VIII MATERIALS FOR A SURVEY OF THE MOSQUITOES OF CALCUTTA.

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[NOTE.—The delay in the appearance of this paper is due to the fact that owing to the absence during almost the whole time of the survey as well as for many years previously, of any scientific officer who could devote more than a small part of his time to the supervision of the conservation of our extensive entomological collections, Mr. Paiva has been unable to devote more than a fraction of his time to mosquito work. For the same reason the survey cannot be regarded as exhaustive, or even sufficient for the "fringe area" to which it was confined, since the methods employed were rough and ready in the extreme. Their chief defects lie in the lack of adequate supervision over the collectors, and in the identification by means of the adults only of the larvae and pupae obtained. With regard to the first of these defects, Mr. Paiva tells me that it was easy to keep a check on the truth of the collectors' statements as to the nature of the breeding-places from which different collections of larvae were brought in, as he quickly found that some species preferred one sort and others preferred others, a fact which could not be taken into account by an ignorant collector anxious to avoid any suspicion that he neglected filthy water. But he was quite unable either to see that every type of breeding-place found was regularly sampled or to instruct the collectors personally in the art of finding larvae in large areas of water over which they might be dispersed; and it is probably on this account that no species known to transmit malaria has been revealed in the collections made either by the corporation kerosening-coolies or by the collectors subsequently employed by the Museum; for it is well known that these mosquitoes breed in clean water. With regard to the second defect mentioned above, it may be pointed out that just as different species of wild animals differ in their ability to thrive in captivity so some species of mosquito develop in captivity more readily than others, and although identifications ought to be checked by rearing up the larvae, they ought always, in the first instance, to be based on the larvae and pupae themselves; for otherwise there is a danger that some species may be completely overlooked owing to their inability to develop under the conditions to which they are subjected. To have done this, however, it would have been necessary for Mr. Paiva to devote the whole of his time to the work at the actual time when the survey was in progress, and this it was impossible for him to do; in addition to which, at the

commencement of the survey, the Museum did not possess a collection of properly named mosquito larvae on which he could have based his identifications. Such a collection has now been formed, both of the common species obtained during the survey, and of some of those found in Calcutta tanks; and I should like to take this opportunity of thanking Major Christophers, I.M.S., and Capt. Davys, I.M.S., for the assistance they have given me by sending isolated larval and pupal skins, together with the adults which emerged from them, of several species not common in Calcutta. But the absence of Mr. Paiva on medical certificate, an absence which will certainly be of long duration and from which it is very doubtful whether it will ever be safe for him to return, has rendered it impossible for the Museum to undertake, as had been hoped might be made possible, a second and more thorough survey on the lines indicated above. And it is in the hope that the experience and unavoidably imperfect results of what has already been done may be of use to others that the present paper has been compiled.—F. H. GRAVELY, Asst. Supdt., Indian Museum.]

Early in October 1909, the Calcutta Corporation commenced the destruction of mosquito larvae in that part of the town locally known as the "Fringe Area," and as it was important to know what species abounded in that area, living specimens of larvae were daily sent to the Indian Museum from every spot which was visited, together with the precise locality and breeding ground of these larvae.

Larvae were received with considerable regularity but for two interruptions which were occasioned by the Durga Puja and Christmas vacations. The larvae were successfully reared in the Museum, and the mosquitoes that emerged from each batch were carefully pinned and labelled. After a large number had been collected, I identified them to the best of my ability.

The Calcutta Corporation stopped the supply of mosquito larvae on the 26th February 1910, without previously informing the Museum authorities that the work was not to be carried on any longer by them. As it was the intention of the authorities of the Museum to carry on the breeding of mosquito larvae for a complete year, arrangements had to be made to secure men to collect larvae during the remaining period, *i.e.*, till the first week of October 1910. It was an extremely difficult task to secure really reliable men for the work and this caused an interruption of a little more than three weeks. On the 22nd March 1910, the work of collecting larvae commenced again, and after several changes of collectors, two men were finally selected for the work. In a short time the daily supply of larvae became enormous and consequently very large numbers of mosquitoes emerged daily. These could not all be pinned, so they were killed and put into separate pill-boxes and after all the mosquitoes had been thus duly arranged, I counted and identified them and made the necessary entries in a rough register. Thus did the work continue till the beginning of October 1911.

In the early part of the survey, I did not think it necessary to separate the *Culex* with the unbanded proboscis from those with the banded proboscis, but later on I considered it advisable to keep them separate. Hence it will be seen that from March 22nd 1910, the two forms are given as *Culex* A (unbanded proboscis) and *Culex* B (banded proboscis).

The following species were bred during the twelve months of the survey:—

Culex A.
Culex B.
Culex concolor, Desv.
Leucomyia gelida, Theob.
Stegomyia scutellaris, L.
Stegomyia fasciata, Fab.
Desvoidea obturbans, Wlk., and varieties.
Toxorhynchites immisericors, Wlk.
Myzomyia rossii, Giles.
Myzomyia ludlowi, Theob.

The area dealt with in the survey has been divided into ten districts which are briefly defined and described in Table I.

Table II gives full particulars of the work done during the year. Each column represents a fortnight's work; Roman figures are used to indicate the districts from which the various larvae were brought in; and the actual number of adults that emerged is shown by Arabic figures in brackets.

In the next three Tables (III, IV and V) the breeding habits for the three principal seasons are compared:—*viz.* the "hot," "rainy" and "cold" seasons.

The hot season in Calcutta generally commences early in March and extends at least to the end of May or the beginning of June. There are occasional showers of rain during this period, but mosquitoes do not find much stagnant water about to encourage the breeding of larvae. Some species however are rather common at this time of the year.

The rainy season commences in June or July and ends after the 15th of October. At this time water is most plentiful and hence it is the most suitable period for the breeding of mosquito larvae.

The cold season starts in November and lasts till the end of February at latest. There is very little or no rain during this time and mosquitoes do not seem to be so plentiful.

It is generally during the cold season that the Calcutta Corporation undertakes the destruction of mosquito larvae. A more suitable time of the year for this kind of work would perhaps be the rainy season as during that time larvae are found in abundance in all kinds of situations, and mosquitoes are most common then. The constant rain may render it difficult to do this work satisfactorily however.

The most common situation in which larvae were found during the rainy season was in earthen pots, except in the case of one species (*Myzomyia rossii*) which was found chiefly in open drains, but during the other two seasons, tanks, open drains, cisterns, cesspools and earthen pots were all utilized as breeding places with about equal frequency. Other artificial collections of water, such as that in tubs, metal cans, iron and earthen pans also served as breeding places, but did not seem to be patronized very much by mosquitoes; probably because some of these were less common, whilst others, being shallow, quickly dried up. In one instance, a canal served as a breeding place for *Myzomyia rossii*.

Table VI shows the number of specimens of each species that emerged during each of the three different seasons and their relative percentage. It will be seen that *Culex* A was the most abundant mosquito in all the seasons. *Myzomyia rossii* was commoner during the hot and rainy seasons than during the cold weather. The largest number of mosquitoes emerged during the rainy season, being as much as 69·9% of the year's total, clearly indicating that the larvae were more easy to obtain at this time than at any other.

The larvae of *Culex* A were found mostly in open drains during all the seasons.

Larvae of *Culex* B were found in about equal proportion in tanks, open drains and earthen pots during the rainy season, and in open drains during the hot season.

Culex A (with the proboscis unbanded) belongs rightly to the *fatigans* group of that genus, and I have noticed all varieties, both in respect to size and markings, emerge from a batch of larvae collected at one time from a single piece of water.

The forms of *Culex* with the banded proboscis (*Culex* B) belong to the *impellens* group.

These were the only two forms of the smaller species of *Culex* which emerged from larvae received during the year's survey.

Larvae of *Culex concolor*, Desv., were not very plentiful and were chiefly found during the rainy season in small collections of water, *viz.*, cesspools, tubs, iron pans and earthen pots, in company with larvae of *Culex* and *Stegomyia*. These larvae are of carnivorous habits and small collections of water are most suitable for them as they can easily capture any other larvae which may breed along with them in these situations.

Larvae of *Leucomyia gelida*, Theob., were only common during the rains, and were obtained chiefly from earthen pots, although some were got from tanks and open drains. This species appears to be entirely absent in the " Fringe Area " during the other two seasons.

Larvae of *Stegomyia scutellaris*, L., were procured in very large numbers during the three seasons from earthen pots, but chiefly during the rains.

During the other two seasons larvae were obtained from open drains and metal cans as well.

Larvae of *Stegomyia fasciata*, Fab., like *S. scutellaris*, were obtained mostly from earthen pots. These two species generally choose small collections of stagnant water to breed in. They will never be found to breed in any foul-smelling water, at least this is what I have observed. They do not seem to like muddy water either.

S. scutellaris and *S. fasciata* are the two principal mosquitoes which are such a source of annoyance in Calcutta during the day. They are purely day feeders and I have never yet caught one in a room after it has become dark.

Larvae of *Desvoidea obturbans*, Wlk., were found in cesspools and earthen pots during all the seasons, and during the cold season were very plentiful in open drains, which apparently contained foul stagnant water. The larvae of this species find cesspools very suitable for breeding. They seem to thrive in foul water.

Larvae of *Toxorhynchites immisericors*, Wlk., breed chiefly in earthen pots and were found in fairly large numbers in such situations during the rainy season. During the other two seasons very few were obtained.

Larvae of *Myzomyia rossii*, Giles, found open drains most suitable during the rainy season, but during the other two seasons they were very numerous in tanks as well.

Larvae of *Myzomyia ludlowi*, Theob., were most common during the rainy and cold seasons, scarcely any having been got during the hot season. Their principal breeding grounds were open drains and earthen pots.

The last two species closely resemble one another. The only constant difference between *M. ludlowi* and *M rossii* is that in the former the legs are speckled, and it is doubtful, as Theobald suggests in vol. v of his "Monograph of the Culicidae of the World," whether it is really more than a variety. Theobald still retains *ludlowi* in the genus *Myzomyia*, but Maj. S. P. James, I.M.S., now regards it the type of a new genus.

Table VII indicates the difference between the proportion in which the various kinds of breeding places are utilized in different localities. This may perhaps be due in some degree to selection on the part of the collectors; but I do not think that it can be entirely accounted for in this way, in which case a difference in the relative abundance of the various kinds of breeding places in the different districts is indicated.

Earthen pots in most cases proved to be the most usual breeding places. In some cases open drains were found to be equally suitable.

Earthen pots were quite common in districts i, ii, iii, vi, viii, ix and x. Larvae of every species found during the survey were taken from earthen pots, especially during the rainy season.

District vi gave the largest number of mosquito larvae, then came districts i, ii, viii, ix, x, iii, vii, iv and v according to the number of larvae found in each district.

From the foregoing remarks it will be seen that not a single specimen of the larvae of any species known to carry malaria has been found in the fringe area, where malaria is most common as far as Calcutta is concerned. Adults of some of these species are to be found in houses in the fringe area when carefully searched for but they must either breed beyond the limits of the area, or in comparatively large areas of water where the collectors did not make proper investigations