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QUEENSLAND.

BUREAU OF SUGAR EXPERIMENT STATIONS.

DIVISION OF ENTOMOLOGY.  
BULLETIN No. 8.

Monthly Notes on Grubs and other  
Cane Pests.

(SECOND SERIES.)

BY

J. F. ILLINGWORTH.

1918-1919.



BRISBANE.

By Authority: Anthony James Cumming, Government Printer.



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Bureau of Sugar Experiment Stations,  
Brisbane, 15th October, 1919.

The Under Secretary,  
Department of Agriculture,  
Brisbane.

SIR,—I have the honour to submit for publication as Bulletin No. 8 of the Division of Entomology of the Bureau of Sugar Experiment Stations a second series of Monthly Notes on the Grub and Other Cane Pests, by Dr. J. F. Illingworth.

I have the honour to be, sir,

Your obedient servant,

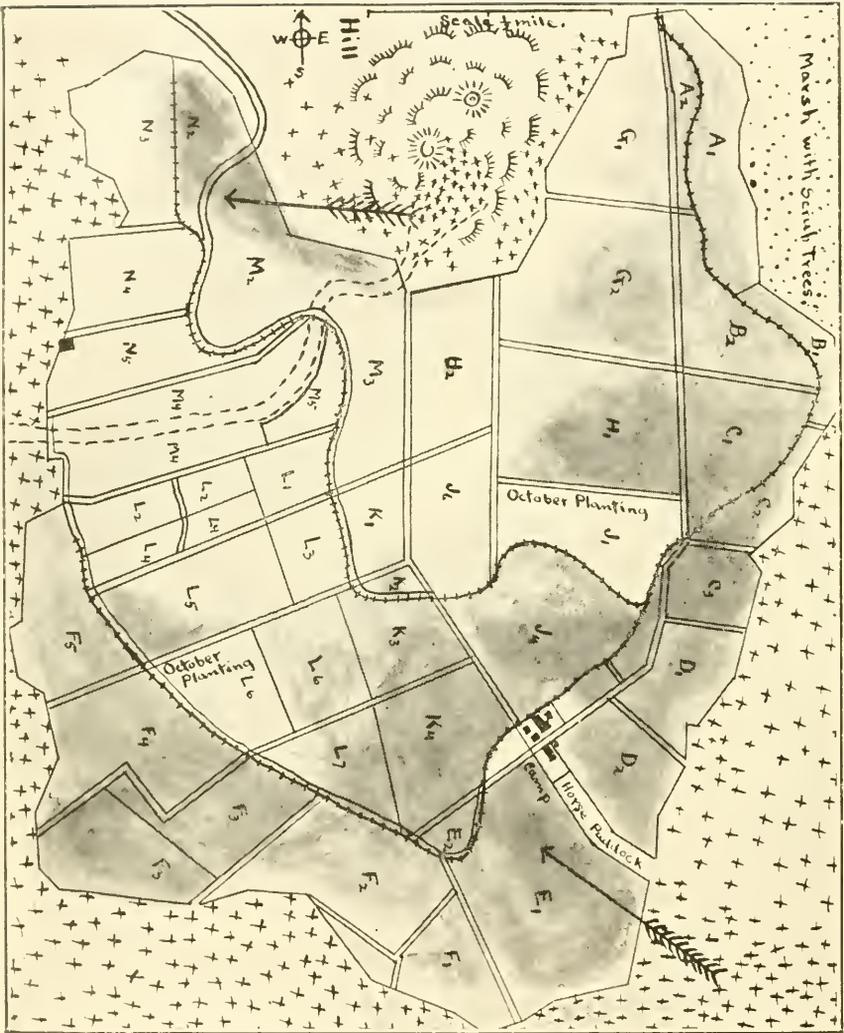
HARRY T. EASTERBY, General Superintendent.

Approved:

E. G. E. SCRIVEN,  
Under Secretary.







SKETCH OF GREENHILLS ESTATE.

Grub infestation indicated by Degree of Shading. White, immune area.

Arrows show direction of prevailing winds.

+++ = Feeding trees of the Beetles.

==== = Roads and Headlands.

+++++ = Trawlines.

{Face Page 5.}

## Monthly Notes on Grubs and other Cane Pests.



BY J. F. ILLINGWORTH.

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### CANE GRUB INVESTIGATION, JULY, 1918.

I have been greatly interested in the rather general acceptance of the idea of late planting for infested soils. Almost everywhere we go we find the farmers routing out the grubby fields; and a number have told me that it is their intention to work the ground thoroughly, preparatory to late planting. There is certainly no time like the present for killing weeds; and if the soil is kept clean-fallow until September, the cane should require very little chipping, thus removing one of the great objections to late planting, *i.e.*, the difficulty of keeping the crop clean during the wet weather. Let me repeat, then, and urge that all infested soils, especially the red volcanic, be thoroughly worked and kept in clean-fallow until planted in September or October. During the process of ploughing three or four times it is possible to work a great deal of trash and other organic matter into the soil; this is worth all the extra effort required to conserve this humus-forming material, for, as explained further on, it undoubtedly is a vital factor in grub control.

Let me again call attention to a very interesting experiment at Greenhills, where in one field (L6) half of the cane was planted in June, 1917, and the rest in October. The latter half is now beautiful cane, very erect and green, in marked contrast to the early-planted half, which went down in the cyclone after a bad attack of grubs. Furthermore, this early cane has deteriorated so much that it is very doubtful if any of it will be fit for milling. This field is particularly interesting because the two plantings are side by side, having the same care, and exactly the same soil.

#### ON THE VALUE OF ORGANIC MATTER IN THE SOIL.

Early in experimentation, from our knowledge of the feeding habits of the grubs, I was convinced of the value of humus-forming material as a factor in their control. Hence, we have followed the matter up with increasing interest.

Our laboratory experiments of placing megass in the soil of potted cane plants proved very encouraging; for the grubs quickly destroyed the roots of the plants in the cheek pots (those containing no megass), while in the ones under treatment the grubs fed upon this organic material in preference to eating the roots of the growing cane. Dr. J. H. Reed tells me that he tried a similar experiment, with the same result, the only difference being that he used chop-chop to mix with the soil.

Everyone who has had anything to do with the growing of cane on infested land has probably noticed that some of the stools at the ends of the rows are of more sturdy growth, and that these stools often keep their footing when the balance of the field goes down. This matter has been variously explained by growers, some contending that the increased growth may be accounted for by the fact that these stools are less crowded. If this was the correct explanation, we would naturally expect to find the same increased growth along the sides of the field, which does not usually appear. My explanation, borne out by experimentation, is that there is more humus-forming material in these particular spots, for in working the land the thrash is naturally dragged to the ends, where it eventually becomes broken up and mixed with the soil.

Again, it appears to be rather common experience that grubs are not so bad on land after it has been thrown out of cultivation for three or four years. I believe this may be explained, also, on the grounds of accumulated humus; for, usually, the weeds and trash are allowed to remain while the land is idle, and are eventually worked into the soil.

On the other hand, the immunity of cane planted on particularly rich land, such as river flats, is evidently due to the fact that soils subject to occasional overflow are naturally rich in organic matter. Nevertheless, even these soils can be quickly ruined by continual croppings, combined with the burning of all trash. In such cases the appearance of grubs on the cane is an almost sure indication that the ground requires more humus. An instance of this kind has been under investigation during the past month. The field, lying on the river bank, has a soil of great depth, and has been planted with sugar-cane for years. I am told that as long as eight years ago the grubs were found in great numbers under the stools, yet the cane showed no injury. The soil being evidently rich enough to feed them, the grubs were not forced to resort to the living cane roots for subsistence. During the past season, however, the cane in this field suffered severely, and investigation shows that there are as many grubs in this soil as in our worst districts. Destruction of the roots by grubs, combined with the cyclone, put all the cane down, which is therefore badly deteriorated.

I realise that the conserving of trash on red volcanic soils is a difficult matter, especially with our present implements; but it must be done, unless a great deal of time is devoted to green manuring. On soils that will scour, however, there is little excuse for the destruction of all

trash. The waste from the ratoon crop should be worked in, and this followed with a heavy green crop of corn or beans to put the soil in prime condition for a new run of cane. If this regular rotation is followed up, the land will not deteriorate; and I feel rather confident that there will be a marked decrease in the injury from the grubs.

#### A STUDY OF THE ROOTING SYSTEMS OF OUR PRINCIPAL SUGARCANES.

We have been making some investigation of the rooting systems, particularly in regard to depth, with the idea in mind that if we could get a variety which would root more deeply than Badila it would be more apt to stand up when attacked by grubs. We naturally looked to D1135, since this cane ratoons so well and has an erect growth. It is also the variety grown largely at Mossman, and is considered rather resistant to the attacks of grubs. Digging in the stools, we found that the principal roots of this cane extended downward, often to a depth of 16 or 18 inches, which is in marked contrast to Goru, with most of its roots extending laterally, often reaching across to the next row. D1135 is a good milling cane, with plenty of fibre, and, even though it is of only average density, will be a valuable variety to grow if it can be shown that it is grub-resistant. There are several fields of this variety in the grub-infested region about Meringa, which so far are in very good condition.

#### NOTES ON LEPIDIOTA ALBOHIRTA.

It is interesting to note that the beetles are very early in forming this season. We have been finding them, turned up by the plough, during the past several weeks. Apparently, many of the grubs pupated near the surface this season, so that many of them are uncovered or crushed in ploughing. Fully three-fourths of those observed were injured in this way, which seems to indicate that working the ground at this season, or earlier, was a profitable procedure.

In following the plough it is very noticeable that all the grubs present in the upper 10 inches of soil are under the old stools of cane, and that many are eating right into the old stalks.

In digging in a patch of blady grass, while searching for *frenchi* grubs, I was surprised to find many of this common grey-back species. They were all in pupating cells, from 1 to 2 feet deep. Such finds would indicate that we shall always have the beetles with us, for these native breeding-places can never be entirely done away with.

#### NOTES ON LEPIDIOTA FRENCHL.

This troublesome species is also a native of grass lands; but it is particularly inimical to sugarcane, because it lasts over for two seasons. The grubs, which were fully grown and feeding on the young plant cane last November, had not yet changed to pupæ on the 1st of July, though

they were found in well-formed cells about 2 feet below the surface. The inner lining of the cell was evidently made from the excrement of the body, which had been formed into a smooth, hard layer.

The second-stage grubs are still much in evidence when following the plough on new land. In this stage the grubs are still small, but will be grown up by October, and ready to do considerable damage wherever they occur.

#### PARASITES AT HAMBLEDON.

This district was once a grub centre, and it has been an important question as to what their disappearance could be attributed to. As far as I could learn, there has been no change in cultural methods—no removal of feeding-trees, or other treatment applied. Of course, vigorous methods were applied at the time, in endeavours to rid the place of the pest, but these same methods, tried in other sections, have failed. Tryon suggested, in his valuable "Bulletin on the Grub Pest of Sugar-cane," that one or more of the natural enemies might be at work in this district. It was therefore with considerable interest that I made the discovery that this surmise was correct. The fields are plentifully supplied with the *Campsomeris* wasps, which are seen flying about everywhere. By digging pits we found that the cocoons of the wasps were abundant under the stools, and that a fair number of grubs were present. The cane showed no injury, except what might have resulted from the cyclone.

The activity of these wasps in the laboratory shows that they would make short work of the grubs, if they could in their turn escape from their own natural enemies.

#### OTHER GRUB DESTROYERS.

It is a revelation to follow the plough during July, and note the cleaning up of the grubs by birds. In one field at Meringa, fully 150 ibises were following two ploughs, leaving not a single grub in their wake. The birds were spread out the whole length of the furrow, which was about 15 chains long, so that their keen eyes detected everything. By following close to the plough we saw that many grubs were turned out from under the stools, but, as soon as the birds had passed along, not one remained. The appetites of these birds is marvellous, for they follow the ploughs assiduously all day long. The contents of their stomachs have been examined when grasshoppers were abundant, and no less than 2,000 young locusts were found in a single bird. These birds are certainly valuable allies of the farmer, and it is a fine thing that they are protected. They are, however, still very timid, showing that they are subject to more or less injury by ruthless humans.

The pewee larks, too, do a lot of good work behind the ploughs, though these birds are not large enough to swallow the largest grubs. I have often watched them break up the biggest grubs before they tried to swallow them.

We need further observations on the bandicoot, which is undoubtedly a great destroyer of insect pests. We have, in former reports, called attention to the useful habits of this animal, but it will be interesting to record a specimen recently dissected by Mr. Girault. Though the animal, which was fully grown, had been killed some time before by dogs, it was possible to remove the alimentary canal almost intact. Mr. Girault's notes state that the following remarkable contents of the stomach were easily identified:—1 unknown Scarabeid grub; 30 slender, pale caterpillars, of the same species, and about  $1\frac{1}{4}$  inch long; fragments of 2 moderate-sized beetles; 1 oat-like seed; 2 large *Chrysomelid* beetles; 2 large ants; 1 large unknown beetle; fragments of a longicorn beetle; cane leaf, pith, and about 3 cc. of dark-green matter, composed of mixed insect and vegetable remains, these latter accounted for by the caterpillars, perhaps.

#### CANE GRUB INVESTIGATION, AUGUST, 1918.

During the month I made a second trip to the Mossman district, this time to obtain a supply of the tachinid parasite of the borer weevil. Though my stay was very brief, I was able to make the most of it, as I was afforded every facility by the mill officials.

I was fortunate in locating an abundant supply of the parasites during my previous visit, for Mr. Crees, the manager, informed me that the borer is not very prevalent in the district. My search through hundreds of truck-loads of cane in the mill yard failed to reveal a trace of these insects. The particular field wherein the flies were found was an old nursery of seedling canes which has had no trash burned, and consequently afforded ideal conditions for the propagation of the borer. Then, too, in 1910, the breeding-cages from which the tachinid parasites escaped were located alongside this field, and the flies have had a good opportunity to become established.

I was surprised to learn that all of the cane of the district is burned before cutting. This may account somewhat for the scarcity of the borers, for the fires destroy a large percentage of those that are left in the discarded canes; or the grubs succumb later to the action of the sun upon the exposed stalks. Furthermore, fully 50 per cent. of the cane grown is D1135, a variety so hard that the borers are not attracted to it. It was instructive to note how the borers selected the softer cane varieties in the nursery, where they had a choice.

The mill, however, now pays on individual analysis, and this is tending to increase the growing of Clark's Seedling and other canes of higher density.

Rats are by far the worst pest at Mossman. Soluble strychnine proved a failure, for the rats would not eat the bait. White arsenic has been used there with success; and "Rat-nip," a trade preparation containing phosphorus, also gave good results. These poisons were applied to pieces of bread and other kinds of food.

I was interested to note the scarcity of natural enemies of the tachinid parasites in the district. The exotic ant, *Pheidole megacephala*, which proved such a mortal enemy to the young flies in Fiji, is present, but only in moderate numbers. In a few cases I found that these ants had cleaned out the borer channels and were living in them, but, as mentioned, they are not abundant enough to offer any serious menace to the flies. Also, a protracted search among the cane leaves revealed only a single jumping spider. These predators are so abundant in Fiji that often several are to be seen on a single canestalk. Swallows were rather abundant over the field, but I do not consider them a serious enemy to the tachinids.

#### DISTRIBUTION OF THE PARASITES.

My original intention was to bring all of the flies to the Mulgrave where the borer beetles are proving themselves a serious pest on the low-lying lands along the river. Very recently, however, I received a letter from the Babinda Association requesting my assistance in the placing of some of the parasites there. A visit to the district proved that the pest was very abundant, and particularly so in the region out around Moolaba.

I finally decided to liberate the flies from three centres—Moolaba, near the station; Babinda, Dr. Reed's farm; and at Gordonvale, on Mrs. Möller's farm. A cage has been established at the latter place for breeding the flies, which are already emerging in considerable numbers.

#### IMPORTANCE OF THE HUMUS SUPPLY IN THE SOIL.

I have been making further investigations at Hambleton during the month. There, certainly, the best system of supplying humus that I have seen is in vogue. All of the waste from the mill is composted and left for about a year before it is put on the land.

This compost is made by building up layers of the various refuse from the mill, filter-press, trash from the carriers, ashes from wood, megass, and so forth. Nothing is permitted to go to waste; even dead animals are buried in the pile.

About thirty loads of this compost, or about 20 tons, are applied to the acre. It has proved a very valuable fertiliser, and the cane shows a marked increase in growth where it has been applied. There is one block near the residence of Mr. A. L. Walker (who, by the way, is a grower of keen perception), which is a most excellent experiment. Part of this was treated with the compost, leaving the remainder untreated. The treated cane is almost a foot taller than the other.

The soil on this farm scours well, and for this reason it is an easy matter to work in trash. Mr. Walker tells me that he leaves the trash from the two last ratoon crops, *i.e.*, volunteering the last ratoons by simply relieving over the rows. After the last crop is cut he ploughs in this double trash and applies compost, or a green crop, which is worked in preparatory to a new series of cane.

In one field, which Mr. Walker was preparing for September planting at the time of my visit, a bean crop had been turned under, whereafter the soil was treated with about 20 tons of compost. At this third ploughing, the soil was distinctly blackened by the rich supply of humus; and, though the surface was clean, Mr. Walker told me that he intends to give it five ploughings altogether before planting to get it in perfect tilth. Is it any wonder that Mr. Walker cuts 50-ton crops without other fertilisers on land which was once thoroughly infested with white grubs?

Digging pits in these fields disclosed a fair number of grubs and several of the cocoons of the parasites (wasps), as reported last month. The grubs are the largest that I have seen, which is probably due to the fact that they are so well fed on the compost.

#### IMPLEMENTS FOR RED VOLCANIC SOILS.

Evidently the sugar-farmers have not the proper agricultural implements for these loose red soils, for it is the general practice among growers to destroy as much trash as possible before ploughing, because they are unable to turn it under with the implements available.

There is urgent need for a machine that will chop up the trash or treat it in some way so that it may be turned in with the plough. Perhaps the rolling cutter, which is used for cornstalks in America, would work. It is a heavy implement, drawn by a pair of horses, and the blades are set crosswise of the row. It cuts all the stalks and trash into pieces about 1 foot long.

The new American sulky plough, with a motor attachment for cutting up weeds and putting them under, has received considerable attention in our magazines. I was interested to read in the July "Sugar Journal" that its fame has reached Australia, through the moving pictures. I am anxious to see it tried on heavy cane trash.

We were able to put under a very heavy crop of Mauritius beans on our experimental plots at Meringa, by rolling the vines well just ahead of the plough. Treated in this way the discs of the plough, if sharp, will cut through the vines easily, providing they are not too old. It is best to turn the beans under when in flower, before the pods are set. If the seed is permitted to ripen there is trouble stored up for ever after. Not only are the vines tough and hard to cut, but the dry beans continue to germinate in the soil for many months, some even coming along to climb over and smother the cane after it is laid by.

#### LATE PLANTING.

This is one of the principal subjects of discussion at this season; and, recently, several farmers have told me that they have known late planting to fail because of grubs. It appears that the principal difficulty is due to lack of cultivation. Investigation, in several instances, showed that the soil became too wet for working just at the time when the beetles were flying.

It must be made clear, then, that late planting will only succeed on soils which are so easily drained that they may be thoroughly worked during December and January. Most of our red volcanic soils are of this character, and these are the soils which are usually infested when planted early. Let me emphasise that it is thorough cultivation during the flight of the beetles which is effective in grub destruction, and that late planting is only recommended to facilitate this cultivation by coinciding with the flight and ovipositing of the beetles.

I feel confident that the problem can be handled best on the heavy wet soils by application of abundant humus. Since these soils scour well, trash and green crops can be easily worked into them. After this preparation, I would advise early planting, for there is no question that this is best where it will succeed. The point here is that the grubs will leave the growing roots alone if the soil is rich in organic matter.

#### CANE GRUB INVESTIGATION, SEPTEMBER, 1918.

With reference to the editorial, "Dealing with the Cane Grub," in the August "Sugar Journal," we cordially appreciate suggestions from men of experience. Indeed, the solving of our problem rests largely with the growers themselves. Experimentation, with us, is necessarily limited to the restricted area about Gordonvale; and it is only by free discussion and suggestions that we can hope for early conclusions. The problem is a tremendous one, and a man, single-handed, might spend many years upon it.

Through the splendid co-operation of a few growers we are beginning to see daylight along the lines of cultivation and the supplying of humus, as indicated in our recent reports. Our experiments with poisons, which are numerous, are not yet concluded. I may state, however, that I am seeking a more satisfactory method of applying the poison than that outlined in "Bulletin No. 4" of this station. I cannot advise the open furrow alongside the stools, because of the tendency to dry them out too much.

#### D1135 vs. Goru.

In a former report I called attention to the rooting systems of these two cane varieties. I have been following the matter up and have found every evidence of the superiority in the ratooning qualities of D1135. It is a cane which comes away with abundant shoots, and, therefore, requires vigorous ratooning. It is advisable to slice right into the stool on each side, so that too many stalks will not develop and result in a grassy crop.

Mr. C. V. Hives, who is a man of recognised experience and ability, has called my attention to an interesting experiment which he has had with the two above varieties. He planted four rows of Goru down through the centre of a field of D1135. The first ratoons on this block were cut last June; and after ratooning the second time he found that

practically all the Goru died out, while the D1135 is doing very well. Undoubtedly, this result is due to the different character of the roots of the two cane varieties.

In ratooning during dry weather Goru often succumbs, while under moist conditions it usually does well. I believe that this is due to the fact that the main roots, which are lateral, are broken off in ploughing, and the stool dries out. This supposition is borne out by the fact that Goru, which was not ploughed, on the same farm is growing well.

Again, referring to the ratooning qualities of D1135, Mr. P. Wienert showed me one of his fields at Fishery Creek, which was planted with Badila in 1916, and the misses, which were abundant, were supplied with D1135. At the time of my recent visit, practically all of the Badila had been killed by the borer-beetle, while the shoots of D1135 were very conspicuous because of their great vigour, and had not suffered in the least from the pest.

#### PARASITES OF THE BORER-BEETLE.

The tachinid parasite (*Ceromasia sphenophori*), referred to in my recent reports, have emerged splendidly in our cage at Gordonvale, where they have had our close attention; but those placed at Babinda and Moolaba have not fared so well. On two occasions we found that ants (*Phcidole megacephala*) had got into the boxes of cane and were making their nests in the channels of the borers. We have no way of knowing, in these cases, whether the flies have escaped safely or not, and must wait for some months to see if they become established in those districts.

We feel rather confident of the result in our own district, because the flies were liberated from day to day, after they had mated in the large cage; and we sometimes saw them flying about in the borer-infested cane, which is alongside. They will have a good chance in this field, for it is not to be cut until the end of the season, and there is plenty of other cane near by.

#### BORER-BEETLES, RATS, AND OWLS.

Let me call attention to the close relation existing between borer beetles and cane rats; and, further on, the value of barn owls in destroying these rodents.

It is a recognised fact that the borer-beetles work along the lines of least resistance in depositing their eggs. If they find a split or hole in the rind of the cane they take advantage of it; for they are able to deposit their eggs more abundantly. The stalks chewed by rats are ideal locations for finding the young grubs of the borer, and for this reason I would urge that these should be discarded when cutting cane plants.

Let us recognise, then, that the destruction of the cane rat is an important step in the control of the borer-beetle, where soft varieties are grown. And, again, that rats are more abundant in badly cultivated fields, especially those with weedy headlands. I think this may be

accounted for by the fact that owls are unable to catch the rodents thus protected. When the headlands are clean the birds are able to discover their prey as the rats cross from one field to another.

My experience with the American barn owl (*Strix practincola*) will be of interest to those suffering from a pest of rats.

A pair of these birds had been nesting for some time on the top of a large, unused chimney of a school building. Upon examination I found that the chimney was almost filled with the cast-up pellets of the birds. Every bird student knows how the owl regurgitates the bones, hair, and so forth in a little pellet shortly after each meal; after raking these out of the chimney they almost filled a 2-bushel bag; and each one represented a rodent, identified by the skull, which was entire. I took the exhibit to a farmers' club, where it stirred up great enthusiasm for the protection of the owls.

I was pleased to learn from the literature here that Australia has four species of barn owls, and that one (*Strix delicatula*) was said to be common in North Queensland. Investigating the matter in the vicinity of the laboratory, at night, I soon discovered a pair with several full-grown young. These birds have a call which is not unlike that of our American species. I can best imitate it by forcibly exhaling the breath between the tongue and teeth, making a sort of rasping sound. These owls are very friendly and come around the buildings at night, even perching on the water tank at the house when I imitated their call.

This immediate region does not suffer from cane rats, and I do not doubt that these birds are doing their part to hold them in check.

#### MOTH PESTS.

Both the army worm (*Cirphis unipuncta*) and the noctuid moth-borer (*Phragmatiphila truncata*) are rather troublesome this season in places along the Mulgrave River. Fortunately, both species are attacked freely by parasites, which keep them from becoming serious pests.

Every grower is familiar with the work of the army worm on young cane plants, the leaves being chipped out at the edges; and the caterpillar is usually to be found during the day hiding between the top leaves. The work of the noctuid moth-borer, though less familiar, is easily recognised on young canes, for the central leaves are usually killed, as all the feeding is being done inside the shoot. On old cane the caterpillars work behind the upper leaf-sheaths, boring into the stalks here and there. Their work may be easily recognised by the abundant frass they throw out.

The caterpillars do not remain long inside the stalk, for a single individual may make a number of tunnels, evidently only going into them to feed, and to hide during the day. The principal damage to mature cane is that the caterpillars cause it to shoot freely at the eyes, due to the injury of the terminal bud.

I would suggest, as a possible control measure, the application of a green crop of beans or peas before planting cane again. This, however, would be of little avail if there were other infested fields of cane near by.

### CANE GRUB INVESTIGATION, OCTOBER, 1918.

During the month I have done considerable travelling, and by consultation with numerous leaders of the industry, in the various districts visited, have been able to increase materially our knowledge of the habits of the various pests of sugarcane.

Incidentally, Mr. Girault and I have been devoting considerable time to the introduction of the tachinid parasites of the beetle-borer (*Ceromasia sphenophori*) in infested districts. It will be recalled from former reports that these parasites had already been liberated at Moolaba, Babinda, and on the Mulgrave. During the past month we have secured fresh colonies and liberated these on the Johnstone and the Herbert. Those of the first locality were placed on the farm of Mr. R. Davis, at Daraji; while on the Herbert they were placed at two points:—Mr. Combo's farm, about 25 miles upstream, and in the mill nursery at Macknade.

#### INVESTIGATIONS AT MOSSMAN.

On all of our previous visits to Mossman we had secured our supply of the parasites from the mill nursery; hence I was considerably disturbed to learn that this paddock had been burnt and milled, precluding all hope of securing further supplies there. A careful search of the district demonstrated that the beetle-borers were scarcely in evidence anywhere; but wherever found there were unmistakable signs that the parasites were with them, and that they were completely under control. On one farm I found these indications of the flies fully 15 miles from the mill nursery, where they were liberated in 1910; and, what was most remarkable, there were several miles of forest country between these two points, with no sugarcane. Evidently the flies have travelled up the country with the wind.

Upon the advice of Mr. C. J. Crees, the mill manager, we were able to locate a few borers on the farm of the Crees Bros. The pest had evidently come from a pile of discarded cane which had been dumped alongside the field when planting, for only a small semicircular area in the field, opposite this rubbish heap, was affected. It was also very noticeable that most of the infested stools were rat-eaten, and the indication was that the rats had been digging out and feeding on the borer-grubs. Fortunately, most of the grubs that we were able to find in this spot was fully parasitised, and were the best material I have ever seen. The benefited regions, where we are placing the parasites, certainly owe much to the public spirit of the Mossman Mill management and to the public spirit of the above gentleman for assisting us in cutting up their crop to secure the parasites, without recompense.

We sometimes hear criticism of the cultivation at Mossman, and it has been said that of the three kinds—extensive, intensive, and pretensive—theirs consisted largely of the latter. This is hardly just to the district, for the remark would never be made by one familiar with conditions there. Most of the Mossman soils are of a type very difficult to work under the climatic conditions. Consisting largely of clay, as most of them do, it is necessary to work them when the moisture content is just right; and since they are usually either too dry, or too wet, it is a difficult matter to turn them up without lumping. As is well recognised among the most experienced growers of the district, the abundant application of green crops will do much to alleviate this condition, and put the soil in better tilth, even without the application of lime, which is now at a prohibitive price.

The rat pest, on some farms, is coming largely under control by clearing out weedy headlands and other areas bordering the canefields. This is done in some cases by fencing close to the cane, along streams and so forth, so that stock can be turned in to assist in keeping the waste places clean. It is an excellent idea, and if carried out generally, would do much to put the rats out of business. It certainly offers every facility for their natural enemies to get at them.

As indicated above, I took advantage of the occasion to try to learn what factors were responsible for the control of white grubs in the district. It will be remembered that this section was once badly affected.

Upon looking up the records at the mill, I found that after they started crushing in 1897 they paid out the following amounts for beetles and grubs collected:—

	£
1898 .. .. .	16
1899 .. .. .	16
1900 .. .. .	88
1901 .. .. .	288
1902 .. .. .	656
1903 .. .. .	456
1904 .. .. .	548
1905 (the last year of the kanakas) ..	1,560
1906 .. .. .	357

During 1906 the growers decided to test the benefit of carbon bisulphide, which had been recommended by French, the Victorian entomologist, for the control of the grubs, wherefore they discontinued payments for collecting the pest, and the practice was never resumed. However, as Mr. Harry S. Staples, who was mill chemist at the time, states in his report dated 16th August, 1910, the carbon bisulphide was not always satisfactory, and never came into general use.

I was very much interested to learn, from the many interviews with growers, that the factors which we have been advocating are evidently

identical with those that have placed the grubs under control at Mossman. These are:—Late planting and cultivation, resistant cane varieties, nitrogenous fertilisers, and the application of green manuring or other organic matter.

I learned from Mr. George Muntz, chairman of the Board of Directors of the mill and one of the oldest growers of the district, that about the year 1906 there was a general change from early to late planting, and that this latter has been the practice up to the present time. He said that even after the mill ceased collecting grubs and beetles, as indicated above, this pest gradually became less and less in the district. Naturally, he concludes that late planting and cultivation is the explanation.

Mr. E. D. Hunt, an American, though a recent arrival, is making a success of a farm which was, up to the time he took it over, thoroughly infested with grubs. The soil is sandy loam, lying along the river bank, hence is subject to occasional overflow. Late in 1915 Mr. Hunt planted a few acres of cane and treated it during November-December with about a bag (160 lb.) of sulphate of ammonia to the acre. He grows principally D1135, and has continued the application of this fertiliser to all of his crop, with the result that he has never suffered from grubs, though feeding-trees are abundant along the stream bordering his farm.

The farm of the late J. D. Johnson is another estate that was once badly infested. Mr. Johnson tried every possible remedy and was a great experimenter, but he had little or no success until he changed to D1135 and late planting. His losses from grubs were immediately greatly reduced. There is little evidence on the place now of the presence of grubs.

Mr. R. A. Donnelly, another director of the mill and a grower of long experience, told me that he had no trouble from grubs for about five years after clearing his land from the scrub, but as the soil became poor the pest became evident, and did great damage in places, yielding as many as twenty-six grubs under a single stool of cane. He considers D1135 very resistant, and states that it will ratoon and make a very satisfactory crop after being attacked, while other canes die out and become worthless. Mr. Donnelly also considers late planting and cultivation very important as grub-controlling factors, and called my attention to the success of these on the adjoining estate, which is known as the "Syndicate." This place, though badly infested, was cleared of the pest by late planting and thorough cultivation.

Mr. J. M. Pringle, on a rather large estate of clay loam soil, also believes in late planting and the application of green crops to improve the tilth. Grubs have not been bad since D1135 was planted in 1910. He once tried an experiment, planting B147 alongside D1135. The B147 was all destroyed by the grubs, while they did no noticeable damage to the latter variety. Mr. Pringle uses meatworks manure on first ratoons, and nitrates on later crops, with good results.

Mr. Pringle also informed me that Mr. Low, on the adjoining farm,

which was formerly greatly troubled by grubs, got good results from late planting and thorough cultivation. The soil, he said, was too wet for early planting, which takes place before May.

Mr. W. S. Johnson, who is managing Drumsara for S. Johnson, sen., began farming in the district in 1906. He informed me that late planting was the general practice at that time. D1135 was beginning to be used. He planted misses in a field of Goru with this variety, and all the Goru was eaten out by the grubs, leaving the D1135 apparently uninjured. Hence, he considers the latter very resistant to grubs.

Evidence dealing more particularly with the value of sulphate of ammonia as a controlling factor was supplied by a number of growers in addition to those already referred to above.

The extensive estate of the late R. O. Jones was subject to serious losses from the grubs during the early years of the mill. He stated before the Royal Commission (6th November, 1911) that he cultivated 450 acres of cane in 1905 and lost 250 acres completely through grubs, representing fully £5,000. At that time, just before he died, he said:—"No human intelligence, so far, can contend with the grubs' depredations, and I do not think anybody has studied the subject more than I have."

The estate was broken up into smaller farms and the sons took charge in 1911. The general use of sulphate of ammonia began in November of that year, and part of the land was planted with Mauritius beans. The cane was planted early, yet the crop did not suffer from grubs, and since that time they have had no further trouble. Mr. W. P. Jones told me that all the surrounding farmers used sulphate of ammonia persistently, and that he considers it the active agent in the control of cane grubs.

The farm of Crees Brothers—a light sandy soil along the river bank—was once badly affected by grubs. The former owner applied large quantities of carbon bisulphide with little apparent result. However, after changing from meatworks manure to sulphate of ammonia, a few years ago, the grubs disappeared, and there has been no sign of them since.

Mr. H. H. Smith, who has been growing cane in the district for the past twelve years, said that his fields were formerly eaten out by grubs, but not seriously since he began the use of sulphate of ammonia. He plants early and applies about 3 cwt. of the ammonia to the acre, in two dressings, during December and January. On one occasion he left a few rows untreated in a field of Goru, and these suffered badly from grubs. Naturally, he is a firm believer in the application of this manure.

Mr. Donnelly also experimented with sulphate of ammonia, observing its action by digging up the stools after it had been applied. He found the grubs limp and inactive, though in no case dead.

As an instance of a farm which has had no sulphate of ammonia, I visited the place of Mr. W. Bunn, at Cassowary. The soil is heavy

clay loam and sticks to the ploughs when wet. Mr. Bunn told me he had no trouble from grubs for several years after clearing the land, but for a number of years now the grubs have been always in evidence. He has used meatworks manure alone, and stated that he found many large grubs under the stools which were blown out by the recent cyclone.

I submit this evidence, for it appears to me that it may be far-reaching in controlling the pest in other districts. At any rate, the practice of these better cultural methods have their principal value outside of their relation to grub-control.

#### HERBERT RIVER DISTRICT.

The principal canegrowing areas lying along the river have ideal soil to work, but I was surprised to find the fields in such a weedy condition. The great drawback, as I learned later, is the labour market during the cutting season, the men demanding up to 30s. a day for chipping. Meatworks is practically the only manure in general use, though sulphate of ammonia has given excellent results wherever tried. Furthermore, there has been no general practice of green manuring in recent years; and I was also surprised to learn that the growers do not recognise the value of the mill compost, for hundreds of tons of this valuable manure is piled up in ricks and has been leaching away for years. The present supply is being used for ordinary filling of mudholes, and the ashes for surfacing the roads. If put up in bags this product should command a considerable market value.

As is well known, this district was once subject to serious injury from grubs; and, since the pest has largely disappeared in recent years, I was interested in investigating the matter.

There seems to be a definite relation of grub-infestation, on the Herbert, to feeding trees, for the areas which were infested in the early days are now free, while the farms that suffer at present are the outlying ones, bordering the scrub and forest, especially those in proximity to the hills, which are covered with timber.

The management at Macknade gave me every possible assistance and kindly furnished me itemised figures of the beetles collected in their district during the past twenty years, with the amount of cash expended. These figures show that decidedly the worst infestation was from 1897 to 1901; then, from 1902 to 1915 the numbers were greatly reduced, and after the latter date, which was the year of the drought, the pest practically disappeared, except on the farms most distant from the mills.

It may be interesting to note that during the above period the mill paid out £11,272 17s. 10d. for 334,022 quarts of beetles, without any noticeable decrease in the pest from year to year. The marked reduction after 1915 was evidently due to natural causes, and was probably in no way connected with the hand-picking.

Very little cane in this district is burned before cutting—last season only about 5,000 out of 130,000 tons, but the trash is largely burned afterwards, and is not conserved for humus. It appears to be the general custom to take off only one ratoon crop and to plough this out and plant cane again immediately.

The burning of trash has evidently had a deterrent effect upon the beetle borers, for they are by no means a serious pest in the district. Even on the farm of Mr. Combo, near Hawkin's Creek, most of the grubs were right down on the butts, and it was very hard to discover any of the damage without first cutting cane.

Mr. W. Walker, who has been connected with the industry for the past forty years at Macknade, gave me a number of his interesting observations.

In the days of the kanaka, he said, the trash was removed to every third row, and he found that the grubs were always present in these trash rows and that the cane in these rows suffered during dry weather. This may evidently be explained by, that the grubs, which naturally develop under trash, are forced down into the soil by drought, and are then compelled to feed upon the cane roots.

At another time Mr. Walker observed that the beetles were attracted to the lights of the quarters, and later on, when the grubs began to do damage, it was worst in the cane bordering these buildings, the beetles evidently going back from the light to the cane to lay their eggs. He also noticed that the beetle went with the wind from a fig-tree which stood in the field, and the cane was usually considerably more infested on that side.

Regarding the beetle-borer, Mr. Walker informed me that they were first seen there nine years ago, and that they must have come from plants received from New Guinea. The moth-borer, however, which is a native insect, he said was very troublesome as far back as 1889. This insect, which is well controlled by parasites, has done little injury in the district in recent years.

Mr. W. Arthur, who is considered one of the best agriculturists of the district, once suffered severely from grubs, but not for the last five or six years. He uses green crops, which he ploughs in preparatory to early planting. His soil is clay loam and rather heavy, but he keeps it in good tilth by conserving his trash, of which none is burned. The single crop of ratoons is volunteered, and the double trash worked into the soil with a green crop before planting another series of cane. Mr. Arthur cultivates the plant crop well, and applies about 5 cwt. of meatworks manure to the acre. It is his intention to use sulphate of ammonia on his ratoons during December, if it can be procured. I noticed that his headlands and fence rows were clean, a factor important in the control of rats and other vermin.

Evidently the immunity from losses by grubs on this farm is due

to the cultural methods, for the owner supplies the required humus and ploughs at a season when the beetles are depositing their eggs—December to February.

#### DESTRUCTION OF TACHINID PARASITES AT THE MULGRAVE.

I regret that I am compelled to report that our colony of tachinid parasites of the beetle-borer was destroyed through the lack of co-operation on the part of the farmer on whose place the breeding cage was located.

The understanding was that the borer-infested field was not to be cut until the end of the season, and that the part just around the cage was not to be burned.

I was considerably disturbed to find, on 10th October, when I made a visit to the cage, after my return from the Herbert River, that the whole field had been burned and cut, and the cage had been dumped out and torn up in moving it into the adjoining field of young plant cane.

Mr. Girault and I not only made two trips to Mossman to get this work started, but we have also had to make frequent journeys to this farm, so that the parasites would have every opportunity to become established.

It is certainly discouraging to find that they now have no chance. The flies which we liberated, having reproduced, are dead, and the offspring are destroyed in the burning and the milling. It is only by a miracle that any of the flies could get away.

I have not been able to see the farmer in charge of the place, for he was away from home; but the matter was reported to the management of the Mulgrave Central Mill, since they were so urgent that we co-operate in the matter of establishing these parasites in the district.

#### THE LANTANA SEED-FLY.

I was interested to note the remarkable distribution of the Lantana Seed-fly. It has apparently spread all up and down the coast, since its liberation in the Cairns district in February, 1917. I found them well established at Mossman, and even as far south as the Herbert River, where they were found all over the district. It is certainly remarkable that so small a fly could cross the natural barriers between the above districts, for there must be considerable stretches with no lantana for them to feed upon.

These insects are doing excellent work wherever established. The eggs are laid in flowers, and the infestation is noticeable even on the green fruit, for it becomes discoloured with brown streaks, and usually withers and falls before becoming ripe. In practically every case the kernel of the seed is destroyed, so that it will not germinate. This, however, in no way affects the parent plants, which will live on for years

if not cut out. I would strongly urge every one to assist in destroying this weed, if found on his premises, now that nature is arresting its spread.

#### CANE GRUB INVESTIGATION, NOVEMBER, 1918.

The extended drought is having a serious effect upon the cane in the Cairns district. Most of the late planting is barely holding its own, while cane planted early in the season is showing serious drying of the lower leaves.

In some cases, where the fields were all prepared, planting has been so long delayed by the dry weather that the plants will not be put in this season. This has a rather serious aspect with regard to our investigation, for I was anxious to get the results from a number of these late-planted areas. However, we may be able to get results from what is already planted if the weather becomes favourable for growth and continued cultivation.

#### CULTIVATION AS A CONTROL MEASURE FOR GRUBS.

As has been demonstrated, cultivation during the period that the beetles are active seriously interferes with the laying of their eggs. Hence, the value of late planting, which permits thorough cultivation right through their ovipositing period.

Let me urge, then, that the cultivators be kept active in every infested field, wherever it is possible to get through the cane. It is important to do this work even though the ground is clean, and it should begin not later than two weeks after the first beetles emerge. It will be well to go over the ground at least every two weeks as long as the beetles are in evidence.

As indicated in my previous report, it may be profitable to start the preparation of the land which is to be planted early (April-May). The ploughing, harrowing, and so forth, will undoubtedly have a deterrent effect upon egg-laying in these new fields. Beetles do not like freshly ploughed ground, especially if it is devoid of grass and trash. Definite observations by growers on these points will be appreciated, for they may save us a lot of detailed experiment.

#### EXCHANGE OF PARASITES.

Since the breeding of our parasitic wasps belonging to the genus *Campsomcris*, was so successful under artificial conditions, it has occurred to me that these insects might be very valuable if liberated in countries where they were free from their natural enemies. These foes are so abundant here that the wasps are scarcely able to make themselves felt in the open, though they breed very prolifically. Vast numbers of their young are destroyed by secondary parasites, and the adults that do escape probably often fall a prey to the numerous fly-catchers which are present here.

Since Australia is the native home of numerous beetles of the family *Scarabaeidae*, with great range in size, this is a fertile field for the development of parasites; but, unfortunately for our own interests, this parasitism has advanced to the hyperparasitic stage, *i.e.*, the parasites are themselves attacked by other parasites. It is a well-recognised fact, however, that insects introduced into new countries, where they are freed from their natural enemies for a time, multiply by leaps and bounds if the climate is suitable for them.

White grubs are becoming increasingly important in sugar-growing countries, and it behoves us to work together for their control.

Our experience with these wasps has been that they are not limited to any particular species of grub, for they are apparently able to adapt themselves to a considerable range in size. Then, too, transportation to foreign countries will be rather simple, since the wasps have a rather extended pupation period.

We are hoping that we may get some relief by the introduction of parasites. At any rate, it is worth making the attempt. We are in correspondence with various sugar-growing countries with this end in view. We, certainly, stand ready to reciprocate, if our wasps are needed elsewhere.

#### EMERGENCE OF BEETLES, 1918.

The long drought has delayed this emergence in many districts, so that it is possible that many will not come out at all. Sections favoured by the rains last month got a crop of beetles at once. About two inches fell around Babinda on the night of 15th October, and the next day the grey-backs were out in force. On the 19th, at dusk, I found the feeding-trees swarming with beetles. One shrub had nothing but green beetles, *Calloodes punctulatus*; others had all three species of *Lepidiota*:—*albohirta*, *caudata* and *froggatti*, in almost this order of abundance. There were cane lands alongside, and the shrubs were in a grass field.

#### NOTES ON LEPIDIOTA FRENCHI.

Changes take place in the grubs of this species during October. Both second and third stage grubs are in cells during the cool weather, but as the hot days come on, the second-stage grubs moult, changing to the third stage, and begin their destructive feeding. At the same time the third stage pupate; hence it is seen that this species spends a full year in the third larval stage. It is shortly after the beginning of this stage that the insects do their worst damage to sugarcane, as indicated in our reports published in the "Sugar Journal" for December, 1917, and January, 1918.

Fortunately, this species only troubles new land, for the beetles do not favour the laying of their eggs in old fields and prefer blady grass.

## CANE CRUB INVESTIGATION, DECEMBER, 1918.

Since weather conditions at our station continued too dry for any new developments, I improved the opportunity to visit Mossman, where heavy rains had fallen early in November. My main object, this trip, was to study the comparative emergence of cane beetles; and, incidentally, to note the various feeding-trees.

Conditions at Mossman are excellent just now. There is abundant feed for stock, the cane is of fine colour, and cultivation is going on everywhere. The soil is just moist enough for ploughing, and the farmers who have land for early planting are beginning the preparations. Their practice cannot be too highly recommended, for horse work at this season is what counts against the beetles.

## EMERGENCE OF CANE BEETLES AT MOSSMAN.

The rains coming in abundance, as they did in this district, brought out, practically, the full crop of beetles, so that they are not stringing along over several months as they did in the Cairns district last season. As indicated in my previous report on this district, I did not expect a very large emergence, for there had been no serious damage in recent years. Hence I got a surprise when I walked out to the river, on the evening of my arrival, and found the two large figtrees near the bridge literally swarming with grey-backs and the foliage mostly riddled. Careful search during the remainder of my week's stay failed to locate any other similar congregation of the pest. A few cane beetles could be found almost anywhere, on the feeding-trees, but not in serious numbers.

Even at Mango Park, where the beetles did so much damage in former years, they were scarcely in evidence. I could only locate a very few on some of their principal feeding-trees, and Mr. Hearn, the new manager, informed me that there were no beetles flying at night. The cane on this estate looks fine in spite of the setback caused by the long, dry spell, and there is every prospect for a successful crop.

Along the river, at the farm of Crees Brothers, I found a few grey-back beetles on mandarin trees, and Victor Crees, who is managing the farm, told me that the beetles swarmed at night on a large rubber tree by the house, but I was not able to locate any upon it.

Examining the low bushes along the roadside, just at dusk, I found a few of both *Lepidiota frenchi* and *L. caudata*, with considerable numbers of very small cane beetles belonging to three species. All of these go back into the soil after feeding, so that they are never seen during the day feeding, or on their feeding-plants.

In the field alongside this road, belonging to Mr. Mullarvey, we found full-grown *frenchi* grubs; and though they appeared to favour the bunches of Guinea grass along the headlands, they were undoubtedly doing some damage to the cane, for it was yellowing in places. These grubs will continue to work until next May, when they go into resting cells, to emerge this time next year.

Mr. R. D. Rex, a prominent grower at South Mossman, told me that his place never suffered from grubs, though the beetles were always in evidence about the feeding-trees in his yard. He said that the beetles simply swarmed about the fig-trees at night, and that the coconut leaves were badly eaten by them. We saw many beetles on these palms.

Mr. Rex always plants early, which is evidently best for clay soils; but his practice of thoroughly preparing the ground by doing the horse work while the beetles are on the wing probably saves him from grub attack.

Mr. Rex made the interesting observation that fruit bats congregate in beetle-feeding trees, even where there is no fruit for them to feed upon. He found the ground strewn with broken parts of beetles next morning, indicating that the bats had been feeding upon the insects. We would appreciate any further evidence along this line.

The Mowbray district appears to be free from grey-backs, for I could not find a beetle on the feeding-trees. Following up the report that grubs were in evidence at this season, I found that the *frenchi* grubs were doing slight damage in some of the newly-planted land. The pest was only noticeable on the high spots in the field, where the humus is naturally washed out of the soil. The cane in the low places was growing strong, with no sign of injury. I also noticed that bandicoots had dug holes in search of grubs in the infested stools, but had not molested the healthy cane.

#### FURTHER EVIDENCE OF THE EFFECT OF LIGHT ON THE GREY-BACKS.

A benzine lantern of high candle-power was taken under the feeding-trees by the Mossman Bridge, and the beetles began swarming around it at once. An ordinary lamp, though giving much less light, appeared equally attractive, probably because, having no cover, the rays went straight up into the tree. I was told that placing the lamp upon a white sheet made it more effective, for the white surface acted as a reflector; and by this means the beetles could be more easily gathered up.

It is my experience that these beetles are much more easily attracted to lights soon after emergence than they are later on, when almost ready for ovipositing.

#### FEEDING-TREES OF THE BEETLES.

By a thorough examination of the scrub, which at Mossman borders most of the cane land, I was able to note the principal feeding-plants of the grey-back beetles. This examination is facilitated by the fact that this species remains on the feeding-plant during the day.

Several new feeding-plants were observed, some of which we are not yet able to name, being unfamiliar with the scrub flora. However, it will be interesting to know that the Candle Nut (*Alcurites molucanna*), a tree with broad, coarse leaves, is much sought after by the beetles, and the foliage is often eaten right to the midribs. Since these plants are so generally distributed it will be well for canegrowers to recognise

them. They bear clusters of nuts on the ends of the outermost branches; and these spherical fruits form an important food of the cassowary. The tall, straight, light-coloured trunk and broad leaves make the plant easy to identify. Other synonyms are Tar-kal and Nappalla.

As is well known, the leaves of all the species of figs are eaten, and I found that the cluster-fig was a favourite, the trees being almost defoliated within a week after the first emergence of the beetles.

As mentioned above, the leaves of the coconut palms were riddled, and I found that bananas suffered as badly where the beetles were plentiful. Mandarin and orange trees are also attractive, though I found no beetles on the rough lemons.

At one place along the border of the cane I found a clump of white, or silver, wattle, with many feeding beetles. These trees are evidently very attractive from the fact that I found no beetles on a large figtree close by.

I will be able to add several to this list when I secure names for the other feeding-plants that I observed.

#### WIREWORMS.

There is evidence that this pest is doing some damage at Mossman. Incidentally, it may be mentioned that this pest is also a native of the virgin grass land, and favours low-lying fields. The adult is the common snap-beetle, which flips up when placed upon its back.

I found the cane, in places, covered with a small, dark-coloured species, many of them in the act of mating. They were so thick that often a dozen could be taken together on a leaf.

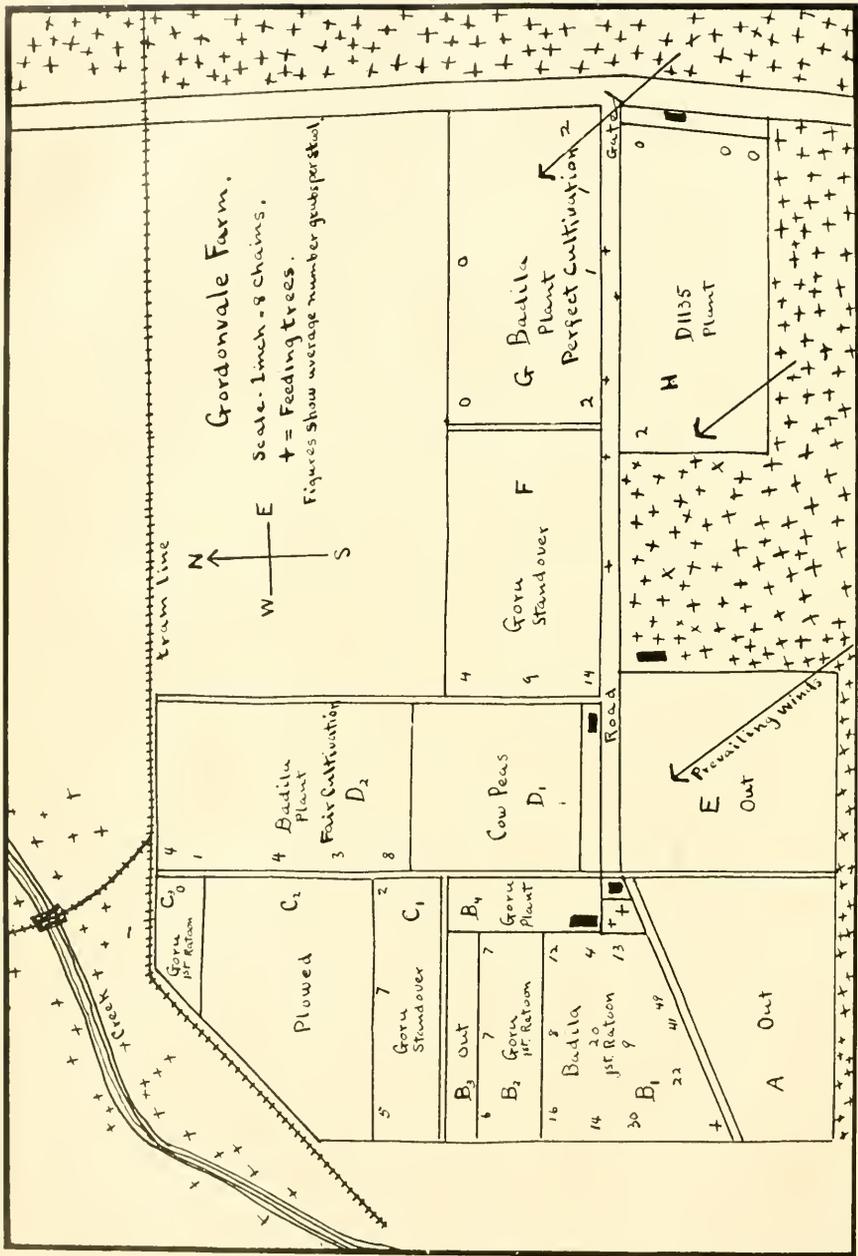
The damage from this pest is principally the destruction of the eyes on young sets, resulting in numerous misses. Their work is easy to recognise if the injured set is examined carefully. Usually the wireworms eat into the pith at the ends of the set while waiting for the eyes to expand. The insects also feed upon the young roots.

Control measures are most difficult, since the wireworms seem to be immune to even the most violent poisons. In practice, cultural methods offer the only relief, and even then we must know the life-history of the particular species with which we are dealing, so as to plant at a time to avoid the larvæ.

It has been found that these insects cannot be starved out, even by keeping the ground fallow for a year, and they pay little attention to deterrents. They are certainly a pest that will require careful investigation before we can hope to do much against them.

I had a brief experience with this pest in Fiji, and I soon saw that ordinary control measures were of no avail. Looking up the literature on the subject I found that other experimenters had come to the same conclusion.





FARM SHOWING DISTRIBUTION OF GRUBS WITH RELATION TO FEEDING TREES.

## CANE GRUB INVESTIGATION, JANUARY, 1919.

Fortunately, we are at last experiencing ideal growing weather, and even the weeds are coming on apace. The cane never looked better.

## BEETLE EMERGENCE.

Really our first good rains did not come, at Meringa, until 19th December, though we had a brief downpour on the 28th of November that brought out a few beetles.

Both the grey-backs, *Lepidiota albohirta* and *L. frenchi*, have come out in great abundance this year, this being the time for the regular biennial occurrence of the latter species.

The extreme abundance of *frenchi* has made it possible for us to add materially to our knowledge of the habits of this species. Since they do not remain on the feeding-trees during the day, like the grey-backs, there has been less opportunity to study them.

Upon the approach of darkness these smaller brown beetles crawl up out of the grass where they have been hiding, and for about ten minutes everywhere about you is one seething hum of the insects. The females settle first, upon any low object—bushes, dry twigs, or even upon the fences—and mating at once takes place. Usually several males cluster about one female, but as soon as one secures connection he lets himself fall backward, so that he hangs head downward, and the other males fly away. The pair remains in this position, perfectly motionless, for about twenty minutes, when they separate and fly to their feeding-trees, where they remain until morning. Soon after daylight, about half an hour before sunrise, they again become active, leaving the trees in one concerted flight, which lasts for about five minutes, when everything becomes quiet. In place of going straight into the ground the beetles usually settle upon the stems of any convenient plant, about 18 inches from the surface; here they remain perfectly motionless for several minutes, then proceed slowly downward into the grass, and finally enter the soil. It is this habit that makes them an easy prey to the "early" bird.

## BIRDS A VALUABLE ASSET.

Soon after the first flight of the beetles this year, my attention was attracted by a flock of fowls and ibises under one of the large rubber trees in the Mulgrave Mill yard. They were all actively feeding upon beetles which were dropping out of the tree. Upon closer observation I saw that there were a number of smaller birds in the branches, and these, too, were eating the insects. Usually when one of the birds hopped on a twig and secured a beetle, several others were dislodged and fell to the ground, where they were quickly gobbled.

I have followed up this interesting line of observation, using my 6X binoculars, with excellent results. Ordinarily the birds are very timid

in this district, because of a lack of effective protection, and scatter before one can get near enough to see what they are eating. By approaching quietly, however, with the glasses I have been able to observe most of our moderate-sized birds feeding upon the beetles. It may be interesting to note a few of these, such as the magpie lark, yellow-belly, leather-head, butcher bird, mynah, satin bower bird, blackbird, laughing jackass, &c. The first two are by far the most numerous, and have the advantage that they follow their prey to the ground if they fail in their first attempt at securing it.

Most of these birds are too small to swallow the grey-backs at one mouthful, but when near enough one can see that the birds beat the insect to pieces on the larger branches before attempting to swallow it. Then, too, the quantity eaten by a single bird is limited, but they make up for this in numbers. Just after daylight there is a constant stream of the birds through the feeding-trees of the beetles.

As will be noted above, even the fruit-eating birds take kindly to the beetles during this, their nesting season, a fact which agrees with my experience in America, where most of the seed-eating birds feed their young upon insect diet.

Protection of the bird-life of a country is certainly worth considering, for we cannot over-estimate their value to man, even of those birds which we sometimes class as enemies, when they occasionally eat our corn or kill our chickens. Undoubtedly, birds are the greatest factor in the control of insect pests.

Theoretically, almost any minute insect, with its rapid methods of multiplication, would overrun the earth, making it impossible for man or other animals to exist, if the offspring of insects all survived and reproduced.

This has been forcibly illustrated by T. Bainbrigge Fletcher, in his work on "Some South Indian Insects," where he takes the case of an insect laying only two hundred eggs and having a life cycle of one month. Starting with 1st January for convenience, a single fertilised female lays 200 eggs, all of which hatch and mature by the end of the month; on the average half of these will be females, each of which will lay 200 eggs on 1st February, and by the end of February we have  $100 \times 200 = 20,000$  mature insects, of which half again will be females laying between them  $10,000 \times 200 = 2,000,000$  eggs. Continuing, simple calculation shows that by the end of the year the descendants would reach the prodigious total of two septillions (2,000,000,000,000,000,000,000) of individuals. The human mind is quite incapable of grasping the significance of such a figure, but a few comparisons may assist the imagination. If 1,000 of the insects weighed only 1 oz., their united weight would be 558,035,718.571.425.5 tons, and if 1,000 measured 1 cubic inch, they would cover an area of almost 50,000,000,000,000 square miles, with a uniform layer 1 inch deep. Taking the dry surface of the whole earth to be 51,000,000 of square miles, they would cover the whole of this to a depth of over 81 feet.

Figures such as these are suggestive of what might take place if an insect meets with particularly favourable conditions for development. Probably the most important of these are: (1) favourable climates; (2) abundant food; and (3) freedom from enemies.

Nature is usually nicely balanced, so that no species becomes predominant. Man, however, is often the means of upsetting this balance by transferring insects to new countries, where, removed from their natural enemies, they often become serious pests; or, again, by cutting the forest, he interferes with the nesting of insectivorous birds, &c., with the result that his crops are destroyed until Nature is again able to maintain her balance.

It is now well recognised that man is able to greatly assist Nature in regaining this equilibrium; and much has been done by the introduction of insect parasites. It is possible, however, to do just as important work by encouraging the birds through protection, &c., so that they will multiply near our homes.

#### CULTIVATION EXPERIMENTS.

I have started an extensive series of cultivation experiments, with proper checks, at the Greenhills Estate, on fields which are regularly destroyed by the grubs. These experiments cover both plant and ratoon crops, and we can hope for some very interesting results within a few months, for the cane is an excellent stand at present.

Three types of implements are being used, harrow, Planet Junior, and plough, and I am also trying different intervals to determine how often it is necessary to stir the ground and disturb the beetles.

The cane in the Meringa plots is a perfect stand; and, though it was planted in April, it got such a setback by the drought that I am still able to keep the horse going through it. I am hoping for results of this intensive cultivation within the next two or three months.

#### NOCTUID MOTH-BORER, *PHRAGMATIPHILA TRUNCATA*, Walk.

Mr. P. H. Edington, at Deeral, has suffered considerably from this pest. The insects have continued for several months on his plant cane; and he told me that he had renewed fully 75 per cent. of the plants in the worst-affected field. At the present time the cane is almost free from attack, and as high as one's head, but very uneven, due to the fact that it has been supplied at various times.

I was not able to locate any of the parasites, though at the time of my visit it was a very difficult matter to even find a caterpillar of the moth in the infested stalks; most of the runs of the borer had been cleared out by the brown ant, *Pheidole megacephala*.

## CANES GRUB INVESTIGATION, FEBRUARY, 1919.

The unprecedented dry weather, for this time of the year, is having a rather serious effect upon the late-planted cane. It is just the condition for the rapid development of the cane grubs, and they are already beginning to show by the yellowing of the cane in a few places at the Greenhills Estate. Out of 181 grey-back grubs picked up behind the plough, 22nd January, in Field E1 of ratoons, 68 were in the first stage, 112 in the second, and one had already reached the third or final stage. Digging under the yellowing stools of ratoons in E2, 5th February, I found an average of six grubs, mostly in the second stage. This field is in the worst-infested area, and suffered severely last season, so it is not surprising to find that the infested stools have no roots and can be easily pulled out with one hand.

It will be of interest to record that grey-back beetles were still in evidence on the feeding-trees, 5th February, and dissection showed that these stragglers were full of eggs. This was just about two months after the first beetles emerged in this district, so the period for cultural control has been somewhat extended.

I have improved the opportunity during the past month for securing further data on controlling factors—both better cultural methods, and the all-important one of feeding-trees.

## BENEFITS OF INTENSIVE CULTURAL METHODS.

Recently I was most gratified by an interview with Mr. David Hunter, a man of long experience in the sugar industry on the Johnstone, whose record as a grower has been so successful, especially in the handling of grub-infested land, that his observations should have the greatest value.

Mr. Hunter first came to the district about twenty-eight years ago, taking charge of land for the Colonial Sugar Refining Company, which grew its own cane at that time. He was quick to notice the value of filter-press on cane land, and became an advocate of intensive surface cultivation.

About 1906 he took up one of the company's farms, which had been thrown out of cultivation for years because of the grubs. This pest had been so severe in the early days that the land was not considered profitable to grow cane; hence he got the place on very reasonable terms, and, being near the mill, he made arrangements for the complete output of compost. Mr. Hunter began applying this in 1908, and by thorough cultivation soon had the farm in perfect tilth, with not a weed in sight anywhere, and he kept the cultivators going so that none would show.

I was interested to learn that Mr. Hunter believes filter-press is rather attractive to grubs, and that he found ammonium sulphate to be the opposite. Anyway, he says that he has seen cane treated with this latter chemical standing and perfect, while untreated cane alongside had fallen because of the grubs. He does not agree with the usual statement,

that ammonium sulphate robs the soil. In this he is in accord with the most up-to-date knowledge of fertilisers. He says that there is no question, but that this chemical brings about a bumper crop; hence, a portion of all the available plant-foods are used up, and these must be renewed from time to time. For this purpose he used meatworks manure. He also returned to the soil all of the waste from the crop. No trash was burned. He accomplished this by relieving into every other row when the plant-crop was cut, and applied manure and cultivation in the free middles. The trash from the first ratoons was relieved into the middles which had been cultivated, and the alternate ones were broken up and fertilised. Finally, the trash from the second ratoons was left, and the whole thing ploughed in. He used this regular system of three crops before ploughing out, and says that late planting is the right thing for that class of soil. It is needless to say that he had no trouble from grubs.

Then, too, results were apparent in the crops he took off, which were double or treble those of adjoining farms, and in one case I found by the mill records that he cut 43 tons per acre, when his neighbour across the road, on the same class of soil, cut 9 tons—the difference being due entirely to better cultural methods.

#### THE QUESTION OF FEEDING-TREES.

Mr. Hunter is also a firm believer in the destruction of feeding-trees, because he says the grubs move back as the scrub is felled. He advocates removing the scrub and pasturing the land for half a mile back from all cane areas, using cane pest destruction funds to assist in this work. He said that the owners of the scrub would, of course, pay part of the cost, and the mills could make use of some of the wood to help out on the expense. Cost of felling and burning would be, approximately, £5 per acre at this time.

Mr. C. E. Jodrell, who is another pioneer of the Goondi district, also obliged me with some of his very valuable observations. He is one of the most extensive growers to-day, having come on to his farm, in the stumps, twenty-five years ago. In those early days the grubs often ate everything out, so it was the exception to get even a 15-ton crop. He told me that the beetles were then in hordes in the feeding-trees just behind his house; and that the flying foxes made havoc among them, so that the remains of the beetles were several inches deep on the ground in the morning. The broken parts of the grey-backs could be plainly seen in the excrement of the bats.

I was interested to learn that there has been no trouble from grubs on this farm since the scrub was cut on the hills surrounding it, about eighteen years ago.

Mr. Jodrell also owns a farm at Daraji, and he told me that he always had trouble from grubs on the part bordering the scrub, but that there is no injury in the fields lying about half a mile away from these feeding-trees.

Mr. Ernest S. Smith, cane inspector at Goondi Mill, from his extensive observations in the district, is emphatic in his belief that the proximity of the feeding-trees accounts for grubs in the soil. He told me that it is a well-recognised fact that grubs which were once very serious throughout the Goondi district have disappeared as the line of scrub has been moved back. It is now only the land lying within half a mile of the scrub which is affected. He could not recall a single instance where fields farther away from the feeding-trees were troubled.

That it is not the length of time that land has been cleared which makes it immune, Mr. Smith cited the Innisfail Estate, which was opened up about thirty years ago, and is still troubled badly with grubs every year, simply because it is bordered by scrub, for the same class of land on the town side of the river is not infested.

In October, 1917, I called attention to an interesting observation in connection with this subject by Mr. W. Walker, who has been a resident of Macknade district for the past forty years. Mr. Walker used to notice a very definite relation of infestation to a particular fig tree in his fields. He found that the beetles usually went from this feeding-tree with the wind, and infested the cane on that side, at some distance from the tree more than immediately around it.

This suggestion bears fruit when we study an estate like Greenhills, where there is always a considerable portion infested. For two seasons I have been collecting data as to the distribution of the grubby areas, and have indicated these upon a carefully-drawn map, using degrees of shading to show relative abundance.

Examination of this map points clearly to the fact that the infested fields lie large within one-half mile of the feeding-trees, and also that the prevailing winds from the south-east are largely responsible for bringing the beetles from the feeding-trees, which are abundant in that direction. Attention should be called to the fact that there is a considerable area of the estate which is considered land safe from infestation, and though part of this is bordered by the forest to the west, the cane is but little infested, evidently because the prevailing winds blow away from these fields into the feeding-trees.

It must be kept in mind that cane is not at all essential to the beetles in their development, for they thrive just as well in grass land; in fact, the wild grasses are the beetles' native food-plants. It is interesting to note, in this connection, that the grey-backs are very abundant, even up on top of the range, where there is no sugarcane for them to feed upon. The only reason that they become such a pest in some of our fields is that we have subjected them to abnormal conditions, by removing their native food plants and destroying all humus in the soil by our destructive methods of farming, by taking off the crop every year, and even burning all the trash.

Careful measurements in the region about Meringa, where the cane has suffered severely from grubs for years, show that all the infested

fields lie well within the one-half mile limit from feeding-trees. Here the worst infestation was on the high ground, where the beetles would naturally come to rest from their flight. It must also be noted that these high spots are naturally poor in humus, and consequently the work of the grubs is more quickly noticeable.

#### FIELD EXPERIMENTS.

The cane in the cultivation plots at Greenhills is at present looking well, especially the plant cane in fields D1 and D2. Unfortunately, I was unable to get the cultivation started as early in the flight of the beetles as I desired, and in the ratoon field E1 it was almost a month late, in some of the plots, so that small grubs were turned up at the very first treatment. It will be noted from the map that all three of these fields border the feeding-trees and have always been the ones most infested, so we are hoping for some rather conclusive results in spite of our late start.

It will be interesting to note from the map that the fields L6 and L7 are in the badly infested area, but, as I have previously noted, a successful crop was secured from these at the last cutting. The lower half of L6 was planted near the end of September, 1917, and after late cultivation produced an excellent crop; the upper half, planted in June, 1917, was a failure, because of the grubs, which put the cane down in February, 1918. The field L7 was planted about the first of October, 1917, but had rather poor cultivation and was pretty weedy. In spite of this the crop was fair, indicating that even the horse-work it got disturbed the grubs so that they were held in check.

#### CANE GRUB INVESTIGATION, MARCH, 1919.

The heavy rains which started on the 25th of February have saved the day in many of our cane fields. Conditions were prime for the grubs, and they were getting in their work to an alarming extent. As usual, Greenhills was the first to show the characteristic yellowing in the affected portions. Some of the ratoon fields lying near the woods have already succumbed, in spite of the rains.

#### FEEDING-TREES.

Continuing the study of the relation of feeding-trees to infestation, I have made further interesting observations, and can now say with some confidence that the beetles travel approximately half a mile when going with the wind, but scarcely any against it. These conclusions are based upon numerous observations in a number of localities, and in no case have I found evidence to refute these conclusions.

As pointed out last month, the infested areas at Greenhills lie principally within the half-mile limit, and the worst infestation is in the higher parts of the fields lying near the feeding-trees.

I have recently instituted careful surveys in the infested areas by counting the number of grubs per stool of cane. As a typical example of this method, I may cite the field of first ratoons, H1, at Greenhills, where, by working at a gradually increasing distance back from the forest, we got the following grubs:—14, 13, 15, 8, 3, 1, the last stool being just about on the half-mile from feeding-trees, to windward. Another excellent example, which works out in perfect accord with this theory, is an infested farm near Gordonvale. Feeding-trees border it to windward, south and east, and the principal infested areas are on the side towards this timber. The worst-infested fields, A and E, are now out of cultivation, having failed completely last season. However, I was able to get the following remarkable figures, by taking the average of a series of stools:—

12 chains from the forest,	45 grubs per stool,	Badila, 1st ratoon.
16 chains from the forest,	17 grubs per stool,	Badila, 1st ratoon.
18 chains from the forest,	13 grubs per stool,	Badila, 1st ratoon.
22 chains from the forest,	12 grubs per stool,	Badila, 1st ratoon.
28 chains from the forest,	7 grubs per stool,	Goru, 1st ratoon.
35 chains from the forest,	5 grubs per stool,	Goru, 1st ratoon.
40 chains from the forest,	0 grubs per stool,	Goru, 1st ratoon.

The same decrease in the number of grubs per stool is shown in every part of the farm as one recedes from the feeding-trees.

#### CULTIVATION EXPERIMENTS.

As stated in my last report, I was unable to get these experiments started in time to derive the maximum benefits therefrom. Nevertheless, the experiments show that there is no material difference between working the soil once a week and once a fortnight; also, that the plough is considerably more effective in disturbing the grubs.

##### *Every Week.*

Plough .. .. .	Average number of grubs per stool,	5
Cultivator .. .. .	Average number of grubs per stool,	8½
Harrow .. .. .	Average number of grubs per stool,	9½

##### *Every Fortnight.*

Plough .. .. .	Average number of grubs per stool,	6
Cultivator .. .. .	Average number of grubs per stool,	8
Harrow .. .. .	Average number of grubs per stool,	7½
Check .. .. .	Average number of grubs per stool,	13½

The check in this case does not show its true value, because it was cultivated twice after the experiment began in spite of my instructions to the contrary. Still, the better cultivation in the other plots is very noticeable from the figures.

There is very decided evidence that cultivation as a means of control must begin during the two weeks after the beetles emerge, before they start laying. Apparently, once the eggs are deposited it is a difficult

matter to destroy all of them by horse-work, for they are probably placed near, or under, the stool. The fields which received this cultivation are in excellent condition at present (14th March), and have a fine dark colour. The field J1 is a good example, since it has suffered from the grubs in former years. It is worth noting that this field was planted very late last October, for J4, which was planted in August, is suffering severely from grubs, and is located just across the tramline, and more distant from the feeding-trees.

In support of this contention I might mention the two ratoon fields, L7 and the lower half of L6, which were cut in November and ratooned while the beetles were on the wing. Both fields are in prime condition, with no apparent signs of grubs, while several of the fields nearby are already going yellow. It will be recalled that these fields were planted in October, 1917, and gave successful cuts last season.

#### ON THE VALUE OF GREEN CROPS.

The finest cane on the Greenhills Estate is in the part of F3 which was planted with Mauritius beans. The lower part of this block was not treated, and it is easy to see where the beans ended, for there the cane is shorter and is badly yellowing from an attack of grubs. All of this block was a failure last time it was planted.

#### MERINGA EXPERIMENTAL PLOTS.

The cane in these plots is in excellent condition, especially the areas which were under beans. All of the fifteen plots, which include the checks, have had frequent cultivation during the whole flight of the beetles, and this probably had considerably reduced the number of grubs.

While it is rather early to draw conclusions, I would say, from tests that we have made of individual stools in the various plots, that white arsenic gives considerable promise when used in the drill at the time of planting, especially when mixed with meatworks manure, which the grubs appear to favour as food.

#### CARBON BISULPHIDE EXPERIMENTS.

The following observations were made on a badly infested field (B1 of Gordonvale farm) of first ratoons. By digging test stools early in February, while the cane was still of good colour, I found that the number of grubs ran from 8 to 49. The owner decided to apply carbon bisulphide, and this was started on the 18th of February. The application was made with the ordinary Danks pump, set so that the discharge was about 3 inches beneath the surface. The maximum charge was given (slot No. 9 = 1 drachm and 55 minims) on one side of the stool, to start with, but the middle of the field was treated on both sides of the stool, using the same charge. Finally, the last part of the field was not treated, for heavy rains (about 10 inches) started on the 25th of February.

On 8th March I examined this field for grubs, and found excellent

results. Along the south side of the field, where we had previously found an average of forty-five grubs per stool, I could only get an average of five. No dead ones were visible in the soil, having probably rotted and been carried away by ants. This was the part treated on one side only.

In the middle of the field, where the stools received treatment on both sides, I was unable to find a single grub, and there was a vigorous growth of new roots starting. The cane tops also looked beautifully green, with no sign of injury from the treatment. I had previously found an average of thirteen grubs per stool in this location. Evidently the rains which followed, a day or so after the application, saved the cane from any ill-effects of the chemical.

I also found that the grubs were still numerous on the untreated portion, and the cane was showing a very noticeable withering, in marked contrast to the treated plants.

#### EXPERIMENTS WITH NITROGEN FERTILISERS.

Our field experiments with these chemicals are not completed, but there are some observations which should be noted. Experienced growers know that the best results come from the application of these fertilisers after the rains begin, when they give to cane-growth the maximum impetus. In our experiments with nitrate of soda and sulphate of ammonia to determine their specific value in making the cane resistant to grubs, I find that where these chemicals were applied during the dry weather in August their effect upon the growth of the cane has not been perceptible, and in the treated field at Greenhills the grubs are showing considerably. On the other hand, where ammonia was applied during January the cane shows a remarkable development and improved colour; and though I found grubs under some of the stools, the numerous new roots are keeping up the vigour of the plant. In another month the contest will be decided, for this is the worst season in the activity of the grubs.

In order to determine the direct effect of these chemicals upon the grubs, I placed grubs in soils with varying amounts of the fertilisers, giving them no roots to feed upon. The experiment was carried along for ten days with no noticeable effect. Several of the grubs became injured and died, but those that remained were perfectly normal at the finish. I would, therefore, conclude that the control exerted by these chemicals lies principally in the increased vigour they impart to the plant.

#### EXPERIMENTS WITH MOLASSES AS A BAIT.

One might naturally conclude that molasses would be attractive to grubs if placed in the soil. It was recently suggested that this would act as a valuable bait if mixed with poisons. Experiments, however, have demonstrated that the grubs will not eat it—at least, not enough to be of value. Where the same amounts of arsenic were used alone in the soil,

results were very rapid; the grubs dying in from one to four days. Even the dry white arsenic gave splendid results. As this chemical has a great affinity for humus and remains in the surface soil for years, it may prove best to apply it in the drill at the time of planting, or perhaps dust it around the young plants, so that the grubs will come in contact with it when they begin their depredations.

#### INTRODUCTION OF PARASITES.

That we may leave no stone unturned, I have continued investigation of the valuable parasites of white grubs in other sugar-growing countries. There are a number available, though it is problematical whether they would prove of value against our native insects. Anyway, it is worth trying, for if we can induce them to attack any of our numerous Scarabeids (root-feeding grubs) the expenses of introducing the parasites will be well repaid. These valuable insects are doing excellent service in Hawaii, Porto Rico, Mauritius, and other countries.

It will be interesting to quote from a letter just received from D. D'Emmerez de Charmoy, entomologist of the latter country. He says:

“There are several parasites of white grubs here. Apart from *Diclis rufa*, an indigenous species parasitic upon two of our melolonthid grubs, *Rhizotrogus gravidus* and *Rhizotrogus pallens*, the others have been introduced.

“I am sending you a copy of a bulletin on the introduction of *Typhia parallela*, in which you shall find a detailed account of the introduction of this parasite, as well as a general description of the spread of its host, *Phytalus smithi*.

“The other principal pest of sugarcane is *Oryctes tarandus*, which has lately been the cause of considerable damage to canes in certain parts of the island; so much so that I went to Madagascar, in 1917, for the purpose of bringing over certain Scoliids, which I thought might prove parasitic upon *Oryctes tarandus*. The details of this introduction are set out in the report I am sending you.

“Since the publication of this report, *Scolia oryctophaga* has been found in places where the insects had originally been liberated, so that I think the parasite to be definitely established. Its effect in checking the spread of *Oryctes tarandus* is now only a question of time.

“I am extremely interested in the work undertaken in Queensland for the purpose of controlling cane grubs, and feel certain that your efforts will result in complete success.

“It would be a real pleasure for me to help you in any way, should you require my services.”

## CANE CRUB INVESTIGATION, APRIL, 1919.

The abundant rains, in the beginning of April, have improved cane conditions materially. Even the fields suffering from grubs have improved where they were not already too far gone.

During the past month I made a survey of the Herbert River district, and found a most gratifying scarcity of grub-injury.

## HERBERT RIVER DISTRICT.

This district, like the Mulgrave and most other cane areas, has suffered for rains, with the result that they will harvest only about half a crop. The lack of grub-injury this year is very fortunate. Even in the areas that were formerly badly infested the grubs are not showing, and digging under the stools failed to reveal them.

The only assignable reason for this immunity is that cultivation has been continuous, because of the dry weather. The farmers in some areas told me that a good lot of beetles were on the wing; and the lack of foliage on the feeding-trees in these localities bears out their statements. In several localities, however, where the beetles were very numerous in former years, they did not appear at all this last season: in fact, beetles have been scarce since the drought of 1915.

During my limited time I was able to make a thorough survey of all the cane areas which had been infested in recent years, through the generous assistance rendered by the officers of the C.S.R. Company's mills. In very few places were we able to locate any grubs by digging under stools, and in no case were there enough to do serious harm. This is certainly remarkable, and must be due to the better cultivation this year.

I had a communication recently from Mr. J. Wittrup, president Halifax Planters' Club, urging me to visit the district. He took me to several farms which had suffered in former years from grubs; but there is no indication that the crop is going to suffer this season. These farmers use meatworks manure, and the cane is of a fine dark-green colour.

Mr. Wittrup called my attention to a small field (A. Baxter's) lying alongside a forest of young Moreton Bay ash trees, which were almost defoliated. He told me that the beetles were exceedingly abundant in this timber, and that the cane never suffered from grubs. It is certainly a notable example of the relation of prevailing winds to infestation, for these feeding-trees lie to leeward of the cane, and the country to windward is all open and without a tree within half a mile.

Mr. W. Walker, at Ripple Creek, told me that he is ploughing up considerable numbers of grubs where he is turning down beans, and that the beetles were abundant on feeding-trees near his house this year, but that the cane has never suffered on either side of the creek. The soil is rich alluvial deposit, which may, possibly, account for the immunity.

Mr. Walker also remarked that the birds did good work on the beetles, which emerged over a very long period this year.

The farm of D. and E. Mullans, near Hawkins Creek, though not showing the usual infestation from grubs, has a most interesting experiment with sulphate of ammonia. They applied the chemical to twenty-two rows in a field of Badila ratoons, using about 2 cwt. per acre. The treated cane is a beautiful dark-green colour, and about double the size of the remainder of the field, which is very yellow. The fertiliser was applied at just the right time, after the rains started in January.

The farm of Combo and Co., which lies in the same narrow valley, shows no sign of grubs in the places where they have appeared every year. Mr. Combo told me that he cut the feeding-trees along the stream before the beetles flew in December. There are other feeding-trees, however, within half a mile to windward, so I presume that the late cultivation has done as much here in making the cane free from grubs.

A visit to the newer cane areas far up the river on the Victoria side, revealed no infested fields, even where grubs did considerable damage last year. The dry weather has stunted the cane in places, but there is none of the characteristic yellowing caused by grubs.

Mr. E. Freeman, cane inspector at Victoria Mill, called my attention to a farm belonging to Mr. M. Deloughery, in the "Pocket," which has produced seven crops of cane right among the trees, without any cultivation. This farmer has had no trouble from grubs, and cuts 50-ton plant-crop. The feeding-trees are on every side. It is a case hard to understand, for Mr. Cole, on a farm alongside, cultivates his cane and has had trouble from grubs since the second crop on new land. The scrub, with fig and other trees, is to windward, but Mr. Cole is having these cut out, so we shall have an opportunity to note the result upon future crops.

Mr. W. Tooth told me that he has had trouble every year with grubs on his high ground, but none are showing this season, although feeding-trees are abundant to windward.

Mr. Tooth says that the cane laying near the scrub is not so badly infested as that on the ridge further back. This observation agrees with our experience, for the beetles naturally come to rest on these elevated spots.

The distribution of grubs is not always easy to explain, but in every case where they have infested fields in former years there are feeding-trees to windward, within half a mile, to account for their presence.

It is interesting to note that none of these infested fields are in the older districts, where the feeding-trees have been cleared away, though the land was infested in the early days.

## GREENHILLS ESTATE.

Entering the plantation on the north, everything appears most favourable for a good crop; but as soon as one passes the high ground at the centre of the estate a terrible scene of devastation opens up. It looks as if a severe drought had struck it, in many places the tops being entirely dry. Fortunately, this year there has been no severe winds, and very little of the cane has fallen. The roots of these drying stools are all eaten off, however, and it is an easy matter to pull them over with one hand, for the soil is exceedingly friable.

A bird's-eye view of the estate under these conditions is most instructive, for it shows, decidedly, what I have been trying to emphasise in recent reports, that infestation has a very definite relation to the prevailing winds and feeding-trees. The part of the field adjoining the feeding-trees, to windward, is often less injured than that of the higher ground further back, as I have noted above. Evidently the beetles, in their blundering flight, follow the lines of least resistance, and come to rest on any elevated area. At any rate, it is common experience that the high ground is most severely affected; it is always in these parts that the injury first appears, possibly because the soil is more leached out and poorer.

It was most distressing to observe soon after I sent in last report, and before the refreshing rains, that the splendid cane of F3 was about to succumb. It will be recalled that part of this field was treated with a green crop of Mauritius beans, the effect of which was most remarkable upon the cane. The grubs were very noticeable in the untreated part of this field a month ago, but the cane of the treated portion continued a healthy green and had every appearance that it was going to resist the attack. The dry weather continued too long, however, and this beautiful field went brown in a week. Evidently the extra humus of the beans was not enough to carry the grubs over the trying period. With abundant, normal rainfall, however, the cane would doubtless have come through in good shape. Anyway, the added humus staved off the injury for more than three weeks, thus showing that this is a step in the right direction.

A second disappointment has been the field C3 treated with sulphate of ammonia. Like the beans, this chemical showed a marked stimulus to the crop, and at the time of writing last report I had great hopes for a successful result. The lack of rain, however, proved too trying, and the cane finally went yellow.

Arsenic at the rate of 10 lb. per acre sprayed or dusted on the vegetation at the time of ploughing the ground preparatory to planting, is proved to be of little or no value in destroying the grubs. All of the plots treated in this way have succumbed. It may be necessary to use more of the poison, but before we draw any conclusions we must await the results of other experiments. Those we have under way indicate that the poison has considerably more effect when applied near the roots of the young plants.

## ON THE VALUE OF CULTIVATION.

Standing out in marked contrast to the surrounding devastated areas are the fields which chanced to get intensive cultivation at just the critical time. In each of these cases the planting was late (October), and, consequently, the cultivation followed through the flight of the beetles. The field of first ratoons (lower half of  $L_6$ ) is showing most remarkable growth, and only slight infestation on one edge. It was cut in November, and the ratooning coincided with the flight of the beetles. It certainly now looks as if we would get another good crop in the midst of this infested area, with no other treatment than proper cultivation.

Then, too, the 40-acre field of plant-cane,  $J_1$ , still has a fine dark-green colour, in marked contrast to the devastated fields on every side of it. Only in a few spots along the tramline is there any indication of grubs, and these do not appear to be spreading, for the recent rains have improved the colour and vitality of the cane.

Digging shows that the grubs are beginning to go down. Many are yellow, showing that they have finished feeding, so the most of their devastation is probably over. Continued rains may possibly revive much of the injured cane if it has time to make new roots before it falls over.

## MERINGA PLOTS.

These plots are located on high ground, where they suffer considerably from any continued drought. During the dry weather in March signs of grubs began to appear on the edge of several of the plots, but in no case has the yellowing extended farther into the plots. Indications now are that the critical period is past, and that we will have a fair cut. None of the injured cane has fallen, so with good rains it will all revive.

It is interesting to observe that the cane in the plot treated with lime ( $CaO$ ) at the rate of 1 ton per acre, has a beautiful dark-green colour, and is the best of all the plots, though the soil in that part of the field is rather poor, being on the highest ground. The meatworks manure appears to be attractive to the grubs, because there is considerable yellowing along the edge of this plot. On the other hand, meatworks manure, mixed with white arsenic, placed in the drill after planting, is showing good results. The cane is of good size, and shows little grub-injury, even where only 10 lb. of arsenic was used per acre. In the plot where 20 lb. of arsenic was used with 5 cwt. of meatworks manure per acre, no signs of grubs have yet appeared. It is too early yet to draw definite conclusions, but these indications are encouraging.

## CANE GRUB INVESTIGATION, MAY, 1919.

The continued rains have wonderfully improved the appearance of the cane in the infested areas. Fortunately there has been no heavy wind, and in most cases the cane is still standing: Even where the leaves became dry and brown new growth has started. Digging revealed new

roots beginning to shoot out: Apparently the grubs reached their zenith about the middle of April, in this district, and they have now (10th May) almost all gone down.

#### MOSSMAN DISTRICT.

During the month I made a careful survey of the grub situation in the Mossman district, a region which had been of special interest to me because of the remarkable way the grub-pest disappeared there. In former reports I have noted my observations on the emergence of the cane-beetles, which were rather numerous last December, and I was therefore agreeably surprised to find little evident injury from grubs this season at Mossman.

I can only assign this immunity to two important factors:—Late cultivation, and the use of ammonium sulphate. This chemical is used rather generally throughout the district. The season, too, has been particularly favourable for late cultivation, and I found absolutely no injury to the late-planted cane. The only places where the grubs got in their work, were in the ratoons and early-plant crops, which had been laid by before the beetles flew. An interesting example of this was on the farm of Crees Brothers. A field of  $13\frac{1}{2}$  acres of Badila was planted in June, 1918, on rich sandy-loam soil. Only about half of it was cultivated during the flight of the beetles in December; the other half was not worked at that time because of the difficulty in getting through it. The crop is most remarkable, for the portion which did not get the final cultivation has suffered considerably from grubs, while the worked half is uninjured. The land was fallow for twelve months before planting, because a crop had failed to strike. At the time of my visit the late-cultivated portion was a beautiful dark-green, with stalks of 5 or 6 feet in length. Mr. Crees informed me that no manure was applied. One could not find a better example of the value of cultivation in the control of grubs.

The late-planted Badila in an adjoining block on this farm gave no indications of grubs. It is about 10 feet high, and could not look finer. About a bag of ammonia was used to the acre, after the rains began, and cultivation was continued right through the flight of the beetles.

This farm formerly belonged to Mr. F. W. Barnard, who had serious losses from grubs in the early days. He became an advocate of the use of carbon bisulphide, and I found that he recognised the value of late cultivation. He wrote:\* “Farmers in this district, on land subject to grubs, have found that by planting not earlier than September the cane is young and growing vigorously at the time the grubs are about. The plant is then continually throwing out fresh rootlets, which enables it to withstand, to a certain extent, the onslaught of the pest. Also, at the time the beetles lay their eggs cultivators are being freely used, which destroys large numbers of them.”

\* “The Australian Sugar Journal,” Vol. 1, p. 481.

As is well known in the district, Mango Park, the estate of the late J. D. Johnson, was once a centre of infestation. Mr. Johnson tried every suggested remedy, and, finally, the worst fields were thrown out of cultivation. I am therefore particularly interested in this estate, for it is no longer a grubby centre. The infestation is very slight this season, and only appears in one small field of ratoons, which received no ammonia and only slight cultivation, which was finished before the beetles flew.

The crop throughout the estate is most promising this season, the foliage is a beautiful dark-green, and since the recent rains the growth has been most satisfactory. Only 123 acres are under cane, at present, but a much larger area could be worked if facilities were available. The present crop, which has been estimated at from 1,600 to 2,000 tons, could well be doubled by increased planting and more intensive cultivation.

D1135 has been the principal crop on this estate, and at present 77 acres of ratoons are of this variety. This cane is very resistant to drought, and, since most of the ratoons had a dressing of ammonia during January, the impetus to the growth is most remarkable. The application of this manure was followed by gentle rains, and the cane got the full benefit.

The 46 acres of plant-cane was all put in late (August to November), and it is worthy of note that the cane has no sign of grubs, although growing on the part of the farm which previously was always affected. A part of this cane is on land which has been out of cultivation for seven years, because it was considered too grubby for profitable working.

Most of the plant-cane has had a dressing of about 4 cwt. meatworks manure per acre, and has made splendid growth, especially HQ 426 (Clark's seedling), which seems especially suited to that class of soil. It is double the size of the Badila, Goru, and D1135, planted at the same time, and covers the ground so that it has no weeds, which are abundant in the latter variety, because of its upright, sparse growth.

Present observations would indicate that it is possible to grow bumper crops on even the worst infested locations by giving care to cultural methods alone.

Infested portions must be planted late, so that the cultivation coincides with the flight of the beetles, particular care being given to forcing cultivation during the first three weeks after the beetles' appearance. Manure also has an important bearing thereon, especially the nitrates, if applied at the time the cane is beginning to suffer from grubs. Nitrates give the cane increased vigour, and forces new roots to replace those that are eaten off.

Mr. W. P. Jones called my attention to one of his fields, which demonstrates the value of intensive cultivation. He had the ground ploughed eight times previous to planting in October. This cane is now a very dense stand on the scrub land, and is about 10 feet high. It has only had about half a bag of ammonia per acre, but the colour is excellent.

Though this land was grubby in former years, there is now no sign of injury, and there is every indication of a 50-ton crop. One can see why Mr. Jones believes in thorough cultivation and the use of nitrate for cane. It was on this estate (the late R. O. Jones's) that such severe injury usually resulted from the grubs. The only place where they showed this season was along a ridge in a field of 4th ratoons, a part of the field which had received no ammonia, but the injury was of no consequence for the cane picked up again after the grubs ceased feeding, about the middle of April.

There is a very interesting experiment in growing cane on the black forest land at Saltwater, on the farm owned by Mr. C. A. S. Andrews. This part of the farm has a most peculiar soil, as loose and friable as a garden, and one would naturally conclude that it would produce excellent crops. Experiments with early plantings, however, have invariably come on well until the cane is about waist high, when it quickly succumbs, as if the soil was too poor or dry. To investigate this matter, last season I dug under dead stools in this class of soil and found that *Lepidiota frenchi* grubs were sufficiently abundant to account for the failure. Hence I was especially interested to find that Mr. Andrews was having success with late planting. He used both Clark's Seedling and D1135, and the cane has made most satisfactory growth in spite of the severe setback that it got by the drought.

This land has been treated with  $5\frac{1}{2}$  cwt. meatworks manure, and  $1\frac{1}{2}$  cwt. sulphate of ammonia, per acre. This black soil is easy to work, for it is free from weeds. No chipping was required, and the scarifier was used only two times; it is nevertheless very clean, and the cane covers the ground.

The late planting in the present case has enabled the crop to escape the grubs, and it is now too late for them to injure it. By cutting in October or November it may be possible to ratoon the field so as to avoid them again, if the horsework is continued through December. Moreover, this pest, which has a two-year life cycle, probably will not continue after this first lot gets out of the way. The *frenchi* beetles appear to prefer blady grass, and, as this is abundant on every side, they may stay out of the ploughed land.

I was interested, too, in the disappearance of the cane rats at Mossman. I could hardly find a trace of them on this trip. The mill made no small outlay in laying poison baits at the end of crushing last season. These were prepared with split canes and arsenic, and scattered in all the rat-infested localities. Results were soon evident, for dead rats were found, and there was a strong odour of carrion along several of the watercourses. At any rate, the rats are not showing up this season, and the prospects are very encouraging.

#### IMPORTANCE OF NECTAR-PRODUCING PLANTS IN CANE AREAS.

The observation of our native parasitic wasps (*Campsomeris* sp.) feeding on flowers of various plants along the Mulgrave River suggested

that it would be wise to have more honey-bearing plants on the waste ground near grub-infested cane areas, so that the wasps would be attracted to these localities and eventually turn their attention to the grubs.

It is well known that the adults of these parasites subsist upon sweet secretions, which they secure largely from flowers, when these are to be had; they also feed upon honey-dew, and in breeding them in captivity we found that they take any form of liquid sweet that is offered them.

As far back as 1901 Mr. J. C. Clarke,\* of the Hambleton Sugar Mill, Cairns, called attention to the importance of planting Congo or pigeon pea (*Cajanus indicus*) around each field, and the growing of the Bona Vista bean (*Dolichos lablab*) as a crop for green manure, so as to encourage the multiplication of parasitic insects which feed on the nectar. He observed that the parasitic wasps were abundant at the flowers; and, at the time of harvesting the cane, close by in the same field, he discovered many of the larvæ of these parasites in the soil, where they were destroying the cane grubs.

In Mauritius, too, the interesting observation was made that *Tiphia parallela*, which was introduced from Barbados, only reproduced successfully in localities where nectar-bearing flowers were present. In its native home this species never was known to visit flowers, for it fed upon the honey-dew from aphids. In Mauritius, however, plant lice are so well controlled by natural enemies that the wasps were compelled to turn their attention to flowers for existence.

These observations would suggest that our own native parasites of the white grubs might be considerably assisted and encouraged if we provided them with suitable nectar-bearing flowers in the vicinity of the infested cane areas. Naturally, these wasps, in their quest for food, are led far into the wild country, and, since they can easily find their natural prey, white grubs, there under the grasses, they seldom return to the cane areas to oviposit.

The abundant flowers of the pigeon pea are particularly attractive to hymenopterous insects. Furthermore, this plant is of recognised value for green manure,† a fact which was demonstrated by the experiments of the C.S.R. Company years ago. They found that it was even better than the black Mauritius bean, especially for the long fallow during the dry months, for its dense foliage prevented the growth of grasses.

I secured a few seeds from Senator Crawford, who has a fine lot of these bushes growing in his yard at Mossman. I shall try some experiments as to their attractive value for the wasps by planting them along the headlands of our infested fields.

\* Agric. Gaz., N.S.W., 1902, pp. 1-6.

† See Illustration, "Australian Sugar Journal," Vol. 1, p. 21.

## GREENHILLS ESTATE.

The immune area, which one sees upon entering the estate, is in excellent conditions, both as to growth and colour. The late rains have done much to retrieve the bad effects of the drought.

Even the infested portion of the estate is considerably improved over what it was a month ago. Little of the injured cane has fallen, so, if the rains continue, much of it will form new roots and revive, now that the grubs have about completed their feeding.

It is interesting to note, again, the good appearance of the cane at the edge of the fields bordering the feeding-trees to windward. In some cases this shows no sign of infestation, the beetles apparently flying for some distance, often several chains, before alighting to oviposit.

The October plant-cane of field J1 is still dark-green in marked contrast to the brown fields on every side. There are only a few spots which have shown any grub-injury, and these are rapidly improving. J4, just across the tramline, planted in August, is a wreck. It had a lot of cultivation, but none at the vital time—*i.e.*, during the early part of December, when the beetles were beginning to oviposit.

It is also very satisfactory to be able to report the splendid condition of the first ratoons in the west half of L6. The slight indication of grubs, noticeable a month ago along the tramline, has entirely disappeared, and the cane is in perfect condition. It will give a second good cut about November, and will probably ratoon again successfully during December.

It will be unfortunate for our investigations if this estate is thrown out of cultivation, as is now considered probable since the loss caused by the grubs is so tremendous. One could not wish for a better growing-soil if the grubs would let the cane alone. It is exceedingly friable and fertile, producing satisfactory crops even without manures. In spite of the fact, however, that I am more and more confident of success with this type of land, I can hardly expect the present lessees to go on paying out money, since they have already expended more than £26,000 above receipts, on the chance that the estate would again produce a 30,000-ton crop.

## CANE GRUB INVESTIGATION, JUNE, 1919.

The past season has been particularly favourable for eradication of cane grubs in most of the Northern districts. The dry weather early in the year necessitated frequent cultivation, which not only hindered egg-laying, but also is a most effective means of destroying the young grubs. Then, too, the continued rains, which were so late in starting, pushed the new roots just at the right time, when the beetles were getting in their worst work; hence, in many cases, the cane was quick to recover.

During the month I made a survey of the grub situation on the Johnstone River; and also secured a fresh supply of the borer-beetle parasites from the Mossman.

## THE JOHNSTONE RIVER DISTRICT.

I was interested to note the remarkable scarcity of grub-injury in the Goondi area, for the beetles were particularly abundant last December. The farm of Mr. R. Davis, which is typical of those at Daraji, has always suffered considerably in former years, but there is no sign of grubs this season. It will be remembered that the Goondi Mill was very late in starting last year because of the damage from the cyclone; hence all the cane was cut after September and the ratooning coincided with the egg-laying of the beetles. Mr. Davis also planted late, so that all of his crop came in for cultivation during the critical time, and his crop is perfect.

I was also able to visit other farms through the kindness of the Colonial Sugar Refining Company's officials, and Mr. E. S. Smith, the cane inspector at Goondi, took me to Stockton paddock, a grazing area of 240 acres owned by Mr. Shaw. This is a most interesting spot, since most of the money from the Cane Pest Destruction Fund is spent for beetles collected there. Furthermore, strange to say, the surrounding cane has not suffered from grub-injury. Mr. Shaw planted 30 acres along one side of this paddock, and though this is adjoining feeding-trees to windward, the first ratoon crop is in excellent condition. Examination revealed numerous grubs in the grass-land; hence, it appears evident that all this extensive supply of beetles is developed there, and they have not taken to the cultivated fields. If, however, all of this area was cultivated, the ravages of the pest would probably appear.

At the South Johnstone Mill the scrub has only been felled along the narrow valleys, so that naturally much of this cane area is affected by grubs, for feeding-trees border most of the fields.

I was very fortunate in making the acquaintance of Mr. F. L. Sugden, one of the most successful growers of the district; a man untiring in his efforts to improve the condition of his fellows, many of whom are labouring under most distressing circumstances. Mr. Sugden's own success has evidently been due to his extensive experience along agricultural lines and scientific application. Although his cane was seriously troubled with grubs for several years, he has now practically rid his fields of the pest. He uses lime in the cane holes on even the new land, and is a firm believer in the value of conservation of humus. He also recognises the value of removing the feeding-trees of the beetles; in fact, this probably accounts for much of his present immunity. Another factor which has an important bearing on this case is that Mr. Sugden controls weeds in the cane of his stump-land by spraying them with sodium arsenite. In this connection Mr. Sugden called my attention to a striking demonstration of the value of spraying. On adjoining stump-fields one grower removed the weeds by chipping, while his neighbour for the same purpose used several sprayings of sodium arsenite. The full-grown cane in both fields now shows a marked difference, although the land was identical in every way. The chipped field is badly damaged by grubs.

while, right up to the line of treatment, the sprayed field is perfect. It may be premature to form a definite conclusion, but the suggestion is certainly worth consideration and further experiment.

#### ON THE VALUE OF LATE CULTIVATION.

Mr. Sugden also drew my attention to a 10-acre field of second ratoons on his stump-land, and gave me the following interesting history:—This cane was planted late in 1916. At the end of the season, 1917, half of the cane was cut and the balance left for plants. The cyclone of March, 1918, wrecked this seed cane, but the best of it was cut, and all the discarded decaying stalks were left on the ground. The other half was so stunted by the cyclone that it made very poor growth, and, later, accidentally was set on fire. Mr. Sugden then decided to draw the logs together so that he could use the pony plough on this part, and consequently cultivated during last December and January while the beetles were flying.

The present result is most remarkable; the cane in the cultivated area is as dark-green as if treated with sulphate of ammonia, and will cut a splendid crop, contrasting sharply the half which was volunteered through the rubbish, which is very yellow and grubby.

Evidently, the pony plough was effective in preventing the ovipositing of the beetles, while possibly the surplus rubbish in the other part was an inducement to the beetles to lay.

#### FEEDING-TREES.

Through the kind assistance of Mr. Sugden I was able to visit the extensive district extending out to Stewart Creek. The whole of this area is new, but is subject to grub-attack, simply because of its proximity to standing scrub. All of the holdings are small, and the owners are working under extreme disadvantage, owing to lack of funds to clear sufficient scrub to make their land immune. With the scrub quickly cleared, I have no hesitation in saying that there would be little or no danger from grub-injury, for the feeding-trees would then be left so far back that the grubs could only damage the edges of the fields.

What I have said in regard to Stewart Creek district might apply to other valleys supplying cane to this mill; for I observed on a trip to the section known as the "Seventeen-mile," that most of the small cane areas surrounded by scrub were considerably grub-infested, and that the broad stretches of cane were immune, except, in some cases, if the fields bordered the scrub.

It will be of interest to state that I do not find on the South Johnstone River the definite relation of infestation to the south-east trade wind that I find in the Cairns district. Evidently the flight of the beetles is considerably influenced as well by the land breeze from the west, which is said to be the prevailing wind at night during the summer. Hence we may justly conclude that in this district any near-by scrub is a menace to the growing of sugar-cane.

## FURTHER NOTES ON THE VALUE OF ARSENIC FOR GRUBS.

Above I have alluded to the destruction of weeds by the use of sodium arsenite. Indeed, I was considerably surprised to find that the farmers, under the direction of Mr. Sugden, were so advanced in their application of this valuable remedy. The Association has purchased and is using most successfully the Vermorel knapsack spray for the eradication of weeds in new stump-land. Not only is the process much cheaper and easier than chipping, but the effect of the arsenic will be far-reaching in the soil for the control of root grubs.

I was very fortunate in being able to discuss this important matter with Mr. C. E. La Caze, a grower of extensive experience, not only here, but also in Mauritius. About a dozen years ago Mr. La Caze was farming on the Herbert River, and had serious losses from grubs. Often half of his plant-cane was destroyed, and, he said, his losses amounted to many thousands of tons on his three farms there. He was faced with bankruptcy and decided upon extreme measures. Learning that white arsenic would destroy termites, he at once decided to try it for the destruction of the grubs on all of his lands. He hit upon the plan of mixing the arsenic with meatworks manure and arranged to have the mixing done at the meatworks. As arsenic was then cheap he used 14 lb. of the poison for each cwt. of the meatworks manure, and applied about 5 cwt. of the manure to the acre, placing it in the drill before planting. Between 500 and 600 acres were treated in this way. The results were immediately noticeable, and, he informs me, there have been no further grubs on that land since.

This information certainly is very interesting, and appears to be conclusive, but Mr. La Caze said that he kept no checks, and also stated that some of the feeding-trees were being removed at about that time, so it will be well to try similar experiments with arsenic in other places before we can decide definitely that the poison was the eradicating factor.

I wish to urge the importance of trying an experiment with arsenic on every grub-infested farm. I do this largely as a result of our success with this remedy at Meringa, where we got excellent results by using only 20 lb. of the poison to the acre, mixing it with about 5 cwt. of meatworks manure, which was applied in the drill at the time of planting.

I would suggest that each grower try at least 1 acre, leaving an area alongside as a check. The poison may be applied either alone or mixed with the meatworks manure; but I think it important to centralise the poison by placing it in the drill. I have advised many growers on stump-land to test its value by using 20 lb. of the poison per acre, applying it in the cane holes after the plants are covered. In the case of ratoons among the stumps, the dry arsenic might be dusted on the trash after cutting, placing most of it in the centres. This could be done easily by placing the poison in two bags of thin hessian, attached at the ends of a pole about 5 feet in length. Holding this by the middle it is an easy matter to dust two centres at a time by walking over the row.

After dusting, the trash should be relieved slightly, thus bringing the arsenic largely into the middles of the trash piles, where the grubs are sure to reach it as it combines with the decaying organic matter. As a matter of course the ovipositing beetles will seek these piles of rubbish, and the young grubs may get their death-blow before the advent of the dry weather, at which time they usually attack the cane roots.

It will be of interest to users of arsenic to know that soreness developed on hands and other parts of the body can be quickly cured by bathing the affected parts in a solution of hypo (hyposulphite of soda). This I learned years ago when I was using the poison constantly.

#### NECTAR-BEARING FLOWERS FOR PARASITES OF WHITE GRUBS.

Last month I called attention to the importance of this subject, hence I was considerably interested when I found these beneficent insects in great numbers in the flower garden at Mr. Sugden's farm, which, by the way, is the finest display of colour I have recently seen. Most canegrowers consider their time too occupied for the growing of flowers, but the trouble of gardening will probably be proved to pay in more ways than one. Both sexes of the wasp *Campsomeris tasmaniensis* were very busy in the garden on sunny mornings, especially on the flowers of the Klondike cosmos and pigeon pea.

It is not improbable that these insects have assisted materially in eradicating the grubs which formerly troubled these fields.

#### MOSSMAN DISTRICT.

The Beetle Borer, though practically wiped out in most parts of the district by the tachinid parasite (*Ceromasia sphenopheri*), has become somewhat troublesome in one field on the farm of Crees Brothers. This is the location where I secured the parasites last year, and both parasites and borers have multiplied there because the cane was simply volunteered without burning the trash.

Fully 90 per cent. of the borer-beetles' grubs are parasitised. The only grubs which escape the flies are those down in the butts of the stalks, where the flies find difficulty in reaching them.

It is interesting to note that a large proportion (more than half) of the flies had already escaped from the puparia. Therefore it would appear best to collect these infested stalks earlier in the season, say, about April, for cane planted late in August, or when the cane is about eight months old.

For the control of this borer-beetle it is decidedly best to burn the trash, for then practically all the grubs succumb, even when inside the discarded sticks on the ground. The flies, on the other hand, are more apt to escape to other fields if the burning is done after cutting the cane green. This I found to be the case in the mill nursery, where we first secured the parasites. Here the trash was burned off after cutting, and I was unable to find a single live grub in the blackened stalks. This cane

had not been burned for several years, and the borers and their parasite were well established. Now I find that there is scarcely any borer-injury, and the few grubs I was able to locate were fully parasitised. Evidently the flies are able to take care of themselves when the trash is fired.

The parasites secured on this trip are to be liberated in the Mulgrave and Babinda districts, where the beetle-borers are still giving considerable trouble, especially on the low-lying fields. There has been a very evident spread of the pest during the past year, because of the lack of care in selecting seed. The parasites that we formerly liberated in these districts may possibly be established, but it is a difficult matter to discover them until the cane is cut. Once they get a start, however, they ought to quickly spread to most of the infested fields.

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