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Notes on Queensland Cane Insects and their Control

SECOND
SERIES

By
EDMUND JARVIS, Entomologist.

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FOREWORD.



Bureau of Sugar Experiment Stations,

Brisbane, 28th February, 1925.

THE Notes comprised in this Bulletin (No. 18, second series), on Queensland Cane Insects and their control, have been prepared by the Entomologist to the Bureau of Meringa, near Cairns, Mr. Edmund Jarvis, and will be of great value to cane-growers.

H. T. EASTERBY, Director.

Notes on Queensland Cane Insects and their Control

By EDMUND JARVIS, Entomologist.

INTRODUCTION.

THE information embodied here has appeared in the form of Monthly Reports, which, being scattered through the pages of our Agricultural Journal and other periodicals, are not readily available for reference purposes until brought together and suitably indexed.

The present publication is a continuation of the Notes on Queensland Cane Insects and their Control commenced in Bulletin No. 17 of this Experiment Station, and covers the period from July 1922 to June 1923.

It may be well to mention that Meringa is situated within 20 degrees of the equator, having an average rainfall of fully 92 inches; while the annual mean temperature may be taken as being about 76° Fahr.

A number of photos are included in illustration of the various insects alluded to, and these, together with a comprehensive index, should enhance the usefulness of this Bulletin.

July 1922.

VISIT TO SOUTH JOHNSTONE.

A trip was made to this district on the 17th instant, with the object of—(1) Investigating certain diseases of cane reported as occurring in the vicinity of the Johnstone River; (2) studying the insect pests of cane; and (3) fixing on suitable spots for liberation in the near future of tachinid fly-parasites to combat the weevil-borer (*Rhabdoenemis obscurus* Boisd.) which on some of the plantations is doing a lot of damage.

On the whole, cane at South Johnstone was found to be particularly free from fungus or bacterial diseases, which have at times, during prolonged wet weather, occasioned serious losses in the Burdekin and other sugar centres. Badila seems to be the variety mostly grown here, and certainly thrives luxuriously on the best classes of red soil.

The cane inspector (Mr. McCartney) drew my attention, for instance, to a block of plant Badila on which many of the stools carried from fifteen to nineteen sticks, 6 to 8 feet in length and from 1½ to 2 inches thick. I wish to thank Mr. James Cran, Mr. P. H. McWalters, and Mr. A. C. Brackenbury for assistance rendered during my visit.

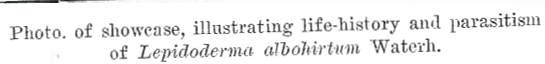


Photo. E. Jarvis.

The following cane affections were noticed; all of them being of minor economic importance:—

(1.) *Form of Dead Heart*.—About 5 per cent. of the cane on a small block of Badila planted last August was affected by a curious disease characterised by death or non-development of the central shoot, followed, as is usual in such cases, by abnormal growth of the top buds, the shoots from which were 6 to 12 inches long. The inner surface of upper leaf-sheaths was intensely red, although the leaves for the most part appeared normal. In some cases the central core yielded to a slight pull, when the basal portion was seen to be decayed and malodorous. Longitudinal

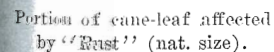
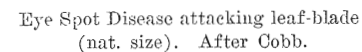
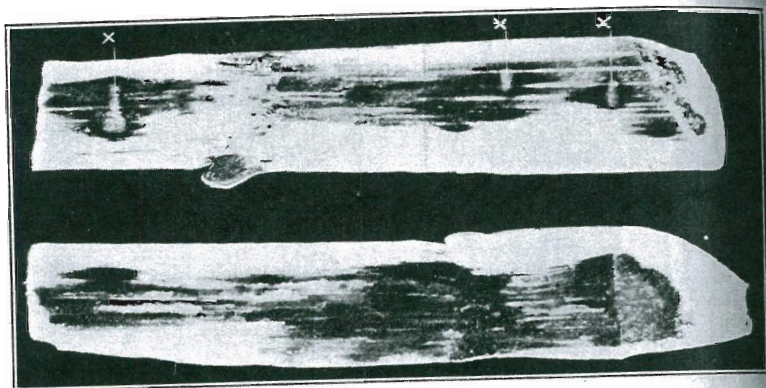


Photo. E. Jarvis.



Sections of canes showed central discolouration of the upper portion, but no gumming of any kind; while the rotting base of the dead-heart, which was often situated 2 inches or more above the terminal core of the stick, presented an appearance of having in the first instance been broken transversely as a result of mechanical injury. A hollow space of an inch or more sometimes occurred behind this decayed end, while the lower portion of the dead-heart, although not decomposed, showed irregular patches and lines of bright red when sectioned lengthwise. It was

frequently noticed that one of the internodes, about 9 inches from the top of canes having this disease, was shorter than those immediately above and below it—indicating, perhaps, that growth of this internode had been checked owing to dry conditions obtaining during its development. A transverse section through this short internode revealed the presence of a decayed brownish-yellow, core-like spot or small cavity, about 4 mm. in diameter, with paler suffused margins, situated near the centre of the stalk, and extending about 1 inch in a longitudinal direction. In some cases the surrounding vascular bundles were also discoloured, appearing as watery yellowish-brown spots in cross-section. Possibly the central shoot may have been affected at this particular stage of growth, resulting in a gradual development of dead-heart later on. No indications of the occurrence of either moth-borers or leaf-eating insects were noticed. Examination of some of the diseased tissue from the decayed core of this short internode showed that bacteria were absent.



Section of cane-stick having "Red Rot." Note characteristic white spots in middle of the red blotches, opposite X X X. After Lewton Brain.

Photo. E. Jarvis.

(2.) *Cane Rust* (*Uredo kuhni*) was noticed in places, but very sparingly.

(3.) *Eye Spot Disease* (*Cercospora sacchari*).—Found associated with plants having dead-hearts, but was not an invariable accompaniment of this affection, and occurred mostly on the older leaves.

(4.) *Red Rot* (*Colletotrichum falcatum*).—Canes exhibiting this well-known disease were seen on some of the trucks. Fortunately injuries due to this fungus can be reduced to a minimum if care be taken to reject when planting any sets showing red discolouration at the cut ends.

(5.) *Bunchy Top*.—A few isolated examples of this curious abnormal development of the upper leaves were noticed among stools of Badila cane.

CANE-BORER AT SOUTH JOHNSTONE.

The weevil-borer *Rhabdocnemis obscurus* Boisd. is causing much damage on some of the cane lands at South Johnstone, and during my visit suitable spots for liberation in the near future of *Ceromasia sphenophori* were selected. It is hoped the activities of this parasite may ultimately relieve the present situation, although it is, of course, within the bounds of possibility that natural enemies or climatic influences may prove serious obstacles to its successful establishment. Long-continued damp conditions favoured by the heavy rainfall of this district might, for instance, enable the entomogenous fungus *Empusa* sp. to develop through the wetter months of the year, in which case it might operate as a severe check on the increase of this useful tachinid fly parasite. The various species of jumping spiders and the ever-present little black ant *Pheidole megacephala* found commonly in our canefields will doubtless destroy a certain percentage of these flies, but losses from attacks of insect enemies are usually of minor importance compared to those brought about by vegetable parasites.

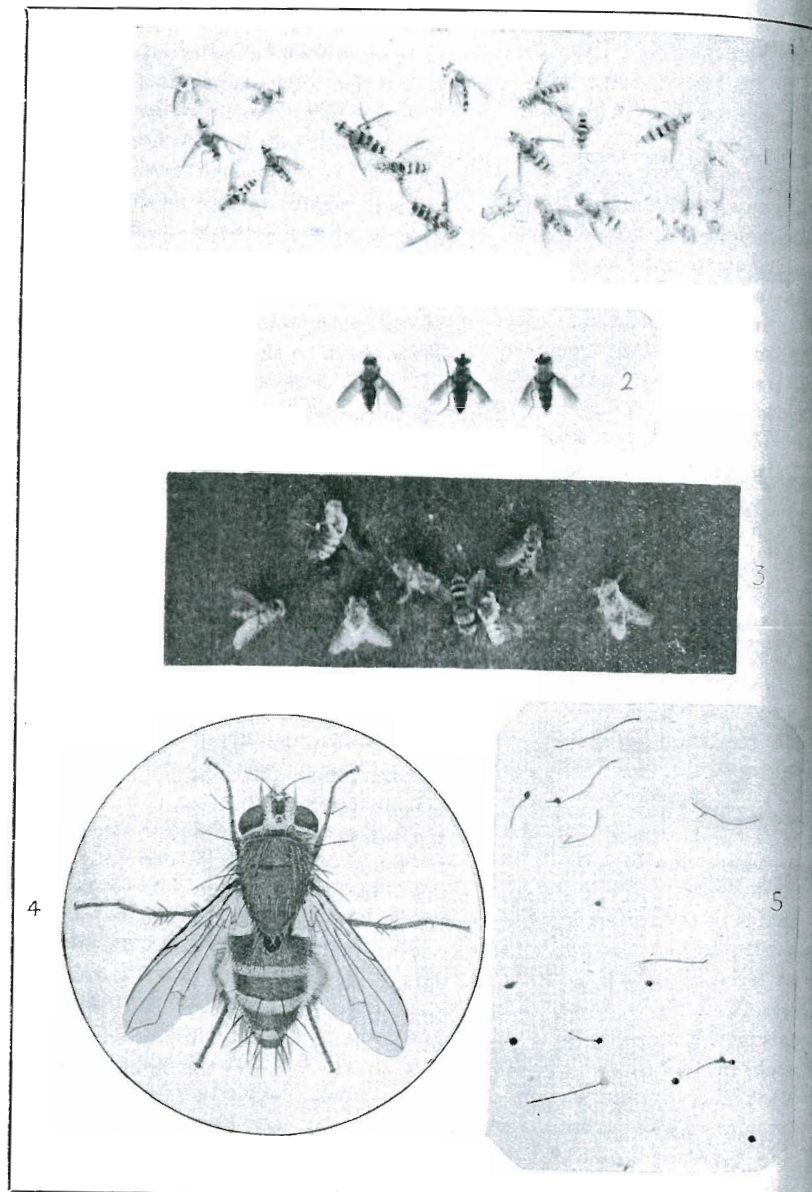
However, we naturally hope for the best, and it may easily happen that the tachinid flies after liberation will spread rapidly and do good control work.

BACTERIAL DISEASES OF GRUBS.

On 12th June three cane-grubs exhibiting a pinkish discoloration were collected from cane furrows at Meringa and kept under observation. Eleven days later one of these had developed a bacterial disease (B2), the internal organs having for the most part disappeared and been replaced by a blackish fluid. When held against strong light the abdominal regions of the body were seen to be partially hollow, and the skin slightly distended by the action of gases. Smears taken from this grub swarmed with motile rod-shaped bacteria, occurring generally in pairs but often in chains of from three to five. Attempts to infect healthy grubs with this bacillus have not, so far, been successful. Cane-grubs attacked by another bacterial disease (B3) (*Coccobacillus* sp. ?), the symptoms of which resembled those produced by *Coccobacillus nigrofasciens*, were obtained this month, smears taken, and cultures made on slices of potato. Healthy grubs inoculated with this disease developed all the characteristic external blackening around the spiracles, &c., after twenty-four hours, and succumbed within three to five days. The rod-shaped organism responsible for this disease differs from that of the preceding (B2) in being proportionately longer and occurring almost invariably in pairs. Grubs affected by it emit an exceedingly offensive odour.

A third cane-grub, displaying dull red patches on the sides of the body, and which had apparently died of some bacterial malady, was found upon examination to harbour multitudes of the *Coccobacillus* No. B3, together with another species (*Micrococcus* sp. ?) (B7).

PLATE II.



- (1) Tachinid Flies (*Ceromasia sphenophori* Vil.), killed by parasitic fungus (*Empusa* sp.) (nat. size).
 (2) Healthy specimens of same.
 (3) Advanced stage of the fungus; showing flies surrounded by whitish cloud of spores or conidia.
 (4) Drawing of *C. sphenophori*, magnified twenty times.
 (5) Conidia of *Empusa*, showing germ-tubes in various stages of growth. Highly magnified.

NOTE.—Figs. 1, 2, 3, 5 original; 4, after Muir and Sweezy.

Colonies established by the latter on pieces of potato were of a decided red colour, while those derived from B3 were creamy yellow. Healthy grubs inoculated with the red bacillus (B7) remained normal; but my assistant, Mr. W. C. Dormer, discovered that, when they were inoculated with the two bacilli mixed together in water, the virulence and activity of the *Coccobacillus* B3 was greatly increased, and that grubs so treated died in about twenty-four hours.

We hope to discover some simple and practical method of infecting cane-grubs with bacterial diseases. This interesting phase of grub control has hitherto received little or no attention in Queensland, although presenting possibilities which should not be overlooked.

August 1922.

CANE PESTS ON THE HERBERT RIVER.

A special visit of inquiry was paid to this district towards the middle of August, with the object of reporting on various cane affections.

Rats and gumming disease appear to be doing most damage, but considerable injury is being caused also by cane grubs and borers.

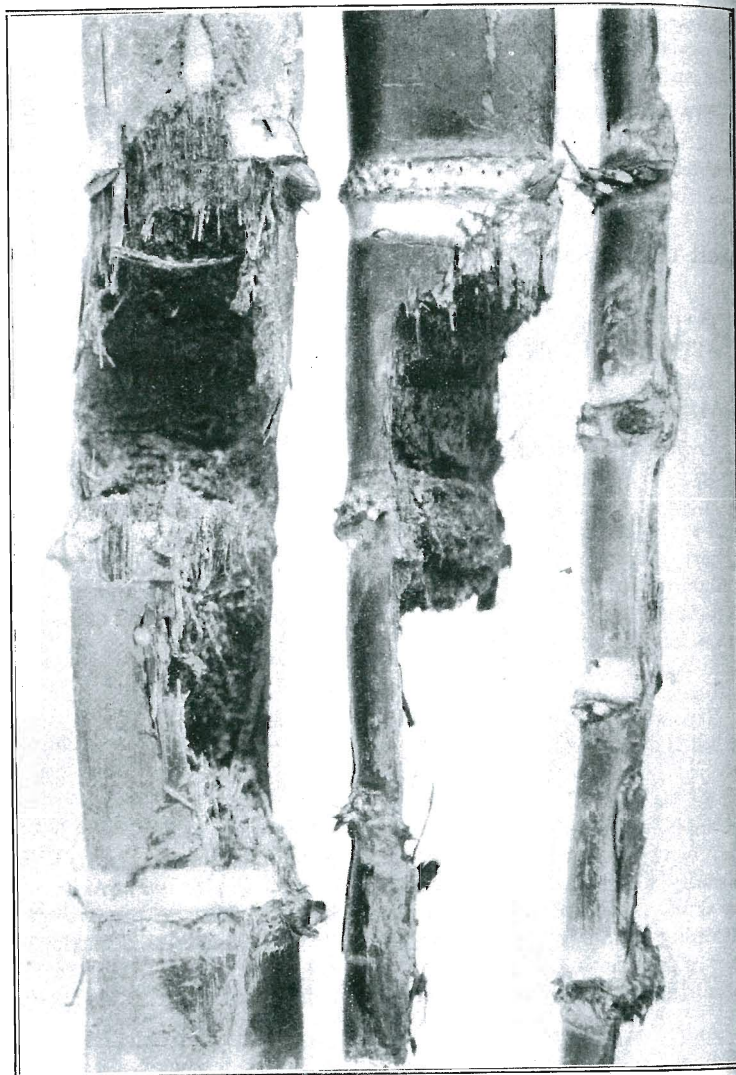
Owing to co-operation on the part of the managers of Macnade and Victoria mills I was able to get over the ground quickly, and so make the most of the limited time available. Interesting evidence bearing on the subject in question was obtained from the secretaries of the Herbert River and Macnade Farmers' Associations, and from Mr. Stephenson of Macknade mill, whose cordial assistance was greatly appreciated. Much of the information gathered will be found embodied in the following notes.

INJURY BY RATS.

This pest, which is said to be most plentiful on the Victoria mill side of the river, is considered responsible for injuries second only, if not equal, to those caused by gumming disease; the loss from rats last year in the Victoria mill area being estimated. Mr. Thornton tells me, at £30,000 sterling. The rats breed mostly in swampy lands and creek beds, being most numerous on selections adjoining such places, more especially where the headlands are narrow in width and allowed to get very weedy. Unfortunately they attack by preference the softer varieties containing most sugar, and by gnawing deeply into the basal portion of sticks will sometimes, when feeding among a heavy crop, bring to the ground in a single night scattered patches of cane of considerable extent.

An offensive campaign has been started by the Colonial Sugar Refining Company under the superintendence of their officer, Mr. Stephenson, the plan of procedure being to distribute poison-baits, manufactured by the company, to "controllers" in the various rat-infested districts. These are supplied with a list of growers to receive the poison; and in the Macknade area a man acting under the controller's direction goes from farm to farm systematically laying the baits. Although

PLATE III.



RAT-EATEN STICKS OF BADILA SUGAR-CANE.

Photo. E. Jarvis.

supplied free of cost, many growers will not take the trouble to do the work themselves, unless their cane happens to be severely attacked. Many different poisons are being tried, but phosphorus bait is thought to have given best results so far. To prepare a good bait of this description, dissolve 2 oz. of phosphorus in 50 oz. of boiling water; stir in slowly 40 oz. of flour, and when this mixture is almost cold add, while still tepid, 40 oz. of molten tallow and 20 oz. of sugar. Definite evidence with regard to the effect of these poisons is not always forthcoming, dead rats being seldom found; but I believe good work is being done, although we cannot expect to see any decided results within a few months after application.

Control Methods.—Briefly, these should consist in such commonplace methods as—(1) Leaving wide headlands and keeping them clean; (2) poisoning the rats, especially on infested blocks when nearly cut out, and during November and December when rats are forced to congregate on smaller areas of uncut cane; (3) cleaning up breeding haunts, when possible, in the immediate vicinity of plantations.

Experimentation with poison-baits should be continued until discovery of a more deadly yet palatable bait than those being tried at present. In this phase of the work we shall be pleased to co-operate with officers of the C.S.R. Company.

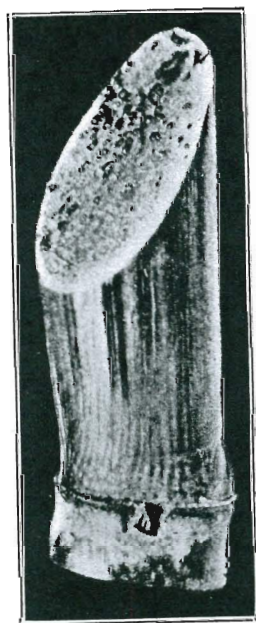
GUMMING DISEASE.

This familiar bacterial disease is prevalent, Mr. Stephenson tells me, throughout the Herbert River district, occurring for the most part in Clark's Seedling (H.Q. 426). Seeing that this variety matures in about eleven months, is rich in sugar, and generally yields a heavy crop, it is naturally a favourite, and grown here more than any other variety. A map of the gummed area is being prepared, and should furnish interesting data regarding the porosity, drainage, &c., of the various soils affected. Good crops of gummed cane can be obtained here, providing the trouble does not appear during early growth. Unfortunately, however, the Badila is already affected, and it is feared may become more so as time goes on, unless Clark's Seedling can be quickly replaced by some less susceptible variety.

Remedial Measures.—It is generally admitted that the chief factors responsible for the occurrence of gumming disease *Bacterium* (*Bacillus*) *vascularum* are—(1) Poor drainage; (2) an impervious subsoil within 2 or 3 feet from the surface; (3) defective cultural methods; and (4) an abundant rainfall. Topographical conditions, the physical nature of the land, and the general texture of the soil are supposed to exert no influence on its development.

According to Professor Cobb, this one condition of drainage has a most important bearing on the prevalence of gumming disease, and he recommends a rotation of crops where possible on land which has been a long time under susceptible varieties of sugar-cane.

A good instance of the benefit to be derived from proper drainage was brought under my notice at Halifax. The farm in question comprises about sixty acres situated on the river bank and divided by a roadway into two equal portions. On one of these which adjoins the river, good crops have always been obtained, while the cane on the other portion, bounded on the far side by a swamp, has invariably either failed altogether or been scarcely worth cutting. Three different selectors were unable to do anything with this latter portion, but the present owner has succeeded in raising a fine crop of cane, uniform in height throughout. This was effected simply by cutting a few deep drains through the block emptying on to the swampy land, and smaller cross-drains leading into them.



AFTER COBB
Gumming Disease of Cane
Cutting from gummed cane,
showing drops of gum
oozing out on the cut end.

Improvement of canes by selection, and the planting of immune or but slightly susceptible varieties, is of course advisable; and I understand that the company have this matter in hand. Less volunteering, and the use of green manures, would probably also tend to reduce the chances of gumming.



A—From sugar cane, stained
with methyl violet with-
out heat and mounted in
water.



B—From a culture on agar
agar sweetened with about
5 per cent of cane sugar.



C—From sugar cane, stained
with fuchsin and mounted
in balsam.

AFTER COBB
Bacterium (Bacillus) vas-
cularum, organism re-
sponsible for Gumming
Disease.

Little or no attention is being given to the selection of clean cane for planting, it being the practice on some holdings to place whole sticks in the drills, and before covering same chop them through here and there while lying in the soil. Needless to say, such lax methods of planting are very unsatisfactory from an economic standpoint, as borers, gumming, or other diseases would escape notice altogether and have a good chance of spreading to clean areas. This controlling factor is of primary importance, since it will avail little to thoroughly work and drain the soil unless clean sets are ultimately planted. Burning the trash has been recommended, as in this way one gets rid of countless numbers of bacteria, fungus spores, beetle-borers, &c.

PEST DESTRUCTION FUND.

Grubs have been very troublesome in places. Collecting the beetles was discontinued at Cordelia about five years ago, with the result that during 1920 considerable losses were experienced, these becoming worse the following year (1921). During the present season the damage in this district has been very severe, and I understand that collecting at Cordelia will be taken up again. At Macknade and Ripple Creek the growers pay so much per acre (up to 150 acres only) into the fund, the amount varying from 1s. 6d. to 2s. This method of payment is considered to be better than that of fixing the amount at so much per ton of cane. Naturally under the former system, the aim of both small and big farmers would be to produce as much cane as possible per acre, and so decrease the amount of the levy; thus, a 24-ton crop at 2s. per acre would cost one penny per ton to protect from grubs, whilst a 36-ton crop at the same rate would mean a reduction to three farthings per ton, and so on.

In order to achieve this result, better methods of drainage, cultivation, seed selection, &c., would have to be adopted, meaning not only heavier crops but also minimum losses from gumming, grubs, and other diseases.

PARASITE OF BEETLE BORER.

The cane-borer, *Rhabdocnemis obscurus*, appears to be spreading on the Herbert River, although occurring mostly in the basal portions of canes. Rat-eaten sticks are very liable to become infested, as the beetles oviposit by preference in soft places where the rind has been gnawed off by rats.

The C.S.R. Company have established a breeding-cage at Macknade for rearing tachinid fly parasites, and I made arrangements with the Secretary of Macknade Farmers' Association to collaborate with them, if necessary, in this useful work, in order that the parasites might have a better chance of spreading throughout the district with as little delay as possible. Mr. Stephenson is in control of the cage at Macknade, and has already bred and liberated a number of flies. In this connection it may be mentioned that tachinid flies are at present emerging freely in our breeding-cages at Meringa Laboratory; and on the 26th instant 60 specimens (mostly females) were liberated by us among bored cane at South Johnstone, while three days later another lot of 25 were let go at Aloomba.

PLATE IV.

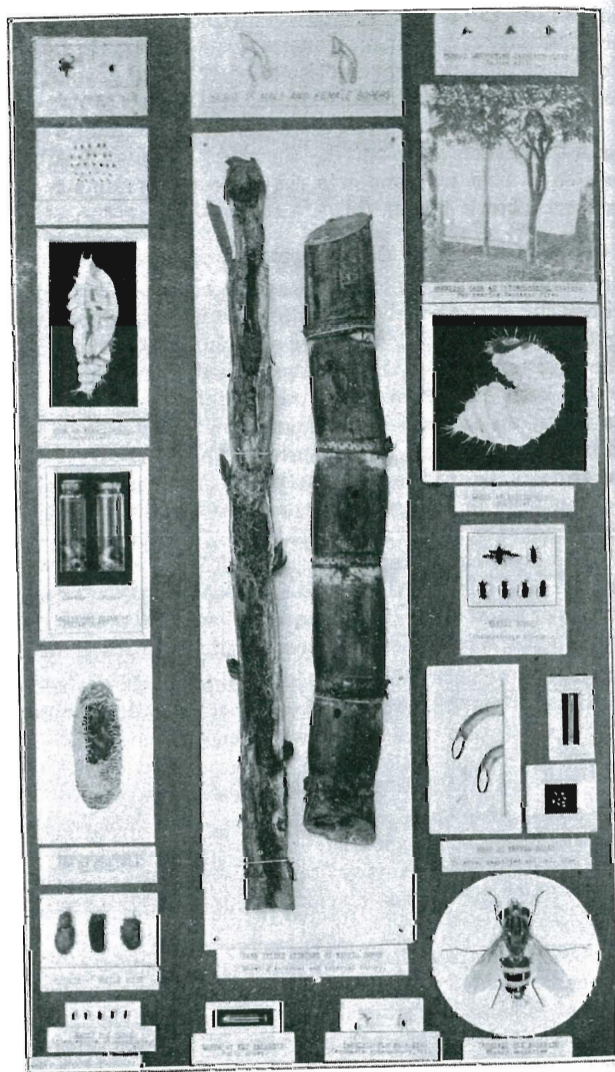


Photo. of showcase, illustrating life-history of Weevil Borer (*Rhabdocnemis obscurus* Boisd.). (Full size, 30 by 18 inc.).

Photo. E. Jarvis.

WHITE ANTS ATTACKING SUGAR CANE.

Destruction of cane-sets at Gordonvale by two species of white ants (*Termes meridionalis* and *Eutermes fumigatus*) was first recorded in Bulletin No. 3 of this office. This damage, however, occurred mostly in ground brought under cultivation for the first time, and is of minor economic importance. In such cases the presence of this pest is doubtless due to infested roots of big trees having been left ungrubbed. I was much interested to learn from Mr. Gibson that a small species of termite is known to attack cane-sets planted in well-worked land at Macknade. In one instance, patches of cane affected in this way were found distributed over a field that had been under cultivation for the past thirty years.

October 1922.

EXPERIMENT PLOTS AT MERINGA.

The cane on these plots was cut during the second week in August, the crop going about 18 tons to the acre, while the c.c.s. was 8.14.

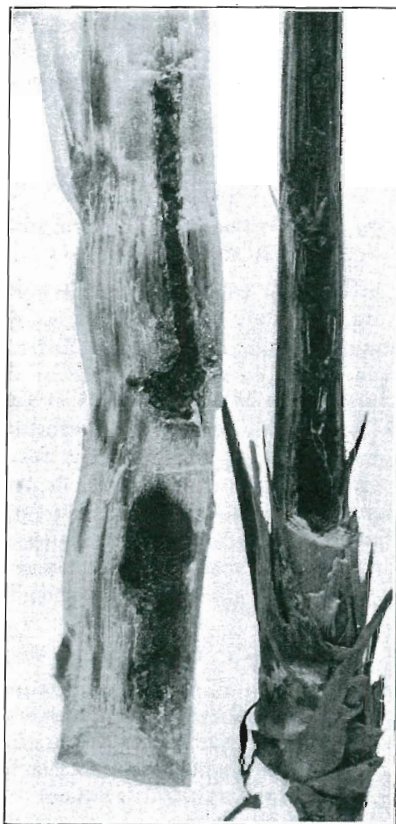
On the plot treated with naphthalene (150 lb. per acre) the cane sticks were straighter and about 6 inches longer than those on adjoining check-plots. The application of chloride of lime, tobacco dust, and coal tar gave negative results; stools on these plots being practically the same height as those on controls alongside. Where the soil had been sprayed with an emulsion of carbolineum and soap (carbolineum 2½ lb., soap 3 lb., water 25 galls.), the cane was noticeably higher than anywhere else. Fifty per cent. of the sticks on this plot were standing, and about 10 per cent. of those on the adjoining check plot. Owing to the crop as a whole having escaped serious damage from grubs, the results of our experiments with these surface deterrents were rendered inconclusive, although data of more or less economic value were obtained.

INJURY FROM MOTH-BORER.

Serious infestation by the large moth-borer (*Phragmatiphila truncata* Walk.) was noticed this season (August to October) among mature crops of Badla and D. 1135 growing on low-lying ground near Aloomba. The caterpillars were found mostly near the top of the canes, and also occurred freely in central and basal portions. From reports lately to hand, this moth appears to have been very much in evidence during the past season both at Meringa and Gordonvale, owing perhaps to climatic conditions having proved unfavourable to the activities of its various parasitic enemies.

The chief natural controlling factor of *truncata* in the Cairns district is a tiny braconid wasp (*Apanteles nonagriæ* Oliff.), the life-cycle of which was studied at our laboratory last December (see "Queensland Agricultural Journal," vol. xvii., p. 81), when it was found that its various stages (from egg to wasp) occupy a period of from 15 to 21 days. This parasite was bred by Oliffe in 1893, from caterpillars destroying cane in

New South Wales; who, when reporting at that time, stated: "After careful observation I have convinced myself that one of the chief, if not the chief reasons that *Nonagria* "*(Phragmatiphila)*" has not spread more widely and done more damage on the Clarence is the fact that two minute and highly interesting parasites are present in such numbers as to keep it within reasonable limits. The most abundant of these parasites is *Apanteles nonagriæ*." The other parasite alluded to by Oliffe is a chalcid



Young ratoons, killed by caterpillars of *Phragmatiphila truncata* Walk.

wasp (*Euplectus howardi* Oliff.), which up to the present has not, to my knowledge, been found in Queensland. Several broods of *Apanteles* were reared by us last year for liberation at Ayr and Rita Island, on the Lower Burdekin; and we hope to continue this work next month, with view to distributing these parasites on various selections in the Cairns district.



External view of young cane shoot bored by caterpillar of *Phragmatiphila truncata* Walk.

FUMIGATING CANE-BEETLES.

Excavations made in canefields at Meringa and Highleigh early in September revealed the fact that greyback beetles had emerged from the pupæ, and were awaiting an opportunity to leave the soil.

Carbon bisulphide was injected at a depth of 9 inches immediately under the lines of stools, in twelve different places, the amount given varying from 2 to 8 drachms. When examined twenty-four hours later, 17 dead and 13 living beetles were found; all living specimens, however, being located at distances exceeding 9 inches from the actual spots of injection.

NOTES ON PARADICHLOROBENZENE.

Since reporting on the possibilities of this fumigant in connection with cane-grub control, a letter has been received by the writer from German manufacturers, stating that for many years the firm of Fritz Schult, of Leipzig, have had the exclusive sale of the preparation in question, which they have lately put upon the market under the trade name of "Globol." At the present time this is largely used in wool-mills, magazines, and storehouses all over the world. "Globol" can be supplied by them in quantities of not less than 100 lb. at the rate of 1s. 3d. per lb., this price, however, being subject to fluctuation. It would take 134 lb. of paradichlor. (costing at least £8 sterling) to treat an acre of cane with $\frac{1}{4}$ -oz. injections on one side only of rows of cane standing 5 feet apart. We may, of course, find, as a result of field experiments to be carried out shortly, that $\frac{1}{4}$ -oz. doses injected 18 inches apart may prove effective, which would materially reduce the cost.

Victor Leggo and Co., of Victoria, who were hoping to be able to manufacture paradichlor., have written to me (under date 5th October) stating: "After making inquiries in England as to the price at which this compound could be delivered in Australia, we find that we could not possibly make it at a price which would be competitive. We have, therefore, abandoned the idea of making it."

When last reporting on the merits of this fumigant ("Australian Sugar Journal," vol. xiv., p. 341) we stated that sets of Badila planted immediately over injections made in open ground at the laboratory had rooted in the contaminated soil, and the growth above ground at that date appeared normal. Subsequent development of these sets, however, did not prove satisfactory, and accordingly further tests were carried out during September and October with cane-sets having single eyes, which were planted both in pots and in the open. As a crucial test, a number of tins of soil, about $3\frac{1}{2}$ in. square by 5 in. deep, were treated with $\frac{1}{2}$ -oz. injections placed immediately below small sets an inch long, each with a single eye. As might have been expected, the dose confined in this way had an injurious effect, owing probably to fumes of paradichlor. entering the cut ends of these sets. The eyes in some tins produced plants about 3 in. in height, which then stopped growing, owing to non-development of roots. It is worth noting that a cowpea seed, which

had not of course received any such mechanical injury, germinated in one of these treated pots, producing a small plant which at present appears to be developing in a normal manner. In an experiment started 16th October, twelve stools of cane about 30 in. high were given $\frac{1}{2}$ -oz. injections placed just under the sets, and when examined after an interval of 24 days both the treated and control plants had noticeably increased in size.

Another experiment is being conducted in which doses are placed 4 to 6 in. from the stools, and on a level with or slightly below sets. This method, as already pointed out, admits of simple application, and we know that the fumes will penetrate the soil to this distance sufficiently to destroy the grubs.

With regard to future extensive field experiments with this chemical, the points we intend studying will relate (as mentioned in my Annual Report for 1921-22) chiefly to its effect on young growing cane-roots and newly planted sets; while the influence exercised by heavy rain, temperature, closely packed volcanic soils, clay lands, &c., on the rate of evaporation and penetration of the fumes of paradichlorobenzene will also, doubtless, furnish data of economic interest.

TACHINID PARASITE OF WEEVIL-BORER.

The work of breeding fly-parasites for future liberation on borer-infested plantations has been continued from month to month; this activity of our Experiment Station being second only in importance to research work connected with cane-grub control.

During August last Mr. W. C. Dormer, my assistant, let go 60 tachinid flies at South Johnstone, and later (27th October) liberated 84 at Macknade, where arrangements have been made by us to collaborate with Mr. West, manager of the Macknade mill, in this useful work.

The Colonial Sugar Refining Company have always been keenly alive to the great economic importance of *Ceromasia sphenophori* Vill. as a natural controlling factor of *Rhabdocnemis obscurus* Boisd. In 1913 they introduced it into Fiji, and, being satisfied with results obtained there, sent an assistant entomologist to Queensland last year to establish a cage for breeding these flies at Macknade mill.

Goondi was visited this month (October), when on the 20th instant 26 parasites were given their liberty on Mr. Davis's farm at Daragoe; the block retained by Mr. Davis for breeding these flies being well infested with beetle-borers.

INTRODUCTION OF DIGGER-WASP PARASITES.

A third breeding-cage for rearing scoliid wasp parasites, and additional numbers of tachinid flies, is just finished, and has a capacity of about 450 cubic feet. The digger-wasp, which we hope to receive from Java about the beginning of January next, will be ultimately liberated from this cage in canefields at Meringa and Gordonvale, where it is expected

they will attack the grubs of our greyback cockchafer. Details of this fascinating phase of grub control will be duly reported from month to month, after arrival of the first consignment of cocoons containing these parasitic wasps.

November 1922.

EFFECT OF WEATHER ON CANE-BEETLES.

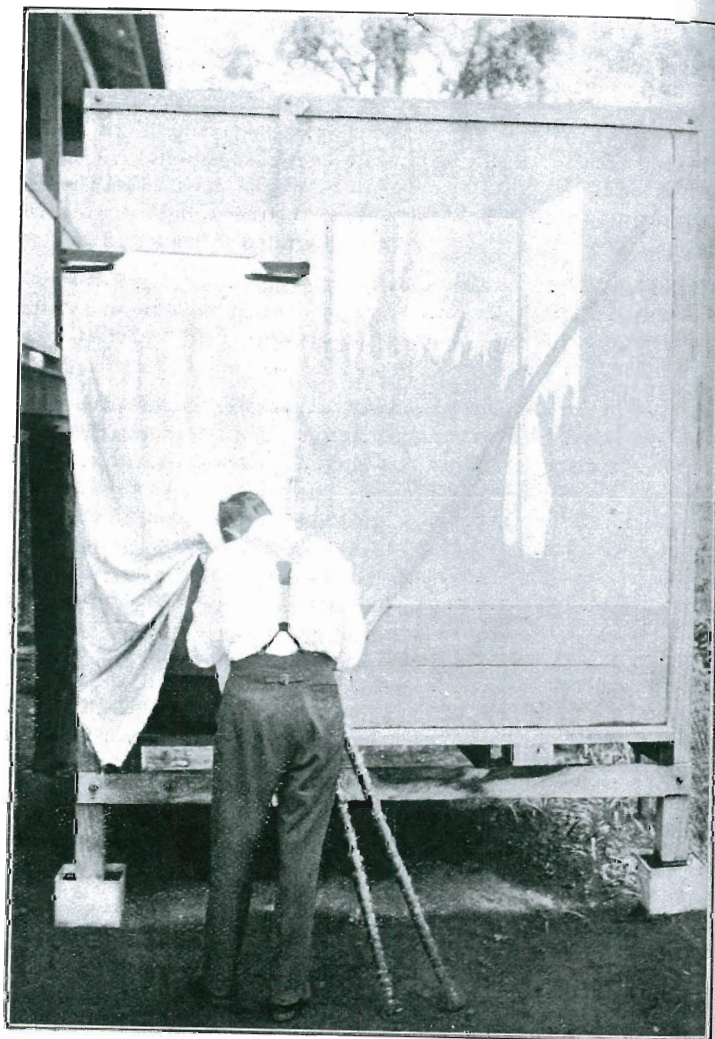
In my October report it was mentioned that excavations made in canefields at Highleigh and Meringa had revealed the presence of grey-back beetles in the pupal chambers. It may be stated that the date of these investigations, which was inadvertently given as 10th September, should be corrected to read 10th October.

Upon looking up weather statistics in relation to rainfall, it appears the present drought conditions are very similar to those experienced in this district during 1915, when the precipitation for the months August to November was only 1.74 inches.

Beetles during that year assumed the adult form about the middle of September, and despite abnormal dryness of the soil were subsequently found alive in pupal chambers at the end of October. A month later, however (28th November, 1915), plenty of dead greybacks were ploughed up on volcanic soil, no living ones being observed. The depth of cultivation on this occasion was 1 foot, in ground fairly loose and very dry. It appears, therefore, that in certain soils adults of this species are able to remain alive underground in dry weather longer than from nine to ten weeks. From June to August, while grubs of these beetles were pupating, 5.30 inches of rain were registered, as against 7.19 inches for the same months during 1922. It is interesting to find that since the beginning of September last, to date (28th November) we have recorded only 1.79 inches at Meringa—viz., 0.05 points more than fell during the same period in 1915.

In the event of present dry conditions continuing for another week or so, multitudes of greybacks that assumed the imago state about seven weeks ago are likely to die in the soil; while others, arising from grubs that pupated later in the year, will be so weakened by protracted confinement underground that, if able finally to emerge from the soil next month (December), they may succumb prematurely before being able to lay eggs. In 1915, for instance, beetles managing to reach the surface when the drought broke in December could not withstand a slight heat-wave lasting a couple of days—when the maximum shade temperature ranged from 95 to 98 deg. Fahr.—but fell dead in thousands from the feeding-trees. No less than 98 specimens were picked up on an area of about 2 square chains, and 25 from under a gum-tree of moderate size. Exceptional interest attached to this mortality from the fact of its having happened about 7 days after emergence of these beetles, and consequently before they had had time to oviposit.

PLATE V.



A CAGE USED FOR BREEDING TACHINID-FLY PARASITES,
MERINGA LABORATORY, NOVEMBER, 1922.

BREEDING TACHINID FLY PARASITES.

During the past month we have built an additional large insect-cage for breeding specimens of *Ceromasia sphenophori*, a parasite of our beetle-borer of cane. This cage has a floor space of 56 sq. feet and is 7 ft. 4 in. high. It is constructed of hardwood, the sides being of mosquito netting, with roof and hood of strong calico. Provision has been made for establishment of conditions resembling as nearly as possible those obtaining in the field, for excluding insect enemies of the fly, and combating entomogenous fungi (see Plate V.).

Further liberations of this parasite have been made this month at Gordonvale, Mount Sophia, and Aloomba.

At the present time, being near the end of the cutting season, it is not easy to procure bored sticks from which to obtain grubs for carrying on our breeding of this useful insect. Growers having standing cane affected by borer-grubs, and who may be willing to help on this work, are asked to communicate with the Entomologist at Meringa.

Tachinid flies will be liberated free of charge on plantations seriously affected by the beetle-borer *Rhabdocnemis obscurus* Boisd., on condition that the owner will agree to leave at least half an acre of badly bored unburnt cane for the parasites to breed in.

SCARCITY OF GRUBS.

Grubs are not easy to procure just now, owing to the prolonged spell of dry weather, so that experimentation against this stage of our greyback cockchafer has been discontinued for the time being. Odd specimens of three or four species of cane-beetles are to be noticed occasionally on the wing during nightfall, but few other insects affecting cane have appeared so far.

Both *albohirtum* and *frenchi* lay eggs during December or January, the grubs of *albohirtum* attaining full size in a period of about six months, whereas those of *frenchi*, which grow more slowly, remain in the larval condition fully a year longer; thus accounting for occurrence in the same furrow—so often noticed by growers—of large and comparatively small grubs.

LARGE MOTH-BORER OF SUGAR CANE.

This moth-pest (*Phragmatiphila truncata* Walk.) is usually in evidence throughout November and December, at which time of year it attacks principally shoots of young ratoon and plant cane. Attempts to procure additional specimens of its parasite *Apanteles nonagriæ* Ollif., the economic value of which was alluded to in last month's report, have not yet proved successful; but as it is usually the later broods of *truncata* that are most freely parasitized, we shall probably breed these tiny wasp-parasites from borer caterpillars collected during December. On the 6th instant 58 ratoons with dead-hearts were collected by Mr. H. Knust at Banna, which when examined yielded forty caterpillars of this moth-borer, tunnels in the remaining shoots being empty. These larvæ pupated in due course and moths commenced to emerge in the breeding-cages about the 18th instant.

NOTES ON PARADICHLOROBENZENE.

We are hoping the price of this fumigant in England or America may prove less than that quoted from Germany. During field experiments, however, it will be possible to test various methods of application, in order to determine the minimum amount of paradichlor. needed per acre to destroy from 80 to 100 per cent. of the grubs. Doses of 1 drachm placed 12 in. apart should prove effective if injected in time to catch the first-stage larvæ; and this would cost about £4 per acre. By placing these doses 18 in. apart the expense could, if desired, be still further reduced. In the event of our being able to purchase this fumigant for 9d. per lb. we reduce the above figures by one half, and could then well afford to give 1-drachm injections, a foot apart, at a cost of £2.

December 1922.

MOTH-BORERS OF SUGAR CANE.

Fossifrontia (Polyocha) sp.—Whilst searching for hymenopterous parasites of our large moth-borer, numbers of young ratoons with dead-hearts were collected at Riverstone, near Gordonvale, which when subsequently examined were found to contain larvæ and pupæ of the smaller pyralid moth-borer. This insect, although a minor cane-pest, must be considered responsible at times for injuries of a rather serious nature, extending in all probability over a considerable area, but fortunately, so far as observed, affecting only a small percentage of the crop.

On 18th November, 1920, the writer collected from within an area of 1 sq. chain no less than 44 dead-hearts from ratoons about 18 in. high in a canefield at Pyramid, which when examined yielded 33 larvæ of this species. In the present instance, however, about 8 per cent. of the shoots collected contained caterpillars, while fully 8 per cent. were parasitized by a braconid wasp parasite.

Tineid Moth-Borer.—Many of the dead-hearts in ratoons got at Riverstone were caused by a little borer smaller than a clothes-moth (9 mm. wing expanse) of a dark slaty-grey colour. This pest proved very abundant also at Pyramid in 1919, where it was observed infesting third ratoons. Out of 75 shoots examined by the writer at that time—about 10 per cent. of those destroyed on a space of about 100 sq. ft.—no less than 55 were killed by this moth-borer, and 20 of these contained living specimens of the larvæ.

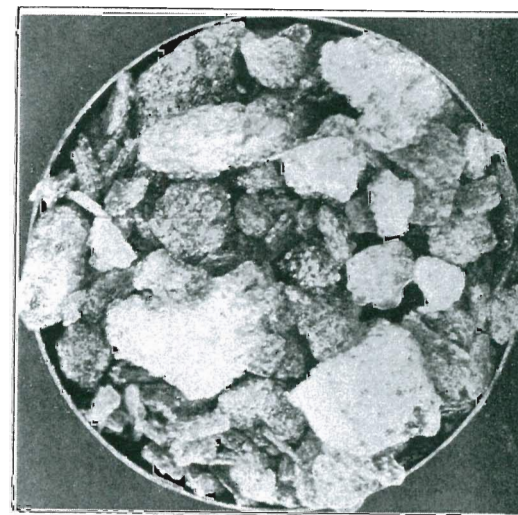
A full description, together with illustrations of the life-cycle stages, of this new cane-borer was published last year (1921) in Bulletin No. 11 of this office. (See also "Australian Sugar Journal," vol. xiii., p. 128.) Strangely enough, although occurring commonly in several localities around Cairns, this insect was not included in any of our large Australian collections of Lepidoptera.

Severest infestations apparently occur among ratoons springing from buds situated above ground-level, the trouble being less noticeable in the case of those arising from buried eyes; while shoots from plant cane originating well underground are rarely attacked.

Dr. Guy A. K. Marshall has kindly identified this moth-borer as *Ephysteris chersæa* Meyr., one of the Gelechiidæ.

NOTES ON PARADICHLOROBENZENE.

Since reporting on this subject last month, advice has come to hand that the United Kingdom can supply us with a crude form of commercial paradichlor. at £5 per cwt. This is a substantial reduction on the German quotation of £6 per 100 lb. We are glad, however, to be able to announce that according to latest advice the British drug-houses, upon making further inquiries, find there is a crude form of this compound which can be supplied at £4 per cwt. This would bring the cost down to about £2 per acre for a treatment of 1-drachm injections placed 12 in. apart. Up to the present we have experimented only with the refined brand of para-



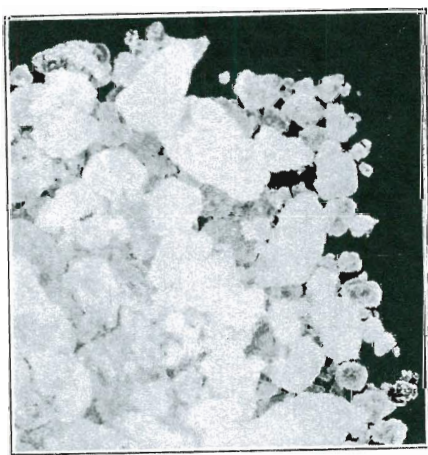
Crude form of paradichlor., consisting of crystalline nodules of whitish to pale yellowish-green colour. Used on Meringa Experiment Plots in 1923.

Photo. E. Jarvis.

dichlor. ("Globol"); so that the effect on cane-grubs of crude forms has yet to be determined. I am of opinion, however, that we shall find these cheaper brands efficient soil fumigants.

Effect of Paradichlor. on Growing Cane.—On 2nd November, a field experiment was started at Meringa in which 48 stools of young plant cane were treated with $\frac{1}{4}$ to $\frac{1}{2}$ oz. injections placed along one side of a row of D. 1135 and from 4 to 6 in. from the stools. The adjoining rows of cane on either side of the treated row formed controls. All injections were 6 in. deep, some being placed immediately opposite stools and others diagonally in intermediate positions. When examined six weeks

later (14th December) both the treated and check stools had made equal growth, while results were as follows:—Injections of $\frac{1}{4}$ oz. placed diagonally and 4 inches from centre of stools, and injections of $\frac{1}{2}$ oz. situated 6 inches from stools but opposite same, had no injurious effect on the foliage. Injections of $\frac{1}{4}$ and $\frac{1}{2}$ oz. 4 inches from and opposite stools caused some of the outer leaves to wither slightly and curl. The odour of the fumigant had penetrated about 10 inches on all sides of injections, and, although $\frac{1}{4}$ -oz. doses had entirely evaporated, the soil remained charged with the smell of paradichlor. Note.—It may be mentioned that none of the treated stools were materially injured, and a few months later growth of both treated and check rows was quite normal, not a single stool having been stunted in any way.



Nodules of paradichlor. of greyish-white colour, and somewhat refined quality.

Photo. E. Jarvis.

In another experiment, injections of $\frac{1}{2}$ oz. placed 7 inches below the surface were found to have completely evaporated after the lapse of 51 days, the rainfall during this period having been only 91 points.

EMERGENCE OF CANE-BEETLES.

The long-continued dry spell of over three months' duration terminated, happily, on the 21st instant, when 87 points were registered at our laboratory, followed next day by 46 points. Temperature during the forty-eight hours immediately preceding these thunder-showers had been very high, our maximum shade heat on the 19th instant being 107 deg. F. and on the 20th 100.5 deg. F.

Cane-beetles appeared close to the station on the 22nd instant, on feeding-trees of *Eucalyptus tessellaris* (Moreton Bay ash), but were not found in any numbers until four days later, when they were noticed on *Ficus pilosa* and *nesophila* as usual. Up to the present, however, the emergence has not been heavy at Meringa this season, owing doubtless to the recent drought conditions. Specimens collected on the 22nd were observed to be much rubbed, owing probably to repeated attempts of the beetles to dig their way to the surface before the ground had been softened by rain. An additional 23 points fell on the 27th instant, so that moisture favourable to further emergence has been maintained. *Lepidiota frenchi* appeared very freely on the 23rd instant, this being the year of its greatest emergence. Grubs of this species pupate at a lower depth than those of the greyback, so are less likely to be affected by climatic influences. *Lepidiota rothei* Blackb. and *Dasygnathus australis-dejeani* Mael. are in evidence in the usual numbers.

Species of the class Insecta appear to have suffered as a whole from the long dry spell of weather, insects of all orders being very scarce at present.

OFFICE COLLECTION OF INSECTS.

In 1914, when first taking up a study of the cane-grub, the writer considered it advisable to form a collection of insects comprising the following classes:—

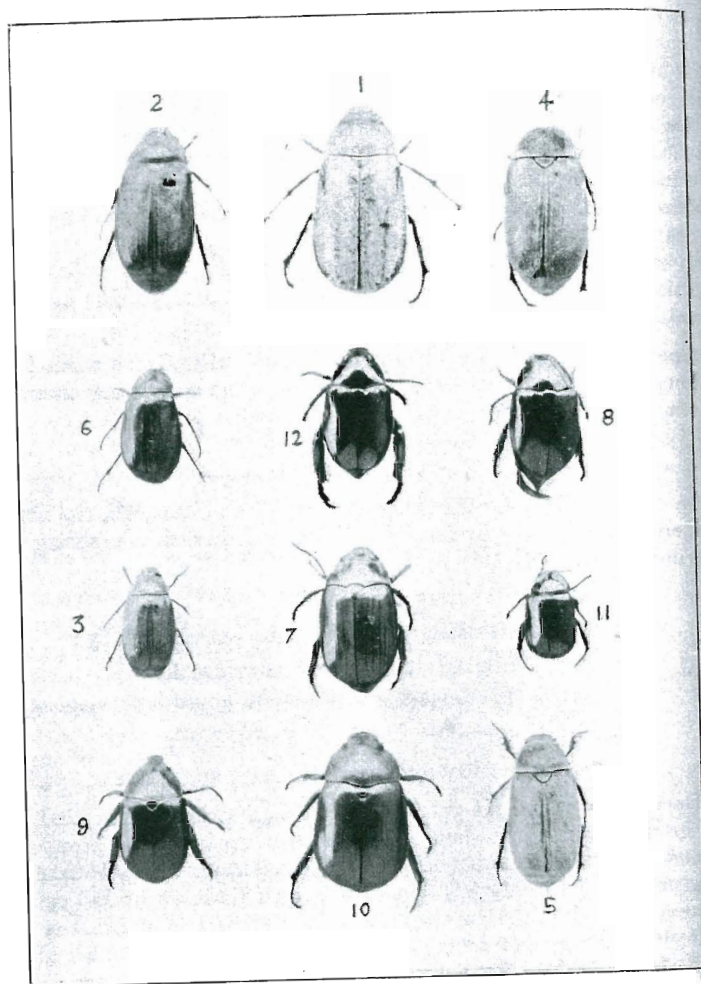
- (1) Insects devouring the roots of cane;
- (2) Insects attacking the stalk and leaves internally;
- (3) Insects injuring stalk and leaves externally;
- (4) Insects closely related to our more destructive cane-pests;
- (5) Useful insects, parasitic and predaceous;
- (6) Insects incidentally associated with sugar-cane.

During the past eight years a reference collection of this kind has been gradually acquired, but owing to such work having been of a spasmodic nature the number of species collected has naturally been small, amounting in all to only 3,796 specimens. Of these about 280 species are beetles, of which 101 species are closely related to our root-eating Scarabæidæ. Parasitic insects of the order Hymenoptera number about 123 species; while dipterous insects include 74 species, of which 21 are Tabanidæ (March flies), and 28 Asilidæ or Robber-flies; larvæ of some of these latter insects being predaceous on grubs of our cane-beetles.

EXPERIMENTS WITH AROMAS FOR ATTRACTING CANE-BEETLES.

This interesting form of control is at present being investigated, and results, so far, have been decidedly encouraging. On the 22nd of this month, for instance, it was proved beyond doubt that *Lepidiota frenchi* can be attracted artificially by means of aromas distilled from the bark and foliage of certain favourite food-plants.

PLATE VI.



Photos. E. Jarvis.

SCARABÆID BEETLES—MOST OF WHICH INJURE CANE.

- (1) *Lepidoderma albohirtum* Waterh. (2) *Lepidiota caudata* Blackb. (3) *L. rothei* Blackb. (4) *L. consobrina* Gir. (5) *L. frenchi* Blackb. (6) *L. No. 215* n. (7) *Anoplognathus boisduvali* Boisd. (8) *A. punctulatus* Oll. (9) *A. smaragdinus* Ohaus. (10) *Anoplostethus letus* R. and J. (11) *Anomala australasica* Blackb. (12) *Repsinus ceneus* Fabr. (About 1/4th below natural size.)

It remains to be seen by future experimentation which of these odours will prove most attractive. We may, I think, consider this discovery a decided step forward in the right direction; since there is every probability that our greyback beetle, as I have long believed, will be found to respond positively to odours derived from some of its many food-plants. Details of work in this connection will be given in next month's report.

January 1923.

MORTALITY AMONG CANE-BEETLES.

It will be of interest to record that a natural check of more or less severity on the increase of our greyback cockchafer has been experienced this season as a result of the late spell of dry weather that marked the closing months of 1922. When cultivation was resumed during the end of December, many growers ploughed up quantities of dead beetles which had not been able to escape from the hard dry soil.

These specimens were probably the offspring of those that emerged at the beginning of November 1921, the grubs from which, having pupated at an early date (July to August), produced beetles in subterranean pupal cells during September last. These specimens would not be able to remain alive underground in dry soil longer than about ten weeks, and consequently must have perished in December before the dry spell broke up. However, greyback beetles, as mentioned last month, have appeared in formidable numbers this season; those at present on feeding-trees being doubtless the offspring of specimens that emerged towards the end of December 1921. Had the first rain during this present season fallen six weeks earlier (beginning of November), we should probably have had a very heavy emergence of greyback cane-beetles.

BREEDING SCARABÆID GRUBS.

Incidentally, while studying the imago condition of *albohirtum*, *frenchi*, and other cane-beetles, attention is also being given this season to a few related species of root-eating Scarabæidæ, the life-cycle of which has never been worked out. Although *Anoplostethus letus* or *Calloodes atkinsoni*, for example (see Plate VI., page 28), are not at present of economic importance, grubs of these species may quite possibly at some future date make their appearance in cultivated land, or even gradually acquire a liking for sugar-cane.

PARADICHLOROBENZENE EXPERIMENTS AT GREENHILLS.

On the 17th instant a plot of Badila cane (August planting) measuring 66 by 264 feet was treated with 1/4-oz. injections of this fumigant, placed 7 inches deep, 1 foot apart, and from 4 to 6 inches from the stools.

The work was done with special metal hand-injectors, invented by the writer for the purpose of administering this compound in dry crystalline

form, and which were found to meet present requirements—viz., a simple way of burying the fumigant uniformly in a reasonable space of time—pending subsequent invention of more rapid hand or machine appliances, which, however, would not be needed unless paradichlor. realises expectations by proving an efficient fumigant.

It may be of interest to mention that the men who were injecting at Greenhills carried the crude crystals in an open 1-gallon tin, suspended at waist-level by a strap passing over the shoulder. An occasional whiff from the exposed fumigant gave no inconvenience, being in fact rather pleasant than otherwise, and moreover, owing to the method of application employed, there was no need to handle the crystals. Since reporting last month on the fall in price of paradichlor. to £4 per cwt., the Director has advised me that in all probability a crude form of this compound may be obtained in the near future at a still lower price—viz., £56 per ton.

BETTER FEEDING-TREES MOSTLY OF FEMALE SEX.

Erroneous ideas with regard to the proportion between the sexes of our so-called greyback cockchafer (*Lepidoderma albobirtum* Waterh.) seem to prevail amongst cane-growers in the Gordonvale district.

In order to obtain reliable data on this question, 86 beetles were collected on 19th January from fig-trees close to the laboratory, and when examined results were—55 females, 31 males. Upon dissecting 50 of these females, development of eggs in the ovarian tubes was as follows:—No. 17 beetles, no sign of eggs; 2 beetles, eggs grown to $\frac{1}{8}$ natural size; 8 beetles, $\frac{1}{4}$ natural size; 4 beetles, $\frac{1}{2}$; 1 beetle, $\frac{3}{4}$; 8 beetles, $\frac{1}{2}$; 1 beetle, $\frac{3}{8}$; 1 beetle, $\frac{2}{3}$; 3 beetles, $\frac{3}{4}$; 4 beetles, eggs natural size and fit for extrusion. On 22nd January an additional 137 greybacks were collected from feeding-trees close to our laboratory, and upon examination it was found that 87 of these were females and 50 males.

The above data indicate conclusively that collecting beetles from their feeding-trees adjoining headlands of canefields can be profitably carried out throughout the month following any big emergence of these cane-beetles.

TACHINID PARASITES OF GREYBACK.

An interesting experiment was undertaken to determine the percentage of greybacks attacked by tachinid flies while resting on food-plants during daylight. On the 10th and 11th of January 200 specimens were collected at random from trees near the laboratory, and each insect confined in a small cage of moist soil. Up to date (27th January) we have discovered 31 per cent. of these specimens to harbour internal dipterous parasites, in one case 6 tachinid flies having issued from a single beetle. This parasite, which was first bred by us at Gordonvale in 1915, and slightly exceeds $\frac{1}{4}$ inch in length, resembles in size and general form the common house-fly (*Musca domestica* L.), but is light brownish in colour, mottled irregularly with pale shades of buff on the thorax and hind edges of abdominal segments. The eyes in living specimens are bright red, this colour fading completely, however, to brown a few hours after death.

Other species of Tachinidae are expected to emerge a few weeks later, and full results in this connection will be reported next month.

EXPERIMENTS WITH AROMAS FOR ATTRACTING CANE-BEETLES.

The possibilities of this fascinating method of control have been discussed by the present writer from time to time in various monthly reports, our first attempts in this direction having been made about eight years ago at Gordonvale laboratory ("Queensland Agricultural Journal," vol. v., p. 169). As stated last month, (December 1922) evidence of positive chemotropism in *Lepidiotia frenchi* Blackb. was then obtained, details of such occurrence being as follows:—Whilst engaged in putting aromas in bait-traps hung to stakes placed about 200 feet apart on open forest country, beetles of *frenchi* happened to commence their usual evening flight. I was carrying at the time a tray of small bottles, some containing different aromas, while others had been emptied—although a drop or two still lingered around the mouth of these or on the corks—when suddenly, without warning, a dozen or more *frenchi* beetles flew on to the tray, buzzed about the bottles, and even alighted on my fingers, which previously had been wetted when pouring solutions into traps already set that evening. Although remaining on the tray for about a quarter of a minute only, this was long enough to indicate that something had attracted them in the first instance. Possibly the movements of the tray as I walked may have caused them to fly off sooner than would have been the case had I remained perfectly still.

The aroma in question, which was perhaps a combination of several different odours arising from the assortment of bottles on the tray, was probably of a fugitive nature, since no further reaction of these beetles was noticed that evening. Subsequent exposures of aromas on 1st January afforded additional encouragement, as *frenchi* beetles were found in four of the traps. In one case two females had been attracted; while in another trap, containing water in which two chemicals had been dissolved, four male specimens were found.

The fighting season is almost over here, although aromas are still being exposed at Riverstone, where greybacks are more in evidence. Up to the present (31st January) nearly 100 different aromas have been tried, but none have, so far, proved decidedly attractive to adults of *albobirtum*.

February 1923.

FIELD EXPERIMENTS WITH PARADICHLOROBENZENE.

Experimentation with this fumigant was commenced on 17th January, when a plot of Badila (August planting) measuring 264 by 66 feet (one-fifth acre) was treated with $\frac{1}{4}$ -oz. injections placed 7 inches deep, 12 inches apart, and from 4 to 6 inches from stools. The rows on this plot at Greenhills were fumigated on one side only, and when looked at about a month later it was seen that the cane had grown vigorously, while the odour of paradichlor. was quite noticeable in the soil a few inches away from injections.

PLATE VII.



PARADICHLOR. EXPERIMENT PLOTS AT MERINGA.

Treating young plant-cane of D. 1135 with crystals of paradichlor. by means of the "Jarvis Injector"—January, 1923.

Photo. E. Jarvis.

About one-third of the chemical had evaporated, so we may conclude that, in the case of $\frac{1}{4}$ -oz. doses lying 7 inches deep, ten weeks or longer might elapse before complete evaporation. On 25th January a plot of first ratoons of D. 1135 (measuring 472 by 36 feet) growing on red volcanic land owned by Mr. P. Martinuzzi at Meringa, was treated on each side of the rows with $\frac{1}{4}$ -oz. injections, 1 foot apart, 6 inches deep, and 4 inches from the canes. Being situated on the brow of a high ridge, this land is usually more or less grub-infested each season, so that we hope to get conclusive results later on.

At the time of injecting, these ratoons were about 3 feet high, and the soil was rather dry, while depth of cultivation varied from 6 to 8 inches. A second plot, separated from the other by a check-plot, and consisting of a strip measuring 14 by 472 feet, received similar treatment to the preceding, except that injections were made 18 instead of 12 inches apart.

When examined about a fortnight later a smell of paradichlor. was noticeable an inch or so below injections (in the unworked subsoil), and the odour had penetrated upwards to the surface and throughout the soil in a lateral direction between the points of injection. In loose soil it could be smelt 9 or 10 inches away. About one-sixth of the crystals had evaporated. A month after application the cane on both treated and check plots had grown considerably, the leaves just meeting between the rows.

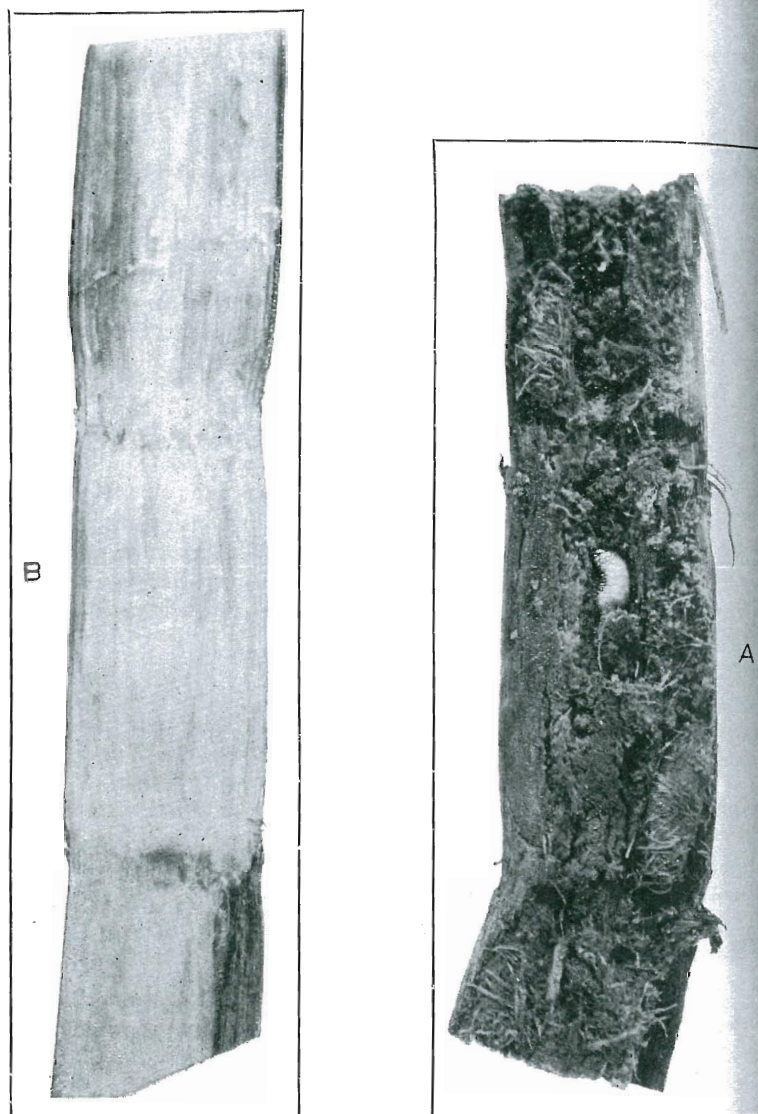
EFFECT ON SUGAR-CANE OF FUMES OF PARADICHLOROBENZENE.

About a fortnight after injecting close to cane-stools, it will be noticed that two or three leaves on plants here and there commence to wither from the point downwards. This characteristic browning, which appears mostly on outer leaves, does not as a rule extend farther than from 12 to 18 inches from the point, basal portions of affected leaves remaining green and continuing to grow in a normal manner. Most stools, however, remain quite unaffected, although standing in the same row and having received exactly similar treatment.

This leaf-browning is probably due to one or more roots having been bruised or broken by the injector, thus allowing fumes of paradichlor. to enter such injured portions and affect normal activities of the plant tissue.

Fumigation of a plot of first-ratoon Badila cane on Block K4 at Greenhills was commenced on the 16th instant, injections being made on both sides of rows, $4\frac{1}{2}$ inches deep, 12 inches apart, and 2 inches from stools. Grubs at the time of injecting were mostly in the second stage, while the cane was about 3 feet high.

PLATE VIII.

A. Portion of cane-stick destroyed by Weevil Borer (*Rhabdocnemis obscurus* Bois.).

B. Section through healthy cane-stick.

Photos. E. Jarvis.

EFFECT OF POISONOUS PLANTS ON CANE-GRUBS.

The possibilities of this form of control have not been altogether overlooked, results of an encouraging nature having occasionally been obtained by us. There is a popular impression that such plants as sorghum, white mustard, &c., if ploughed under, will poison any grubs chancing to feed on the rotting foliage.

Experiments with both of these plants were carried out by the writer during 1921, when it was clearly demonstrated that grubs after devouring young sorghum plants (about 9 inches high) and mustard leaves were not injuriously affected, but, on the contrary, appeared plumper and more active, as though such diet agreed with them. Similarly, when fed with the foliage of *Tagetes glandulifera* ("Stinking Roger") they manifested increased vitality. In this case, however, our experiments went to show that cane-grubs have a decided liking for leaves of this weed, so that the plant might prove useful as a trap-crop. Possibly this liking may furnish an explanation of various reports one hears about the freedom from grub-attack noticed in canefields around Bundaberg, where "Stinking Roger" happens to be one of the commonest weeds.

While experimenting in 1922 with species of *Jatropha*, *Datura*, *Asclepias*, &c., our most promising results were obtained from plants belonging to the genus *Crotalaria*. The merits of this genus as a factor in cane-grub control are still under investigation here, and may yield interesting data in the near future. In this connection I wish to acknowledge assistance received from Mr. F. B. Coleman, of the Department of Agriculture, Brisbane, who has forwarded me seeds of various poisonous plants for experimental purposes.

CARBON BISULPHIDE FOR CANE-GRUBS.

Cane-growers would do well to bear in mind that eggs deposited by the first brood of greyback beetles which started emerging 22nd December were hatched about 10th January, producing grubs which at the present time are mostly in the second stage, while eggs laid by the brood of beetles that appeared later, about the middle of January, are nearing the end of the first instar. During the next few weeks, fumigation of the soil with carbon bisulphide should be carried out on areas in the Cairns district presumed to be grub-infested, the ground at present (26th February) still continuing in good condition for such treatment.

Operations in this connection were commenced at Greenhills on 14th January, at a time when grubs were mostly in the first stage or had just moulted into the second. The soil at that time was fairly dry, although moist enough to retard upward evaporation of the fumigant. On some of the blocks treated, many of the stools examined appeared to be free from grubs, or but slightly affected, while others gave decided evidence of infestation. Grubs for the most part were feeding among the surface roots, at depths varying from 3 to 5 inches, and, although the ground

was examined to a depth of 2 feet or more, none were found below 9 inches. No time should be lost while the cane continues small enough to get amongst, and the grubs can be destroyed before large enough to work appreciable damage. In the event of heavy rain supervening, fumigation must be discontinued for a few days until excessive moisture



Portion of cane-stick prepared for placing in breeding-cage. Grubs have been inserted in the two holes shown plugged with fibre; and a third empty hole is awaiting borer-grub shown resting on stick at side of hole.

Photo. F. H. Taylor.

has drained away, and left the soil sufficiently open for the fumes of bisulphide to freely penetrate in all directions. When examining a block thought likely to be grub-affected, several stools in various parts of the field should be dug around, in order to gain an approximate idea of the percentage of grubs per stool, of their size, and of the depth at which

they are lying. The fumigant should then be injected an inch or two above them, care being taken to close the holes made, by pressing the surface soil with one's foot after each injection. When treating very young plant-cane injections on one side of rows is sufficient, while for ratoons or early plant-cane it is often advisable to fumigate both sides.

TACHINID FLY PARASITE OF CANE-BORER.

Our rearing of these parasites has been discontinued of late owing to difficulty in procuring borer-infested canes from which to obtain grubs for the cages. These flies do not appear to breed as readily in sticks of D. 1135 as in Badila, owing perhaps to canes of the former variety being thinner, less juicy, and containing a larger percentage of fibre. Canes of Badila retain their moisture for a longer period when placed in breeding-cages than is the case with D. 1135, which, if transferred during hot weather, does not always root in time to prevent shrinking of the rind. Occurrence of the cane-borer last season at Freshwater, near Cairns, has been brought under our notice recently by the manager of Hambledon mill, and we hope in the near future to liberate tachinid flies at various infested centres in that district.

March 1923.

THE LOWER BURDEKIN DURING MARCH.

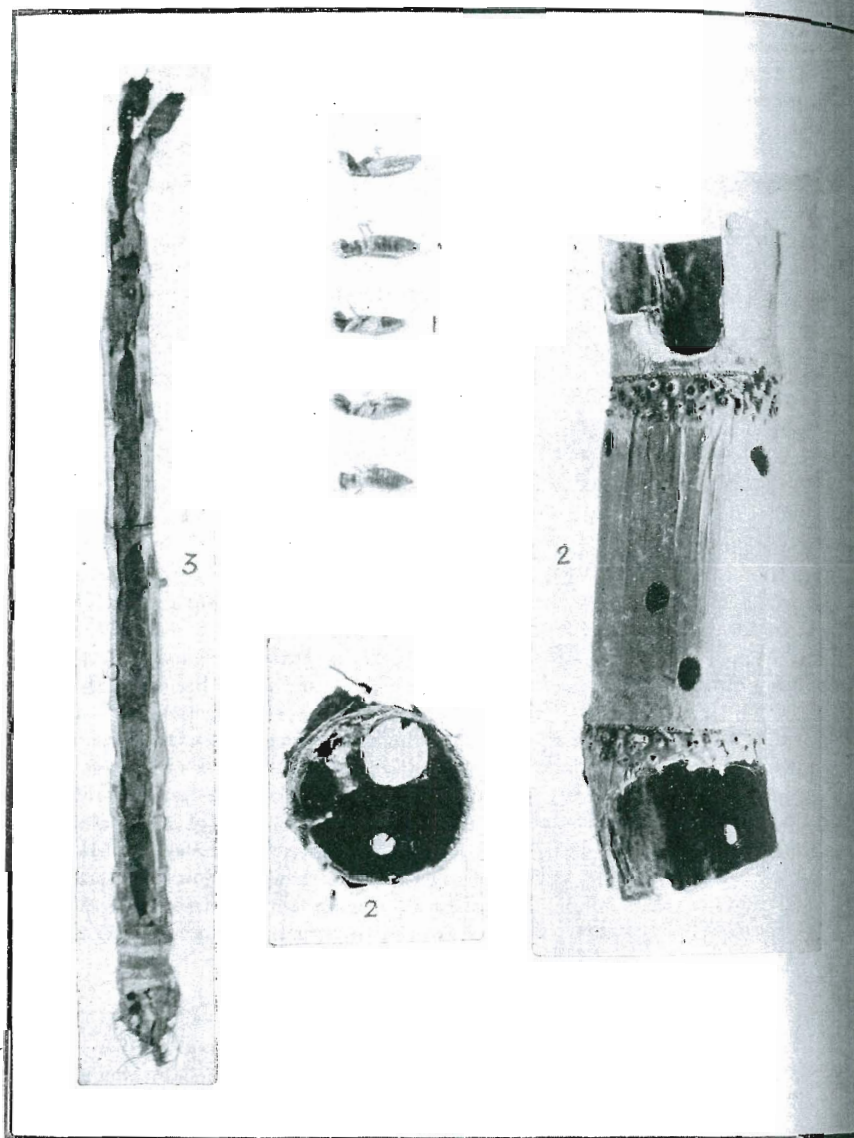
A trip was made this month to the above district, Ayr being reached at midday on the 14th. The secretary of the Pest Destruction Board, Mr. W. M. Saxby, introduced me to Mr. C. R. Crofton, president of the Shire Council, Messrs. A. H. Land, W. H. Ferguson, and other prominent growers, to whom I am indebted for cordial co-operation, and in some cases for hospitality received. Owing to the interest taken in this investigation we were able to travel over a considerable tract of country; visiting Kalamia Mill, Rita Island, Pioneer, Jarvisfield, Seaforth, and part of Maida Vale. On the evening of 16th instant, by request of the association, I delivered an address in the Ayr Shire Hall on "Control of the Greyback Cane-beetle," which was followed by general discussion regarding those cane-pests causing trouble at the present time on the Burdekin, in order that growers might have an opportunity of asking any questions occurring to them in this connection.

EFFECT OF DROUGHT.

The long-continued dry weather has very seriously affected many plantations, the stools on which, although only 3 to 5 feet high, have turned yellowish brown, while in some canefields the plants are already dead, or too far gone to recover. In contrast to these drought-stricken areas it is refreshing to note the numerous stands of irrigated cane, displaying varying shades of rich green, which at present (14th March) are 6 to 8 feet in height.

The water used for irrigating purposes lies quite near the surface, often from 9 to 15 feet, and is obtainable by putting down "spears"—

PLATE IX.



CANE DESTROYED BY TERMITES.

- (1) Workers and Soldier of *Mastotermes darwiniensis* Frogg. (nat. size).
 (2) Portion of cane-stick hollowed out by termites, and transverse section of same (nat. size).
 (3) Section of cane-stick 3 feet long hollowed out by termites.

Photo. E. Jarvis.

viz., iron pipes pierced along the sides with $\frac{1}{2}$ -inch holes at distances of a few inches apart, these when placed in position being covered by an outside sheathing of wire gauze, to exclude any larger particles of soil that if entering might clog the pipe by being sucked into it. The water is raised by a centrifugal pump to a height corresponding with that of the highest point on the land to be irrigated, and from thence conveyed to the plantation by overhead flumings; or, if the ground be nearly level, is simply pumped direct into a deep channel cut along the highest head-land. Many growers are of opinion that it does not pay to grow cane on the Lower Burdekin unless provision be made for irrigation during dry seasons.

RATOON CROPS.

Some growers are in favour of doing away with ratoon crops altogether, believing that heavy plant crops, when forced by irrigation, have an exhausting effect on the soil, unfitting it, in fact, for an immediate production of vigorous ratoons. Possibly the leaching of certain plant-foods on much-irrigated areas might tend to gradually impoverish such cane-land. It has been noticed, too, that grubs usually do more damage to ratoons than to plant-cane. Doing away with the former would mean more frequent and uniform cultivation of the soil as a whole, which in itself tends to increased fertility. Again, it would afford better opportunity for combating the grub-pest, by means of such methods as poison-baits dropped in planting drills, collecting of the grubs, &c. Further, the percentage of grub-infestation on a plantation is generally revealed when ploughing out a crop, and thus the grower, being forewarned, would have ample time if necessary to take action for controlling the pest before grubs became large enough to do damage. Adoption of such control measures would naturally be dependent on factors of an entomological nature, such as—average time of emergence of greyback beetles; duration of larval instars of same, &c., considered in relation to times of planting and other field work obtaining in the Burdekin district. However, if deciding, on the other hand, to grow ratoons, weakly crops could, if desired, be manured in the usual way. I cannot advocate too strongly stirring of the surface soil at short intervals during the egg and first larval stage of the beetles.

WHITE ANTS ATTACKING SUGAR-CANE.

This pest appears to be working injury second only in economic importance to that caused by the greyback beetle. Strictly speaking, the insect in question is a termite, of larger size, however, than any occurring in the Cairns district. It tunnels in living cane-sticks, often completely devouring the interior portion above ground, leaving only the rind. Even when canes are bored throughout their whole length the heart-leaves at first manage to keep green for a time, but in final stages of injury the stick dies, and when cut open is seen to be merely a hollow pipe. (See page 38.)

Unfortunately this pest has established itself on land that has been under cane for twenty years, so that its presence cannot be attributed altogether to the occurrence of old tree stumps or roots. although these in the first instance might have harboured colonies of this termite. Mr. W. Payard, of Brandon, told me he lost two-thirds of a crop of Badila through ravages of white ants on an area of eighteen acres. from which he finally cut 200 tons instead of an estimated yield of 600 tons. It seems he got rid of them on one occasion by sprinkling around their nests a bait composed of molasses and arsenic, which he said proved so effective that two flour-bags could easily have been filled with their dead bodies. Mr. Payard has remarked that the so-called "soldier ant" (*Iridomyrmex* sp.), a very active, pugnacious species which nests underground, destroys these termites, which are never found in the immediate vicinity of its communities. I was interested to observe in this connection that some termites occupying an infested cane-stick, carried to my hotel at Ayr, were quickly discovered and attacked by a common little black ant (*Pheidole* sp., probably *megacephala*). This insect would, I feel sure, help us very materially to combat *Mastotermes darwiniensis* Frogg., if introduced into affected canefields. This could be very simply accomplished during the fighting time of *Pheidole* in the rainy season, while swarming of the winged males and females is taking place. In our own district (Cairns), which is nearer the seaboard, these useful little ants have already obtained a footing in most cane areas, where they operate as a natural controlling factor against both the weevil-borer and large moth-borer of sugar-cane.

Fumigation of the ground with carbon bisulphide, after clearing off and burning all affected cane-stools, would destroy these termites in a wholesale manner, and at the same time, by killing injurious soil bacteria, improve the fertility of the land. With view to efficiently controlling this pest we are at present experimenting with poison-baits, using for this purpose living specimens of *Mastotermes* brought from the Burdekin.

LARGE MOTH-BORER.

Rita Island was visited on the 16th instant, this being the locality where caterpillars of the borer *Phragmatiphila truncata* Walk. have been very much in evidence during past seasons. At the present time, however, little damage is being done, as it is the early broods of this moth, emerging from May to June, that cause most damage. I was interested to learn from Mr. Cody that he had noticed caterpillars, which he believed to be those of *truncata*, boring the somewhat thick stems of "cat-tail" grass. After a short search, specimens of this grass-borer were found, but when subsequently examined proved to be those of a lepidopterous borer not affecting sugar-cane.

As it was the wrong time of year, I was not able to obtain data regarding the possible occurrence on Rita Island of *Apanteles nonagriæ* Oliff., a useful little braconid wasp that effectively controls this moth-borer in the Cairns district.

As a general rule, which possibly may hold good in the Lower Burdekin district, damage from Large Moth-Borer seldom extends throughout the growing period, but gradually disappears when the cane is about half-grown. Occasionally, however, the tops of mature sticks are bored, although not always in such manner as to cause dead-heart.



Basal portion of ratoon being eaten by a cane-grub.

Photo. F. H. Taylor.

CANE-GRUBS.

These occurred in patches on some of the irrigated areas. On Mr. A. H. Land's selection, for example, several fine stools of cane were seen to be falling over from the effects of grub injury, the main feeding roots having been severed, so that one could pull up a large stool with little or no exertion. The soil here was an almost black sandy loam—ideal cane land, I should say—and grubs unearthed by us were working at a

depth of about 6 inches. The average number per stool was four, most of them being in the third stage. Although apparently these of the common greyback cockchafer, the disposition of the small stout bristles bordering the anal path in these grubs differs very noticeably from the arrangement of such characteristic setae on the anal segment of grubs of our greyback of the Cairns district.

Probably when reared to the beetle stage we shall find the Burdekin greyback to be a variety of *albohirtum*, constituting, perhaps, a distinct race, possibly owing its origin to soil variation, environment, rainfall, and other climatic influences.



Arrangement of bristles on venter of anal segment of grub of *Anoplognathus boisduvali* Boisd.

Micro-photo. E. Jarvis.

Other grubs noticed were those of the "Christmas beetle" (*Anoplognathus boisduvali* Boisd.), termed "Gold beetle" on the Burdekin, and probably the same with the species called "Golden beetle" by Herbert River growers, and "Red-head" grubs (*Dasygnathus australis-dejeani* MacL.) a cane-pest of minor importance, subsisting mainly upon humus in the soil. Additional species of Scarabæidæ not yet recorded as affecting cane, occurring in this district, are *Anoplognathus frenchi* and *Calloodes grayanus*, the former, which must not be confused with *Lepidiota frenchi* Blackb. of our canefields, being of a uniform brilliant metallic gold colour, while *grayanus*, a much larger species, is dark lustrous green edged with a marginal band of golden brown. (See Plate VI., page 28, for illustrations of these beetles.)

CONTROL MEASURES FOR GRUBS.

The mechanical nature of the Burdekin soils, together with the dry weather conditions often experienced in this district at a time when grubs are too small to materially injure cane (February to April, during which months the average rainfall is 19.55 as against 44.78 inches during the same period in the Cairns district), point to the advisability of using soil fumigants as being the controlling factor most likely to prove effective. So far as we know at present, carbon bisulphide would meet all requirements. A few days after treatment, when the grubs were dead, the plantation could if necessary be irrigated, with every certainty of securing a good crop.

Experiments in hand with paradichlor. indicate that this fumigant, if applied to the soil a week or so before fighting of the beetles, would very likely prove an efficient deterrent, it being highly improbable that



Dried Grubs of Grey-back Cockchafer, in the form of a valuable Poultry Food.

Photo. E. Jarvis.

egg-laden females would enter or lay their eggs in ground contaminated with an odour that would prove fatal to their offspring. Such treatment could be applied during October, before emergence of the beetles, this month being usually a dry one in the Ayr district (average precipitation = 0.89 inches), which would allow time for the fumes of paradichlor. to spread freely in all directions.

Upon appearance of the beetles, which I presume generally emerge in November, this being the wettest month (average = 12.26 inches), treated areas would still continue repellant, as $\frac{1}{4}$ -oz. injections of the crystals of this fumigant do not evaporate completely until five to seven weeks after application, and even after this has taken place the soil retains the odour for about three weeks longer.

NATURAL ENEMIES.

The only species noticed during my visit was a larval specimen of the "Skipjack" beetle (*Agrypnus mastersi*), which is predaceous upon grubs in the soil, as the ground was exceptionally dry, and flowers very scarce. Mr. J. McElroy, however, told me he had often observed small wasps—which from his description I took to be males of our *Campsomeris* digger-wasps—flying erratically close to the surface of the soil on cane-land. The digger-wasps we are hoping to introduce very shortly from Java should prove serviceable in the Burdekin district, since the host-grubs parasitized by them in Java inhabit chiefly sandy-loam soils.



Dried Grey-back Cane Beetles.

Analysis.—Proteins 63.75 per cent.; nitrogen 10.20 per cent.; potash 1.75 per cent.; phosphoric acid 1.66 per cent., &c.

NOTE.—These dried beetles and grubs were fed with great success to insectivorous birds at Sydney Zoological Gardens; supplying certain vitamins very necessary to the dietary of birds in captivity.

Photo. E. Jarvis.

COLLECTING THE BEETLES.

With regard to collecting cane-beetles, about 6,000 quarts, principally of greybacks, were paid for last season at the rate of 1s. 6d. per quart. The manurial and food value of this species in dried condition is alluded to in Bulletin No. 17 of this office, pp. 72, 73, 80. (See also present illustrations on pages 43 and 44 of the present bulletin).

Collecting was commenced in the middle of December, finishing up about the end of February. During last season grubs in the Kalamia mill area alone destroyed between 5,000 and 6,000 tons of cane. The mill manager, Mr. A. C. Park, thinks March the best month in which to plant; but one cannot always be sure of the weather at that time of year. Cane

is planted there mostly in May, June, September, and occasionally early in October. Mr. Land has had good results from using tops of cane planted in May.

Feeding Trees.—The chief food-plants of the greyback cockchafer are said to be Moreton Bay fig (*Ficus macrophylla*); rough-leaved fig (*Ficus opposita*); and Moreton Bay ash (*Eucalyptus tessellaris*).

CANE DISEASE.

Badila cane affected by a disease apparently identical with that commonly known as "Top Rot" was noticed on land belonging to Messrs. Holson and Tapolium. This trouble seems to develop chiefly during hot weather, from February to March, often after heavy rain. The damage caused by it varies very considerably (in the present instance less than 10 per cent.).

In stools harbouring the disease, injury is generally confined to one or two sticks, which, strangely enough, may often be observed growing side by side with healthy canes. In advanced stages of "Top Rot" the central core and heart-leaves die, and when removed the basal decomposing portion emits an offensive smell.

Up to the present this malady has received little investigation. It is said to be caused by a parasitic fungus, which it is assumed gains entrance to the plant through its roots. Conditions favourable to development of "Top Rot" are supposed to be—(1) Defective drainage; (2) late planting (should this chance to be followed by climatic conditions conducive to the disease); (3) heavy rain during the first two or three months of the year; and (4) planting of varieties of cane known to be susceptible to "Top Rot."

April 1923.

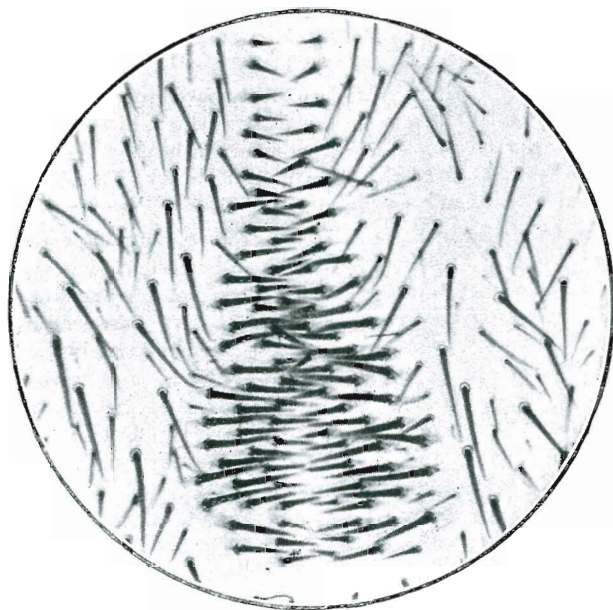
SATISFACTORY PROGRESS OF EXPERIMENTS WITH PARADICHLOROBENZENE FOR CONTROL OF CANE-GRUBS.

Experiment Plots at Greenhills.—These consist of half an acre of first ratoons (Badila), treated on 16th February with $\frac{1}{4}$ -oz. injections placed 1 foot apart, 2 inches from stools, and $4\frac{1}{2}$ inches deep on each side of rows; the cane being about 4 feet 6 inches high at the time of application. Check-plots were left on two sides of the treated area, all plots being 24 rows wide (two chains), in order that the cane from each might ultimately be conveniently harvested and weighed separately.

Seven weeks later (6th March) cane in the check-plots began to show signs of grub-affection, and ten stools when examined yielded from 1 to 6 grubs per stool (average 3.7). All grubs collected were feeding within 4 inches of the surface, mostly among the cane-roots, some having commenced to eat holes in the basal portion of sticks.

Large patches of this yellowing grub-eaten cane occurred in both of the control plots, while in the fumigated area there was no sign whatever of grubs, the cane being uniformly green and normal in appearance. Ten stools, however (those appearing backward in growth), were examined

in various parts of this treated plot, but although the soil was searched to a depth of 1 foot not a single grub could be found. On 9th April a second examination of ten stools (five treated and five checks) gave similar results—viz., an average of about 3 grubs per stool in the controls, and none in the treated area. The soil in the latter plot was still impregnated with the fumigant, odour from which was quite noticeable in unbroken subsoil at a depth of 18 inches. About $1\frac{1}{2}$ drachms of the $\frac{1}{4}$ -oz. injections had evaporated during this interval of seven weeks, leaving $\frac{1}{2}$ -drachm of each injection still operative in the soil. When last examined (17 days later) on 26th April, the cane throughout the treated area continued uniformly green and of normal growth, the edge of the southern



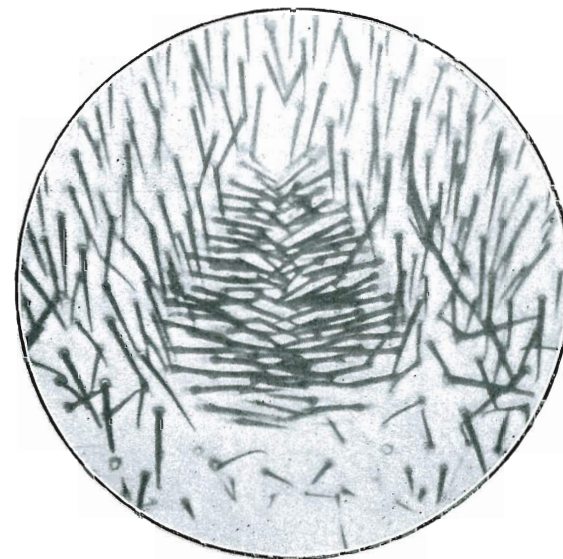
Arrangement of bristles on venter of anal segment of grub of *Lepidiota consobrina* Gir.

Micro-photo. E. Jarvis.

boundary of this plot contrasting quite noticeably in colour with the yellowing in a large grub-affected patch occurring in the adjoining check. At the present time (28th April) grub-infestation at the corner of the large block containing these experiment plots is mostly in patches of varying size, from 100 to 1,000 square feet, but as the season advances may extend more widely.

Note.—Owing to grub-infestation on these check-plots being slight (about 3 grubs per stool), the cane did not fall, and when rain fell at the beginning of June this yellowing cane rooted afresh, and in a few weeks had become greener, although still appearing yellowish.

Later Experiments at Greenhills.—On the 11th instant a small area of 66 feet by 25 feet, first ratoons Badila, damaged by third-stage grubs of *albohirtum*, was treated with $\frac{1}{4}$ -oz. injections, placed 1 foot apart, about 4 inches deep, and close to stools in order to obtain additional data with regard to the killing powers of paradichlor. under field conditions. During the fortnight following this application the weather happened to be rather showery, about 1.50 inches of rain falling at Meringa between the dates 15th and 22nd April. Subsequent examination of these stools fifteen days after application yielded 20 grubs, 18 of which were either dead or dying, only 2 being apparently unaffected. Several of the dead grubs, quite black and decomposed, were lying in hollows eaten into underground portions of canes, indicating that paradichlor. probably exercises a paralysing effect, thus preventing the escape of grubs overtaken by the fumes.



Arrangement of bristles on venter of anal segment of grub of *Lepidiota caudata* Blackb.

Micro-photo. E. Jarvis.

Plots at Meringa.—The plots fumigated at Meringa on 25th January consist of first ratoons of D. 1135 growing on an area of volcanic soil usually infested each season. Injections of $\frac{1}{4}$ oz. of paradichlor. were placed 6 inches deep, 4 inches from stools, and from 12 to 18 inches apart. The treated area of nearly half-an-acre consists of two strips, 472 feet in length by 36 feet wide, running along the summit of a ridge of high land that had been ploughed about 6 inches deep.

The condition of the cane on these plots about a fortnight after injection was described in my February report ("Australian Sugar Journal," vol. xv., p. 47, April 1923). When next examined, on 27th April (about three months after application), the cane both on treated and check plots was 7 to 8 feet high; but while the foliage of that on the treated area was dark green and of upright growth, the cane on adjoining control plots had turned more or less yellow in places, owing to the presence of grubs. This was very marked on the strip where injections had been made 18 inches apart, which chanced to pass through some grub-infested patches. Looking down on these plots from a height of 10 or 12 feet one could distinctly notice the green edge of the treated areas sharply bounded by the yellowing borders of the check-plots. This occurred, of course, on portions where grubs happened to be working, but it was very encouraging to note that not a single patch of such yellowing cane was present in the treated plots, which appeared of a uniform dark healthy green throughout their entire length.

INTRODUCTION OF GRUB PARASITES INTO JAVA.

On the 28th of this month the first consignment of Queensland scoliid digger-wasp parasites was forwarded to Prof. S. Leefmans, Chief of Zoological Division, Institute for Plant Diseases, and will leave Townsville on 8th May. This package contained twelve cocoons of our digger-wasps *Campsomeris tasmaniensis* and *radula*, which, being spun within the last ten days, should reach Buitenzorg before the wasps are ready to emerge from the cocoons. A second consignment, more recently spun, was forwarded on 1st May to catch the same boat, and these will be followed up by other lots until we succeed in introducing these parasites into Java, where it is hoped they may help to control the ravages of scarabæid grubs affecting cane and cassava crops, such as those of *Lepidiota stigma* Fab., *Leucopholis rorida* Fab., &c.

At the present time (2nd May) we have 190 paralysed grubs of *albohirtum* in our breeding-trays, to which are attached either maggots or eggs of *Campsomeris* wasps in various stages of development.

In return for cocoons sent away, we shall receive those of two species of scoliid parasites from Java, for introduction into our canefields to wage war against grubs of the greyback cane-beetle and of *Lepidiota frenchi*.

One of these wasps, *Dielis thoracica* Fab., attacks the grubs of four different scarabæid beetles. Its life-cycle occupies from 43 to 48 days. In general it is confined to areas badly grub-infested in East Java and on the south coast of Sumatra, where it is found practically throughout the wet season and also during the dry monsoon of six months. In Java these wasps frequent honey-bearing flowers of the orders Compositæ, Malvacidæ, &c., including those of genus *Sida*, three species of which occur commonly around Meringa, and are habitually visited by our *Campsomeris* wasps.

VISIT TO LOWER BURDEKIN.

Inspection of the more serious cane-pests of this district made last month (March) was followed up—as promised to the cane-growers at Ayr—by a second visit undertaken on the 23rd instant when field demonstrations regarding the use of carbon bisulphide as a soil fumigant for white ants attacking cane, and its mode of application, were carried out by Mr. W. C. Dormer, one of my assistants. Owing to a continuance of dry weather many growers were unable to be present, being very busy irrigating their cane, but those who attended were well pleased with the results obtained by such fumigation.

Like most methods of control, prevention in this case is better than cure, as when termites have entered the sticks above ground-level it is almost impossible to destroy them. The best time to treat this pest is shortly after planting, before the young shoots are more than 18 inches high. During this period of growth, any termites that may be in the soil will probably have discovered and surrounded the cane-sets, and could then be killed by simply fumigating the rows with carbon bisulphide. This treatment should practically clean up the land, thus preventing any future attack on the standing crop.

Since my recent visit to the Burdekin the value of paradichlor. for destroying cane-grubs has been clearly demonstrated by field experiments, and it would certainly be advisable to try its effect upon white ants. We have not yet worked out the possibility of poison-baits in this connection, but such methods of control might prove serviceable during certain periods in the life-cycle of this pest.

Another phase of control which I hope to investigate is that of treatment of the sets, before planting, with some palatable solution, non-poisonous to handle, but fatal or repellent to termites.

May to June 1923.

PARADICHLOROBENZENE PROVED TO BE AN EFFECTIVE FUMIGANT FOR CANE-GRUBS.

In my April report the appearance of our experiment plots at Greenhills and Meringa on the 28th of that month was outlined, when the condition of treated cane in both these localities was found to be very satisfactory.

I mentioned that about the end of April several yellowing grub-infested patches had commenced to show up in the check-plots at Greenhills, but that no such indication of grubs was observable in the area treated with paradichlor. Similarly, on the plots at Meringa one could quite easily pick out the treated from check stools by the decided difference in colour of the leaves, the treated cane being dark green, while that in the check rows continued getting yellower day by day.

PLATE X.



PARADICHLOR. EXPERIMENT PLOTS AT MERINGA.

End of a row of D.1135, 7½ months after fumigation with paradichlor.; indicating difference in height and normal growth of leaves as compared with grub-smitten stools alongside. Assistant H. Knust, who injected this row consisting of 300 healthy stools.

Photo. E. Jarvis.

During the interval between 22nd April and 17th May, only 36 points of rain fell at Meringa, with the result that an examination of our experiment plots here on the latter date yielded still more convincing proof of the effectiveness of paradichlor. as a cane-grub destroyer, the contrast between green and grub-smitten lines of stools having, during this dry interval of about twenty days, become very marked indeed.

At this time interesting evidence was afforded in connection with the work of injecting these stools on 25th January. This work was carried out by different men, each using a "Jarvis injector," and treating separate rows, the cane on that date being less than 3 feet high. In some rows stools had been accidentally missed, while others had not been injected to the proper depth (owing possibly to the spear having met with a stone or other hard substance). The whereabouts of such missed stools, however, was now clearly revealed, four months after application, by yellowing of the foliage, due to some of the grubs at these points having escaped fumigation.

By carefully counting all the stools in six of the treated and the same number of untreated rows of cane, the following conclusive results were obtained:—

Plot 1—Treated: (Three rows consisting of 900 stools of cane)—
20 stools affected by cane-grubs.

Plot 1—Untreated: (Three rows consisting of 900 stools of cane)—
575 stools affected by cane-grubs.

Plot 2—Treated: (Three rows consisting of 900 stools of cane)—
49 stools affected by cane-grubs.

Plot 2—Untreated: (Three rows consisting of 900 stools of cane)—
779 stools affected by cane-grubs.

Note.—Injections in Plot 1 were made 12 inches apart, 4 inches from plants, and 6 inches deep; while in Plot 2 injections were 18 inches apart.

Affected stools occurring in treated rows were often surrounded by or growing alongside green injected cane, thus showing that such occurrence was in many cases not due to failure of the fumigant at all, but to defects in application. This was very clearly exemplified in the case of a row consisting of 900 stools injected by one operator, and which happened to form an edge of a treated plot. This row presented an unbroken line of green foliage and did not include a single affected stool, showing it had been carefully and uniformly treated throughout the entire length. Running parallel to it, and only 4 feet 6 inches away, the edge of an adjoining check-plot formed an almost continuous row of yellow grub-eaten cane. The unmistakable contrast between these two rows of cane growing side by side was amply sufficient in itself to prove the effectiveness of the fumigant.

The next examination at Meringa was on 27th May, by which time, owing to continuation of dry weather, some of the cane in check-plots had apparently succumbed, and much appeared to be dying. The

difference between treated and check stools was naturally still more marked, as injected cane had remained green, indicating the presence of enough moisture in the soil to enable stools having uninjured roots to continue making slow growth. Between 29th May and 4th June we had a fall of 2.14 inches of rain, which came just in time to freshen up the grub-eaten cane.

The latest inspection of these plots was on 11th June, when the treated cane was seen to be higher than that affected by grubs. (See accompanying photographs.)

Greenhill Plots.—When last examined on 11th June we found that the injected cane had continued unaltered during the recent dry spell, without a single stool showing grub-injury; while on the other side, in the check-plots, decided evidence of grub-infestation was still very noticeable over patches of varying extent.

INTRODUCTION INTO JAVA OF QUEENSLAND CANE-GRUB PARASITES.

The consignment of digger-wasp parasites, reported last month as having been sent to Buitenzorg for introduction into sugar-cane and cassava plantations in East Java, were supplemented this month (May) by additional parcels containing in all 160 cocoons, spun at our laboratory last month. A further shipment of 75 cocoons will be forwarded to Java by the next mailboat on 9th July.

This total of 259 cocoons was derived from eggs laid here during March to June by our digger-wasps *Campsomeris tasmaniensis* and *C. radula* on the grubs of greyback cane-beetles, each parasitized grub being confined in a separate breeding-tin. The average temperature during this period was 80.75 deg. Fahr., and the total rainfall about 21 inches.

In return for cocoons sent away, we shall receive from Prof. Leefmans those of two species of scoliid wasps from Java for introduction into our own canefields to combat grubs of the greyback cockchafer and those of *Lepidiota frenchi*.

Although our digger-wasps destroy a small percentage of the grubs of these cane-beetles, the proportion killed in this way in the Cairns district does not vary much, owing to natural checks imposed on these parasites by their hyperparasitic enemies—at least three of which are already known to us, and have been studied to some extent at this station. In all probability, however, these natural checks would not materially affect the increase of introduced digger-wasps, the hyperparasites of which do not, so far as we know, occur in Queensland.

The establishment of inter-relationships between parasitic insects and their various hosts has not been brought about in a day, but in many cases centuries may have elapsed during such adjustment of the so-called "balance of nature." We may, therefore, reasonably assume that our Queensland insects affecting wasps of the genus *Campsomeris* are not likely to attack larvæ of *Dielis thoracica* and *D. javana*, the two digger-wasps we are hoping to establish in our canefields.

POISON BAITS FOR WHITE ANTS.

Experimentation along this line of control work was commenced on 9th May, when a number of poison-baits were prepared and placed in cages of soil in which specimens of the white ant *Mastotermes darwinensis* had previously nested in tunnels. The medium used consisted of small pieces of crushed sugar-cane which had been dipped in various arsenical solutions, such as copper arsenate (with and without molasses), sodium arsenite of different strengths, &c.

Best results were obtained from the simplest preparation—viz., arsenite of copper $\frac{1}{2}$ oz., water $2\frac{1}{2}$ pints—which gave a mortality of 100 per cent. after four days. The pieces of cane were merely dipped in the above solution and laid on top of the soil. The termites evidently came up out of the ground to feed on this bait, but whether they would do so under outside field conditions has yet to be determined. Arsenious acid (white arsenic) $\frac{1}{2}$ oz., sodium carbonate 1 oz., water 3 pints, proved effective after seven days, giving a mortality of 100 per cent.

We are still experimenting in the laboratory with other baits, and hope to report results from these and from field tests in the near future.

June to July 1923.

THE ARMY WORM (*CIRPHUS UNIPUNCTA* HAW.).

This pest, which usually appears more or less abundantly each year, and effects quite appreciable damage to leaves of young ratoon and plant cane, proved sufficiently destructive during the present season to excite comment from cane-growers; several instances of such outbreaks having been recently brought under our notice.

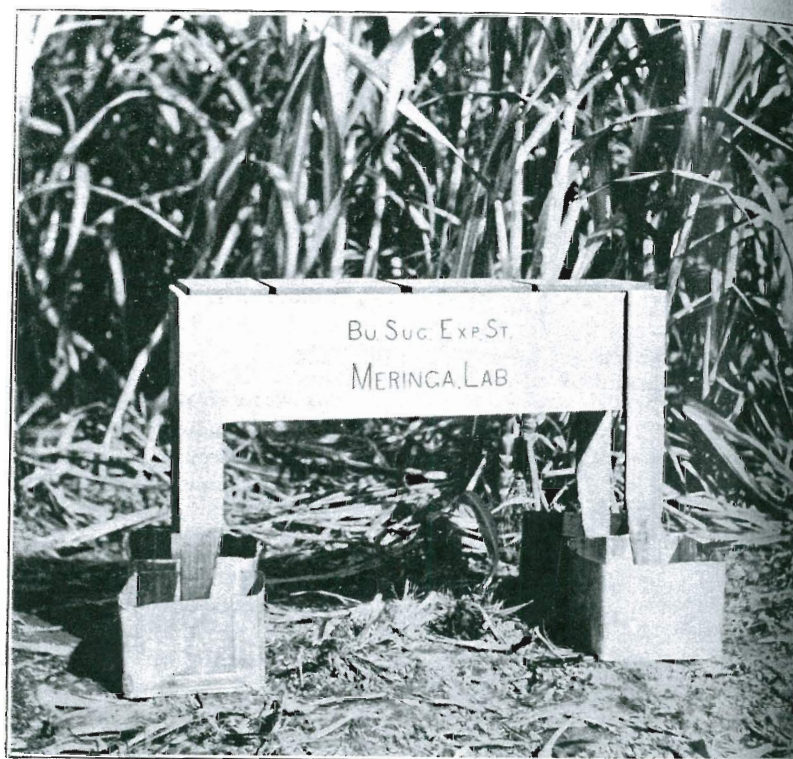
The caterpillars of this insect occasionally occur in overwhelming numbers, often entirely consuming many acres of valuable cereal and other crops. Moving forward like a vast army they generally take everything before them, leaving canefields or wheat paddocks, for example, completely stripped, only the bare midribs of cane-leaves or stems of wheat, &c., being left on the ground.

The first outbreak noticed by us this season was at Mr. Rushworth's farm on the Upper Mulgrave area. The damage here was very local, extending in fact over only a couple of acres, the cane on which, however, had been completely defoliated. Many caterpillars were collected from which to breed parasites, as this particular army-worm is controlled by quite a number of natural enemies. A large ichneumon was observed parasitizing pupæ of this moth.

Although familiar with the caterpillars, most growers are not aware that these arise in the first instance from eggs laid on the cane-leaves by the parent moth.

Cirphus unipuncta measures about $1\frac{1}{2}$ inch across the outstretched wings, which vary in colour from pale yellowish or reddish brown to buff or creamy grey, and are characterised by having a distinct white

PLATE XI.



Method of providing for natural liberation of Tachinid Fly Parasites among cane affected by the Weevil Borer (*Rhabdoenemis obscurus* Boisd.). The box, on antproof legs, holds a number of canes taken from a Breeding-cage, containing pupæ from which Tachinid Flies are about to emerge, and will escape through slits left in the cover of box.

Photo. G. Bates.

spot near the centre of each upper wing. Eggs of the earlier broods are generally laid on rank grasses in damp, low-lying situations, from whence the swarms of caterpillars, after having quickly eaten the herbage around, then travel in search of fresh fields. At this stage they are generally about half-grown, and, being in countless numbers, often able to effect serious damage to young cane, &c. Larvæ and pupæ collected from this locality and confined in cages at our Insectary yielded two species of tachinid flies, one syrphid fly, and an ichneumon wasp (*Rhyssa semi puncta*). Two additional species of Ichneumonidae were observed flying restlessly over the denuded rows of cane, being probably parasitic on caterpillars of this pest.

The second outbreak was at Highleigh, on Skeen Bros.' farm, where the infestation was more extensive, the larvæ being very common on headlands in low-lying situations, but mostly hidden among unfolding cane-leaves and behind leaf-sheaths. Hundreds of a large grey species of tachinid fly were noticed here.

A second visit to Mr. Rushworth's selection was made on 14th June, when the cane was seen to be recovering, and caterpillars had practically disappeared. Ichneumons, however, were very plentiful, and mostly of the male sex.

The occurrence of *Cirphis unipuncta* in the Cairns district at present is not only very local, but appears also to be followed almost immediately by natural checks, proving so effective that the pest as a rule seldom occurs injuriously again in the same locality for many years.

DISTRIBUTION OF TACHINID FLIES.

A good start has been made this season in the work of breeding parasites for liberation in plantations affected by the beetle-borer *Rhabdoenemis obscurus* Boisd.

In addition to stocking the big cages at Meringa with grub-infected canes, from which flies will emerge during August and September, the method of distribution by means of wooden boxes of cane-sticks containing pupæ of this parasite is being carried out.

These breeding-boxes, which measure about 3 feet in length and hold from 15 to 25 sticks, are taken into the field and set up among cane infested with beetle-borers. (See Plate XI.) The four legs supporting this box are stood in pans of water as a protection from ants, and after nailing up in manner indicated by photo, or tying a few cane-leaves over the top of the cage to afford shade from the sun, nothing more is required except an occasional visit from the grower to see that the water has not all evaporated, or trash, &c., been blown against the legs.

Canes in these boxes are kept separate one from the other by small wooden slats, so that all flies emerging can easily make their way among them to the top of the cage and escape through narrow transverse spaces left for that purpose in the cover. This method affords a ready means of liberating the flies in a natural manner without handling them in any way, and is specially adapted for distribution on selections near at hand.

CONDITION OF PARADICHLOROBENZENE PLOTS.

At Greenhills, which was visited 11th July, the cane is making slow growth, owing to the continuance of dry weather.

Stools affected by grubs in the check-plots during April and May are gradually recovering, grubs having gone down to pupate about two months ago. One can, however, easily locate these injured patches by the excess of dead leaves, and general stunted appearance of the stools.

Cane on the treated area remains free from grubby portions, and has grown slightly, but, like all the unaffected stools on this part of the Greenhills estate, is showing the effect of poor cultivation and want of moisture. This poverty of growth is still more noticeable in cane growing on the area which includes our experiment plots at Meringa, which are situated on a high ridge of light volcanic soil cultivated about 6 inches deep.

Stools on the check-plots which had started to pick up after a slight fall of rain (about 1 inch) at the end of May have now returned to their previous condition, most of them being practically dead on two of these plots.

Although none of the cane anywhere around has made much growth, the difference in colour between treated and check stools is again very marked, especially on the eastern edge of a treated strip of three rows 472 feet in length, on which injections of paradichlor. were made 18 inches apart.

CAIRNS SHOW EXHIBIT.

Our Experiment Station was again represented at the annual meeting of the Cairns Agricultural, Pastoral, and Mining Association held at Woree on 6th and 7th June. This exhibit took the form of coloured diagrams and charts, illustrative for the most part of the underground working and life-cycle stages of our principal cane-beetle, *Lepidoderma albobirtum* Waterh., and the effect produced by grubs of this notorious pest on the growing cane crop during each month of the year.

A general collection of insects, and of the grubs, pupæ, and adults of root-eating cockchafer beetles affecting sugar-cane, was also on view; together with other exhibits of a scientific nature, comprising the chief parasitic and predaceous enemies of our various cane-pests, and dissections showing portions of the anatomy of the greyback beetle, &c.

Specially designed glass frames, in which could be seen actual living specimens of cane-grubs devouring the roots of growing plants, and of the giant white ant *Mastotermes darwiniensis* Frogg. in their nest tunneling in cane-sticks, proved an attractive feature.

Many growers availed themselves of the invitation to freely discuss various phases of the cane-grub question, and seek information respecting insect pests that were troubling them; so that much interchange of opinion took place.

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