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A PLEA FOR THE COLLECTIVE INVESTIGATION OF INDIAN *CULICIDIÆ*, WITH SUGGESTIONS AS TO MOOT POINTS FOR ENQUIRY, AND A PRODROMUS OF SPECIES KNOWN TO THE AUTHOR.

By Geo. M. Giles, Lt.-Col., I.M.S.

(*Read before the Bombay Natural History Society on 11th December*, 1900.)

Within the last week we have received in India the details of the 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 mosquitoes of the genus *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.

I can see in this experiment no 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 shew any one conversant with the laws 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 an asexually multiplying malarial protozoon mechanically into the veins of a healthy man, 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

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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, develops in the 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.

In fact, no one who has any special knowledge of the subject will believe that there can under the circumstances be any other route of infection. 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 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 sexual 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 develops into a tape-worm, each sexually multiplied strikle 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 this 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 practically 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 asexual 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 comparatively 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 the utmost effort that has yet been made in India has been the vote of the magnificent sum of Rs. 30 per monsem by the city-fathers of Calcutta, to hire a man to destroy mosquito larvæ. I doubt if India will ever be a pleasant residence for the white man for the greater part of the year, but I am by no means sure that the tropics would not be well nigh as healthy a residence as the temperate zone, could we but do away with malaria.

Under these circumstances, it is obvious that the first step in the attack of the problem of prevention is the acquisition of an exact knowledge of the life-history of the various species of mosquito of each malarial country, and this is a task which might well be taken up by the members of this Society, and it is to urge upon you how much might be done by a body animated by a common interest in natural history, such as the Bombay Natural History Society, that I am very glad to comply with the request that your Honorary Secretary has done me the honour to make to me of contributing a paper on the subject to your transactions. Such experiments and observations are badly wanted, for the number of workers is extremely small, and it is surprising how difficult it is to induce people to go to the least trouble either to observe or even to avail themselves of what is already known to protect themselves from the attacks of the most widely spread and destructive of tropical diseases.

Such being the case, I would suggest to the members of the Society the following points for collective effort and investigation:—

1. To make a representative collection of the mosquitoes of India. In which connection I shall be happy to receive, and, as far as possible

name all collections sent to me. Wherever possible, it will be well to send a series of specimens, so that it may provide for sending duplicate specimens to Mr. Theobald, who is also working at the group for the British Museum, and to admit of specimens being returned for the reference of the collector, as well as providing specimens for the Society's collection.

2. The identification of larvæ and pupæ with their corresponding adult insects, which is best ascertained by "breeding out." In conducting such experiments it is important to copy, as nearly as possible, natural conditions. It is, for example, very difficult to keep *Anopheles* larvæ alive for any length of time, except in a large apparatus in which natural conditions are followed. A large naund, half filled with mud from an *Anopheles* pool, and filled with its water covered with a correspondingly large net, is required.

3. The manner in which each species tides over the season unfavourable to its multiplication. *Anopheles*, *e.g.*, at any rate, in Northern India, is rare in the hot weather, but I am inclined to believe that a careful search will discover all stages of the insect all the year round. And, in any case, the adults, though scarce in the hot weather, are never entirely absent, but it may be that larvæ also survive in suitable localities. At present, in the North-West Provinces, for example, larvæ are to be found in great numbers, but pupæ are very rare. It may be, therefore, that the duration of larval life is protracted, and that the change with the pupal stage is indefinitely postponed by a cold which is yet insufficient to kill the larvæ outright.

It has been suggested that the adults deposit their eggs on dry ground, in places likely to be covered with water in the rains. Zoologically speaking, this is in the last degree improbable, but the question should be tested. To do so, a known *Anopheles* pool should be covered in, after it has dried up, with wire gauze.

If the idea be founded on fact, larvæ should be found during the following rainy season in the pool thus protected from the visit of adult females.

It has also been suggested that the larvæ can resist dissecation. I have experimented on this point and find that the larvæ die and decompose long before the mud in which they have been stranded is anything like dry, but confirmatory observations are desirable.

4. *The method and place of deposition of ova.*—As regards *Anopheles* there is a good deal of doubt. I have never found the eggs except in water, and it is in the last degree unlikely that they are ever deposited elsewhere. Observations of insects placed under such unnatural surroundings as the interior of a test tube are valueless in such connection, as the gravid insect must drop her eggs somewhere. As a colleague of mine remarks; he knew of a case of a lady who was confined in a brake-van, but it does not follow that a train in motion is the natural lying-in place of the human female. I have known *Culex pipiens* deposit eggs in a pill box, but the ova so deposited though promptly placed in water, failed to hatch out.

It is rather difficult to distinguish the eggs of *Anopheles*, owing to the smallness of the groups. The best plan of searching for them is to skim the surface of the pool with a table-spoon and to examine the water so skimmed in a shallow glass vessel placed on a sheet of white paper by means of a powerful hand lens. A very good weapon for skimming is the table appliance known as a "crumb-scoop."

5. *Methods of destroying mosquitoes.*—I fear that the task of preventing malaria by the systematic destruction of *Anopheles* larvæ, is a much larger order than we have been led to believe. It has been gravely suggested that a map of such pools should be prepared for every town, but in India, in the rains, such maps would have to be on a large scale, for they are simply everywhere. As a rule, you will not find them in large collections of water, especially in the open, but every depression in the road-side ditch, every garden irrigation tank, every hydrant-fed puddle is full of them. I have met with them in a depression in the asphalted platform of a busy railway junction, in brickfields, in soakage pools, in river beds in the hot weather; in fact, in every possible situation. Nor do they seem very particular as to the cleanliness of the water, or as to its being rich in green algæ. It would, indeed, require a small sanitary army, and an inquisitorial search of private premises, such as would never be tolerated in India, to deal with them by kerosine or other larvæcides.

But this admitted, there is no doubt a good deal might be done in the way of diminishing their numbers even if they cannot be exterminated, and in the matter of individual prophylaxis a great deal could be accomplished, as these insects rarely fly far, and there must be

hundreds of Europeans whose bungalows are so far from neighbours, that they might secure a practical immunity from mosquitoes of all sorts, by the expenditure of a very little trouble and attention. In this part of the world at any rate the great source of mosquitoes of all sorts, *Anopheles* included, are the small pukka tanks which are to be found in nearly every compound for storing water for the garden. In most gardens there will be half a dozen of these connected with each other and the well-head by means of cemented channels. All that is required is to insist that these and all naunds and other small storages of water shall be emptied to dryness, and left so for a few hours, once every week or ten days.

If every one in an European cantonment would do this they would be but little troubled with mosquitoes even in the rains and might almost banish them in the hot weather. Secondly in the rains search the compound and its environs for pools. Fill up the small ones with a few shovels of earth and kerosine the large ones. The excavation made at the end of the run for the bullocks from the well-head is an almost certain find for *Anopheles* in the rains. It should be kerosined weekly. Such measures, however, cannot deal with adult mosquitoes that are already harboured in the house, and they are long-lived insects. It is usual to lime-wash houses in the cold weather. This should be preceded by a thorough fumigation with sulphur; pastiles for which purpose, each sufficient for 1,000 cubic feet of room-space, have been made for me by Messrs. Waldie of Cawnpore. Favourite lurking places, such as bath-rooms, should be periodically fumigated by burning one of these pastiles. It is almost needless to say that all doors and other openings should be closed before lighting the pastile and that it should be left closed for a few hours. Again a good deal can be done by keeping "chicks" down at dusk and dawn; just the times they are usually freely opened. It seems well nigh impossible to induce people to adopt these simple and not very onerous precautions, but will some of the members give the matter a systematic trial and report on the result thereof?

With the view of assisting members who are unaccustomed to the entomological Branch of Natural History studies, your Secretary has kindly consented to reproduce the following notes on methods of collecting which I have drawn up for private circulation among friends

who helped me by collecting but which has not as yet been issued as I have not yet received the fair proof :—

NOTES ON THE COLLECTION AND PRESERVATION OF MOSQUITOES.

Mosquitoes or gnats are small, two-winged insects (*Diptera*) and are all, except in the small genera *Corethra* and *Mochlonyx*, provided with a long suctorial proboscis. In all cases, the males have beautifully plumed antennæ, while those of the females, though also 14 or 15-jointed, have only a few scanty hairs. They are too well known to require minute description, and are unlikely to be confused with any family but the *Chironomidæ* or midges, from which they may be distinguished by the fact that, in all mosquitoes the veins of the wings are fringed with scales, like those of butterflies and moths.

Springing from either side of the root of the proboscis are two feelers or palpi which, in the males, are usually about the length of the proboscis, but, in the females, differ in length in the different genera.

Behind the wings are a pair of club-shaped organs, the halteres or balancers, which represent the hinder wings of four-winged insects, but in gnats are probably auditory organs. The thorax also carries three pairs of legs, each consisting of two short pieces, the coxæ, at their root, followed by the femur, tibia, and five tarsal joints, the first of which last is generally as long as, or longer than the tibia. Each leg ends in a pair of claws, often of complex form in the males, between which are plume-shaped epipodia which, by retaining air, enable the insect to pitch and float upon the surface of water.

The abdomen shows eight visible segments and terminates in the males in a pair of claspers, and in the females in lobed appendages.

Like all other *Diptera*, gnats undergo a complete metamorphosis.

The adult insects deposit their eggs on the surface of standing water, and from these are hatched out larvæ, which may be found, in warm climates, in almost every small collection of water.

After about ten days, the larvæ change into small, tadpole-shaped creatures, the nymphs or pupæ, provided with a pair of breathing horns, springing from the back of the thorax. While in this stage they do not eat and after about three days, the pupa-skin bursts along the middle, and the full-grown gnat slowly extricates itself and flies off. They generally pair immediately after, but many species do not deposit their eggs until they have obtained a feed of blood. As a rule, it is only the females that bite, and they only occasionally ; the more habitual food of these insects being the juices of plants.

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 secured by the survival of impregnated females, which hide and remain quiescent during seasons unfavourable to the well-being of the larvæ. No instance of survival of quiescent larvæ is known, but the possibility of such a habit should be borne in mind and looked for.

In attempting to describe a mosquito, the exact position of all bandings, *e.g.*, whether at the base or apex of joints and segments, and of all spots on the wings, or elsewhere, should be carefully noted.

The gnat family (*Culicidæ*) includes some seven or eight well-established genera, of which the two following are most important :—

ANOPHELES.—Palpi about as long as the proboscis in both sexes, but tapered in the females, while they are clubbed in the males. They rest on walls, &c., with the body at an angle to it, the proboscis pointing at the wall. Their eggs are deposited either singly or in small groups ; and their larvæ have no long breathing tube but lie nearly horizontal at the surface of the water. There are about 30 species.

CULEX.—Palpi about as long as the proboscis in the male, but rarely clubbed ; very short in the female. Rest on walls with the body parrellel to the surface ; eggs deposited in boat-shaped masses consisting of 200 to 300 eggs. Larvæ lie in the water as if suspended by the tail from the surface, and are provided with a long breathing tube, springing from the back of the eighth abdominal segment. There are over 160 known species.

Less important genera are

AEDES.—Palpi very short in both sexes.

MEGARHINA.—Palpi usually long in both sexes—Large, brilliantly coloured, sylvan species.

CORETHRA and MOCHLONYX.—Small, hairy gnats, unprovided with the usual long proboscis. In the latter genus, the first tarsal joint is short.

COLLECTING.

Mosquitoes may be collected—

(*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.

(*b*) By means of a net :—Bend 2 yards of stout iron wire so as to form a ring 9" 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% formaline solution, and marked with a distinguishing letter or number in order to identify them with the adult pinned insect.

KILLING COLLECTED MOSQUITOES.

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 3½" high by 2" wide, fitted with either a well-fitting cork, or preferably with a metal screw-top.

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 ¾" in the bottom of the bottle; dust over this a little dry plaster; and then pour over all, ½" 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 stupified, 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 dipped into the pill box or bottle, answers very well.

PRESERVING THE INSECT.

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.

For identification, the insects must be pinned as described below :—

Requisites—

1. No. 20 Insect pins : (Obtainable from D. F. Taylor & Co., New Hall Works, Birmingham). A quarter of an ounce, costing about half a crown, will last a long time.
2. Card discs—cut from rather thin cardboard by means of a 20-bore gun-punch.
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 1½ inches deep, may be utilized 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. If intended for receiving a permanent collection, they should have dust-proof lids and be made as nearly air-tight as may be. In any case a small muslin bag, full of naphthalin or camphor, should be securely pinned into a corner of the box so that it cannot move, and it is a good additional precaution to paint the entire inside with strong spirituous solution of perchloride of mercury.

TO PIN THE MOSQUITO.

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 a 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.

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 recognizable 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 3″×1″×$\frac{1}{16}$″ with a hole $\frac{3}{4}$″ 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 creosote 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.

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 1 foot in diameter and 4 inches deep and fill it with puddle water which has been strained through muslin to avoid the falacy 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 18″ high so as to form the supports of a miniature mosquito net made of gauze or the material known as "leno," and 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 utilized 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 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.

The writer will be extremely grateful for any specimens collectors may send him to the undermentioned address—

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A PRODROMUS OF THE INDIAN *CULICIDÆ.*

Two years' ago, when I took up the task of collecting the literature of the *Culicidæ*, it is an actual fact that no more than four species were recorded as having been found in all India. There was in fact hardly any other known country with such scanty records of the subject.

The subjoined list includes 32 species, and I have little doubt the final total of species will be found to be not far off a hundred, as new species are constantly turning up, and I find that many European species are to be met with in the Himalayas, while the wide range of climate of the plains renders the occurrence of a wide variety of forms a practical certainty.

The species enumerated below it must be understood are merely those that have been verified by myself. When Mr. Theobald's work on the collections that have been made for the British Museum appears, the number will doubtless be largely increased. In the case of new species it must be understood that the names are provisional, as it is very possible that, though we are in correspondence some may have been described under a different new name by him.

The short descriptions are based on a systematic plan in which only a few points are noticed, and the number preceding the name refers to the position the species takes, or would take, in the system of tabulation adopted in my recently-published Handbook of the group.

Family CULICIDÆ.

Subfamily CULICINÆ.

Genus I. MEGARHINA, R. Desvoidy.

6. MEGARHINA IMMISERICORS, Walker.

Caudal adornment yellow and black. Tarsi with certain broad bands whitish. Thorax metallic green; scales on costa blackish. Calcutta, Travancore, Ceylon, Burma.

8. MEGARHINA SIKKIMENSIS, Giles.

Caudal adornment yellow and black. Tarsi with certain joints or bands whitish. Thorax chocolate-coloured, with a greenish lustre. Col. Brit. Mus. sent by Mr. G. A. Dudgeon.

Genus II. ANOPHELES, Meigen (1818).

5. ANOPHELES ROSSII, Giles.

Wings with four black spots on the white costa, and some of the other veins with alternate portions white-scaled and black-scaled, forming indistinct additional spots; tarsal joints pale grey with minute apical bands; abdomen indistinctly banded, the lighter basal portion of the segments greatly preponderating; thorax without longitudinal markings. Found throughout India.

15. ANOPHELES FULIGINOSUS, Giles.

Wings very dark, but with three small white interruptions on the costa; abdomen uniformly black. The last two hind-tarsal joints white, the rest black, saving a minute ring on articulation between the second and third joints: apex of palpi white. Found throughout India.

16. ANOPHELES NIGERRIMUS, Giles.

Wings intensely black, except two very small yellow interruptions on the costa, the outer one of which is sub-apical, and a few white dots on the longitudinal veins; abdomen entirely black; tarsi with apical whitish rings to some of the joints; apex of palpi black.

This may possibly be identical with *An. pseudopictus*, Grassi. Found throughout India.

21. ANOPHELES LINDESAII, Giles.

Wing not distinctly spotted, but with the costa and some of the anterior veins black-scaled, giving a diffused darker appearance to this portion of the wing, the rest of its scales being grey, with the exception of a small whitish spot at the apex of the wing; 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.

Taken at Bakloh, Punjab Himalayas, and also at Naini Tal; not common.

Possibly purely a hill species. I have not been able to find its larvæ.

Genus III. PSOROPHORA, R. Desv.

4. PSOROPHORA sp.

♀. Wings brindled with alternate ochreous and dark brown scales; apical and internal fringe with eight dark interruptions. Legs banded, ochreous, and white. Palpi of ♀ half the length of the proboscis.

Received from Major Close, I.M.S., Moradabad.

5. PSOROPHORA sp.

I am inclined to think that the above are identical, but the point cannot be decided without comparison. Both are large insects covered with woolly tomentum and looking much more like dung flies than like ordinary mosquitoes.

Myingan, Burma. Coll. Brit. Museum.

Genus V. CULEX, L.

1. CULEX MIMETICUS, Noe. (1899).

Wings spotted; anterior margin black, interrupted by three linear, pale yellow intervals about equal to the black spots in length. Body with smooth tomentum? Abdominal segments with pale basal bands; tarsal joints with white basal bands. Proboscis banded. The femora of the middle legs are thickened at the base. A small species which mimics *An. superpictus*, the wings presenting a strong superficial resemblance to those of that species. Length about 5·6 mm.

Taken at Bakloh, Punjab Himalayas, in May; at Shahjahanpur, N.-W. P., in early October; in the Nilgiri Hills; and apparently common all over India.

3. CULEX ANNULATUS, Schrank.

With five, or more rarely four, black wing-spots. Tomentum smooth; tarsi conspicuously banded; thorax not dorsally ornamented; palpi of the male longer than the proboscis.

Bakloh, Naini Tal, in the rains.

4. CULEX SPATHIPALPIS, Rondani (1872).

Wings with three black spots formed by accumulations of scales; tarsi with obvious bands; tomentum smooth; thorax dorsally

ornamented with white marks; palpi of the male rather shorter than the proboscis, the last joint somewhat spatulate (approaching the characters of *Anopheles*).

Naini Tal, in the rains.

13. CULEX TÆNIATUS, Meigen.

C. elegans, Ficalbi (1889), *C. rossii*, Giles (1899), "Jour. Trop. Medicine," p. 64.

Wings unspotted; joints of the tarsi with basal snow-white rings; thorax black with a pair of submedian, snow-white lines forming a V behind, and two lateral semilunar patches, prolonged posteriorly into fine lines of the same; abdominal segments black with basal white bands best marked in front; nape with six silvery lines.

A truly cosmopolitan species, common throughout India. Varies greatly in size. A dwarf variety from Calcutta is the smallest true gnat I have met with.

21. CULEX ALBOPICTUS, Skuse.

Wings unspotted; tarsal joints banded white, on the first two of the fore and middle, and on all those of the hind legs; dorsum of thorax traversed by a line of silvery scales for rather more than its anterior half; the pleuræ silvery spotted; abdominal segments narrowly banded silvery, and with lateral silvery spots: femora slightly tipped silvery.

Mr. Theobald regards this as a synonym of *C. scutellaris*, Walker, but as the latter has three thoracic stripes, not one, I conclude the species are distinct. Appears common all over India.

45. CULEX IMPELLENS, Walker.

Wings unspotted; tarsi brown with very minute basal lighter band to all the joints, and a light knee-joint; thorax unadorned, brown; abdomen brown, with yellowish basal bands to the segments. Proboscis brown, with a broad yellowish band beyond the middle.

Shahjahanpur; October. This corresponds with my notes on the type, but, without actual comparison, the identification must not be considered final. This species persists throughout the cold weather in the N.-W. P.

45*a*. CULEX TRITÆNIORHYNCHUS, sp. n.

Wings unspotted; tarsi minutely basally banded pale ochreous; thorax unadorned, fuscous; abdominal segments fuscous, with rather

narrow yellowish-white basal bands. Proboscis with three ochreous bands.

Travancore—From Captain James, I.M.S.

46*a*. CULEX PERTURBANS, Walker.

Wings unspotted ; tarsi with lighter basal bands ; thorax unadorned ; abdomen with ochreous apical bands. Proboscis with a single ochreous band, a little beyond the middle. Wing scales of the usual form.

54. CULEX DIVES, Schiner.

Wings unspotted ; tarsal joints basally white-ringed ; thorax and abdomen dark brown, with minute white dots laterally. Apices of palpi, bases of antennæ, and frons white-scaled.

I have not personally verified the occurrence of this form, and perhaps its habitat hardly entitles it to be considered an Indian species.

63*a*. CULEX PSEUDOTÆNIATUS, sp. n.

Wings unspotted ; tarsi black with white rings formed on the bases and apices of contiguous joints. Thorax black, elaborately adorned with fine white lines (almost as in *C. tæniatus*, Meig.) ; abdominal segments black with narrow basal bands : venter pale fawn. The general coloura'ion is an intense violet-black.

Mr. Theobald regards this as a synonym of *C. notoscriptus*, Skuse, but there are several notable differences, and Skuse's description is too minute to assume these as due to oversight.

Bakloh and Naini Tal.

64*a*. CULEX GUBERNATORIS, sp. n.

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 round anterior median and four lateral spots at the corners of the notum ; abdominal segments black with large snowy lateral spots, and a minute terminal median spot on the last : venter sooty. Allahabad Government House Garden.

98*a*. CULEX BITÆNIORHYNCHUS, sp. n.

Wings unspotted ; tarsal joints deep brown with ochreous bands at base and apex so that two joints combine to form rings at the articulations ; thorax unadorned, black, covered with mingled black and golden scales ; abdominal segments black with distal ochreous bands. Proboscis black with two ochreous bands at the tip and in the middle. Travancore—from Captain James, I. M. S.

95. CULEX ATRIPES, Skuse.

Wings unspotted; tarsi uniformly coloured; thorax dark violet, with prothoracic lobes, the pleuræ, and a spot in front of the wings silvery; abdominal segments not banded, but with a silvery spot on either side; knees with a minute spot.

The specimens I refer to this species were received from Calcutta and are considerably rubbed. I am very doubtful as to the identification as the venter is not entirely silvery but more or less banded.

In the absence of perfect specimens, however, it is inadvisable to attempt to establish a new species.

95*a*. CULEX PANALECTORIS (Alcock's gnat), sp. n.

Wings unspotted; tarsi unbanded, nearly black; thorax dark mouse colour, adorned with lighter lines of the same tint precisely as in *C. tæmatus*, Meig.; abdomen sooty, dorsally unadorned, but with lunate silvery apical bands to the segments as in *C. ventralis*, Walker.

This species may possibly be *C. ventralis*, Walker, but the wings do not correspond to my notes on the much mutilated type in the British Museum.

Received from Major Alcock, Superintendent, Indian Museum, Calcutta.

97. CULEX FATIGANS, Wied.

Wings unspotted; tarsi uniformly brown; thorax with a median and two lateral dark lines, the latter much the most conspicuous; abdominal segments brown, with basal whitish bands; knees unspotted. This is a most puzzling species. Mr. Theobald tells me that it would be possible to differentiate some 30 species or varieties more or less running into each other. In most of these there are no signs of thoracic ornament. He differentiates all, however, from *C. pipiens*, L., by the closeness of the posterior transverse to the middle transverse vein. In any case, during the dry weather, it is out and away the commonest of Indian mosquitoes, and some of its forms are to be found throughout the year. During the past hot weather it was a perfect plague in Lucknow.

99*a*. CULEX PULCHRIVENTER, sp. n.

Wings unspotted; tarsi unbanded, black; thorax golden-scaled, with a fine median and broader lateral bare black lines; abdominal

segment black, snowy basal bands, and the venter elaborately adorned with golden snowy white and black markings.

Naini Tal.

100. CULEX FUSCANUS, Wied.

Wings unspotted; tarsi unbanded; thorax rather dusky, with grizzly hairs arranged so that the ground-colour shows through as four (darker) lines; abdominal segments dusky, with light grey apical bands.

"East India."

I have as yet met with no species corresponding to this description.

108. CULEX CONCOLOR, R. Desvoidy.

Wings unspotted; tarsi unbanded; thorax pale red with three indistinct brown lines; abdomen pale yellow with dark incisuræ, *i.e.*, apically lighter; wings with the veins nearly nude.

Appears to be common all over India in the rains.

122*a*. CULEX MICROPTERUS, sp. n.

Wings unspotted; tarsi unbanded; thorax dorsally unadorned but with white spots on pleuræ; abdominal segments black, with white basal bands expanding into lateral spots, and a distal fringe of yellowish hairs; wings proportionately very small.

Allahabad, Lucknow; in the rains.

130*a*. CULEX ALBOLINEATUS, sp. n.

Wings unspotted; tarsi unbanded, brown; thorax unadorned, black-grounded, with bronzy tomentum; abdominal segments black with greenish-white basal bands and a broad brownish-white median line.

Shahjahanpur; October.

131. CULEX PIPIENS, L.

Wings unspotted; tarsi unbanded, brown; thorax pale testaceous, unadorned, black when denuded; abdominal segments reddish-brown, with yellowish basal bands, narrow in middle, but expanding laterally; knees unspotted.

Naini Tal.

131*a*. CULEX VIRIDIVENTER, sp. n.

Wings unspotted; tarsi unbanded, dusky; thorax chocolate-brown with bronzy tomentum; abdominal segments with yellowish basal bands having a blunt backward median prolongation; venter almost naked, save for a few colourless scales, green in fresh specimens; knees with minute lighter dots.

Mr. Theobald regards this as one of the numerous varieties of *C. fatigans*, Wied., but the deltoid extension of the abdominal bands makes it easily distinguishable in the fresh state ; and it is moreover a hill species, whose larvæ are capable of maintaining them in pools in the course of hill torrents.

150. CULEX OBTURBANS, Walker.

Wings unspotted ; tarsi unbanded ; thorax with brown tomentum, unadorned ; abdomen cupreous-greenish, with a white dot near the tip.

Appears to be common all over India during the rains.

Subfamily CORETHRINÆ.

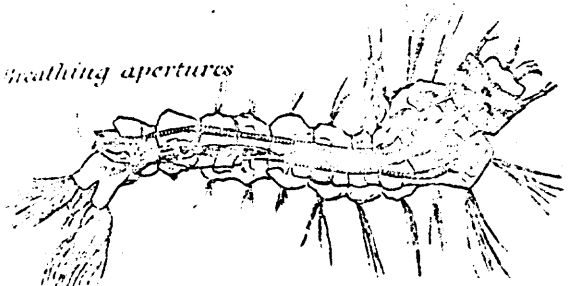
Genus VII. CORETHRA.

9*a*. CORETHRA ASIATICA, sp. n.

Wings unspotted ; legs uniformly coloured, antennæ unbanded ; generally pale, the thorax with a faint darker median line.

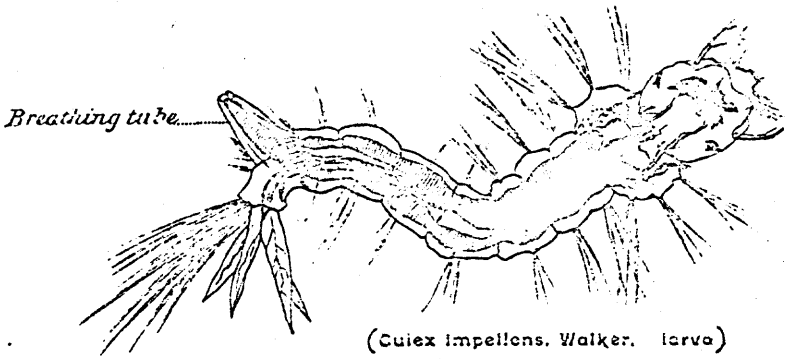
Shahjahanpur, N.-W. P. ; October.

This is the first record of the occurrence of any member of the subfamily, so far as I am aware, in Asia.

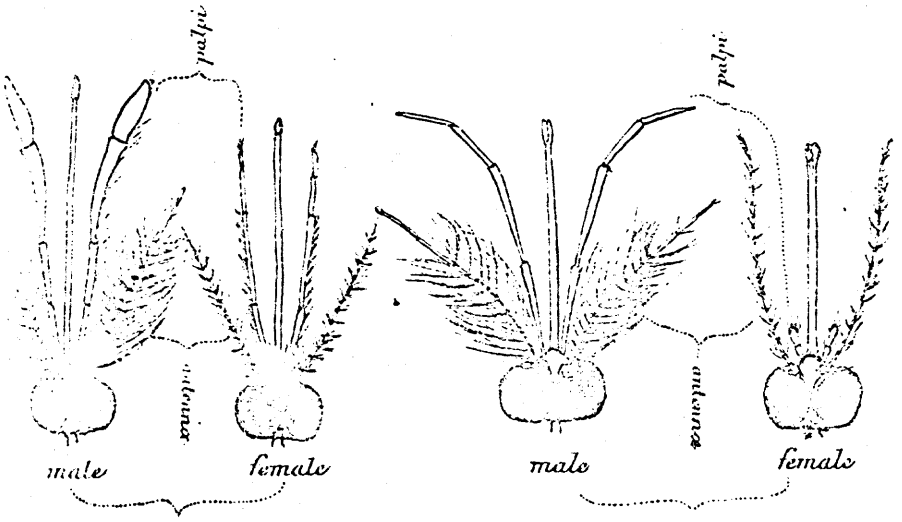


The anterior parts are shown in the prone position and the hinder ends in profile, owing to the body being twisted by the pressure of the cover glass.

(Anopheles Rossii. Giles. larva)

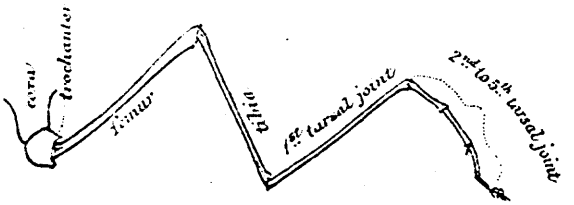


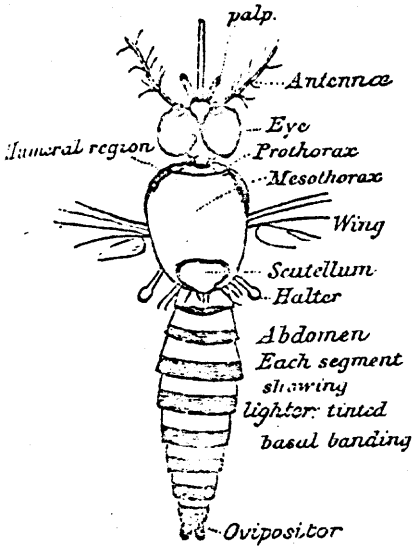
(Culex Impellens. Walker. larva)

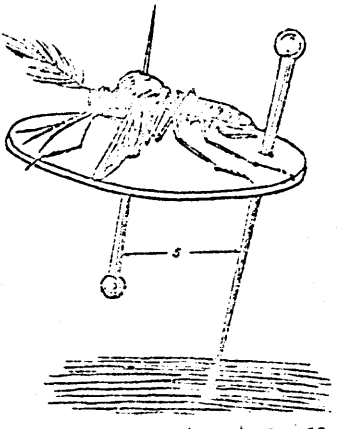


Anopheles

Culex

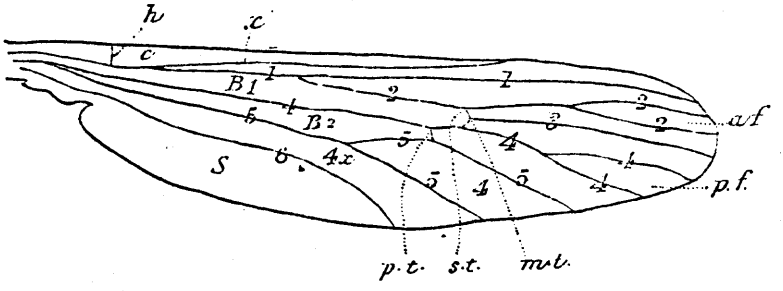






Mosquito pinned on disc.

C. fatigans, Wied.



Wing of C. impellens, Walker. x 33 diams.

A.....auxiliary vein
1 to 6.....first to sixth longitudinal veins
h.....humeral transverse vein
s. t.....supernumerary transverse vein
m. t.....middle transverse vein
p. t.....posterior transverse vein
c.....costal cell

S.c.....Subcostal cell
B.1.....first basal cell
B 2.....second basal cell
A.....anal cell
Ax.....axillary cell
S.....spurious cell
a. f.....anterior fork cell
p. f.....posterior fork cell