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Some Animals of the Paddy-field

By A. C. J. WEEREKOON

(A modified version of the Presidential Address delivered before the Ceylon Natural History Society in 1954)—Illustrations by the Author.

BESIDES the larger animals like birds, fish, reptiles and mammals that are at various times to be found in paddy-fields there are also many very small ones which do not generally attract our notice. Many of these have pains-takingly to be looked for in the soil before they can be found ; yet they are as interesting to the naturalist as are the large animals, perhaps more interesting in view of our marked ignorance of their habits. Furthermore, they constitute that soil fauna which, it is generally supposed, plays an important part in maintaining the fertility of the soil. As if to make up for their small size—few ever exceed a third of an inch in length—they occur in immense numbers. There are anything between 900 and 9,000 of them, depending on the season, in a square yard of the fields in Meegoda which we* studied. These numbers represent a population of 3.5 to 35 million individuals per acre, a population so dense that each footstep taken in crossing these fields will have disturbed between 25 and 250 of the animals—particularly so since most of them, nearly 80 per cent., live within the uppermost two and a half inch layer of the soil.

Of this teeming population the vast majority, about 70 per cent. were insects ; about 25 per cent. were worms ; the remainder included two different species of thread-worm, three snails, one leech (a variety that does not attack man), two water-fleas and one water-mite. Of this last lot the mites, water-fleas and leeches were present in the field when it was covered with water, that is during its wet phase, and are truly aquatic animals. As the field dried during the ripening of the grain they disappeared. It was the fate of one of the water-fleas that first turned my attention to the ecology of paddy-fields. This animal, *Cyclestheria* (Fig. 1), is a beautiful pale-yellow or pale-cream in colour, and it seems to glide through the water like some minute oyster mysteriously endowed with movement. Most of the time, however, it lies on its side in the detritus at the bottom of the water and its flat leaf-like legs, which had by their rhythmic beating produced the smooth gliding movement of the animal through

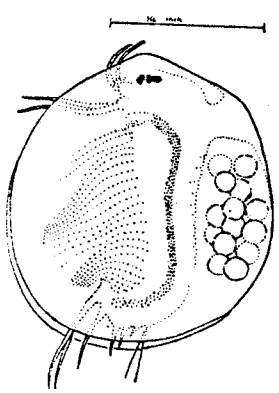

Fig. 1.

*Mr. E. L. Samarasinghe (now Asst. Librarian, Ceylon University) and the author.

the water, now drive a current of water into the shell at one end and out at the other. On its way past the two sets of legs this current is strained through the hairs that fringe them, and tiny particles of organic matter (detritus, algae, bacteria and the like) borne in it are thus gathered by the animal and ultimately conveyed to its mouth. The leaf-like legs are also for breathing, exchange of dissolved gases between the water outside and the body-fluids within the animal taking place between their greatly expanded surfaces. It is obvious that for such an animal continuous immersion in water is a vital necessity ; yet in the course of casual collections before this investigation was begun I had found it in several paddy-fields, a habitat which I knew was periodically drained of its water-cover. How, I wondered, did this delicate creature tide over the dry phase of the field? and that began an inquiry which has given me the material for this article. As for the Cyclestherias it seems that as the fields dry some of them make their way into the adjoining drainage channels, in the more stagnant pockets of which, here and there, they may survive ; most, however, are trapped in puddles in the drying fields and ultimately die when these puddles too disappear. I have been able to recover the empty shells of dead Cyclestherias from the mud. But how the fields are repopulated is still uncertain. The animals might swim back into them from the little " colonies " in the drainage channels ; or their eggs may have remained alive in the drying mud of the fields and hatched when the fields were once more flooded. Fig 1 shows a number of eggs in this animal's brood-pouch. They normally develop within it till they are little replicas of the parent and are able to fend for themselves ; they then swim out of the pouch by way of its posteriorly placed opening.

So much for the smallest group of this fauna ; something now about the largest group, the insects. Most of these insects are larval stages of various two-winged or *Dipteran* flies and thus belong to the same group as the house-flies and the mosquitoes. Besides the Dipterans which constitute 94 per cent. of the insect-fauna of paddy-soil, nine other orders of insects are represented in the remaining 6 per cent. ; and amongst them are many interesting types. There are two species of dragon-fly larvae, for example, *Orthetrum sabina* and *Neurothemis tullia* (Fig. 2), not in the least handsome but full of interest. These larvae feed on other small aquatic animals which they capture with a curious structure called the " mask." This is the very much elongated and altered lower lip of the larva, which it carries folded in three beneath its face. As will be seen from Figs. 3 and 4 most of the animal's face is covered by this structure ; hence its name. The larva lies very still on the surface of the mud, or just beneath it, waiting for some unwary animal to approach. When one does come within striking distance the mask is shot forward suddenly and the two-clawed lobes at its tip close over the victim which is then brought to the larval jaws by a return of the mask to its original position. Strange as it is this method of food-capture is not the most curious thing about the dragon-fly larva. There are much more curious things it does : it breathes with its rectum, for example. This last portion of its gut is a large chamber dilatable by special muscles attached to its outer wall. By this means water is drawn into the rectum and sent

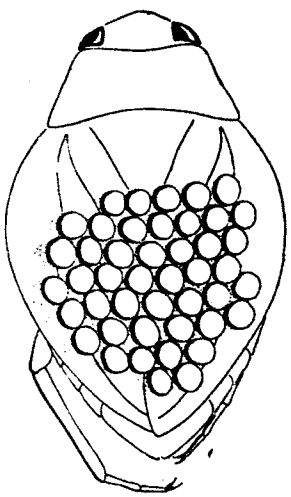

Fig. 2.

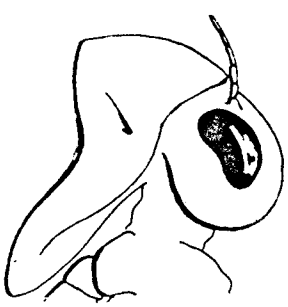

Fig. 3.

out again after remaining there for a while. The whole process is constantly repeated and respiratory exchange occurs between this water and the air within the mesh-work of fine tubes or *tracheae* with which the wall of the rectum has been richly provided. This is not the only

Fig. 4.

unusual function of the dragon-fly rectum; it is also used for rapid movement through the water. The larva has the full insect complement of six legs, but these carry it about relatively slowly and rather clumsily. When speed is required or long distances have to be travelled the water in the rectum is forcibly squirted out through a narrowed anus, and as a result the larva itself moves by recoil in the opposite direction, that is it moves forwards. A repetition of this process carries the animal with speed over long distances, and affords us an example of jet-propulsion in nature.

Another of the less common orders of insects is the order *Hemiptera*, which includes water-bugs of various sorts. The first of these that I wish to mention are the tiny water-striders, *Mesovelia* and *Microvelia*. They are very much alike in general appearance and I have, therefore, illustrated only one of them, *Mesovelia*. This rather sluggish little insect (Fig. 5) walks about on the surface of the water in

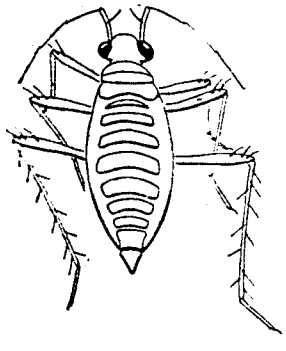

Fig. 5.

search of its food. It can do this without sinking into and drowning in the water because its legs are covered with hydrofuge—that is to say, water-repelling, hairs which prevent them from being wetted. The animal is, of course, surrounded by air and hence has no difficulty in replenishing supplies in the system of air-tubes (tracheae) within its body for breathing purposes.

The next hemipteran on the list, *Ranatra* or the water stick-insect, is also air-breathing but it lives within the water (Fig. 6). It spends

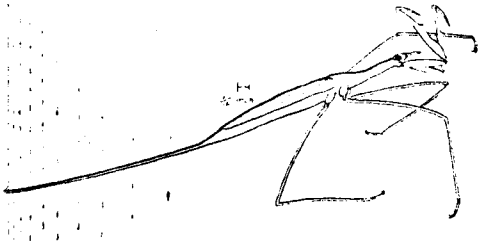

Fig. 6.

most of its time suspended from the surface of the water by a long tubular prolongation of the hind end of its abdomen. Through the open end of this tube (the *siphon*) communication is maintained between the atmosphere and the tracheal system of the insect, which thus breathes as through a "schnozzle." With its supply of air thus assured *Ranatra* hangs quietly from the water-surface, its long scraggy buff-coloured legs lending it the appearance of a cluster of small twigs or roots and helping to deceive its prey (other insects and even small fish) into approaching within striking distance of its raptorial fore-legs. These, as can be seen in the figure, closely resemble the fore-legs of the more familiar praying-mantis and function in much the same way.

Unlike the first three hemipterans referred to the next one, *Micronecta* popularly called a water-boatman, is completely emancipated from the surface-film of the water though it still breathes air. It manages to do this by carrying around it its own store of air in the form

of a little bubble held in the space between its abdomen and its wings. When the oxygen in this store is used up the insect replenishes it by swimming to the water-surface and thrusting the tip of its abdomen through. *Micronecta* is a powerful swimmer, its third pair of legs being flattened and provided with rows of very stiff bristles along their edges (Fig. 7) so that they function as an efficient pair of oars. Its first pair of legs is also noteworthy. These legs are small and are not generally to be seen when the insect is looked at from above as it is in the figure. They are used, when the animal is not swimming, to hold on to submerged objects and prevent its floating to the surface of the water with the buoyancy of its store of air; they are also used to hold on to its prey. But more interesting than either of these uses is the fact that these legs are rubbed against the insect's proboscis (a sheath protecting its delicate mouth parts) to produce a high-pitched and very clear sound. A dozen little Micronectas in an aquarium can produce a very noticeable volume of sound. The stridulation seems to occur only at night.

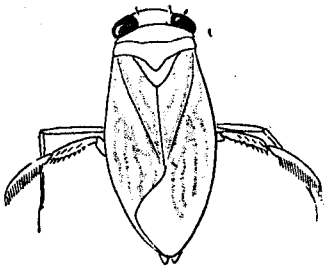

Fig. 7.

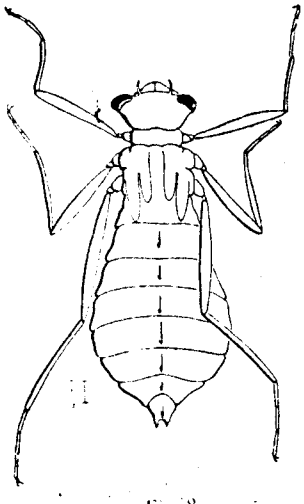

Fig. 8.

The fifth hemipteran illustrated (Fig. 8) is *Sphaerodema rusticum*. This is equally emancipated from the surface film though it is not as agile a swimmer as is *Micronecta*. Its method of breathing is also essentially similar, and I mention the animal in this account because of its curious breeding habits. The female lays her eggs in neat rows cemented to the back of the male who then acts as nurse-maid, carrying the eggs around with him till they hatch. It is only after that that the now empty-egg-case becomes detached from his back, freeing his wings and allowing him to fly again. Till then he must remain a prisoner in his own particular paddy-field. About all the water-bugs referred to it is necessary to remember that they can fly in their adult stages and frequently do so. A drying paddy-field can, therefore, be escaped from by flight to some other body of water, and does not face these insects with the necessity of having to exist in an essentially different environment, as it does *Cyclestheria*.

Another of the rarer insects of the paddy-field is the Springtail shown in Fig. 9. It

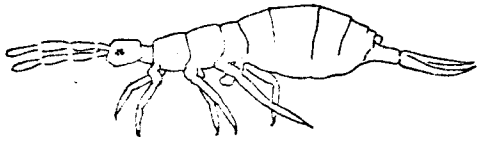

Fig. 9.

belongs to an order of insects, the *Collembola*, which zoologists find especially interesting because they possess many features not found in other orders of living insects but which it is supposed the ancestral insects living many millions of years ago did possess. To give just one example: the springtails are wingless; and that not because they have lost in the course of their evolution, wings which they once had, but because they never had wings at any time in their history. In short they are primitively wingless, unlike the bed-bugs and the fleas or the wingless castes of the ants and the termites. Besides features of this sort which serve to make these springtails a sort of "living fossils" there are others of interest in themselves. Their legs are very feeble and carry

them about extremely slowly. But if one watches carefully one notices that from time to time an individual leaps off the ground in a kind of standing long-jump that carries it over distances as much as one hundred times its own length. These leaps are made with the assistance of the *furcula*, a forked lever found at the end of the abdomen (Fig. 9). This furcula is normally bent forwards beneath the abdomen where it is held in place by a peg-like downgrowth of the abdominal wall. When the furcula is suddenly released and straightened it levers the insect off the ground in one of the astonishing leaps referred to earlier. Springtails are detritus feeders ; and are very abundant in drier soils than those of paddy-fields. In dry-arable soils they have been found to occur in tens of millions per acre. In the paddy soils we studied populations were seldom larger than ten thousand per acre ; and that too only after the fields had lost their cover of water. The mud of the flooded fields contained no springtails.

Of the eleven different beetles in this fauna I shall mention just two : *Berosus* because its larva has the bizzare shape of some Mesozoic Dinosaurian reptile (Fig. 10). The outgrowths

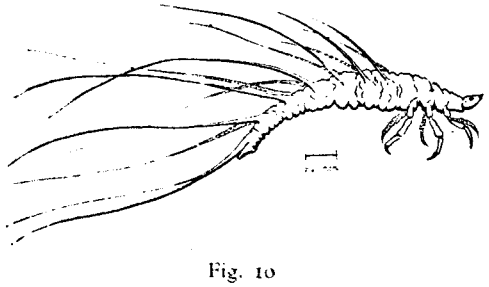

Fig. 10

on its body, however, are not protective or poisonous spines : they are delicate gills with the help of which the animal breathes. And *Paederus* because its adult stage (Fig. 11) is claimed by many people in this country to be capable of raising blisters on the human skin by contact. It is a conspicuously coloured red-and-black animal. It is not aquatic but is nevertheless present even when the fields

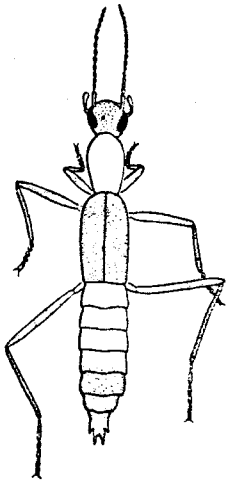

Fig. 11.

are flooded, running over the water-surface in search of its food and looking very like an ant. As for its blistering abilities, though we spent much time in the fields during our studies our skins were never in any way affected by them.

The mayflies or *Ephemeroptera* are represented in this fauna by one of their most delicate species —*Ceanis*. Its larva is very well adapted for life in an environment like the paddy-field where the surface on which the larva moves contains a large amount of a very fine sediment which could soon clog its gills. These are a double row of flat plates with frayed edges, attached to the upper surface of its abdomen. The front pair is enlarged and thickened into a pair of shields which cover the others and protect them from the sediment (Fig. 12).

Moths and Butterflies belong to an order of insects (*Lepidoptera*) which has very few members adapted for an existence in water. One of these few is often to be met with in the water of paddy-fields. Nevertheless I hesitate to count this a fortunate occurrence since the animal concerned, a species of *Nymphula*, happens to be a pest of the paddy plant. Its larva lives in the water in a case which it cuts and makes for itself out of the leaf of this plant.

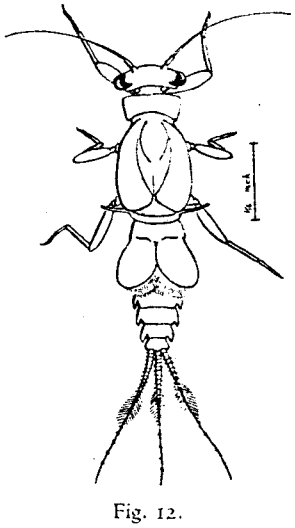

Fig. 12.

It breathes with the aid of the numerous branched gills which protrude from the surface of its body (Fig. 13).

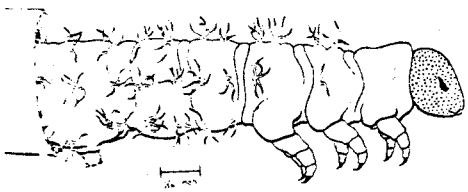

Fig. 13.

With *Chaoborus* we come to the order of insects which is commonest in this fauna. *Chaoborus* itself, however, is relatively rare. In its adult stage it is very like a mosquito in appearance and could easily be mistaken for one; but its larva (Fig. 14) is quite distinctive.

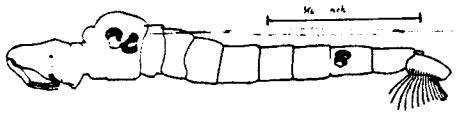

Fig. 14.

It is colourless and perfectly transparent save for two tiny black eyes and for the horse-shoe shaped air-sacs, two in front and two behind, which it possesses. On its head the limbs which in other insects serve as "feelers," the *antennae*, have been modified into a pair of powerful grasping organs for seizing its prey. At its hind end are a row of bristles which form a sort of fin with the help of which the larva is able to scull its way very rapidly through water. Nevertheless it spends most of its time quite motionless in the water, floating effortlessly with the buoyancy of its air-sacs. Other little animals in the water are unable to detect it as it floats thus, quiet and invisible, and when near enough are seized by its raptorial antennae. The prey is swallowed whole, digested in the stomach of the larva, and the undigested remains thrown out through the mouth—a feeding habit reminiscent of that of the owl. There are other strange things about this *Chaoborus* larva. I have already mentioned that it floats with the buoyancy of its air-sacs. This it is able to do at any level in the water, even when it happens to be living in a deep lake. It must, therefore, be able to alter, in some still not understood manner, the quantity of air in these sacs. Next there is its transparency and lack of colour, which have earned for it the name "phantom larva." Most planktonic animals—those, that is, that spend their lives floating in the water, and carried about hither and thither by the currents in it unlike the fishes which are not thus completely at the mercy of these currents—tend to be transparent and colourless or a pale blue, and zoologists were quick to assume that these features were adaptations to a planktonic existence. This "phantom larva" has often been cited as one of the most outstanding examples of an animal displaying such adaptations. It came, therefore, as rather a surprise when it was shown about the year 1938 that the *Chaoborus* larvae of certain Danish lakes spent the day buried in the mud of the lake-bed and only entered the water at night, when the water being dark it made no difference whether the larvae were colourless and transparent or not. And now in Ceylon we have found these larvae in an almost equally unexpected situation—the drying mud of a paddy-field that had been drained of its water-cover. They must have been trapped there, of course, by the draining of the field. But would they have continued to live there till the field was flooded once more? or would they have at last died of starvation and desiccation?

Some of the commonest dipteran larvae in this fauna are those of the crane-fly *Erioptera*. This larva is a tiny whitish maggot-like creature which attains a maximum length of about a quarter inch. It bears near its hind end a small cluster of tubular gills and also a pair of *spiracles* or openings into the system of branching air-tubes (tracheae) within its body (Fig. 15). Round these spiracles are five hairy projections called *lappets* which can fold over the spiracles and serve to prevent water entering them. In

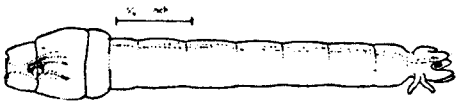

Fig. 15.

a dish of water in the laboratory these lappets open outwards and suspend the larva from the surface-film in much the same way that the *Culex* mosquito larva is suspended from this film by the lappets at the tip of its respiratory siphon. But unlike the mosquito larva which can free itself and swim down from the surface whenever it wants to, this *Erioptera* larva seems quite unable to do so and wriggles helplessly about, hanging from the surface of the water. If this larva depends mainly upon atmospheric oxygen for its breathing—and it is difficult to see why it should have open spiracles and an elaborate mechanism to keep water out of them if its needs could be satisfied mainly by dissolved oxygen taken in through its gills—then this inability to release itself from the surface-film suggests that the larva will be found when the soil is covered, at most, by a very thin layer only of water. It is very interesting therefore that we found *Erioptera* larvae most abundant in samples collected when the fields were drying, and absent or extremely scarce in those collected when the fields were covered with water. This might, of course, be the result of larvae being killed by suffocation when the fields were flooded. But certain other facts suggest instead that the life-cycle of this animal is so adjusted to its environment that egg-laying occurs as the fields are beginning to dry, when perhaps there is still some little water on them; that by the time these eggs hatch the soil though still thoroughly sodden is expected to the air; and that the newly-hatched larvae grow through the dry phase; and pupate and emerge as the winged adult flies at the end of that phase.

The next animal I shall refer to is also a dipteran insect, *Tanytarsus*. This "dancing midge" is very closely related to the familiar Lake-fly of the Beira Lake in Colombo; and though its larva (Fig. 16) is not red in colour

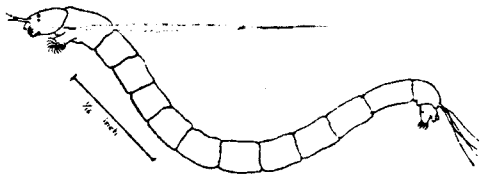

Fig. 16.

like that of the Colombo lake-fly, the two larvae resemble each other in many fundamental ways. One of which is that both are devoid of spiracles so that their tracheal systems are shut off from direct communication with the atmosphere. Breathing is therefore through the general surface of the body, oxygen being absorbed from solution in the water with which the animal is surrounded. About the *Tanytarsus* larvae of these paddy-fields the most interesting fact that emerged from our study was that they were most frequent in samples collected during the wet phase of the fields, from October to January; and least frequent, even absent, during the dry phases before and after the wet. This cycle is directly the opposite of that of *Erioptera* and seems to be correlated with the fact that *Tanytarsus* larvae depend on water for their supply of oxygen. Egg-laying apparently occurs at or just before the Yala rains; larvae hatch soon thereafter, grow through the wet phase of the fields; pupate and emerge as the fields begin to dry again. Here then, in the life-cycles of these two insects, *Erioptera* and *Tanytarsus*, one an air breather, the other obtaining its oxygen from the water, we get some idea of how the difficulties presented by the paddy-field as a place to live in are avoided; difficulties springing from its regular and marked fluctuations between wet and dry phases. Nevertheless this is only a very partial insight into the problem; for though many members of the fauna behave like one other of these two insects, many others do not; *Naidium breviseta*, for instance.

This animal is a delicate little worm, about a quarter to a third of an inch when full grown, and white in colour. It is not only the commonest of the ten different kinds of worms that we found in paddy-fields, it is also the most abundant animal in the entire fauna. There were a little over 2,500 of them within each square yard of soil in December ; and about 1,000 per sq. yd. on an average through the eight months of the survey (average total fauna for the same period being about 5,000 per sq. yd.). *Naidium breviseta* cannot leave the fields during an unfavourable phase by flying away as we have seen some of the insects do ; yet it survives and seems to flourish. What is more its numbers fluctuate in much the same way as those of *Tanytarsus*. With such evidence as we have it is difficult to say with any certainty what accounts for this similarity. Like many other aquatic worms *Naidium* does not reproduce itself by a sexual process. Instead when the worm reaches maturity a part of the hind end of its body develops into a special region or *bud*, which gradually increases in size and forms within itself all the organs of another individual. The bud ultimately breaks off from its parent and leads an independent existence.

The last inhabitant of paddy-soil I shall mention is *Palpomyia*, another dipteran larva. This is the most abundant insect in the fauna, there being on an average about 800 of them per sq. yd. It is a tiny slender thread-like animal seldom exceeding a third of an inch in length. Its whitish body is cylindrical, devoid of limbs and almost devoid of bristles ; its head is a hard brown truncated cone (Fig. 17).

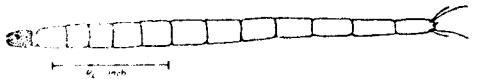

Fig. 17.

It is equally at ease in water and in soil, moving through both with the same rapid side to side flexing of its body. In water this movement makes the animal look at times like a vibrating wire ; in soil it enables the animal to bore its way through, producing a narrow wavy tunnel. *Palpomyia* larvae are very active creatures and the combined effect of many hundreds of them continually burrowing their way about beneath each square yard of paddy-soil must be quite considerable and awaits investigation. You will recall that at the beginning of this article I referred to our ignorance regarding the part played by soil-fauna in maintaining soil-fertility ; here in the case of *Palpomyia* we have an example of that ignorance. One thing more : *Palpomyia* belongs to a group of dipterans called the "biting midges" (*Ceratopogonidae*). Adult females amongst them have their mouth-parts adapted for piercing their prey and for sucking its juices. This prey is generally itself some type of insect, but many biting-midges feed on the blood of mammals, including man. In Ceylon the only species of biting-midge that has been found to attack man is one known as *Lasiohelea stimulans*, the "biting eye-fly," which is something of a nuisance to people in the mid-country areas of the Island. Its larva has not yet been discovered, nor do we know where it lives. It is just possible that some of the biting-midge larvae we collected from these paddy-fields might have been *Lasiohelea stimulans* larvae. I consider that possibility very slight since at no time during the field-work of this survey was either of us bitten by a midge.

The paddy-field is a strange place, full of wonders ; and I hope this brief introduction to a few of its inhabitants will lead more people into taking an interest in this much-neglected section of our fauna.