S. B. Low P. 1978

BRITISH MUSEUM

(NATURAL HISTORY).

HOW TO COLLECT MOSQUITOES

(CULICIDÆ).

Austen

2.

1.

1^{b.}

1a.

3.

The Wing of a Mosquito or Gnat (*Culex* sp.)
and of a Midge (*Chironomus plumosus*).

EXPLANATION OF PLATE.

Fig. 1. Wing of a gnat or mosquito (*Culex* sp.), $\times$ about 16.

- 1a. Portion of 2nd longitudinal vein, greatly enlarged, to show the covering of flattened hairs and scales.
- 1b. Portion of hind margin of wing, greatly enlarged, to show the fringe of scales.

Fig. 2. The same wing denuded of hairs and scales, to show the course and nomenclature of the veins.

C. costal vein (in Culicidae this runs right round the margin of the wing): the anterior margin of of the wing is called the costa.

1a, mediastinal vein.

1, 1st longitudinal vein.

II, 2nd „ „ „, issuing from the 1st.

III, 3rd „ „ „ „ 2nd.

IV, 4th " "

V, 5th " "

VI, 6th " "

VII, 7th " "

VIII, 8th " "

Tr, anterior transverse vein, connecting the 3rd and 4th longitudinal veins.

Tr², posterior transverse vein, connecting the 4th and 5th longitudinal veins.

It will be observed that the 2nd, 4th, and 5th veins are forked (the branch nearer the costa is spoken of as the *upper*, that nearer the hind margin of the wing as the *lower* branch in each case), and that the sixth vein does not reach the margin of the wing. The relative lengths of the forks of the 2nd and 4th veins may vary in different species.

Fig. 3. Wing of a midge (*Chironomus plumosus* L.), $\times$ about 12, showing that the veins are destitute of flattened hairs and scales.

HOW TO COLLECT MOSQUITOES

(CULICIDÆ).

INTRODUCTION.

Systematic Position, Distinctive Characters, and Life History of Mosquitoes.

Mosquitoes or gnats (strictly speaking, the terms are synonymous) are the names popularly applied to the family Culicidæ, of the order of insects known as Diptera (*Two-winged* Flies), which also includes, besides other families the species of which are more or less gnat-like in form, such as the true midges (Chironomidæ), fungus-midges (Mycetophilidæ), daddy long-legs (Tipulidæ), &c., a large number the members of which are more "fly"-like in shape, *e.g.*, the blue-bottles and house-flies (Muscidæ), tsetse-flies (*Glossina*), horse-flies (Tabanidæ), hover-flies (Syrphidæ), &c.

Culicidæ are by no means the only blood-sucking Diptera, for the order also comprises the blood-sucking midges (genus *Ceratopogon*, belonging to the family Chironomidæ), the Simulidæ, Tabanidæ, and blood-sucking Muscidæ (*Glossina*, *Stomoxys*, *Hematobia*). The *females* of all of these suck blood in the perfect state, while the males are usually harmless, though in the tsetse-fly the blood-sucking habit is stated to be common to both sexes,* as has been asserted to be the case in certain species of mosquitoes (*see* below, "Observations on Habits, Distribution," &c., pp. 12-13).

The other blood-sucking Diptera, with the possible exception of *Ceratopogon*, are sufficiently distinct from Culicidæ

* Surgeon-Major David Bruce, A.M.S., "Further Report on the Tsetse Fly Disease or Nagana, in Zululand," p. 3 (London : Harrison & Sons, 1897).

in outward form to obviate any risk of confusion. In countries in which mosquitoes abound they are recognised without difficulty. In England, however, where some seventeen species of the family occur, though not, as a rule, in any great abundance, or causing much annoyance by their bites, a large amount of confusion apparently exists as to the characteristics of a mosquito or, as it is more commonly called, a gnat. This confusion is mainly due to the fact that the midges (Chironomidæ), which, with the exception of the genus *Ceratopogon* are perfectly harmless, often attract attention from the habit of the males of dancing in the air in swarms on fine evenings in spring and early summer, and, owing to their similarity in shape, size, and general appearance, are commonly mistaken for gnats (Culicidæ).

A fundamental structural difference between Culicidæ and Chironomidæ consists in the fact that in the former the costal vein runs right round the margin of the wing, while in the latter (as in the vast majority of Diptera) it is confined to the front margin alone and stops short at the tip (compare plate, Figs. 2 and 3). For practical purposes, however, more important differences consist in the possession by the mosquito or gnat of a greatly elongated proboscis (containing the piercing stilets, which enable it to obtain its food), whereas the proboscis of the midge is so short as to be invisible without close examination; and also in the fact that while in Chironomidæ the wing is either bare or else uniformly clothed (membrane as well as veins) with fine hairs, *in Culicidæ*, while the membrane of the wing is bare, *the veins are clothed with flattened hairs or scales*, which project (especially towards the tip of the wing) at a characteristic angle of about 45° (*see* plate, Figs. 1, 1^a). On the costa (*i.e.*, anterior margin of the wing) and certain of the veins, especially the mediastinal and 1st and 5th longitudinal (for the nomenclature of the veins compare Figs. 1 and 2), the hairs are replaced either wholly or in part by truncated scales; but hairs and scales are merely modifications of the same structures, and in some species the scale-like form may

predominate on all the veins. The posterior margin of the wing carries a deep fringe of elongated, feather-shaped scales (*see* Figs. 1, 1^b). The body, legs, and palpi are also clothed with hairs and scales, and the tarsi (*i.e.*, the five terminal joints of each leg) are frequently banded with white in various ways.

The preliminary stages (larva and pupa) of all mosquitoes are passed in water—generally stagnant fresh water,* whether clean or foul, and either in permanent ditches, ponds, or tanks, or in temporary pools of rain-water. Species that frequent houses breed in butts or tubs of rain-water or in other vessels of water within or in the precincts of the houses themselves, or in cesspools which are open to the air. In the case of the best-known species of *Culex* that infest houses, the eggs are laid on the surface of the water in the so-called “boat-shaped” masses; specimens of various Indian species of *Anopheles*, on the other hand, kept in captivity by Major Ross, I.M.S., were found never to oviposit on the water itself, but always upon hard surfaces (as the wall of a test-tube), on which the eggs were laid separately in roughly star-shaped groups; the inference being that in a natural state these forms deposit their eggs on stones in the vicinity of pools, into which they are washed by rain.

The mosquito larva is a small greenish or greenish-brown creature, with a round head, a rounded swollen thorax, and an elongated jointed abdomen, from near the end of which, in *Culex*, the breathing tube arises. In the pupa the head

* Ficalbi, however, states (“Revisione Sistematica della Famiglia Delle Culicidae Europee” (Firenze, 1896), pp. 291—292) that “the larvæ of the Culicidae can also live in salt water, and that of a degree of saltness, as in the case of the water of salt pans or stagnant salt-marshes, greater than that of the sea; this fact may be of importance in explaining the presence of mosquitoes in places in which fresh water does not exist.” Again, Dr. T. L. Bancroft, of Burpengary, Queensland, has met with four species of *Culex* and one of *Anopheles* that breed in sea-water at Deception Bay, near Brisbane. It is, on the contrary, asserted by L. O. Howard (“The Principal Household Insects of the United States,” p. 20 :—U.S. Dept. of Agriculture, Bulletin No. 4, New Series, Washington, 1896) that :—“Water that is somewhat brackish will support mosquitoes, but water which is purely salt will destroy them.”

and thorax are fused into a mass, on the under side of which depend the rudiments of the wings, legs, and proboscis, while from the dorsal side project a pair of funnel-shaped breathing organs; the terminal segment of the abdomen bears a pair of swimming-plates. In the case of *Culex* the larvæ and pupæ are exceedingly active, moving about in the water by a jerking or wriggling motion of the body; they are under the necessity of coming to the surface to breathe at frequent intervals. The larva of *Anopheles* is more sluggish, and its habit is to float horizontally at the surface of the water.

In the case of *Culex pungens*, Wied., a common North American species, it was found by Howard (*op. cit.*, p. 14) that the minimum time occupied by the whole life-history cycle was ten days—"namely, sixteen to twenty-four hours for the egg, seven days for the larva, and two days for the pupa." But the period necessary for a generation "is almost indefinitely enlarged if the weather be cool," so that it is also permissible to suppose that it is accelerated by heat.

In the perfect state, Howard found that the male insects died quickly in confinement, but that the females were much longer-lived, some even existing without food for three weeks.* In cold climates large numbers of the perfect insects pass the winter in a state of hibernation.

List of Articles Required for Collecting and Preparing Mosquitoes.

One entomologist's collecting-net of book-muslin (one or two spare net-bags should be taken in case the one in use gets torn).

One dozen glass-bottomed pill-boxes ($1\frac{1}{2}$ to 2 in. in diameter is about the best size).

* In Queensland Dr. T. L. Bancroft has kept a certain species of *Culex* alive for 70 days in confinement.

A cyanide killing-jar, or materials for making same, as follows :—

$\frac{1}{4}$ lb. of cyanide of potassium (in lumps).

1 lb. of plaster of Paris.

A glass jar with wide mouth and closely fitting lid.

Entomological forceps (two pairs), with curved ends, for holding pins.

One ounce No. 20 entomological pins (D. F. Tayler and Co., New Hall Works, Birmingham. These pins are sold in boxes at 7s. 6d. per ounce, and as the pins are exceedingly fine, an ounce will go a very long way).

Common pins (three or four packets).

Gun-wad punch, No. 20 bore.

Cards (4-sheet Bristol Board) from which to punch discs : a supply of the latter should be prepared ready for use.

Needles (two or three) mounted in handles, for arranging legs and wings.

A good pocket lens.

Cork-carpet or pith—one or two sheets about 6 in. square, on which to perform the operations of pinning, etc.

A strongly-made wooden box (a cigar-box will do), in the bottom of which is fixed a layer of cork-carpet or pith (if the latter is used it should not be less than half an inch thick).

Importance of Sending Home Specimens for Determination in the Best Possible Condition.

It should be borne in mind that, for the purpose of the scientific determination of species, *mosquitoes cannot be col-*

lected with too great care. As important specific characters are furnished by the *wings* and *legs*, it is of the utmost consequence that these should not be denuded of their scales, or otherwise injured; *unless attention is paid to this point the specimens will probably be quite worthless for determination.*

Spirit Not to be Used.

Specimens for determination must *on no account* be placed in spirit.

Specimens to be Pinned Immediately they are Dead.

Mosquitoes should in all cases be pinned, and that as soon as possible after death; duplicate specimens for dissection can, of course, be preserved in spirit, but if this is done care must be taken, by the use of corresponding labels or numbers, to prevent confusion between species.

Number of Specimens of Each Species Required.

In collecting specimens of a species of mosquito for determination some *half dozen* examples of *each sex* should, if possible, always be obtained.

How to Distinguish the Sexes.

The usually harmless male mosquitoes can be distinguished from the females (which, in the majority of species, alone bite and suck blood) by the possession of plumose antennæ, forming tufts in front of the head; in the females the antennæ, though long, are nearly bare (having whorls of only short hair at the bases of the joints); while the palpi in the case of females of the typical genus *Culex*, to which the majority of the described species belong, are quite short. In the genus *Anopheles* the palpi are as long as the proboscis in both sexes, but are more swollen at the tips in the males.

Method of Collecting and Killing.

For capturing mosquitoes in the open an entomologist's collecting net is necessary, from which the insects can be transferred to glass-bottomed pill-boxes; in doing this great care must be taken not to pull off the legs: inside buildings it is possible, with care, to capture mosquitoes on walls and windows in the pill-boxes themselves. Specimens of species that habitually infest houses are best obtained in good condition by *breeding* them; this can readily be done by keeping the larvæ or pupæ in a basin of water covered over with book-muslin. In any case mosquitoes should be collected alive in the glass-bottomed pill-boxes*; if care is taken, several specimens can be got into one pill-box. To kill the mosquitoes the box is opened a fraction of an inch on one side, and placed for a few minutes in a cyanide killing-jar,† which must, of course, be closed. As soon as the insects are quite dead (if the mixture in the jar is of

* These boxes can be obtained from any dealer in natural history apparatus, but care should be taken to see that the *bottoms*—and not the tops, as is often the case—are made of glass. Since the boxes are constructed of cardboard, they are liable in tropical countries to go to pieces in the rains, and to prevent this they should be covered with jaconet (cut *on the cross* and stuck on with liquid glue) and then coated with Aspinall's enamel.

† A cyanide killing-bottle can be procured ready for use from Hinton and Co., Bedford Street, London, W.C., or any other chemist will prepare one to order, but when mosquitoes (or indeed *any* Diptera) are collected in the manner here advised it is preferable to make a large-sized killing-jar for oneself as follows:—Take any fairly large glass jar (such as a pickle-bottle) with a wide mouth and closely fitting lid, and cover the bottom with a layer of dry plaster of Paris to the depth of half an inch: pour in above this a layer equal in depth consisting of *powdered* cyanide of potassium, mixed with rather more than its bulk of dry plaster of Paris: cover this mixture with a layer of dry plaster of Paris to the depth of a quarter of an inch or so, and pour in above the whole a layer, half an inch in depth, consisting of plaster of Paris mixed with water to the consistency of cream. As soon as the top layer of plaster is dry the jar is ready for use. To obviate the risk of cracking the jar owing to the heat evolved when plaster of Paris is mixed with water, it may be advisable to stand the jar in warm water before adding the final layer. The exact amount of cyanide of potassium to be used is of no great consequence, but in the case of a properly prepared jar the odour should be readily perceptible on removing the lid; if it is not, the reason may be that the mixture is too dry, when a little water poured on to the top layer will probably set matters right. After some months' use the cyanide loses its efficacy (to obviate this so far as possible the jar should never be allowed to remain open), and the mixture must then be renewed.

reasonable strength from three to five minutes is sufficient, and mosquitoes should not be allowed to remain exposed to the effects of the cyanide longer than this) they should be turned out on to a sheet of cork-carpet or pith; they should be touched as little as possible, the manipulations necessary in arranging the wings and legs being performed with a needle.

To Pin a Mosquito.

Take a card disc and write on it all the data connected with the specimen to be pinned, as follows:—(1) Name of *locality*, including *altitude* if necessary; (2) *date*—day, month, year—thus, 9. 11. 98; (3) *collector's name*; (4) any *remarks of interest*, e.g., “Most troublesome species in district”; “Abundant in bamboo-jungle”; “Uncommon,” etc. Place the disc on a sheet of cork-carpet or pith, and picking up with the entomological forceps one of the fine No. 20 pins, thrust about one-third of an inch of it through the centre of the disc; in doing this the pin should be held by the forceps below the middle, otherwise, owing to its fineness, it may bend and fail to pass through the card. Lay the specimen *on its back* (turning it over with the aid of a needle or one of the No. 20 pins held in the forceps), and thrust the pin, which now carries the disc, through the centre of the thorax, between the bases of the legs, until the tip of the pin projects one-sixth of an inch beyond the dorsal surface of the thorax*; invert the disc (the specimen will then be right side up), and thrust an ordinary pin through the disc near the margin for the purpose of carrying both disc and specimen. The next and last thing to be done is to arrange the legs and wings as far as possible; *i.e.*, the wings must be made to project at an angle from the body, and not allowed to remain closed, and the legs must be dis-

* Should it be found impracticable to proceed in the manner here prescribed, owing to the difficulty of making the specimen lie in the required position on its back, it may be pinned in the ordinary way through the middle of the thorax from the *dorsal* side; in this case, however, the specimen must be *pinned first* (*i.e.*, before it is mounted on the card disc): it should be drawn two-thirds of the way up the pin, and the latter should then be thrust through the disc, holding the pin with the forceps *below* the specimen; mount the disc on a common pin, as in the first method.

posed symmetrically on the card disc so that all parts of them can be readily seen, instead of being left crumpled up beneath the body. These operations must be performed as gently as possible with the help of a needle mounted in a handle, or by the aid of a No. 20 pin held in the forceps, and care must be taken that hairs and scales are not rubbed off in the process. As the tissues contract in drying, the legs and wings are very apt to get pulled out of place, and, to correct these changes, the specimens should be examined one or twice during the next day or two after being pinned.

Preservation of Larvæ and Pupæ.

Specimens of larvæ and pupæ should always be preserved, especially when it is possible to breed some of them out, or otherwise to determine the species to which they belong. They should be killed and kept in alcohol or formol.* If the former is used, ordinary methylated spirit will do, provided that the specimens are killed and preserved for three or four days in spirit diluted with half its bulk of water; after this they may be transferred to spirit of ordinary strength.

Of formol a 4 per cent. solution (*i.e.*, one part of ordinary commercial 40 per cent. solution to nine parts of water) is quite strong enough for killing and preserving.

Larvæ and pupæ (whether preserved in formol or alcohol) should be kept in small glass tubes, plugged with cotton wool to prevent the specimens from shaking about, and then corked; the corks may be coated with paraffin wax, though this is not absolutely necessary. Each tube should contain a scrap of paper on which the necessary data (locality, date, whether from fresh or salt water, collector's name, &c.—with, if possible, a reference to pinned specimens of the perfect insect, so that these may be identified) should be written in pencil.

The tubes should be packed in cotton wool in a small tin box for transmission to England.

* Otherwise known as formaldehyde or formalin.

It is scarcely necessary to add that each species should be kept distinct, in a separate tube.

Observations on Habits, Distribution, &c.

Detailed observations on the habits, distribution, seasonal occurrence, &c., of mosquitoes will always be useful, provided that care is taken to note the species to which they apply—the species being distinguished by means of letters or numbers attached to the pins of the specimens.

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).

Investigators in countries infested by mosquitoes will therefore, render especially valuable assistance by endeavouring, by means of their own observations, to supply answers to the following questions:—

1. Are there any species of mosquitoes that subsist wholly or in part on the juices of plants (or fruits)? If so, which are the species of mosquitoes in question, and on what plants do they feed?

2. In the species (if any) in which this mode of feeding occurs, is it confined to the *male* alone, or

* *Vide*, Ficalbi *op. cit.*, p. 293.

characteristic of both sexes? And is it habitual or exceptional?

3. Are there any species of mosquitoes in which the male sucks blood like the female? If so, which?

Transmission of Specimens to England.

Pinned specimens of mosquitoes, like those of other insects, rapidly develop mould during the rainy season in tropical countries, and since mouldy specimens are practically worthless for purposes of scientific determination, the insects should be sent home as soon as possible after being collected. To contain the specimens, if a proper entomological store-box is not available, any small strongly-made box (such as a cigar-box) will serve, in the bottom of which a layer of cork-carpet or pith (not less than half an inch thick, in the case of the latter) is firmly fixed. The greatest care must be taken to prevent specimens getting loose and rolling about in transit, since in this way a single loose disc might easily destroy or hopelessly damage all the other specimens in the box. To prevent this the pins supporting the cards should be inserted as tightly as possible into the cork-carpet or pith, and they should all be driven in to the same level; if this is done a sheet of soft paper (newspaper does very well) can be *fixed* into the box, resting on the heads of the supporting pins, in order to minimise the damage should a disc happen to get loose. The box containing the specimens should be well wrapped in cotton-wool, or similar material, and firmly packed in an outer box for transmission (by Parcel Post) to England.

N.B.—Not only Mosquitoes, but all Diptera should be Collected, Prepared, and sent Home in the Manner above Described.

The above instructions, though drawn up with special reference to mosquitoes, are equally applicable to the collecting of Diptera in general, except that in the case of the

large forms, such as horse-flies (Tabanidæ), robber-flies (Asilidæ), etc., it is not necessary to use so fine a pin as a No. 20 (D. F. Tayler and Co.'s entomological pin No. 5—price 1s. 6d. per ounce—would do instead).*

Besides Mosquitoes, all other Blood-Sucking
Diptera should be collected.

Specimens of blood-sucking Diptera, other than mosquitoes, should also be collected, and when forwarded should be accompanied by special notes as to their occurrence and habits.

Address for Specimens.

Specimens of mosquitoes (or other *Diptera*) intended for the British Museum should be directed to

E. E. Cluett,

THE BRITISH MUSEUM

(NATURAL HISTORY),

CROMWELL ROAD,

LONDON, S.W.

to whom

✓ All communications on the subject should be addressed. ~~to~~
~~the Director~~

* For detailed instructions on collecting Diptera in general, see—"How TO COLLECT DIPTERA (Two-winged Flies), with Notes on the Habits of the Perfect Insects and Larvæ"—issued by the British Museum (Natural History).

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