sorted into three forms, one of which I thought might be identical with Skuse's *C. atripes*, distinguished by the tarsal claws of the ♂ being of nearly equal length; but this character appears to vary somewhat in *Ar. ventralis*, and in any case it is quite distinct from Skuse's species, as specimens received from Australia show that this is a true Culex.

1. ARMIGERES VENTRALIS (Walker).

Proc. Linn. Soc. Lond. v, p. 144; iv, p. 91. = *C. obturbans*.

Plate xiv, fig. 11, Venation of wing; 12, Tarsal claws of ♂.

Wing veins clothed with rather scanty but intensely black scales, short and close setting towards the base, and linear and outspread on the outer part of the wing. Tarsi uniformly sooty, smooth scaled. Thorax with dark brown ground, and the mesonotum uniformly clothed with long hair-like nearly black scales, creamy at the sides. Abdominal segments with their terga uniformly sooty except that of the last, which is creamy white; occasionally the corners of the ventral bands give a deceptive appearance of lateral spots, but they do not really involve the terga.

Head with flat black scales, except the orbits and median and lateral patches on the occiput, which are of an impure white. Antennæ of ♂ three quarters the length of the uniformly sooty proboscis, with almost

25

black verticils, those of ♀ banded. Palpi of ♂, smooth, black, subulate, its four outer joints subequal, and exceeding the proboscis by the entire length of the end joints; those of ♀ minute, intensely black. Humeral callosities whitish; scutellum dark in the middle, creamy laterally; pleuræ marbled dark grey and whitish. Halteres with whitish stems and fuscous knobs. Legs sooty, except the undersides of the femora and knees, which are creamy white. Ventral segments black behind, with broad basal white bands pointed at the sides, and easily visible when the insect is viewed from one side. Fore and mid tarsal claws of ♀, equal and toothed, of hind simple, those of male, larger and somewhat unequal, but similarly armed (in the *obturbans* type they are more unequal). *Length.*—About 7 mm.

Habitat.—Appears common all along the southern Asiatic littoral from India to China, but I have not met with it inland.

Captain James, I.M.S., notes that the larva of this mosquito is large, and has a characteristic whitish woolly appearance. It rests perpendicularly to the surface, and further has very large and characteristic swimming fans. It breeds chiefly in pots and tubs of dirty water, in the open and under trees. It is very rare to find this mosquito in houses, though it is not uncommon in woods.

2. **ARMIGERES PANALECTOROS**, Sp. n.

Plate xiv, fig. 13, Venation of wing; 14, Cephalic appendages of ♂; 15, Tarsal claws of ♂; 16, Decoration of thorax.

Closely resembles the above, but is much smaller, and has the thorax rather elaborately decorated with creamy lines, a median broad one, commencing about the middle of the mesothorax, and dividing behind, to turn forward as a pair of lateral lines, which again curve backwards. The scutellum is clothed almost entirely with creamy scales and the tarsal claws of the ♂ are extremely unsymmetrical, even on the hind legs. *Length.*—From 3·5 to 4 mm.

Habitat.—Calcutta, during the rains.

Genus XIV. **CULEX**, Linnæus.

(Linn. Syst. Nat. (1735), Linnæus; Fn. Suec. 1890, pl. x, figs. 1—4 (1761), Linnæus; Zweiflüg. Ins. i, 1 (1818), Meigen; Gen. Crust. et Ins. iv, 256 (1809), et Hist. Nat. d. Crust. et d. Ins. xii, 284 (1802), Latreille; Dipt. Exot. 6 (1821), Wiedemann; Mém. Soc. d'Hist. Nat. de Paris, iii, (1827), Rob. Desvoidy; Hist. Nat. d. Ins. i, 33, 2 (1834), Macquart; Dipt. Exot. p. 29 (1838), Macq.; Ins. Brit. Dipt. iii, p. 243 (1851), Walker; Brit. Ent. xii, 537 (1835), Curtis; Dipt. Scand. (1850), Zetterstedt; Fn. Austr. ii, (1864), Schiner; Dipt. Neer. 323 (1877), Van der Wulp; Bull. Soc. Ent. Ital. xxvi, 315, et Revis. Sist. d. fam. d.

Culicidæ Europ. p. 224 (1896), et Venti Spe. d. Zanzare Ital. p. 98 (1899), Ficalbi; Dipt. Arg. p. 57 (1891), Arribálzaga; Trans. Linn. Soc. N.S. Wales, p. 1724 (1889), Skuse.)

The Linnæan genus included all gnats having the ♂ palpi long and those of the ♀ short, and has of late years come to include an enormous number of species, so that some subdivision is urgently needed.

Even as now, as restricted by Mr. Theobald, it includes some 130 well-defined species (without counting some of the older and inadequately described names), but it is difficult to find any basis for further natural subdivision and for the present we must be content with an artificial classification, based on the coloration of the wings, tarsi, &c. In the restricted genus *C. pipiens*, L., is made the type species, and its characters may be said to be based on those of that species. Mr. Theobald defines the restricted genus as follows :—

Palpi of the ♀ short, three or four-jointed; of the ♂ long, three-jointed; constrictions at the bases may give the ♀ a four or five-jointed and the ♂ a five-jointed appearance; the last joint in the ♀ is usually large; the male may have the last two joints swollen, much as in *Anopheles*, or they may be narrower and the last pointed. The antennæ, like those of the preceding genera, are pilose in the ♀, plumose in the ♂, and are composed of fourteen joints, the last two in the male being long and thin.

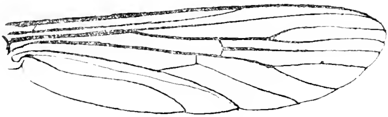


FIG. 45.—Venation of wing in Culex.

Head ornamented with narrow curved scales over the occiput, and upright forked scales, especially thick on the back of the head, flat scales on the sides; thorax with narrow curved hair-like or spindle-shaped scales; scutellum with narrow curved or spindle-shaped scales only; abdomen with flat scales; wings with small median scales to the veins and more or less thin linear lateral ones to some or all of the veins. In the wings, the first sub-marginal cell is longer and narrower than the second posterior cell, and the posterior cross-vein is always nearer the base of the wing than the mid cross-vein. The scales may collect in certain areas and form spots (*C. annulatus*), or may be ornamented with spots of differently coloured scales (*C. mimeticus*). The ungues of the ♀ are equal, simple or uniserrated, of the ♂, unequal on the fore and mid legs, the large uni- or biserrated, the smaller uniserrated or simple.

Owing to the large number of species to be dealt with it will be more convenient to subdivide its tabulation into a number of groups as follows :—

In the first group are included all *Culices* with spotted wings, whatever may be the decoration of the other parts; in the second, all the plain-winged *Culices* with a banded proboscis; while the remaining groups, including all species with unadorned wings and proboscis, are based on the presence or absence of pale bands on the tarsi, and their exact position when present; so that, to determine the group to which any species under examination may belong, only three characters need be noted :—*viz.*, those of the wing, proboscis, and tarsi. Each group is further subdivided according to the characters of the abdomen, in addition to which the characters of the thorax should also be carefully noted, before referring to the tables, when identifying an unknown species. The seven groups may be distinguished as follows :—

Group I.—With spotted wings (proboscis banded or unbanded).
Group II.—With unspotted wings, but with the proboscis banded.
Group III.—With wings and proboscis unadorned, but with pale basal bands on the tarsal joints.
Group IV.—As in group III., but with pale bands on the apices of the tarsal joints.
Group V.—As in group III., but with pale bands "on the tarsal articulations," *i.e.*, involving two contiguous joints.
Group VI.—As in group III., but with certain tarsal joints wholly white.
Group VII.—As in group III., but with the tarsi unadorned.

Although this is not a natural grouping, it aids very materially in identifying species in this still unwieldy genus.

GROUP I.—SYNOPTIC TABLE OF SPOTTED-WINGED CULEX.

A. Spots along the costa.

Proboscis with a pale band in the middle; costa black, with yellow spots and apex; abdominal segments basally yellow banded	1. *mimeticus*, Noè.
Proboscis pale ferruginous, with a broad yellow band in the middle. Wings with three long yellow and three long black costal spots; a large species, with apical abdominal bands enlarged in the middle	2. *Bigotii*, Bellardi
Proboscis unbanded (?)	3. *Hyrcanus*, Pallas.

B. Spots on the wing field.

iii. Abdomen with basal pale bands; tarsi banded.

α. Thorax not ornamented.

Wing spots five; mid ungues of ♂ with larger tooth twice- and smaller once-toothed	4. *annulatus*, Schrank.
Wing spots indistinct, like above species, but mid ungues of ♂ both twice-toothed	5. *Ficalbii*, Noè.

β. Thorax ornamented.

Thorax with lines of white scales; wing spots three; legs spotted	6. *spathipalpis*, Rondani.
Wings with four spots; fork-cells very long	7. *longiareolatus*, Macquart.

iii. Abdomen with basal pale bands; tarsi unbanded.

Wing spots four or five	8. *glaphyropterus*, Schiner.

iv. Abdomen with apical pale bands.

Wings with a single brown patch near apex..............	9. *fulvus*, Wiedemann.
Wings with five spots; palpi of ♂ filiform, not spatulate as in *annulatus*	10. *penetrans*, R. Desvoidy.

vii. Abdomen with apical triangular pale median spots.

Wings with one spot at base of third long vein	11. *Jamaicensis*, n. sp.

1. CULEX MIMETICUS, Noè.

(Boll. d. Soc. Ent. Italiana, xxxi, p. 240, Firenze (1899).)

Plate xv, fig. 16, Wing of ♀; 17, Palpi and proboscis of ♂; 18, Tarsal claws, ♂.

Wings with the inner two-fifths of the costa black, followed by two pale yellow interruptions, each about equal to the intervening black portion, and a large pale apical spot; these spots involve I. and II. and III. are wholly yellow scaled, but the rest are mainly dark scaled; the internal fringe is dark except a broad yellow patch opposite the anal cell. Tarsi black, with four narrow yellowish bands on the articulations of each leg, commencing with the tibio-tarsal. Thorax dark grounded with greyish-yellow scales, but no obvious ornamentation. Abdomen black with pale yellow basal bands, which are distinctly triangular on the anterior segments. Proboscis spatulate, black, with a narrow but conspicuous yellow band beyond the middle.

Head black with ferruginous tomentum. Palpi of ♀ black minute; of ♂, one-third longer than the proboscis, subulate, black, with last three joints basally yellow-banded and strongly tufted. The femora are yellow beneath and there are minute knee-spots, but legs elsewhere nearly black. Venter yellow with narrow black apical bands to the segments. *Length.*—5 to 6 mm.

Habitat.—First described from Italy. Appears common in the Hills in India, especially in the Nilgiris, and also appears in the plains in the cooler seasons of the year.

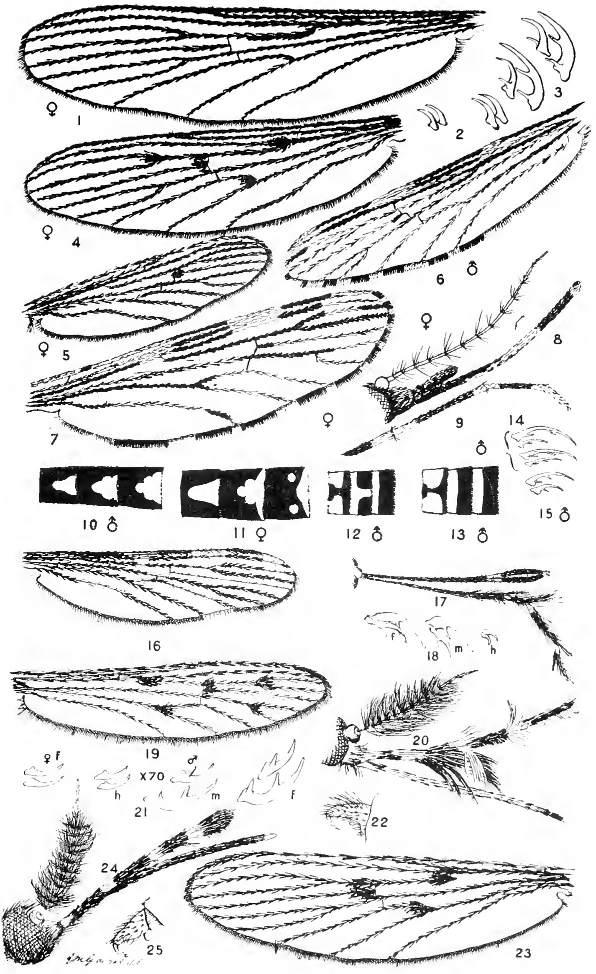
2. **CULEX BIGOTII**, Bellardi.

(Mem. R. Acad. Torino, se. 2, T. xxii, p. 200.)

Plate xv, fig. 6, Wing of ♂; 7, Wing of ♀; 8, Cephalic appendages of ♀; 9, Hind tarsus; 10, Antennæ, abdominal segments of ♂; 11, of ♀.

Wings with the costa yellow at the base and apex (in the ♀), with a minute black dot || axillary incision and two large black spots, one in the middle, the other commencing || base of anterior fork: II. and V. are mainly black, but the rest of the veins are mainly yellow: or (in the ♂) black at the base up to a short white interruption preceding the middle black spot, but the rest of the wing almost entirely pale-scaled; internal fringe pale at base and apex, black elsewhere but for yellow interruptions at each longitudinal junction, and with an extra one inside that of VI. in the ♀; these light interruptions are rather narrow in the ♀, very wide in the ♂. Tarsi black with broad yellow bands on the articulations; last joint of hind pair all yellow, those of other legs less markedly so. Thorax dark-grounded, with a large, ill-defined, cordate black spot. Abdominal segments black, with yellowish apical spots shaped like the "club" of playing cards; the hinder segments with additional lateral spots in the ♀. Proboscis nearly black with a broad median yellow band, ill-defined behind where it shades off into the dark base.

Head brown with golden and black scales Palpi brindled with gold and black scales; those of ♀ over one-fourth the length of proboscis, with a sub-terminal yellow dorsal spot; those of ♂ much longer than pro-



Culices with spotted wings. 1, *C. Ficalbii*; 2 and 3, ♀ and ♂ ungues of *C. glaphyropterus*; 4, *C. longiareolatus*; 5, *C. Jamaicensis*; 6 to 11, *C. Bigotii*; 12, Ant. abd. segs. of *C. annulatus*; 13, of *C. Ficalbii*; 14, ♂ tarsal claws of *C. Ficalbii*; 15, of *C. annulatus*; 16 to 18, *C. mimeticus*; 19 to 22, *C. annulatus*; 23 to 25, *C. spathipalpis*.

boscis, subulate, strongly tufted, mainly yellow, but darker in the middle of the joints. Antennæ of ♂, nearly as long as proboscis. Pleuræ marbled with yellow, brown and white; scutellum pale; ventral segments pale with dark hinder borders. *Length.*—8 or 9 mm.

Habitat.—Mexico, Brazil.

Note.—This is one of the largest and certainly the handsomest of all mosquitoes and can hardly be mistaken, unless indeed one chances to have read the original description.

3. CULEX HYRCANUS, Pallas.

(Reisen durch das Russisch. Reich. (1771).)

A grey species, rather hirsute, with a fuscous line down the abdomen; wings with black spots along the costal margin. Described by Pallas in 1771. Found near the Caspian Sea; not since recorded. In company with *C. Caspius* (Pallas), but less common and vicious.

Nothing corresponding to this inadequate description has come to hand at the Museum.

4. CULEX ANNULATUS, Schrank.

= *C. variegatus*, Schiner = *C. affinis*, Stephens.

(Beitr. zur Naturgesch. 97, 70; et Ins. Austr. 984, Schrank; Ent. Syst. iv, 400, 2, et Syst. Antl. 35, 4, Fabricius; Syst. Beschr. i, 4, 2, et Klass. i, 2, 1, Meigen; Dipt. n. d. France, 160, 1; et Suit. i, 35, 12, Macquart; Ins. Lapp, 806, 1; et Dipt. Scand. ix, 3640, 8, Zetterstedt; Fn. Austr. ii, 626, Schiner; Dipt. Neer, 325, Van d. Wulp; Ins. Brit. Dipt. iii, p. 246, Walker; Vent. Sp. Zan. Ital. p. 139 (1899), Ficalbi; Ins. Austr. 983 (= *variegatus*), Schiner; Zool. Journ. N. 1 (1825) (= *affinis*) Stephens.)

Plate xv, fig. 12, ant. abd. segs., ♂, contrasted with those of *C. Ficalbii;* 15, Mid tarsal claws, ♂, contrasted with those of the same; 19, Wing of ♀; 20, Cephalic appendages ♂; 21, Tarsal claws, both sexes; 22, External genitalia, ♂.

Wings with the costa unspotted, though brindled with brown and yellow scales; but with five (or rarely four) tufts of long scales, *viz.*, at origin of II. on the cross veins, and at forks of II., IV. and V. Tarsi with the upper three joints of the fore and mid, and the upper four of the hind legs with broad yellowish basal bands. Thorax brown with scattered golden scales, not noticeably marked. Abdominal segments black, with yellowish basal bands and anterior segments marked as in figure 12, pl. xv. Proboscis yellow, unbanded, though darker at base and apex.

Head brown, with scattered grey scales, and a slight frontal tuft. Palpi dark brown, those of ♀ with a pale spot in the middle; those of ♂ slightly longer than the proboscis, with four yellowish bands, and dense tufts of hair in the middle and at base of the fourth joint. Legs dark brown with yellowish knee spots, and subapical bands on the femora, ventral segments pale, with apical black spots. Abdomen of ♂, very narrow at base. *Length.*—About 10 mm.

Habitat.—Throughout Europe, also found in the Lower Himalayas, and doubtfully recorded from America.

5. **CULEX FICALBII**, Noè.

(Boll. d. Soc. Ent. Italiana, xxxi, p. 231 (1899).)

Plate xv, fig. 1, Wing of ♀; 13, ant. abd. segs. of ♂ contrasted with those of *C. annulatus;* 14, Fore and mid claws of ♂ contrasted with the mid claws of *C. annulatus.*

Closely resembles *C. annulatus*, but the wing tufts are less distinct, and the other markings less brilliant. It differs in the femora having no subapical yellow garters; the mid claws of ♂ have two accessory teeth on the smaller claw and the anterior abdominal segments are somewhat differently marked (*vide* contrasted figures). In the specimens sent to the museum by Prof. Grassi the scales on root of II. are very long, but it is difficult to make out any tufted spots; but this may be the result of rubbing. The stems of the fork cells are also proportionally short, especially the hinder. *Length.*—About 12 mm. The wing of the ♀ in this museum is the largest I have traced.

Habitat.—Italy, found only at Macarese and Pato.

6. **CULEX SPATHIPALPIS**, Rond.

(Dipt. Ital. Prodro. vol. i. (1886) Rondani; Bull. Soc. Ent. Ital. p. 242 (1890); Venti Spec. Zan. Ital. p. 146 (1899), Ficalbi.)

Plate xv, fig. 23, Wing of ♀; fig. 24, Cephalic appendages, ♂; 25. External genitalia, ♂.

Presents a close general resemblance to *C. annulatus*, but has only three tufted spots on the wings, those at the bases of the fork cells being wanting, but it is certainly distinct, the ♂ palpi being entirely different, shorter than the proboscis, but little tufted, and spatulate, the last two joints being expanded much as in *Anopheles*. The orbits and a median line on the head are white and the thorax has an indistinct median white stripe. The stems of the fork cells are very short. *Length*—About 7 to 9 mm.

Habitat.—Italy, Gibraltar (where it is known as the "dove mosquito"), Lower Himalayas, where I took a specimen at Naini Tal, about 7,000 feet elevation.

NOTE.—Should fresh material from the Canaries show that this is synonymous with *C. longiareolatus*, Macquart, the present name must sink, as Macquart's description is of course much the older.

7. **CULEX LONGIAREOLATUS**, Macq. (Dipt. Exot. I, p. 34).

(Dipt. Exot. i, p. 34, Macquart; Hist. Nat. des Iles Canaries, Berthelot.)
Plate xv, fig. 4, Wing of ♂.

Closely resembles *C. spathipalpis* and probably identical. There is an additional tuft at the base of anterior fork, but there is always a tendency to this at the forkings in all these species with tufted wings. Although very long, the fork cells are proportionally shorter than in *C. Ficalbii*. The two specimens in the museum are very old and the collection of fresh material from the Canaries is hence a desideratum. *Length* about 9 mm.

Habitat.—The Canary Islands.

8. **CULEX ♂ GLAPHYROPTERUS**, Schiner ("F. R." p. 247).

Plate xv, fig. 2, Tarsal claws of ♀; 3, of ♂.

Wings with black spots formed of accumulations of scales, arranged as in *C. annulatus;* tarsi dark brown, without bands; thorax indistinctly ornamented; abdominal segments nearly black, with white basal bands.

Antennæ brown with the rotund basal joint yellow, and the plume brown; nape with deep grey or brassy tomentum; thorax generally brownish-yellow on the dorsum, with brassy or golden tomentum, usually four dark longitudinal lines can be made out; pleuræ ferruginous. Wings densely brown-scaled, accumulations of these determine the position of the spots in exactly the same situations as in *C. annulatus;* hips and the roots of the coxæ yellowish; knees pure yellow; tarsi black or nearly so. Abdominal segments nearly black, with a whitish anterior band, the last segment with most white. *Length.*—9 mm.

Habitat.—Described by Schiner alone from Austria.

A very elaborate supplementary description of this species is given in Ficalbi's "Venti Specie di Zanzare," 1899. In this the ♂ palpi are said to be moderately clubbed at the end, brownish-black, rather lighter at the base, but without adornment; those of the ♀ are brownish-black, with a short conical fourth joint. The indistinct thoracic adornment consists of a median, two lateral and border lines of golden-yellow on a maroon-brown ground.

9. CULEX FULVUS, Wied. (A. Z. I, p. 546).

Wings with a brownish-black patch at the apex; tarsal joints with yellow apical bands, lanugo smooth; thorax not dorsally ornamented; palpi longer than the proboscis.

Body black, with yellow hairs, and the hinder legs banded brown. *Length* two and a half lines (German). ♀—Antennæ brownish; proboscis and palpi (which latter are somewhat longer than is usual) golden-yellow, with brownish-black apices; ground colour of the body glistening brownish-black, thickly beset with golden-yellow hairs, those on the abdomen being somewhat lighter, and on the incisuræ abdominis blackish. Wings, golden-yellow along the costa, and brownish-black at the apices: legs golden-yellow; in the front legs, the extreme apex of the femur, tibiæ, and foot-joints brownish-black on top; the middle legs are missing, but the hinder legs have the femur and tibæ also brownish-black at the apex, while the foot-joints, on the contrary, are much brighter, and brownish-black elsewhere; the basal half of the second foot joint also remains yellow.

Habitat.—Brazil.

10. CULEX PENETRANS, Desvoidy (F. R. p. 246).

Wings with five more or less distinct spots; tarsi with yellow bands; lanugo smooth; thorax fulvous with two brown dorsal lines; palpi of the male filiform.

In the ♂, the palpi are more filiform than in *C. annulatus;* the antennæ of the ♀ are yellowish-brown; in the ♂, shorter and more plumose than in *C. annulatus;* thorax fulvous, with two brown dorsal lines; abdomen yellow, with brownish incisuræ; wings with yellowish scales, and with five more or less distinct spots; tarsi yellow with brown rings; filiform, and pale yellowish in the ♂, with the third joint of the middle pair ciligerous. *Length*—3 lines.

Habitat.—France.

11. CULEX JAMAICENCIS, Theob. (Monog. I, p. 345).

Plate xv, fig. 5.

♀.—Wing with a single obvious spot, formed by a tuft of long scales at the origin of III., with the costa and long veins brindled with alternate patches of black and white scales. Tarsi sooty; all joints of hind, upper three of mid, and upper two of fore legs with pale ferruginous basal bands, and an additional band across the middle of the hind first tarsal. Thorax with the dorsum black grounded, densely clothed with narrow curved yellow scales intermixed with long stiff black bristles. Abdominal segments sooty, with large triangular spots on their hind borders, with the apex pointing forwards. Legs and other appendages all speckled with white, exactly as in *S. pipersalatus mihi.*

Head black-grounded, with black erect forked scales, and yellow narrow curved scales. Palpi unbanded, but brindled yellowish just at tip. Proboscis brindled, with an ill-defined band on which yellow scales preponderate, occupying the middle third. Antennæ fuscous. Legs brindled throughout, except on the tarsi, which are sooty, save on the light bands. There is a distinct patch of yellow on the outside of the femora, just above their apices, and on the knees. Venter pale yellow. *Length.*—About 5 mm.

Habitat.—Jamaica.

CULICES WITH UNSPOTTED WINGS.

The eleven preceding species may be said to have the common characteristic of mimicking the *Anopheletes;* and in any case, the spotting of the wing is so striking a character that, for purposes of tabulation, it is obviously desirable to keep them apart. For the same reason those of the plain winged species which present the easily-noted character of a banded proboscis have been tabulated in a group by themselves, although the plan involves their separation from species to which they are more naturally allied.

The remaining species are divided into two large series, viz., those with banded and unbanded tarsi respectively, and these are subdivided into groups according to the position of the pale tarsal banding and the decoration of the abdomen. As none have spotted wings, the note to that effect will be omitted in the remaining short descriptions.

In the majority of species the scales clothing the wings are of all one colour, though generally a little paler on the internal fringe, but in *C. dorsalis*, Meig., and its allies—Rondanis' *C. penicilaris, C. pulchritarsis*, and *C. pulchripalpis*, as well as in *C. annulipes, C. solicitans, C. maculiventris, C. marinus* and some others, they are "brindled," with intermixed pale and dark scales, which makes them look under the microscope as if peppered and salted, although it does not give rise to spotting.

The remaining groups are then as follows:—

A. Proboscis banded in one or both sexes = group II.

B. Proboscis unbanded :
a. With the tarsi basally pale banded, but none of the joints entirely white = group III.
b. With the tarsi apically pale banded, but none of the joints entirely white = group IV.
c. With the tarsi banded on the articulations, but none of the joints all white = group V.
d. With one or more of the tarsal joints entirely white = group VI.
e. With the tarsi unadorned = group VII.

Group II.—Culices with Unspotted Wings but with the Proboscis Banded.

a. With the tarsal joints basally pale banded.

i. The abdominal segments with pale basal bands and lateral spots.

12. *C. tæniorhynchus*, Wied. Band on proboscis nearer the base than the apex.

ii. Abdominal segments with a pale median line connecting pale basal bands.

13. *C. solicitans*, Walker. Band on the middle of the proboscis broad and nearly white.

iii. Abdominal segments with pale basal bands only.

14. *C. Vishnuii*, Theobald. Band on proboscis, narrow, yellow, placed just outside the middle, hind tarsal joints banded. Both fore tarsal of ♂ toothed.
15. *C. annulirostris*, Skuse. Proboscis with a broad white band on the middle third. Thorax unadorned.
16. *C. Bancroftii*. Very doubtfully in this group as the proboscis is not stated to be banded. Thorax with a distinct white adornment.
17. *C. sitiens*, Wied. Band on proboscis yellow, narrow, outside its middle. Hind tarsi unbanded.
18. *C. tritæniorhynchus*, *sp. n.* A broad yellow band on proboscis well beyond its middle, and with the tip, and a less sharply-defined band near the base, of the same colour ; tarsal bands very narrow.
19. *C. confinnis*, Arribál. Band on proboscis very broad and near the base ; a very small and dark-tinted species.

iv. With the abdominal segments apically pale-banded.

20. *C. albirostris*, Macquart. The white band on proboscis occupies the greater part of its length.

vi. Abdominal segments with pale lateral spots.

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[1] 59. *C. albitarsis*, Theob., and 57. *C. longipalpis*, Van der Wulp. These species have two ill-defined bands on the proboscis, and so might be traced to this position. Their descriptions will be found below as their probosces are more likely to be regarded as unbanded.

γ. With the tarsi light banded "on the articulations" (two joints participating).

i. Abdominal segments with light basal bands (or median spots) as well as lateral spots.

21. *C. annulioris*, Theob. Median and lateral abdominal spots alike triangular: band on proboscis yellow, occupying all its middle third.

22. *C. plumosus*, Theob. Median abdominal light patches lunate, lateral ones at mid-length of segments. Band on proboscis narrow, ferruginous, and in the middle. Large fore claw of ♂ with two accessory teeth; anterior margin of mesonotum tufted.

23. *C. hirsutipalpis*, Theob. Median abdominal light patches lunate, lateral ones basal. Bands on proboscis median and broad. Large fore claw of ♂ with one accessory tooth.

24. *C. dissimilis*, Theob. Median light abdominal patches lunate, traces of lateral spots on the hinder segments only. Band on proboscis, narrow, yellow, well beyond the middle. Large fore-claw of ♂ with an extra tooth.

25. *C. Duttoni*, Theob. Band on proboscis dull red on apical half. Thorax brown scaled with pale fore border and patches in the middle and over the roots of wings.

iii. Abdominal segments adorned only with pale basal bands.

26. *C. impellens*, Walker. Tarsal bands very narrow, wings with 4 but little inside 3.

27. *C. annulus*, Theob. Tarsal bands very narrow, wings with 4 far internal to 3.

28. *C. cingulatus*, Fabr. Tarsi banded on the articulations of hind legs only. Abdominal bands well-marked, semilunar. Proboscis banded in the ♂ only.

29. *C. secutor*, Theob. Like *C. cingulatus*, but with the abdominal banding indistinct.

δ. The tarsi unbanded.

v. Abdominal segments banded on bases and apices of contiguous segments.

30. *C. infulus*, Theob. Proboscis black, with a pale yellowish band in the middle, and a narrow one just inside its tip.

31. *C. tigripes*, de Grandpré et de Charmoy. A band on the proboscis beyond its middle, sometimes incomplete above. Legs dark, marked, especially on the anterior borders of femora, with equidistant yellow specks.

12. CULEX TÆNIORHYNCHUS, Wied.

= *C. damnosus*, Says (?) = *C. confinnis*, Arribál (?).

Tarsi black, with all the last and broad bands at the bases of the other four joints of the hind legs snowy-white; the fore and mid legs with the upper three tarsal joints basally white banded. Thorax fuscous grounded, densely clothed with narrow, curved, yellowish-brown scales and numerous long black bristles, exceptionally large tufts of which are found at the roots of the wings and on the lobes of the scutellum. Abdomen black, with very narrow cream-coloured basal bands to the segments, and brilliant lateral tufts of snowy scales placed rather nearer their bases than to their apices. Proboscis with a sharply-defined yellow band much nearer the base than the apex.

Head black grounded, the nape tinted with yellow, narrow, curved. and black erect forked scales; antennæ black; palpi, ♀, nearly black, with yellow tips; of ♂, black at the base, golden brown at the tip, with basal snowy bands to the last three joints and a very large tuft of golden hairs springing from the lower surface of the apex of the third joint. Wings with 2 nearly ||, but just internal to 3, 4 widely internal; aux. junct. well outside 2. Femora pale below, black elsewhere, as also are tibiæ but for a small knee-spot. Ventral segments dark, with square, yellowish basal marks. *Length.*—About 6 mm.

Habitat.—St. Lucia, British Guiana, South America.

13. **CULEX SOLICITANS**, Walker.

(Insect. Saund. p. 427 (1856), Walker; Cir. No. 40, 2nd se. U.S.A. Dept. Agri. (1899), Howard.)

Wings mottled with brown and pale scales. Tarsi dark above but paler on the end joints, with pale basal bands, except on the first joint of fore legs and on the end joints, which are almost too pale to show them, the first mid tarsal with an additional pale band in the middle. Thorax nearly black-grounded, densely clothed with golden-brown scales but unadorned. Abdomen with creamy-white to yellow scales, forming a central broad line and with basal white bands, with a dark brown to nearly black quadrangular patch on each side of the central mass of pale scales; there are also white scales laterally on some of the segments. Proboscis with a broad, nearly white band in the middle. Bases of fork cells nearly even, and 4 about its own length inside 3.

♀.—Head brown-grounded, densely clothed with golden scales, nearly black at the sides; palpi dark with lighter tips. Scutellum with bright golden marginal bristles; pleuræ densely white-scaled. Legs rather light coloured, brindled with dark and light scales; with white knee-spots. Halteres testaceous with rather darker knobs. The species is very distinct and not in any way connected with Wiedemann's *C. tæniorhynchus.* Walker's type is in the British Museum, and is certainly a very well-defined species. The markings of the abdomen, the mottled scales on the wings (seen only in certain lights), and the difference in the scales of the head will at once separate it from any other. *Length.*—6 mm.

Habitat.—U.S. of America, especially the Atlantic Seaboard; Galapagos Islands; Jamaica; Formosa (?) Will breed in brackish water.

14. CULEX VISHNUII, Theobald (Monog. I, p. 355).

Plate xvi, fig. *5a*, Variations of abdominal adornment; *5b*, Fore tarsal claws of ♂.

Tarsi with whitish basal bands on all but the end joints and first of foreleg. Thorax clothed with yellowish scales, indistinctly adorned with two bare dark submedian lines and by three rows of black bristles. Abdomen black, with broad yellowish basal bands and with also a creamy fringing on some of the hinder segments, the last all yellowish. Proboscis dark with a narrow ferruginous band just outside its mid length. Wing with fork of II just outside that of IV, and 4 far internal to 3. Both claws of fore tarsi of male toothed.

Head dark brown, with pale scales. Palpi of ♂ banded yellow and black; second joint at apex, third in the middle, fourth and fifth narrowly at base. Legs dark brown except the greyish under sides of the femora and dull white knee-spots. Halteres pale ochreous. *Length.*—About 4·5 mm.

Habitat.—Southern India and Ceylon.

15. CULEX ANNULIROSTRIS, Skuse (" S. A. C." p. 1, 737).

Wings unspotted. Upper three tarsal joints basally white-ringed. Thorax dorsally deep brown with golden scales and hairs, but with some white marks on the pleuræ. Abdominal segments deep brown, with narrow white basal bands. Proboscis with a broad white band in the middle third of its length. Wing with fork of II much internal to that of IV, and with 4 far inside 3.

Head dark brown, clothed with pale curved scales, white at the sides, and forming a narrow border round the eyes, and with scattered black upright forked on each side and pale upright forked scales in the middle in front; eyes deep purple, almost black; clypeus dark brown; palpi deep brown, with the apex pale in the ♀; those of ♂ dark brown with two broad and two narrow basal yellow bands, one of the former exactly ‖ that on proboscis. Legs dark except under sides of femora, and minute white knee-spots. Halteres yellow with darker knobs. Fore and mid tarsal claws of male unequal, with extra teeth on both claws, but those of the smaller ones are very minute. Ventral segments with broad pale basal bands. *Length.*—Over 4 mm.

Habitat.—Appears to occur all over Eastern Australia.

16. **CULEX BANCROFTII**, Skuse ("S. A. C." p. 1, 740).

Tarsi with snow-white basal bands. Thorax dark brown with two submedian longitudinal lines ending in a spade-shaped expansion, and two lateral curved lines of snow-white; abdomen violet black, with white basal bands to the segments; a small silvery patch on each side of the head.

Mr. Theobald, in the monograph, treats this as a variety of the above, but the figure he gives of the thoracic ornament differs entirely from Skuse's diagram, and Skuse makes no mention of a band on the proboscis. Referring to some specimens sent from Queensland by Dr. Bancroft, he says: "I can detect no structural difference in this specimen from *C. annulirostris*, in spite of its peculiar ornamentation on the thorax, except a slight variation in the position of the posterior cross-vein." But it is very unlikely that Skuse would overlook the band on the proboscis, and I suspect that they are not dealing with the same species.

17. **CULEX SITIENS**, Wied. ("A. Z. I." p. 544).

Tarsi dark brown, with narrow basal bands on the three or four upper joints of the fore and mid legs, *but with the hind tarsi unbanded*. Thorax dark brown, with scattered golden scales, paler in the middle, but not noticeably marked. Abdominal segments deep brown, with narrow ochreous basal bands, except the first, which has a dark brown patch in the centre.

Wings with fork of II, just internal to that of IV, and 4 twice its length inside 3. Proboscis deep brown, with a narrow yellow band well outside the middle.

♀ Head brown, with creamy curved, and numerous black forked scales; palpi short, thick, dark brown, greyish at top. Pleuræ dark brown, with a white patch under the wings and another over the middle legs. Legs dark brown, except the greyish-yellow undersides of the femora, which are armed with a distinct row of strong bristles. Halteres with pale stems and fuscous knobs. *Length.*—3 mm.

Habitat.—Straits Settlements (Taipang).

Observations.—The identification of this form with Wiedemann's species from Sumatra, and in similar instances of other species where the "type" is missing and the original description inadequate, is of course more or less problematical; and the form here described would answer as well in fact to Walker's description of *C. impellens*, but it is certainly better to follow this course than to make a new species, and so leave the older names with a probably merely nominal status.

18. CULEX TRITÆNIORHYNCHUS, Giles.

(Journal Bombay Nat. Hist. Soc. xiii, p. 607.)

Tarsi minutely basally banded pale ochreous. Thorax unadorned, fuscous. Abdominal segments fuscous, with rather narrow yellowish-white basal bands. Proboscis fuscous, with three separate ochreous bands, one forming the tip; the second, sharply defined and much broader, beyond the middle; the third less sharply defined, especially in the ♀, and placed midway between the large broad band and the base. Wing with the fork of IV just inside that of II, and 4, but its own length internal to 3; less than this in the ♂.

A minute species, of generally dusky tinting, and with proportionately long legs. Head fuscous; eyes with a barely perceptible whitish margin; nape fuscous, with a few whitish hairs; antennæ fuscous, minutely banded white in the ♂; palpi of ♂, considerably longer than the proboscis, exceeding it by more than the length of the markedly subulate terminal joint, fuscous, with minute white basal bands to the last three joints, ♀, exceptionally minute, nearly black, with an indistinct greyish tip. Halteres pale yellow. Legs fuscous, the tarsi with minute ochreous basal bands to all the joints; first hind tarsal longer than the corresponding tibia in both sexes. *Length.*—Under 3 mm.

Habitat.—Travancore, Southern India.

19. CULEX CONFINIS (Arribál.) ("L. A." p. 49).

Very like *Tæniorhynchus tæniorhynchus*, Arribálzaga, but of smaller size and darker colour, while the band on the proboscis is broader; but it differs generically in the form of the wing scales. The broad white proboscis band extends from near the base to the middle. Legs fuscous, fore femora sparsely decorated with scattered white scales, with a narrow white band a little before the apex; tibiæ speckled white externally, uniformly coloured inside; knees white; fore and mid tarsi with the first three, and the hinder with four, or all the joints, with basal white bands; first hind tarsals distinctly shorter than tibiæ. Abdomen dark fuscous, with coffee-coloured scales above and narrow whitish apical bands; greyish below. *Length.*—4·5 to 5 mm.

Habitat.—Chaco in Formosa, Argentina.

NOTE.—Mr. Theobald remarks: "In some respects this might be the *C. tæniorhynchus*, Wiedemann, but as I have seen no banded-proboscis forms of *Culex* from lower south than New British Guiana, except *Panoplites titillans* and *Tæniorhynchus fasciolatus*, I cannot possibly say. I believe, however, that *tæniorhynchus*, which is so common at New Amsterdam, will be found to extend farther into South America, and that this species of Arribálzaga's will prove to be *Culex tæniorhynchus*, Wiedemann" (Monog. p. 384).

20. CULEX ALBIROSTRIS, Macquart ("D. E." Sup. iv, p. 10).

Proboscis white, except at the base and tip, where it is black. Abdomen with the hinder borders of the segments white; tarsi blackish, with a white ring at the base of each joint. *Length.*—Two lines ♂.

Habitat.—New Zealand.

NOTE.—No banded-proboscis forms have been sent from New Zealand. but from the description of this species, the abdomen is pretty clearly apically banded.

21. CULEX ANNULIORIS, Theobald (Monog. I, p. 371).

Plate xvi, fig. 6, Abdominal adornment.

Tarsi dark with yellowish-white bands on the articulations, rather indistinct on the last two joints. Thorax deep amber-brown, with bronzy scales and a few creamy ones in front. Abdomen, steely black, with triangular median basal, and lateral apical spots. Proboscis black with a well-defined yellow ban occupying all its middle third. Bases of fork cells nearly level, and 4 more than twice its length inside 3.

♀.—Head brown, with creamy curved, and bright brown forked scales; palpi dark with a few white hairs at the tip, rather large and much clubbed. Scutellum dark with a few pale scales intermixed. Legs red-brown, the femora mottled with grey scales, with yellowish knee-spots. Fore tarsal claws equal, uniserrated. Halteres with pale stem and fuscous knobs.—*Length* 6 mm.

Habitat. — Described from a single specimen from Salisbury, Mashonaland.

22. CULEX PLUMOSUS, Theobald (Monog. I, p. 373).

Plate xvi, fig. 7a, Abdominal markings; 7b, Bristles of fore border of mesonotum; 7c, Tarsal claws of ♂.

Tarsi dark brown, with pale bands on the articulations. Thorax unadorned, dark brown, with bronzy curved scales, and pair of submedian tufts of bristles on the fore border of mesonotum.

Abdomen yellowish-brown, with lunate yellow basal median patches, the hinder margins of which are recurved in the second to fourth segments, in addition to which there are round spots on the middle of the sides of the segments. Proboscis brown, with a narrow ferruginous band in the middle. Wings with 4 just inside 3. Tarsal claws of ♀, serrated; the large fore-claw of ♂, with two accessory teeth.

♂.—Head nearly black-grounded, with creamy curved and black forked scales on the nape, and dull yellow lateral patches; there is a scanty frontal tuft of yellow hairs; palpi black, with two yellow bands, the fourth joints rather dilated, all black (the last missing). Pleuræ dark brown, with some yellow scales and dark bristles. Legs dark brown, yellowish on the bases and undersides of the femora, and on the apices of the joints. Halteres with pale stem and fuscous knobs. *Length.*—6·5 mm.

Described from a single ♂. Mr. Theobald's surmise that this is the ♂ of his *C. Annulioris* is very probably correct, as there is often a good deal of sexual differentiation in the abdominal marking of gnats.

Habitat.—Salisbury, Mashonaland; March.

23. CULEX HIRSUTIPALPIS, Theobald (Monog. I, p. 378).

Plate xvi, fig. 9, fore-tarsal claws of ♂.

Tarsi nearly black; all the first joints with pale basal bands, their apices participating in the band on the first tarsal articulation; the fore and mid legs having the two first and the hind all its articulations pale banded. Thorax dark brown, with hair-like golden scales, unadorned. Abdomen deep brown, the first segments all white, except a pair of dark spots in the middle, the others with narrow, semi-lunar, basal pale spots, which spread out to form narrow bands, and also lateral pale basal spots. Proboscis deep brown, with a broad yellow band in the middle. Wings with fork of IV, distinctly outside that of II, and 4 rather near 3. Tarsal claws of ♀, simple; large fore-claw of ♂, with a single accessory tooth.

Head brown, with creamy scales on the nape and flat white ones laterally, with numerous black forked scales behind; palpi of ♀. black with a few grey scales near the tip; those of ♂, longer than the proboscis by the last two joints, pointed at the apex, but rather dilated near it, and with this part densely armed with long black hairs, with the apex and three bands of yellowish-brown. Scutellum with pale scales; pleuræ dull brown with greyish reflections. Legs brown, with the femora yellowish below, and white at the apex. Halteres pale ochreous. *Length.*—About 5 mm.

Habitat.—Salisbury, Mashonaland; February.

24. **CULEX DISSIMILIS,** Theobald (Monog. I, p. 376).

Plate xvi, fig. 8, Tarsal claws of ♂.

Tarsi yellowish-brown, with paler bands on the articulations (sometimes indistinct on the hind legs). Thorax dark brown grounded, with scattered golden scales. Abdomen dark brown, with semi-lunar basal ochreous patches, not forming complete bands, except on some of the hinder segments; the first almost white, with two dark patches in the middle, and there are traces of lateral spots on the hinder segments. Proboscis dark brown, with a narrow pale band well beyond the middle, rather indistinct in the ♀. Wings with fork of IV distinctly internal to that of II, and 4 but little inside 3.

Head brown, with creamy curved, and brown forked scales; palpi of ♀, nearly black; those of ♂, nearly half as long again as the proboscis, with the apex yellowish and four bands of the same tint, the second of which corresponds with that on the proboscis. Scutellum light brown; pleuræ brown, with two white patches. Legs pale yellow, with scattered brown scales. Halteres pale yellow. *Length.*—4 mm.

Habitat.—Freetown, Sierra Leone.

25. **CULEX DUTTONI,** Theob. (Monog. II, p. 318).

Tarsi pale, banded on all but the last articulations (in the ♂, the last two bands are indistinct), but not on the tibio-tarsal. Thorax black grounded, clothed with narrow golden-brown, and broader creamy scales arranged so as to form an indistinct adornment, the pale ones forming an anterior border to the mesonotum, and patches about its middle, and over the roots of the wings. Abdomen deep brown, with whitish basal bands and small lateral snowy spots. Proboscis nearly black, with a dull reddish band on the apical half. Large fore-claw of male, with one extra tooth. Wings with 4 twice its length inside 3.

Head dark brown, with whitish orbits and very numerous bright brown forked scales; palpi of ♀, black, with a few white scales intermixed; those of ♂, subulate, moderately tufted, with five broken white bands (two or three on the third joint). Pleuræ dark, with a few white patches. Legs dark brown, pale on coxæ and bases of femora, and with white apices to all the greater joints. Halteres yellowish. *Length.*— 5 mm

Habitat.—Duketown, West Coast of Africa.

26. CULEX IMPELLENS, Walker

(Proc. Linn. Soc. Lond. iv, 91).

Plate xvi, fig. 3a, Head and appendages; 3b, Venation of ♂ wing.

Tarsi dark brown, with narrow pale bands on the tibio-tarsal articulations, and three other narrow but distinct basal bands on the fore legs, but only one or two on the mid and hind, and those by no means distinct, especially on the latter. Thorax with a rather pale ground with dark spots on dorsum and pleuræ, clothed with golden tomentum. Abdomen brown, with distinct yellow basal bands. Proboscis brown, with a broad yellow band beyond the middle. Wings with the fork cells very long and their bases nearly even; 4 but little inside 3, especially in ♂.

Head brown, with creamy forked scales in front and two groups of dark ones behind; palpi nearly black, those of ♀, very minute, with a yellowish tip; of the ♂, somewhat longer than the proboscis, with four yellow bands, of which the two proximal are broad, and the two distal very narrow. Halteres pale yellow. Legs brown, rather short; the femora paler, with pale knee-spots. Venter banded in the same way as the dorsum of the abdomen, but with the dark parts less distinct. The ♂ ungues of the fore and mid legs are unsymmetrical, with an accessory tooth to each claw; those of the hind legs and of the ♀, equal and simple. *Length.*—About 4 mm.

Habitat.—Described originally by Walker, from Makessar, in the Celebes. Appears to be common through the N.W.P., and Punjab, in India, in the autumn, and, together with *C. fatigans*, is essentially the cold weather gnat of that part of India. Although not so vicious as in the warmer season, it bites, and also breeds to a moderate extent, for the whole of the cold weather.

27. CULEX ANNULUS, Theobald (Monog. I, p. 358).

Tarsi dark brown, with yellow bands on the articulations, but mainly basal, on all but the last joints of the fore and mid legs, but very ill marked on the hind legs. Thorax (denuded) dark brown with pale gold scales, but no sign of adornment. Abdomen deep brown, with broad creamy basal bands widest in the middle, especially in front, so that on the first segment the brown is reduced to a pair of lateral spots. Wing with fork of II || to that of IV, and 4 far internal to 3. Proboscis deep brown, with a broad yellow band rather towards the apical half.

♀.—Head dark brown, with creamy curved, and dark forked scales; palpi dark, a little greyish at apex. Scutellum pale brown, with eight border bristles on the middle lobe; pleuræ pallid, with a black spot in the middle. Legs dark brown. Ventral segments impure white, with apical lateral dark spots. Halteres with grey stem and dark knob. *Length.*—About 3·6 mm.

Habitat.—Southern China.

28 **CULEX CINGULATUS**, Fabr. ("S. A." 36, 11).

Tarsi brown, with the last joints nearly white; pale-banded, on the hind legs only, at the tibio-tarsal, and on all the tarsal articulations. Thorax brown, covered with pale golden-brown scales, with traces of three bare longitudinal lines on the mesonotum. Abdomen brownish-black, each segment with a semi-circular basal band of white scales. Ungues of ♀, small, equal, and simple. Proboscis banded in the ♂ only.

Head yellowish in the middle, a dark brown patch on each side, and pure white, between the dark patches and the eyes, at the sides; a few black forked upright scales dotted about and dark brown bristles projecting forwards; palpi of ♀, covered with black scales; those of ♂, brown, with basal white rings on the joints; proboscis of ♂, dark brown, paler at the tip, and in some lights, along the basal half; that of ♂, with a white band and yellow tip. Pleuræ pale, with three white patches. Halteres, with grey stem and pale brown and white knobs. Venter creamy-white. *Length.*—4 mm.

Habitat.—Lower Amazons, Rio de Janeiro.

Dr. Lutz calls it "the small day mosquito."

NOTE.—The above description applies in the main to certain female specimens from South America, identified with this species by Mr. Theobald, in which the proboscis is not banded. Fabricius, however, who appears to have based his descriptions on a ♂ specimen, distinctly states that the "haustellum is ringed white"; so that should the males corresponding to Dr. Theobald's specimens turn out to have an unbanded proboscis, the identification must necessarily be erroneous.

29. **CULEX SECUTOR**, Theobald (Monog. II, p. 321).

Tarsi deep brown, with pale bands at the tibio-tarsal, and all the tarsal articulations of the hind legs only. Thorax deep brown, covered with pale golden-brown scales, and adorned with two prominent bare lines in the middle in front, slightly expanding anteriorly. Abdomen almost black, with traces of white basal banding, which is fairly distinct on the second and third segments. Proboscis with a narrow pale band on its apical half, in the ♂ only.

Head nearly black, with golden-brown linear curved scales and dark brown forked scales; rather paler in the middle; palpi of ♀ nearly black, with a grey band at the base of the long, last joint; those of ♂ with a snowy spot at the base of the last joint, and the next with a pale basal band. Pleuræ brown, with grey patches. Legs deep brown, with white knee-spots. Tarsal claws of ♀ all equal and simple; those of ♂, unequal, with a single extra tooth on the larger claws of the fore and mid legs only. Halteres with dark stem and pale knob. *Length.*—About 4 mm.

Habitat.—Jamaica, up to 4,900 feet, after the autumnal rains. "These insects follow one like a cloud." It seems possible that it may be merely a variety of *C. cingulatus.*

30. **CULEX INFULUS**, Theobald (Monog. I, p. 370).

Tarsi with yellow bands on the articulations, the first joints banded both at base and apex, but the upper one not extending on to the tibia. Thorax very dark, unadorned, but with some yellow scales in front. Abdominal segments dark brown, with yellow apical bands, very well marked behind. Proboscis black with a pale yellowish band in the middle, and a narrow one before the apex. Wings with 4 twice its length inside 3, pale at the base, with a distinct round, dark spot.

♀.—Head black, with a few pale yellow scales and numerous black forked scales; palpi black, with a few white hairs at the tip. Scutellum and pleuræ alike dark tinted. Legs dark below, with yellow femora. Halteres with pale stem and brown knobs. Venter yellowish. *Length.*—5 mm It can be distinguished from the other "banded-proboscis" species by the small vitta just before the apex of the proboscis, as well as the broader central one, the basal and apical metatarsal and tarsal banding, and the dark round spot at the root of the wings.

Habitat.—Described from a single ♀ from Perak, Straits Settlements.

31. **CULEX TIGRIPES**, de Grandpré et de Charmoy.

"Les Moustiques," Planter's Gazette Press, Port Louis, p. 6.

= *C. maculicrures*, Theob. Monog. II, p. 34.

Plate. xvi, fig. 4a, Wing of ♂; 4b, of ♀; 4c, Head and appendages of ♂; 4d, Thorax of *var. Mombaensis.*

Wing densely clothed with black linear and truncate scales; tarsi unbanded, deep brown. Thorax unadorned, fuscous-grounded, clothed with curved golden scales. Abdomen deep chocolate, with ferruginous apical bands, broadened laterally by triangular basal patches of the same tint. Proboscis with a white band, sometimes incomplete above, beyond the middle. Femora black, their anterior borders decorated with equidistant ferruginous specks.

A very large gnat of a generally deep red-brown. The head has the nape clothed with yellow curved and black erect fork scales. In the ♂

the antennæ are one-fifth shorter than the proboscis, which is distinctly spatulate beyond the ventral white patch. The palps are subulate and greatly exceed the proboscis in length, and though not distinctly banded, show paler patches at the bases of the joints, and the last two joints have tufts of pale yellow hairs. In both sexes there are small pale knee-spots and apical tibial dots, and the venter is elaborately marked, especially on the hinder segments, with central fawn spots, separated from nearly pure white lateral patches by a narrow black streak curving backwards and outwards. The anterior and mid ungues are large and unsymmetrical, each claw being provided with a strong accessory tooth. A variety of this species, *C. Mombaensis*, having the thorax adorned with paler lines as in Plate xvi, fig. 4d, is distinguished by Mr. Theobald, in his monograph.

Habitat.—Southern and Central Africa, and also Queensland, according to Bancroft, who calls it the "long-lived mosquito," having kept it in captivity for five months.

GROUP III.—CULICES WITH THE WINGS AND PROBOSCIS UNORNAMENTED, BUT WITH SOME OR ALL THE TARSAL JOINTS BASALLY, PALE BANDED.

i. The abdomen with more or less distinct pale bands combined with lateral spots.

a. With distinct thoracic adornment.

32. *C. Japonicus*, Theob. Thorax dark, with five golden-scaled lines; abdominal banding narrow but complete. Femora not gartered above the knee-rings.

33. *C. albo-annulatus*, Macqt. Thorax with golden scales, adorned with five dark bare lines. Abdominal banding incomplete. Femora with pale garters above the knee-spots.

b. With the thorax unadorned.

34. *C. occidentalis*, Skuse. Most of the abdominal segments with narrow basal bands and spots. Wing scales all brown.

35. *C. flavifrons*, Skuse. Like the above, but with mixed yellow and brown wing scales.

36 *C. imprimiens*, Walker. Banded on the anterior abdominal segments only.

37. *C. rubrithorax*, Macqt. Abdomen black, with narrow basal bands on all but the two last segments and triangular lateral spots. Thorax brick-red.

38. *C. marinus*. Theob. Anterior four abdominal segments with basal, last two with apical, pale bands, with white lateral spots on the mid length of most of them. Wing scales mixed black and white.

39. *C. vigilax*, Skuse. Abdomen with narrow yellow basal bands, with white lateral spots. Thorax black, mottled with golden scales.

ii. Abdominal segments, with a pale median line or spots in addition to banding.

40. *C. maculiventris*, Macquart. The transverse bands on the abdomen are placed on bases and apices of contiguous segments, and there is a yellowish-grey median line. Venter pale, with the hinder border of segments mottled black.

41. *C. hirsutus*, Theob. Abdomen black, with yellow basal bands and large apical median spots. Thorax chestnut, with a creamy median line and four lateral spots.

iii. Abdominal segments, with basal pale bands only. (None have any distinct thoracic adornment.)

42. *C. vagans*, Wied. Thorax with golden-brown hair-like scales. Leg-bands broad.

43. *C. cæcus*, Theob. Thorax tawny-brown. Leg banding minute. Anterior and mid tarsal claws of ♀ toothed.

44. *C. procax*, Skuse. Thorax black, with golden scales. Tarsal claws of ♀ equal and simple.

45. *C. vexans*, Meig. Abdominal bands, white, narrowed in the middle. Tarsal banding narrow.

v. Abdominal pale bands placed on the contiguous borders of some or all the segments.

46. *C. cantans*, Meig. The abdominal bands spread out laterally so as to almost form lateral lines; they are basal on the anterior, and basal and apical on the last three segments. Wing scales uniformly brown. Tarsal bands broad.

47. *C. annulipes*, Meig. Abdominal banding very indistinct. Wings with some intermixed light scales.

48. *C. sylvestris*, Meig. Abdominal segment with pale basal bands narrowed in the middle, and the last two apically banded as well. Tarsal bands narrow.

49. *C. testaceus*, Wulp. Abdomen black, with creamy scales at the bases and more at the apices of the segments. Tarsi banded on the hind legs only.

vi. Abdominal segments unbanded, but with pale lateral spots.

50. *C. terrens*, Walker. Has the second hind tarsal joints entirely white.

51. *C. tibialis*, Desv. Second hind tarsal simply banded. Tibia intensely black, robustly ciliated.

viii. Abdominal segments without definite banding.

a. With the thorax distinctly adorned.

52. *C. vittiger*, Skuse. Thorax conspicuously adorned with two pairs of broad yellowish stripes alternating with black intervals. Mid-length of abdominal segments rather darker, giving rise to indistinct banding.

b. With the thorax unadorned.

53. *C. flavescens*, Theob. Abdomen uniformly ochreous. Tarsal bands yellow; very broad.

32. CULEX JAPONICUS, Theobald (Monog. I, p. 385.)

C. aureostriatus, Doll. (?) Naturkundig Tidsch. voor Neder. Ind. (Deel. XIV, p. 385).

Tarsal joints black, with white basal bands on the three upper joints of the hind, and two of the mid legs; fore legs unbanded. Thorax reddish-brown, with three parallel straight, and a pair of lateral curved stripes of golden scales, the median one forked behind, and enclosing a bare space. Abdomen black, with narrow white basal bands and white lateral spots as well as light bristles on the hind borders.

♀.—Head dark brown, with white orbits and median and lateral patches on the nape. Appendages all nearly black. Pleuræ with silvery puncta. Legs dark, tufted above, with large white knee-spots, which amount to a complete ring on the hind femora. Halteres with light stems and knobs. Ventral segments with broad white basal bands. *Length.*—5·6 mm.

Habitat.—Tokyo, Japan.

NOTE.—The above name must be regarded as provisional, as in all probability it is synonymous with Dolleschall's *C. aureostriatus*, from Amboina. The only point on which his description does not correspond is that he makes the abdominal banding apical, but the hinder fringe of light bristles masks their position, and it is easy to be mistaken on such a point, unless one regards its determination as a matter of importance. Pending the receipt of specimens from Amboina, or examination of Dolleschall's types, *C. Japonicus* must, however, stand as a provisional new species.

33. CULEX ALBO-ANNULATUS, Macqt.

Macqt. "D. E." p. 10, "Suppl. 4"; "S. A. C." p. 1732.

Tarsi purple-black, with white tarsal bands to the upper three joints of the fore and mid legs, and on the upper four, of the hind.

Thorax deep red-brown grounded, clothed with golden scales, and adorned by five bare lines, as in marginal figure, which are rendered more prominent by edges of white scales. Abdomen dark olive, with narrow white incomplete basal bands, and with lateral spots placed at the mid length of the segments. Femora with white garters just above the apex. Fore tarsal claws of ♂, very unequal, the large one with one extra tooth, the small one simple.

Head brown, with median and lateral patches of pale curved scales and black forked scales; palpi of ♀, black, with one white ring, and also the apex pale; those of ♂, with four white rings. Pleuræ dark, with patches of white scales. Legs with minute knee-spots, dark except at the base, and on above, speckled bandings. Halteres yellow with fuscous knobs. *Length.*— 5 to 5·5 mm.

Habitat.—Eastern Australia.

34. CULEX OCCIDENTALIS, Skuse ("S. A. C." p. 1729).

Plate xvi, fig. 15, Tarsal claws of ♀; 15a, Abdominal adornment.

Tarsi dark, with all but the last hind, and the upper three joints of the fore and mid legs with basal yellow bands, broad on the hind and indistinct on the fore legs. Thorax reddish-brown, with hair-like golden scales. Abdomen sooty, with narrow yellowish patches and lateral spots at the bases of the segments. Tarsal claws of fore and mid legs thick, equal, each with an accessory tooth.

Head brown, yellowish round the orbits, and in the middle; redder outside this, but with the flat-scaled side patches creamy; palpi black, with the apex white; proboscis black. Pleuræ testaceous, with creamy-white patches. Legs with the femora chestnut coloured, darker below, with small yellow knee-spots. Halteres yellow, with one side of the knob darker. Venter covered with mingled creamy-white and dark scales. *Length.*—5-6 mm.

Habitat.—Victoria; and King George's Sound, Western Australia.

35. CULEX FLAVIFRONS, Skuse ("S. A. C." p. 1735).

Closely resembles *C. occidentalis,* differing only in there being some yellow scales intermixed with the dark ones of the wings, and that the first hind tarsal joints are rather longer in proportion to the tibiæ. Very doubtfully distinct.

Habitat.—Blue Mountains, N.S.W. and Brisbane, Australia.

36. CULEX IMPRIMIENS, Walker

(Proc. Linn. Soc. v, p. 144).

Tarsi dark brown, with broad pale basal bands on the hind legs and less prominent markings on the upper joints of the other legs. Thorax unadorned, dark brown, with pale golden linear curved scales. Abdomen sooty, with traces of pale bands at the bases of the second and third segments, and also basal lateral spots. Fore tarsal claws of ♀, equal, with an accessory tooth.

♀.—Head wanting in the single type. Scutellum chestnut; pleuræ chestnut with some white scales. Legs dark brown, but paler at their bases. Wings with bases of fork cells nearly even, and 4 twice its length inside 3. III prolonged inwards as an unscaled extension. Halteres pale with fuscous knobs. *Length.*—6·5 mm.

Habitat.—Amboina.

37. **CULEX RUBRITHORAX,** Macquart ("D. E." p. 9).

Tarsal joints with white rings, especially distinct on the hind legs; thorax brick-red, unadorned, but armed with four double rows of brown bristles. Abdomen black, with narrow basal white bands, except on the last two segments, and triangular lateral spots. Proboscis tawny, black at base and tip (sometimes all black).

♀.—Head black, with narrow, pale yellow orbits, behind which is a broad band of flat black scales, creamy-white on the nape and at the sides; palpi black. Pleuræ marbled chestnut and white. Legs dusky yellow, with minute paler knee-spots, the tibiæ nearly black. Tarsal claws equal; those of fore and mid legs, with an extra tooth. Venter white, with a few dark scales on the hinder borders of the segments. Halteres yellow, with dusky knobs. *Length.*—5 mm.

Habitat.—Queensland; Tasmania.

38. **CULEX MARINUS,** Theobald (Monog. I, p. 396).

Tarsi black, with rather narrow basal white bands on the upper three joints of the fore and middle, and on all the hind tarsal joints. Thorax black-grounded, with fawn and brown scales of the usual linear form. Abdomen covered with nearly black scales, dull purplish in some lights; the first four segments with a broad basal band of creamy-yellow, to almost white, scales, the two following with creamy-white lateral spots, and the last two with creamy-yellow apical borders; laterally are white central spots on most of the segments, which show above, towards the apex; first segment with two patches of dark scales and a few scattered flat light ones, and numerous golden hairs. Proboscis dark, often with a tendency to a yellow band in the middle. Larger fore claw of ♀, with two extra teeth. A few white scales intermixed with the darker ones along the costa.

Head black, with scattered curved white, and black forked scales; palpi nearly black, with white apex in ♀; those of ♂, with the last joint pointed, but the next two dilated, strongly tufted narrow pale basal bands to the last two joints, and a small spot near the base. Pleuræ dark brown, with white patches. Legs bronzy-black, with white knee-spots and some scattered white scales above, especially on the undersides. Venter black, with scattered white scales. Most nearly resembles *C. vigilax*, Skuse. and differs from *C. albo-annulatus*, in having all the hind tarsals white banded, but there are no flat fusiform scales on the thorax. *Length.*—About 5 mm.

Habitat.—Queensland, Australia. Sometimes breeds in salt water.

39. **CULEX VIGILAX,** Skuse ("S. A. C." p. 1731).

Upper three of the fore and mid, and all the hind tarsal joints violet-black with white basal bands; thorax black, mottled with golden scales and setæ, but unadorned with any distinct marks. Abdominal segments narrowly banded in front with yellow, and with lateral patches of pure white. There is a tendency to banding of the proboscis.

Antennæ dark brown, three-quarters the length of the proboscis, joints of the scaphus, ochreous brown; head covered with dark brown, and indistinctly mottled with yellow scales; proboscis about seven times the length of the palpi in the ♀, almost black, ochreous beneath, from just beyond the base to a little beyond the middle; palpi dark brown, the last joint with white scales at the apex. Thorax almost black, densely covered with black and bronzy fusiform scales, closely applied and differing entirely from the usual *Culex* form; mottled with small patches of narrow curved golden scales and setæ; metanotum nearly black, somewhat testaceous laterally; halteres entirely ochreous. Legs black, with intermixed white scales, which predominate on the undersides of the femora, and with distinct golden knee-spots. All three pairs of tarsal claws with an extra tooth on each claw, the fore and mid being very unequal (*vide* Plate xvi, fig. 10, fore and hind claws of ♂). *Length.*—5 to 5·5 mm.

Habitat.—Eastern Australia.

40. **CULEX MACLIVENTRIS,** Macquart ("D. E." Cap. i, p. 7).

Wings unspotted; tarsi inconspicuously basally white banded; thorax black with rufus tomentum, unadorned. Abdomen black, the segments with both the fore and hind borders and a median line yellowish.

"Thorax black with rufous tomentum. Abdomen black with the incisions and a dorsal line yellowish; tarsi faintly white-ringed. Length 2 lines (♀). Proboscis brown; palpi black, with the apex white; antennæ brown. Frons drab. Abdomen black, with both anterior and posterior borders of the segments and a dorsal line of a greyish-yellow. Legs yellowish; tarsi black, with a little white at the base of each joint. Wings unspotted" (Macquart).

I have seen the type in the Jardin des Plantes, and this is certainly a most characteristically marked species. It is rather smaller than *C. pipiens*, and the proboscis is rather darker at the tip and base than in the middle. The eyes are black without any sign of lighter margin; the antennæ brown. The thorax and abdomen are absolutely as described, and the markings of the latter are very characteristic; the venter pale with the hinder borders of the segments mottled black. The banding of the tarsi is so inconspicuous that it might easily be overlooked. The wings have the veins clothed with alternate white and dark brown scales, the fringe of the internal border being drab; the second posterior cell is shorter, but a good deal wider than the first submarginal.

Habitat.—Algeria.

41. **CULEX HIRSUTUS,** Theobald (Monog. I, p. 392).

Tarsi black above, paler on the last joints, with very broad and distinct white basal bands on all the dark joints, and with signs of them on the paler ones. Thorax dark brown, clothed with deep chestnut scales, and adorned with others of a creamy tint, arranged to form a median line and four spots. Abdomen nearly black, with basal yellowish bands spreading laterally, and nearly joined in the middle by large apical spots, especially prominent on the hinder segments. Tarsal claws as in *C. albo-annulatus.*

Head with rows of dark brown, yellow, and creamy scales, and whitish orbits; palpi of ♀, dark brown, white at apex; of ♂, with four yellow bands, one of which is close to its base. Legs pale above, and dark on the tibia, which has a broad white basal band, with small white knee-tufts. Pleuræ brown, with small white patches. Halteres pale yellow venter marked with black, white, and yellow scaled patches. *Length.*—4 to 4·5 mm

Habitat.—Salisbury (4,000 ft.), Mashonaland.

Note.—The only *Culex* with at all similar abdominal markings is Mr. Theobald's *Albolineatus*, but that has unbanded tarsi.

42. **CULEX VAGANS,** Wied. ("A. Z. I." p. 545).

Plate xvi, fig 14, Venation of wing of ♀.

Tarsi deep brown with rather narrow ochreous basal bands to the three upper joints of the fore and mid legs, and broad ones on all but the last of the hind pair. Thorax with a clear brown ground, clothed with golden-brown, linear curved scales, unadorned. Abdomen deep brown with broad ochreous basal bands as well as ochreous hinder borders to the segments, and long white lateral spots. Wings with transverse veins placed far out, and fork cells unusually short, their veins with flaxen scales.

♀.—Head of a warm dark brown; proboscis rather pale brown, darker at the top; palpi dark brown, with clear brown rings in the middle and at the tip; nape densely covered with lighter yellow, curved scales. Pleuræ brown, marbled with white. Halteres pale brown. Legs deep brown, except on the femora, which are lighter, especially on their undersides. Ventral segments pallid, with narrow dark hinder borders. *Length.*—5 mm.

Habitat.—China—Redescribed from a specimen sent me by Capt. Victor Lindesay, I.M.S., from Hong Kong.

43. **CULEX CÆCUS,** Theobald (Monog. I, p. 413).

Tarsi nearly black, with all the hind, and the upper three joints of the fore and mid legs, narrowly basally white banded. Thorax dark brown, with bright tawny curved scales. Abdomen dark, with narrow basal whitish bands. Nape grey, with a black patch on either side. Prothoracic lobes very distinct.

♀.—Eyes with narrow whitish orbits; cephalic appendages brown. Scutellum paler than the rest of the mesonotum, with broadish white scales on the lateral lobes and a few narrow ones at the base; seven distinct brown hairs on the median lobe of the scutellum, and many others on the lateral lobes; metanotum pale brown; pleuræ pale ochreous with three large patches of greyish-white scales. Legs yellowish-brown with paler knee-spots; tarsal claws of fore and mid pairs equal, each with a small basal extra tooth. *Length.*—5 mm.

Habitat.—Straits Settlements, in Mangrove swamps; November.

44. **CULEX PROCAX,** Skuse ("S. A. C." p. 1742).

Wings unspotted; tarsi with basal white bands on all but the end joints of fore and mid legs. Thorax red-brown with golden scales, unadorned. Abdomen black, the segments narrowly banded white in front and fringed yellow behind. Head with a clear white spot on either side. Tarsal claws of ♀, equal and simple. Very diminutive.

♀.—Head, umber-brown to black; palpi black-scaled with a few grey ones intermixed; proboscis ferruginous, black at apex and base. Pleuræ umber-brown, with scattered white scales. Undersides of femora pale; legs elsewhere dark brown. Halteres yellow. Venter black, with a few white scales. *Length.*—3·8 mm.

Habitat—Queensland and N.S.W., Australia. Said by Skuse to fly by day.

45. **CULEX VEXANS,** Meigen.

= *C. articulatus*, Rondani.

[Syst. Beschr. vi, 241, 16, Meigen; Dipt. Scand. ix, 3464, Zett.; Isis (1831), 1203, 50, Ruthe; Fn. Austr. ii, 627, Schiner; Dipt. Neer. 325, V. d. Wulp; Bull. Soc. Ent. Ital. 258 (1896), Ficalbi, and Venti Specie Zan. Ital. p. 125 (1899), Ficalbi; Sp. Ital. d. Gen. Culex, Bull. Soc. Ent. Ital. (1872), Rondani (= *articulatus*).]

Tarsal joints all more or less narrowly basally white banded except the last. Thorax unadorned, dark grounded, with golden scales. Abdomen brown, with basal white bands, narrowed in the middle. Tarsal claws all with an extra tooth in both sexes; those of fore and mid legs of ♂, markedly unequal. Hook of claspers of ♂, bifid (*vide* Plate xvi, fig. 13).

Head brown, with yellowish scales; palpi of ♀, brownish-black, with a small fourth joint, with a few pale scales, those of ♂, brownish-black, longer than the proboscis, and pale at the bases of the joints; proboscis yellowish-brown, darker at the base and tip; antennæ brown. Thorax unadorned, clothed with pale golden scales; pleuræ with patches of white scales. Abdomen brownish, with basal white bands, narrowed in the middle. Wings with yellowish-brown veins. Legs with the coxæ brownish, with white scales; femora brown, yellowish at the base and beneath; tibiæ slightly spinose, brown. Venter yellow with a dark median line. *Length.*—About 7 mm.

Habitat.—Has been recorded from most parts of Europe, but doubtfully so from England.

46. **CULEX CANTANS,** Meigen.

= *C. stimulans*, Walker; = *C. maculatus*, Meig.; = *C. fumipennis*, Stephens.

(Syst. Beschr. i, 6, 6, Meigen; Dipt. N. d. Fr. 160, 2, Macq.; Ins. Lapp. 806, 3, Zett.; Dipt. Scand. ix. 3461, Zett.; Fn. Austr, ii, 627, Schiner; Dipt. Neer. 326, Van der Wulp; Ins. Brit. Dipt. iii, 246, Walker; Bull. Soc. Ent. Ital. p. 258 (1896), Ficalbi; Syst. Beschr. i, 6, 7 (= *Maculatus*), Meigen.)

Tarsi black, with some white scales intermixed on the first joints; tbe first three of the fore, upper four of the mid, and all the hind joints basally white banded, very broadly so on the last. Thorax unadorned, dark grounded, with golden-yellow and brown curved linear scales, rather paler in front of the scutellum. Abdominal segments nearly black, with pale yellow basal bands, broadening laterally so as to almost or quite meet in some specimens; venter white. All of the ♂ tarsal claws with one extra tooth and also the fore claws of the ♀. (Plate xvi, fig. 12).

Head dark grounded, with creamy curved linear, and yellow, and also black, erect forked scales; palpi, ♀, nearly black, with scattered white scales; those of ♂, longer than the proboscis, with yellowish brushes and rings on the middle joints. Pleuræ brown, with creamy patches. Legs yellowish at the base, the femora dark tipped but with yellow knee-spots, and the tibiæ clothed with irregularly mixed black and white scales. Halteres entirely pale yellow. *Length.*—About 6 mm.

Habitat.—Europe; Northern America.

I have also received a specimen from Dr. Price, of Conoor, Nehilgerri Hills, Southern India (about 6,000 feet), who notes it as a sylvan species.

47. **CULEX ANNULIPES,** Meigen.

Syst. Beschr. vi, 241, 15, Meigen; Dipt. Scand. ix, 3462, 10, Zett.; Fn. Austr. ii, 627, Schiner; Dipt. Neer. viii, 346, Van der Wulp; Ins. Brit. Dipt. iii, Walker.)

Tarsi light yellow, with white basal bands, but the last joint quite black. Thorax dark ferruginous, with two faint darker converging lines. Abdomen yellowish-grey with ill-marked bands, but uniformly light yellow according to Ficalbi. Wing veins with some white scales intermixed with the darker ones.

Proboscis rather yellowish, darker at base and apex; palpi of ♂, yellowish, with the apices of each joint darker, with brown specks and tomentum; in the ♀, very brown; nape rather brownish, ferruginous; pleuræ speckled whitish. Wings with the veins ferruginous; the fork cells, with their branches longer than their stems, that of the hinder the shorter. Legs generally yellowish, femora yellow, speckled black above; tibiæ light yellow. *Length.*—10 to 12 mm.

Habitat.—Northern Europe, including England; a sylvan species.

48. **CULEX SYLVESTRIS,** Theobald (Monog. I, p. 406).

Tarsi black above and pale below, with narrow white basal bands to all the joints of the hind and on the upper three of the fore and mid legs. Thorax deep brown, with thin golden scales, pale in front of the scutellum. Abdomen, with dusky brown to black scales, with basal bands of pure white, bent in in the middle, last two segments with apical white bands as well. The lateral flat-scaled area of the head consists of an antero-internal black spot with a white patch behind and outside it.

Vertex and nape, clothed with golden curved linear, and ochreous, and also black erect forked scales; palpi of ♀, black with white apex; those of ♂, with the third and fourth joints dilated, with white basal bands, that on the latter very broad. Pleuræ brown, with white patches. Legs dark except at base, with small yellow knee-spots. Venter mostly white, with narrow lateral dark patches. *Length.*—4·5 to 5 mm.

Habitat.—Canada ; Manitoba. July and September; a sylvan species.

49. CULEX TESTACEUS, Van der Wulp

[Tijdschr. voor Ent. p. 128 (1869)].

Tarsi dark-scaled *with a white band at the base of the two upper joints of the hind legs only.* Thorax brown, with creamy curved scales, and golden hairs at the roots of the wings. Abdomen, covered with dusky black scales, with creamy ones at the bases, and a few at the apices and on the middle of the segments. Tarsal claws of ♀, equal, all with an accessory tooth.

♀.—Head dark brown, with pale curved scales in the middle, black upright ones behind, and flat creamy ones at the sides; antennæ testaceous, with narrow pale bands; palpi testaceous, black scaled at the apices ; proboscis testaceous, with brown and creamy scales, black at the apex and dusky at the base ; clypeus chestnut-brown. Pleuræ deep red-brown, with white scales. Legs and insect generally, including the veins of the wings, of a bright testaceous tint. *Length.*—6 mm.

Habitat.—North America ; Ontario.

50. CULEX TERRENS, Walker (Ins. Saund. p. 429).

Tarsi dark, with basal white bands on the upper joints of fore and mid legs, and the hind legs adorned in an exceptional manner ; the first joint being white both at base and apex with a broad black band in the middle, the next all white, and the third joint with a broad tasal white band, while the last two joints are unbanded. Thorax brown, with broad lateral patches and the middle line paler. Abdomen with metallic purple reflections and golden-orange scales scattered over it, with five pairs of distinct white lateral spots, and two, on the sides of the penultimate segment. Covered with dense golden-brown hairs.

Head brown; eyes black, bordered with a line of white scales ; proboscis, palpi and antennæ deep chestnut-brown. The plumes of the male antennæ deep silky brown. No traces of banding on the palpi. Pleuræ marbled cutaneous and white. Legs brown, paler at their bases, especially below. *Length.*—6 mm.

Habitat.—South America.

Observations.—No one could recognise this species from Walker's description ; but the broad white band, involving three joints of the hind tarsi, is absolutely distinctive. It appears to be rare, as no fresh specimens have reached the British Museum.

51. **CULEX TIBIALIS,** Desvoidy ("Essai," p. 404).

Tarsal joints with basal yellowish bands; thorax fuscous with grey tomentum, unadorned; abdomen uniform black; tibiæ black, hirsute.

Black, with cinereo-fuscous tomentum; antennæ yellowish-brown; femora pale yellow, with black cilia at the apex; tibiæ black with strong hairs; first joint of the tarsi with yellow ciliæ. *Length.*—4 to 6 lines.

♂.—Antennæ yellow-brown; palpi and proboscis fuscous; body black, with dusky grey tomentum. Femora of the colour of honey black and hirsute at the apex; tibiæ intense black, robustly ciliate; joints of the tarsi honey-tinted, black at the apices. Wings rather dusky, the veins with brown scales.

Habitat.—Brazil.

Observations.—Mr. Theobald thinks this may be a synonym of *C. cingulatus*, Fabr.

52. **CULEX VITTIGER,** Skuse ("S. A. C." p. 1728).

Tarsi black, with basal white bands; the first joints of the fore and mid legs being almost all white, but the remaining banding narrow except on the hind legs, on which it is fairly marked. Thorax conspicuously adorned with two pairs of broad yellowish-scaled stripes, alternating with equally wide black scaled lines. Abdomen mostly yellowish-grey, with some dark scales across the middle of the anterior segments; producing an indistinct banding. Wings with fork of II a trifle inside that of IV; and 3 but little inside 4. Palpi of ♀, large for a *Culex*, distinctly five jointed.

♂.—Head brown with narrow curved, and erect, forked scales yellow; palpi with ochreous and brown scales. Pleuræ densely covered with whitish scales. Legs brown, yellowish at the base. Halteres yellow with brown knobs. *Length.*—6 mm.

Habitat.—Bush country along East Coast of Queensland; and N.S.W., Australia.

53. **CULEX FLAVESCENS,** Theobald (Monog. I, p. 410).

Tarsal joints with ochreous basal bands, so broad as to leave only narrow black tips. Thorax golden scaled. Abdomen entirely covered with ochreous scales.

♀.—Head densely covered with narrow golden-yellow curved, and upright brown, and black, forked scales; antennæ yellowish at the base brown apically, basal joint bright ochreous; palpi ochreous with brown scales; proboscis ferruginous, darker at tip. Scutellum and pleuræ yellowish. Wings with fork cells level, and 4 close up to 3. Legs ferruginous, darker on the tibiæ; the fore and mid tarsal claws symmetrical, each with an extra tooth. A very yellow species. *Length.*—6 mm.

Habitat.—Described from four specimens in the Hope collection, the origin of which is unknown.

Group IV.—Culices with Uniformly Coloured Wings and the Tarsal Joints Apically Pale Banded.

Only one species is recorded with the feet ornamented in this way, and no specimens answering to the description quoted below have come to hand. Possibly it really belongs to the next group, or it may be, as suggested by Skuse, synonymous with *C. albo-annulatus*, Macqt.

54. **CULEX CAMPTORHYNCHUS**, Thomson

(Eugen. Resa. Dipt. p. 443).

Thorax fuscous brown; pleuræ lighter; mesothorax marbled with short fulvous-golden scale-like hairs, and sparsely clothed with long erect fuscous hairs on the sides and near the wings. Abdomen fuscous, with the sides pale. Legs long, light coloured; tarsi with the joints apically whitish, the first almost as long as the tibia. *Length.*—4 mm.

Habitat.—Sidney, Australia.

Group V.—Culices with the Wings Unspotted, and the Proboscis Unbanded, but with the Tarsi Banded "on the Articulations" (*i.e.*, two Joints Participating).

i. The abdominal segments ornamented with pale lateral spots, in addition to basal bands.

55. *C. gelidus*, Theob. Scales clothing the dusky ground of the thorax frosty on the anterior two-thirds, very dark behind. Proboscis with a broad black terminal band.

iii. The abdominal segments with pale basal bands.

56. *C. morsitans*, Theob. Thorax chestnut-brown, with five creamy-white lines.

vi. The abdominal segments unbanded, but with pale lateral spots.

57. *C. Canadensis*, Theob. Last two tarsal joints dusky white.

C. cingulatus, Fab. The ♀ of this species, which has the proboscis banded in the ♂ only, would be traced to this position.

55. **CULEX GELIDUS,** Theobald (Monog. II, p. 20).

Tarsi dark, with three pale bands on the fore, and four on the mid legs, the upper ones on the articulations, the lowest basal only; hind legs banded in the same way as the middle pairs, but indistinctly. Thorax dusky yellowish-brown to brown, with the front two-thirds covered with frosty-white, curved scales; the hind portion with almost black scales and long dark bristles. Abdomen brown with basal creamy-white bands and pale lateral spots. Ungues of the ♀ equal and simple. The proboscis has a broad black band on the apex, so that there is a tendency to pale banding.

♀.—Head with frosty-white curved scales in front, and upright white ones at the back, sides clothed with ochreous scales, with apparently two yellow bristles at the edge projecting forwards from the middle; palpi with black scales, slightly ochreous towards the base on the inner side. Pleuræ pale reddish, with a few black hairs. Legs ferruginous, with scattered dark scales. Venter yellowish. Halteres with white stem and black scaled knobs. *Length*—4·5 mm.

Habitat.—Straits Settlements and Travancore. Mr. Theobald describes a variety of this species, *C. gelidus, var. cuneatus*, from the same localities, in which the pale abdominal bands show a median wedge-shaped extension.

56. **CULEX MORSITANS,** Theobald (Monog. II, p. 8).

Tarsi dark, with the pale bands on the tibio-tarsal and upper tarsal articulations:—in the ♀, all the hind articulations are banded. Thorax chestnut-brown, ornamented with median and two lateral creamy lines on either side (differing somewhat in the two sexes). Abdomen fuscous, with yellowish basal bands. Tarsal claws of ♀, equal and simple.

Head dark brown, with white orbits, and two pairs of paler patches on the nape, indistinct in the ♀; palpi of ♀, dark, with a yellowish apex; of the ♂, longer than the proboscis by the last joint, which has a white band at its base, and with two other bands on the next two articulations. Pleuræ brown, with a few creamy scales. Legs dark brown, but pale at the base, and with yellow knee-spots. Venter yellow, with fuscous lateral patches on the middle of the segments. Halteres with pale stems and dark knobs. *Length.*—From 6 to 7 mm. Differs from *C. vexans* in the tarsal claws of the ♀ being simple, and not toothed.

Habitat.—England.

57. CULEX CANADENSIS, Theobald (Monog. II, p. 3).

Tarsi dark, except the dusky-white last joint of hind legs, which have also pale bands on the tibio-tarsal and next two articulations; while the mid legs have but two bands, and the fore pair are unbanded. Thorax deep chestnut-brown, with curved golden-brown scales, paler and broader ones at the sides. Abdomen dusky black, with basal white lateral patches, which show on the dorsum of the fourth to seventh segments.

Head dark brown, covered with pale golden curved, and with a few black and ochreous upright forked scales and a border of pale scales round the eyes, black bristles projecting forwards, and a tuft of pale golden scales between the eyes; the lateral flat-scaled portions, pure white in the ♂; palpi nearly black, those of the ♂ with a white basal band on the fourth joint. Pleuræ purplish-brown, with several patches of white scales. Legs yellowish-brown, darker on the upper parts of the tibiæ. Halteres with white stems and black knobs. Venter uniformly ochreous. *Length.*—About 6 mm.

Habitat.—Lake Simcoe, Ontario; June and July.

GROUP VI.—CULICES WITH THE WINGS AND PROBOSCIS UNORNAMENTED, AND WITH ONE OR MORE OF THE LAST TARSAL JOINTS ALL WHITE ON ONE OR MORE PAIRS OF LEGS.

a. With last two joints of all the legs white.

58. *C. longipalpis*, Wulp. The pale banding of the remaining tarsal joints, and of the abdominal segments, is basal.

b. With the last joints only of all the legs entirely white.

59. *C. leucacanthus*. Loew. The pale banding of the remaining tarsal articulations is "on the articulations," and that of the abdominal segments, basal.

c. With the last two tarsal joints of the hind legs only all white.

60. *C. albitarsis*, Theob. Remaining pale bands on the hind legs placed on the articulations. Fore and mid legs with a single pale band on the tibio-tarsal articulation.

[1] 56. *C. Canadensis*, Theob. Might very possibly be traced to this position, *vide ante*; No. 56.

d. With the last joints only of the hind legs, all white.

61. *C. dorsalis*, Meig. The remaining tarsal banding is on the articulations. Thorax reddish, with indistinct creamy lines. Abdomen with pale basal bands and lateral spots. Tarsal claws of ♀, equal and simple.

62. *C. penicillaris*, Rondani. Closely resembles the above, but the tarsal pale bands are less marked, and the tarsal claws of ♀, equal and toothed. The palpi of the ♂, not banded.

63. *C. pulchritarsis*, Rondani. Closely resembles the two above species. Tarsal claws of ♀, equal and toothed. Palpi of male banded, but its last joint not all white.

64. *C. pulchripalpis*, Rondani. Closely resembles the three above species, but has the last joint of ♂ palpi all white. (The form of tarsal claws of ♀, is unknown.)

58. CULEX LONGIPALPIS, Van der Wulp

(Bijdragen der Midden Sumatra Exped. iv, p. 9).

Tarsi dark, with basal white bands, an additional band on the middle of first joint, and the last two joints of all the legs whitish, the white clearest on the hind legs. Thorax red-brown, unadorned. Abdomen nearly black with pale basal (?) bands ("lighter incisuræ"). Proboscis yellowish in the middle but dark at base and apex. Palpi of ♀, as long as the head, and "two-jointed."

♀.—Generally fuscous. Antennæ, dark brown, indistinctly lighter banded. Legs with coxæ brownish-yellow, the femora and tibiæ clothed with white and black scales so as to give a spotted appearance. Halteres yellow. Anus ferruginous. *Length.*—4·5 mm.

Habitat.—Alahn Pandjang and Sœrœlangœn.

59. CULEX LEUCACANTHUS, Loew.

[Bescha. Europäischer Dipt. Dritter Bd. Halle (1873)]; "F. R." p. 265.

Tarsi dark except the last joints, which are all white, and with pale bands on three of the fore and mid, and on four of the hind articulations. Thorax brazen yellow, with two ill-defined darker longitudinal streaks; abdominal segments black, with basal white bands. Palpi of the ♂, whitish; an abundance of whitish hairs on the body, and the internal wing-fringe of the wing characteristically brilliant white.

♂.—Head of a pale brassy tint, with nearly black hairs; palpi whitish. Pleuræ speckled snow-white. Legs nearly white at the base with a white knee-spot on the tibio-femoral articulation. *Length.*—Very minute, $1\frac{2}{3}$ lines.

Habitat.—Kasan.

NOTE.—This is evidently a very distinct species, but nothing resembling it has come to hand.

60. CULEX ALBITARSIS, Theob. (Monog. II, p. 25).

Tarsi pallid in some lights, with the last two joints of the hind legs and the apex of the next white; and showing also a band on the tibio-tarsal articulation of all the legs, though the fore and mid pair are otherwise unbanded. Thorax unadorned, clothed with dark bronzy scales. Abdomen, with the last segments yellowish, deep golden-brown in front, with creamy, lunate basal bands, and with lateral spots on the second to seventh segments (*vide* Plate xvi, fig. 16a).

♂.—Head deep brown with linear curved, and erect forked scales, alike of a golden tint, yellow orbits, and flat-scaled lateral patches; palpi brown, with the last joint clubbed, and the apex of the next joint, and a band half way down yellow (Mr. Theobald can only detect two joints in the appendage); antennæ and proboscis, golden-brown. Pleuræ dark grey and rich ochreous, with a patch of creamy scales. Ventral segments, golden, with narrow black hinder borders. Legs yellowish-brown; tarsal claws of fore and mid legs unequal with an accessory tooth (Plate vi, fig. 16). Halteres pale with fuscous knobs. *Length.*—6 mm.

Habitat.—Bonny, West Africa; July.

61. **CULEX DORSALIS**, Meigen.

(Syst. Beschr. iv, 242, 18, et i, 2, 3, Meigen; Dipt. Scand. ix, 3464, Zetterstedt; Isis (1831), 1203, 50, Ruthe; Fn. Austr. ii, 627, Schiner; Dipt. Neer. 325, Van der Wulp; Bull. Soc. Ent. Ital. p. 246 (1896), Ficalbi; Ent. Mo. Mag. p. 228 (1895), Austen.)

Tarsi dark brown, with rather broad yellow bands on the tibio-tarsal and tarsal articulations, except the last tarsals, which are dark. Thorax brown, with bright tawny-red and pale creamy, curved scales forming two lines on the mesothorax, and also forming a line in front, and a patch before the scutellum. Abdomen brown, with a few scattered pale scales, and creamy basal bands, a central line of pale yellow scales and pure white lateral spots. Ungues equal and simple in the ♀. Wings with numerous white scales, intermixed with the darker ones, especially along the costa.

♀.—Head brown, with pale yellowish curved, in the middle, upright pale forked, and ochreous flat scales at the sides; antennæ brown, basal joint bright ferruginous, basal and next few following joints with creamy scales; palpi yellowish-brown, with brown and dull creamy scales, especially numerous at the apex; proboscis brown, darker towards the tip. Pleuræ brown, with numerous whitish scales. Legs clothed with mixed yellow and black scales, the latter most numerous towards the apices of the long joints, and with white knee-spots. Venter, with scattered white scales. *Length.*—5 to 5·5 mm.

Habitat.—Northern Europe, including East Coast of England, where it is known as the "Norway Mosquito," having been introduced, it is said, some twenty-five years ago in a yacht, from Norway.

NOTE.—I have seen the types in the Jardin des Plantes, and they afford a good illustration of the uncertainty of the older descriptions of gnats. One of the types is really, I think, a specimen of *C. pipiens* that has somehow got misplaced, but the other four, which are in very fair condition, answer well to the above description, although this differs from Meigen's, in some points.

62. CULEX PENICILLARIS, Rondani.

(Boll. Soc. Ent. Ital. (1872), Rondani; Venti Sp. Zanzare Italiane, p. 112 (1899), Ficalbi.

Closely resembles *C. dorsalis*, Meig., but differs, according to Rondani, in the tarsal banding being less obvious. The fore and mid tarsal claws of the ♀ are equal and *toothed*, not simple as in Meigen's species. *Length* 5 to 9 mm.

Habitat.—Italy.

NOTE.—After reading the descriptions of the above, to say the least, very closely-allied species, including Ficalbi's arguments as to their distinctness, I am left with a strong suspicion that they should all (*penicillaris*, *pulchritarsis*, and *pulchripalpis*, Rond.) stand as varieties of *C. dorsalis*, Meig. This in spite of differences in the tarsal claws, which Coquellett may, after all, be right in regarding as variable. Ficalbi argues, for example, that Rondani's *penicillaris* cannot be *dorsalis* because Meigen describes the banding of the tarsal joints as basal, but as a matter of fact, Meigen's types show that his description was erroneous, as their tarsi are really banded exactly as described by Ficalbi for *penicillaris*.

63. CULEX PULCHRITARSIS, Rondani.

(Sp. Ital. Culex, Boll. Soc. Ent. Ital. (1872), Rondani; Venti Sp. Zanzare, Ital. p. 133 (1899), Ficalbi.

Tarsi with the last joints entirely white, but with the others nearly black, with broad snowy bands on all the articulations including the tibio-tarsal. Thorax dark, with golden scales, but unadorned. Abdomen chocolate-brown, with narrow straw-coloured basal bands, which expand at the sides into lateral spots with the apex behind. Tarsal claws of ♀, symmetrical, each with an extra tooth on the fore and mid legs, simple behind. Wings, brindled with a mixture of nearly equal numbers of black and of white scales.

Head brown: palpi of ♀, brown, the small fourth joint brownish-black with a white apex; in the ♂, longer than the proboscis, slightly clubbed, brown, with pale rings at the base of the last three joints, hair tufts maroon-brown, pale at their apices; antennæ of the ♀, brownish-black; in the ♂, with maroon-brown plumes, with pale reflections; basal joint with white scales: a white border round the eyes. Pleuræ speckled white. Legs clothed with mixed white and black scales, the former preponderating on the femora, except at the base and apex, tibiæ darker. Fore tarsal claws of ♂, with two extra teeth to the larger, and one on the smaller claw. *Length.*—7 to 8 mm.

Habitat.—Italy.

64. **CULEX PULCHRIPALPIS,** Rondani. ("F. V. S." p. 172).

Last hind tarsal joints entirely white, the rest nearly black, with rather narrow pale bands on the articulations, rather indistinct on the fore and mid legs. Thorax with brazen-yellow scales. Abdominal segments chocolate-brown, with rather narrow tarsal bands, expanding into triangular lateral spots. Palpi of ♂, about length of the proboscis, with the last joint entirely white, and three white rings.

♂.—Head yellowish and brown; antennæ brown, with white scales on the basal joint. Pleuræ grey, sprinkled with white scales. Legs generally dark but with white knee-spots, and the bases and undersides of the femora pale; the apices of the tibiæ participating in the uppermost tarsal bands. *Length.*—Including the proboscis, 7 to 8 mm.

Habitat.—Italy. Redescribed by Ficalbi from a single ♂ specimen in Rondani's collection, but not noted by any other author.

Banded-Legged Species, Inadequately Described, and hence of only Nominal Status.

65. **CULEX CASPIUS,** Pallas.

= *C. parvus*, Macquart (?).

(Reisen derch das Russisch. Reich. Pallas; Nou. Suit. à Buffon, Hist. Nat. d. Ins. Dip. t. i (1834), Macquart.)

Like *C. pipiens*, but a little smaller, with the same buzz and ferocity; greyish. The thorax with cinereous stripes; tarsi indistinctly banded; covered with short pubescence, the wings also with delicate fringes on the veins and margin. Antennæ filiform in both sexes; proboscis longer than thorax, its sheath snowy white; palpi very short, scarcely as long as the head, thick.

Habitat.—Marshes near the Caspian Sea; treacherous, very common and numerous.

66. **CULEX PARVUS,** Macquart (1834).

[Nou. Suit. à Buff. Hist. Nat. d. Ins. Dipt. tom. i (1834).]

Wings unspotted; tarsi with white rings; for the rest like *Culex pipiens*. *Length.*—2 lines.

Habitat.—France.

NOTE.—Possibly the same as the preceding.

67. **CULEX NICAENSIS,** Leach

(Zool. Journ. ii. 292, 2, Leach).

Head and thorax dark brown. Legs cinereous, with tarsi grey ringed. Abdomen dark brown, all the segments bordered behind with cinereous. *Length.*—10 mm.

Habitat.—Nice; common.

NOTE.—Not noticed by Ficalbi, or any recent observer; the type apparently not existing.

68. **CULEX ANNULITARSIS,** Macquart ("D. E." i, p. 8).

= *C. fasciatus*, Fabricius (?).

Fuscous; tibiæ white ringed; first hind tarsal joints whitish, with fuscous rings. *Length.*—2 lines (♀).

Legs brown; femora with whitish bases, hind tibiæ with a large white ring at the tip; first hind tarsal joints whitish, with a small brown ring.

Habitat.—Mauritius.

69. **CULEX BIPUNCTATUS,** Rob. Desvoidy.

(Mem. Soc. d'Hist. Nat. de Paris, t. iii (1827), Rob. Desvoidy; Suit. à Buff. i, 35, 11, Macquart.)

Thorax, with dorsum dark red and the pleuræ lighter, with two silvery spots in front. Femora pale yellow; knee yellowish, tarsi ringed brown and yellow. Dorsum of abdomen yellow, with a median blackish line. *Length.*—4 lines.

Habitat.—France.

NOTE.—The type is not traceable, nor has the species been observed since it was described.

GROUP VII.—CULICES WITH UNBANDED TARSI.

This is a large group of nearly seventy species, which are extremely difficult to tabulate, on account of the close resemblance of many of the forms included.

The most convenient basis of tabulation appears to be the ornamentation of the abdomen, and in view of the large number of species included, it will be more convenient to deal with each category separately. Of the eight types of abdominal marking, all are represented except the fifth, viz., that in which the abdominal segments have pale bands, both at base and apex.

The group is accordingly subdivided as below:—

i. Abdominal segments with pale basal bands and more or less distinct lateral spots.
ii. With basal pale bands and longitudinal stripes, median or lateral.
iii. With basal pale bands only.
iv. With apical pale bands.
vi. Unbanded, but with lateral spots.
vii. Unbanded, but with a pale median line.
viii. Quite unadorned.

It must be understood that it is not necessarily implied that ALL the segments are thus marked, but that, in each case, a greater or less number of them conform to the description.

Subdivision i.—*Culices with unbanded tarsi and the abdomen ornamented with pale basal bands together with lateral spots. Four species only conform to this description.*

70. *C. univitatus*, Theob. The tibiæ have broad white apical bands, especially well marked on the hind legs. Head brown, with one white patch.
71. *C. quasiunivitatus*, Theob. Closely resembles the above, but has two black patches on the head.
72. *C. restuans*, Walker. Tibiæ without apical pale band. Two pale round spots on the mesonotum. Tarsal claws of ♀, equal and simple.
73. *C. australis*, Erichson. Tibiæ without apical band. Mesonotum clothed with golden scales, arranged more or less in lines. Tarsal claws of ♀, equal, but with extra tooth.

70. **CULEX UNIVITATUS**, Theobald (Monog. II, p. 29).

Legs with the tarsi uniformly coloured, but with broad white apical bands on the tibiæ, most marked on the hind legs. Thorax deep brown, with scattered golden curved scales; scutellum with three patches of pale, sometimes silvery, scales. Abdomen brown to purplish-black, with more or less basal white banding, sometimes rather yellowish, and with triangular basal white lateral spots.

Head brown, with creamy linear curved, and dark erect forked scales; the lateral flat scales creamy-white, with a bare line in the middle;

proboscis brown, darker at the tip; palpi of ♀, black, with a few grey scales; those of the ♂, longer than the proboscis by all the last, and half of the next joint, brown, with a white band on the basal third. Legs yellowish on the femora, darker below, with clear yellow knee-spots. Pleuræ brown, with whitish patches. Halteres with a dusky lateral line and darker knobs. Venter with broad white basal bands. Tarsal claws of ♀, equal and simple; those of ♂, unequal, with an extra tooth on the fore and mid legs: the hind equal and simple. *Length.*—About 5 mm.

Habitat.—South Africa: Durban and Salisbury, Mashonaland. February to April, and also from Singapore, in July.

71. **CULEX QUASIUNIVITATUS,** Theobald (Monog. II, p. 32).

Closely resembles the above, but differs in having two black patches on the head; by the tarsal claws of the fore and mid legs of the female having each an extra tooth; and by there being a pair of indistinct median pale lines on the point of the mesonotum. *Length.*—5 mm.

Habitat.—Salisbury, Mashonaland.

72. **CULEX RESTUANS,** Sp. n. (Walker, MS.).

(Monog. II, pp. 119 and 142).

Tarsi uniformly bronzy-black. Thorax bright chestnut-brown, with golden-brown curved scales; two round pale spots on the mesonotum, a patch of pale scales just in front of the root of the wings, and paler scales around the bare space in front of the scutellum. Abdominal segments dusky brown, with basal bands of yellow, and pure white lateral spots. Ungues of the ♀, equal and simple.

♀.—Head black, with numerous pale creamy, curved, and black, upright forked scales, with flat white scales at the sides of the head; palpi black, greyish at the tip; antennæ with the basal joint and base of the second, testaceous, remainder blackish-brown, with pale pubescence; clypeus and proboscis brown. Scutellum pale with six bristles to the middle lobe. Pleuræ pale brick-red, with four white patches. Legs bronzy-brown to black, except the coxæ, the bases of, and ventral sides of femora, which are very pale, and also a yellow knee-spot. Halteres with pale yellow stem and dusky knob. *Length.*—6 mm.

Habitat.—Toronto and Ontario, Canada.

73. **CULEX AUSTRALIS,** Erichson (1842).

= *Culex crucians*, Walker (1856) (?).

[Archiv. für Naturg. viii, p. 470 (1842), Erichson; Ins. Saundersiani, i, p. 432 (1856) (= *C. crucians*), Walker (?)].

Tarsi, uniformly black. Thorax, deep rich chestnut-brown, with small golden curved scales, more or less arranged in lines.

Abdomen black, with basal creamy-white bands and large lateral white spots. Tarsal claws of ♀, large, equal, uniserrated.

Head dark brown, with narrow, pale yellow eye-borders, and with golden curved scales on the nape and creamy flat-scaled lateral patches; palpi of ♀, large, reddish-brown, with a few grey scales; those of the ♂, rather shorter than the proboscis. Pleuræ chestnut-brown, with small, flat, whitish scales. Legs black, unbanded, with a distinct yellowish knee-spot. Halteres with pale stems and fuscous knobs. Venter whitish. *Length.*—About 6·8 mm.

Habitat.—Australia; Tasmania.

Subdivision ii.—*Culices with unbanded tarsi, and the abdomen ornamented with longitudinal stripes in addition to banding.*

74. *C. albolineatus*, sp. n. Abdominal segments with greenish-white basal bands and a distinct but not sharply-defined pale median stripe.
75. *C. mediolineatus*, Theob. Abdominal segments with a broad yellow median line and lateral basal spots, with traces of pale apical banding.
76. *C. Spencerii*, Theob. Abdominal segments creamy-white, with black lateral patches at the mid-length of the segment, leaving a white median line with basal and apical banding. Thorax black, with golden scales and pale lines.
77. *C. rusticus*, Rossi. All the abdominal segments brownish, with black lateral spots. Thorax greyish.
78. *C. albifasciatus*, Macquart. Abdomen dusky, with yellowish-white median line and incomplete apical bands.

74. **CULEX ALBOLINEATUS**, sp. n.

Plate xvii, fig. 10a, Venation of Wing of ♀.

Tarsi uniformly brown. Thorax black-grounded, clothed with bronzy scales, with two indistinct narrow median black lines. Abdomen black; all the segments with greenish-white basal bands, and the darker portions pale brown in the middle shading into black at the sides so as to form a paler median line. Wings with the fork-cells very long, quite three times the length of the stem, in the anterior fork.

♀.—Head greenish-grey; antennæ black, with greyish verticils; palpi deepest brown, minute. Wings with very long, hair-like scales. Halteres pale throughout. Legs dark brown, with paler femora. Venter greenish-white throughout. *Length.*—About 5·5 mm

Habitat.—Described from a single ♀ specimen taken in my bungalow at Shahjahanpur, N.W.P., India, October 20th, 1900.

75. CULEX MEDIOLINEATUS, Theobald (Monog. II, p. 113).

Tarsi uniformly brown. Thorax rich golden-brown, with two paler longitudinal parallel lines, placed wide apart. Abdomen brown, with a broad median ochreous line, ochreous lateral basal spots, and traces of apical pale bands; venter ochreous. Fore and mid ungues of the ♀, equal, uniserrated; hind equal and simple. Fork-cells short.

♀.—Head covered with narrow, hair-like curved golden scales in the middle, and numerous thin ochreous and deep brown upright forked scales, sides clothed with small, flat, ochreous scales, and golden bristles projecting forwards over the coppery eyes; antennæ brown, joints rather thick, basal joint testaceous; palpi bronzy-brown; proboscis rich dark ochreous, with jet-black apex. Pleuræ chestnut-brown. Legs brown, with a bronzy-ochreous tinge, unbanded; femora pale at the base. Halteres yellow. Venter with ochreous scales along the sides, and pale hairs on the hind borders of the segments. *Length.*—4·5 mm.

Habitat.—Thayetmyo, Upper Burmah.

76. CULEX SPENCERII, Theobald (Monog. II, p. 99).

Tarsi uniformly dark. Thorax black, with narrow, golden-curved scales in the middle; the sides, with broader, creamy, coloured ones, and two short, parallel, paler lines behind, besides other pale scales in front of the scutellum. Abdomen covered with creamy and white scales, with large, black-scaled lateral patches on the middle of each segment, so as to leave a median white stripe, combined with basal and apical banding. Tarsal claws of ♀, symmetrical, each with an extra tooth.

♀.—Head brown, with pale golden curved, and yellowish, upright forked scales, a pale border round the eyes; small, flat, creamy scales at the sides, and then flat dark ones; antennæ black, basal joint with a large tuft of pale scales on the inside; second joint testaceous at the base; palpi densely black-scaled, sometimes grey towards the tip. Pleuræ dark brown, densely white-scaled. Legs brown, with pale scales scattered about on the tibiæ and metatarsi; femora mostly pale ochreous, with a few black scales. Halteres yellow with the knob darker. Venter white. *Length.*—4 mm.

Habitat.—Manitoba, Canada.

77. **CULEX RUSTICUS**, Rossi (1790).

= *C. punctatus*, Meigen (1818) ; = *C. quadrimaculatus*, Macquart (1834).
[Fn. Etrusca, tom. sec. Libarni. (1790), Rossi ; "S. B." i, (1818) (= *punctatus*), Meigen ; "F. R." p. 280 (1896) (= *quadrimaculatus*).]

Tarsi unbanded ; thorax brownish-grey ; abdominal segments brownish, with black lateral spots.

"Greyish, the abdomen with black spots. Antennæ fuscous, with scanty verticillate hairs ; proboscis black. Thorax greyish ; all the abdominal segments with black spots. Legs fuscous ; hind pair very long ; femora paler, but the apex black. Wings dusky, with the internal margin ciliated and the veins scaled, &c. *Length.*—3½ lines (Rossi)."

Meigen describes *C. punctatus* as follows :—

"Abdomen ashy-grey, with two rows of black spots, triangular in form ; thorax brownish-grey, with four dark lines ; antennæ and palpi of the ♂, dark brown ; proboscis brown, &c. *Length.*—4 lines."

Macquart describes *C. quadrimaculatus* as :—

"Thorax black, with greyish-yellow tomentum, and with the abdomen with quadrangular black spots, &c. *Length.*—3½ lines."

Mr. Theobald has no doubt as to the above three names being synonymous.

78. **CULEX ALBIFASCIATUS**, Macquart.

(Dipt. Exot, i. 35, 4 (1838), Macquart ; Dipt. Argentina, p. 44, Arribálzaga Verh. zool-bot. Gesell. xv, 596, 6 (1865), Phillipp.)

Legs unadorned, clothed with brown and grey scales. Thorax black, ornamented with narrow, reddish-brown curved scales, with a median yellow-scaled line and a broad line of yellow scales on each side in front, narrowing behind. Abdomen dusky brown, with a median yellowish-white line spreading out apically on each segment, and with a basal patch of pure white scales on each side of the segments. Ungues of the ♀, equal, uniserrated.

Head creamy in the middle, dusky at the sides, the linear and forked scales of these areas being of corresponding colours ; lateral flat scales yellowish ; proboscis and palpi dark brown, in both sexes ; those of ♂, with dense fuscous tufts. Pleuræ dark brown, with numerous frosty patches. Legs with the femora pale beneath, and with small white knee-spots. Venter with numerous white scales, very dense apically. Halteres with yellow stems and dusky knobs, covered with greyish white scales. *Length.*—About 5·5 mm.

Habitat.—South America ; Brazil, Rio de Janeiro, Buenos Ayres, Chili. "Bites during the daytime, but does not enter houses."

Subdivision iii.—*Plain-winged Culices with the tarsi unbanded, and the abdominal segments with basal pale bands.*

a. With the pale basal abdominal bands well marked, broadening externally to form lateral spots continuous with the band.

79. *C. punctor*, Kirby. Thorax prominently adorned with five white lines.
80. *C. diversus*, Theob. Pale abdominal bands yellow, expanding in the middle as well as laterally, so as to look like three spots.
81. *C. nemorosus*, Meig. Pale abdominal bands creamy; very narrow in the middle; venter white, with three dark lateral spots.
82. *C. pipiens*, L. Abdominal bands yellowish; the denuded thorax uniformly dark. Anterior fork cell very long in proportion to its stem; 4 close to 3.
83. *C. quasipipiens*, Theob. Closely resembles the above, but the anterior fork cell is shorter in proportion to its stem, and its base is well inside the auxiliary junction.
84. *C. fatigans*, Wied. Denuded thorax, testaceous, with two distinct dark lines. Anterior fork cell shorter than in *C. pipiens* (about 4½ times the length of its stem), 4 well internal to 3. Antennæ proportionally shorter than in *C. pipiens*.
85. *C. virgultus*, Theob. Basal abdominal bands broad and white, expanding into lateral spots on the hinder segments, instead of the expansion being most marked in front, as in the three preceding species. A tuft of bristles projects from the front of the sternum. Venter with golden hairs.
86. *C. decens*, Theob. Pale abdominal bands white, expanding on the sixth and seventh segments, the eighth being nearly all white. Legs with only a trace of a knee-spot.
87. *C. masculus*, Theob. Pale abdominal bands narrow and white, expanding on the last three segments. Legs with pale spots at the apices of the femora and tibiæ.
88. *C. tipuliformis*. Pale banding of segments, 2 to 5, represented by a semilunar spot, those behind it expanding laterally. Legs with distinct longitudinal white lines on the femora and tibiæ.
89. *C. confirmatus*, Arribál. Abdominal bands white, simply broadening externally. Thorax yellowish unadorned. Tarsi yellowish-brown. Ventral segments black, with large semilunar pale apical spots.

b. With the pale bands of the hinder segments expanded in the ♀ only.

90. *C. nigripes*, Zetterstedt. Tarsi without distinct ornament. thorax black. Venter black, with an indistinct paler median line.

c. With the pale bands of the last two hind segments laterally expanded in the ♂ only.

91. *C. sagax*, Skuse. Abdominal pale bands sinuous, and ochreous in the ♀. Thorax without defined ornament. Pleuræ spotted.

d. With fairly broad, simple basal abdominal pale bands.

92. *C. viridiventer*, Sp. n. Thorax without obvious adornment. Scales of venter colourless. Abdominal pale bands, with a deltoid median expansion.
93. *C. consobrinus*, Desv. Thorax with an ill-contrasted median stripe of darker scales. Abdominal pale bands dull white, with some white scales on the sides of the dark part of the segments.
94. *C. sylvæ*, Theob. Thorax reddish-brown in the middle, pale at the sides. Tarsi black. Venter white. Wings with 4 close up to 3.
95. *C. pervigilans*, Bergroth. Thorax without defined ornament. Venter white, with median black spots.
96. *C. pusillus*, Macquart. Thorax brown, with whitish lines. Tarsi pale yellow. Wings with 4 very close to 3.
97. *C. flavipes*, Macq. Thorax rufous, with a pair of submedian dusky lines. Venter pale yellow. Tarsi dark.
98. *C. ornatus*, Hoffmanseg. Thorax whitish, with two black streaks. Tarsi nearly black.
99. *C. luteolateralis*, Theob. Thorax purple-black, with broad lateral yellow lines. Tarsi yellowish-brown. Venter dusky.
100. *C. pulchriventer*, Giles. Thorax golden-scaled, with fine median, and broader lateral black lines. Tarsi black. Venter elaborately adorned with white, yellow and black.
101. *C. Reesii*, Theob. Thorax with a broad dark median line, separating two pale golden stripes. Tarsi dark brown. Venter yellow, with two black patches on the first segment.

e. With the pale basal abdominal bands narrow.

102. *C. linealis*, Skuse. Pale abdominal bands ochreous. Thorax brown, with four parallel golden lines. Tarsi violet-black. Ventral segments ochreous, with narrow black apical bands.
103. *C. Zombaensis*, Theob. Pale abdominal bands grey. Thorax golden-brown, with two well separated dark longitudinal lines. Tarsi brown. Venter with many white scales.
104. *C. impudicus*, Ficalbi. Abdominal bands white. Thorax dark grey, with two yellow lines behind. Tarsi nearly black. Venter whitish, with black lateral spots near the bases of the segments.

f. With incomplete, or indistinct, basal pale abdominal banding.

105. *C. hirsuteros*, Theob. White abdominal bands on the anterior segments, lateral spots on the last two. Thorax brown, with creamy scales. Tarsi brown. Venter pale brown.

106. *C. uncus*, Theob. Abdomen with white basal patches, which sometimes extend, to form incomplete bands. Thorax chestnut-brown, unadorned. Tarsi black. Venter white-banded. Halteres with hooked knobs.

107. *C. pruinosus*, Theob. Abdomen with the bases of the segments slightly paler, with white lateral spots on the last three. Thorax frosty-grey, with traces of two darker lines. Tarsi brown.

108. *C. sericeus*, Theob. Abdomen brown, with indistinct ochreous bands. Thorax rich brown, with darker median line and lateral patches. Pleuræ grey, with two black spots.

109. *C. nigritullus*, Zetterstedt. Abdomen dusky, with indistinct pale bands. Thorax dark, golden scaled, unadorned. Tarsi brown. Venter dusky, with faint pale basal bands.

79. **CULEX PUNCTOR**, Kirby.

(Fauna Boreali-Americana, Ins. p. 309.)

Tarsi uniformly deep brown. Thorax deep red-brown, with five lines of brilliant white scales, viz., a fine median, two complete broad lateral, and external to these again a narrower pair of lateral lines incomplete in the middle. Abdomen dark chocolate, with basal pale bands which spread out laterally. Legs brown; the coxæ, with brown and white scales. Ungues of the ♂, unequal, the larger toothed, the smaller simple (?); hinder, equal and simple; in the ♀, equal, uniserrated.

Head dark brown, with narrow curved creamy scales, flat narrow pale ones at the sides, and numerous creamy upright forked scales; antennæ brown, with deep bright brown plumes; proboscis brown; palpi dark brown; those of ♂, with rather deep flaxen-brown hair tufts; the two last joints nearly equal, the antepenultimate longer, nearly as long as the last two put together. Pleuræ black, with two large patches of snowy scales. Legs testaceous. Halteres yellow, with the knob and a lateral stripe black. *Length.*—6 to 6·5 mm.

Habitat.—Hudson's Bay, St. Martin's Falls, 65° N. lat.

80. **CULEX DIVERSUS**, Theobald (Monog. II, p. 73).

Tarsi uniformly nearly black. Thorax with golden-brown curved scales, with two broad, dark median lines, with bright brown scales, and two smaller lateral lines posteriorly. Abdomen deep dusky-brown, with basal yellow bands expanded at the middle and at the sides into white spots, so as to appear as three spots. Tarsal claws of ♂, uniserrated, equal and large.

♀.—Head black, with rather large curved scales, small flat ochreous ones at the sides, and with black and golden-brown bristles; antennæ black, basal joint black, with a thick mass of yellowish scales on the inside, base of the second joint ferruginous; palpi dark brown, with black scales; proboscis black, with a few yellow scales near the base; clypeus black. Pleuræ dark, with dense yellow and white patches. Legs dark, with yellow knee-spots, and the upper joints paler below. First hind tarsal joints not as long as the tibiæ. Halteres ochreous, with pale scales on the knob. Venter white. *Length.*—6·5 mm.

Habitat.—England (Tunbridge Wells).

81. **CULEX NEMOROSUS,** Meigen (1818).

= *C. sylvaticus*, Meigen (1818); = *C. guttatus*, Curtis (1829); = *C. provocans*, Walker (1848); = *C. salinus*, Ficalbi (1896); = *C. reptans*, Meigen (1804); = *C. fasciatus*, Meigen (1804); = (?) *C. stricticus*, Meigen (1838); = *C. detritus*, Halliday.

("S. B." i, 4 (1818), Meigen; "S. B." (1830) (= *sylvaticus*), Meig.; Guide to Arrang. Brit. Ins. (1829) i, (= *guttatus*), Curtis; Brit. Ent. xii, 537 (1834), Curtis; Ins. Brit. Dipt. iii, p. 247 (1851), Walker; Suit. i, 34, 5, Macquart; Ins. Lapp. 806, 2; Dipt. Scand. ix, 3457, 3, Zetterstedt; Fn. Austr. ii, 628, Schiner; Klass. i, 3, 2 (= *reptans*), Meigen; Klass. i, 4, 5 (= *fasciatus*), Meigen; Dipt. n. d. Fr. 161, 3, Macq.; Dipt. Neer. viii, 327, Van der Wulp; "F. R." p. 109 (= *stricticus*, Meig.), reprint, (Ficalbi); "List," p. 7 (= *provocans*), Walker; Noti sulle Zan. Ital. ixa, Nota. (*C salinus*) (1896), Ficalbi; "V. S." p. 129 (1899), Ficalbi.)

Tarsi uniformly black. Thorax black, covered with golden-brown and golden scales, those at the sides being paler and brighter than those in the middle, and may form two, more or less distinct, parallel, narrow lines on each side of the darker central area. Abdomen black, with basal, white or creamy-yellow bands, which are usually expanded laterally and narrowed in the middle, sometimes looking only like white lateral spots; venter white-scaled, with three lateral dark spots. Bases of the femora pale yellowish-white. Ungues of the ♀, all equal, thick, uniserrated; of the ♂, with the fore and mid ones unequal, the hind equal, all uniserrated.

Head dark brown, with golden linear curved, and somewhat darker, erect forked scales; antennæ dark, with some white scales on the basal joints palpi of ♀, dark brown, with some paler scales; those of ♂, nearly black, rather paler at the articulations, moderately clubbed and barely longer than the proboscis. Pleuræ dark testaceous, with large patches. Legs dark brown, with the bases of the femora paler, especially their undersides. Halteres densely clothed with whitish scales. Venter white, with three pairs of darker lateral patches. *Length.*—About 7 mm.

NOTE.—Varies a good deal, and hence has been repeatedly redescribed under various synonyms, some of which are distinguished by Mr. Theobald as varieties as below:—

Variety 1, *salinus*, Ficalbi. Posterior three-fourths of the segments speckled with hazel scales, anterior fourth white.

Variety 2, *stricticus*, Meigen. Basal bands absent, white lateral spots only remaining.

Variety 3, *luteovittatus*. Basal bands yellowish, expanded in the middle, lateral spots whitish.

Variety 4, *detritus*, Halliday. A small variety, with the small scaled, lateral basal patches of the mesonotum very prominent.

Habitat.—Common throughout Europe, from Lapland to Italy, as a sylvan species. Ficalbi's *salinus* breeds in salt marshes, and the larvæ of others are found in all sorts of fresh water and even in large lakes.

82. **CULEX PIPIENS,** Linnæus (1758).

= *C. vulgaris*, Linnæus (1767); = *C. alpinus*, Linnæus (1767); = *C. agilis*, Bigot; = *C. ciliaris*, Linnæus (1767); = *C. communis*, De Geer; = *C rufus*, Meigen (1818); = *C. phytophagus*, Ficalbi (1889); = *C.* (?) *domesticus*, Germar (1817).

[Fn. Suec. (1890), Linn.; Sp. Ins. ii, 469, 1; et Ent. Syst. vi, 400, 1; et Syst. Antl. 33, 1, Fabr.; Ins. Austr. 481, 980; et Fn. Boica. iii, 2585, Schrank; Klass. i, 5, 9; et "S. B." i, 7, 10, Meigen; Gen. Crust. iv, 246, Latr.; Dipt. n. d. Fr. 161, 4; et Suit. i, 34, 4, Macq.; Ins. Lapp. 807, 4; et Dipt. Scand. ix, 3455, Zett.; Fn. Austr. ii, 628, Schiner; Dipt. Neer. 328, V. d. Wulp; Venti Sp. Zan. Ital. 159, Ficalbi; Syst. Nat. xii, 1002, 2, Linn. (= *ciliaris*): Ins. Austr. 481, 981, Schrank; Ins. Lapp. 807, 5; Dipt. Scand. ix, 3456, 2, Zett. (= *ciliaris*); Fn. Austr. ii, 628, 1, Schiner (= *ciliaris*); Dipt. Neer. 329, V. d. Wulp (= *ciliaris*); Ins. Brit. Dipt. iii, 247, Walker (= *ciliaris*); Ins. vi, 316, 1, de Geer (= *communis*); Bull. Soc. Ent. Fr. ix, 122, Bigot (= *agilis*); "S. B." i, 7, Meigen (= *rufus*); Rev. Sist. d. Culicidæ Europeæ, p. 276, Ficalbi (= *phyophygus*); Reise nach Dalmatien, &c., Germar (1817); "S. B." i, 8, Meigen (= *domesticus*).]

Tarsi uniformly deep warm brown. Thorax, with the ground colour very dark, and without any distinct colour markings in the denuded state; clothed, when uninjured, with golden-brown curved scales, and three lines of black bristles, the middle one of which ends in a bare space in front of the scutellum. Abdominal segments, dark brown, with broad flaxen basal bands, rather deeper in the middle, but expanding laterally into distinct spots, which may form complete lateral pale lines on the segments

Tarsal claws of ♀, equal and simple. Anterior fork cell usually at least seven times as long as its cell. Palpi of ♂, exceeding the proboscis by all the last, and a full third of the next joint. Antennæ, reaching barely beyond the base of the antepenultimate palp joint.

Head black-grounded, clothed with golden linear curved, and black erect forked scales, with a narrow line of the former between the eyes but without distinction of eye-borders; the lateral flat-scaled areas creamy-white; proboscis golden-brown at the base, nearly black for its apical third; palpi of ♀, deep brown; those of ♂, light golden-brown, with dense brushes of dark hairs; antennæ brown. Pleuræ chestnut-brown, with a few small creamy patches. Legs brown, with small white knee-spots, and the femora pale at the base, and for all their undersides. Halteres pale yellow, slightly darker on the knobs. Venter pale yellow. *Length.*—About 5 mm.; very variable.

Habitat.—Throughout Europe, and also found in Northern America.

83. **CULEX QUASIPIPIENS,** Theobald (Monog. II, p. 136).

Tarsi uniformly brown. Thorax brown, with narrow curved golden scales. Abdomen brown, with curved basal, very pale yellow to white, bands; last segment often pale scaled. Legs unbanded, brown; knee-spot pale; ungues equal and simple. Head with pale scales.

Closely resembles *C. pipiens*, differing mainly in the form of the curved scales of the head which are much smaller in this species; and in venation of the wing, the anterior fork cell being shorter in proportion to its stem, and its point of bifurcation well inside, instead of outside the auxiliary junction (*vide* fig. 45). *Length.*—5 mm.

Habitat.—Sambalpur, C.P., India.

84. **CULEX FATIGANS,** Wiedemann (1828).

= *Heteronycha dolsa*, Arribálzaga (1896); = *C. æstuans*, Wiedemann (1828); = *C. pungens*, Wiedemann (1828); = *C. pallipes*, Meigen (1838); = *C. Macleayi*, Skuse (1896); = *C. Skusii*, Giles (1899); = *C. anxifer*, de Grandpré et de Charmoy (1900).

("A. Z. I." p. 10, Wiedemann; "S. B." Th. oder Suppl. (1831) (= *pallipes*) Meigen; "L. A." p. 56 (= *H. dolosa*), Arribálzaga; "S. A. C." p. 1745 (1896) (= *C. Macleayi*), Skuse; *ibid.* p. 1748 (= (?) var. *ciliaris*), Skuse; 1st Edition, p. 299 (= *Skusii*), Giles; "A. Z. I." p. 9 (= *pungens*), Wiedemann; Bull. 25th N. Se. U.S. Dept. Agri. p. 22, &c. (1900) (= *pungens*), Howard; "Les Moustiques," Port Louis, 1900, = *C. anxifer*, de Grandpré et de Charmoy.)

Tarsi uniformly dark brown. Thorax, when denuded, rather pale red-brown with two distinct dark lines; clothed with golden scales and three lines of black bristles, much as in *C. pipiens* but often showing a more or less distinct ornamentation of darker lines. Abdominal segments nearly black, with straw-coloured basal bands of uniform width on the hinder segments, but expanding to form continuous lateral whitish lines on the second and third anterior segments. Tarsal claws of ♀, equal and simple. Wings, with the anterior fork cell about four or four and a half times the length of the stem in ♀. Palpi of ♂ proportionally shorter than in *C. pipiens*, exceeding the proboscis by but little more than their last joint. Antennæ of ♂, almost exactly the length of the proboscis; distinctly proportionally longer than in *C. pipiens*.

♀.—Head brown, covered with pale golden-brown to creamy, curved scales and a few scattered black, dark brown, and occasionally ochreous, upright forked scales, flat creamy-white scales laterally, and a faint pale narrow border round the eyes, numerous black and brown bristles; antennæ dark brown, with pale pubescence; basal joint pale ferruginous to ochreous, basal half of the second joint pale ferruginous; palpi of ♀, densely covered with deep brown scales, and in some specimens, with a few pale grey ones, and with numerous small black bristles; those of ♂, dark brown. Proboscis, covered with dark brown to violet-black scales, sometimes paler in the middle, and with a pale apex. Pleuræ pale testaceous, with three or four white patches. Legs generally dark brown, but with yellow coxæ and minute knee-spots, and the undersides of the femora grey. Halteres yellow, with darker knob. Venter straw-coloured. *Length.*—About 4 mm.: variable.

Habitat.—Is found throughout all the warmer parts of the world; is a purely domestic species, and its individuals probably must outnumber those of all the rest of the family. It has much the same distribution as *Steg. Fasciata*, but is found all the year round. It certainly occurs as far North as Italy. Its larvæ will breed in any water, even in concentrated filth, but I have some doubts as to the identity of these with the form we meet with breeding in tanks of clean water in gardens in India, though it is not easy to define the differences.

NOTES.—Professor Grassi has laid great stress on this species being identical with our European grey gnat, *C. pipiens*, and as far as I can judge from the figure in his recent work, which, though small, is probably, being the work of so distinguished a biologist, proportionally exact, he is quite right in his assertion that the material he has been working with is identical with Ross's "grey mosquito." *C. fatigans* undoubtedly occurs in Italy, and the proportions of the palpi and antennæ to the proboscis are those of that species and not of *C. pipiens*, which, however, is found also in Northern Italy, and probably occurs all over the peninsula. It appears to me, however, that undue importance is attached to points of this kind. Both species are very variable, and Mr. Theobald's comparison of some 300 wings of *C. fatigans* shows that individual wings may vary to such an extent in one species as to render characters of this sort, deduced from the examination of a few specimens only, of but little value, except in a general way. In one instance the right and left wings of the same insect (of *C. pipiens*) did not agree; two differences, however, proved to be constant. First, in *C. pipiens*, 4 is close up to 3 (about its own length internal), while in *C. fatigans* they are well separated (seldom less than twice the length of 4 apart). Secondly, in *C. pipiens* the anterior fork cell is fully five and a half times the length of its stem, while in *C. fatigans* it is proportionally shorter (not less than four and a half times its stems' length). The two figures given below are chosen as the nearest alike that I could find in my own small collection.

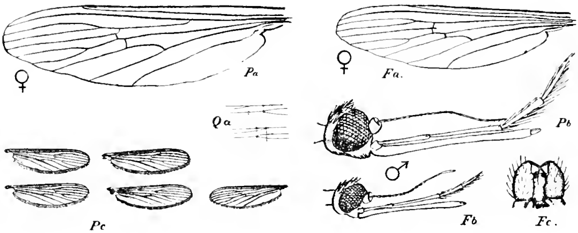


FIG. 45.—*Pa*, venation of wing of *C. pipiens*; *Fa*, of *C. fatigans*; *Qa*, relative position of fork of II. to aux. junct. in *C. quasipipiens* (the upper), as contrasted with that in *C. pipiens* (the lower outline); *Pb*, head and appendages of *C. pipiens*; *Fb*, those of *C. fatigans*; *Pc*, group of outlines of wings of *C. pipiens* to illustrate their variability. (These last not at standard magnification, but reduced from figures in Mr. Theobald's monograph.)

In certain specimens there may be some indications of thoracic ornament, but as a rule there is no definite adornment, so that I believe Wiedemann's description must be taken as applying to the denuded thorax only. At the same time some varieties exhibit more or less distinct true scaly decoration.

Mr. Theobald describes the following sub-species, some of which have already appeared as distinct species:—

A. *Type.*

Abdomen dusky black, with basal pure-white bands and basal white lateral spots; pleuræ and metanotum chestnut-brown.

B. Sub-species *luteoannulatus.*

Abdomen dusky black or brown, with basal flaxen-curved bands and pure white lateral spots; pleuræ and metanotum chestnut-brown; thorax with traces of two parallel bare median lines.

C. Sub-species *Macleayi.* Skuse.

Abdomen brown, with basal pale flaxen to almost white bands and white lateral spots; thorax with two very clear median parallel bare lines in front, widening out towards the fore end.

D. Sub-species *Skusii.* Giles. *C. sp. prope, C. ciliaris.* Skuse.

Abdomen with pale flaxen bands and white spots; the thorax with traces of four parallel bare lines.

E. Sub-species *trilineatus.*

In which the median line of dark thoracic bristles shows as a third median line on the thorax.

Each of these sub-species can again be divided into varieties according to the colour of the spots on the first abdominal segment as follows:—

Variety 1, with scales pale yellow.
Variety 2, with scales dusky black.
Variety 3, with scales pale yellow and black.

Localities for Sub-species.

Macleayi in Australia;
Skusii in Australia;

The others in widely separate areas, and may occur side by side.

85. **CULEX VIRGULTUS,** Theobald (Monog. II, p. 123).

Plate xvii, fig. 11, Tarsal claws of ♂; 11a, Head and appendages; 11b, Arrangement of bristles on the mesonotum.

Tarsi uniformly dark brown. Thorax bright chestnut-brown, with small curved golden-brown scales and two short single rows of bristles, a pair of bristles before the last one on each side. Abdomen dusky brown, a broad band of white scales at the base of each segment, which on the last few segments form lateral borders. Ungues of the fore and mid legs unequal, uniserrated; of the hind legs equal and simple. A tuft of bristles projects from the front of the sternum.

♂.—Head brown, with scattered curved creamy scales over the crown, white flat scales at the sides and forming a narrow border to the eyes, a few black upright forked scales dotted over the crown; palpi much longer than the proboscis, yellowish-brown towards the base, dark brown near the apex, a small yellower pale band towards the base, hairs dense, silky brown; proboscis yellowish-brown, darker towards the base and tip. Pleuræ pale brown and grey. Legs with deep ochreous-brown scales, darker on the tibiæ and tarsi, a yellow spot at the apex of the former. Halteres pale brown, rather darker on the club. Venter densely clothed with long golden hairs. *Length.*—6 mm.

Habitat.—Rio de Janeiro.

86. **CULEX DECENS,** Theobald (Monog. II, p. 34).

(Rept. Liverpool School Trop. Med. 1901.)

Tarsi uniformly brown. Thorax deep brown to black, with chestnut-brown scales. Abdomen almost black, with basal white bands, regular on the third to fifth segments, but widening out prominently on the sixth and seventh to form clear lateral spots, the eighth being mainly white. Tarsal claws of ♀, equal and simple.

♀.—Head almost black, with small narrow curved creamy, and numerous dark upright forked scales, quite black in some lights, the pale scales forming a distinct line round the eyes; clypeus dark brown; palpi black; those of ♂, longer than the proboscis by the last joint and one-third the next, black, with a trace of a light band near the base; antennæ dark brown, with black verticillate hairs and pale pubescence; proboscis deep bronzy-brown. Scutellum brown, with pale scales and seven bright brown bristles on the middle lobe. Pleuræ marked ochreous and grey, with three white patches, one of which, of elongated form, lies just over the first two pairs of legs. Legs brown, grey at their bases, with a trace of a knee-spot. Halteres yellow with dusky knobs. *Length.*—5 mm.

Habitat.—Bonny, Africa.

87. **CULEX MASCULUS,** Theobald (Monog. II, p. 125).

Tarsi uniformly purple-black. Thorax deep brown with golden-brown curved scales, and with three rows of black bristles, the middle row ending at the middle of the mesonotum. Abdomen dusky brown, with narrow white basal bands, which form three lateral patches on the last three segments. Six central scutellar bristles. Tarsal claws of the fore and mid legs of the ♂, unequal, the larger one toothed, the smaller, and both the hind claws, simple.

♀.—Head covered with creamy scales in the middle, flat white ones at the sides, with numerous black and brown upright forked scales all over the crown; antennæ brown; palpi of ♀, black, very short; those of ♂, deep brown, with a small pale ring on the basal third. Pleuræ brown, with dull white patches. Legs pale at the base and ventral surface of the femora, remainder purplish-black, a pale spot at the apex of femora and tibiæ, last tarsal joint deep ochreous. Halteres pale at the base, fuscous for their apical halves. Venter deep brown; with basal bands, much broader and more distinct than those on the terga. *Length.*—About 4 mm.

Habitat.—Freetown, Sierra Leone; September.

88. CULEX TIPULIFORMIS, Theobald (Monog. II, p. 325).

Tarsi uniformly brown. Thorax brown with narrow golden-brown curved scales, paler behind; pleuræ with white scales. Abdomen dark brown with basal white median semicircular patches on segments two to five, spreading out laterally on the apical segments. Looks much like a small midge.

♂.—Head dark brown, with narrow curved grey scales on the occiput, flat grey at the sides, and numerous ochreous and brown upright forked ones, the former on the front of the head; clypeus chestnut-brown; proboscis brown, mottled with creamy-grey scales, thin; palpi deep brownish-black, with pearly-white scales below; antennæ brown; scutellum reddish-grey at the margin, with apparently six bristles to the mid lobe. Pleuræ marbled pale brown and yellowish, with white patches. Legs unbanded, paler brown, with white scales, very long and thin, with a distinct longitudinal white line on femora and tibiæ. Halteres, yellowish-brown with dusky knobs. Venter ochreous. *Length.*—5·8 mm.; of the hind leg, 7 mm.

Habitat.—Bakloh, Lower Himalayas, Punjab, 5,000 feet.

89. CULEX CONFIRMATUS (Arribál.)

Ochlerotatus confirmatus, Arribál. L. A. p. 46.

Plate xvi, fig. 17, Tarsal claws of ♂; 17a, Venation of wing, ♂; 17b, Head and appendages; 17c, Extremity of ♂ palp more highly magnified.

Tarsi yellowish-brown, unbanded. Thorax dark-grounded, with greyish-yellow scales in front, and fawn behind; unadorned. Abdominal segments violet-black, with narrow, whitish basal bands, broadening externally. Palpi broad ended, nearly black.

This species is a small dark-tinted gnat, not showing its abdominal banding, except on close inspection. The head shows a few silvery scales behind, but the palps and proboscis are entirely black. There are a few white tufts on the pleuræ and coxæ. The venter is prettily marked, each segment having a large, semilunar basal ferruginous spot, surrounded by the black narrow remnant of the segment. The ♂ palps are very peculiarly formed, being barely as long as the proboscis and clubbed, the club being formed of the fourth joint, the fifth being a mere olive-shaped rudiment; the first two joints are very short and the third nearly as long as the clubbed fourth. *Habitat.*—The specimens described were sent me from Brazil, along with a quite distinct species of *Panoplites*, by Dr. Lutz. The above, however, agrees best with Arribálzaga's description, although the ♂ palps are unlike those of its congener in his classification, *C.* (*ochlerotatus*) *albifasciatus*, Macquart. He appears, however, not to have obtained a male specimen. *Length.*—About 5 mm.

Habitat.—South America; Rio de Janeiro, Buenos Ayres, Brazil, New Amsterdam; Jamaica.

90. **CULEX NIGRIPES,** Zetterstedt.

= *C. impiger*, Walker; = *C. implacabilis*, Walker; = *C. incidens*, Thomson (?) (Ins. Lapp. (1838-40), Zetterstedt; p. 292, "F. R."; Brit. Mus. List, p. 7, Walker (= *impiger*); Eugen. Resa. Dipt. p. 443 (= *incidens*), Thomson.)

Tarsi uniformly black. Thorax black, with ferruginous scales and black bristles in front, and brown ones projecting over the roots of the wings. Abdomen black, with deep fuscous scales and basal white bands, which spread out laterally on the last few segments in the ♀; entirely black in the ♂. Fore and mid tarsal claws of ♀, symmetrical and each with an extra tooth.

Head dark brown, with deep golden-brown curved scales and upright forked ones, and a small patch of pale scales on each side, a tuft of brown bristles projecting forwards; palpi and proboscis black, palpi of ♀ with paler scales on the last joint, which is broad and flat; those of ♂ entirely black; antennæ black, basal joint with dull ochreous scales; proboscis long. Pleuræ black, with white and grey scales. Legs black, including the coxæ, but pale on the undersides of the femora. Halteres pale, with darker knobs. Venter black, with an indistinct paler median line. *Length.*—4·6 to 6 mm.

Habitat.—Arctic regions generally; Lapland and Greenland, Alaska, Hudson's Bay, Kindu Kush mountains, N.W. Frontier of India, at 13,500 feet; California (?). It will be noticed that with the exception of the Californian habitat of the doubtfully synonymous *C. incidens*, all the above records refer to intensely cold climates.

91. **CULEX SAGAX,** Skuse ("S. A. C." p. 1744).

Tarsi uniformly black. Thorax intense black, with golden-brown, and pale, almost white scales, the latter especially before and on the scutellum and at the sides. Abdomen deep blackish to violet-brown, with basal sinuous ochreous bands in the ♀, which spread out laterally on the last two segments in the male.

♀.—Head dark, with golden-brown scales and hairs: palpi black-scaled; proboscis black; antennæ black, nearly as long as proboscis; in the ♂, black with grey lateral patches, his palpi yellowish, dark at the extremity, with a pale band on the basal third. Pleuræ dark brown with four or five white patches. Bases of the legs brown, with some pale scales; femora pale ochreous at base and below with a few scattered ochreous scales. Halteres ochreous. Venter densely pale ochre-scaled in the ♀; with black median patches in the ♂. *Length.*—5 mm.

Habitat.—Australia; N.S.W. and Queensland.

92. CULEX VIRIDIVENTER, sp. n.

(Journ. Bombay Nat. Hist. Soc. xiii, p. 609.)

Plate xvii, fig. 12, Tarsal claws of ♂; 12a, Venation of wing of ♀; 12b, Diagram of abdominal banding contrasted with that of *C. fatigans*; 12c, Larva, × 7 diams.

Tarsi uniformly dusky. Thorax chocolate-brown with bronzy tomentum. Abdominal segments with yellowish basal bands having a blunt, deltoid, backward median prolongation. Venter almost naked, save for a few colourless scales, green in fresh specimens. Knees with minute lighter dots. Tarsal claws of ♀, equal and simple.

Head with deep chocolate ground, clothed with ferruginous linear curved, and black erect forked scales, with creamy lateral patches, narrowing above to form a whitish posterior border to the eyes; proboscis, antennæ and palpi nearly black; the last exceeding the first in length by half the length of the subulate terminal joint. Scutellum nearly bare, the middle, with six strong bristles and strong tufts on the lateral lobes. Pleuræ and sternum black, the former marked with greyish scales. Legs dark greyish brown, with narrow yellowish tips to the femora and tibiæ; the coxæ and bases of femora yellowish; first hind tarsal joint shorter than its tibia. Halteres pale yellow. Venter clothed with colourless scales, through which the green plant juice on which both sexes feed is visible, so as to give a distinctive pale green hue to fresh specimens. *Length.*—About 5 mm.

Habitat.—Naini Tal, Himalayas, 7,000 ft. Breeds in pure rain-water pools in the course of hill streams which become raging torrents even after moderate rain. The larva is notable for its very long antennæ and also for its long respiratory syphon. The adult females do not bite.

93. CULEX CONSOBRINUS, R. Desvoidy ("Essai," p. 408).

= *C. inornatus*, Williston; = *C. impatiens*, Walker; = *C. pinguis*, Walker (?).

[List, Brit. Mus. Dipt. p. 5, Walker (= *impatiens*); North American Fauna, Washington Gov. Press (1893), Williston (= *inornatus*); Science Gossip, pp. 79-81 (1867), Walker (?) (= *pinguis*).]

Tarsi brownish-yellow. Thorax bright chestnut-brown, darkened towards the sides, and on a narrow dusky central line; with scattered golden curved scales. Abdomen brown, with dusky-brown scales, with basal dull white bands, and white scales at the sides.

♀.—Head dark brown, depressed in the middle line, covered with creamy curved scales and with ochreous upright forked ones behind, black bristles, and a few yellowish ones projecting forwards between the eyes; eyes dark, with a narrow pale border; face reddish; palpi, reddish-brown, with a few pale scales on the inside; proboscis dark brown, very long. Pleuræ bright brown with scattered pale scales. Legs yellowish-brown, with pale knee-spots, and the femora dusky above. Halteres with ochreous stems and dark knobs. *Length.*—About 6·5 mm.

Habitat.—America, from Colorado to Hudson's Bay.

94. **CULEX SYLVÆ**, Theobald (Monog. II, p. 96).

(Described as a sub-species of *C. nigripes*, Zetterstedt.)

Tarsi uniformly black. Thorax black, with reddish-brown scales in the middle, pale scales at the sides. Abdomen black, with basal white bands, in both sexes. Palpi and proboscis black; posterior cross vein close to the mid cross vein.

Head dark brown, with narrow curved, pale creamy scales, and dark upright forked ones, flat creamy scales at the sides; antennæ black; basal joint black, with a few grey scales; palpi of ♀, black scaled, with a few dull grey ones at the tips, last joint broad; those of ♂, black with the third joint and the end of the fourth much dilated, rather shorter than the proboscis, which is intensely black; clypeus black. Pleuræ dark brown with white patches. Legs black, with white knee-spots; the undersides of the femora rather paler. Venter white. Male claspers with spirally curved claws. *Length.*—About 5 mm.

Habitat.—New Forest, Hampshire; June.

95. **CULEX PERVIGILANS**, Bergroth.

(Wiener Entomolog. Zeitung, p. 295 (1889), Bergroth.)

Tarsi uniformly nearly black. Thorax dark brown, with dull golden scales more or less longitudinally arranged, with traces of two median parallel bare lines. Abdomen black, with basal white bands; venter white scaled with median black spots. Ungues of the ♀, small, much curved, equal and simple; in the ♂, the fore and mid ungues are unequal, uniserrated, the hind equal and simple.

Head yellowish, with numerous black bristles projecting forwards and narrow eye borders: palpi of ♀, thick, black, with a few scattered scales; those of ♂, longer than the proboscis by all the last and half the next joint, very tapering, brown, with a pale band towards the base. Pleuræ testaceous, with a few white scales. Legs black, with white spots at the apices of the femora and tibiæ. Halteres with pale stems and a broad, cup-shaped knob with a black rim. *Length.*—6 mm.

Habitat.—New Zealand.

96. **CULEX PUSILLUS**, Macquart ("D. E." sup. 4, p. 9).

Tarsi, pale yellow. Thorax brown, yellowish and paler behind, ornamented with whitish lines. Abdominal segments dark brown, with white basal bands.

Head and appendages black or nearly so. Legs pale yellow. Much resembles *C. fatigans*, Wied., but has 4 very close up to 3. *Length.*—3 mm.

Habitat.—Egypt.

97. **CULEX FLAVIPES**, Macquart (1838).

= *C. molestus*, Kollar ; = *C. serotinus*, Philippi.

(Dipt. Exot. i, 1, 35, 5 (1838), Macquart; Hist. fio. y polit. de Chile, Zool. vii, 332, 1 (1852), Blanch.; Verhandl. zool.-bot. Gesellsch. xv, 595, 1 (1865), Philippi ; An. Soc. Cient. Arg. iv. 112 (1882), Arribálzaga; Catal. 4, 3 (1883), et Bol. Acad. Arg. iv, 112 (1882), Arribálzaga ; Aufzahl. d. Chile, Dipt. i, 1 (1865) Philippi (= *serotinus*); Bras. vorz. läst. Ins. 187, f. 13 (1832), Kollar (= *molestus*) ; Trans. Linn. Soc. Lond. xvii, 331, 1 (1837), Walker ; Dipt. Arg. 528 (1891), Arribálzaga.)

Tarsi uniformly fuscous. Thorax rufous, with minute curved golden scales, and with two parallel median fuscous lines. Abdomen fuscous with basal yellow bands ; venter ochreous, with pale scales. Tarsal claws equal and simple in both sexes.

♀.—Head brown, with numerous dull golden curved scales and forked upright fuscous ones, a pale creamy border round the eyes, and a pale flat-scaled patch on each side ; proboscis deep brown at the tip, ochreous brown at the base ; palpi ochreous, covered with deep brown scales ; antennæ pale brown ; basal joint bright testaceous ; clypeus brown. Scutellum, with pale scales and seven bristles to the median lobe. Pleuræ marked with dusky and frosty scales. Legs yellow at the base ; tibiæ and tarsi clothed with fuscous scales. Halteres pale, with fuscous knobs. Venter pale yellow. *Length.*—About 5 mm.

Habitat.—South America ; Lower Amazon, Chili, Brazil, Argentine, Uruguay.

Observation.—The above description is abbreviated from Mr. Theobald's account of the species he takes to be Macquart's, and which he finds is so variable as to account for its want of accordance with the type in the Jardin des Plantes.

98. **CULEX ORNATUS**, Hoffmanseg (Meigen).

= *C. equinus*, Meigen (not the *C. ornatus* of Ficalbi).

(Syst. Beschr. Eur. Zweiflügel. i, 5, 4 (1818), Meigen; Klass. d. Zwei. Aufl. 3, 4, Meigen; Suit. i, 35, 9, Macq.; Dipt. Scand. ix, 3458, 4, Zett.; Fn. Austr. ii, 629, Schiner; Dipt. Neer. p. 327, Van der Wulp.)

Tarsi nearly black. Thorax whitish, with two black streaks. Abdomen fuscous, with basal white bands.

Head, proboscis, and antennæ dark brown, the last with brown hairs in the ♂; palpi of the ♂, blackish-brown, with long hairs and three whitish spots. Pleuræ dark brown, with white patches. Legs brown, with the coxæ dull yellow; femora dark brown; knee spot white; tibiæ and tarsi dark brown. Wings with brown scales. *Length.*—3 lines.

NOTE.—The type in the Jardin des Plantes is represented by a pin only. Mr. Theobald does not think that Ficalbi's description ("F. R.," p. 285) applies to Meigen's species.

Habitat.—Northern Europe, including England.

99. **CULEX LUTEOLATERALIS**, Theobald (Monog. II, p. 71).

Tarsi uniformly yellowish-brown. Thorax deep purplish-black, with a broad lateral yellow to orange line on each side, the darker median portion with dull yellow and brown scales. Abdomen deep brown, with basal creamy-yellow bands. Wings in the ♀, with yellow and brown scaled veins. Second joint of anterior in ♀, dilated.

Head dark brown, with narrow curved golden-yellow scales in the middle, flat ochreous and dusky ones at the sides, with a few dull upright forked scales, and a tuft of golden bristles projecting between the eyes; eyes large, black and silvery; palpi of ♀, orange-scaled at the base, black at the apices; those of ♂, entirely brown, much longer than the proboscis, and looking only three-jointed, with a very dense black tuft on the last joint. Pleuræ dark brown with a few pale scales. Legs dull ochreous, covered with brown scales, the ground colour showing in the femora, especially at the bases and under sides; femora, tibiæ and first tarsals spiny, the first hind tarsal joints not quite as long as the tibiæ; femora rather dilated. Tarsal claws as in Plate xvii, fig. 5. Venter dusky. *Length.*—Variable, about 4 mm.

Habitat.—Durban, South Africa, January; Salisbury, Mashonaland, March; Perak, Straits Settlements.

100. CULEX PULCHRIVENTER, Sp. n.

(Journ. Bombay Nat. Hist. Soc. xiii, p. 608.)

Plate xvii, fig. 1, Tarsal claws ♀ and ♂; 1a, Venation of ♀ wing; 1b, Head and appendages ♂; 1c, Diagram and abdominal adornment of ♀; 1d, Ditto of ♂; 1e, Larvæ, × 7.

Tarsi unbanded, black. Thorax golden-scaled, with a fine median, and broader lateral bare black lines. Abdominal segments black, with snowy basal bands, and the venter elaborately adorned with golden, snowy-white, and black markings.

Head black, with two bands of golden scales, separated by a delicate bare black line, with a fine line of golden scales round the eyes; lateral flat-scaled patches white, rather small; antennæ but two-thirds the length of the proboscis in the ♂; black throughout in the ♀, the internodes are covered with whitish down, and there is a silky patch on the basal joint; palpi of ♀, very short, black, with a few golden hairs at the apex and at the base of the third joint; those of ♂, only four-fifths the length of the proboscis, the last joint tapered, but flattened and very short, black with a few yellow hairs at the apex and a ring on the base of the third joint. Pleuræ and coxæ, dark with a few silvery patches. Legs sooty-black, save for the golden undersides of the femora, a distinct knee-spot, and a few stray bristles of the same colour on the other joints. The five middle segments of the venter are adorned with lunate golden apical patches, bounded by a sooty line, which separates them from a pair of lateral snowy patches. *Length.*—5 to 6 mm.

Habitat.—Naini Tal, Himalayas, 7,000 feet. Essentially a sylvan species. Breeds in clean water pools in the course of hill torrents. The larvæ are large, nearly black, with the sides of the head yellow, and have extremely short respiratory syphons.

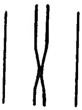
101. CULEX REESII, Theobald (Monog. II, p. 145).

Tarsi uniformly dark brown. Thorax dark brown, with two pale parallel stripes when denuded, covered with pale golden scales, and with a broad median dark line of deep brown scales. Abdomen deep brown, with pale creamy-white basal bands, often dull. Venation much as in *C. pipiens*, but stem of the first submarginal cell longer. Tarsal claws of ♀, equal and simple.

♀.—Head dark brown, with grey curved scales and black upright forked ones, pale grey round the eyes; proboscis dark brown, pale at the tip; palpi of ♀, short, densely black scaled, those of ♂, nearly black, with two pale bands near the base; antennæ dark brown, with pale pubescence and dark hairs, slightly testaceous at the base; clypeus deep brown. Scutellum, with yellowish grey scales and eight bristles on the middle lobe. Pleuræ marked pale brown and grey. Legs dark brown, unbanded, except the bases and venter of the femora, which are pallid. Halteres with grey stem and dusky knob. Venter, densely covered with pale ochreous scales; first segment with two patches of black scales and densely hairy. *Length.*—About 4·7 mm.

Habitat.—Hong Kong, China, October.

102. **CULEX LINEALIS,** Skuse ("S. A. C." p. 1747).



Tarsi uniformly violet-black. Thorax brown, with four parallel golden scaled lines. Abdominal segments violet-black, with narrow ochreous basal bands.

♀.—Head brown, with golden scales and hairs; antennæ brown, five-sixths the length of the proboscis, which is six times the length of the palpi, both being clothed with violet-black scales. Pleuræ brown, with a few, rather indistinct, white patches. Legs violet-black, with a small yellow knee-spot, and the coxæ and femora yellow, except the violet-black subapical portion of the latter on its upper side; hind tibiæ one-third longer than their first metatarsals. Wings with auxiliary junction || 3; fork of II well outside that of IV, its cell barely the longer but much the narrower; 4 twice its length inside 3. Halteres ochreous. Venter ochreous, with narrow black apical bands, a character which alone suffices to distinguish it from *C. pipiens*, L., and *C. fatigans*, Weid. *Length.*—About 5 mm.

Habitat.—Knapsack Gully, Blue Mountains; Hexham and Wheeney Creek, N.S.W. October to January.

Observations.—An obviously distinct species, though nothing answering to it has been received in the British Museum from Australia.

103. **CULEX ZOMBAENSIS,** Theobald (Monog. II, p. 143).

Plate xvii, fig, 13a, Arrangement of cross-veins; 13b, End of proboscis; 13c, Palpus of ♀.

Tarsi uniformly brown. Thorax deep brown, with narrow curved dull golden-brown scales and two narrow, parallel, bare, dark lines, wide apart. Abdomen dark dusky-brown, with narrow basal grey bands. Ungues of the ♀, equal and simple. Wings, with the stem of the first sub-marginal cell not quite as short as in *C. pipiens*.

♀.—Head brown, with pale, narrow curved, and almost white flat scales at the sides, together with numerous black upright forked ones; clypeus dark brown: palpi black, with a small apical joint (?); proboscis deep brown in the middle, black at the base and apex; antennæ deep brown.

Scutellum pale brown, with eight bristles on the median lobe. Pleuræ golden-brown, with dull white patches. Legs brown, unbanded, knee-spots creamy-white, as also are the apices of the tibiæ. Halteres with yellow stem and dusky knob. Venter with many white scales. Differs from *C. pipiens* in the pale abdominal bands being narrow and grey. *Length.*—5 mm.

Habitat.—Zomba, British Central Africa.

104. **CULEX IMPUDICUS,** Ficalbi ("F. R." p. 295).

Tarsi uniformly nearly black. Thorax dark brownish-grey, with two longitudinal, brassy lines behind; pleuræ white-spotted. Abdominal segments dark, with white narrow basal bands, and hinder borders. Claspers of ♂, exceptionally large and of peculiar form. Tarsal claws of ♀, equal, simple.

Head dark, with the nape and orbits clear grey. Proboscis, nearly black; palpi of the ♂, pointed, surpassing the proboscis by the length of the entire last joint, together with the end of the penultimate; nearly black, as also are those of the ♀. Antennæ in both sexes, with the verticils nearly black, and the stem with alternate white and black rings, the latter being the narrower; the basal joint nearly black, bordered with white scales. Pleuræ dark, spotted and speckled with white. Legs with the coxæ speckled white, elsewhere nearly black except the undersides of the femora, which are yellowish. Venter whitish, with black lateral spots placed near the bases of the segments (in the ♀ only). *Length.*—6·5 to 7 mm.

Habitat.—Sardinia and Sicily

105. **CULEX HIRSUTEROS,** Theobald (Monog. II, p. 98).

Tarsi uniformly brown. Thorax brown, with scattered creamy scales (a dark median stripe when denuded). Abdomen deep brown, with basal bands of white scales, except on the last two segments, which show only a basal patch of white scales on each side. Tarsal claws of ♀, all symmetrical, thick, and uniserrate.

♀.—Head dark brown, densely covered with creamy curved scales in the middle, and with scattered upright forked ones; sides of the head, with a small patch of almost black, flat scales; antennæ nearly brown, with a few pale scales on the inner side of the basal joint; palpi covered with brown, to almost black, scales; proboscis, very dark brown, faintly testaceous at the base; clypeus, deep testaceous. Pleuræ reddish-brown, with white patches. Legs brownish, rather yellowish on the femora, which sometimes have a knee-spot, in the hinder pair. Halteres ochreous. Venter, pale brown. *Length.*—Little over 3 mm.

Habitat.—Woodstock, Virginia, U.S.A.

106. **CULEX UNCUS**, Theobald (Monog. II, p. 53).

Tarsi black. Thorax chestnut-brown, with tawny and black scales and a few lateral pale ones. Abdomen brownish-black, with basal white patches, which extend in some cases nearly across the segments, to form incomplete bands. Clypeus very blunt and broad. Knobs of the pale halteres, hook-shaped.

♀.—Head and appendages black, save for narrow creamy orbits, which are wider behind, and expand below to join with the lateral flat-scaled patches of the back of the head, which are of the same colour. Pleuræ yellowish-brown, with whitish patches. Legs nearly black, except the pale undersides of the femora. Venter white banded. *Length.*—4 mm.

Habitat.—Straits Settlements; amongst plantains in the Klang jungle.

107. **CULEX PRUINOSUS,** Theobald (Monog. II, p. 32).

(Rept. Liverpool School Trop. Med. 1901.)

Tarsi uniformly brown. Thorax covered with frosty-grey scales, with traces of two parallel darker lines. Abdomen with the last three segments with basal lateral white spots, almost forming bands, bases of the other segments slightly paler, in the ♂, with more or less distinct banding. Wings with fork of II over four times the length of its stem; that of IV more than twice; 3 and 4 forming a very acute angle. Tarsal claws of ♀, equal and simple; those of ♂, very unsymmetrical, each with an extra claw in fore and mid legs.

Head brown, clothed with hoary, narrow curved, and numerous ochreous upright forked scales; clypeus and proboscis, deep brown; antennæ brown, basal joint paler; palpi of ♀, nearly black; those of ♂, ochreous, with dark brown scales, and black brushes on the last two joints, with a narrow pale band near the base. Scutellum frosty; pleuræ ochreous, darker above. Legs nearly brown, saving the nearly white undersides of the femora. Halteres ochreous. *Length.*—About 5 mm.

Habitat.—West Africa.

108. **CULEX SERICEUS,** Theobald (Monog. II, p. 147).

Tarsi uniformly brown. Thorax rich dark brown, with narrow curved dusky-bronze scales, with a narrow median dusky line, and a linear dusky patch on each side in front. Abdomen dark brown, with dull ochreous basal bands, often indistinct. A broad grey band round the head in front.

♀.—Head black, with dusky-brown, narrow curved, and black upright forked scales; around the eyes, and generally in front, a distinct border of white scales, which expand behind into flat-scaled white lateral patches; antennæ dark brown; palpi short and thick, almost black; proboscis deep brown, black at the apex, which is rather expanded. Scutellum reddish-brown, with apparently five strong bristles on the middle lobe; pleuræ grey, with two dark spots above. Legs brown, the femora ochreous, mottled with brown scales. Halteres grey, with dusky knobs. *Length.*—5 mm.

Habitat.—Kong Kong, China; October.

109. **CULEX NIGRITULUS**, Zetterstedt (Dipt. Scand. t. ix).

Plate xvii, fig. 14, Fore and hind tarsal claws of ♂; 14a, Head and appendages of ♂.

Tarsi uniformly brown. Thorax dark brown, with thin golden-brown curved scales, paler on each side of the scutellum. Abdomen dusky brown, with indistinct pale basal bands, widest in the middle, sometimes dull white, at others, when worn, cinereous. Venter dusky, with faint narrow pale basal bands. Tarsal claws of ♀, equal and simple; of the ♂, as in figure. A small delicate species 3·5 to 4 mm. long, with the abdominal banding much less marked than in *C. pipiens.*

♀.—Head dark brown, with pale golden curved scales and a pale clear border round the eyes; flat whitish scales at the sides of the head; black upright forked scales before the white lateral patches and brown ones behind; antennæ blackish-brown, basal joint bright ferruginous; palpi of ♀, dark brown; those of ♂, with two paler bands. Scutellum with seven bristles on the middle lobe; pleuræ pallid. Legs brown, pallid on the coxæ and undersides of the femora. Halteres pale, the knob clothed with creamy scales. Venter dusky, with faint basal bands. *Length.*—3·5 to 4·5 mm.

Habitat.—Scandinavia and England.

Subdivision iv.—*Culices with unbanded tarsi and the abdominal segments with pale apical bands.*

110 *C. Salisburiensis*, Theob. Abdomen dark brown, with narrow yellow apical bands, expanding at the sides to form lateral spots. Thorax golden-brown with indistinct linear markings. Tarsi brown.

111. *C. concolor*, R. Desv. Abdomen chocolate-brown, with broad yellow apical bands, almost covering the hinder segments. Thorax yellowish-brown, with a pale patch before the scutellum, and indistinct linear markings. Tarsi, with mixed dark and yellow scales. Venter, creamy.

112. *C. fuscanus*, Wied. Abdomen dusky with light grey apical bands. Thorax dark with signs of linear marking.
113. *C. territans*, Walker. Abdominal segments brown, with whitish hinder borders. Thorax golden-brown, with two dark lines. Tarsi brown.
114. *C. hortensis*, Ficalbi. Abdomen black, with pale apical bands. Thorax, mouse-coloured, unadorned. Tarsi blue-black. Venter white, with black lateral spots.

110. CULEX SALISBURIENSIS, Theobald (Monog. II, p. 112).

Tarsi uniformly brown. Thorax brown, with golden-brown curved scales; showing more or less linear ornamentation, a dull, bare, median line and lateral ones at the back, expanding in the middle of the thorax. Abdomen dark brown, with narrow, apical, yellowish bands, expanded laterally so as to form yellow lateral spots. Ungues of the ♀, equal and simple; fork-cells of the wings rather short, and the cross-veins distinctly alternated, 3 distinctly outside 2, and 4 far internal.

Head black-grounded, with straw-coloured linear curved, and black erect forked scales; the lateral flat scaled patches whitish; antennæ brown, with a lighter patch on the side of the basal joint; palpi short, black, with a peculiar quadrangular terminal joint (*vide* Plate xvii, fig. 9). Pleuræ brown, with two broad transverse creamy lines. Legs brown; coxæ, unbanded; femora, pale, slightly mottled; tibiæ and tarsi black; knee spot indistinct. Halteres, with pale stems and fuscous knobs. *Length.*—About 4 mm.

Habitat.—Salisbury, Mashonaland; March and April.

111. CULEX CONCOLOR, Robineau Desvoidy.

(Mém. d. l. Soc. d'Hist. Nat. de Paris, iv, 405.)

Plate xvii, fig. 8a, Venation of wing of ♂; 8b, of ♀.

Tarsi uniformly clothed with mixed ferruginous, and deep chocolate-brown scales, the latter preponderating on the upper joints, while the last ones are almost entirely clothed with the lighter scales. Thorax with chocolate ground colouring, and two sub-median raised ridges, densely clothed with ferruginous scales, the ridges sometimes showing as bare lines; a large creamy patch in front of the scutellum, prolonged into two very indistinct lateral lines. Abdomen deep chocolate-brown, with equally wide apical bands, which cover almost all of the last two segments. In the ♂, the last four or five segments may be entirely ferruginous, the banding being represented only by a brindling of black scales towards their bases. Tarsal claws of ♀, long, black, simple.

Head intensely black-grounded, with occiput and nape clothed throughout with linear curved, straw-coloured scales, mixed with erect forked scales, which are of the same tint in the middle, and black at the sides so as to form an indistinct paler median patch; lateral flat-scaled areas aud orbits creamy; antennæ with the basal joint pale-scaled in both sexes, intensely black elsewhere in the ♀, very markedly banded in the ♂; proboscis and other appendages clothed in the same way as the tarsi, the paler scales preponderating on the tip of the former; palpi of ♀, one-fourth the length of the proboscis, the paler scales very numerous about their mid length internally; those of ♂, longer than the proboscis by more than the length of the last joint, the base of which, together with the apex of the next, is somewhat flattened out and furnished with dense brushes of strong black hairs, the paler scales preponderating on the articulations, so as to produce indistinct banding. Pleuræ grounded light brown, with creamy patches. Wings with III, prolonged inwards as a distinct, unscaled vein. Halteres pale, with reddish knobs. Legs with the femora and tibiæ rather regularly beaded with patches of the paler scales. Venter, creamy-white. *Length.*—About 7·5 mm.

Habitat.—Appears common throughout India in the rains, and recorded also from Straits Settlement, and China, Fou Chow. Captain James I.M.S., says the larva float nearly horizontally.

112. **CULEX FUSCANUS**, Wied. (D. E. p. 9).

Tarsi unbanded; thorax rather dusky, with grizzly scales, arranged so that the ground colour shows through as four (darker) lines. Abdominal segments dusky, with light grey apical bands.

Generally dusky. Antennæ dusky, palpi yellowish beneath, with two white spots, fuscous. Wings yellowish on the costa. Legs yellowish-fuscous.

Habitat.—East India; Malacca, Singapore, Sarawak (Wallace).

Nothing answering to this description has been received in the British Museum.

113. **CULEX TERRITANS**, Walker (MS. Saund. p. 428).

Tarsi uniformly brown. Thorax brown, clothed with deep golden-brown scales, with two median dark lines; abdominal segments brown, with whitish hinder borders. Tarsal claws of ♀, equal and simple.

♀.—Head brown, with deep golden-brown, narrow curved and darker, upright forked scales; antennæ dark brown, testaceous at the base; palpi brown; proboscis brown, black at the apex. Pleuræ brown, with a few white scales. Legs dark brown, bases and venter of the femora pale brown; coxæ chestnut-brown, with a few white scales; knee-spots creamy-white. Halteres brown, with pale stems. *Length.* —6 mm. Is quite distinct from *C. pungens*, which latter has the abdominal segments basally banded, and may be a synonym of *C. fatigans*. Redescribed from Walker's type.

Habitat.—United States.

114. **CULEX HORTENSIS,** Ficalbi ("F. R." p. 292; "V. S." p. 69).

Tarsi uniformly blue-black. Thorax mouse-coloured, tending to yellowish, without special adornment. Abdomen black, with narrow white apical bands. Tarsal claws of ♀, equal and simple.

Head dark, with the nape and narrow orbits yellowish-white; proboscis blue-black, rather pale at the apex; antennæ grey, with a ring of whitish scales on the basal joint; palpi of ♀, blue-black, with a white ring on the middle; the last joint oblong; those of ♂, longer than the proboscis by half the length of the short last joint, subulate, not very hirsute, blue-black, with a ring on the middle, and a basal spot of white scales. Pleuræ, spotted and speckled white. Legs blue-black, except the base and undersides of the femora, a distinct white knee-spot, and an apical white ring on the tibiæ. Wings nearly black, with the fork cells much longer than their stems. Halteres pale. Venter white, with black lateral spots. *Length.*—About 5·5 mm. ♂, and 7 to 5 mm. ♀.

Habitat.—Italy; said not to bite.

Subdivision VI.—*Culices with unbanded tarsi and abdomen, but the latter with pale lateral spots.*

a. With obvious thoracic adornment.

115. *C. serratus*, Theob. Thorax brown, with a broad pale median stripe. Abdominal spots white, most marked behind.
116. *C. lateralis*, Meig. Thorax with bronzy scales; showing a fine median, and broad lateral white lines. Venter brown, with basal white bands.
117. *C. suballbatus*, Coquillett. Thorax dark in the middle, white at the sides. Venter with silvery bands, prolonged on to the sides of the segments.

b. The thorax without distinct colour markings.

α. With the venter banded.

118. *C. atratus*, Theob. Abdominal spots white, most distinct behind. Venter with broad creamy basal bands.

β. With the venter white.

119. *C. scholasticus*, Theob. Abdominal spots white. Thorax chestnut, with traces of paler lines.
120. *C. cinereus*, Theob. Abdominal spots white. Thorax grey.
121. *C. nigrochætæ*, Theob. Abdomen sooty, with a few white lateral scales. Thorax black, except the scutellum, which is yellowish.
122. *C. atripes*, Skuse. Abdominal spots silvery. Thorax dark violet, with a white oblong spot before the wings.
123. *C. iracundus*, Walker. Abdominal spots white. Thorax golden-brown.

γ The venter yellow.

124. *C. Freetownensis*, Theob. Abdominal spots small, white, apical. Thorax dark grey.
125. *C. modestus*, Ficalbi. Abdominal spots triangular, yellow. Thorax black on the dorsum; yellowish-white behind.

δ. The venter grey.

126. *C. nebulosus*, Theob. Lateral spots dull grey, minute. Thorax tawny-brown.
127. *C. inflictus*, Theob. Abdomen black, with triangular basal white spots. Thorax brown in front, pale behind.
128. *C. rimosus*, Theob. Abdomen brown, with four white apical lateral spots.

115. **CULEX SERRATUS,** Theobald (Monog. II, p. 45).

Plate xvi, fig. 18, Tarsal claws (fore and mid of ♂, and fore of ♀); 18a, Adornment of thorax and head.

Legs uniformly dark brown. Thorax dark brown, with a broad stripe of creamy-grey in the middle. Abdomen brownish-black, with basal white lateral spots, especially noticeable on the apical segments. Ungues of ♀, equal, uniserrated; of ♂, unequal in fore and mid legs, the larger one with two teeth, the smaller with one tooth.

Head marked with brown and white as in figure; some of the forked scales are yellow; proboscis and palpi dark brown, with some grey scales near the end in both sexes; those of the ♂, but little longer than the proboscis. Pleura reddish-brown, with white patches. Legs with the under surfaces of femora and tibiæ pale. Halteres pale ochreous. Venter almost entirely white-scaled. *Length.*—About 6 mm.

Habitat.—South America: Rio de Janeiro and Lower Amazon. New Amsterdam, Trinidad.

116. **CULEX LATERALIS,** Meigen

("S. B." i. 5; "F. R." p. 282).

= *C. albopunctatus*, Rondani (*fide* Ficalbi).

Tarsi uniformly black. Thorax black, covered with bronzy-brown scales, with a narrow median, and broad lateral white lines (*vide* fig. 2, p. xvii), contracted about the middle of the mesonotum; numerous pale scales in front of the scutellum. Abdomen dusky-black, with basal lateral white patches.

♀.—Head black, with creamy spindle-shaped scales in the middle, and forming a row behind, pure white at the sides, between which, on the occiput, is a patch of black, curved scales with scattered long forked scales, mostly ochreous in front, and black behind; a small pale patch just in front, projecting between the eyes; border of the eyes with a narrow white rim; antennæ dark brown, basal joint very dark brown; proboscis black; palpi rather long, covered with black scales showing metallic violet reflections. Legs with pale coxæ, bases of the femora, and knee-spot white; remainder dark brown. Halteres white scaled. Venter brown, with basal white bands. Differs from *C. ornatus* in having only abdominal spots in place of bands. *Length.*—6·5 mm.

Habitat.—Recorded from most parts of Europe, including England.

117. **CULEX SUBALBATUS,** Coquillett.

[Proc. U. S. Nat. Mus. vol. xxi, p. 302 (1899).]

Tarsi black. Thorax brownish-black in the middle, and white at the sides. Abdomen brownish-black, with silvery lateral spots.

♀.—Head and appendages black, except the basal half of the second antennal joint, which is yellow; the first joint, and the occiput next the eyes, covered with white tomentum; proboscis curved downwards towards its apex. Pleuræ nearly black, with several white-scaled patches; tufts of black hairs above the roots of the wings; scutellum, metanotum, and post-angles of thorax yellowish-brown. Halteres yellow with brown knobs. Venter with silvery bands, which are prolonged on to the sides of the segments. *Length.*—7 mm.

Note.—Coquillett describes the fore tarsal claws as unequal, with the larger claw only with an accessory tooth. Mr. Theobald remarks that if this be accurate, it is the only instance of such an arrangement in the ♀, out of over 300 species he has examined.

Habitat.—Japan (no specimens have been received in the British Museum).

118. **CULEX ATRATUS**, Theobald (Monog. II, p. 55).

Tarsi nearly black. Thorax deep umber-brown to almost black. Abdomen black, sometimes with a dull coppery-brown sheen; each segment with small lateral basal white spots, most distinct on the apical segments; venter with broad basal creamy bands. Fore and mid ungues of the ♂, unequal, the larger with a long median tooth, the smaller with a sharp basal tooth; hind equal and simple.

Head with whitish, curved linear, and black erect forked scales, rather darker just inside the lateral flat-scaled patches, with a bare median line in the ♂, darker on the frons, but with white orbits. Appendages dark brown to black; palpi of ♂, not quite so long as the proboscis, the fourth joint and end of third, much expanded and armed with strong black tufts; proboscis of ♀, much expanded near the end. Wing with the scales of the anterior long veins wider than common. Pleuræ brownish, with a row of black bristles down to the coxæ of mid legs. Legs dark brown, to almost black, except at the base; a pale knee-spot, and another at the tibio-metatarsal joint. Halteres with a dark lateral line on the pale stem and the knob fuscous. Ventral segments impure white, with narrow black hinder borders. *Length.*—Under 3 mm.

Habitat.—West Indies; Jamaica, Trinidad. "A terrible pest in mangrove swamps."

119. **CULEX SCHOLASTICUS**, Theobald (Monog. II, p. 120).

Thorax chestnut-brown, with small dark brown curved scales, and traces of two paler longitudinal lines; abdomen covered with dusky scales, each segment with a lateral, dull white, basal triangular spot. Tarsal claws of the ♀, small, equal, simple; of the ♂, unequal in fore and mid legs, equal and simple in hind; fore and mid uniserrated.

Head with grey, curved linear, and black, erect forked scales, and with lateral flat-scaled white patches, quite silvery in the ♂; antennæ brown, brindled in the ♂; palpi of ♀, black; those of ♂, longer than the proboscis by almost all the two last joints, brown at base, black at apex, subulate, and not tufted. Pleuræ pale brownish-grey, with a few white scales. Legs unbanded, covered with deep purplish-black scales with sometimes bronzy reflections: coxæ pallid; femora pale beneath. Halteres grey, with fuscous knobs. Venter densely white-scaled. *Length.*—About 5 mm.

Habitat.—Grenada and St. Lucia, West Indies.

120. **CULEX CINEREUS**, Theobald (Monog. II, p. 58).

Tarsi dark brown. Thorax covered with dense grey scales. Abdomen dusky-black; the segments with lateral white patches, which are more or less connected to form a white lateral line.

Head covered with grey scales, slightly darker behind; eyes bordered with a thin pure white line; palpi dark brown in both sexes, those of the ♂, longer than the proboscis, except the extreme tip, which is white; proboscis dark brown; antennæ brown, as long as the proboscis. Pleuræ, metanotum, and scutellum ochreous-brown, the last with the bristles of its mid lobe arranged in two separate lateral tufts. Legs dark brown, with femora pale beneath; coxæ pure white. Halteres entirely pale. Venter white-scaled. *Length.*—About 6 mm.

Habitat.—Freetown, Sierra Leone, in houses.

121. **CULEX NIGROCHÆTÆ,** Theobald (Monog. II, p. 60).

Tarsi dark brown. Thorax blackish, densely covered with narrow curved fawn-coloured scales, with a dark median line when denuded, and black bristles; metanotum pale chestnut-brown; abdomen dusky-black, olive-brown on the dorsum, with a few white lateral scales. Fore and mid tarsal claws of ♂, very unequal, the large claws with an accessory tooth, the smaller simple (*vide* Plate xvii, fig. 3).

Head brown, with narrow white orbits, the clypeus chestnut-brown: appendages nearly black, but the proboscis rather paler and reddish at the tip; palpi of ♂, with the second joint short, about half the length of the apical joint; apical joint with a few black bristles; the verticils of the antennæ springing from the middle, instead of, as usual, from the bases of the joints. Pleuræ, metanotum, and scutellum more or less ochreous, the last with the bristles of the mid lobe arranged as a continuous fringe. Legs dark brown. Venter whitish. Halters with pale stems and fuscous knobs. *Length.*—3·5 mm.

Habitat.—Lagos, West Africa.

122. **CULEX ATRIPES,** Skuse (" S. A. C." p. 1750).

Wings unspotted. Tarsi uniformly coloured. Thorax dark violet, with prothoracic lobes, an oblong spot before the roots of the wings, and the pleuræ whitish. Abdominal segments not banded, but with a silvery spot on either side. Knees with a minute spot.

Head and appendages intensely violet-black, but for narrow silvery eye-borders. Scutellum ochreous, violet-brown scaled above and fringed with long hairs; metanotum red-brown. Legs violet-black, with some white scales intermixed on the basal halves of the femora. Halteres with pale stems and dusky knobs. Venter densely silver-scaled. *Length.*—Under 4 mm.

Habitat.—Australia (N.S.W.). No specimens of this species have been received in the British Museum.

123. **CULEX IRACUNDUS,** Walker ("List," p. 6).

Tarsi unbanded. Thorax dark brown, with pale golden linear curved scales. Abdomen purple-black, with white lateral spots. Tarsal claws of ♀, equal and simple.

Head fusco-testaceous; palpi of ♂, rather shorter than the proboscis. Pleuræ brown, with white scales. Wings with stem of ant. fork cell half the length of the cell, and 4 far internal to 3: the type is too rubbed to admit of certainty, but Mr. Theobald thinks that the characters of the wing-scales are those of *Tæniorhynchus*, rather than of *Culex*. Halteres pale, with dusky knobs. *Length.*—3½ lines.

Habitat.—New Zealand.

124. **CULEX FREETOWNENSIS,** Theobald (Monog. II, p. 69).

Thorax dark brownish-grey, with long greyish scales, and three lines of black bristles. Abdomen dusky-brown, with small lateral patches of white scales on the apical borders of the segments; venter pale, ochreous when denuded. ♀, ungues equal and simple; fore and mid ungues of the ♂, unequal, uni-serrated, the fore nearly straight, the smaller only a little shorter than the larger; the mid more unequal, the larger one curved; hind ungues equal and simple, small.

Head brown, with a border of brownish-white scales around the eyes, and over the occiput, with numerous scattered dark upright forked ones; proboscis black, slightly paler at the tip; palpi black in the ♀, deep brown in the ♂, with scanty black tufts. Pleuræ brown, with white patches. Legs deep brown, with rather a coppery sheen; coxæ, bases of the femora, and their ventral surfaces, pale grey. Halteres with pale stems and fuscous knobs. Venter yellowish. *Length.*—4·5 to 5 mm.

Habitat.—Freetown, Sierra Leone.

125. **CULEX MODESTUS**, Ficalbi (1889), ("F. R." p. 279).

Tarsi black, unbanded. Thorax unadorned, dorsally blackish, yellowish behind; abdomen dorsally dark brown, with triangular yellowish lateral spots and sparse lateral yellow hairs, but clear yellow beneath. Tarsal claws of ♀, equal and simple, those of fore and mid legs of ♂, unequal, each with an accessory tooth.

Head with the nape brown and somewhat paler orbits; proboscis nearly black; antennæ brown, with a yellowish basal joint; palpi nearly black, those of ♀, with a long end joint, those of the ♂, longer than the proboscis by the greater part of the last joint, subulate, and differing from those of *C. pipiens* in not being tufted. Pleuræ yellowish. Legs nearly black, with the coxæ and the femora below yellowish, the former with a few black scales. Venter uniformly yellowish. *Length.*—6 to 7 mm., including the proboscis.

Habitat.—The Marshes, near Ravenna, Italy.

NOTE.—Mr. Theobald thinks that this species is distinct from Zetterstedt's *C. fusculus*.

126. **CULEX NEBULOSUS**, Theobald (Monog. II, p. 31).

(Rept. Liverpool School Trop. Med. 1901.)

Tarsi uniformly dark brown. Thorax brown, with tawny-brown scales, but showing two darker lines when denuded. Abdomen dark brown, with traces of dull grey apical lateral spots. Upper leg joints unadorned.

♀.—Head dark brown, with narrow curved, dull golden-brown scales, numerous brown upright forked ones and a distinct white border round the eyes, and white scales at the sides; clypeus, proboscis, palpi and antennæ brown, basal joint of the latter testaceous at the base. Scutellum brown, with very narrow, almost hair-like, pale scales, six bristles to the mid lobe; metanotum dark chestnut-brown. Pleuræ brown and ochreous, with scanty flat white scales. Legs brown; coxæ and trochanters ochreous, the former with dull white scales; femora dull pale ochreous beneath. Halteres yellow, with dusky knobs. Venter grey and brown. *Length.*—About 3·7 mm.

Habitat.—Old Calabar, Africa.

127. **CULEX INFLICTUS**, Theobald (Monog. II, p. 115).

Tarsi uniformly black. Thorax brown in front, pallid behind, small pale brown curved scales on anterior part and three double rows of black bristles in front, two behind. Pleuræ pallid. Abdomen dusky-black, with basal white, triangular, lateral spots.

Venter grey. Fork-cells of wings short Tarsal claws of ♀, very small, equal, and simple.

♀.—Head brown, with pale curved, and black upright forked scales, and orbits formed of white curved scales; antennæ brown, with pale bands, basal joint large and testaceous, dark on the inside; palpi black-scaled, testaceous at the base; clypeus chestnut-brown; proboscis dark brown scaled, short, a little longer than the antennæ; eyes deep purplish-black. Pleuræ pale silvery-grey. Legs black, unbanded, base and venter of femora grey, knee and tibial spots orange. Wing with fork of II internal to that of IV, its cells two and half times the length of the stem; and with 4 far internal to 3. Halteres with yellow stem and dark knobs. Venter grey. *Length.*—4 mm.

Habitat.—Grenada, West Indies.

128. **CULEX RIMOSUS,** Theobald (Monog. II, p. 327).

(Rept. Liverpool School Trop. Med. 1901.)

Tarsi dark brown, with their undersides somewhat yellowish. Thorax deep brown. Abdomen deep brown, with metallic bronzy and violet reflections, with four white apical lateral spots on the hinder segments, and grey venter. Legs deep brown, unbanded. Wings with rather broad scales, like *C. atratus*, Theobald. Tarsal claws of ♀, small, curved, equal and simple.

♀.—Head dark brown, with narrow curved dull-grey scales and numerous short upright black ones; clypeus black, *with a transverse sulcus*; antennæ brown, with reddish-brown basal joint; proboscis black, testaceous at the apex; palpi rather thick, black; scutellum deep ferruginous, with the margin grey. Pleuræ greyish-brown. Legs, with the coxæ and undersides of femora very pallid; elsewhere deep brown. Halteres yellowish, with dusky knobs. *Length.*— 2·8 mm.

Habitat.—Old Calabar, West Africa.

Observations.—Mr. Theobald considers it probable that the peculiarities of the wing-scales of this species, and of his *C. atratus* from Jamaica, may be of generic value.

Subdivision vii.—*Culices with unbanded tarsi and the abdomen unbanded, but with a pale median line.*

129. *C. trilineatus*, Theob. Thorax gold-coloured, with three dark lines. Abdomen ochreous in the middle, dark at the sides. Venter yellow.

130. *C. ochraceus*. Theob. Abdomen black at the sides, with a sharply-defined, serrated yellow median stripe. Thorax black, with broad golden lateral lines. Venter yellow.

129. **CULEX TRILINEATUS**, Theobald (Monog. II, p. 105).

Tarsi uniformly dark brown. Thorax clothed with golden and creamy scales, and adorned by a pair of broad dark sub-median lines, separated by a creamy interval on its anterior three-fourths. Abdomen bright ochre-yellow in the middle and nearly black at the sides, which show as even-bordered black lines from above. Wings with brown scales. Tarsal claws of ♀, symmetrical; those of fore and mid legs with extra teeth, those of the hind pair simple.

♀.—Head with linear curved, and erect forked scales alike yellow; clypeus pale ferruginous; proboscis yellowish-brown, dark at the apex; palpi yellowish, with a few black scales and hairs at the apex, and a dark band at the base. Pleuræ ferruginous, with a few whitish scales. Legs unbanded, ochreous basally, dark brown on the tibiæ and tarsi; knee-spots pale. Halteres ochreous, with paler stems. Venter yellow. *Length.*—5 mm.

Habitat.—Thayelmyo, Upper Burmah.

130. **CULEX OCHRACEUS**, Theobald (Monog. II, p. 103).

Tarsi uniformly deep brown. Thorax nearly black, with broad lateral golden-scaled lines. Abdomen pale yellow, the segments with triangular black patches with their apices forwards, so as to form a broad median reserrate pale stripe, bounded by serrated black lines (*vide* Plate xvii, fig. 7). Wings black, intermixed with ochreous scales, the latter specially numerous on the costa. Tarsal claws of ♀, symmetrical, each with an extra tooth.

♀.—Head, with narrow curved, and erect forked scales, yellow on the occiput but black on the nape; the lateral flat-scaled patches yellowish, with black internal boundary; with narrow creamy eye-borders; palpi clothed with mixed brown and yellowish scales, the last joint minute and nipple-shaped. Pleuræ nearly black, with golden and white patches. Legs ochreous with intermixed brown scales, the long joints pale at the base and darker at their apices; with small knee-spots. Halteres and venter both ochreous. *Length.*—4 to 5 mm.

Habitat.—Salisbury, Mashonaland.

Subdivision viii.—*Culices with unbanded tarsi and the abdomen unadorned.*

a. With the abdomen pale.

131. *C. bicolor*, Meig. Abdomen impure pale yellow.

b. With the abdomen dusky.

132. *C. pseudocinereus*, Theob. The junctions of segments reddish, giving a quasi-banded appearance. Thorax grey, with indistinct linear marking. Pleuræ dark grey, with a broad white line above the middle leg.
133. *C. metallicus*, Theob. Thorax black, with silvery scales in front and brown behind. Pleuræ with some brilliant white scales. Abdomen metallic purple.
134. *C. Frenchii*, Theob. Thorax chestnut-brown. Pleuræ with indistinct paler patches. Abdomen sooty. Venter yellowish.
135. *C. invidiosus*, Theob. Thorax brown; the pleuræ paler. Abdomen nearly black. Venter brown, reddish at the base.
136. *C. invenustus*, Theob. Thorax dark-brown. Pleuræ yellowish. Venter rather pale. Mid femora dilated.
137. *C. nigripalpis*, Theob. Thorax chestnut. Pleuræ pale brown. Abdomen almost black. Venter grey.
138. *C. longipes*, Theob. Thorax dark chestnut. Pleuræ pale brownish-grey. Abdomen dusky. Venter yellowish.
139. *C. fusculus*, Zetterstedt. Thorax ferruginous. Pleuræ dark slate coloured. Abdomen black.

31. **CULEX BICOLOR**, Meigen ("S. B." p. 1; "F. R." p. 277).

= *Culex marginalis*, Stephens, 1825 (?).

Tarsi unbanded; thorax dorsally greyish-chestnut, with traces of darker longitudinal streaks; abdomen dorsally, uniform pale yellow. Said to be less markedly yellow than *C. lutescens*.

Proboscis brown; palpi and antennæ of the ♂, yellowish-brown. Coxæ yellowish, especially at the base and beneath; tibiæ darker yellow, and the tarsi brown. Wings brownish-yellow. Halteres yellowish. Abdomen dorsally, pale dirty yellow. *Length*.—7 to 8 mm.

Habitat.—Northern Europe.

NOTE.—Inadequately described from types in confessedly bad condition. Mr. Theobald appears to believe that the description refers to rubbed specimens of *C. pipiens*, L.

132. **CULEX PSEUDOCINEREUS**, Theobald (Monog. II, p. 62).

Tarsi uniformly brown. Thorax clothed with grey, narrow curved scales, with three indistinct dusky longitudinal lines. Abdomen unbanded and unspotted, deep dusky-brown, the junctions of the segments rather testaceous, giving a quasi-banded appearance. Fore and mid ungues of the ♂, very unequal, the larger with a long tooth; hind ungues equal, simple, small.

♂.—Head brown, covered with narrow curved pale grey scales, and with a broad white border round the eyes, spreading out laterally, and with numerous small black upright forked scales; antennæ grey, with narrow brown bands and brown verticillate hairs; proboscis black; palpi a little longer than the proboscis, dark brown, the penultimate joint very short, not more than one-third the length of the apical joint, the latter with a few long brown hairs on each side, the former also with a few thinner ones, the long antepenultimate joint with some very short thick bristles on the apical half and a narrow pallid band on the basal half, its base expanded. Metanotum dark brown. Pleuræ deep greyish-black, with a broad line of white scales running down to the base of the middle leg, and another smaller patch on the metapleura. Leg sunbanded, dark brown, bases and venter of femora pallid. Venter dark brown. Halteres with yellow stems and dark knobs. *Length.*—4·8 mm.

Habitat.—Salisbury, Mashonaland; February.

133. CULEX METALLICUS, Theobald (Monog. II, p. 63).

Plate xvii, fig. 4, Tarsal claws, ♂ and ♀; 4b, Thoracic adornment; 4b, External ♂ genitalia.

Tarsi uniformly brown. Thorax black, with long curved hair-like silvery scales on the anterior half and long bright brown ones behind. Abdomen flat, smooth, with metallic purple scales. Ungues of the ♀, rather long, equal and simple; of the ♂, unequal in the fore and mid legs, equal in the hind. Wings thickly scaled along the veins and with lateral long scales, dark along the costal border.

Head and appendages dark brown, the former with the nape clothed all over with mixed pale grey curved linear, and black erect forked scales; palpi of ♂, with an indistinct band near the base. Legs deep brown, yellowish at the base and on undersides of femora. Palpi black with some brilliant white scales. Halteres deep yellow on the stem, with fuscous knobs. Looks much like a *Janthinosoma*, but the legs are smooth; differs from *C. gelidus* in having the abdomen metallic purple. *Length.*—About 4·7 mm.

Habitat.—Bonny, West Africa; in the bush.

134. CULEX FRENCHII, Theobald (Monog. II, p. 66).

Tarsi uniformly brown. Thorax deep bright chestnut-brown, with pale golden scales scattered over its surface, three double rows of black bristles, two median bare lines, and a curved bare patch on each side of the mesonotum. Abdomen dusky black, unbanded; venter yellowish.

♀.—Head dark brown, covered with a few pale creamy curved scales, golden upright forked ones in the middle, and forked black ones over the whole surface; palpi rather long, black, testaceous at the base; clypeus brown; proboscis black-scaled; antennæ dark brown, with the basal joint, and base of the second, reddish yellow; pubescence pallid, hairs black. Scutellum bright testaceous. Pleuræ bright brown, with indistinct paler patches. Legs with pale coxæ and bases to the femora, knee-spots orange, rest dark brown, with dull ochreous reflections. Halteres entirely ochreous. Venter yellowish. *Length.*—5 mm. It is the only Australian species at present known, with the legs and abdomen alike unbanded.

Habitat.—Victoria, Australia.

135. **CULEX INVIDIOSUS,** Theobald (Monog. II, p. 329).

(Rept. Liverpool School Trop. Med. 1901.)

Tarsi uniformly deep brown. Thorax deep chestnut-brown. Abdomen blackish-brown, quite unadorned. Tarsal claws of ♀, small, equal and simple. Much resembles *Ædes niger* in colouration.

♀.—Head deep brown, almost black; the occiput covered with dull ochreous grey narrow curved, and black upright forked scales; flat scales of lateral patches, small, dull-white; a narrow rather indistinct grey border round the eyes; clypeus deep chestnut-brown; proboscis deep blackish-brown; palpi short, densely black scaled; antennæ brown, basal joint testaceous in the centre. Scutellum rich shiny brown, with six bristles to the mid lobe and four on each of the lateral; pleuræ paler brown. Legs deep brown; coxæ and bases of femora pale. Halteres ochreous, with dusky knobs. Venter brown, reddish at the base, very hirsute; lateral scales violet-grey in some lights. *Length.*— 3·2 mm.

Habitat.—Bonny, Africa; May.

136. **CULEX INVENUSTUS,** Theobald (Monog. II, p. 330).

(Rept. Liverpool School Tropical Med. 1901.)

Tarsi uniformly dark brown. Thorax dark brown, showing when denuded three dark lines. Fore and mid femora much dilated. Tarsal claws of ♀, small, much curved, equal and simple.

♀.—Head almost black, with narrow ochreous grey curved scales, blackish and brown thin upright forked ones, white flat scales at the sides, and a narrow white border round the eyes; eyes black; palpi short, dark brown; proboscis rather short, dark brown, testaceous at the tip; antennæ dark brown, basal joint black, last two joints very hairy; clypeus black. Scutellum greyish-brown; pleuræ yellowish-brown, rather darker in front. Legs dark brown with pale grey bases. Venter rather pale. *Length.*—3·5 mm.

Habitat.—Degama, West Africa.

NOTE.—The dilatation of the femora may be of generic value.

137. **CULEX NIGRIPALPIS**, Theobald (Monog. II, p. 322).

Tarsi uniformly dark brown. Thorax chestnut-brown. Abdomen almost black, unbanded, grey ventrally. Proboscis almost black; palpi longer than proboscis, black, last two joints with black hairs, acuminate. Fore and mid tarsal claws of ♂, unequal; the internal larger, and alone with an extra tooth, those of hind legs equal and simple.

♂.—Head dark brown, with golden linear curved scales on the sides, mixed, on the nape, with numerous black forked scales; lateral, flat-scaled areas greyish, extending on to the sides of occiput; antennæ banded grey-brown, with black verticils; proboscis black, reddish at apex; the palpi exceeding it in length by nearly all their last two joints; the latter black with traces of a pale band near the base of the middle joint, last joint a trifle shorter than the next, and both of them armed with stiff black bristles. Scutellum yellowish, with six bristles on the mid-lobe; pleuræ pale brown. Legs nearly black, except the greyish undersides of the femora. Wings with fork of II four times as long as its stem, its bifurcation well inside that of IV, and 4 more than twice its length inside 3. *Length.*—2·5 mm.

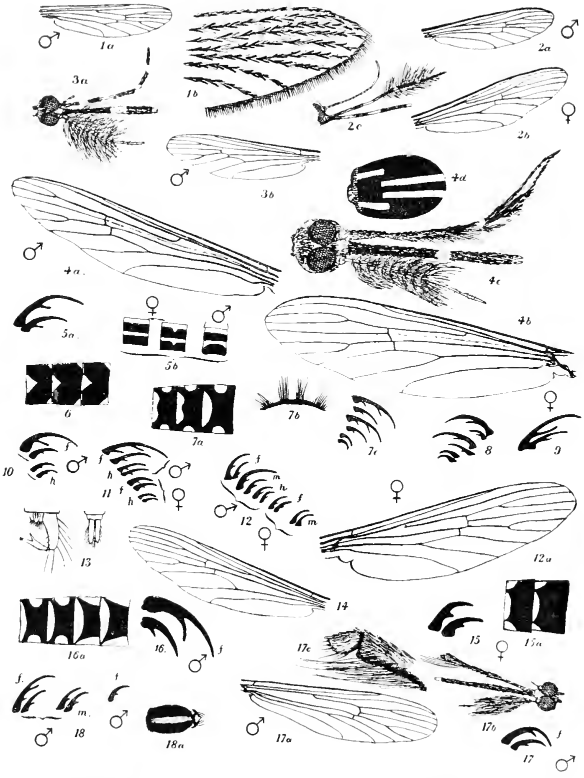
Habitat.—St. Lucia, West Indies.

138. **CULEX LONGIPES**, Theobald (Monog. II, p. 68).

Tarsi uniformly dark. Thorax dark chestnut-brown, with curved black scales, more or less longitudinal ornamentation, and long black bristles; pleuræ pale brown to grey, with long black bristles. Abdomen dusky black, unbanded; venter yellowish. Legs unusually long, dark brown; coxæ and venter of femora pale. Tarsal claws of ♀, very small, simple, and equal. Fork cells of wing short.

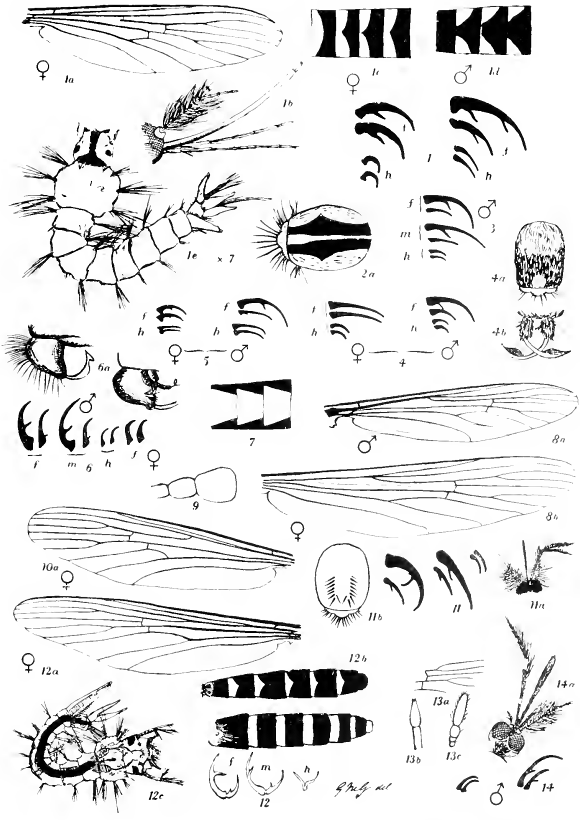
♀.—Head dark brown, with white eye-borders, and the curved and erect scales of the nape alike black; clypeus castaneous; cephalic appendages, uniformly dark brown. Pleuræ pale brown to grey, with numerous black bristles. Venter yellowish. Halteres, with pale brown stem, and the knob nearly black. *Length.*—4·3 mm.

Habitat.—Singapore (one specimen taken in a house).



1, *Stegomyia pipersalata*, sp.n.; 2, *Culex tritaeniorhynchus*, sp. n.; 3 *C. impellens*, Walk.; 4, *C. tigripes*, de Grandpré et de Charmoy; 5, *C Vishnuii*, Theob.; 6, *C. annulioris*, Theob.; 7, *C. plumosus*, Theob.; 8 *C. dissimilis*, Theob.; 9, *C. hirsutipalpis*, Theob.; 10, *C. vigilax*, Skuse 11, *C. marinus*, Theob.; 12, *C. cantans*, Meig.; 13, *C. vexans*, Meig. 14, *C. vagans*, Wied.; 15, *C. occidentalis*, Skuse; 16, *C. albitarsis*, Theob. 17, *C. confirmatus*, Arribál; 18, *C. serratus*, Theob.

Face Plate XVII., p. 468.



1, *C. pulchriventer*, sp. n.; 2, *C. lateralis*, Meig.; 3, *C. nigrochetæ*, Theob.; 4, *C. metalicus*, Theob.: 5, *C. luteolateralis*, Theob.; 6, *C. impudicus*, Ficalbi; 7, *C. ochraceus*, Theob.; 8, *C. concolor*, Desv.; 9, **C.** *Salisburiensis*, Theob.; 10, *C. albolineatus*, sp. n.; 11, *C. virgultus*, Theob.; 12, *C. viridiventer*, sp. n.; 13, *C. Zombaensis*, Theob.; 14, *C. nigritullus*, Zetterstedt.

Face Plate XVI., p. 468.

139. CULEX FUSCULUS, Zetterstedt (1850).

(Dipt. Scand. t. ix, "F. R." p. 278.)

Tarsi unbanded, yellowish-brown, especially on the last joints. Thorax clothed with ferruginous tomentum; the pleuræ dark slate colour. Abdomen dorsally black.

Palpi of the ♂, rather longer than the proboscis, and with the two last joints somewhat dilated; the antennæ with brownish plumes. Wings cinereous. Legs with the femora and tibiæ yellowish, rather browner at the apices; knees marked by a white spot. Abdomen dorsally black. *Length.*—Of the ♂, $2\frac{1}{2}$; of the ♀, 2 lines (Zetterstedt). Some individuals have dirty white spots on the sides of the abdomen.

Mr. Theobald, who was lent a specimen of this species, figures the head with a peculiar median pale band, clothed with broad curved scales of exceptional form, and with the lateral flat-scaled areas very much broader than usual. The ♀ palp is shown with a very minute, bead-like end joint, and he figures also some scales, not unlike those of the head, but with long beaded stalks, on the scutellum.

Habitat.—Zetterstedt described it from Scandinavia, and Siebke from Norway.

UNBANDED-LEGGED SPECIES, INADEQUATELY DESCRIBED (REPRODUCED IN EXTENSO FROM MR. THEOBALD'S MONOGRAPH).

140. CULEX LURIDUS, Doleschall.

(Natuurkundig. Tijdsch. voor Ned. Ind. D. xiv, p. 384.)

"Greyish-brown. Abdomen greenish, with black scales. Legs fuscous hoary. Wings pellucid, with black veins. *Length.*—$2\frac{1}{2}$ lines. Smaller than *C. setulosus*, almost the same colour and markings. The abdomen is greenish-black, haired on the back with broad transverse stripes.

"*Habitat.*—Middle Java (Gombong); during the dry season in houses."

141. CULEX RUFINUS, Bigot.

(Exp. Scientif. d. l. Tunisie, Dipt. p. 7.)

"Pale fulvous. Antennæ brownish. Thorax rufous above; scutellum paler, clear drab, abdominal segments fuscous, broadly banded with pale brown bands. Wings very pale yellow. General colour pale yellow; tergum reddish, darker laterally.

"*Habitat.*—Tunis, in May."

NOTE.—Probably a worn specimen.

142. **CULEX MOLESTUS**, Wiedemann ("A. Z. I." p. 544).

"Reddish-brown, with black abdomen. Thorax deep red-brown. Antennæ and other appendages brown. Abdomen black. Wings with brown scales. *Length.*—$1\frac{1}{2}$ lines.

"*Habitat.*—Sumatra."

NOTE.—Described from a very defective specimen.

143. **CULEX OCHRIPES**, Macquart ("D. E." Sup. IV, p. 11).

"Fuscous. ♂ palpi yellow, apex black, elongated. Legs ochreous. *Length.*—3 lines ♀.

"Thorax and abdomen brown (denuded). Proboscis yellow, brown at the apex; palpi of ♂ dilated at the end, longer than the proboscis by a third of its length, yellow, last joint black. Wings greyish, reddish on the outer border.

"*Habitat.*—South America."

NOTE.—Arribálzaga makes no note of this species; it was evidently described from worn material. I cannot trace the type. I (Mr. Theobald) do not think the species could be identified unless from the type. I expect it is either *C. flavipes* or *C. fatigans*.

144. **CULEX SICULUS**, R. Desvoidy (1827).

"Thorax pale brick-red, with grey hairs. Abdomen more or less brownish-red, pale yellowish in the ♂, with a brown band on each segment. Proboscis yellow, with the apex brown in the ♀; palpi and antennæ brownish in the ♀. Legs with the femora and tibiæ pale yellow, the tarsi brown-ringed, knees with a silvery spot. *Length.*—Of the ♂, $2\frac{1}{2}$ lines, of the ♀, 3 lines.

"*Habitat.*—Sicily."

145. **CULEX SETULOSUS**, Doleschall.

(Natuurkundig. Tijdsch. voor Ned. Ind. D. xiv, p. 384.)

"Pale fuscous, hairy. Thorax slightly narrowed in front, thickly clothed with ash-grey hairs. Abdomen paler, bristly. Legs uniformly fuscous. Wings hyaline, scaly, with yellow veins. *Length.*—2 lines.

"*Habitat.*—Middle Java; during the dry season in houses. Equally numerous and not less troublesome than *C. nero.*"

146. **CULEX GENICULATUS**, Olivier (1791).

"Thorax cinereous, with two blackish lines near the middle line and two on the sides. Abdomen dorsally brown, with the borders of the segments whitish. Legs with the femora white below and at the base; tibiæ and tarsi blackish. Proboscis black; antennæ brown.

"*Habitat.*—Paris (Olivier, and R. Desvoidy)."

NOTE.—There has been no recent record of this doubtful species.

147. CULEX CALCITRANS, R. Desvoidy (1827).

[Essai sur les Culicides, Mém. Soc. d'Hist. Nat. de Paris (1827).]

"Thorax dorsally reddish, with three brown stripes, and with the pleuræ cinereous. Abdomen pale yellowish on the dorsum; incisuræ marked with black. Legs yellowish, with the tarsi brownish. *Length.* 3 lines."

NOTE.—I (Mr. Theobald) believe this is only a partly denuded ♀ *Culex pipiens.*

148. CULEX RUBIDUS, R. Desvoidy.

(Essai sur les Culicid. p. 404.)

"Antennæ brownish; proboscis yellowish, with brown apex; palpi yellowish-brown. Thorax reddish, with a black dorsal line. Abdomen brownish, with triangular yellowish lateral spots. Wings brownish-yellow, with villous veins. Hind tarsi with white cilia. *Length.*—4½ lines (?).

"*Habitat.*—Carolina."

NOTE.—I (Mr. Theobald) have seen nothing answering to this, and Coquillett does not mention it.

149. CULEX MERIDIONALIS, Leach (1825).

(Zool. Journ. N. vii, Oct. 1825.)

"Head and thorax reddish-brown. Legs greyish-brown. Abdomen dorsally reddish-brown, with lighter bands on the dorsum of each segment behind. *Length.*—5 mm.

"*Habitat.*—Nice."

NOTE.—Described by Leach in his paper "Description of Thirteen Species of *Formica* and Three *Culex*, &c." (Z. J. vii, 1825). It is said by Leach to be common in Nice. It is probably only *Culex pipiens.*

150. CULEX PALLIPES, Macquart (1838).

= *C. melanorhinus*, Giles (1900).

[Dipt. Exoti. p. 33, Macq.; Gnats or Mosq. p. 342, Giles (= *melanorhinus*).]

"Fuscous. Thorax with rufous scales, the sides and pectus pale. Wings with the first sub-marginal cell longer than the second posterior."

NOTE.—Must not be confused with *C. pallipes*, Meigen, which has the proboscis and basal bands on the abdomen yellow. To mark the distinction, the name *Melanorhinus* was given in the first edition, but in now, according to Macquart's name, a merely nominal status, this hardly remains necessary.—G. M. G.

Genus XV. **DEINOKERIDES,** Theobald

(Monog. II, p. 215).

As no males have come to hand it is doubtful if this genus should be included in the *Culicina* or the *Ædomina*. Its distinguishing ch.racter is the structure of the antennæ, which have the second joint of extraordinary length and clothed with scales. The only gnats which have antennæ at all similar are the *Megarhinæ* and certain species of the genus *Anopheles*, but in none of these is the second joint so disproportionately long as in *Deinokerides*, and in these it is dilated, instead of tapering uniformly. The remaining twelve joints are also much longer than usual and are clothed with bristles nearly as stout as those of the rather ill-developed verticils.

Mr. Theobald defines his new genus as follows :—

"Head clothed with curved thin scales on the vertex and with long orked upright scales, which are fimbriated at the apex as well as forked. Thorax with flat curved spindle-shaped scales. Abdomen covered with flat scales. Palpi of ♀, three-jointed : *antennæ with the second joint very long, as long as the three following joints* ; much longer than the proboscis. Tarsal claws of ♀, equal and simple."

1. **DEINOKERIDES CANCER,** Theobald (Monog. II, p. 216).

Thorax blackish, brown towards the scutellum, with scattered bronzy-black scales. Abdomen blackish-brown, with deep umber-brown scales ; venter paler. Legs brown, with bronzy reflections ; coxæ pallid ; femora yellowish at the base and underneath ; ungues of the female equal and simple.

♀.—Head blackish-brown, with greyish flat curved scales, somewhat creamy-coloured towards the front, with scattered brown forked upright scales ; antennæ bright brown, basal joint yellowish, base of the second joint the same, fourteen-jointed, *second joint very long* ; palpi covered with chocolate-brown scales ; clypeus bright chestnut-brown ; proboscis blackish-brown, darkened and expanding towards the tip, paler at the base. Pleuræ chestnut-brown. Wings with clavate scales on II. Halteres yellow, with the knob nearly black. *Length*.—About 4 mm.

Habitat.—West Indies, Jamaica and St. Lucia. Very prevalent in the rainy seasons; inhabits crab holes on the sea-shore, and also bred from *larvæ* found in pools in a road.

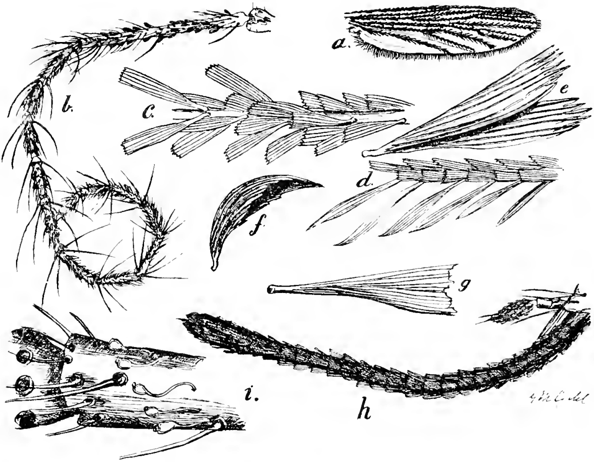


FIG. 46.—*Deinokerides cancer*, Theob. ♀.—*a*, Wing, showing distribution of different forms of scales; *b*, antenna of ♀; *c*, arrangement of scales on anterior fork; *d*, on posterior fork; *e*, twin scales from head; *f*, linear curved scale from nape; *g*, erect forked scale from nape; *h*, proboscis and palp; *i*, end of second antennal joint, showing peculiar sense-organs (probably olfactory).

Genus XVI. **BRACHIOMYIA,** Theobald

(Monog. II, p. 343).

This genus is represented by a single species, and as in the preceding case, the ♀ alone is known, so that its position is doubtful.

It much resembles *Deinokerides*, but the second antennal joint is not quite so disproportionately long. The distinctive character of the genus lies in the first five joints of the antennæ being clothed with scales, and in the fore and mid femora being dilated.

Mr. Theobald defines his new genus as follows :—

"Head covered with very thin, narrow, curved scales, all pointing forwards ; mesothorax and scutellum with small, narrow, curved scales ; antennæ of the female fourteen-jointed, very long and filiform, the second joint long, the succeeding joints gradually becoming shorter, apical joint globose-oval ; the second to fifth joints densely covered with scales and with longish hairs, remaining joints with shorter hairs and no scales, verticillate hairs scanty and short, absent on the second and third joints ; basal joint globose, bare ; palpi short, four-jointed, apical joint the longest, the two basal joints small ; clypeus prominent, nude ; proboscis long, but not so long as the body. Legs with the fore and mid femora swollen ; fore and mid ungues equal and simple, the former straighter than the latter. Wings with venation as in *Culex*, the scales rather thick, either truncated (in middle of veins) or lanceolate laterally."

1. **BRACHIOMYIA MAGNA,** Theobald (Monog. II, p. 344).

Tarsi brown, unbanded. Thorax glistening brown, unadorned. Abdomen unbanded, steely-grey, with dull brown scales, sparsely mixed with yellow behind. Antennæ of ♀ considerably longer than the body.

♀.—Head brown, with grey linear curved, and yellow erect forked scales; antennæ filiform, brown, with the basal joint ochreous; palpi brown, short, three-jointed, the basal joint stoutest. Pleuræ mottled yellow and brown, metanotum nude. Halteres yellow, with dusky knobs. Legs brown, pale at the base and on undersides of femora, which are dilated in the fore and mid legs. Tarsal claws equal and simple, with a large yellow empodium between them. Venter pale brown. *Length.*—4·3 mm.

Habitat.—St. Lucia, West Indies.

CHAPTER XIV.

The Ædomina Sub-family.

In this sub-family the palpi was much shorter than the proboscis in both sexes. It is divided by Mr. Theobald into six genera as follows :—

Section A.—Proboscis formed for piercing; metanotum nude.

a. Palpi three- to five-jointed. Body showing generally a distinct metallic lustre.
One or more of the legs provided with a paddle-shaped expansion, formed of elongated scales. "3" nearer apex of wing than "4"; "2" nearer apex than "3"; III extended into basal cell......Genus XVII. *Sabethes*.[1]

b. Palpi two- or three-jointed; non-metallic.
Wing scales large and flat, and bracket-shaped; fork-cells normal...................................... Genus XVIII. *Ædomyia*.
Wing scales small, linear like *Culex*; fork-cells normal Genus XIX. *Ædes*.

c. Palpi five-jointed; fork-cells normal; metallic .... Genus XX. *Hæmagogus*.

d. Palpi two-jointed; fork-cells very small; with metallic spots of flat scales on the thorax and elsewhere .... Genus XXI. *Uranotænia*.

Section B.—Proboscis formed for piercing; metanotum armed with chætæ; palpi small.
Proboscis rather or very long ....Genus XXII. *Wyeomyia*.

Genus XVII. **SABETHES,** Robineau Desvoidy.

(As modified by Mr. Theobald, Monog. II, p. 347.)

Plate xi, figs. 7 and 8.

(Essai s. 1, tri. des Culicides (1827), Rob. Desv.; Brit. Mus. List i, 1 (1840), Walker; Dipt. Arg. xi, p. 66 (1891), Arribál.)

Head clothed with flat scales. Thorax with small flat scales. Abdomen with small flat scales, palpi rather short in both sexes.

[1] *Sabethes* is included in the *Culicina* in Mr. Theobald's monograph, but the receipt of additional material has led him to modify his views on the subject, as the palpi are undoubtedly short in both sexes. The sheets of the Monograph were, however, in too advanced a stage to admit of the alteration being embodied in the text.

Antennæ fourteen-jointed, second joint small, the joints increasing in length towards the apex, very pilose in the ♀, more so in the ♂. Legs scaled, certain parts being provided with very long, hair-like scales. Wings with rather broad scales, anterior fork-cell longer and narrower than the posterior; "3" nearer the apex of the wing than "2"; "4" nearer the apex still; III carried through into the basal cell, and continued to the root of the wing as a spurious vein.

The characters given by Robineau Desvoidy for this genus are not sufficient, so that it has become necessary to modify the generic definition as above; moreover, owing to the small number and bad condition of the few existing specimens, certain males had been mistaken for females, it is only while passing through the press, that a number of excellently preserved specimens have been received from Para which show that the palpi are really short in both sexes, and that the genus is therefore one of the *Ædomina* sub-family, *S. remipes*, Weid., being taken as the "type."

The chief distinctive feature apart from the scale ornamentation is the position of the cross-veins. Although the forward position of the posterior cross-vein is similar to *Mucidus*, the wing scales at once prevent confusion between the two genera. The curious large patches of long leg scales occur again in *Eretmapodites*, Theob., but here too, the venation readily separates them.

Walker's *Sabethes scintillans* cannot be included in the genus. It is distinctly a *Psorophora*. The members of this genus are purely sylvan in habits, and appear to be very uncommon.

The wing scales in this genus present a good deal of resemblance to those of *Panoplites* in general form, being distinctly unsymmetrical, and having a tendency to the same bracket-shaped outline, but they lie close to the wing and have a strong metallic lustre quite wanting in the scales of that genus, owing to those of *Sabethes* being coarsely striated transversely, as well as longitudinally.

Of the three species, *S. remipes* and *S. nitidus* have a paddle on the mid leg only, while *S. longipes* has paddles on all three legs.

1. **SABETHES REMIPES,** Wied.

(Auss. Zweiflüg. Ins. i, p. 573 (1828), Wiedemann; Novara. Reise. Dipt. p. 31 (1868), Schiner; Hist. Nat. Dipt. i, 37, 18 (1834), Macq.)

Plate xi, fig. 7a, Wing of ♂; 7b, Head of ♂; 7c, Antennæ ♀; 7d, Mid leg of ♂; 7e, Wing scale.

Wings unspotted, metallic violet-brown. Tarsi unbanded. Thorax and abdomen deep metallic steely blue, unadorned, but the venter yellow. Tibiæ and first tarsal joints of middle legs provided with a paddle-shaped expansion of long, hair-like scales, the other legs simply densely scaled. Generally deeply coloured, with varying reflections throughout.

Head and appendages clothed with flat, steel-blue scales; antennæ of ♀, with very dense verticils, approaching the characters of a male; her palpi three-jointed, about one-fourth the length of the proboscis, acutely fusiform; those of ♂, much shorter than the proboscis, the last three joints of nearly equal length, with tufts of long flexible, silky hairs. Thorax black, with flat purple and blue scales. Abdomen covered with deep blue scales, purple and coppery at the apex, with silvery spots laterally, yellow ventrally. Legs steel-blue or purple, the mid leg with a dense mass of long scales forming a kind of paddle on the tibia and first tarsal joint. Wings with rather large flat brown scales, violet along the costa. *Length.*—6 mm.

Habitat.—Amazon region.

2. **SABETHES NITIDUS**, Theob. (Monog. II, p. 347).

Specimens of this new species have been recently received from Para. It closely resembles the preceding, differing mainly in the scaly "paddle" of the mid leg being white on its apical half, instead of wholly black.

3. **SABETHES LONGIPES** (Fabr.).

S. loculipes, R. Desv.

Syst. Antl. iv, 400, 2 (1794), Fabricius; Aussereurop. Zwei. Ins. i, 11 (1828), Wiedemann; Essai s. l. tr. d. Culicides, Mém. d. l. Soc. d'Hist. Nat. de Paris, iii, (1827) (= *loculipes*), Desvoidy; Hist. Nat. Dipt. i, 36, 16 (1834), Macquart; Dipt. Exot. i, 34, 3, pl. 1, fig. 2 (1838), and Sup. i, 8, 9, pl. 1, fig. 2 (1848), Macquart; Dipt. Argentina, p. 67 (1891), Arribálzaga.)

Plate xi, fig 8+ Fore leg: 8m, Mid leg; 8h. Hind leg.

Wings unspotted; dusky-brown, but with some metallic lustre. Thorax unadorned, clothed with broad, lanceolate scales with azure-green and bronzy reflections. Abdomen unadorned, of much the same tinting, but the venter whitish. Last three mid-tarsal joints white; the hind tarsi white beneath but dark above; all three legs with broad paddle-shaped expansions.

♀.—Head dark brown, with metallic flat scales, mauve at the sides; antennæ dark brown, basal joint almost black, with a grey rim; palpi very short, black scaled; proboscis of moderate length, curved, black-scaled, metallic; eyes and clypeus black. Thorax black, with metallic coppery and iridescent scales; abdomen black, with coppery and metallic purple lustre. Legs deep metallic purple-blue, and the front pair with a small paddle, involving all the tibiæ and half the first tarsal, which latter is white beneath; the middle legs bear a much larger paddle, although the upper third of the tibia is unfringed, and has the first three tarsals white with long white lateral scales: hind legs with apex only of tibiæ fringed, first three tarsi silvery-white beneath. *Length.*—7 mm.

Habitat. — Amazons (Bates), 1861 (F. V. T.); Guiana (Macq.); Brazil (Wied).

Genus XVIII. **ÆDOMYIA,** Theobald

(Monog. II, p. 218).

The character distinguishing these gnats from the rest of the sub-family is the form of the wing scales, which are large and bracket-shaped, almost as in *Panoplites.* The head is clothed with narrow upright scales, which are rather fan-shaped than forked; on the thorax the scales are broad and lanceolate, and on the scutellum, pleuræ and abdomen they are flat and spatulate; clypeus with tufts of scales; metanotum nude. The venation of the wings is much of the usual type. The palpi are said to be two- or three-jointed, but this character is of little value in identification as the number cannot be determined without mounting the appendages separately in balsam. May be distinguished from *Stegomyia* (♀) by the scutellum being clothed with broad flat, instead of narrow curved scales.

1. **ÆDOMYIA SQUAMEPENNIS** (Arribál.).

Ædes squamipennis, Arribál. ("L. A." p. 62).

Wings with the purplish black costa interrupted by three clear white patches which extend across the wing and round its apex. Tarsi and legs elaborately banded, the long joints each with several yellow bands and with broad, irregularly basal and articular bands. Thorax unadorned, dark brown, with its scales yellowish in the middle, and white behind and at the sides. Abdominal segments brown, with two creamy patches on the hinder and two white ones on the fore borders, the apical segments ochreous. Proboscis black, with two narrow white bands. Apices of mid and hind femora with a tuft of long dark scales.

Head whitish, with a tuft of broad creamy scales between the eyes and dark scales at the sides; clypeus black, with two streaks of white scales; palpi dark with ill-marked white banding, of the ♀, white at the apex; antennæ nearly black, the last two joints being much thickened, and olive-shaped in the ♂. Scutellum whitish in the middle, with a tuft of black scales on each side. Pleuræ dark brown, with whitish patches. Venter yellowish at the base, black with basal white patches behind. *Length.*—About 4 mm.

Habitat.—West Indies, South America, India, Straits Settlements. Enters houses and bites, but not severely.

2. ÆDOMYIA VENUSTIPES, Skuse.

Ædes Venustipes, Skuse ("S. A. C.," p. 1761.)

Wings with all the veins densely clothed with mixed brown and yellow scales, the former preponderating, but unspotted. (Scales described as "somewhat broad, more or less elliptical.")

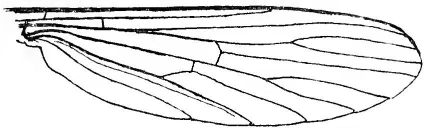


FIG. 47.—The wing of *Ædomyia venustipes*.

Legs elaborately banded dark brown and white, the hind legs with all the two last tarsals white except the apex of the fifth joint, other joints with broad basal white bands. Thorax clothed with mixed brown and yellow scales, with apical and lateral yellow patches. Abdomen densely clothed with mixed brown and white scales, the latter preponderating on the sides and beneath. Proboscis deep brown with subapical and median white bands. There is no mention of any femoral tufts. Pleuræ deep brown with white patches, scutellum with yellowish-brown scales. *Length* 3·81 mm.

Habitat.—Elizabeth Bay, Sydney, Australia.

NOTE.—Nothing corresponding to Skuse's description has come to hand from Australia, but the circumstance of Skuse describing it as Ædes, together with the form of the wing scales, makes it probable that it belongs to this genus. As, however, he describes from a single female specimen, it is possible it may be a *Panoplites*. Its close general resemblance to the preceding species, however, makes this unlikely.

Genus XIX. **ÆDES,** Meig.

(As restricted by Mr. Theobald, Monog. II, p. 224.)

Meigen's genus originally comprised all species having short palpi in both sexes. These, however, are of such very varying types that, in spite of the small number of species included, the separation of the preceding, and three other genera, has necessitated the revision of its definition which, in Mr. Theobald's restricted sense, is limited as follows:—

"Head clothed with both flat broad, and narrow curved scales, over the occiput, the former always predominating, the latter sometimes nearly absent. Thorax with narrow curved scales; scutellum usually with four bristles to the mid lobe. Palpi short, *apparently* two-jointed in both ♂ and ♀, always much shorter than the proboscis, rounded apically, scaly, and with a few bristles and hairs. Scutellum with narrow curved scales Antennæ fourteen-jointed, plumose in the ♂, pilose in the ♀, the second joint often rather swollen; proboscis about the length of the antennæ. Wings rather long, the scales much as in *Culex*, the lateral ones long and slender; the first sub-marginal cell generally longer and narrower than the second posterior cell, both cells of moderate length. Legs with the ungues of the ♀, both equal and toothed and simple, of the ♂, unequal, the larger toothed, the smaller toothed or not so.

"The essential characters are: (i.) The palpi short in both sexes; (ii.) the palpi two-jointed; (iii.) the wings clothed with ordinary scales as in *Culex*; (iv.) curved scales only on thorax and scutellum.

"In regard to the number of joints in the palpi there is some difference of opinion. Ficalbi says they are two-jointed, with a trace of a third joint. I cannot find more than two joints, but there is a basal notch which might be mistaken for a joint."

They are soberly coloured insects, generally sylvan, and the European forms are said not to bite, though there is some doubt if this applies to the American and African species, and *Æ. Butleri*, from the Malay peninsula, is said to be very troublesome. With the exception of *Æ. fuscus*, they appear to be rare insects, as the number of specimens received in the Museum has been but small.

Table of Species of the Genus Ædes.

iii. Abdominal segments with pale basal bands.

1. *Ædes fuscus*, Osten-Sacken. Abdomen dull black, with creamy basal bands of crescentic form.

vi. Abdominal segments unbanded, but with pale lateral spots.

A. Anterior fork-cell longer than the posterior.

2. *Æ. Butleri*, Theob. Abdomen intensely black, with white lateral patches. Anterior fork-cell twice the length of its stem.

3. *Æ. nigricorpus*, Theob. Generally resembles the above, but has the fork-cells much longer. Thorax dark bronze, unadorned.

B. Posterior fork cell as long as the anterior.

4. *Æ. Pembaensis*, Theob. Thorax adorned with two pale stripes in front.

viii. Abdomen unadorned.

A. Anterior fork cell longer than the posterior.

5. *Æ. Cinereus*, Meig. Abdomen nearly black. Thorax dark, with a faint, pale median line.

6. *Æ. Obscurus*, Meig. Generally dusky. Under border of abdominal segments darker.

7. *Æ. Rufus*, Gimmerthal. Abdomen nearly black. Thorax reddish, with median and lateral darker lines.

8. *Æ. pertinans*, Williston. Abdomen deep brown. Thorax unadorned, brown, and generally dusky.

9. *Æ. perturbans*, Williston. Abdomen and thorax alike ellow.

B. Posterior fork-cell as long as the anterior.

10. *Æ. niger*, Theob. Abdomen entirely black. Thorax brown. Pleuræ pale.

1. ÆDES FUSCUS, Osten-Sacken.

(Bull. U.S. Geol. Surv. p. 191.)

Abdominal segments steely-black, with creamy basal patches. Ground colour of thorax nearly black, with golden-brown, narrow curved scales. Legs bronzy-black; the tarsi unbanded.

Head dusky, with yellow lateral patches, and narrow eye-borders; palpi very short, black, as also is the proboscis. Pleuræ, chestnut-brown with white patches. Venter creamy-yellow. Femora silvery below, and with minute white knee-spot. Tarsal claws of ♀, equal and simple; of ♂, on the fore and mid legs unequal, the smaller simple, the larger with extra tooth; on the hind legs equal, and both toothed. *Length.*—About 4 mm.

Habitat.—America; Canada and United States.

2. ÆDES BUTLERI, Theobald (Monog. II, p. 230).

Abdominal segments intensely black, with white lateral basal spots. Wings with the anterior fork-cell longer than the posterior, and quite twice the length of its stem. Ground-colour of thorax black, uniformly clothed with dark bronzy, narrow curved scales.

♀.—Head black, with lateral patches, a narrow median line, and delicate eye-borders, white; clypeus and appendages black. Pleuræ dark umber-brown with four white patches. Wings dusky brown, with a peculiarly narrow, triangular, hinder fork-cell. Legs with femora pale beneath, and small white knee-spots. Tarsal claws equal, toothed at the base on the fore and mid legs; simple in the hind pair. *Length.*—About 4 mm.

Habitat.—Jungle, Selangor; Straits Settlement. Said to be common and troublesome.

3. **ÆDES NIGRICORPUS,** Theob. (Monog. II, p. 231).

Plate xiv, fig. 23, Venation of wing.

Veins of wing very densely clothed with uniformly black, long scales; anterior fork-cell three and a half times as long as its stem, the latter much shorter than the stem of the shorter and wider posterior fork-cell, which is, however, nearly twice as long as its stem. Tarsi uniformly black. Thorax clothed with narrow curved, black scales, on a black ground. Abdomen, seen from above, uniformly black, but with small white lateral spots.

♀.—The uniformly sooty tint of this species leaves little room for description. Seen from above it is entirely so, with the exception of a few white scales on the apices of the femora. The venter, however, has broad white basal bands. May be distinguished from the preceding species by the much greater length of the anterior fork-cell as compared with its stem, and in having some upright forked cells on the head which are absent in *Æ. Butleri*. *Length.*—About 2·8 mm.

Habitat.—Described from a single, very well preserved ♀ specimen, sent me by Dr. Gray, of St. Lucia, West Indies; the disc marked "St. Glivan, Castries." Also recorded from the Lower Amazon.

4. **ÆDES PEMBAENSIS,** Theob. (Monog. II, p. 235).

Closely resembles the two preceding species, but may be distinguished by the fork-cells being of nearly equal length, and their stems more than half the length of the cell. The head is blackish-brown, covered with flat scales, and like that of *Æ. Butleri*, has no erect forked scales. The knees apparently unspotted.

Described from a single ♀ specimen. *Length.*—4·5 mm.

Habitat.—Pemba Island, East Africa; August.

5. **ÆDES CINEREUS,** Meig. ("S. B." II, p. 13; "F. R." p. 300).

Abdomen black, with a few grey scales at the sides, and a pair of basal white patches on the last segment. Thorax nearly black, with a faint median line of golden scales. Wings densely brown scaled; the anterior fork-cell longer and narrower than the posterior, and but little longer than its stem.

Head black, with dusky flat scales and black erect forked, in the ♂; but with yellowish lateral patches, median line, and eye-borders in the ♀; palpi black, short in both sexes, but with those of the ♂, distinctly shorter than the ♀. Pleuræ nearly black, with a few white scales. Legs deep red-brown, rather paler at the articulations; tarsal claws of fore and mid legs of ♂, unequal, the larger only with an extra tooth simple and equal in the hind legs. *Length.*—about 6 mm.

Habitat.—Throughout Europe, including England.

6. **ÆDES OBSCURUS,** Meig. (M. S.).

In the collection of the Jardin des Plantes, I found a specimen, labelled as above, in Meigen's handwriting. It has the hind borders of the segments distinctly darker than in front, but cannot be said to be banded.

My notes on the venation of the wing, as roughly made out with a hand lens from a specimen I did not care to handle too curiously, correspond sufficiently well with Mr. Theobald's notes on *Æ. cinereus*, with which I am inclined to think it must be identical. No such name is traceable in Meigen's works, and possibly the specimen was so labelled by him, before he had finally made up his mind how to call his new species, though it must be admitted that the name *obscurus* is much the more appropriate of the two.

7. **ÆDES RUFUS,** Gimmerthal ("F. R." p. 300).

Is said to be redder than *Æ. cinereus*, and to have three darker lines on the testaceous thorax.

Probably identical with the above, and in any case inadequately described.

8. **ÆDES PERTINANS,** Williston.

Abdomen unbanded, brown. Thorax brown, unadorned tarsi unbanded (?), brown; of a generally brown tint.

Description from Williston, "Trans. Ent. Soc. Lond." 1896, p. 271: "♂ and ♀.—Face, basal joint of the antennæ, and base of the proboscis yellowish; antennæ and the rest of the proboscis nearly black, the former only a little more hoary in the ♂, than in the ♀; the terminal joint of the ♂, only a little longer than the preceding ones; mesonotum brown, thickly clothed with dark brown scales; pleuræ yellow, with white tomentum. Abdomen deep brown, with brown scales. Venter yellow with white scales; forceps of the ♂, small, yellow. Legs deep brown, the femora, and in a less degree the tibiæ, showing the yellow ground colour on the under side. Wings nearly hyaline; veins uniformly brown scaled. *Length.*—3 mm.

"*Habitat.*—The coast of St. Vincent, West Indies, and on the hills at 1,000 ft."

9. **ÆDES PERTURBANS**, Williston.

Abdomen varying from yellow to brown, unbanded. Thorax generally yellow, unadorned. Tarsi unbanded (?) brown; general colouration yellowish.

Description from Williston, "Trans. Ent. Soc. Lond." 1896, p. 271: "♂ and ♀.—Head black; antennæ brown; plumosity of the ♂, long, abundant and black; terminal joint as long as the seven or eight preceding it together, and clothed with short hair; in the ♀, the joints are slenderer, and the end one is no longer than the two preceding ones combined; the verticils of moderate length; proboscis black, as long as the abdomen; palpi brown. Thorax yellow; mesonotum a little darker, and clothed with brown scales. Abdomen yellowish, yellowish-brown, or brown; the terminal segment and the hypopygium brown or blackish, and clothed above with brown scales. Legs brown or blackish; the femora for the most part yellow, with grey or purplish reflections in some lights. In some specimens, the tibiæ largely yellowish beneath the tomentum. Veins of wings uniformly brown scaled. *Length.*—4·5 mm.

"*Habitat.*—The island of St. Vincent, West Indies."

Some specimens sent me by Dr. Lutz from San Paola, South America, labelled "wood mosquito, probably sp. n. of group *Ædes*," corresponded entirely to Williston's description, but the specimens, unfortunately, arrived in a terribly damaged condition. The body was clothed with mixed brown and yellow scales. Mr. Theobald believes the species to be identical with his *Wyeomyia Grayii*, in which case the latter would stand as *W. perturbans* (Williston). We have not seen the type.

10. **ÆDES NIGER**, Theobald (Monog. II, p. 237).

Abdomen uniformly black. Thorax nearly black, paler on the pleuræ and at the roots of the wings. Anterior fork-cell barely longer than the posterior, its stem two-thirds as long as its cell.

♀.—Head and appendages dark brown, the former clothed with dusky flat scales, with three dark bristles projecting forwards and inwards on each side. Legs dark brown, except on the coxæ which are pallid, with very small simple tarsal claws. Halteres, with white stem and black knob. *Length.*—2 mm.

Habitat.—Old Calabar, West Africa.

Genus XX. **HÆMAGOGUS**, Williston.

(As limited by Mr. Theobald, Monog. II, p. 238).
(Trans. Ent. Soc. Lond. 1896, p. 271, Williston.)

The essential character of this genus is that while the palpi are short in both sexes, as in *Ædes*, the one known species has five distinct joints, but in general appearance, it much more closely approaches Desvoidy's *Sabethes*. The antennæ are almost as short, in proportion to the proboscis, as the palpi. Mr. Theobald defines the genus as follows :—

"Head covered with flat scales, also the abdomen; palpi short in both sexes, five-jointed, the first and fifth joints small, second long, nearly the same length as the third and fourth together; antennæ fourteen-jointed. Wings with the two fork-cells rather short; scales normal, much as in *Ædes*. In the ♂, the front claws are unequal, and each with a single tooth; in the ♀, equal and simple."

1. **HÆMAGOGUS CYANEUS** (Fabr.).

= *Culex cyaneus*, Fabr.; *Hæmagogus splendens*, Williston.

(Syst. Antl. 35, 9, Fabricius; Dipt. Exot. p. 8, Wiedemann; Trans. Ent. Soc. Lond. (1896), p. 272 (= *splendens*), Williston.)

Thorax deep blackish-brown, with deep metallic-blue lustre, with brilliant green, coppery, and violet scales. Abdomen black, with brilliant blue and violet scales, the first five segments with basal lateral white spots forming more or less of a lateral white line. Legs metallic-blue; undersides of hind femora pale golden on the basal half. (*Vide* Fig. 51; 7, and 7a, p. 509.)

♀.—Head black, clothed with brilliant flat scales, those at the sides bright blue and white, those behind metallic-green and blue; palpi covered with bright purple scales; proboscis long, deep violet-black; antennæ dark brown, basal joint dark. Ground-colour of pleuræ nearly black, clothed with brilliant, glistening, white scales. Veins of wings clothed with iridescent brown scales, the fork-cells decidedly shorter than their stems, and their bases in one line. *Length.*—5 mm.

Habitat.—South America and West Indies.

NOTE.—Mr. Theobald believes that Williston's *H. splendens* is synonymous with the *Culex cyaneus* of Fabricius.

Genus XXI. **URANOTÆNIA** (" L. A." Arribál. p. 63).

This genus was separated from *Ædes* by Arribálzaga, in 1891, and is certainly a very distinct type. The gnats belonging to it are all inhabitants of warm climates, of small size, and are characterised by the possession of patches of scales of nearly circular outline, showing no signs of striation except under high powers, which bring out very close, transverse markings. These scales, in almost all lights, are of a beautiful iridescent sky-blue, or occasionally white, and give the insects a most distinctive appearance. The palps in both sexes are quite rudimentary, consisting of but one, or it may be, two short pieces; but the proboscis is proportionally, very large, being as long as, or longer than the wing, the sheath broadened at the tip, and especially in the ♂, fringed near the end on its margins with numerous strong hairs. It may be distinguished from the other genera of the *Ædes* group by the form of the fork-cells, which are very short, with the anterior cell shorter than the posterior. IIa, and IVa are continuous, without flexure to the apex of the wing, while IIp and IVp, are much curved. On casually examining the wing, it looks much as if there were no extension of I beyond the origin of II, but it really extends quite to the tip, though almost bare of scales. The scales of the wing veins are lanceolate, with a graceful sigmoid curve.

Arribálzaga founded his genus on two species, *Pulcherrima* and *Nataliæ*, and pointed out that Osten-Sachen's *Ædes saphirinus* appeared to be of the same type, to which, of previously known species, Mr. Theobald adds Walker's *C. argyropus*, which, together with ten new species which have come to hand, brings up the total to fourteen species.

For the following rough notes on the larvæ, which I reproduce *in extenso*, I am indebted to Dr. W. L. Forrest, of Antigua.

"Found in ponds, covered with lemna-like weed, and other aquatic plants. Colour, creamy-white; dark brown head. Not at all timid, remains at surface at the same angle as *Culex*.

"*Head*.—Dark brown, densely chitinous, smooth, heart-shaped, with truncated apex, longer than broad, longer than thorax, as wide as abdomen; eyes slightly in front of widest part, with a row of bristles pointing forwards; antennæ same colour as head, terminate with simple spines, basal joint with a few bristles; whorls close, pointing sideways, extremities curving forwards, forming a straight line in front. On upper surface, on either side of the median line, there is a single, stout, vertical spine, one pair is posterior to the centre of head, and one pair anterior, a little in front, and extending slightly towards lateral edge. There is also a curved row of bristles behind the base of the antennæ.

"*Thorax*.—Much wider than long, translucent, surface studded with colourless, circular cells (warts or pits); frontal margin beset with long compound bristles, not quite so long as head, pointing forwards; mesothorax with similar bristles slightly longer, several rows confined more to lateral regions; near the uppermost bristle on each side, a slight circular depression surrounded with fine hairs; metathorax similar to mesothorax, also with the two circular depressions. Tracheal angle situated between pro- and mesothorax, very slight dilation.

"*Abdomen.*—First and second segments slightly shorter than remainder, with compound bristles as on thorax; third to ninth each with a lateral tuft of hairs (short) arranged in a circle; eighth segment, respiratory siphon, almost as long as three segments, with ten short spines on under side near base, a compound hair at the middle, on upper side several compound hairs, slightly chitinous; ninth segment, swimmerets* very short, half length of segment, three sets (?) plain compound bristles, very long; tracheæ appear to touch, in the centre of each segment a chain pattern."

Table of Species of the Genus Uranotænia.

A. With one or more of the distal hind tarsal joints entirely pale.

iii. Abdominal segments basally pale banded.

1. *Uranotænia minima*, Theob. Last hind tarsals all yellow with more or less complete apical banding of other joints. Abdominal pale bands yellowish-brown. Thoracic adornment unknown. Anterior fork-cell quite as long as the posterior.

iv. Abdominal segments with apical pale bands or median spots.

2. *U. annulata*, Theob. Last two hind tarsals all white, remaining joints with apical pale bands; fore and mid legs unbanded. Pale abdominal bands grey. Thorax chestnut-brown, sharply separated from grey pleuræ; apparently without blue adornment. Anterior fork-cell much shorter than the posterior.

3. *U. geometrica*, Lutz. Hind legs with last two tarsals all white and apical pale bands to other joints, fore and mid tarsi indistinctly banded. Abdominal segments black, with triangular white median patches. Thorax reddish-brown, with blue spots in front of the wings, at back of mesonotum, and on middle of scutellum.

v. Abdominal segments basally and apically pale banded.

4. *U. pulcherrima*, Arribálzaga. The proportion in which the contiguous segments contribute to the pale yellow abdominal bands is very irregular. Last hind tarsal joint white, with apical or articular banding to most other tarsals. Thorax clear red-brown, with brilliant blue median line on anterior half of mesonotum, and patches of the same at the roots of the wings.

vi. Abdominal segments unbanded, but with pale lateral spots.

5. *U. argyropoda*, Walker. Hind legs with last two tarsal joints, and apex of next, white; fore legs with a broad whitish band, formed of all the fourth with the apex of third and base of

* Swimmerets—anal tubercles?—G. M. G.

fourth joint. Abdomen dusky, with apical white lateral patches. Thoracic adornment unknown. A large mosquito (7 mm.)

6. *U. Lowii*, Theob. Hind legs with last two tarsal joints and apex of next white, but without other banding of the legs. Abdomen dusky, with traces of pearly-blue apical lateral spots. Thorax bright chestnut, with silvery-blue spots at the roots of the wings and distinct darker linear adornment. Very small (1·5 mm.).

B. With the tarsi unadorned.

iv. Abdominal segments with pale bands.

7. *U. saphirina* (Ost.-Sack.). Thorax tawny, with blue median line extending on to scutellum, and other blue patches.

8. *U. nataliæ*, Arribál. Thorax dark fawn, with *darker* median lines. Blue spots in front of wings.

9. *U. pygmæa*, Theob. Thorax black, with pale bronzy scales and glistening white (*not blue*) spots.

vi. Abdominal segments unbanded but with pale lateral spots.

10. *U. domestica*, Theob. Thorax bright reddish-brown with two white spots in front of, and three on the scutellum. Anterior fork-cell rather longer than the posterior.

11. *U. Malayi*, Theob. Thorax bronzy-black, with no white adornment beyond a few white scales in front. Anterior fork-cell markedly shorter than the posterior.

viii. Abdomen unbanded.

12. *U. socialis*, Theob. Abdomen black with a white spot on the fifth or sixth segment. Thorax deep chestnut with blue median line not extending to scutellum, and other blue and mauve ornamentation.

13. *U. cæruleocephala*, Theob. Abdomen uniformly brown. Thorax chestnut, with white spots in front and before the wings. Head entirely azure-blue.

14. *U. Mashonaensis*, Theob. Abdomen uniformly dark brown. Thorax bright rufous, without distinct ornament. Head clothed with sombrely-tinted scales.

1. **URANOTÆNIA MINIMA**, Theob. (Monog. II, p. 267).

Last tarsal joint of fore and mid legs, and last two of fore legs pale yellowish, but darker on the fore legs; all the other tarsal joints more or less distinctly apically pale banded. Denuded thorax deep brown with pale median line. Scaly adornment uncertain, but probably without azure-blue spots. Abdominal segments dark brown, with pale yellowish-brown apical bands. Wings without glistening basal patches and with anterior fork-cell longer and narrower than the posterior.

♂.—Head and appendages yellowish-brown; the proboscis much dilated at the tip, and the basal joint of the antennæ purplish-grey. Pleuræ and coxæ very pallid. Wings with dark tooth-like scales on the costa; and the scales clothing the veins, for the most part, short and truncate; the fork-cells proportionally longer than in most of the genus. Legs dark, pale on the undersides near the base, and with pale spots or bands at the apices of the long joints. Venter with pale scales. *Length.*—Under 2 mm.

Habitat.—Quilon, Travancore, India.

REMARKS.—By no means a typical member of the genus. The spiny costa recalls that of my *Steg. brevipalpis.*

2. URANOTÆNIA ANNULATA, Theobald (Monog. II, p. 250).

The whole of the last two, and apices of the other hind tarsal joints whitish; fore and mid legs unbanded, deep brown. Thorax deep chestnut-brown, sharply separated from the pale grey pleuræ, but without any of the glistening patches characteristic of the genus, beyond creamy spots on the prothoracic lobes. Abdominal segments black, with grey apical bands. Anterior fork-cell much shorter than the posterior.

Head small, entirely clothed with whitish scales but for a median line of dark cells; proboscis, antennæ, and the very minute palpi, dark brown. Scutellum clothed with nearly black flat scales. Legs yellowish-grey at the base and on undersides of the femora, and with minute knee-spots, fairly distinct on the hind legs, elsewhere deep brown. Fore and mid tarsal claws of ♂, simple but very unequal, those of ♂ hind legs, and of ♀, equal and simple. *Length.*—About 2 mm.

Habitat.—Bonny, West Africa.

3. URANOTÆNIA GEOMETRICA, Lutz MS. (Monog. II, p. 247).

Last two hind tarsal joints entirely white, with conspicuous apical pale bands on the other hind tarsals and on those of the other legs. Thorax reddish-brown with two paler lines, and glistening azure-blue patches before the roots of the wings, on the prothoracic lobes, and on a median patch just before a bare patch in front of the scutellum. Abdomen black with median white apical patches. Anterior fork-cell much shorter than the posterior.

The head and its appendages, save for some blue scales on the occiput, are almost black throughout, and the ground-colour of the thorax and abdomen piceous. The segments of the latter are obscurely basally banded with a lighter brown than that of the nearly black scales covering their hinder borders; and in the mid-line this deep-tinted border is interrupted by a snowy spot, especially prominent in the ♂. In addition to the tarsal banding, the apices of all the femora and tibiæ have large white spots, and the tips of the fore tarsi may be all white, though to a less extent than is the case on the hind legs. Wing mainly fuscous-scaled, with two minute and indistinct whitish spots, on the apex, and interrupting the costa opposite the posterior transverse vein, respectively; and with iridescent blue patches at the bases of V and II. The armature of the long wing vein is, even apart from the round-scaled patches, peculiar, their bases being clothed with truncate scales, while their distal portions are more sparsely clothed with long lanceolate scales of peculiarly graceful form and arrangement.

Habitat.—Santos, Brazil (Lutz).

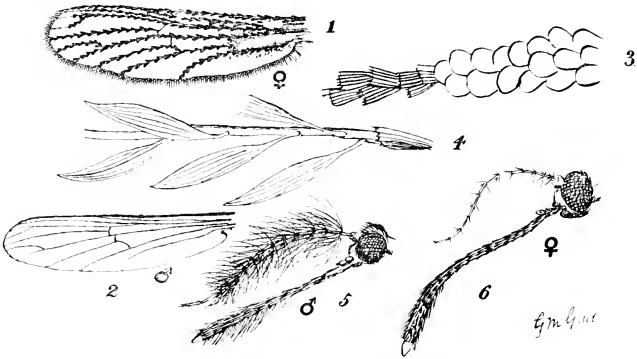


FIG. 48.—1, Wing of ♀, × 15 diameters; 2, Venation of ♂ wing; 3, Base of V, showing form of the generic blue scales; 4, Arrangement of scales on distal part of a long vein; 5, Head and appendage of ♂; 6, of ♀.

4. **URANOTÆNIA PULCHERRIMA**, Arribálzaga.

("L. A." p. 65.)

Last hind tarsal joint all white, with distinct white apical bands on the other joints; there are traces of apical banding on the upper joints of the fore and mid legs, the lower joints of which are much paler than the upper. Thorax bright testaceous, with a median pale blue line in front, not extending to scutellum, a pale blue patch on each side of the wings, another on the scutellum, and patches of deeper blue on the prothoracic lobes. Abdomen dusky brown, with whitish cross-bands, rather irregular. Fork-cells both small, the hinder the larger.

Head clothed with flat scales of a dark brown and deep ochreous brown colour on the occiput, a small blue patch on each side close to the eyes, behind are short black upright forked scales; antennæ brown, with narrow pale rings, basal joint bright pale reddish-yellow, proboscis and palpi black, the latter very small, especially in the ♂, the former expanded towards the tip. Pleuræ pale yellow, with a prominent azure-blue spot over the fore coxæ. Wing scales closely resembling those of *U. geometrica*, and like it, with azure-blue patches at the base of II and V. Legs dark brown, with small white knee-spots, and apical rings on the tibiæ. The proportion in which the contiguous abdominal segments contribute to the pale bands is most irregular, some of them being mainly formed by the apex of the segment in front, while others are almost purely basal, but on the venter the pale bands are more regularly apical. It may be distinguished from *U. geometrica* by its more complete abdominal banding, and by only the fifth, instead of the last two tarsal joints being entirely white. *Length.*—About 2·5 mm.

Habitat.—Brazil and Argentina, South America; and I have recently received two ♂ specimens from Dr. Forrest, of Antigua, whose remarks on the larvæ of *Uranotænia* may be taken to refer to those of this species.

5. URANOTÆNIA ARGYROPODA (Walker). ("List," p. 2.)

Last two hind tarsal joints and apex of next yellowish, but with the tarsi apparently otherwise unadorned, beyond a broad band consisting of all the fourth fore tarsal and parts of the joints above and below it, which appear pale in certain lights. Thorax (much denuded) ferruginous, with hair-like brown scales and patches of flat blue scales on the prothoracic lobes. Abdominal segments dusky, with white lateral apical patches. A large mosquito. Venation of wing as in *Eretmapodites*.

♀.—Head black with azure-blue orbits; palpi black, with a white patch in the middle; proboscis black; scutellum ochreous, with dusky flat scales. Pleuræ brown, with white patches. Legs brown, with the femora yellowish, white at apex and base, and with a dull white, subapical spot. Venter brown with apical white borders to its segments. *Length.*—7·5 mm.

Habitat.—New Zealand.

Observations.—In the absence of the male it is impossible to determine the generic position of this species, the type of which is in none too good a condition, but personally I do not think it can belong to the present genus, all the other species of which are very small, while this is above the average size of most genera; in addition to which, the venation of the wings is as different as it well can be, and I should prefer to place it provisionally in *Eremapodites*, the wing scales of which much resemble those of *Uranotænia*.

6. **URANOTÆNIA LOWII,** Theobald (Monog. II, p. 339).

Last two hind tarsal joints and half of the next white, but with no distinct banding of the fore and mid legs. The thorax is of the usual chestnut-brown, with some ill-defined darker ornament, in the shape of a pair of submedian lines and patches above the wings, but the characteristic iridescent patches are represented only by two small bluish-white spots in front of the wings. Abdomen dark brown, with traces of pearly-blue apical spots.

♀.—Head clothed with flat, deep brown scales, with a small iridescent silvery-blue patch on each side; its appendages deep brown; the proboscis spatulate. Scutellum clothed with flat black scales; pleuræ pale ochreous. Wings with small fork-cells, and the hinder much the larger, with a few iridescent scales at the bases of IV and V. Venter ochreous. Legs brown with the mid femora dilated. *Length.*—1·5 mm.

Habitat.—St. Lucia, West Indies.

7. **URANOTÆNIA SAPHIRINA** (Osten-Sacken).

Ædes Saphirinus, Ost.-Sacken, Trans. Amer. Ent. Soc., II, p. 47.

Tarsi uniformly pale brown. Thorax tawny-brown, paler on the pleuræ, with a metallic-blue median mesothoracic line reaching the scutellum, a pale blue line in front of the wings, and two blue spots on the pleuræ. Abdomen brownish above, pale below, with pale apical bands. Wings with an iridescent patch at the bases of III and IV.

Head with a sapphire-blue front and median line; proboscis very long, "incrassated" at the tip. Pleuræ pale tawny-brown, with three sapphire-coloured marks; "feet brownish, paler at the base, a snow-white dot on the upper side of the femora, and of the tibiæ." Halteres with pale stem and brown knob. *Length.*—2·5 mm.

Habitat.—United States; Washington, Brooklyn, Ithaca.

Remarks.—No specimens have come to hand of this species, but it is evidently a very distinct species, and there can be no practical doubt as to its belonging to this genus. I do not understand why Mr. Theobald believes that the tarsi are banded. No mention of such a character is made in the original description, nor is it indicated in a subsequent figure by Howard, and the closely-allied *U. nataliæ* has also unbanded tarsi.

8. **URANOTÆNIA NATALIÆ,** Arribálzaga ("L. A." p. 64).

Tarsi unbanded, dark brown, their last joints reddish. Thorax dark fawn, with a darker median line; a long pale blue spot on each side in front of the wings; prothoracic lobes blue. Abdomen black, with pearly bands.

♀.—Head testaceous, clothed behind with blue scales; palpi deep piceous; proboscis piceous, brown at the base, with short fuscous pilosity; eyes black with a silvery border. Pleuræ pearly. Wings moderately densely clothed with fuscous scales, which tend to pale blue in places. Legs pale testaceous, with the apices of the femora and tibiæ deep pitch-brown. Halteres pale reddish, with dusky knobs. *Length.*—2 to 2·5 mm.

Habitat—South America; Buenos Ayres and San Paolo.

9. **URANOTÆNIA PYGMÆA,** Theobald (Monog. II, p. 254).

Tarsi deep metallic-bronze or purple, unbanded. Thorax black, covered with narrow shiny pale bronzy scales, with a short clear silvery-white line on each side just in front of the wings, another small white spot on the prothoracic lobes, and others on the pleuræ. Abdominal segments dusky, with whitish apical bands which are sometimes indistinct; venter grey. Wings with purplish-black scales and with a line of silvery-white scales at the base.

♀.—Head dark brown, with broad flat scales, black in the middle, and with a few black upright forked ones and flat white ones in front, forming a very distinct broad white border to the eyes, which widens out laterally, forming a pale violet-coloured patch on each side; antennæ brown; palpi very short, black; proboscis dark brown, nearly as long as the body, expanded apically, hairy. Scutellum nearly black. Legs generally purple-black, with the coxæ and bases of femora pale, and a faint knee-spot on the hind legs; the bases of the mid femora dilated in the ♀. *Length.*—2 mm.

Habitat.—Queensland.

10. **URANOTÆNIA DOMESTICA,** Theobald (Monog. II, p. 253).

Tarsi unbanded, nearly black. Thorax bright reddish-brown, a small metallic-silvery spot on each side in front, and three silvery spots on the scutellum. Abdomen dark brown, with lateral silvery spots.

♀.—Head dark brown, covered with dark brown flat scales, a patch of silvery-white ones on each side near the eyes, towards the middle, and a patch of dull ochreous ones laterally; at the back of the head is a patch of dull ochreous narrow curved scales, and projecting forwards numerous black bristles; proboscis almost black; palpi very small, black and scaly; antennæ brown. Pleuræ chestnut-brown, with a white patch. Wings with the anterior fork-cell longer than the posterior, and a glistening but not very pure white spot at the base. Legs almost black, a silvery spot near the apex of the hind femora, and at the apex; also one on the apices of the tibiæ. Venter dusky. *Length.*—3·8 mm.

Habitat.—Old Calabar. "Taken in the Vice-Consulate, and hence possibly a domestic species."

11. **URANOTÆNIA MALAYI**, Theobald (Monog. II, p. 258).

Tarsi unbanded, black. Thorax black, with flat bronzy spindle-shaped scales, with some white ones just behind the head, and in front of the roots of the wings. Abdomen dusky blackish-brown, with small triangular basal lateral white spots.

♀.—A rather dusky species. Head clothed with flat black scales, with a few grey ones forming a pale central line, a border of creamy white scales round the eyes and at the sides, a few small black, upright scales at the back of the head; a few black bristles projecting in front; antennæ brown; palpi black scaled, and with black bristles; proboscis dark brown, with short blackish bristles. Scutellum clothed with flat dark scales. Pleuræ purple-black, with white scales. Wings with small fork-cells, the anterior being the smaller, but with the cross-veins further out than is usual in this genus, so that the stems are proportionally shorter than in most species; but apparently without any glistening basal patches. Legs black, with pale knee-spots. *Length.*—3·8 mm.

Habitat.—Jungle, Selangor, Straits Settlements.

12. **URANOTÆNIA SOCIALIS**, Theobald (Monog. II, p. 340).

Tarsi unbanded, brown. Thorax chestnut, with iridescent blue adornment, consisting of a median line, stopping short at a bare space in front of the scutellum; a spot on the mid lobe of the latter, and patches before the roots of the wings and on the prothoracic lobes. Abdomen black, unbanded, and usually unspotted, though occasionally with a whitish apical patch on the fifth or sixth segment. Wings with an azure patch at the base of V.

♀.—Head dark, covered with flat black scales and flat metallic-blue ones bordering the eyes in the middle; clypeus fawn; palpi brown, very hairy; antennæ brown with grey bands, basal joint bright testaceous; proboscis black, swollen apically. Pleuræ pale brown, with a small blue patch. Wings, with fork-cells small, the hinder the larger. Legs dark, with snowy spots on the apices of the femora and tibiæ; the fore and mid femora dilated. Venter greyish. *Length.*—About 2 mm.

Habitat.—Jamaica. Is said not to bite.

13. **URANOTÆNIA CÆRULEOCEPHALA**, Theobald

(Monog. II, p. 256).

Tarsi unbanded, brown. Head with shiny azure-blue scales. Thorax chestnut-brown, with a small silvery-white spot on each side in front, and a white line on each side, just in front of the wings. Abdomen brown, unbanded.

♀.—Head covered entirely with flat azure-blue scales, slightly paler around the eyes, and with black upright forked scales behind; antennæ brown, with rather large joints; proboscis brown; palpi black, very minute. Scutellum clothed with flat black scales. Pleuræ paler than the mesonotum, sometimes with a white patch. Wings with venation much as in other typical species, but apparently without basal patches. Legs deep brown, unadorned. Halteres with white stem and black knob. *Length.*—About 2·4 mm.

Habitat.—Old Calabar. Taken in officers' mess.

14. **URANOTÆNIA MASHONAENSIS**, Theobald

(Monog. II, p. 259).

Tarsi unbanded, brown. Thorax bright rufous. Abdomen unbanded, brown. Wings with normal venation, but apparently without glistening basal spots. Scutellum clothed with linear curved black scales.

Head and appendages entirely dark brown, but for a pair of creamy lateral patches behind the eyes; proboscis much dilated. Pleuræ pale yellowish. Legs uniformly brown, with pale coxæ. Tarsal claws simple in both sexes, but markedly unequal in the fore and mid ungues of the ♂. *Length.*—About 2·8 mm.

Habitat.—Salisbury, Mashonaland.

Observation.—This is the only *Uranotænia* with curved narrow scales on the scutellum, and even here there are flat ones intermixed. Mr. Theobald further describes an allied form which he names *U. alba* in which the abdomen is apically pale banded.

Genus XXII., **Wyeomyia,** Theobald

(Monog. II, p. 267).

This genus has been separated by Mr. Theobald from *Ædes* on account of the metanotum being armed with bristles instead of being nude, as in all other mosquitoes except the single species of the genus *Trichoprosopon.*

Unfortunately, it is often by no means easy to make out the characters of this region, as in most positions it is much hidden by other parts of the insect, especially by the scutellum, the bristles of which are very apt to look as if they sprung from the really nude metanotum below them. It is on this account often difficult to distinguish female specimens from those of *Stegomyia*. The members of that genus, however, are seldom so devoid of ornament as the species included in the present genus, so that it is well to regard any very sombrely-tinted *Stegomyia* with suspicion, and to examine the metanotum with special care. In *Ædes*, it will be remembered, the scutellum is clothed with curved scales.

Mr. Theobald's definition of the genus reads as follows :—

"Head covered with flat scales; also the prothoracic lobes and scutellum; mesonotum with spindle-shaped scales; *metanotum with bristles on its posterior half*. Palpi equal in the male and female, apparently four-jointed; antennæ fourteen-jointed, basal joint of moderate size; proboscis very long and thin, often longer than the body. Wings with the basal lobe long and narrow; fork-cells long and narrow. Abdomen unbanded, but with either apical or basal white lateral spots or unadorned. Ungues of the female equal and simple."

They have a habit of hovering in the air with the hind legs held over their back, and their long, thin legs give them a very spider-like appearance. Dr. Lutz speaks of them as "wood mosquitoes," haunting damp woods near rivers or the sea shore, and often breeding in water held in the cups of plants of the *Bromelia* order, and states that the larvæ resemble those of *Culex*, but are usually brightly coloured—red, green, or blue.

Table of Species of the Genus Wyeomyia.

i. The abdomen unbanded, but with pale lateral spots.
  1. *W. longirostris*, Theob. Abdominal lateral spots basal. Metanotum black, with two large, golden-brown bristles.
  2. *W. Trinidadensis*, Theob. Abdominal lateral spots basal. Metanotum with three bristles on the outer row and two behind. Mid tarsi white on one side.
  3. *W. discrucians*, Walker. Abdominal lateral spots apical. Metanotum with four bristles in two tufts.

ii. Abdomen unadorned.
  4. *W. Grayii*, Theob. Metathorax with four bristles placed in a square.
  5. *W. pertinans* (Williston). Metathorax with a single row of bristles.
  6. *W. aranoides*, Theob. Metathorax destroyed. Base of venter white.

1. **WYEOMYIA LONGIROSTRIS,** Theobald (Monog. II, p. 275).

Thorax black, shiny when denuded, covered with dusky and bronzy scales; prothoracic lobes with broad scales, showing metallic reflections; metanotum intense black, with two clear golden-brown bristles near the posterior border (and two smaller ones ?); pleuræ testaceous and brown. Abdomen black, with lateral basal white patches; venter pale scaled. Legs dark brown, long; coxæ ochreous. Ungues of the ♀, equal, simple.

♀.—Head black, with flat black scales, showing metallic-green and purple reflections; sides of the head with similar grey scales; two long black bristles project in front between the eyes, and other shorter ones on each side; proboscis very long, much longer than the whole body, sometimes nearly as long again, thin, covered with dark brown to black scales, hairy at the apex; antennæ deep brown, less than one-third the length of the proboscis; palpi very short, covered with deep purplish-black scales, somewhat testaceous at the base, apparently four-jointed, the last joint being very small; clypeus deep purplish-black. *Length.*—3·5 to 4 mm.

Habitat.—Rio de Janeiro.

2. **WYEOMYIA TRINIDADENSIS,** Theobald (Monog. II, p. 277).

Thorax deep brown, with bronzy scales. Abdomen black, with metallic-green reflections, and with basal white lateral spots, which often pass into basal bands; venter white scaled. Legs long, black, the mid tarsi white above. Ungues small, equal, simple. Proboscis as long as, or longer than, the whole insect.

♀.—Head covered with flat brown scales with metallic-violet and sometimes green reflections, sides with rather grey scales; around the eyes are short black bristles projecting over, and two between them; antennæ rather short, black, with paler basal joints; palpi very short, covered with purplish-brown scales; clypeus brown, with grey sheen; proboscis thin, as long as, or longer than, the whole insect, deep brown. *Length.*—2·8 mm.

Habitat.—Trinidad.

3. **WYEOMYIA DISCRUCIANS** (Walker).

(= *Culex discrucians*, Walker, Ins. Saunders, p. 360, *nec. J. discrucians*, Arribálzaga.)

Thorax brown and ferruginous, with brown flat spindle-shaped scales; pleuræ pale, with pale golden sheen; metanotum with four chætæ in a line. Abdomen steely-brown, its segments with apical pale golden triangular lateral spots and pale golden bands ventrally; first segment ochreous, with pale hairs. Legs brown; bases and venter of femora yellow; last fore tarsi somewhat of an ochreous tint. Ungues equal and simple in the ♀.

♀.—Head covered with flat violet-brown scales on the occiput, with golden ochreous scales at the sides and behind; across the back of the head runs a semicircular line of almost black, forked upright scales, one deep, looking like a black curved line with a hand-lens, a character which at once separates this from other species of the genus; proboscis nearly as long as the abdomen, clothed with dark coppery scales; palpi black; antennæ brown, with narrow pale bands. It may be distinguished from Arribálzaga's *Janthinosoma discrucians* by the fore tarsal claws of the ♀, which instead of being simple have an accessory tooth in that species. *Length.*—6 mm.

Habitat.—Rio de Janeiro.

4. **WYEOMYIA GRAYII**, Theobald (Monog. II, p. 269).

= *Æ. perturbans*, Williston (?). (Trans. Ent. Soc. Lond. 1896, p. 272.)

Thorax testaceous-brown, with dusky scales; pleuræ ochreous, densely clothed in parts with broad white scales. Abdomen dusky black above; venter ochreous. Legs black, coxæ and venter of the femora ochreous; ungues of the ♀, equal and simple. Metanotum with four chætæ, placed quadrangularly. Proboscis not quite as long as thorax and abdomen.

♀.—Head covered by flat broad scales, dull purplish in the middle, ochreous at the sides, and white between the eyes; in some specimens the ochreous scales border the eyes as well; clypeus ochreous-brown, antennæ almost black, only a little over half the length of the proboscis; palpi short, black scaled; proboscis black, long and thin, swollen at the tip, apex pilose. *Length.*—3 to 3·5 mm.

Habitat.—West Indian Islands.

5. **WYEOMYIA PERTINANS**, Williston, Monog. II, p. 272).

= *Æ. pertinans*, Williston (?). (Trans. Ent. Soc. Lond. 1896, p. 271.)

Thorax brown, with dusky-brown scales on the mesonotum; pleuræ yellow-brown with white scales; metanotum deep brown, with four bristles in a straight line and some smaller ones between them, usually making six in all. Abdomen deep brown, with dusky brown scales; venter ochreous. Legs deep brown; femora and tibiæ yellowish ventrally, not bristly. Ungues of ♀, equal and simple.

♀.—Head yellowish-brown, with flat scales, ochreous at the sides, purplish-brown in the middle; clypeus deep brown; antennæ almost black, basal joint pale testaceous; palpi black scaled: proboscis covered with black scales. *Length.*—3 mm.

NOTE.—In all probability the above species is identical with that described by Williston, but in the absence of his types, the original description has been retained in its place under *Ædes*.

6. **WYEOMYIA ARANOIDES**, Theobald (Monog. II, p. 274).

Thorax shiny black when denuded, with deep bronzy-brown scales; pleuræ dark in front, pallid posteriorly, with white scales; prothoracic lobes with white scales. Abdomen dusky brownish-black above, creamy-white below, especially at the base. Legs ochreous, with brown scales, darkest on the tibiæ and tarsi. Ungues of the ♀, equal and simple.

♀.—Head covered with flat dusky brown and black scales, grey round the eyes and white at the sides; clypeus bright ferruginous, with two rows of white scales; proboscis longer than the whole body, deep brown with coppery reflections; palpi deep brown, densely scaled, with brilliant coppery reflections; antennæ dark brown, basal joints deep brown and bright testaceous. *Length.*—3 mm.

Habitat.—Straits Settlements.

NOTE.—Mr. Theobald's single specimen has the metanotum destroyed by the setting pin, but he is convinced that it belongs to this genus. No other species has a bright-tinted clypeus.

CHAPTER XV.

The Corethrina Sub-family.

It is very doubtful if this group of insects can be fairly included in the same family as the rest of the *Culicidæ* as the family stands at present; as although the venation of their wings and their scaly curvature is typically that of a mosquito, the anatomy of their mouth parts is entirely different, being that of a midge or *Tipula*; for they have no proboscis at all comparable to that of the true mosquitoes, and have in its stead, merely a short rostrum, ending in a pair of rounded knobs. They appear to frequent mostly the open country, and are also found in woods.

Although they are said to sometimes make their appearance in enormous swarms, they are certainly generally not common insects, as with the sole exception of the solitary female from which I describe *Cor. Asiatica*, not a single specimen referable to this sub-family was included in the enormous collection received at the British Museum from all parts of the world.

On this account I have little to add to the information collated in the first edition. The palpi are four-jointed, and about the same length in both sexes; the antennæ fourteen-jointed, plumose in the ♂, and with scanty verticils in the ♀. The abdomen is clothed with hairs not scales, and even the scales of the thorax and wing-veins are so long and narrow as to approximate to hairs in form.

The two genera of this sub-family may be distinguished as follows:—

First tarsal joint longer than the second.........Genus XXIII. *Corethra.*
First tarsal joint shorter than the second ......Genus XXIV. *Mochlonyx.*

Genus XXIII. **Corethra,** Meigen (" S. B." i, 14).

Gnat-like insects with no true proboscis, but with a short rostrum ending in a pair of rounded knobs. The venation of the wing is as in a typical *Culex*. The abdomen devoid of scales but hairy, and the wings and thorax clothed with long hair-like scales; first tarsal joint longer than the second.

Table of the Species of the Genus Corethra.

I. With the wings spotted.

A. With the wings dotted or banded.

a. With the antennæ banded.

1. *Cor. pallida*, Fabr. Almost colourless, but with a slightly reddish tint. Abdominal segments with the distal border black. Wings with one band.
2. *Cor. Nyblæi* (Zett.). Dull white. The abdomen, lateral lines, and minute spots fuscous.
3. *Cor. punctipennis*, Say. Generally pale yellow, with dusky hairs and down. Wings with several clear brown spots.
4. *Cor. gibba*, Meigen. General colouration greenish. Wings with a single band. Characters of the legs and antennæ not noted.

II. With the wings unspotted.

A. With the legs darker at the apices of the tibiæ and tarsal joints.

a. With the antennæ unbanded (?).

5. *Cor. pilipes*, Gim. Legs fringed with long hairs on the inner and outer sides.

B. With the legs uniformly coloured.

a. With the antennæ banded.

6. *Cor. plumicornis*, Fabr. Pectus and sides of the thorax whitish.
7. *Cor. Manillensis*, Schiner. Thorax pale orange, with three longitudinal brown lines.

b. With the antennæ unbanded.

8. *Cor. culiciformis*, De G. Much darker in colouration than any of the other species.
9. *Cor. flavicans*, Meigen. General colouration yellowish.
10. *Cor. rufa*, Zett. Generally rufous, with bright brown thoracic marks. Legs more generally uniformly yellow.
11. *Cor. obscuripes*, Wulp. Generally darker than neighbouring species. Abdomen dark brown, with glossy greyish incisions.
12. *Cor. fusca*, Stæger. Almost black, with the abdominal segments bordered whitish, and the legs dirty yellow.
13. *Cor. Asiatica*, sp. n. Pale straw-coloured throughout; very hirsute, with indistinct thoracic ornament.

1. CORETHRA PALLIDA, Fabr.

Tipula pallida, Klass, "d Zoo," i, p. 34, and Fabr. "Ent. Syst." iv, p. 245; also Gmellin, "Syst. Nat." v, p. 2,026, *Cor. pallida*, Panzer, "Fauna Germanica," cix.

Wings with an oblique brownish band in the middle. Legs with numerous bands. Antennæ black-ringed; otherwise almost colourless.

Meigen's specimen of this species in the Jardin des Plantes is in a very bad state, even the wings being too mildewed to make out the venation, but the first sub-marginal cell seems very narrow, especially at the base.

The specimen is very pale, with a slight tint of reddish. The eyes are black; the antennæ whitish, with a black band on each joint. Thorax with three clear brown stripes. Abdomen nearly white, with a narrow black band on the hinder border of each segment. Legs very pale and pubescent, with nine black bands on the femora and seven on the tibiæ. Wings with the veins very white and pubescent, except the transverse veins which are brownish, so as to form an oblique spot on the middle of the wing. *Length* of the ♂, $2\frac{1}{2}$ lines; of the ♀, 2 lines.

Habitat.—Europe, England; a comparatively rare species.

2. **CORETHRA NYBLÆI** (Zetterstedt).

Erioptera nyblæi, Zett.

Wings with dusky spots and a band over the transverse veins. Legs with apical dusky bands on the apices of the tibiæ and tarsal joints. Antennæ banded.

Description from Zetterstedt, "Insec. Lapponica," Col. 830. ♂ and ♀.—Dull, whitish. Thorax with three brown lines, the middle one of which is double; metathorax with a double spot, with points on the wings, the knees, and on the apices of the tibiæ and tarsal joints fuscous. Entirely dull whitish and markedly villous. Antennæ pale, with fuscous rings and long hairs; palpi rather fuscous. Thorax with obscurely bordered brown lines, the lateral ones short and placed behind, the middle one double at the base and produced beyond the middle of the dorsum of the thorax; metathorax with a double dusky brown spot. Abdomen rather flattened in the dry specimen, with a sometimes interrupted, fuscous lateral line, and very minute puncta of the same tint. Wings hyaline grey, with markedly villous veins, the villosity forming the dusky spots mentioned above; the transverse veins drawn back into a semicircle beyond the middle of the wing and obscurely villous, so as to form a lunate band. Halteres white. *Length.*—Nearly 3 lines.

Habitat.—Norwegian Lapland.

3. **CORETHRA PUNCTIPENNIS**, Say.

Cor. trivittata, Loew.

Wings with several clear brown spots. Legs with numerous brown dots. Antennæ banded brown.

Although Loew's description is much the more complete, there can be little doubt that the above names are synonymous. Description from Say, "Journ. Acad. Nat. Sci. Philadelphia," iii, p. 16, and from

Loew. The shaft of the antennæ distinctly banded brown, with yellowish-white hairs; eyes black. Thorax with three yellowish-brown stripes; the middle one smaller behind and the others smaller in front. Wings with extremely clear brown spots. Legs with numerous brown dots; ♂, very pale yellowish, clothed with long fuscous hairs and with down. Antennæ banded black, with dense dusky verticils; dorsum of the thorax marked with three black lines, the median one of which is doubled behind, while the lateral ones do not quite reach the front. Scutellum fuscous laterally. Metanotum nearly black. Abdomen with black bands. Legs pale yellow, the first tarsal joint somewhat fuscous from the apex; the apices of the femora, and the bases and apices of the tibiæ banded black. Wings ornamented with rather small greyish-black spots. *Length* of the body $2\frac{1}{6}$ lines; of the wings, $2\frac{1}{2}$ lines.

Habitat.—Maine, Osten-Sacken; Pennsylvania, Say.

Noted from the island of Porto Rico by V. von Röder, in "Entomolog. Zeitung." Stetin, 1885, p. 338.

4. **CORETHRA GIBBA**, Meigen.

Wings with an obscure band. Characters of antennæ and legs not stated. Greenish.

Description from "Nouveau Dict. d'Hist. Nat.," article "*Corethra.*" —Green, with the corselet elevated and prolonged in front, and the wings white and marked with an obscure band.

5. **CORETHRA PILIPES**, Gimmerthal.

Wings unspotted (?). Legs with apices of the tibiæ and tarsal joints darker. Antennæ unbanded (?). Legs beset with long hairs on the inner and outer sides.

Description from Gimmerthal, "Bull. Soc. Imp. Naturalistes de Moscou," xviii, p. 279 (1845). — Head and thorax brown, the latter with some yellowish pubescence and scarcely visible darker stripes, the middle one of which is divided by a deeper longitudinal line; palpi and antennæ brown. Abdomen greyish-brown, with pale yellow incisuræ, and long hairs on either side. Legs pale yellow; the apices of the tibiæ and of the tarsal joints brownish; all the legs beset with long hairs on the inner and outer sides, which forms the distinguishing character of the species; halteres dirty yellow. Wings yellowish on the costa. *Length.*—3 lines (♂). Mr. Theobald believes this to be identical with *Cor. Nyblæi.*

Habitat.—Riga.

6. **CORETHRA PLUMICORNIS**, Fabr.

Wings unspotted. Legs uniformly coloured. Antennæ reddish, with brown bands. Abdomen pale brown.

Description from Mr. Theobald's "rough notes."—*Cor. Crysallina*, De G., *Cor. lateralis*, Latr.; *Cor. Hafniensis*, Gimmel. This species can be at once distinguished from *Cor. culiciformis* by the brown banded, tastaceous antennæ, and by the pectus and sides of the thorax being whitish; the abdomen is pale brown and hairy. Legs pale testaceous and pubescent.

Habitat.—Europe, as far north as Denmark; England.

7. CORETHRA MANILLENSIS, Schiner.

Wings unspotted. Legs uniformly pale yellow. Antennæ yellow with black rings. Abdomen without bands.

Description from "Reise der Novara," Diptera. p. 30.—Pale reddish-yellow, the thorax dull, with three more deeply coloured, longitudinal stripes, the middle one of which, clearly defined elsewhere, is diffuse in front. Scutellum with a clearer median line. Abdomen somewhat glistening, with very delicate long hairs, the last two segments brownish. The claspers of the male genital apparatus extend to a length exactly that of the last abdominal segment. Head clear yellow; the eyes black; the antennæ yellow with black rings; the tuft of plumes light brownish-yellow; the palpi clear yellow. Legs very pale yellow, almost whitish; the tibiæ fringed with long, but very fine hairs. Wings yellowish, with reddish-yellow veins, which are thickly fringed, the fork of the marginal veins somewhat longer than that of the discoidal veins. *Length.*—2 lines (German).

The species corresponds in habit with *Cor. pallens*, Schiner, but can be distinguished at a glance by the uniform colouration of the legs.

Habitat.—Manilla.

8. CORETHRA CULICIFORMIS, De Geer (1776).

= *Tipula culiciformis*, De Geer.

(Mém. pour serv. à l'Hist. d'Ins. vi, 372, De Geer; Hist. Nat. Cr. et Ins. xiv, 288, Latreille; Dipt. Beschr. i, 16, 2, Meigen; Hist. Nat. Dipt. i, 47, 2, Macquart; Regn. Anim. 2nd. edit.)

Wings unspotted. Legs uniformly coloured. Antennæ unbanded. Darker in colouration than most of the other species.

Head chestnut-brown; rostrum brown, with dark hairs; palpi dark brown, with dark brown hairs; eyes black and silvery; antennæ pale ochreous, with scarcely any trace of banding, and dark verticillate hairs. Thorax pale grey, with two broadish chestnut-brown median lines separated by a narrow pale line. with two broad lateral lines on the posterior half of the mesothorax, the space between them and along the sides and between the two median lines chestnut-brown; golden-brown bristles over the roots of the wings, and narrow curved hair-like scales on the mesonotum; scutellum pale ochreous, with a compound border of golden-brown bristles; metanotum chestnut-brown, with darker centre; pleuræ pale ochreous. Abdomen pale yellowish to testaceous-brown, with long golden hairs, posterior borders of the segments with a narrow dark rim. Legs ochreous, with dark hairs, slightly dusky on the tarsi; ungues equal, small, and brown in the ♀. Wings with a yellowish tinge, with dull yellowish hair-like scales and yellow veins. *Length.*—About 4·5 mm.

Habitat.—Europe generally.

9. **CORETHRA FLAVICANS**, Meigen ("S. B." p. 248).

Wings unspotted. Legs unbanded. Antennæ black, unbanded. Generally pale yellow.

There is a specimen labelled with this name by Meigen, in the Jardin des Plantes. Though not so colourless as *Cor. pallida*, it is of a very pale yellow tint throughout, except the eyes, antennæ, proboscis and palpi, which are all black. The thorax is glabrous, mainly chestnut-brown, with a fine median white line and two large, round, lateral snowy spots. The abdomen is of a pale ferruginous colour, the fore borders of the segments being rather darker. Legs pale ferruginous, without any markings. Wings pale iridescent yellowish, the veins of the same colour. Both the first sub-marginal and the second posterior cells are long and narrow, the former being a trifle the longer; the bases of the cells are nearly opposite, their stems short and of nearly equal length. About the same size as *C. Pallida.*

Description from Meig. "S. B." p. 243. Yellow, with the sides of the thorax whitish; clear yellow, almost sulphur-yellow on the hairs of the antennæ and the legs. The thorax is whitish at the sides. *Length.*—♂, $2\frac{1}{2}$ lines.

Habitat.—The specimen in question is from Germany.

10. **CORETHRA RUFA**, Zetterstedt.

Wings unspotted (?). Legs sometimes with the joints apically banded. Antennæ unbanded (?). Of a generally rufous colour with bright brown marks on the thorax.

Description from Zetterstedt, "Insec. Lapponica," 808.—Rufous with obscure brown marks on the thorax, dorsum of the abdomen fuscous, the legs yellow. ♀, like *Cor. plumicornis*, F., but differently coloured, being entirely fuscous testaceous. Antennæ often pale. Thorax with a double median stripe, and an ovate spot on either side, of bright brown. Abdomen pubescent, fuscous above, with a median testaceous line at the base, sometimes extending beyond the middle; venter pale. Wings pale, with markedly villous veins; halteres pale.

Legs yellow, either spotless, or with the apices of the femora, tibiæ, and tarsal joints fuscous. *Length.*—3 lines.

Habitat.—Lapland.

11. **CORETHRA OBSCURIPES**, Van der Wulp.

Wings unspotted (?). Leg uniformly (?) dusky. Antennæ unbanded (like *Cor. rufa*). Of a generally more dusky tint than the neighbouring species.

Description from Van der Wulp, "Dipt. Neerlandica," i, p. 333 (1877).—Like *Cor. rufa*, Zett., but of a darker colour. Thorax ash-grey with dark brown bands; the lateral band between the neck and the root of the wing narrow and light grey; scutellum brownish. Abdomen dark brown, with glossy greyish incisions. Legs brownish-grey, the coxæ and bases of the femora yellowish: hairs on the ventral aspect brown; halteres yellow. Wings of a grey tint, with light brown veins.

Cor. culiciformis differs from this species in having the hairs of the abdomen yellow, while *Cor. fusca* has the scutellum and legs alike yellowish.

Habitat.—Holland.

12. **CORETHRA FUSCA**, Stæger.

Wings unspotted (?). Legs without bands, or spots (?). Antennæ unbanded (?). (Said to resemble *Cor. culiciformis.*) Generally dusky-black.

Stæger's heading shows he is doubtful whether this be a new species, or identical with *Cor. culiciformis.*

Description from Stæger, "Naturh. Tidsskr." (Kröyer), Bd. ii, p. 556 (1839).—Fuscous black; the thorax behind with a lateral line and the scutellum pale; antennæ with black hairs. Distinguished from *Cor. plumicornis* by its smaller size. Body dark brown with stiff hairs; borders of the abdominal segments whitish. Legs dirty yellow. *Length.* —2½ lines.

Habitat.—Denmark.

13. **CORETHRA ASIATICA**, Giles.

Journ. Bombay Nat. Hist. Soc. xiii, p. 610.

Wings unspotted; tarsi unbanded, generally pale straw coloured. The thorax with an indistinct darker median patch in front and a pair of lateral ones behind. Antennæ without obvious banding.

♀.—Head pale dusky brown; eyes black; rostrum and palpi dusky-brown, hairy; antennæ very indistinctly banded brown and grey. Of a pale straw colour. Thorax with a median dark brown line, broad in front, narrowing behind, and two lateral dark brown patches behind on the mesonotum, separated by black specks. Abdomen straw-coloured, with dusky specks laterally, and darker at the base. Legs stout, pale, darker towards their apices. Wings yellowish, the veins very densely clothed with long hair-like yellow scales, specially long on the inner fringe, and with 4 barely internal to 3. Halteres pale yellow.—*Length.*—2·3 mm.

Habitat.—Shahjahanpur, N.W.P., India; taken in my dining room near a lamp. I was unable to find any further specimens, or the breeding place of the larvæ.

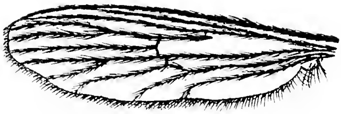


FIG. 49.—Wing of *Corethra Asiatica*, sp.n., magnified 20 diameters.

Genus XXIV. **MOCHLONYX**, Loew.

In this very peculiar genus the legs differ from those of all other members of the family in having the second tarsal joint longer than the first, instead of the latter being, as in the other genera, one of the longest in the entire appendage.

Another singular point is that, while the imagines much resemble those of *Corethra*, the larvæ are more like those of *Culex*.

Mr. Theobald, to whom I am indebted for the following diagnosis, is, I understand, of the opinion that in reality but one species, *Mochlonyx velutinus*, Ruthe, can be considered as established, and that the others are but synonyms.

In this genus the proboscis is much shorter than the head and thorax, but rather longer than the head. Palpi four-jointed, and twice as long as the proboscis; antennæ fifteen-jointed, the last two joints longest and verticillate; joints increasing in size from base to apex. Tranverse veins rather more distant from the margin than in *Corethra*, otherwise much the same, the veins being very delicate; the branches of the forked veins more than twice as long as their stems. Ungues large, with a distinct accessory tooth.

1. MOCHLONYX VELUTINUS, Ruthe.

Thorax brown with golden-yellow hair and two closely approximated darker longitudinal stripes; scutellum and metathorax also brown. Abdomen pale yellow with transverse brown stripes, which are clearer and broader on the hinder than on the fore segments, and on the last segment occupy the whole of the upper side. Head, antennæ and palpi brown, plume lighter, nearly rusty-yellow. Legs yellow; tarsi brownish, ungues blackish-brown. Wings transparent, with golden-yellow veins clothed with scales.

Habitat.—Europe, including England.

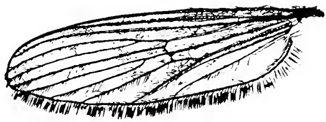


FIG. 50.—Wing of *Mochlonyx velutinus*. From a photograph by Mr. G. C. Bignell, late R.M.L.I.

2. MOCHLONYX EFFOETUS, Halliday.

Brownish-red, with yellowish down, almost of a golden gloss; bands on abdomen longer; front thickly clothed with yellow hairs. Palpi fuscous; antennæ fusco-ferruginous, paler at the base. Sutures of the thorax delicately marked with fuscous: hinder edge of abdominal segments and lateral lines darker; pleuræ paler. Wings hyaline, a little yellowish towards the costa; veins pale, fusco-ferruginous; halteres pale with fuscous colouration at the tip. Legs pale ferruginous with fuscous hair; hind femora slightly embrowned before their tips. Four ♀ specimens in Mr. Clifton's collection. Not now traceable.

Habitat.—England.

3. MOCHLONYX CULICIFORMIS (De Geer).

Meinert; "Overs. K. Dansk Vidensk. Selsk," p. 16 (1883).

Tipula culiciformis, De Geer, "Mém. pour servir à l'Hist. d' Ins." vi, p. 2 (1776).

Fuscous brown with ferruginous hairs, thorax with an indistinct double median line; metanotum blackish. Abdomen pallid, the dorsal terga for the most part densely sprinkled with dusky black. Palpi and antennæ dusky black, the antennæ of the ♀

broadly, and of the ♂ narrowly, banded, with ashy hairs at the apex. Halteres pallid with a brownish knob. Legs pale yellow, with the knees and apices of the hind tarsal joints fuscous. Wings smoky in the ♂, yellowish in the ♀. *Length.*—2½ to 3 lines.

Habitat.—Europe.

De Geer also gives a long account of the life history of this species, *l. c.*

APPENDIX.

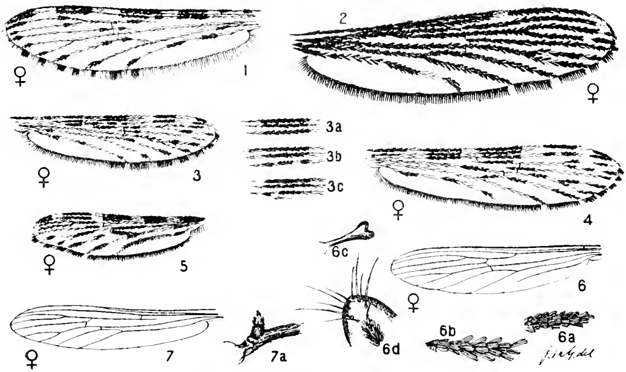


FIG. 5. 1, Wing of *An. pulcherrimus*, Theob.; 2, Wing of *An. Bancroftii*, MS. name; 3, Wing of *An. metaboles*, Theob,; 3a, 3b, 3c, Variations in the arrangement of dark and light scales in its large middle spot; 4, *An. Gambiæ*, MS. name; 5, Wing of *An. Christophersi*, Theob.; 6, Venation of Wing of *Limatus. Durhamii*, Theob.; 6a, Scale arrangement on ant. br. II; 6b, on post. br. IV; 6c, halter; 6d, metanotum; 7, Venation of Wing of *Hæmagogus cyaneus*; 7a, Palpus and base of its proboscis.

DURING the short interval that has elapsed since the sheets of the Brit. Mus. Monograph have passed the stage of "paged proof," a considerable number of additional new species have come to hand. The bulk of these are Culicinæ, and amongst these are certain very beautiful *Tæniorrhynchi* with prominently spotted wings, the males of which might possibly be mistaken for *Anopheletes* by anyone unaware of the existence of these new "dapple-winged" mosquitoes.

To undertake the task of working out the whole of this new material would involve great delay, but with the view of bringing up to the latest possible date the record of the genus *Anopheles*, descriptions of the following five additional species are subjoined, together with the diagnosis of an additional new genus (*Limatus*) closely allied to *Trichoprosopon*. Certain of the new *Anopheletes* are the subject of some excellent work recently reported to the Malaria Committee of the Royal Society by Drs. Christophers and Low. The numbers preceding the names of the subjoined species, indicate the position they should take in the synoptic table of the genus.

3a. ANOPHELES PULCHERRIMUS, Theob. "R.S., M.C."

Wings with the costa white at the base and black at the apex, with its intervening portion about equally divided between three each of black and white patches involving the aux. and I, in addition to two small black basal dots; the other veins mainly white-scaled, but there are black dots near the end of each longitudinal branch, besides two additional black lengths on VI, and some dots about the cross-veins; internal fringe, mainly white, with short black interruptions opposite each cell. Last three hind tarsal joints, and all but the base of the second, white; upper three of the fore and mid tarsals, with rather broad, pale apical bands. Femora and tibiæ mainly white-scaled, more or less elaborately spotted black. Thorax black-grounded, rather densely clothed with large, fusiform white scales. Abdomen shaggy, with densely placed, mixed black and white scales, arranged so as to show narrow but distinct black basal bands and to form strong lateral tufts to the hinder border of the segments.

♀.—Head black-grounded, with its curved and forked scales alike white, and a dense white frontal tuft; palpi brown, the last joint white except at the very base, and the next three joints with narrow pale apical bands; antennæ black, with scanty pale verticils, and clothed for the most part of their length with white seales. Pleuræ marbled brown and white. Venter densely white-scaled. *Length.*—About 5 mm.

Habitat.— Lahore, Punjab, India.

Note.—This species is elosely allied to the *Pharœnsis* group, but its long white hind feet separate it from its allies in the artificial classification adopted for the genus.

16a. **ANOPHELES BANCROFTII**, MS. name.

Wings intensely black, with a single minute white interruption of the costa opposite the middle of the fork-stems, and a slightly larger patch of white on the apex; there are two good-sized white lengths on VI, and scattered white scales on some of the other veins, but none of them are numerous enough to catch the eye, except under considerable magnification; though the internal fringe shows distinct white interruptions at each longitudinal junction except that of VI. Last joint of hind feet rather pale brown, the remaining tarsal joints with more or less distinct, but minute apical pale bands. Thorax and abdomen alike black-grounded, and rather densely clothed with long, golden-brown hairs.

Head black-grounded, with a rather scanty, pale brown frontal tuft, and the scales of the vertex and nape, both curved and erect forked, rather darkly tinted; appendages of head uniformly sooty and very hirsute. Pleuræ marbled with black, and pale golden-brown. Halteres sooty, except at the pallid bases of their stems. Venter sooty. *Length.*—About 7 mm.

Habitat.—Bupengarry, Queensland.

Note.—Much resembles *An. barbirostris*, V. der Wulp, but differs in the inner part of the wing being altogether darker and more densely scaled, in the second pale spot being absolutely on the apex in place of being sub-apical, and in the banding of the tarsi being much less obvious. In reality the form is, I think, more nearly allied to *An. atratipes*. Skuse.

20a. **ANOPHELES GAMBIÆ**, MS. name.

Wing with the costa dark at the apex and base, with three yellowish interruptions, the two outer of which are nearly as large as the intervening dark portions, while the innermost is barely larger than a fourth basal dot; the part of the sub-apical dark spot which lies on I, is subdivided by a white spot; remaining long veins with the pale portions preponderating, but all with much black; internal fringe with narrow pale interruptions at all but the sixth long junction. Upper three fore tarsal articulations pale banded; mid and hind legs with three apical bands, very indistinct in the latter, the last two joints being all black. Thorax dark-grounded, with scattered yellowish-brown, broad, fusiform scales. Abdominal segments dark, densely clothed with long golden hairs, but nude of scales.

♀.—Head black-grounded, with the scales of vextex and a strong frontal tuft whitish, the nape black-scaled; palpi black, the last joint and apex of the next yellowish-white, and with narrow apical pale bands on the next two joints; antennæ dark, unbanded, the basal and the next two or three joints with numerous white scales. *Length.*—About 4 mm.

Habitat.—The Gambia Valley, West Africa.

25a. **ANOPHELES METABOLES**, Theob. ("R.S., M.C.").

Wing with the costa dark at the base, pale at the apex, with three whitish interruptions of the dark costa (involving aux. and I), and two large basal dots; of the former, the two outer are larger than the intervening dark portions; the junction of the largest dark and light spots is opposite the cross-veins, while the innermost are of small size; remaining long veins mainly whitish, with subterminal and a few other black dots; internal fringe with broad white bands at the longitudinal junctions. Tarsi, with narrow but distinct yellowish bands on the articulations. Thorax, dark brown-grounded, densely clothed with whitish scales, but without any prominent markings. Abdomen dusky, unbanded, fairly densely covered with brownish-white scales, which, however, are nowhere accumulated into tufts. Tibiæ and femora, irregularly mottled with dark brown and golden scales.

Head dark brown, with a fairly dense frontal tuft of hairs, which look parti-coloured in certain lights; scales of nape white, those of the flat-scaled lateral patches rather dark; antennæ banded in most lights, with scanty verticils, and clothed almost to the end with white scales, intermixed with a few black ones; palpi black, very hirsute, especially at the base; a narrow white ring on the second articulation; and the last two joints whitish, but for a dark band on the base of the last joint. Halteres with black knobs, showing dense patches of large creamy scales. *Length.*—About 3 mm.

The details of the distribution of dark and pale patches have been found to vary greatly, even in specimens reared from the same batch of eggs, the portion of the spot which is placed on I, being either all dark or variously interrupted with dark and light spots (*vide* fig. 51, 3a, 3b, 3c).

Habitat.—Lahore, Punjab, India.

29a. **ANOPHELES CHRISTOPHERSI**, Theob. ("R.S., M.C.").

Wing yellow at the very apex, but black at the base, with four yellow interruptions (involving aux. and I) less than half the length of the intervening black portions of the costa, and placed at fairly even distances; the external of the two middle pale spots extends obliquely inwards over the cross-veins, and the remaining long veins are variegated with black and yellow lengths, the former preponderating towards the costal, and the latter towards the inner margin; internal fringe dark, with the apex yellow, and pale interruptions of the same tint at all but the sixth longitudinal junction. Tarsi golden-brown, with mixed golden and umber-brown scales, so arranged as to give faint indications of pale articular banding. Thorax (denuded) yellowish-brown. Abdomen dusky, with some powdery whitish tomentum, and numerous pale brown hairs.

♀.—Head black, with a scanty yellowish frontal tuft and a large triangular patch of broad, yellowish-white curved scales on the vertex; nape with black curved, and erect forked scales; palpi dusky at the base, but for a narrow whitish ring on the second articulation; the last two joints impure white, rather darker on the articulation between them, and just at the tip; about as long as the proboscis; antennæ black, with scanty dark verticils and much white lanugo. Pleuræ marbled with dark and lighter brown. Halteres with pale stem and darker knob. *Length*—About 2 mm.

Habitat.—The Dowars, India.

LIMATUS DURHAMII, Theob. *gen. et. sp. nov.*

(Monog. II, p. 349).

This genus is allied to *Trichoprosopon*, the metanotum being provided with bristles and scales, and is separated from its neighbours by all parts being clothed with uniformly flat scales, mostly rounded at their free ends. The proboscis is not very long, but is much swollen at the tip, the ♀ antennæ very small, and with the usual single verticils. The venation of the wing is much as in typical *Culex*.

In the one known species the wings are unspotted, the veins densely clothed with nearly black, round-ended scales, some of those near the ends of the inner long veins being rather elongated. Tarsi and legs generally, nearly black. Thorax densely clothed with flat, round-ended scales of two sizes, mostly of a lustrous violet-black, but with a marking of rich golden scales in front, arranged so as to form a "broad arrow"; the very large prothoracic lobes uniformly golden-scaled. Abdomen metallic-violet, with triangular basal lateral patches especially well marked on the hinder segments; the first segment mainly ochreous.

♀.—Head with dark bronzy and golden flat scales, white at the sides; cephalic appendages, uniformly nearly black; the palpi apparently three-jointed and very small, barely extending beyond the clypeus. Scutellum densely covered with flat, purple scales and golden marginal bristles; pleuræ mainly silvery white. Metanotum golden brown-grounded, with three pairs of large, and a number of small bristles behind, and a dense patch of golden scales in the middle. Halteres uniformly dark purple-scaled, the knob bilobed. Venter uniformly densely golden-scaled. *Length.*—3 to 3·5 mm.

Habitat.—Para, Brazil.

Correction.—The receipt of further specimens, bred out from the egg, has shown that the species described as *Megarhina Gilesii*, Theobald, is really the female of that noted as *M. immisericors*, Walker, but that the species really belongs to the genus *Toxorynchites*, so that both should stand as *Toxorynchites immisericors* (Walker).

INDEX (GENERAL).

The principal reference to each subject is indicated by heavier type.

A.

B.

C.

U.

V.

W.

Y.

Z.

INDEX OF SPECIES AND OF THE SYSTEMATIC PORTION GENERALLY.

In consulting this Index (except in the case of generic descriptions), the specific, and not the generic, name should be sought. The latter will be found, indicated either by initials or in full, after each specific designation. The reference to the systematic description of species is, in each case, indicated by heavier type.

SUB-FAMILIES AND GENERA.

TABLE OF CONTRACTIONS.

Æ.	Ædes.
Ædom.	Ædomyia.
An.	Anopheles.
Ar.	Armigeres.
Br.	Brachiomyia.
Cor.	Corethra.
C.	Culex.
Cyc.	Cycloleppteron.
D.	Deinokerites.
E.	Eretmapodites.
H.	Hæmagogus.
J.	Janthinosoma.
M.	Megarhina.
Moch.	Mochlonyx.
Muc.	Mucidus.
O.	Ochlerotatus.
P.	Panoplites.
Ps.	Psorophora.
Sab.	Sabethes.
St.	Stegomyia.
Tæ.	Tæniorhynchus.
Tip.	Tipula.
Tox.	Toxorhynchites.
Tr.	Trichoprosopon.
U.	Uranotænia.
Wye.	Wyeomyia.