BIOLOGY AND CONTROL OF THE FRINGED NETTLE GRUB

(*Macroplectra* (*Natada*) *nararia* Mo.)

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Nettle grubs are well known in Ceylon, particularly to Uva planters, as a pest of tea that has been troublesome for over sixty years. They are the larvae of moths of the family Cochlidiidae (*Limacodiidae*) in which the species of economic importance are mainly tropical in distribution, being pests on tea, coconuts, plantains, coffee, oil-palms, and other plants. Both the structure of the larvae and the form of the cocoons in which they pupate are unusual amongst Lepidoptera, although despite their economic importance the family has not been as much studied as many others, including their equally unusual relatives, the Psychidae or Bagworm moths. Not all cochlidiid larvae are called nettle grubs; the name is due to the presence of stinging (urticating) spines on the body; some species are called slug caterpillars or gelatine grubs. All have thick short fleshy bodies, a small retractile head and minute thoracic legs; the segmentation is indistinct, and there are no abdominal feet, although in some species there are secondary sucker discs on the first eight abdominal segments. The cocoons are nearly spherical in shape, off-white to brown in colour, so that superficially they resemble a large seed; they possess a lid or operculum through which the adult moth emerges.

The species occurring on tea in Ceylon, and the history of their occurrence as pests, were reviewed in detail by Austin (1931, 1932, 1932a) and by Hutson (1923, 1932, 1932a). The commonest species causing severe damage to tea has continued to be the Fringed Nettle Grub (*Macroplectra* (*Natada*) *nararia* Moore). The Blue-striped Nettle Grub (*Parasa lepida* Cram.) is quite common in much smaller numbers, whilst *Thosea* spp. have in recent years caused local damage very occasionally (Austin, 1957). The purpose of the present article is to record the facts known about the Fringed Nettle Grub and to report recent work on the control of this pest. All further reference in this article to 'nettle grubs' implies the Fringed Nettle Grub unless otherwise stated.

Distribution and Economic Importance

Outbreaks of the Fringed Nettle Grub are commonest in the Uva Province, particularly in the Passara, Badulla and Bandarawela districts, though severe outbreaks have occurred occasionally in districts outside Uva, notably in Dolosbage and Matale. In Uva they occur mostly above 4,000 feet, and even above 6,000 feet. The incidence of outbreaks varies greatly from year to year, being affected directly or indirectly by weather conditions. The pest was reported from 35 estates in 1959 and it is clearly the most injurious caterpillar pest of Ceylon tea at the present time. No estimates have been made of the acreage affected by nettle grubs in a bad year, but this would appear to be several hundred acres and occasionally a few thousand acres. Whilst this is a small percentage of Ceylon tea, it is a serious problem on those estates which have several fields affected. A severe outbreak not uncommonly results in the complete defoliation of whole fields with the loss of crop for many weeks. The pest is most common in the dry weather of the N.E. monsoon zone, and outbreaks usually occur from July to September, although severe attacks have been known to continue through wet weather later in the year. In the S.W. monsoon zone, attacks are most likely to occur from March to May.

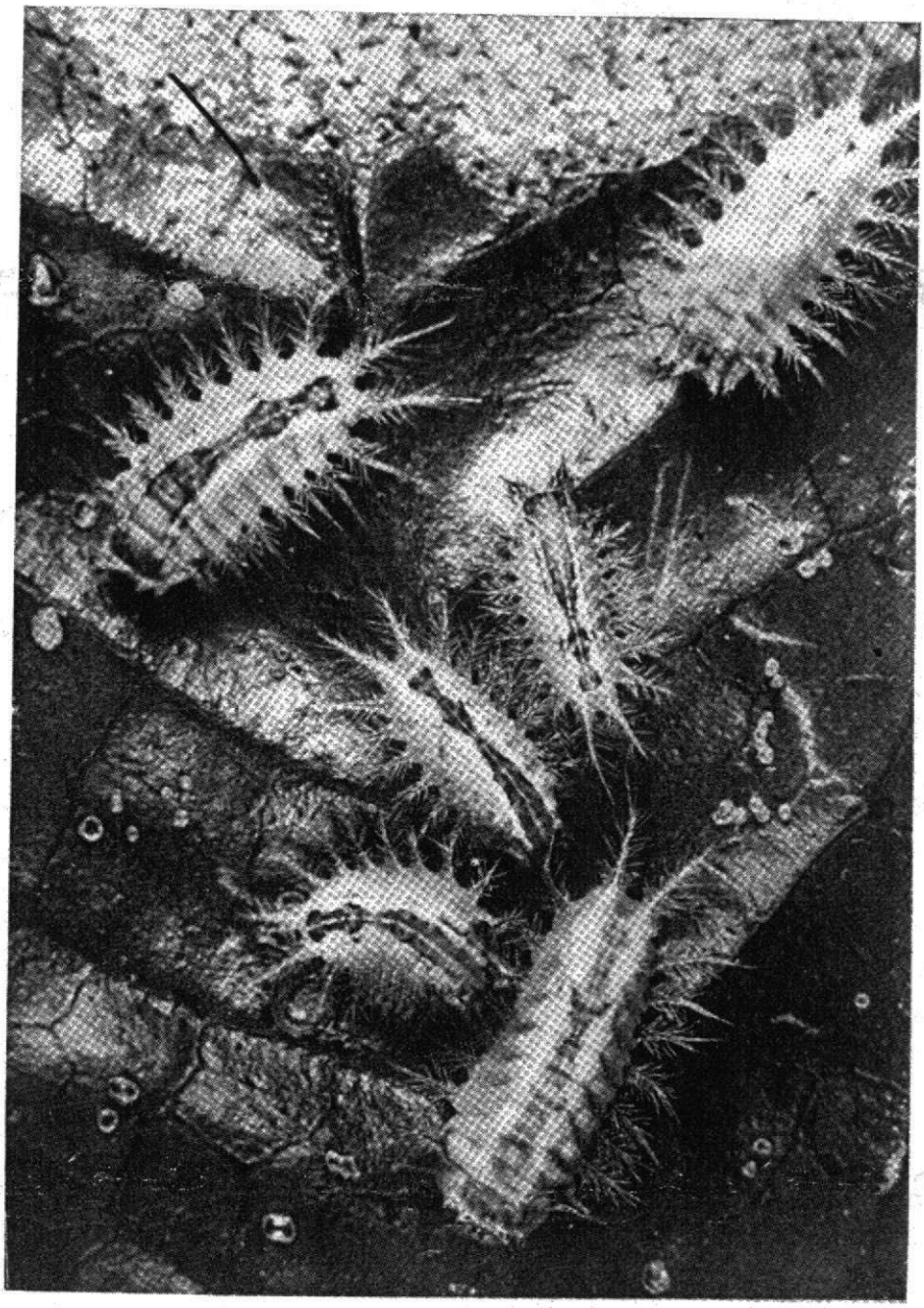

Plate 1. Larvae of the Fringed Nettle Grub (*Macroplectra nararia* Moore)

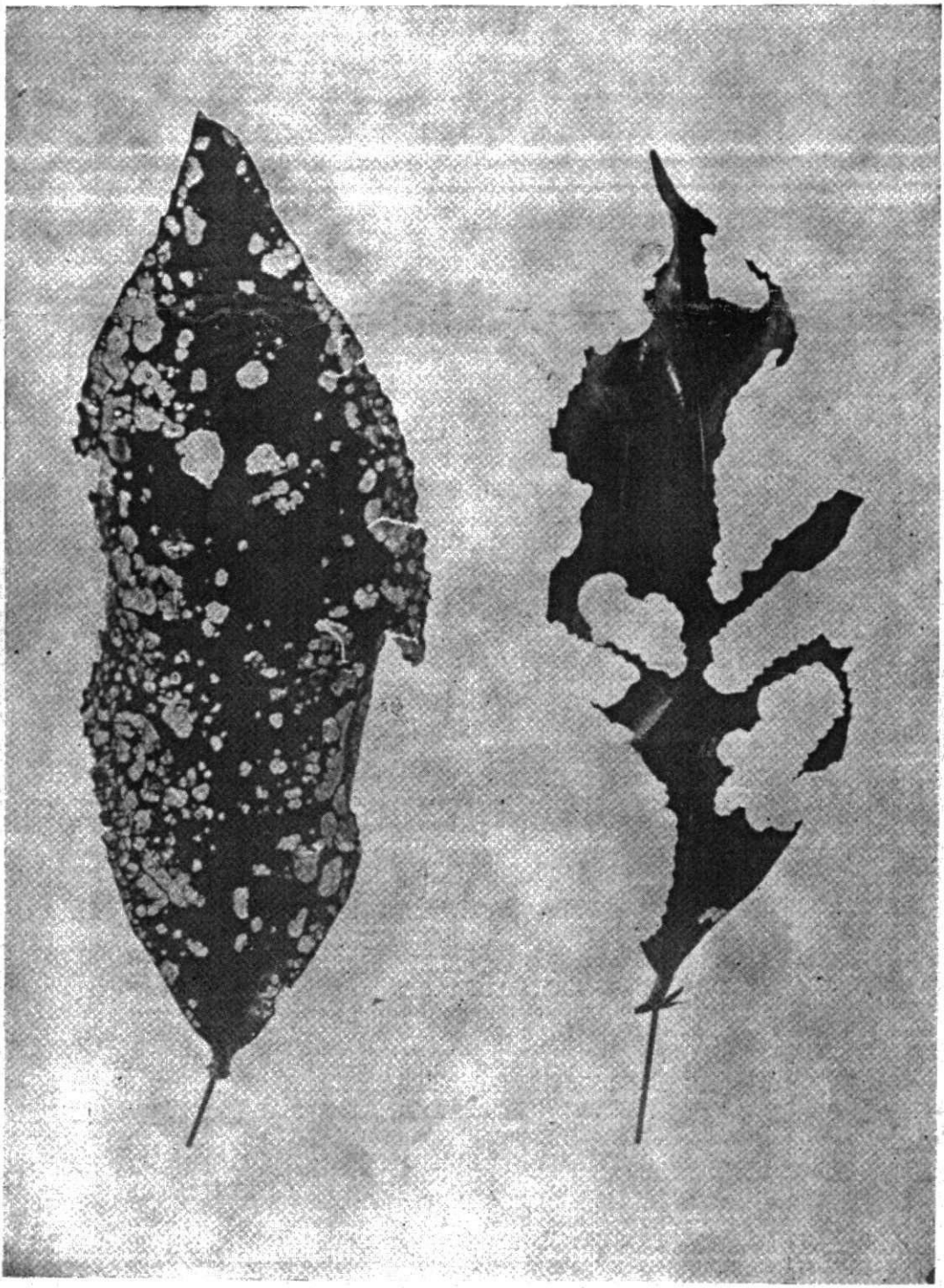

Plate 2. Damage to tea foliage caused by young and older larvae of the Fringed Nettle Grub.

Life-history and Description

The eggs are not easy to find since they are laid singly by the female moth on upper surfaces of mature leaves. They are oval and flattened, 1.25 mm × 1 mm in size, at first pale-yellow, or greenish when seen on a leaf, but they become opaque or pale-brown before hatching. They have a shiny appearance, which is the most distinctive feature for finding them. Many eggs may be laid on a single leaf. They hatch after about one week.

Although the eggs are laid on the upper surfaces of leaves, the newly-hatched larvae, which are 1/25th of an inch long, always migrate to, and begin feeding on, the undersurface of leaves where at first they eat away small areas leaving only the upper epidermis of the leaf intact. When about two weeks old (3rd instar) the grubs are able to eat right through the leaves resulting in a quite different appearance of damaged leaves (see Plate 2). In serious attacks every part of all the foliage may be consumed leaving the frames of the bushes completely bare.

The older larvae, 10-12 mm in length when mature, are illustrated in Plate 1. The ground colour is pale yellowish-green to apple green and the median dorsal strips is darker, predominantly purple, bordered on both sides with pale yellow. The lateral fringe of hairs which accounts for the common name of this species, consists of nine pairs of tubercles bearing tufts of pale translucent urticating hairs. There are also two pairs of anterior tubercles bearing much shorter hairs. The larval stage lasts 5-6 weeks.

The mature larvae pupate mostly on the ground beneath the bush, among dead leaves or in crevices amongst stones, and sometimes on the lower branches of the bush. They spin a cocoon which is globular, one-sixth of an inch in diameter, consisting of a hard papery shell covered with a thin webbing of dark brown or purplish-brown silk. Inside this cocoon the grub pupates and emerges about three weeks later by pushing off the circular lid or operculum prepared by the grub.

The adults are inconspicuous, very pale brown moths of which a description has been quoted by Austin (1932), from whom the following details are quoted. Austin found that female and male moths lived for 3 to 12 days in captivity, averaging six days. Moths rest up during the day and become active at dusk; egg-laying, which commenced on the day following emergence, was carried out mainly between 6-30 p.m. and midnight. Females laid about 500 eggs, most of them within three to four days of emergence. Austin observed that the moths were not active on windy nights, and a mass migration of the moths has never been observed.

The life-cycle from egg to adult takes about ten weeks according to Austin (1932) and this fits in well with the frequency of generations observed by Gadd *et al* (1946) so that there are probably five generations in a year. Peak numbers most frequently occur in July to September, but this is very variable and little is known of the cause of outbreaks.

The Fringed Nettle Grub in Ceylon is known to complete its life-cycle only on tea, coffee, and dadap (*Erythrina lithosperma*). Grubs have been found feeding on many other trees and shrubs in small numbers, but there is no evidence of them maturing on these plants.

Natural enemies

The following insect parasites have been reared from *M. nararia*:—

Fornicia ceylonica Wilkn.
Rhogas sp.
Goryphus variibalteatus Cram.
Tricholyga sorbillans Wd.
Euplectrus sp.
Neoplectrus maculatus Ferr.
Platyplectrus natadae Ferr.
Autoplectrus taprobanes Gadd.

Gadd (1946) and Gadd, Fonseka and Ranaweera (1946) made a detailed study of the Euplectrini, tiny wasp-like parasites of young nettle grubs, comprising the last four species listed above. *Neoplectrus maculatus* is unusual in that the adult females are predators, feeding on the body fluids of nettle grubs, whilst the larvae are parasites of the nettle grubs (Gadd and Fonseka, 1945). *Fornicia ceylonica* and *Rhogas* sp. were noted by Austin (1931) and have been found frequently since that time, but little is known about the normal balance between the host and these various parasites and the effect of other factors upon it.

The adults and nymphs of the Pentatomid bug *Cantheconoidea robusta* Wolff. have been noted on several occasions as predacious on nettle grubs. The Crow (*Corvus splendens*) is the only bird recorded as feeding upon nettle grubs (Austin, 1931).

Wilt Disease

The virus disease known as wilt or granulosis disease is an important factor in the natural control of nettle grub populations. The disease is transmitted from one larva to another by contact or by ingestion with the foliage eaten. A grub suffering from wilt disease soon becomes sluggish and loses appetite. The normal green coloration of the body changes to a dull yellow (a bright yellow is characteristic of insect-parasitized grubs); finally the grub becomes motionless and the body turns to a brown colour at the time of death. At this stage, the larva is entirely flaccid, emitting an offensive smell and the internal tissues have disintegrated.

Most virus diseases of insects are specific to one species or affect only a few. Thus, wilt disease of the *M. nararia* affects *Parasa lepida* only slightly and does not appear to affect *Thosea* species of nettle grubs at all. Under conditions in the field, the spread of wilt disease is increased by high host-density and generally by humid air conditions and wet weather. It does not normally become epidemic in an outbreak of nettle grubs until the grubs are nearly all mature and the major part of the damage to the tea bushes has been done. It is commonly epidemic at the onset of the N.E. monsoon in Uva, but this is not always the case, and outbreaks of the pest have been known to continue through very wet weather.

Virus diseases of insects are well known, particularly in lepidopterous larvae (butterflies and moths), and the study of this subject stemmed to a large extent from early work on 'jaundice' in the silkworm. Over sixty years ago, workers started experiments on the artificial use of these virus diseases for the control of insect pests, and in recent years, successful use has been made of some of them. Notable instances include the control of the Alfalfa caterpillar, *Colias eurytheme* Boisd. in the U.S.A. (Thompson & Steinhaus, 1950), the Wattle Bagworm, *Kotochalia junodi Heyl.* in South Africa (Ossowski, 1957), and the cabbage caterpillars *Pieris brassicae* L. and *P. rapae* L. in Hawaii (Tanada, 1955).

Thus the possibility exists of artificially spreading the disease by spraying a suspension of the virus on the bushes attacked by nettle grubs and initiating an epidemic when the larvae are quite young.

Little is known about the interactions of wilt and insect parasites as controlling factors of nettle grubs. Gadd *et al* (1946) have shown that, as would be expected, parasites cannot develop in a host suffering from wilt, and it seems likely that wilt is sometimes responsible for upsetting the balance between the nettle grub and its insect parasites. When outbreaks occur, they are sometimes brought under control by wilt within the span of a single generation, but never by insect parasites. Nevertheless, the latter may be of considerable importance in the normal balance of populations.

Recent Experiments on Control

Virus Wilt Disease

A previous experiment was reported by Austin (1958) using a spray solution of a semi-purified granulosis virus from the Fringed Nettle Grub prepared by Dr K. M. Smith of the A.R.C. Virus Research Unit, Molteno Institute, Cambridge, U.K. An epidemic of the wilt disease was successfully spread amongst a population of nettle grubs at Passara. In view of these results we carried out a further trial on an estate in Uva in 1959; in this instance the suspension of the virus was prepared simply by macerating diseased larvae in blood albumen solution (Tanada, 1955). The details of this trial are as follows:—

Groups of two, three and five dead Nettle Grubs which had died from wilt disease were separately macerated, each group in 50 c.c. of 0.2% blood albumen solution. Each 50 c.c. suspension was then diluted before spraying with 0.75 gallons of water.

Six small plots of ten bushes each, which were naturally infested with Nettle Grub, were marked out. Three of these were sprayed with the three different 'concentrations' of virus. The three other plots were sprayed as controls with water only. The Nettle Grub larvae at the time of spraying were small, being second and third instars. Counts were made at intervals after spraying of the number of (1) healthy, (2) wilted and (3) obviously parasitised larvae on all plots.

There were no obvious differences in effect between the concentrations of virus used, and in Table 1 the numbers for the three sprayed plots and for the three unsprayed plots are grouped together.

TABLE 1.—*Results of Experiment 1 on control with wilt disease*

Days after spraying	Date	No. of living larvae per 150 leaves (30 bushes)					
		TREATED PLOTS			UNTREATED PLOTS		
		Healthy	Wilted	Parasitised	Healthy	Wilted	Parasitised
0	10. 8.59	265	0	0	214	0	0
9	19. 8.59	121	2	0	174	0	0
14	24. 8.59	162	30	0	346	0	3
22	1. 9.59	75	24	1	349	6	1
40	19. 9.59	2	19	0	30	12	2
57	6.10.59	12	4	1	8	4	4
67	16.10.59	227	0	1	292	0	3
81	30.10.59	447	17	2	326	8	1
88	6.11.59	222	23	2	225	14	0
95	13.11.59	83	16	1	98	7	0

The results suggest that a good degree of control took place within three weeks of the spraying (note numbers for 14 and 22 days after spraying), which was by the time the Nettle Grub larvae matured. It was further observed, in visual comparison of the sprayed and unsprayed plots that a fair part of the foliage damage caused by the Nettle Grub was prevented by spraying. However, the speed of

action, which was quite similar to the results previously reported by Austin (1958), left much to be desired and was very much slower than that obtained by effective insecticides.

In order to see whether the virus persisted on the foliage for more than the span of a single generation, counts were continued after the first generation of larvae had matured and pupated. On these very small plots, there was a heavy reinfestation of the treated plots (on which the population had been reduced) from outside. Thus, the counts shown in Table 1, for 67-95 days after spraying, record the numbers of the second generation. The numbers for the treated and untreated plots were very similar and there was no evidence that the virus persisted on the foliage for more than the span of the first generation, about six weeks.

Chemical Control

The use of the detergent "Teepol" (Shell Co. of Ceylon) at a concentration of 1%, as an alternative to common soap solution, was tested and recommended by Austin (1957) and several estates have made use of this chemical. By 1959, reports of the use of Teepol on a fairly large scale were far from encouraging, and it was decided to retest Teepol and compare it with two possible insecticides of low mammalian toxicity—DDT and malathion. Austin (1958) had also reported very good results with endrin, but this insecticide is toxicologically far too dangerous to be used for spraying tea.

The detailed results of a replicated small plot experiment (2) carried out in 1959 are given in Table 2. Each of five treatments was applied to four plots of 25 bushes in a randomised block design. The sprays were applied by pressure-retaining knapsack sprayers at a rate equivalent to 60 gallons of spray per acre; two applications were made at an interval of five days. The concentrations given in Table 2 are percentages of the actual insecticide in the diluted spray. The following proprietary formulations were used: a malathion 50% emulsifiable concentrate, a DDT 50% wettable powder, and a DDT 25% emulsion. 'Teepol' is supplied as the unformulated detergent and was used at 1% in water.

Counts were made of the number of live nettle grubs present on five leaves, selected at random, per bush, making a total number of leaves examined per plot of 125. A count was made just before spraying (precount) and at five days and fourteen days after spraying; after this time, all grubs had pupated.

TABLE 2.—*Results of Experiment 2 on chemical control of nettle grubs*

TREATMENT	No. of living larvae per 500 leaves (100 bushes)		
	Precount	After 5 days	After 14 days
Malathion 0.2%	163	24 (S)	1
DDT Wettable Powder 0.2% ...	279	32 (S)	8
DDT emulsion 0.1%	166	16 (S)	3
Teepol 1%	169	127 (S)	48
Untreated control	187	152	69

(S) = sprays repeated after five days.

The results confirmed that Teepol was of little value, and malathion and both formulations of DDT were promising, and gave a more rapid kill than had previously been obtained by the use of the wilt virus. It will be noted that the number of grubs in the untreated plots was less after five days, and again after fourteen days, than was initially recorded in the precount. A similar decline in numbers will later be noted in the results recorded for other experiments recorded in Table 3 and 4. It is apparent that usually a large number of grubs do not reach maturity; where the population of very young grubs is as great as ten or more per leaf, as is frequently

the case in an outbreak, this could be caused by starvation due to over-crowding, although the reason for it when the numbers are lower (as in Table 2)is not apparent. It was not, in any of the instances recorded in Tables 2—4, due to insect parasites or wilt disease. However, any experiment on nettle grub control is likely to record declining numbers within the span of a single generation, but the severity of the foliage damage does not usually decline. On the contrary, older grubs eat a great deal more and the bushes are often devoid of foliage by the time they have matured.

Further work on chemical control was concentrated upon the use of DDT in emulsion formulations, which are likely to be more economical in use than wettable powders. It was hoped in 1960 to carry out a large scale experiment comparing the use of the wilt virus and DDT. Unfortunately, the occurrence of wilt in the field in 1960 was very slight, and attempts to produce a sufficient quantity by artificially spreading the disease amongst grubs in the laboratory were not successful. Consequently, when large-scale outbreaks occurred in Uva in 1960, the opportunity was taken to test further the value of DDT on a large scale.

In experiment No. 3, carried out on an estate in the Badulla district, a trial was arranged with the Superintendent, in which an area of 18 acres of tea was divided into four quarters of 4½ acres each. Two of these were sprayed with DDT emulsion at two different rates; the remaining two quarters were left unsprayed for comparison. DDT was used as a 25% emulsifiable concentrate (E.C.) formulation at 3 pints in 70 gallons of water per acre (approx. 1 lb DDT/acre) on one plot, and at 6 pints in 70 gallons of water per acre (approx. 2 lb DDT/acre) on the other. These rates were repeated after nine days. Spraying was done with pressurized knapsack sprayers. Counts were made of the number of living grubs on two leaves per bush on fifty bushes distributed across each plot, making a total of 100 leaves per plot. Counts were made initially before spraying (precount) and nine days and twenty-four days after spraying. The results are given in Table 3.

TABLE 3.—*Results of Experiment* 3 *on chemical control*

TREATMENT	No. of living larvae per 100 leaves (50 bushes)		
	Precount	After 9 days	After 24 days
DDT (emulsion) 1 lb./acre	564	35 (S)	0
DDT (emulsion) 2 lb./acre	563	0 (S)	0
Untreated control	562	297	198
Untreated control	1200	334	247

(S) = sprays repeated after nine days.

This experiment demonstrated a very promising effectiveness of DDT on a large scale, and even one application of the lower dosage rate of 3 pints of the 25% emulsifiable concentrate (E.C.) in 70 gallons of water per acre appeared to be fairly adequate. It was known that it is often a problem on many Uva estates to find sufficient water for spraying in the dry weather, when nettle grubs usually occur. For this reason the opportunity was taken when a further outbreak occurred at an eatate near Hali-Ela to try the effect of applying the same dosage rates of DDT per acre in very much smaller volumes of water with a motorised knapsack mist blower. With the co-operation of the Superintendent, an area of 12 acres in a field badly attacked by young Nettle Grub was divided into four quarters, two of which were left as unsprayed controls. Half of each sprayed plot was treated at low-volume using a motorised knapsack mist blower, and the other half at the normal volume applied by conventional knapsack sprayers. The details of the treatments were as follows:—

Plot A1 (1½ acres) 6 pints DDT (E.C.) in 4 gallons water per acre (= 2 lb DDT/acre), by mist blower.
Plot A2 (1½ acres) 6 pints DDT (E.C.) in 70 gallons water per acre (= 2 lb DDT/acre), by knapsack sprayers.
Plot B (3 acres) Untreated.
Plot C1 (1½ acres) 3 pints DDT (E.C.) in 4 gallons water per acre (= 1 lb DDT/acre), by mist blower.
Plot C2 (1½ acres) 3 pints DDT (E.C.) in 70 gallons water per acre (= 1 lb DDT/acre), by knapsack sprayers.
Plot D (3 acres) Untreated.

Counts of live grubs were carried out as in Experiment 3. The results are recorded in Table 4.

TABLE 4.—*Results of Experiment 4 on chemical control*

PLOT	TREATMENT	No. of living larvae per 100 leaves (50 bushes)	
		Precount	After 8 days
A1	DDT, 2 lb./acre, low volume	1090	0
A2	DDT, 2 lb./acre, high volume ...		0
B	Untreated control		318
C1	DDT, 1 lb./acre, low volume	998	0
C2	DDT, 1 lb./acre, high volume ...		0
D	Untreated control		138

As in the previous large-scale experiment an extremely good control of Nettle Grub was obtained and the kill was rapid. No living grubs were found on any of the 4 treated plots when first re-examined after eight days, whilst a heavy infestation continued to do severe damage on the untreated plots. In these circumstances, the Superintendent sprayed these plots shortly afterwards, with successful control, and no further counts were made.

Discussion

Considerable caution is necessary in the use of insecticides on tea. They should be chemicals of a low human toxicity, so that the spraying labourer can use them as recommended without danger to health. They should not themselves cause any damage to the plants. If used on tea in plucking, they should not taint the made tea, and if any residues of the insecticide are present in the made tea these should be harmless to the consumer. In these respects, DDT is one of the safest insecticides for the spraying labourer to use, is non-phytotoxic, and has been shown to cause no taint in the made tea even in gross dosages. The question of residues in the made tea is being studied; this work will be reported elsewhere, but meanwhile it does not look as if there will be any serious deterrent to the use of DDT on these grounds.

The first criterion in judging whether or not to use an insecticide is that it should be profitable to apply the treatment. With many pests this is far from easy to judge, and data on crop losses caused by the pest are often hard to obtain. However, in the case of a nettle grub outbreak which is liable to defoliate many acres of tea, the case is clear-cut. The cost of treatment with DDT is small *e.g.*

3 pints of a 25% DDT emulsion at Rs. 16/- a gallon	Rs. 6.00
3 labourers per acre, to spray at 70 gallons per acre ...	Rs. 6.75
Total cost per acre ...	Rs. 12.75

If we are able to do the low-volume spraying by motorised knapsack mistblower, two labourers should be able to spray at least six acres per day with one machine, and the cost per acre for labour is 75 cents, and for petrol 50 cents; making a total cost of Rs. 7/25.

Thus there is no question of the profitableness of treatment provided the use of DDT does not run us into other difficulties. This is the remaining reason for caution, based on the fact that insecticides not infrequently, but by no means always, have undesirable side-effects on the balance of insect populations—of pests and parasites—on a crop, so that some species, previously present in harmless numbers, becomes numerous and pest. This is of particular importance on tea, which as a perennial crop covering large areas, supports a large variety of potential pests, and their parasites and predators, at low population levels. Very few artificial measures at present interfere with this balance of populations.

However, the local and infrequent use of insecticides on the tea crop, which is all that is required, is a very different thing from the overall treatment of a crop, for the reason that if the balance of nature is upset on a few acres, this *may* be quickly restored by immigration of insects from the surrounding untreated areas. One of the most commonly recorded side-effects of DDT is an increase in mite populations. This has happened on several crops in many countries, and therfore we should look closely for such an effect on tea. So far, although DDT has been used locally on tea on several occasions during the last few years, no such effect has been proven. In one instance only, there appeared to be an increase in Tea Red Spider (Austin, 1958), but in several other instances no increase of mites was observed. This aspect is now under close investigation.

If it is shown that DDT is not generally liable to have this effect or other undesirable side-effects, there can be no objection to its use on tea. If used on tea in plucking, certain restrictions may be necessary to prevent or minimise residues in made tea. No general recommendation can yet be made.

The artificial use of the wilt virus is also a possible means of control, but in order to supply a virus suspension to estates in sufficient quantity, the T.R.I. would have to establish a special unit for the purpose. This could be done, but the cost per acre would almost certainly be greater than the cost of DDT, and it is clearly not desirable unless the use of insecticides is proved to be unwise.

Summary

1. An account is given of the biology of the Fringed Nettle Grub (*Macroplectra nararia* Mo.) and of factors in the natural control of the pest, including wilt virus disease.

2. In a small plot experiment, a suspension of wilt virus, made simply by macerating diseased grubs in a 0.2% blood albumen suspension, was sprayed over bushes infested with nettle grubs. This started an epidemic of the wilt disease which greatly reduced the numbers of the grubs within two to three weeks. Some of the foliage damage caused by the grubs was prevented but the speed of action of the virus was slow. There was no evidence of the virus persisting on the foliage to affect a later (second) generation of nettle grubs which developed six weeks after spraying.

3. Three field experiments on the use of insecticides are reported. In a small scale replicated trial, 1% Teepol gave virtually no control. DDT at 0.1% (emulsion) and 0.2% (wettable powder), and malathion at 0.1% (emulsion), gave good control. Two field-scale trials with DDT emulsion gave excellent results with a rapid kill of grubs. 1 lb actual DDT per acre in emulsion form appeared to be adequate; this was successfully applied in 70 gallons of water per acre by knapsack sprayers and in 4 gallons of water per acre by motorised knapsack mistblower.

4. Factors in the use of DDT on tea are discussed; no general recommendation for use on tea can yet be made.

Acknowledgment

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References

AUSTIN, G. D. (1931). The 'Nettle Grub' pest of tea in Ceylon. *Tea Quart.* **4**: 74 86.

AUSTIN, G. D. (1932 & 1932a). The 'Nettle Grub' pest of tea in Ceylon. *Tea Quart.* **5**: 4—16 and **5**: 47—52.

AUSTIN, G. D. (1957). Annual Report of the Entomologist for 1956. *Bull. Tea Res. Inst. Ceylon* no. 38: 51—52.

AUSTIN, G. D. (1958). Annual Report of the Entomologist for 1957. *Bull. Tea Res. Inst. Ceylon* no. 39: 53—54.

GADD, C. H. (1946). Ceylon Euplectrini. *Bull. ent. Res.* **36**: 331—337

GADD, C. H., FONSEKA, W. T. (1945). *Neoplectrus maculatus* Ferr. A predator and parasite of *Natada nararia* Mo. and other nettle grubs. *Ceylon J. Sci.* (B) **23** (1):9-18.

GADD, C. H., FONSEKA, W. T., and RANAWEERA, D. J. W. (1946). Parasites of tea nettle grubs with special reference to *Platyplectrus natadae* Ferr. and *Autoplectrus taprobanes* Gadd. *Ceylon J. Sci* (B) **23** (2): 81—94.

HUTSON, J. C. (1923). The fringed Nettle Grub *Natada nararia* Mo. *Year Book Dept. Agric. Ceylon:* 11—15.

HUTSON, J. C. (1932 & 1932a). Some insect pests of tea in Ceylon. Nettle Grubs I & II. *Trop Agric.* **78**: 189—210, and **78**: 255—286.

OSSOWSKI, L. L. J. (1957). The biological control of the Wattle Bagworm (*Kotochalia junodi Heyl.*) by a virus disease. *Ann. appl. Biol.* 45: 81—99.

THOMPSON, G. G. & STEINHAUS, E. A. (1950). Further tests using a polyhedrosis virus to control the alfalfa caterpillar. *Hilgardia* **19**: 411—455.

TANADA, Y. (1955). Description and chracteristics of a granulosis virus of the imported cabbageworm. *Proc. Haw. ent. Soc.* **15**: 235—260.