Economic Damage and Control of the Cacao Capsid, *Helopeltis* sp. (fam. *Capsidae*, ord. *Hemiptera)* in Ceylon

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Introduction

NUMEROUS members of the family *Capsidae* to which *Helopeltis* belongs are notorious, wherever they occur, for the drastic toxic effects and economic damage they cause on cultivated plants during the course of their feeding. The cacao plant in most regions of the world is susceptible to attack and damage by a number of species of Capsid bugs belonging to the genera *Sahlbergella, Distantiella, Helopeltis* and *Bryocoropsis*. The type of injury caused by all these bugs is generally similar in that the primary damage surrounds the point of insertion of the stylets into the plant tissue of young shoots, leaves or pods. In Ceylon, only one species of Capsid bug, *Helopeltis antonii*, has been recorded as attacking cacao. This species was first recorded in 1880 as causing a serious die-back of cacao shoots in the Matale district. More recent studies by de Silva (1956) of the Division of Entomology in collaboration with the Commonwealth Institute of Entomology, suggest that an entirely new species of *Helopeltis* is responsible for damage to cacao plants in the main cacao-growing regions of the Island. Hence the species of *Helopeltis* being dealt with in this paper will be referred to as *Helopeltis sp.*

The severe economic damage caused by the *Helopeltis sp.* in Ceylon has necessitated a series of biological, ecological and control studies of this pest. The description of the new species of *Helopeltis* predominant on cacao in Ceylon today, its detailed biology, &c., will be dealt with separately by de Silva in due course. This paper is mainly concerned with a review of the economic damage caused to cacao in Ceylon by *Helopeltis sp.*, a comparison of this damage with that caused by related Capsids in other countries and the insecticidal control trials conducted to date against the pest in Ceylon.

Habits and Nature of Damage

Helopeltis sp. is found in all cacao growing areas in Ceylon but the heaviest damage to the crop is recorded in the plantations in the Dumbara Valley. It feeds at all hours of the day and usually is found on pods of all ages feeding on the shaded sides. Damage to cacao by this pest is rapid and spectacular. All stages of *Helopeltis sp.* feed on the plant juices of the crop and while feeding is mainly on the pods, less frequently young stems and shoots or leaves are also attacked. Within 2 to 4 minutes of the insertion of the stytets into the plant tissue for feeding, what is frequently referred to as a " water-soaked " circular area of tissue develops around the point of insertion. This " water-soaked " area increases in diameter to between 3 and 6 mm. as feeding by an adult bug on a pod continues. The diameter of this area on young stems is considerably greater ranging up to 8 or 10 mm. The diameters of the lesions caused by the younger

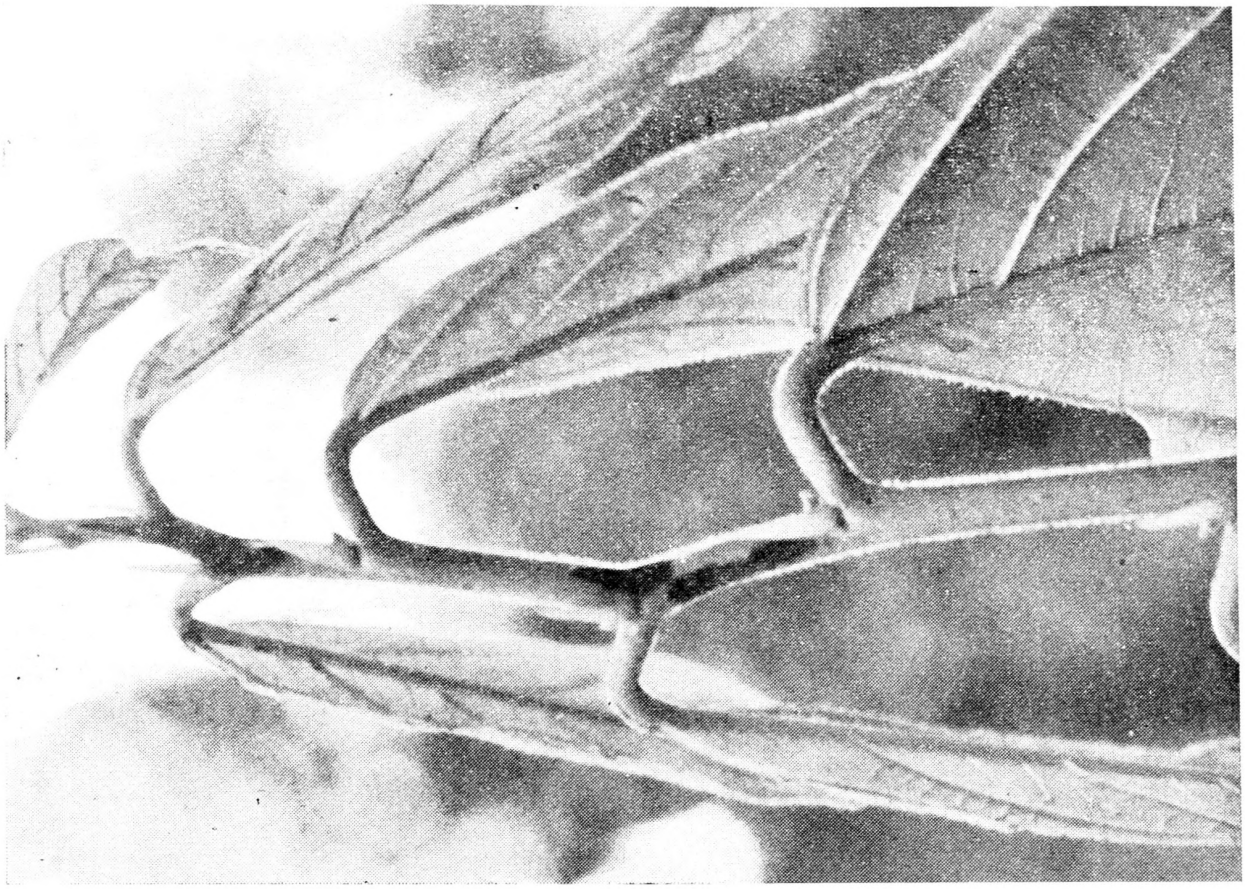

Plate 2.—Lesions caused by *Helopeltis sp.* on young stem of cacao plant.

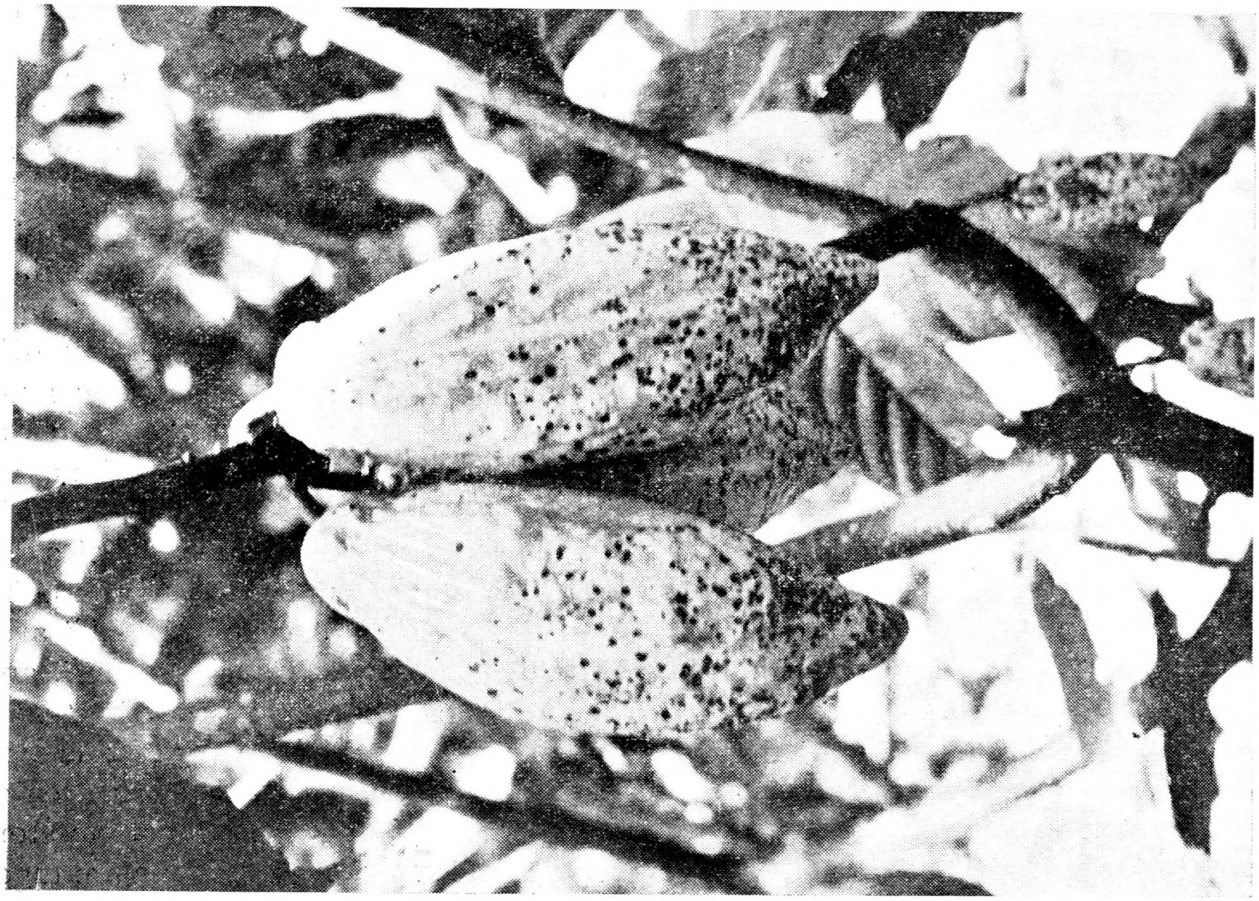

Plate 1.—Cacao pods attacked by *Helopeltis sp.* Note the concentration of attack in the shaded zones of the pod.

stages are smaller. The "water-soaked" area is initially deep translucent green but within a few hours becomes depressed and deep brown. In a few days after feeding these lesions become almost black. A single adult bug has been found to be able to produce up to as many as 60 such lesions in a 24-hour period of feeding. On pods therefore *Helopeltis* damage appears in the form of numerous circular areas of depressed brownish to blackish dead tissue while on stems these areas are larger and usually oval rather than circular. In the case of the Capsids, *Salhlbergella singularis* Hagl. and *Distantiella theobroma* (Dist.) which occur in the Gold Coast of West Africa, Goodchild (1952) has shown that the primary "water-soaking" effect surrounding the point of insertion of the stylets in feeding by these bugs is due to the histolytic effect of esterases in the saliva injected into the wound. No organic pathogenes have been found in the saliva of these species. The primary wounds caused by these bugs are said to be subsequently invaded by the fungus *Calonectria rigidiuseula* and this is said to aggravate the damage done to the plants by *Helopeltis*. It is most likely that the same holds true for *Helopeltis sp.* in Ceylon, but investigations are presently under way to clarify these points.

As a consequence of the feeding of *Helopeltis sp.* on cacao, economic loss of crop may result in several ways. Young pods attacked by these bugs frequently fail to develop further, may be invaded by the fungus *Phytophthora palmivora* and are shed prematurely. Older pods atacked by this pest exhibit concentrated spotting (Plate I) which is responsible for the retardation in growth or the malformation of these pods. Such damage on older pods frequently attracts subsequent attack by the cacao pod-boring caterpillar, *Dichocrocis punctiferalis* Gn.

Attack by *Helopeltis sp.* of the young shoots or growing stems results in collapse, death and browning of areas of the superficial tissue (Plate 2). When concentrated, as is usually the case whenever attack of stems occurs, the growing shoot first dies and a die-back sets in which frequently affects the entire new growth. The leaves on damaged stems dry up and are shed. Consequently the young growth is represented only by the withered twigs on the plant (Plate 3). Cacao plants in this condition caused by Capsid attack in West Africa have been referred to as "stagheaded". Initially this type of attack causes a reduction in the canopy of the plant. If this attack is not checked by the various remedial measures and is allowed to repeat itself with each appearance of new flush the plants are ultimately killed.

In Ceylon, the *Helopeltis sp.* concentrates its attack on cacao pods. However, extensive attack of shoots and stems of old and young plants by this pest, with consequent die-back and even death of plants, has been observed especially where shade is inadequate as a consequence of bad pruning or neglect. The reasons why this pest which normally feeds and multiplies on cacao pods, and this too commencing from the shaded areas, should attack extensively the young stems and shoots of cacao plants when the normal shade is depleted is not clear, and close investigation is required to elucidate the factors involved. The relationship between damage by capsids and overhead shade or the cacao canopy has been studied widely in

Plate 3.—" Stagheading "—Die-back of young flush and stems due to *Helopeltis* attack under poor shade.

Africa but the various workers are not agreed, hence the basic factors involved are still obscure. (Taylor 1954, Posnette 1943, Williams 1953).

A frequent observation on damage by *Helopeltis sp.* to cacao pods in Ceylon is a highly concentrated attack on a few or all the pods of a particular tree or trees, whereas pods on other trees are left undamaged. While no work has been done to elucidate this point in Ceylon, attempts have been made in Africa to obtain cacao resistant to Capsid attack (Taylor 1954) but field trials have finally shown no significant differences in susceptibility of the selections and ordinary West African Amelonado cacao to Capsid attack. In Ceylon too, it is most likely that the heavy attack observed on pods of certain plants and the relative freedom from attack of other plants is more the result of heavy egg-laying and nymphal feeding by *Helopeltis* dependant upon the distribution of gravid females in the plantation rather than to specific features of the cacao plants which render them more attractive or repellent to attacks by this bug.

While no parasites or predators of this pest have been recorded in Ceylon it has been observed that wherever the red ant *Oecophylla smaragdina* is present on cacao pods tending mealy bug populations, *Helopeltis* damage is extremely rare.

Control

The heavy damage and losses caused by *Helopeltis* and other Capsids to the cacao crop and its harvests have necessitated repeated attempts at the development of effective control measures against this pest in many parts of the world.

Before the development and extensive use of the synthetic organic insecticides, preparations, such as, kerosene emulsion (Dudgeon 1910) Nicotine Sulphate sprays and dusts (Cottrell 1926) lime sulphur and Tropical Mortegg (Cottrell 1943) and derris dusts (Betrem 1940, 1941 ; Verbeek 1924) were used for the control of the Capsid bugs, but as can be expected the results achieved were poor. When the insecticides DDT and gamma BHC became available various workers reported successful control of Capsids with formulations of these insecticides. (Harrison *et al* 1948 ; Nichol 1950 ; Taylor 1954.)

In Ceylon the earliest experiments with synthetic organic insecticides were directed at evolving suitable control measures against *Helopeltis sp.* by the use of spray techniques. The type of terrain and equipment limitations restricted our earlier trials to the use of either knapsack sprayers with long spray lances or to the power driven mist blower (J. Duiker & Co., The Hague, Holland) of the type which could be normally operated when slung on the shoulders of a spray operator (Fernando *et al* 1954). With knapsack sprayers supporting 8-foot spray lances it was found that satisfactory control of *Helopeltis* could be obtained if spraying was done with a DDT emulsion prepared by mixing 1 fluid ounce of a 25 per cent. DDT emulsifiable concentrate in 2 gallons of water and spraying the pods and bases of the larger branches of the plants at the rate of about 40 gallons of the prepared spray per acre. Similar satisfactory control of this pest was obtained when low volume spraying was carried out with the mist blower. In this case the spray was prepared by mixing 2 pints of a 25 per cent. DDT or 20 per cent. Dieldrin emulsifiable concentrate with water to make 1½ gallons of spray and applying this concentrated spray to the pods and main branches at the rate of about 1½ gallons of spray per acre.

Administration of insecticides for the control of *Helopeltis* by spray techniques where each plant required individual attention, was found to be tedious and slow unless a very large number of sprayers and spray operators were engaged in the operations at the same time on a large plantation. The slowness of the operations therefore prevented control of the pest over wide areas in a short period of time so that reinfestation of treated areas from untreated areas invariably occurred. Generally the satisfactory spray treatments mentioned gave residual insecticidal protection of the crop from *Helopeltis* attack for a period of about one month, at the end of which reinfestation by the pest always occurred. Hence spraying of the cacao crop had to be repeated at monthly intervals for complete protection of the crop until harvest. The same spray schedule was found to be effective in the control of *Helopeltis* attack on

young shoots and stems but spraying could be discontinued soon after the stems and flush hardened.

In view of the slowness and tediousness of spraying operations on the cacao crop and the necessity to repeat such spraying at monthly intervals in order to prevent reinfestation of the crop by *Helopeltis,* it was felt that experiments to evaluate the effectiveness of insecticidal dust formulations and dusting techniques should provide the most fruitful line of further research on the control of this pest. Furthermore, a very handy and efficient light power duster which could be operated from the shoulders of an operator had become available (Plate 4.)

Trials to evaluate the effectiveness of a series of insecticidal dusts in *Helopeltis* control were initiated at the peak of an attack by this pest in August 1955 at Mahaberiatenne Cacao Estate, Teldeniya. Five to eight-acre blocks of cacao separated from each other, but within the same plantation, were selected for the dusting trials. Pods of all stages of development were present on the trees and *Helopeltis sp.* was very apparent on most plants. A day before dusting, 25 to 80 plants carrying *Helopeltis* infestations were selected at random in each 5-8 acre block. As many pods as possible on these plants with obvious *Helopeltis* populations as nymphs were then selected at random. A count of adult bugs present before treatment and 24 hours after treatment with insecticides on the selected plants was carried out and recorded. A similar

Plate 4.—Dusting a plantation with the Mistral I duster to control *Helopeltis sp.*

count of nymphal stages of the bugs on the selected pods of these plants was made and the counts recorded and also noted on aluminium foil labels attached to the pods. Two or three pods entirely free of *Helopeltis* were marked with red labels on the selected plants for maintenance of observations on reinfestation by *Helopeltis* after initial control by dusting had been achieved. Preliminary observations on *Helopeltis* populations on cacao pods showed that while populations of adult bugs fluctuated within 24-hour periods, those of nymphs showed no fluctuations in this period of time. Where differences in populations of nymphs on a given pod occurred within a 24-hours period this was usually found to be the result of the last nymphal instars changing to adults which flew away. That this had happened was usually indicated by the presence of the cast skins on the pods.

Dusting was carried out with a "Mistral I" power duster, (Birchmeier Cie AG. Kunten), which is a light duster of high efficiency (Plate 4) and ideally suited for dusting operations on the cacao crop under local conditions. The purpose of this trial was to assess the effectiveness of various insecticidal dusts in controlling existing populations of *Helopeltis* and also in preventing reinfestations of cacao by this pest. Areas were dusted in parallel tracts and 5 to 8 rows of cacao plants being covered at a time. About 10 pounds of insecticidal dust was used per acre to obtain good coverage of the plants under still conditions. A 5-acre block was dusted in about 45 minutes and under normal operational conditions about 35 acres of cacao can be dusted in an 8-hour day with a single duster.

The results of the dusting trial where six insecticidal dusts were tested for their effectiveness in immediate control of existing *Helopeltis* populations are presented in Table I. These results would indicate the gamma BHC 1.3 per cent. dust, Endrin 1.5 per cent. dust and Dieldrin 1 per cent. dust gave complete control of the pest within 24 hours after treatment. Aldrin 2.5 per cent. dust, gamma BHC 0.65 per cent. dust and DDT 5 per cent. dust gave relatively poor control of the pest. In view of the particularly poor control of the *Helopeltis* with Aldrin dust, tests with this product were not pursued further. The treated plots were examined 2 weeks after treatment in order to assess the incidence of any freshly hatched nymphs from eggs which existed in the pods during the first dusting (eggs hatch in about 10 days). Such nymphs were found only in the plot treated with the 0.65 per cent. gamma BHC dust. In this case the dusting was repeated and the complete control of the bugs was achieved.

Observations were maintained approximately at monthly intervals on the marked clean pods on the selected plants with a view to assessing accurately the period of freedom of the plant from *Helopeltis* after the insecticidal treatments, and also for timing the next treatment. Records were also maintained of the clean and attacked pods other than those labelled for observations of onset of infestation on the selected plants. It was expected that while observations on the labelled pods would give an accurate indication of the onset of reinfestation of the plants by *Helopeltis*, those on the other pods of these plants would give a fair idea of the value of the control operations in terms of protected crop. Table 2 represents the

TABLE 1—Control of *Helopeltis sp.* by Dusting Cacao with a series of Insecticidal Dusts at the rate of 10 lb. dust per Acre.

Insecticide and Strength of dust used	*Acreage Treated*	*No. of trees under observation*	*No. of pods under observation*	*Bug infestation before dusting*			*Bug infestation after dusting*			*Per cent. mortality of bugs, 24 hrs. after dusting*
				Adult bugs	*Nymphs*	*Total No. of Bugs*	*Adult bugs*	*Nymphs*	*Total No. of bugs*	
Aldrin 2.5% dust	5	25	69	18	229	247	4	66	77	71.66
DDT 2.5% dust	5	25	51	5	129	134	0	18	18	86.56
Gamma BHC 0.65% dust	8	80	177	47	913	960	3	101	104	89.06
Dieldrin 1% dust	5	25	73	33	393	426	0	2	2	99.53
Endrin 1.5% dust	5	25	32	1	90	91	0	0	0	100
Gamma BHC 1.3% dust	5	25	60	8	145	153	0	0	0	100

TABLE 2— Effectiveness of a series of Insecticidal Dusts in preventing attack of Cacao pods by *Helopeltis sp.*

Insecticidal Treatment	*Acreage Treated*	*No. of trees under observation*	*Dates of treatments*	*Dates of observations*	*Condition of Observation Pods*		*Condition of other Pods*		*Per cent. observation pods free from attack*	*Per cent. other pods free from attack*	*Increase or Decrease in per cent. free pods (other) in period of the treatment*	*Period of freedom of crops from bug attack after treatment*
					Clean	*Attacked*	*Clean*	*Attacked*				
Gamma BHC 0·65% dust	8	30	12. 8.55	23. 8.55	81	—	193	459	—	29·7%	14·1% increase in 3·5 months approx.	2·5 months approx.
			23. 8.55	28. 9.55	81	—	262	434	100%	37·5%		
				11.10.55	81	—	289	413	100%	41·2%		
				10.11.55	69	12	284	493	85·2%	36·6%		
				21.12.55	69	12	405	521	85·2%	43·8%		
Gamma BHC 1·3% dust	5	20	18. 8.55	31. 8.55	56	—	84	208	—	28·8%	24·7% increase in 3·5 months approx.	2·5 months approx.
				28. 9.55	56	—	140	188	100%	45·7%		
				11.10.55	56	—	134	188	100%	44·7%		
				10.11.55	49	7	111	196	87·5%	37·0%		
			25.11.55	21.12.55	49	7	240	208	87·5%	53·5%		
Dieldrin 1% dust	5	20	18. 8.55	31. 8.55	41	—	86	358	—	19·4%	29·0% increase in 3·5 months approx.	2·5 months approx.
				28. 9.55	41	—	199	305	100·0%	39·5%		
				11.10.55	41	—	205	306	100%	40·5%		
				10.11.55	38	3	199	267	92·5%	42·7%		
			25.11.55	21.12.55	35	6	252	263	85·4%	48·4%		
Endrin 1·5% dust	5	25	19.10.55	9.11.55	60	—	66	203	—	21·8%	45·6% increase in 1 month approx.	2 months approx.
				21.12.55	60	—	516	180	100%	67·4%		
				7. 1.56	38	22	—	—	63·4%	—		
DDT 5% dust	5	25	19.10.55	9.11.55	59	—	118	323	—	26·8%	37·6% increase in 1 month approx.	2 months approx.
				21.12.55	59	—	526	291	100%	64·4%		
				7. 1.55	54	5	—	—	91·5%	—		
Untreated Check	5	25	—	14. 9.55	49	—	85	412	—	17·2%	4·4% decrease in 3 months approx.	Attack continued
				11.10.55	27	22	53	447	55·2%	10·6%		
				10.11.55	22	27	54	409	44·9%	12·0%		
				21.12.55	17	32	78	555	34·7%	12·8%		

data obtained in those studies. The 0.65 per cent. and 1.3 per cent. BHC dust, 1 per cent. Dieldrin dust 1.5 per cent. Endrin dust and 5 per cent. DDT dust all gave satisfactory protection of the crop against *Helopeltis* attacks for periods of 2 to 2½ months. This period cannot be construed as a measure of the residual effectiveness of the insecticidal dusts but rather as the period required before an effective build-up of *Helopeltis* entering from the neighbouring cacao areas into the treated tracts could take place in the treated areas. As mentioned earlier the treated tracts were of the extent of 5 to 8-acre blocks each surrounded by untreated cacao areas. If a large-scale area control of the pest is undertaken it is very likely that the period of protection of the crop against effective reinfestation by *Helopeltis* would be very much longer. Observations, as listed in Table 2, on the condition of other pods clearly indicate an increase in the percentage of pods free from attack by *Helopeltis* after treatment with the insecticidal dusts tested. The untreated plot used as a check showed a progressive uninterrupted increase in attack by *Helopeltis* and a decrease in the percentage of pods free from attack by the pest. The decrease in the number of attacked pods as shown in Table 2 is due to the fact that while allowance was made for harvesting some of these were lost between examinations to attack by squirrels or premature shedding due to attack by *Phytophthora* or physiological causes. The general increase in number of pods was the result of setting of new pods. The spectacular increase in pods, free from *Helopeltis* attack in Endrin and DDT tested areas is the result of carrying out the test dusting treatments during a peak period of flowering and pod setting. No apparent adverse affect on the setting of cacao flowers as a consequence of the insecticidal treatments was observed during these studies. On the basis of the results of these studies, the following recommendations for the control of *Helopeltis* attack on cacao in Ceylon are made :—

The cacao crop should be examined at least at fortnightly intervals after setting of pods commences. As soon as *Helopeltis* bugs and damage by this pest to the pods are recognized early in the season, dust with either 5 per cent. DDT, 1.3 per cent. gamma BHC, 1.5 per cent. Endrin or 1 per cent. Dieldrin dusts using a power-driven duster of the type described and dusting at the rate of about 10 lbs. of dust per acre. DDT and BHC dusts are cheaper at present than the other two dusts mentioned. Ten to twelve days later the dusted areas should be examined and if the pest is present dusting should be repeated. This treatment will serve to control any bugs surviving the first treatment and also those nymphs which were within the eggs during the first dusting. Dust masks or respirators and goggles are recommended for use by those concerned with the dusting as a protection against the irritant effects of the dusts and to prevent inhalation. The crop should subsequently be inspected at monthly intervals and dusting repeated when *Helopeltis* reappears.

Wherever attack of stems and young flush is detected the treatment recommended is as described above. However, in this instance, immediate steps should be taken to rehabilitate the appropriate shade.

Summary and Conclusions

(1) An unidentified and unrecorded species of *Helopeltis* and not *Helopeltis antonii* is responsible for heavy damage to the cacao crop in this country.

(2) The pest damages the cacao crop by inducing feeding lesions on pods which results in the premature shedding of the pods, retardation in growth or malformation of older pods and attracts the cacao pod borer *Dichocrocis punctiferalis*, and on growing flush and stems which results in die-back of new growth which if it occurs season after season results in the death of cacao plants.

(3) The pest normally prefers shade when attacking the pods and predominantly feeds on pods but attacks the stems of cacao plants when the overhead shade is poor due to bad pruning or neglect.

(4) No highly efficient naturally occurring biological controlling agents against *Helopeltis sp.* have been observed in Ceylon but the red ant, *Oecophylla smaragdina*, when present on pods nursing species of mealy bugs acts as a deterrent to *Helopeltis* attack.

(5) DDT and Dieldrin, both as high volume and low volume sprays have proved effective in the control of *Helopeltis sp.*, but spray techniques are tedious and slow and require repetition at monthly intervals for the satisfactory protection of the crop.

(6) A light power-driven duster ideally suited for use on local cacao plantations was available, and low percentage dust formulations of the insecticides DDT, gamma BHC, Dieldrin, Aldrin and Endrin were tested to assess their effectiveness in (*a*) immediate control of existing *Helopeltis* populations, (*b*) the prolonged protection of the cacao crop from reinfestation by this pest, and (*c*) increasing the amount of undamaged crop at harvest.

(7) Aldrin 2½ per cent. dust gave poor control of the pest even when repeated 12 days after the first treatment. DDT 5 per cent., gamma BHC .65 per cent. and 1.3 per cent, Dieldrin 1 per cent., and Endrin 1.5 per cent. dusts all gave complete to near complete control of the pest when applied at the rate of 10 lb. per acre.

(8) All the insecticidal dusts tested except Aldrin gave protection from *Helopeltis* attack for periods of 2 to 2½ months after dusting. This period of protection might well be longer if large-scale area-control is undertaken.

(9) All treated areas showed increases in the numbers of pods free from *Helopeltis* attack for periods up to 3½ months after treatment whereas the untreated check area showed a progressive decrease in the number of pods free from *Helopeltis attack.*

(10) No apparent effect on the pollination of cacao flowers as a consequence of insecticidal treatments was observed.

(11) Recommendations for the control of *Helopeltis* on cacao are made on the basis of these studies.

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