

The Control of Root-eating Scarabaeid Grubs in Queensland Cane-Fields.

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(With 11 text-figures.)

The world-wide damage caused by the larvae of various lamellicorn beetles to sugar-cane, cassava, pasture land, root crops, and miscellaneous economic trees and plants, has engaged the undivided attention of many scientists during the last thirty years or more.

The "White Grub" question in America, the notorious Cockchafer or "May Bug" in Europe, and the formidable "Grub Pest" of Australian cane-fields, constitute exceedingly complex problems which have for many years defied the efforts of entomologists, and at the present time, although partially solved, cockchafer beetles still continue to be responsible for tremendous financial losses.

It is interesting to note that the destructive species in each of these three examples are classed amongst the *Melolonthinae*, most of the grubs of which subfamily, in addition to their habit of ingesting soil and extracting from it organic matter, also devour living roots and the growing vegetable tissue of harder underground portions of plants.

While the majority of Queensland cane-beetles (including our most destructive) belong to the *Melolonthinae*; the subfamily *Rutelinae* is also represented in our cane-fields by two species, both of which, however, happen to be of minor importance.

In the present article it is my intention to deal with six of our northern scarabaeid beetles, all of which are common at times under cane-stools, and inflict damage of a more or less serious nature to the setts, roots, and subterranean basal portions of growing cane-sticks.

I. ON SIX NORTHERN SCARABAEID BEETLES.

1. *Lepidoderma albohirtum* Waterh.; Grey-back Cockchafer.

(Text-figs. 1-3, 10)

Undoubtedly, this beetle is our chief pest of sugar cane. While preeminently destructive in the North, it also ranges into our Southern cane-lands, effecting occasionally considerable injury around Bundaberg, Mackay, Proserpine, and other sugar-growing districts.

Life-cycle stages described:

Its obtusely ovate creamy yellow eggs are deposited in an earthen chamber formed in the soil by the female beetle, at a depth of from 12 to 18 inches or more. When just layd they measure about 4.25 by

2.85 mm, but when about to hatch assume a more rounded appearance, becoming fully 6 mm in diameter.

The grub, when fully grown (end of the third instar), is a little over 2 inches in length. In general colour it is creamy white, becoming pale bluish white and somewhat translucent at the beginning of each instar, the anal segment being suffused with brown, dark grey, or slaty blue, according to the colour of the soil ingested.



Fig. 1.

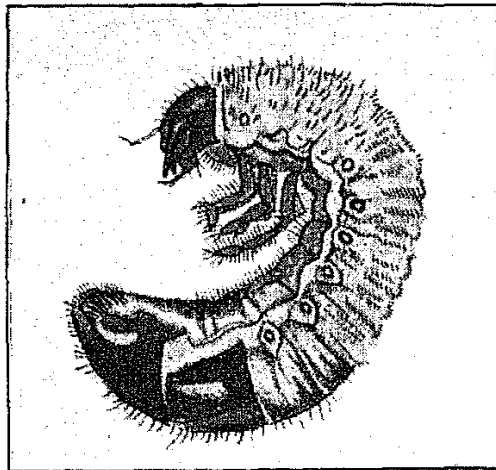


Fig. 2.

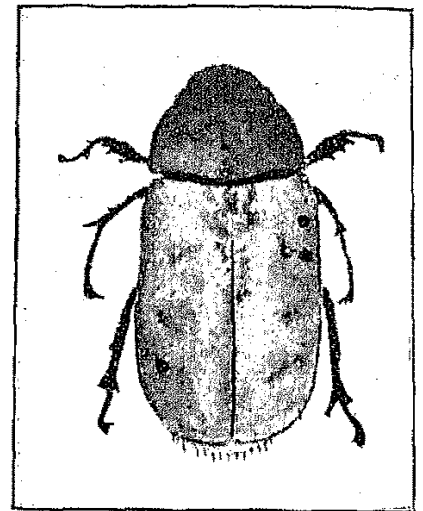


Fig. 3.



Fig. 4.

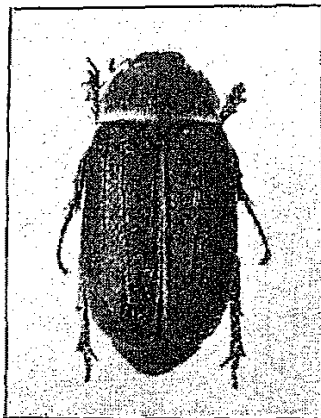


Fig. 5.

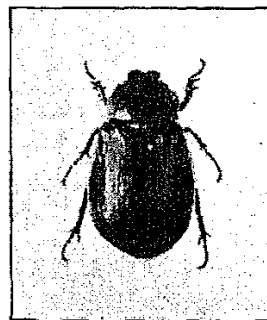


Fig. 6.



Fig. 7.

The grub of *L. albohirtum* resembles those of the species of the genus *Lepidiota* given below in general form and colouration, each of which, however, can be easily separated and identified by differences in the arrangement of the vestiture on the centro-ventral portion of the anal segment, which differences are well illustrated in the accompanying microphotographs.

The pupa of the "Grey-back", which is about the largest of those of *Scarabaeidae* occurring in plough-furrows, measures $1\frac{1}{2}$ inches long by nearly $\frac{3}{4}$ of an inch in width, and is furnished, as will be seen in the illustration, with two very noticeable horn-like processes on the cremaster. Its colour is dark yellowish red of variable degrees of intensity in different specimens.

The perfect insect is of the size and form shown in the photograph, the body being deep blackish brown, and more or less thickly covered (excepting on legs and centro-ventral area of abdominal segments) with numerous white, pointed scales.

Freshly emerged specimens are uniformly grey above, but after the lapse of a few days become more or less rubbed, the bare portions of the elytra, etc., appearing then as irregular dark blotches. A detailed description of the life-cycle stages of this cane-beetle, to which the reader may refer, if desired, has been published by the writer in the *Queensland Agricultural Journal* (Vol. XVI, pp. 46—50, 1921).

Unfortunately the life-cycle of this insect occupies only one year; a fact which doubtless accounts for its ability, during ravages of exceptional severity, to cause consternation among those growers whose selections chance to be situated in localities liable to such grub-infestation. The maximum amount of damage usually becomes apparent during the months of May and June, when affected stools turn yellow; indications which in severe cases are quickly followed by browning of the leaves and ultimate fall of the cane-sticks.

2. *Lepidiota frenchi* Black b.; French's Cane-Beetle.

(Text-figs. 4, 8)

This Cockchafer appears on the wing during November or December, generally emerging from the ground a week or ten days after the first flight of Grey-backs.

Upon catching a specimen one notices a faint whitish bloom overspreading the general body colour of dark reddish brown, which, if looked at with a pocket lens, is seen to be due to the presence of numberless tiny white circular scales. The outer edges of the pronotum of this insect are dark red, turned up slightly, and symmetrically scalloped, the hind margin of same being densely bordered with these curious scales. The ventral surface of body, including the legs, is thickly clothed with white scales, which, on the thoracic plates, vary from circular to pear-shaped, and near the coxae are replaced by long silvery hairs. Its four life-cycle stages have been fully described by the present writer in *Bulletin* Nr. 5, Div. of Ent. of our Sugar Bureau, so need not be given here. Although in evidence each season, fortunately the grubs of *L. frenchi*, which are almost as large as those of *L. albohirtum*, do not injure cane-roots every year. These beetles are excessively abundant at times; damage to young shoots of plant and ratoon-cane being accomplished every second year during the months of September to December.

3. *Lepidiota caudata* Black b.; Glossy Scrubchafer.

(Text-fig. 9)

Grubs of this beetle are common at times in cane-fields situated near scrub-land, and often responsible for serious injury. Growers constantly mistake them for larvae of *Lepidiota frenchi*, but the vestiture on the venter of the anal segment is darker in *L. caudata*, and the bristles forming the pear-shaped mass meet across and obscure the central path.

The perfect insect is deep purple or brownish red, of darker shade than in *frenchi*; the dorsal surface of its elytra being also more sparingly

and minutely punctulate than in the latter species, with the scales very much smaller.

This cane-beetle is one of the first to emerge, usually appearing on the wing during normal seasons early in September.

Like *frenchi*, *L. caudata* has a life-cycle of two years.

The beetles are said to feed on the foliage of Euphorbiaceous plants.

Fig. 8.

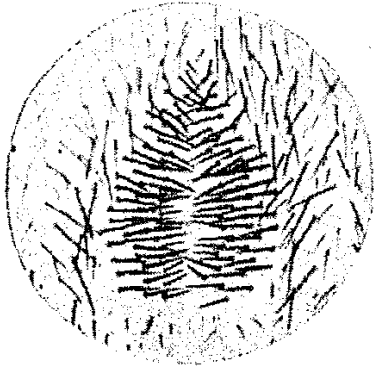


Fig. 9.

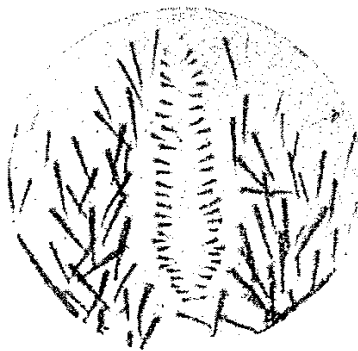
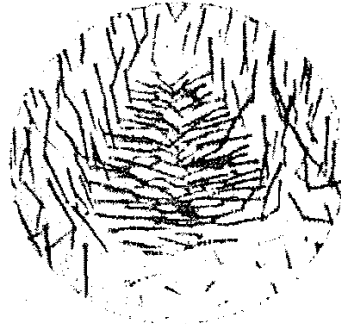


Fig. 10.

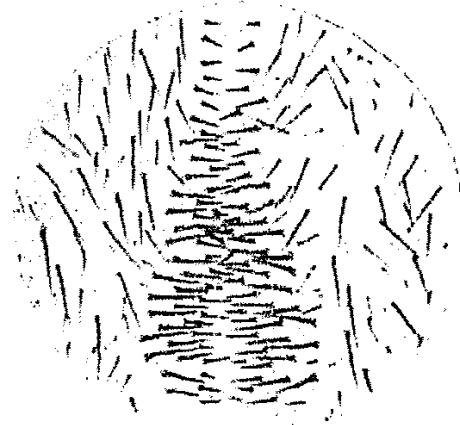


Fig. 11.

4. *Lepidiota consobrina* Gir.

(Text-figs. 5, 11.)

Closely resembles *L. frenchi* in general appearance and colouration. The beetles emerge, however, about three weeks earlier than *frenchi*, are of local occurrence, and much less numerous in forest country. It is easily distinguished from the latter by the following specific differences:

The Larva. — Setae on venter of anal segment in both species are arranged in the form of a pear-shaped figure, which in *consobrina* is elongated cephalad in two parallel rows of short bristles (see microphoto). Width of head 7.2 mm; in *frenchi* 5 mm.

The Beetle. — Average length $1\frac{1}{8}$ inches; *L. frenchi* 1 inch. Antennal joints 6 and 7 stouter in male than in female. The teeth on outer edge of front tibiae have the points more obtuse than in *frenchi*, and are not equidistant. Front tibial spur stouter and blunter. The ventral transverse bands on abdominal segments 1 to 4 narrower centrally and sub-ventrally than in *frenchi*. In addition to the above differences the circular white scales on the elytra of this species are distinctly larger than those of *frenchi*.

Grubs of this Cockchafer are frequently found under cane-stools and in localities near scrub-land, where they often occur very plentifully and doubtless effect serious damage.

5. *Anoplognathus boisduvali* Bois d.; Christmas Beetle.

(Text-fig. 7.)

This beautiful beetle occasionally does serious damage in the Herbert River and other Northern districts, although around Cairns and Babinda it seldom proves troublesome except on localised areas in the immediate vicinity of low-lying or swampy ground supporting *Eucalyptus platyphylla* (Broad-leaved Gum-tree), which is the favourite food-plant of this insect.

Description. — Elytra pale creamy yellow, with faint green and pink iridescence, edges of suture green, about 20 rows of fine punctures on each elytron, half the number being straight and clouded in part with smoky brown, having the appearance of somewhat broken, parallel, dotted lines; outer edges of elytra bordered with golden brown. Head, pronotum, and scutellum metallic greenish gold, minutely punctulate. Pygidium bright green, edged with blue. Ventral area of body iridescent coppery green; thorax, legs, and anterior margins of abdominal segments more or less clothed with short white hairs; tibiae and tarsi purple. Length 25 mm (nearly 1 inch).

The fully grown grub is about the same size as that of *L. frenchi*, but its head is darker in colour and of lesser width.

The vestiture of the venter of the anal segment is quite different from that of the former species. Unlike larvae of *Lepidiota*, the grubs of *Anoplognathus* are able to crawl over level ground by lying extended on the ventral surface and steadying themselves with their legs, which project about a quarter of an inch on either side.

In the Burdekin district this insect is known commonly as the "Golden Beetle".

6. *Lepidiota rothei* Black b.

(Text-fig. 6.)

This beetle is abundant every second year, flying at the same time as *Lepidiota frenchi*. Its grubs occur rather sparingly in cane-fields, where they subsist mainly on decaying vegetable matter, being often present in considerable numbers on trash which has been lying for a few months on the ground between cane-rows.

The perfect insect is dark shining reddish brown, covered on the elytra with innumerable fine punctures, each containing a single white pear-shaped scale. The ventral surface and legs are more or less densely scaled, excepting on tarsi and anterior margins of abdominal segments. Length 17.5 mm.

The anal path of the grub of *L. rothei* is bordered by two somewhat parallel rows of short bristles, which meet over the centre of the path, and are of similar colour to the surrounding vestiture.

II. HOW TO CONTROL GRUBS OF THE GREY-BACK COCKCHAFFER BEETLE.

1. The Paradichlorobenzene treatment.

Initial experiments with this soil fumigant against our chief cane-beetle (*Lepidoderma albobirtum* Waterh.) was commenced by the Sugar Bureau during February to April, 1915; while, strangely enough, in the same year its use as an important insecticide was independently demonstrated in America, where Paradichlor was shown to be an excellent fumigant for combatting insects attacking stored products, etc. etc. At the very time when such conclusive results were being obtained in the United States, our laboratory experiments carried out by the writer in North Queensland against cane-grubs were also proving highly satisfactory.

It was not until the year 1924, however, that our Experiment Plots laid down on various cane-lands in the Cairns district served further to establish, beyond any possibility of doubt, the value of Paradichlorobenzene for destroying grubs of the Grey-back Cockchafer (Bull. Nr. 19. Div. of Ento. Bur. Sug. Expt. Stations. pp. 37—47, 1926).

Taking, for example, one of our Experiment Plots at Worree near Cairns, it should interest economic entomologists and cane-growers generally to learn that according to the figures supplied to the Bureau of Sugar Experiment Stations by the Colonial Sugar Refining Company — who weighed and crushed the cane harvested from this plot (both on treated and check areas) at their Hambledon Plantation Mill — the plot treated with dry nodules of Paradichlorobenzene yielded cane at the rate of 27.208 tons per acre, whereas the grub-affected cane cut from the adjoining untreated check plot of similar size gave a yield of 14.032 tons per acre, representing the gain of an additional 13.428 tons of cane per acre as a direct result of such fumigation.

We must not overlook the fact that increased tonnage is not the sole benefit one derives from a control measure of this kind, since destruction of the grubs under plant-cane means also the development of healthy ratoons for the following season.

The above mentioned Experiment Plots were situated on friable soil of light red colour, which had been planted with variety D. 1135 about four months prior to being injected. The dose of Paradichlor used was $\frac{1}{4}$ oz., injected $4\frac{1}{2}$ inches deep, and 12 inches apart on both sides of the cane-rows, 6 inches from stools.

2. How to apply Paradichlorobenzene.

The following methods have been tried at Meringa Experiment Station, viz. Machine application, injecting, and dropping by hand in an open furrow.

By the first method a man with a horse could fumigate about three acres of cane-land per day. The appliance used by us is a small corn planter adapted for such work by slightly altering the construction and making a few additions.

With such a machine uniform doses of the crystalline nodules can be buried close alongside rows of cane at regular depths and distances

apart; the soil above them being at the same time levelled and slightly consolidated by means of a special roller attachment. Both injecting the fumigant or dropping it by hand are cumbersome in comparison, although by the latter method it would be possible to treat small areas of young cane.

The various Experiment Plots laid down during 1922 to 1925 were fumigated with a special appliance designed by the writer for injecting dry fumigants at uniform depths and distances apart, as without some such aid at that period the doses would have had to be put in with a dibble or trowel. Not being intended for use on extensive areas of cane land, however, a man using the above appliance would not do much more than one quarter to one third of an acre per day of eight hours.

3. Quantity and cost per acre.

When treating ratoon crops from 3 to 4 feet high by machine application, a dose of $1\frac{3}{4}$ drachms (Apoth.) would need to be used on badly infested land, but in most cases $\frac{1}{8}$ oz. will be found sufficient. For plant-cane one to two feet high, the dose should be about 1 drachm; while for still smaller cane 2 scr. (Apoth.) would prove effective. In each case these doses are to be administered from 5 to 6 inches from the nearest cane-shoots, 15 to 18 inches apart, and about $4\frac{1}{2}$ inches deep, on both sides of the rows.

Aproximately, the quantities required per acre work out as follows: —

Dose of 1 drachm. —	{	Placed 15 inches apart	113 lb.
		Placed 18 inches apart	98 lb.
Dose of $4\frac{1}{2}$ scruples	{	Placed 15 inches apart	169 lb.
		Placed 18 inches apart	147 lb.

The price per acre, including labour, would depend largely, of course, upon the market price of Paradichlor. In Queensland, at the present time (May 1928), it would be about £6. 15. 00 for maximum doses — applied in exceptional cases to advanced ratoons — and £4. 10. 00 for the majority of crops requiring fumigation.

4. Paradichlorobenzene does not injure the cane.

During November of 1922 a field experiment in which 48 stools of young plant-cane about 14 inches high, growing on friable volcanic soil, were treated with $\frac{1}{4}$ and $\frac{1}{2}$ oz. injections placed along one side of a row of D. 1135, and from 4 to 6 inches from the stools; an adjoining row of similar cane on each side of this treated row serving as check-plants.

Some of these injections were placed immediately opposite stools, and others diagonally in intermediate positions, all being 6 inches deep. When examined a few months later none of the treated stools were found materially injured by this fumigant, while some months later still, growth of both the treated and check rows was seen to be quite normal, not a single stool having been stunted in any way (see Bull. No. 18, Div. of Ent. pp. 25, 26).

Points to be remembered.

1. The vapour arising from Paradichlorobenzene is harmless to human beings and domestic animals. Being five times heavier than air it diffuses downwards through the soil from points of injection, per-

- meating also in a lateral direction, and upwards through the surface soil during evaporation of moisture from the ground.
2. Paradichlor is non-poisonous, cleanly to handle, non-inflammable, and practically insoluble in water.
 3. The correct time of year for administering this fumigant, modes of fumigation, cost per acre, etc., apply only to the Grey-back Cockchafer (*Lepidoderma albobirtum*), which has a life-cycle of one year.
 4. Do not use excessive doses; from 1½ to 3 scruples weight (Apoth.) is sufficient in most cases for plant-cane 1 to 2 feet high; and five scruples for older plant or ratoon crops.
 5. Avoid placing the crystals closer than about five inches from the nearest shoots of very young plant cane.
 6. Do not fumigate when the soil is very dry, or excessively wet.
 7. Only one treatment is required each year, — to be given when possible during December or early in January, before commencement of the wet season.
 8. Store this fumigant in tins or closely fitting wooden boxes when not required, to prevent waste from needless evaporation of the crystals.

5. The Bisulphide of Carbon treatment.

Past experience in Queensland has demonstrated the value of this soil fumigant for combatting cane-grubs.

Its great volatility, however, during ordinary temperatures renders it difficult at times to secure uniformity of evaporation under subterranean conditions, such troubles often arising from variations in soil porosity, due to gradual compression of the ground in places during growth and expansion of the basal portion and main roots of various trees or plants.

Field experiments carried out at Meringa have demonstrated that the eggs, larvae, pupae, and imagines of our Grey-back Cockchafer can be destroyed by fumigating such affected soil with Carbon Bisulphide.

The best time for using this fumigant is when the soil is firm, yet nicely moist, and with good porosity, while the surface is compacted owing to recent wet weather. If very dry or too porous, however, even large doses injected at such times may have little or no effect on soil-frequenting grubs or adults.

The following guide as to the best time for treating different classes of land will be serviceable to cane growers.

Highland volcanic soil, or coarse sandy loams: — From four to five days after a fall of 2 or 3 inches of rain.

Clay-loams, or fine sandy loams: — About six days on land that has been well worked and drained.

Sandy soils: — Two or three days after heavy rain.

Failure to secure good results from the use of Carbon Bisulphide is generally due to lack of essential knowledge on the part of the operator. When a farmer, who has neglected to fumigate at the right time, suddenly notices evidence of grub damage amongst his cane, he generally hastens to inject at once, without stopping to consider whether the soil be in a fit state for such fumigation.

The amount of Carbon Bisulphide required per acre would necessarily vary somewhat according to the age, etc., of the stool to be treated. One drum per acre (about 60 lbs.) has been recommended by some authorities

as being sufficient in most cases. For young plant- or ratoon-cane growing on light classes of soil doses of about 1 drachm, injected 3 to 4½ inches deep, 18 inches apart, and on both sides of rows planted 5 feet apart, should destroy 70 to 95 per cent. of the grubs. This would take about 1¼ drums (77 lbs.) of Carbon Bisulphide per acre — equal to about £2. 15. 00 for material.

A similar treatment would be suitable for older plant-cane or ratoon-crops, either on clay-loams or light soils, but in such cases it will often be found advisable to inject every 12 inches instead of 18 inches apart, which works out at about two drums per acre, equal to £4. 10. 00 for material.

Carbon Bisulphide should not be applied to very young cane just beginning to make roots, but treatment delayed until the stools are established, and the cane about two feet high.

6. Other Methods of Control.

The commonsense remedial measure of collecting the beetles and grubs is practised in some of the Northern sugar-growing districts, and has been found beneficial. As much as 1/6 per quart is sometimes paid for Grey-back Cockchafers, the usual price, however, varying from 6 d to 1/- per pound (about 272 specimens).

In the Herbert district 2/- per lb. is given for the beetles of *Anoplognathus boisduwali* Bois d.

The mode adopted for collecting Grey-back beetles is to shake or jar their feeding-trees during the early hours of morning, at which time these beetles are resting amongst the foliage in a semi-torpid or sleepy condition, and upon feeling any sudden vibration of the leaves or twigs usually release their hold, and falling to the ground are easily picked up or swept into sacks. Growers have been advised by us to plant or leave (when found growing naturally) clumps of feeding-trees, such as *Ficus pilosa* or *F. beniamini*, close to headlands at intervals of a few hundred feet apart, as these particular food-plants, which are much frequented by the beetles, would probably attract most of the specimens in the immediate vicinity, and also facilitate the collecting of same. Such trap-trees should be pruned at intervals, with a view to encouraging a low and spreading growth of leaves.

Several other forms, of an artificial and biological nature, for combating *Lepidoderma albobirtum* during its larval and imago conditions are being studied at Meringa Experiment Station.

Being an indigenous species, and able to breed unrestrainedly throughout vast tracts of uncultivated country, one cannot hope to eradicate this insect altogether. By practising the above-mentioned control measures, however, cane-growers are now in a position effectually to control, if desired, the ravages of this pest on areas devoted to the cultivation of cane.

The additional yield of sugar obtained from varieties such as "badila", which happen to be very susceptible to grub-attack — and owing to this fact are seldom planted on land liable to infestation —, would cover any cost incurred by fumigation of the stools.