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DIVISION OF ENTOMOLOGY.

Board of Commissioners of Agriculture
and Forestry.

TERRITORY OF HAWAII.

The Leaf-Hopper of the Sugar Cane

BY

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Honolulu, August 1st, 1903.

The Commissioners of Agriculture of the Territory of Hawaii:

Gentlemen:

In the absence of the Superintendent of Entomology, I herewith submit for publication a report on the subject of the leaf-hopper of the sugar-cane, an insect imported into these islands during recent years. I have already reported very fully at intervals during the last twelve months on most points connected with this leaf-hopper attack to various members of the Hawaiian Sugar Planters' Association, and some of these reports have been printed in their publications. For the sake of completeness, I have here repeated matter contained in some of these reports, though at less length. Appended also are some important notes on the subject of chemical treatment of seed cane containing eggs of the leaf-hopper, with a view to destroying these without injury to cane. These notes were kindly furnished me by Mr. C. F. Eckart, Director of the Experiment Station, at Makiki, and the experiments on which they are based were conducted with the greatest care and exactness. More than a year ago I declared the necessity of making these experiments and it is fortunate that Mr. Eckart has been able to make them.

R. C. L. PERKINS.

History of the Occurrence of the Sugar-Cane Leaf-Hopper* in Hawaii.

1. In the latter half of the year 1900 I first observed and collected specimens of the leaf-hopper of the cane, but it was not until the end of 1901 or the early part of 1902, that it came under my notice as doing quite serious damage locally on Oahu, and still some months later when its ravages were reported as being more extensive and it was submitted from one of the other islands—namely, Kauai.

In my report written on Nov. 15th, 1902, I remarked: "This small insect is highly injurious to cane and its destructiveness threatens to exceed that of the cane-borer"—a statement, as the sequel proves, by no means exaggerated.

As for various reasons it was not possible for me at that time personally to visit the windward islands, during Mr. Koehle's absence from the Territory, I strongly advised that precautions should be taken to keep the pest from being carried thither in seed or other cane, on the supposition, or rather in the hope, that it had not already become established there.

Not long afterwards, however, I learnt that it was already strongly established both on Maui and the Northern parts of Hawaii, and that any precautions against its introduction were therefore unnecessary.

From that time to the present, samples of cane attacked by the leaf-hopper have been brought to me for examination constantly from all the sugar-growing islands and most districts of these islands, as well as many insects or other creatures supposed (rightly or wrongly) to be attacking these.

*For description see Appendix (note IV.)

Judging from observations made by me on other imported insects, to the rate of increase of which I have paid special attention, I should consider that the leaf-hopper was introduced two or three years prior to 1900; but that until 1900 it was not in such numbers that it would be likely to come under the observation even of an entomologist, except by the merest chance. It is true that some plantation managers think the leaf-hopper has been present on their plantations for many years, but this is certainly an error of identification. During six years' continuous collecting, from 1892 to 1897, when I formed a large collection of leaf-hoppers of many species and from every island, I never met with a single individual of the present pest.

It is incredible that a species which is always gregarious, which produces on the cane the most obvious and characteristic outward signs of its presence, and which when mature is readily attracted to the lights, should have entirely escaped my notice. Then, again, it was one of the first species noticed and collected by me on my return to active field work in 1900. In the early days of my collecting here an allied species of leaf-hopper was known to me to frequent the cane-fields in small numbers, and this would certainly not have been distinguished from the present pest except by a more careful comparison than a non-entomologist would be likely to make. To sum up, it can be stated most positively that the present leaf-hopper attack is due to a pest comparatively recently introduced into the islands and not by one of old standing, which has suddenly become injurious, as some are inclined to think.

THE HAWAIIAN LEAF-HOPPER, AN AUSTRALIAN SPECIES AND NOT IDENTICAL WITH ANY OF THE HITHERTO REPORTED SUGAR PESTS IN OTHER COUNTRIES.

2. Seeing then that our leaf-hopper was an imported species, in a Report to the Hawaiian Sugar Planters' Association, written on Nov. 15th, 1902, I stated that it was of the utmost importance for us to learn whether our leaf-hopper were one of those al-

ready known to attack cane in other countries or some species hitherto unknown as a pest, and in the latter event whence it had been imported. Obviously, if the species proved to be West Indian we did not want to send to Java to look for natural enemies.

Such literature as was to be procured in the islands dealing with leaf-hoppers injurious to cane I examined with great care, and in a report written to Mr. Tenney of the Planters' Association on October 23rd, 1902, I expressed my opinion that the Hawaiian pest "was certainly none of these," and reiterated this in my report of Nov. 15th above mentioned. At the same time I called attention to the similarity in habits between the pest here and the Javanese species (*Dicranotropis castatrix*). Finally, after much correspondence with other countries, the matter was conclusively settled for me by Mr. Kirkaldy, who obtained from Germany cotypes of the Javanese insect described by Breddin and found it to be quite distinct from the Hawaiian one. Other authorities considered the Javanese insect and ours identical.

Meanwhile I was also corresponding with Australian entomologists in the hope of procuring specimens of a Queensland cane-infesting leaf-hopper for comparison with ours; but it was not till some six months after I began this correspondence that I had the great satisfaction of receiving from Mr. James Clark of Cairns, four specimens of this Queensland species, which proved to be the same species as our own. Mr. Clark also informed me that this leaf-hopper had been known there for years, that it was their only species, that it did no noticeable damage and was probably kept in check by some efficient natural enemy.

As I have mentioned in former reports the fact that leaf-hopper was present on cane in Queensland was discovered by me when inspecting some seed-cane imported from that country, the said seed-cane containing numerous eggs of a leaf-hopper, while a few very young insects were also present. These not being at a stage of development when their identity with our own species

could be decided, it was only on receipt of Mr. Clark's specimens that this was finally settled.

GENERAL ACCOUNT OF HABITS OF THE LEAF-HOPPER.

3. It is not necessary to describe at great length the habits of the leaf-hopper, since they must now be familiar to most of those concerned, and at one time or another I have already fully reported upon these. The following summary may, however, be given. The eggs are laid in a chamber formed by the ovipositor of the female in the tissues of the leaf or in the stem of the cane. The number of eggs contained in one of these chambers varies considerably. Lately in Hamakua district I carefully opened up some hundreds of these chambers and found the number of eggs in each to be from one to twelve in number. That end of the egg which is nearest the external surface is the head end of the future leaf-hopper and the red pigment spots, which form the eyes of the newly-emerged insect, are conspicuous at some distance behind the narrow apical extremity of the egg before it hatches. In the leaves the eggs are deposited on either surface of the thicker parts, and being of elongate form, they usually reach about half way through the tissues. The scar is always visible and is often covered with a little whitish excretion. The apex or head end of the eggs is generally just about level with the surface of the leaf, but sometimes they even protrude a little from the orifice of the chamber. The young emerge perpendicularly, head first, sometimes two together from the chamber, and as they emerge, the appendages at first apparently stuck to the body become free, and the little insect is at once active, and may be seen to perform peculiar sidling or retrograde movements similar to those of older ones or of the adult. As a number of individuals generally hatch from a single chamber, and as the chambers are extremely numerous in a single leaf, very many being sometimes present in a square inch of surface, and as also in a stripped cane thousands of these chambers may be present in a

single stick, the total number of leaf-hoppers that can, and sometimes do, emerge from a single stick and its crown of leaves is almost incredible.

The young when they hatch are of a sociable nature and gregarious and especially congregate at the base of the leaves, and this habit is also largely retained by the adults, which often also form large flocks in the seclusion of the youngest leaves of the crown.

It is in the immature stages while growth is proceeding that the chief damage to the cane is done and the great excretion of honey-dew takes place.

It is not necessary to trace in detail the development of the insect through its post-embryonic stages to the adult, since in this point it essentially agrees with the several other island Delphacids, in which I have studied these points and presents no abnormal features.

The development of the tegmina and wings proceeds in the usual manner, by the outgrowth of lobes of the meso- and meta-thorax. The fully-winged insect is capable of at least moderately extensive flights, as is shown by the fact that it is attracted by the lights of steamers at some distance from the land, and on land to lights very far removed from its proper haunts. It is essentially nocturnal in its activities and when disturbed in the daytime flies but a short distance, or is even unwilling to fly at all, trusting to its leaping powers to escape, or is content to sidle round the leaf or stem out of sight, or to run backwards when threatened from the front.

The male, except for its rather smaller bulk, its darker abdomen, and different sexual structures, is extremely like the female. Copulation takes place at night. The adult hoppers, most of which lie still or hidden by day, emerge in crowds from their concealment at or shortly before dark. The female not rarely lays eggs by day, but probably much more often by night. When laying, the ovipositor is held at right angles to the ventral surface, and its point of attachment just behind the posterior legs

is very clearly seen when the tip is inserted into the tissues of the leaf.

BRACHYPTEROUS OR FLIGHTLESS FORM OF THE ADULT LEAF-HOPPER.

4. At certain seasons of the year, in certain localities at least, and perhaps in all, a distinct form of the leaf-hopper appears, differing very greatly from the ordinary adult. This form is remarkable for the fact that the wings are so little developed as to be unfit for flight and the characteristic markings of the fully-winged individuals are lost. In fact, no one at first sight would suppose the short and long winged forms to belong to the same species, the tegmina, or upper wings, of the former not extending so far back as the tip of the body, while the lower pair are aborted into scarcely visible lobes.

Polymorphism in the development of the wings, affecting also often other parts of the body is a well-known feature of the Delphacid leaf-hoppers, and may be seen in other Hawaiian species. This appearance of a single species under two or more apparently totally distinct forms adds greatly to the difficulty of the student in determining the identity of these leaf-hoppers.

One point in connection with this flightless form is worthy of notice. Although the insect has not been with us for study for a sufficiently long time for us to speak with certainty on the point, yet, so far, the worst attacks of leaf-hopper have always followed or been partly coincident with the production of these flightless females, that is to say, during the colder months of the year, or in the early summer. In the course of my recent tour of investigation through Hamakua to Oloa, I did not find a single example of the short-winged form, while in the winter months from some plantations not less than fifty per cent. of the adults sent were of this form. This fact and some observations that I have made on other Hawaiian species, lead me to believe that the flightless leaf-hoppers are more prolific than the fully winged specimens.

MIGRATORY SWARMS OF THE LEAF-HOPPER.

5. As has been already stated, the leaf-hopper of the cane is nocturnal in its habits, and these insects are not seen on the wing by day except casually or when disturbed. On certain occasions, however, they have been seen flying in one direction in the day time in such numbers as to form a migratory swarm, quite like that which occurs in the case of certain locusts, dragon-flies, butterflies and other insects. I am not aware that such migrations have been recorded previously of leaf-hoppers, but they are known to be undertaken by the somewhat allied group of *Aphidac*. It would appear from observations made, that these leaf-hopper migrations are largely due to the fact that the food supply in the place whence they originate has become exhausted or impoverished by the number of the insects.

SIGNS OF LEAF-HOPPER ATTACK AND ITS RESULTS.

6. When leaf-hoppers are present in large numbers the mid-rib and sheath of the leaf often become conspicuously red either in spots or almost wholly, but such an appearance may be due to other causes. The minute discolored scars marking the opening of the egg chambers are a certain sign of the presence of the insects, even though they may not themselves be noticed. I detected the presence of the pest by these scars (on samples of cane sent for examination for other reasons) on certain plantations where at the time the leaf-hopper was said not to exist at all. Like other insects of their sub-order, leaf-hoppers excrete large quantities of a clear, sweet liquid, called honeydew, and on this the usual fungi grow. Consequently in bad attacks whole fields of cane may be black with the usual black fungus, or in striking contrast, white with another species, or the black smut may be followed and overgrown with the white fungus. Either of these fungi, however, may follow bad attacks of other insects that excrete honeydew, while on the contrary, bad attacks of leaf-hop-

per are not always followed by a very large fungus growth, for apparently much depends on climatic conditions. Very heavy rains sometimes so entirely wash off the honeydew that no medium for fungus growth remains. These fungi necessarily add to the damage done by the leaf hoppers. Though they send no* hyphae into the tissues of the leaf, yet they sometimes entirely cover these, and the white fungus may be stripped off from either surface in flakes of considerable thickness, forming a solid shield against light and air.

The result of leaf-hopper attack when very severe is seen in the drying up of the leaves (from the constant sucking of their juices) before their full functions are performed. In consequence of this the joints of the stem, even at the time when they should be thickening, become on the contrary tapering and contracted, so much so sometimes that the crown topples over and is even entirely destroyed, further growth, of course, being at an end. Young cane is sometimes entirely killed out before any considerable length of stem has been produced.

Although total destruction of a plant only occurs when the leaf-hopper is in the most excessive numbers, yet even when present in large numbers the injury done must be considerable. Should a plantation, thus attacked, after all produce a crop that comes up to the estimates, yet it is safe to say that without the pest these would be largely exceeded.

RELATIVE IMMUNITY OF DIFFERENT VARIETIES OF CANE FROM ATTACK.

7. Some varieties of cane, other things being equal, appear less subject to attack than others. It must not be for a minute

*Of course reference is here made only to the fungi which usually follow the attacks of Homoptera. Several species of true leaf parasites are found in the cane-fields and appear now to be more than usually disseminated, possibly owing to the abundance of leaf-hoppers and insects accompanying them, that carry the spores. These fungi so far as I have examined them appear all to be known in other countries and are probably importations into Hawaii.

supposed that were a plantation formed entirely of one of these more immune varieties it would necessarily escape with little or no damage. The mere fact that the leaf-hopper will attack graminaceous plants other than cane (in the absence of the latter) is sufficient proof that such is not likely to be the case, for there are naturally much greater differences between these and cane than between the most different varieties of the cane itself. Relative immunity from attack is a most difficult matter to judge of, because one can never be sure how much immunity is due to the nature of the variety of cane and how much to other causes. Even in a field of cane of one variety and apparently similar in growth, one can frequently see the capriciousness of the leaf-hopper in its attacks (a capriciousness notorious too in other insects) from the fact that certain spots are more badly attacked than others. In some cases this is no doubt due to causes that can be perceived by man, such as greater shelter from prevalent winds, a ranker growth of leaf, presumably affording more abundant juice for food, but in other cases no adequate cause for this capriciousness is apparent.

It seems certain that some varieties of cane will stand the attack of leaf-hopper better than others. Mr. Eckart, Director of the Hawaiian Sugar Planters' Experiment Station, has furnished me with a list of new varieties of cane (see Appendix, Note II below), grown there, arranged in order, according to the relative injury that each sustained from leaf-hopper.

There may come, however, so severe an attack that no cane can resist it. Thus we have seen plants of "Yellow Caledonia" (at the extreme end of the list) which were of the strongest and most thrifty nature previous to the attack, some entirely destroyed and others very badly injured after a bad outbreak. It is, however, probable that from an attack of hopper which would entirely destroy a field of "Rose Bamboo," for instance, a field of "Yellow Caledonia" might recover.

MODE OF OCCUPATION OF NEW FIELDS IN A DISTRICT WELL OCCUPIED BY LEAF-HOPPERS.

8. When a field of cane is first occupied by leaf-hoppers they sometimes appear to spread over this in a very uniform manner, provided always that the conditions of growth of the cane, shelter, &c., are uniform. This can sometimes be very well seen in fields of very young cane. One that was examined by me consisted of cane about one month above ground, and on the average each plant was the home of two mature leaf-hoppers. Obviously these had migrated thither from adjoining fields, as they could not have reached maturity on such young plants.

Two fields of cane adjoining one another, one of Yellow Caledonia, the other of Rose Bamboo variety, each about five months old held a stock of 20-50 adult hoppers to each crown, uniformly distributed in either field. These also had come by migration, for, at the time, there were very few young in these fields, and the egg chambers nearly all contained unhatched eggs. This uniform distribution of hoppers over new fields, of course, only applies to such districts as have already in some parts, at least, a superabundant supply of the pest. Their first appearance in a district has (so far as such early and exact evidence as I have on the subject goes) generally been limited to a quite small area of one plantation.

ON STRIPPING CANE IN LEAF-HOPPER ATTACK.

9. As I have incidentally mentioned, leaf-hoppers like the more sheltered spots and hence it can sometimes be seen that they are in less numbers in well stripped fields than in those that are not stripped. This probably means nothing more than that the total number of the insects present are more unevenly distributed than would be the case were all fields stripped. Probably not many of the pest are destroyed by stripping, since most of the eggs laid in such leaves as are stripped have already hatched, and those

which have not will produce young after the leaves are removed, as I have myself proved.

Fields of unstripped cane that already contain leaf-hopper in such numbers as to be doing considerable damage, are better left in that condition, because a large proportion (in fact most) of the eggs and pupae of some of the most active of its enemies are to be found attached to the old dead or half-dry leaves, and some of these enemies are more intolerant of exposure by stripping than are the leaf-hoppers themselves.

DIFFERENCE IN SEVERITY OF LEAF-HOPPER ATTACK ON NEIGHBORING PLANTATIONS

10. In some cases it is evident that neighboring plantations have suffered from the attack of leaf-hopper in a very different degree. This is due to several causes and sometimes obviously (1) to the difference in the length of time that the leaf-hopper has been present in large numbers. Thus a limited area in a district becomes first badly infected and when this spot has produced a superabundant supply of the pest, it spreads (sometimes in a migratory swarm) over a much larger adjoining area, which suffers greatly, while the cane immediately adjoining this larger area is not much injured. (2) Slightly different climatic causes probably exert a restraining influence or the reverse. (3) In some cases the number of natural enemies of the leaf-hopper (especially the numbers present when first it has occupied a new locality) may turn what threatens to be a bad outbreak into a light attack. In some cases the fact that on adjoining plantations the seriousness of the attack differs greatly seems inexplicable, and due only to that apparent capriciousness of the insect, of which I have already spoken.

Some eight months ago I wrote in my report, "There is little doubt that its destructiveness will vary very much with the locality and according to the season and it is by no means certain that it has as yet, even on Oahu, multiplied to the fullest extent." Later observations have fully convinced me of the truth of these

statements, and I would add that were the pest allowed to multiply unchecked by natural enemies, it is by no means necessarily the plantations which hitherto have suffered most that would do so in other seasons, nor those which have escaped considerable damage this year, that would be exempt another year.

NATURAL ENEMIES OF THE LEAF-HOPPER ALREADY PRESENT
IN THIS COUNTRY.

II. During my recent journey through Hawaii, very careful examination was made as to the status of all the insects present in the cane-fields in connection with the leaf-hopper attack. Some of these are direct enemies of the hopper, others are attracted by the exudations of the injured cane or the fungoid growths, while others are parasites of some of the foregoing.

The natural enemies that I observed to be present, and their parasites, were the chief source of interest on this journey, because attention to the former might naturally give some information as to what we might look to for aid in other countries, while a consideration of the parasites here present would influence one's choice in the selection of such natural enemies as it may be advisable to import.

I will now enumerate the most important species of insects or other creatures present in infected cane-fields in connection with leaf-hopper attack. The habits of a few of these are, I regret to say, not yet accurately determined, the time at my disposal on my journey through Hawaii being insufficient for examining into some of the most obscure species. Those which seemed of primary importance were, however, for the most part fully investigated.

(a) *The Black-Spotted Red Lady-Bird (Coccinella repanda.)*

One enemy of the leaf-hopper is ubiquitous or nearly so throughout the cane-fields and in many parts extremely numerous. This is the red, black-spotted lady-bird (*Coccinella repanda*), long

since imported into the islands by Koebele. Naturally an Aphiscater, it is taking quite kindly to feeding on the young leaf-hopper. The beetle itself probably does not do much execution, but the larva is very efficient on the young, especially at the moment when they emerge from the eggs, and in their younger stages, and also is able sometimes to obtain the eggs themselves.

In some fields of young cane, where the leaf-hoppers were all adult, or only very few young are to be found, this lady-bird was either absent or in very small numbers. The reason is obviously because they are not greatly attracted until the young leaf-hoppers appear, since these are the chief food of the lady-bird's larva.

In Hamakua, some fields of young cane, where young leaf-hoppers were already very numerous, were estimated on June 21st to have three adult lady-birds to each stool on the average, and very often several larvae of the same in addition, as well as numerous eggs.

(aa) *Braconid Parasite of Coccinella Repanda.*

Most unfortunately an enemy of this lady-bird is already in the field and generally distributed, though not yet very numerous. It is, so far as is known to me, the only lady-bird parasite at present found in these islands and probably came from America at the same time that the one foreign lady-bird, that was found here prior to Koebele's importations, was brought (accidentally) to this country. This parasite is the *Centistes americana* of Riley.

This parasite was known to me in 1892 as attacking *Neda abdominalis*, some time before the *Coccinella* above mentioned was introduced, but now it seems chiefly, if not entirely, to attack the latter. It was found generally distributed over windward Hawaii and more numerous in proportion to the number of its host in parts of Hilo than in Hamakua. Several times the female of the parasite was seen grappling with and curled around the mature lady-bird in which it was laying an egg, and the dead and dying beetles could be found in some numbers any day in many

cane-fields. Long after the emergence of the larva of the parasite from the interior of the lady-bird and after it has completed its cocoon, the unfortunate beetle still shows signs of life in the spasmodic twitching of its legs.

(b) *Scymnus and Cryptolaemus.*

The other lady-birds noticed in the cane-fields are the *Platymus*, (in small numbers locally), the *Cryptolaemus* (common locally) and the small *Scymnus vividus* (common locally). The first named was never seen to attack leaf-hopper and was no doubt attracted by *Aphis*, its usual food. The *Cryptolaemus* had been evidently attracted by mealy-bug, which was common on the roots and stems of a grass growing in the cane-fields. Having demolished these the larvae of this lady-bird were starving and wandering over the cane in search of food, and in several instances were seen to kill and eat the young leaf-hoppers. The *Scymnus* larva was also seen to attack the young hoppers. Neither of these species were, however, to be compared with the larva of the *Coccinella*, either in numbers or effectiveness as destroyers of leaf-hoppers.

(c) *The Lace-Wing Fly (Chrysopa microphya.)*

Though I have enumerated elsewhere 30 species of Hawaiian lace-wings, only the one above mentioned was found in the cane-fields.

The larva of this lace-wing fly is an excellent enemy of the leaf-hopper in the taller cane. In the young cane these larvae are absent or scarce, because this affords indifferent shelter to the delicate fly. They are also very much more numerous on some plantations than others, though present in all that were visited. Several of the flies and their larvae may in places be seen on nearly every stool of cane and the eggs and puparia were everywhere, especially on old, unstripped leaves. The lace-wing larva is not only able to destroy the young leaf-hoppers, but was also

seen to obtain the eggs, its long-pointed jaws being well adapted for such work.

(cc) *Hemiteine Parasite of the Chrysopt.*

The lace-wing fly has also its parasite, in the shape of an ichneumon fly, which was seen laying its eggs in the pupa of this useful insect. I am inclined to think that this parasite is always comparatively rare and is not likely to become common enough to check the production of the lace-wings, but time alone can prove this. This parasite was seen in the most diverse localities, but always singly.

(d) *Nesomicromus vagus* (*Hemerobiidae*).

This insect was fairly common in several localities on the affected cane. Its larva was not found and hence there is uncertainty as to its food. It is possible that it was living on the minute *Psocidae*, which browse on the black fungus which grows on the excretions of the leaf-hopper, and not on the latter. As no *Aphis* or other likely food was present it could only have been bred at the expense of one or other of these.

(e) *Reduviolus blackburni*, a predatory native bug.

This narrow pale-colored bug, was noticed in various localities, but not very commonly. It preys on the young of the leaf-hopper and no doubt on other small insects affecting or frequenting the cane, and it also sucks up the sweet excretion of the leaf-hopper. Another species, *R. lusciosus*, was seen in the Olau cane-fields, but was not seen to attack the leaf-hoppers.

(f) *Native Pentatomid Bug* (*Occhalia grisea*).

In large numbers in some localities, but especially in fields in the neighborhood of native forest. The young were repeatedly seen sucking the juices of mature leaf-hoppers, but the fully developed bugs usually feed on caterpillars and larger insects.

(g) *Zelus peregrinus* (Imported Reduviid bug).

In my earliest reports I called attention to the efficiency of this bug as a destroyer of leaf-hopper and at the same time mentioned its demerits, as it is also a destroyer of highly beneficial insects. This bug was first seen as a great rarity in the Government Nursery in 1897. By 1900 it had become common and soon spread generally over Oahu, increasing very rapidly in cane-fields affected by leaf-hopper. Excepting possibly Kauai, it is now found on all the islands. Both the young and mature bug feed on the leaf-hoppers and they seek these when hidden at the bases of the leaves as well as in the open. Not infrequently we may see this bug with its beak thrust into the body of a *Coccinella*, but in the cane-fields at the present time it is clearly feeding chiefly on the leaf-hopper.

(h) *Small Bug of Fam. Anthocoridae.*

I have not been able to determine the species of this minute and obscure bug, which exists in great numbers in badly affected cane in some localities, and is rare or absent in others. It is of nocturnal habits apparently and secretes itself during the daytime in the same way and places as do young leaf-hoppers. I have very little doubt that it preys on these, for the small *Anthocorids* are notoriously great destroyers of other small insects. Its extraordinary profusion in some samples of badly affected cane leads me to suspect that it will prove of great importance, and it is rapidly extending its range and will soon be ubiquitous.

(i) *Hymenopterous Parasite of the Leaf-Hopper. (Ecthrodelflux fairchildii.*

Appended to this report (Note III) will be found a technical description of an external hymenopterous parasite of the leaf-hopper, and one which is a very efficient enemy in some localities and will shortly be spread over the whole islands.

This interesting parasite was first submitted to me by Mr. G.

Fairchild and I have named it specifically after him. There is no doubt that this parasite has transferred its attack from one or more of the native Delphacid leaf-hoppers to the imported species. I have long suspected the Hawaiian species of *Gonatopus* to be parasitic on leaf-hoppers and this supposition is greatly strengthened by the fact that the new and allied form of parasite is so. External parasitic larvae on native leaf-hoppers were found by me many years ago on Hawaii, but I was unable to rediscover them on my recent hurried trip, the old locality having been spoilt, owing to the total destruction of the forest. Could the *Gonatopus* be collected in some numbers and transferred to the cane-fields I suspect it would attack the leaf-hopper, as does the parasite now under consideration. The *Gonatopus*, being wingless, has not the same facility for transferring its attack to the cane leaf-hopper as has the winged *Ectthrodelphax*. I may add that I believe there is at least one other hymenopterous parasite on the native Delphacids of the forest.

To return to the *Ectthrodelphax*, it is always the young of the leaf-hopper that is attacked, and a single hopper may sustain either one or two parasites. These are nearly always lodged beneath the lobes which develop into the tegmina, or upper wings; one on each side of the body, when two parasites are present in the same host.

The parasite appears externally as a small, nearly circular, impressed black object adherent to the young leaf-hopper. The latter seems to be hardly inconvenienced by the parasite, remaining as active and plump as the non-parasitized individuals.

After a time, however, (always shortly before the full growth of the parasitic larva) the hopper becomes sluggish and then entirely stationary. This may happen either shortly before or not till some time after the black shell-like covering of the parasite splits by a longitudinal (mediodorsal) fissure and exposes the back of the white maggot within. This torpidity of the leaf-hopper and the splitting of the covering of the parasite is almost certainly the outward sign of a change of habits in the parasite (probably

coincident with a moult and change of form of the latter). From this time until the hopper dies and the maggot finally quits hold of its prey the sight as examined under a lens forms one of the most repulsive sights that natural history can afford.

Soon after the splitting of the black covering and the exposure of the white maggot, a conspicuous change takes place in the colour of the latter, it becoming pink or reddish. No doubt the maggot, which has hitherto fed delicately without doing any vital injury to its host, now proceeds to ingest the contents of the hopper in an indiscriminate manner, and the change in color is clearly due to this. If removed at this time from the hopper it is seen to have very mobile and hard (chitinized) mouth parts, while the thin and collapsed black covering still adheres some distance behind the head. Growth is extremely rapid and the simultaneous shrinking of the hopper, as its contents are absorbed by the parasite, enhances this effect. Thus when the splitting of the black covering takes place the hopper may be three or four times the size of the parasite, when the latter is full fed the proportions may be exactly reversed. The removal of the contents of the hopper can be easily seen through parts of the cuticle. Generally early in the proceedings the soft contents of one or both eyes and of the head are seen to be in rapid motion, like a boiling fluid; suddenly all the pigment is removed from one eye (usually the one on the opposite side to the parasite) and it becomes an opaque white spot, then the other is often similarly destroyed, or sometimes both more or less simultaneously.

Finally the maggot, when it has finished feeding withdraws its head, and may then some times be seen busily engaged in applying sticky matter from its mouth to its body. Its surface thus becomes strongly adhesive and when it quits its prey, it is able (though of course quite legless) to crawl freely over any surface however smooth. Soon it spins a neat white cocoon, from which it emerges as an active winged insect in about 18 days.

(j) *Various Species of Earwigs (Forficulidae), Etc.*

Four species of earwigs in all have been found on the cane plants, the particular species in any one field generally depending on the nature of the locality. Of these four species two have been actually seen to destroy the leaf-hopper, and there is very little doubt that the others do so also. Further it is probable that one or two other species of earwigs could be found were all the cane-fields to be thoroughly investigated. The species collected by myself in badly affected cane-fields are *Anisobis annulipes*, *Labia pygidiata*, *Labia ?sp?*, and *Chelisoches morio*. No doubt the earwigs are always present in the cane in some numbers whether leaf-hopper be present or not, and I do not suppose that they are of any great importance in this connection. The same may be said of the green cricket (*Xiphidium*) which will eat leaf-hoppers voraciously in confinement and certainly does so to some extent in the field, while it also feeds on the leaves of the cane, which are no doubt its chief food.

(k) *Ants (Various species).*

At certain times ants kill considerable numbers of young leaf-hoppers, while at other times if they do not actually protect them from their enemies they certainly do not harm them. When the hoppers are excreting an abundance of honey-dew I believe the ants rarely or never interfere with them, since they prefer this sweet excretion to the hoppers themselves. In order to determine which species of ants would kill the young leaf-hoppers, only such individual ants as were actually seen to kill these in the field were collected by me. The following species form the collection: *Tapinoma melanocephala*, *Prenolepis bourbonica*, *Pheidole megacephala*, *Tetramorium guineense*, *Cardiocondyla Wroughtonii* and *Monomorium floricola*.

(l) *Probable Dipterous Parasite.*

I include here with some doubt a native species of *Pipunculus*

observed in some numbers in some cane-fields and certainly breeding there.

I have frequently observed these flies in the forests of several islands where leaf-hoppers are abundant, but never in the long course of my collecting have I previously found them in the cane-fields or outside the forest. As it is known that insects of this group are parasitic on leaf-hoppers, it is highly probable that the species observed by me in fields attacked by the cane-leaf-hopper are parasitic on this species. This species of *Pipunculus*, appears to be undescribed, though very close to the *P. nigrotarsatus*, collected by me in the Kona forests.

(m) *Spiders of Many Species.*

In my early reports I called attention to the large number of spiders generally found in the cane-fields, and there is no doubt that owing to the abundance of food furnished by the leaf-hoppers these have in some localities multiplied to an extraordinary degree. Fully twenty species of diverse families are known to me to frequent the cane-fields, a large proportion of these being imported species. The species most numerous on one plantation are often extremely different from those on another. Thus in one locality it is a common *Tetragnatha*, in another a species of *Cyclosa* or *Argiope*, in another an *Attid* or *Thomisid*, that most abounds; in general two or three forms are abundant on a single plantation. I believe the species that hunt their prey without the use of webs are far more effective against leaf-hoppers than those that spin these. To what extent the multiplication of individuals has proceeded in parts of some plantations may be judged from the fact that as many as 50 nests of one single species of spider have been counted on a single leaf, and each of these nests will probably contain from 40 to 50 eggs on an average.

(mm) *Parasite of Spiders.*

Some of the most effective species of spiders are themselves not exempt from attack. Thus a *Cryptid* Ichneumon pierces the cov-

ering of the nest and lays a few eggs amongst those of the spider. Two or three of the resulting larvae are sufficient to entirely destroy every egg in the spider's nest, from which, instead of scores of young spiders, there usually emerge two or three specimens of the parasite. This parasite is widely, if not generally distributed, but where it was most common not more than 5 per cent. of the spiders' nests were destroyed at the time of my visit to Hawaii.

(n) *Fungi Parasitic on the Leaf-Hopper.*

Several species of fungus are well known to attack the native leaf-hoppers in certain localities and two or three of these have, as might have been expected, transferred their attack to the sugar-cane species, while others have not yet done so. In 1892 a considerable mortality amongst native leaf-hoppers, caused by one of these fungi, was noticed in parts of Kona district and subsequently Koebele and myself found leaf-hoppers killed in the same manner in Olaa.

These diseases are very noticeable amongst the cane leaf-hoppers in Olaa, though comparatively a very small percentage of the hoppers present were affected at the time of my visit. Probably with more rainy weather (at the time of my visit it was extremely dry) these fungi would be more active agents in destroying the pest. It should be noticed that at the time when I made my observations, it was the mature leaf-hoppers, almost invariably, that were attacked, and if this proves to be usually the case, the value of these fungi will be greatly diminished, since the leaf-hopper does most damage before becoming mature, and further, of those killed a considerable proportion may already have laid their eggs.

The evidence of disease is manifest in the hoppers before actual death takes place. The infected insect is slow and lethargic and finally stations itself on the under side of the leaf in the open,—that is to say, it generally leaves its concealment at the base of the leaf or elsewhere and moves for a longer or shorter distance to-

wards the tip. After a time the filaments or hyphae of the fungus grow out from the inside of the insect on the ventral surface and attach it to the leaf. Finally special hyphal outgrowths on which the spores are produced, are formed over the rest of the surface. Even after death during the early stages of fungus growth, the hoppers appear perfectly natural, and without close examination it is not always possible to be sure whether the insect is really dead or merely resting on the leaf. At present we cannot judge of the effectiveness of these fungus diseases, because there has been no special investigation as to their prevalence, and the percentage of leaf-hoppers killed, at the various seasons of the year. As has been mentioned, at the time I looked into the matter, the conditions were, in my opinion, unfavorable for the spread of such diseases, owing to the climatic conditions. It may be said, however, that in Olaa, and no doubt in some few cane-growing districts besides, conditions are as a rule exceptionally favorable for the growth of entomophthorous fungi, as is evidenced by the large mortality amongst insects of all kinds from such parasites. Caterpillars, moths, beetles, cockroaches, may be easily found killed by them, and the variety of the destroyers themselves is considerable. Since, however, in most localities, even in the wet mountains, such attacks are comparatively rare or rarely noticed, it is hardly probable that those fungi which destroy the leaf-hoppers could be established in the localities, still less favorable for fungus growth, that are occupied by most cane-fields.

INSECTS PRESENT IN THE AFFECTED CANE FIELDS THAT INCREASE THE INJURY DONE BY LEAF-HOPPER, AND BUT FOR THE PRESENCE OF THE LATTER WOULD BE EITHER ABSENT OR FAR LESS NUMEROUS.

12. It would not be proper to pass entirely unnoticed the large number of insects attracted to the hopper-affected cane. Though they have no effect on the leaf-hopper itself, some of them do injuriously affect the cane. Chief amongst these are the species of *Haptencus* (*H. tetragenus* and *H. mundus*) and two

or three species of *Carphophilus* (*C. maculatus* and *C. dimidiatus*), two or more of these insects being often present in the same cane-fields. Breeding as they do in the parts attacked by the young leaf-hoppers, they certainly add to the injury by increasing fermentation and decay.

It may be noted in passing that some of the above mentioned species are under ordinary circumstances not infrequently a source of considerable loss, owing to the fact that where seed cane is allowed to lie around before planting they frequently lay their eggs in the slightly fermenting ends of this seed. Such seed-cane when planted will in some cases entirely fail to sprout, since the larvae of the beetle develop quite well under ground and cause its decay, and in fact instances are known where a very large proportion of seed planted has been ruined by these insects. Much less, therefore, under the present circumstances should seed cane be left exposed for these insects, now so abnormally numerous, to deposit their eggs in, and if not planted when cut, nor protected, it might well be given treatment with corrosive sublimate. (See Appendix, note I below).

With the more sluggish larvae of *Carphophilus* and *Haptoncus* there are frequently found the active larvae of one or two species of *Cucujidae* or *Cryptophagidae*, and it is quite likely that these may prey on the former. Otherwise, excepting that they are rarely killed by fungus diseases, they appear to have no enemies.

Similarly breeding in the parts injured by the leaf-hopper, and adding to the injury, may be mentioned several Diptera, notably species of *Drosophila*, which are extremely abundant on some plantations, *Eurcsta annonae* commonly and another Ortalid in one or two instances.

Again with these (in abundance locally) were two species of *Staphylinidae*, the common imported *Homalota* so frequently attracted by fermenting vegetable matter, and a common *Philonthus*.

Finally, there may be casually mentioned a host of more or

less conspicuous insects, not ordinarily seen in numbers in the cane-fields, the species varying very much according to locality, but all attracted by the sweet excretions of the leaf-hopper.

Species of *Sarcophaga*, *Eristalis punctulatus*, *Volucella obesa*, the little cockroach, *Phyllodromia hieroglyphica*, and common *Hemiptera* being the most conspicuous. Possibly with these should be included the three *Elateridae*, *Acolus cinnamomeus* in many localities, and two native species, *Eopenthes Konac* and *Hodacnus sp?* only in proximity to the native forests. Feeding on the black fungus may be found certain minute *Psocidae*, one extremely small and pretty species being in countless numbers on almost all plantations. None of the insects in this last section can be considered in any way beneficial or injurious, excepting that they may, and probably do, carry and spread the spores of noxious fungi.

IMPOSSIBILITY OF EMPLOYING ARTIFICIAL MEANS TO DESTROY LEAF-HOPPER.

13. When one is acquainted with the habits of the leaf-hopper, its mode of feeding, the love of concealment shown by the larger number of individuals, the hidden eggs, present in numbers at all seasons : and at the same time acquainted with the mode of growth of a thrifty cane-field, the question of insecticides as a mode of repression cannot for a moment be entertained.

As the leaf-hopper is attracted with great facility to strong lights, I thought it possible that until imported natural enemies were available these might be employed, as unquestionably myriads might be attracted and caught in receptacles containing sticky or oily fluids, placed just beneath the lights, on still dark nights. I am told by managers of plantations, who are naturally the best judges, that on account of the expense involved, such a plan is impossible.

POSSIBILITY OF NATURAL ENEMIES BEING OBTAINED FROM OTHER COUNTRIES.

14. To any one who has paid attention to the list of natural ene-

mies of the leaf-hopper now present in these islands, as above enumerated; who considers that all these were available in these small islands, with their infinitesimally small insect fauna, as compared with that of the rest of the world; who will take the trouble to investigate the admirable work done by some of these natural enemies, there can be no doubt whatever but that an abundance of additional enemies can be introduced from other countries.

I have already in earlier reports stated that good enemies of leaf-hoppers are to be found in certain Australian lady-birds. I have since learnt that Mr. Koebele himself observed such enemies on his former trip to Australia. That many enemies of leaf-hopper other than lady-birds can be found, there is no doubt whatever, some are already well known.

SUMMARY AND CONCLUSION.

15. In the foregoing pages I have dealt with the history of the leaf-hopper since its importation into the islands, its probable native home, its effect on cane and different varieties of cane, its habits, the various other insects that accompany it, whether injurious or otherwise, the impossibility of using insecticides against it, and the possibility of securing effective natural enemies from other countries. More especially have I considered the various natural enemies, animal or vegetable, already present here, and the parasites with which some of these natural enemies are themselves inflicted.

The fine work done by some of the natural enemies now present, added to the fact that as good or better ones can surely be imported from other countries, can leave no doubt whatever in the mind of any entomologist who has investigated the matter, that the leaf-hopper can be so far eliminated by these means as to be-

come as innocuous, as are now a score of what were once some of the worst pests here.

For some of these latter one may now go a long day's march in search without success. So far as the economic entomologist is concerned they are practically non-existent, and the ordinary man has even forgotten that they ever existed.

I further believe that even with the aid of the natural enemies available here on the spot, that by a constant watching for an increase of the pest and by transporting large numbers of the most efficient of its enemies to a spot threatened with a bad outbreak, the damage done by leaf hopper could be reduced to small proportions. Obviously in the long run it will prove much more economical to send away for additional natural enemies. A few, or it may be even one, species of parasite or predaceous insect successfully introduced would render it unnecessary to pay further attention to the pest.

It is amusing to read the advice given by the leading English-speaking entomologist of a former day, the late Prof. Westwood of Oxford, to the Grenadan planters on a bad outbreak of leaf-hopper occurring in their island.

"I can see," he says, "but little ground for coming to any other conclusion than that man will not be permitted to frustrate the intention of Providence, but that we must look alone with submission to that Power for the removal of these pests."

No doubt the religious feeling which inspired the above remarks is very pleasing to contemplate, but the advice to do nothing is now a little out of date, not to say ridiculous, in the light of our present knowledge. It must, however, be remembered that this advice was given three-quarters of a century ago (1833) and economic entomology has advanced somewhat since those days.

APPENDIX.

NOTE I. From the following experiments made by Mr. C. F. Eckart it will be seen that treatment with corrosive sublimate solution is the most effective cure for seed-cane containing eggs of leaf-hopper, since it does not injure this seed.

RELATIVE RESISTANCE OF LEAF-HOPPER EGGS TO HYDROCYANIC ACID GAS, CORROSIVE SUBLI- MATE, AND CARBOLIC ACID.

Sections of cane, eight inches long, were cut from badly affected one-year old cane. The sections were selected as a rule, from the youngest parts of the sticks, and only such portions were taken as bore evidence of hopper eggs having been recently deposited. The pieces of cane so selected were then well mixed and lots of ten sections were taken at random for use in each of several experiments.

The treatment to which the several lots of cane were subjected was as follows:

- (1) Immersion in 1% solution of corrosive sublimate for 3 hours.
- (2) " " 1% solution of corrosive sublimate for 6 "
- (3) " " 2% solution of corrosive sublimate for 3 "
- (4) " " 1% solution of carbolic acid for 3 "
- (5) " " 1% solution of carbolic acid for 6 "
- (6) " " 2% solution of carbolic acid for 3 "
- (7) Fumigation for 24 hours with Hydrocyanic Acid Gas (one ounce of Cyanide of Potassium for 27 cu. ft of space).
- (8) Untreated cane (8 sections).

After treatment the respective lots were placed in boxes with tight fitting glass tops, and at intervals of from two to three days the young hoppers, which had hatched out, were counted and killed.

The various solutions of Carbolic acid were found ineffective in destroying the hopper eggs, and the counting in such test was discontinued after one week.

The tests were started on February 21st, 1903, and the number of hoppers counted on different dates appear in the table below. The figures for carbolic acid given under date of February 28th, are for the week preceding, only one count having been made:

No. of Test.....	Feb. 21.....	Feb. 22.....	Feb. 24.....	Feb. 26.....	Feb. 28.....	Mar. 2.....	Mar. 4.....	Mar. 7.....	Mar. 10.....	Mar. 12.....	Total for 19 days
1	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	1	0	0	0	0	0	1
3	0	0	0	0	0	0	0	0	0	0	0
4 . . . . .	.	.	.	.	56	.	.	.	.	.	.
5 . . . . .	.	.	.	.	3	.	.	.	.	.	.
6 . . . . .	.	.	.	.	3	.	.	.	.	.	.
7	0	0	0	0	0	0	0	1	0	0	1
8	0	2	21	25	24	31	19	36	23	19	200

Another series of experiments was conducted with similar lots of cane, to note the effect of fumigating sections of stalk with Hydrocyanic acid gas for varying lengths of time, one ounce of Cyanide of Potassium being employed for 27 cu. ft. of space. It was also determined to merely dip other sections in Corrosive Sublimate and compare the results with those obtained where the cane was soaked in such solutions.

The tests may be designated by the following numbers:

- (1) Fumigation with Hydrocyanic Acid Gas for 24 hours.
- (2) " " Hydrocyanic Acid Gas for 12 "
- (3) " " Hydrocyanic Acid Gas for 6 "
- (4) " " Hydrocyanic Acid Gas for 3 "
- (5) Dipping in 1% Corrosive Sublimate Solution.
- (6) " " ½% Corrosive Sublimate Solution.
- (7) " " 1% Corrosive Sublimate Solution.
- (8) " " 2% Corrosive Sublimate Solution.

The canes were put in boxes as in the preceding experiment and the insects hatching out were counted from time to time and killed. The numbers of hoppers found on different dates were as follows:

No. of Test....	Mar. 20.....	Mar. 25.....	Mar. 31.....	April 2.....	April 6.....	April 18.....	April 25.....
1	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0
4	0	0	4	0	1	0	0
5	0	0	0	2	0	0	0
6	0	1	6	0	0	0	0
7	0	0	1	0	0	1	0
8	0	0	1	0	0	0	0

The gas was found to be very effective in destroying the eggs, when the cane sections were fumigated for periods of 6 hours and over. Of the Corrosive Sublimate solutions, 2% appeared the most effective, only allowing one insect to appear.

After treatment as above described, one hundred eyes for each test were planted to note the effect of Corrosive Sublimate and Hydrocyanic Gas on germination:

No. of Test.	Percentage of Eyes Which Germinated
1	2
2	7
3	36
4	Not planted
5	70
6	57
7	73
8	70

It is seen that the length of time that the seed cane was in contact with the gas had a marked effect on the vitality of the eye. Corrosive sublimate apparently exerted no injurious influence as far as germination was concerned, except in the case of a $\frac{1}{2}\%$ solution. It is quite possible that the difference in the percentage of germinating eyes, between test No. 6 and 7 was quite accidental, owing to some slight difference in quality of seed cane before treatment.

Cane which had been soaked for several hours with 1% and 2% solutions of Corrosive sublimate was not planted, but the eyes of such cane showed remarkable vitality in the glass covered boxes. At the end of a month's time, shoots six inches long projected from the canes.

The length of time in which leaf-hopper eggs may remain unhatched in the cane stick may be seen from the following figures, which embrace a continuation of the count of insects hatching in untreated canes. (Test No. 8, started Feb. 21):

Date of Count.	Insects Found.
Feb. 21	0
" 22	2
" 24	21
" 26	25
" 28	24
Mar. 2	31
" 4	19
" 7	36
" 10	23
" 12	19
" 14	26
" 18	10
" 20	11
" 23	4
" 25	3
" 28	4
" 31	3
April 2	0
" 16	0
" 18	0
" 25	0
Total	261

NOTE II. *Varieties of Cane.*

The following list of new varieties* of cane at the Hawaiian Planters' Experiment Station has been drawn up for me by Mr. C. F. Eckart, the Director. They are arranged in order, according to the amount of damage sustained from leaf-hopper attack, Queensland 4 suffering most and Yellow Caledonia least:

* i. e. Varieties other than the old standard ones of these islands.

- | | |
|----------------------|------------------------|
| (1) Queensland 4 | (9) Yellow Bamboo |
| (2) Queensland 1 | (10) Tiboo Merd |
| (3) Queensland 8 A. | (11) Louisiana Striped |
| (4) Louisiana Purple | (12) Striped Singapore |
| (5) Demerara 95 | (13) Big Ribbon |
| (6) Gee Gow | (14) Queensland 7 |
| (7) Cavengerie | (15) Demerara 117 |
| (8) Demerara 74 | (16) White Bamboo |
- (17) Yellow Caledonia.

NOTE III. *Description of Parasite of Cane-Leaf Hopper.*

I here give the characters of a highly interesting and important Hymenopterous parasite of the leaf-hopper, for which it is necessary to make a new generic name. Its life history has been partially written in the earlier part of this report.

Ecthrodelphax—New genus:

Generally similar in structure to *Gonatopus Perkinsi* Ashm., but winged, and the thorax consequently much modified.

Antennae evidently thickening towards the apex, second joint of the flagellum very elongate and slender, first much shorter and thicker, about equal to third in length. Head about twice as wide as the prothorax, above distinctly concave between the eyes, posteriorly emarginate. Prothorax twice as long as its width at base, wider on its anterior than on the posterior half. Mesothorax greatly narrowed in front, its sides being strongly convergent, the furrows crenate, contiguous at the scutellum and thence divergent anteriorly, so as to enclose a narrow triangular area. Tegulae placed far back on the mesothorax, and very remote from the prothorax. Legs as in the *Gonatopus* above mentioned, the front trochanters very long and clavate, the apical part being thickened, all the femora clavate, the basal part thickened; claws of the front tarsi very long, asymmetrical, but of

equal length, the one knobbed at the apex, the other pointed and both denticulate.

Ecthodclphax Fairchildii—New species:

Black; the head (except the eyes and a transverse band enclosing the ocelli) the prothorax, tegulae, wing nervures, the legs entirely or almost so, a median transverse abdominal band beginning on the apical part of the second segment, all pale in color, from yellowish to rufo-testaceous. Head above, mesothorax and abdomen shining; propodeum transversely strigose, generally more regularly so posteriorly. Antennae dark, base and tips. Length 2.5 mm. (but variable. Female only known.*

HAB. HAWAIIAN ISLANDS.

(Obs.—This insect would, under the latest scheme of classification of the *Hymenoptera* proposed by Ashmead, be placed with the *Sphécoidae*, since the wings are remote from the prothorax. It has, however, no relationship with that group.)

NOTE IV. *Description of Cane Leaf-Hopper.*

The following is a brief technical description of the cane leaf-hopper, *Perkinsiella saccharicida*. It is condensed from Kirkaldy's original description (*Entom.* 1903, p. 179).

Second segment of the antennal peduncle about one-half longer than the first, which is much wider at the apex than basally, flattened and explanate.

Long-winged form both sexes. Tegmina elongate, narrow, extending far beyond apex or abdomen, interior half of clavus and cerium more or less smoky, a long dark smoky stripe on the mid-

* Since the above description was sent to press I have bred many males of this parasite. These have not the peculiar characters seen in the thorax and legs of the female, and seem very similar to the Hawaiian *Labeo*, so that I have some suspicion that the latter will prove to be the male of *Gonastopus*.

dle of membrane, three or four nervures of the latter smoky at apex. Length with wings $6\frac{1}{2}$ mill.

Short-winged female. Tegmina reaching only to base of fifth segment, tegmina without the smoky markings of the long-winged form, the neuration similar but shortened.

The following table will distinguish the known cane leaf-hoppers, except *Delphax saccharivora* of the West Indies, of which I have no description to hand. Only the long winged forms are considered. The characters are partly taken from Kruger's work on sugar-cane:

- A. Front wings twice as long as the hind ones; hind tibiae without long spur.....*Phenice maculosa*. (Java, India?)
- AA. Front wings not twice as long as the hind ones; hind tibiae with long spur.
- B. Front wings of a uniform brown color.....
.....*Eumctopina Krugeri* (Java, Borneo)
- BB. Front wings not uniformly brown.
- C. Wings much longer than the hind body.....
.....*Perkinsiella Saccharicida*. (Australia, Hawaii)
- CC. Wings not much longer than the hind body.....
.....*Dicranotropis vastatrix* (Java)

