

THE BIONOMICS OF TEA LOOPER (*BISTON SUPPRESSARIA* GUEN.) (LEPIDOPTERA: GEOMETRIDAE)

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The bionomics of Tea Looper (*Biston suppressaria* Guen.) was studied at two sites located at Sapumalkande Group, Dehiowita and Mohamedi Group, Latpandura. Observations on the life cycle showed that five to six generations of this pest can be produced in a year. The parasite *Apanteles* sp. (*glomeratus* group) was found to be an important mortality factor of the fourth and fifth instar larvae. It was evident that *Apanteles* was responsible for the regulation of tea looper populations. Adverse effects on the parasite such as those that can be caused by insecticide applications could, therefore, induce tea looper outbreaks. The outbreaks at the two sites which began in 1966 were the result of dieldrin spraying against Shot-hole Borer (*Xyleborus fornicatus* Eichh.) carried out in 1965; these outbreaks diminished with time, as the effects of dieldrin wore off and by 1967, the caterpillar ceased to be a pest.

Tea Looper (*Biston suppressaria* Guen. = *Buzura strigaria* Mo.), also known as the common looper caterpillar, is one of the most destructive pests of tea. Its occurrence on tea in Ceylon was not recorded until very recently, when the first outbreak occurred on an estate in the Kotmale District in 1964. The number of outbreaks increased to 9 in 1965 and 10 in 1966, and thereafter no new outbreaks were reported, but the pest continues to be found in small numbers in some of the originally attacked fields. In addition to this, this pest has been found to occur to a lesser extent, associated with twig caterpillar (*Ectropis bhurmitra* Wkr.) outbreaks. At present, Tea Looper is a comparatively less important pest than the Twig Caterpillar, although it is potentially more dangerous. In North-East India it is a serious pest, and is known to cause considerable losses to many estates in Upper Assam, North Bank and Eastern Dooars, and its pest status has become increasingly important since 1944 (Das 1965). The reasons for the recent upsurge of the tea looper and the twig caterpillar populations in Ceylon have been studied and published (Danthanarayana & Kathiravetpillai 1969). These studies showed that the outbreaks were associated with large scale dieldrin spraying carried out against the Shot-hole Borer (*Xyleborus fornicatus* Eichh.) of tea between 1960 and 1966; it was evident that dieldrin spraying was detrimental to the pest-parasite (predator) complex, and the outbreaks were largely due to the upset of the 'natural balance' of the pests.

The main object of the investigations reported here was to study the biology of two populations of Tea Looper so that population regulation of the pest could be understood to some extent. It was hoped that these studies would be of help for a better understanding of the population dynamics of this pest, which will in turn lead to streamlining of control measures, and possible prevention of further outbreaks. Descriptions of the adult moth, larva and the nature of damage have been published (Danthanarayana 1966). The life history and habits of this pest in North-East India have been published by Das (1965). Because Tea Looper is not normally found in large numbers, and as the outbreaks were of short duration, it was not possible to carry out very detailed investigations. As a result, these studies have been of more of an extensive nature than intensive, but it is known that in case of insect pests, extensive studies will produce considerable information about the pattern of population level over a large area, and will help in the prediction of damage and the application of control measures (Southwood 1966).

Materials and methods

Field observations were carried out at two sites, viz Sapumalkande Group, Dehiowita and Mohamedi Group, Latpandura (off Kalutara South). At Sapumalkande, an outbreak of Tea Looper developed in February 1966 in a field, 75 acres in extent. This field had been pruned and treated with dieldrin for shot-hole borer control in March 1965. The tea bushes were of old seedling type, and had *Gliricidia sepium* as shade. There were 3200 tea bushes per acre. An area, of approximately half an acre, was demarcated in this field for the experiments, by marking out 44 rows of 40 bushes each. The experimental site at Mohamedi was located in a 28-acre field which developed a tea looper outbreak in March 1966. This field which had been pruned and treated with dieldrin in 1965 consisted of old seedling tea shaded with *G. sepium*. There were 2800 tea bushes per acre. The observations were confined to an area demarcated as at Sapumalkande.

At both sites, the rows and bushes were numbered and sampling for larvae was carried out at seven to 10-day intervals. On each sampling occasion, the total number of all but first instar larvae found on a single bush, selected at random from each row, was recorded. Thus, in all, 44 bushes were sampled on each occasion, the search for larvae being carried out by two people. The larvae collected were taken to the laboratory and their parasitism determined by dissection. The number of parasite grubs and the size of the caterpillar were then determined. The different larval stages of this caterpillar were identified by head capsule measurements. The numbers of the parasite (*Apanteles* sp.) cocoon masses found during routine sampling were also recorded and the number of cocoons per mass determined. The dispersal of newly hatched larvae was studied by placing sticky traps. These consisted of 0.093 sq. m wooden platforms propped up horizontally to be in level with the tops of tea bushes. The upper surface of these platforms were smeared with the sticky compound 'Ostico' (ex Plant Protection Ltd, UK). In every eighth row, five such traps were placed so that there were 30 traps in all. The larvae deposited on these traps were counted and removed on each day of sampling. The fecundity of the female moth was determined by dissecting the 26 females that emerged in the laboratory from pupae brought from the field. Since the eggs are fully developed at the time of emergence, fecundity could be determined by counting the number of eggs found within each female.

The flight behaviour of the moths was studied at Pelmadulla Group with a Robinson Mercury Vapour Moth Trap, which was set up in January 1969.

Results

The life history

In most respects, the life history of Tea Looper is similar to that of Twig Caterpillar (Danthanarayana & Kathiravetpillai 1969). There are five or six generations of Tea Looper per year. The complete life cycle from egg to egg lasts from seven and a half to nine weeks. The female moth lays her eggs in several batches in the crevices of the bark of shade trees (Fig. 1). The eggs are minute and measure 0.4 by 0.7 mm. After the eggs are laid in masses of about 50 to 200, they are covered by buff coloured fluffy hairs. The freshly laid eggs have a greenish-blue colour, resembling that of turquoise, but assume a dark grey colour before hatching. The incubation period of the eggs is eight to nine days. The eggs are laid mostly above two to five m from ground level and are, therefore, found much above the level of tea bushes. Some egg masses are also found at higher levels up to 16 m or more, depending on the height and the type of shade trees. After hatching, some of the minute first instar larvae find their way to the tea bushes below on a silk thread. At this time some larvae are dispersed by wind whereas others crawl down along the shade

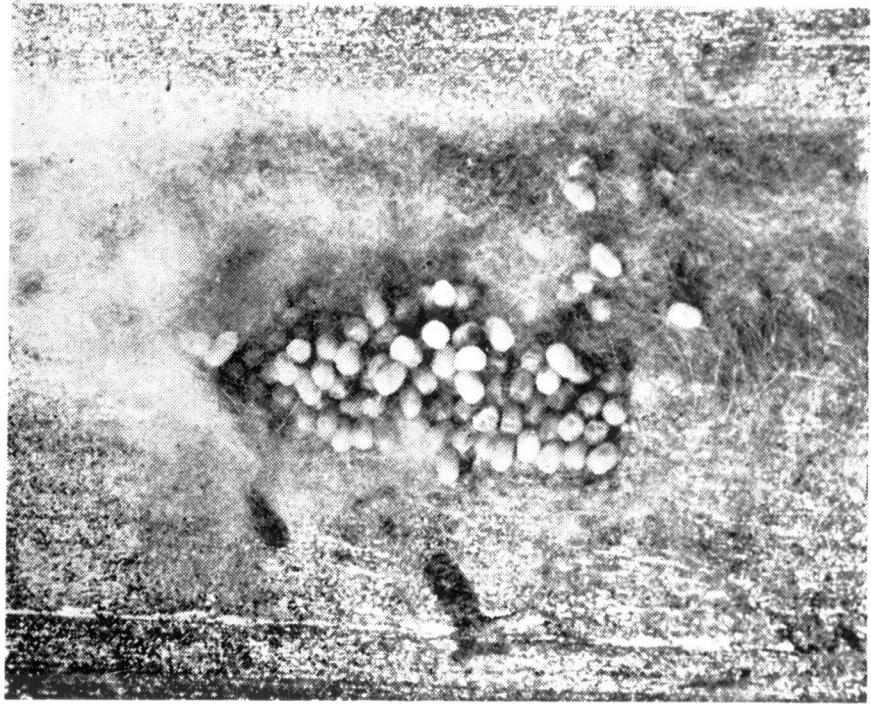


FIGURE 1—A batch of eggs of the Tea Looper laid in the crevice of the bark of a shade tree



FIGURE 2—Young larvae of Tea Looper feeding on tea flush

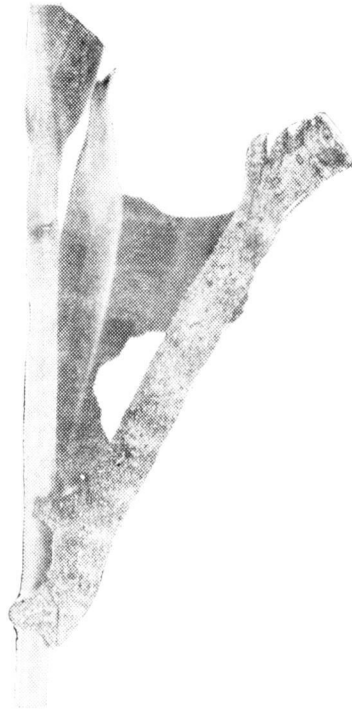


FIGURE 3—A mature *Tea looper* feeding on tea leaves

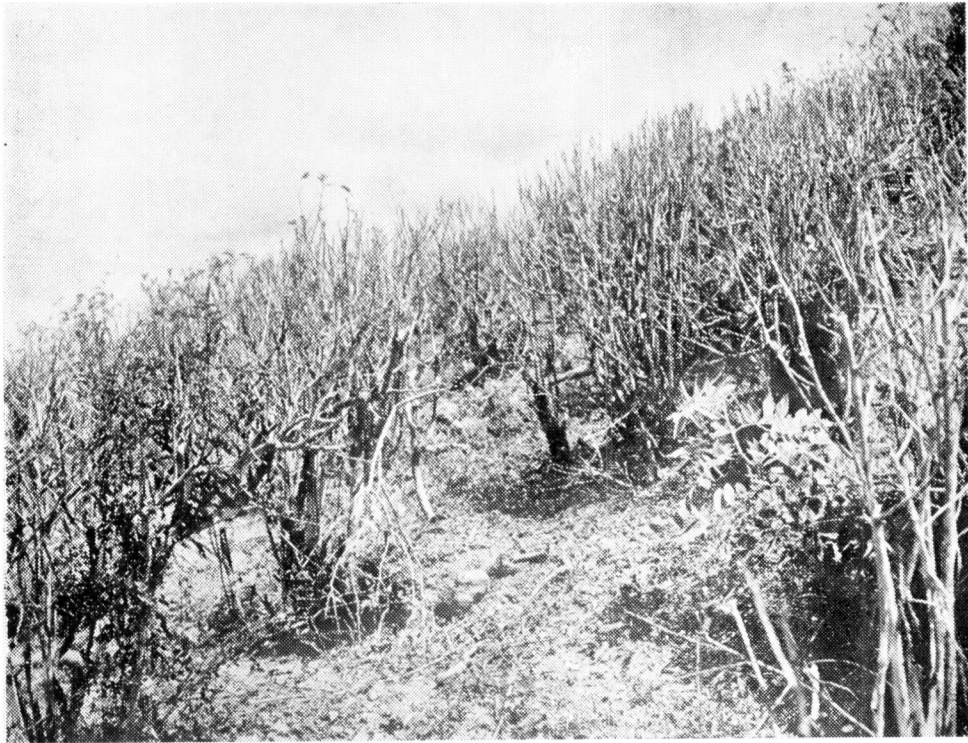


FIGURE 4—Heavy defoliation on tea caused as a result of looper caterpillar damage

tree trunk and find their way onto tea bushes. The young larvae feed on the flush, but as they grow, mature leaves are consumed, causing heavy defoliation (Figs 2, 3 & 4). The larvae undergo five distinct larval stages (Table 1) within four to five weeks. Then they leave the tea plant and enter the soil underneath for pupation which occurs about three to five cm below the soil surface. The moths emerge about two and a half to three weeks later. The moths are generally sluggish, and they rest during the day, flattened against tree trunks or rocks with wings expanded. There is no evidence of feeding by moths. Although the sex ratio is nearly 1 male : 1 female in light traps, mostly males are caught, indicating that the females are less active (Table 2). Copulation takes place soon after emergence, usually within 24 hours. Males die within three days, and the females, as soon as the last batch of eggs is laid, which is about three to five days after emergence.

TABLE 1 — *Measurements of body lengths and head-capsule widths of larvae, together with their 95 % fiducial limits*

Instar	Body length (cm)	Width of head (mm)
1	0.25 ± 0.03	0.61 ± 0.03
2	0.89 ± 0.02	1.09 ± 0.02
3	1.69 ± 0.08	1.70 ± 0.03
4	2.90 ± 0.06	2.62 ± 0.05
5	4.90 ± 0.67	4.11 ± 0.03

TABLE 2 — *Weekly catches of Tea Looper moth in a Robinson Mercury Vapour Moth Trap from January to April 1969*

Month	Week	No. of moths trapped	
		Male	Female
January	1	2	0
	2	0	1
	3	15	1
	4	15	0
February	1	1	0
	2	1	0
	3	13	0
	4	7	0
March	1	3	0
	2	12	1
	3	28	0
	4	10	0
April	1	3	0
	2	7	0
	3	5	0
	4	9	1

Population dynamics

The seasonal changes of the Tea Looper numbers and numbers of *Apanteles* cocoons at the two sites are shown in Figs 5 and 6. These show that at Sapumalkande (Fig. 5), there were five generations of the pest from February 1966 to February 1967, whereas at Mohamedi (Fig. 6), there were six generations between March 1966 and

March 1967. Considering the time taken to complete a single generation, it is unlikely that there could be more than six generations a year. The fecundity of the female moth was found to be 482 ± 205 (95% fiducial limits). The minimum number of eggs found within a female was 302 and the maximum 2763. Although with this high fecundity, the Tea Looper can be expected to have very high larval populations, the numbers actually found at the two sites were low, with a maximum of 1264 larvae per acre at Sapumalkande and 19008 larvae per acre at Mohamedi. A reason for this could be that many first instar larvae are destroyed or dispersed from the habitat soon after hatching. The observations made using sticky traps (Table 3) show that the first instar larvae are dispersed by wind, which also occurs in Twig Caterpillar, and the numbers of first instar looper larvae dispersed in this manner were much more than what were actually found on tea bushes. In the case of Twig Caterpillar where more detailed studies were made, it was found that 89 to 98% of the entire population are destroyed before they attain the second instar (Danthanarayana & Kathiravetpillai 1969). Since the life history and habits of the two pests are almost identical, it seems possible that much of the tea looper population is destroyed before they get onto the tea bushes for further development, as happens with the Twig Caterpillar.

TABLE 3 — Numbers of first instar caterpillars caught on sticky traps at Sapumalkande in 1966

Date	Numbers caught	Estimated No. of larvae deposited per acre
16th April	4	5800
8th June	2	2900
30th October	1	1450
29th November	1	1450

Three mortality factors of larvae were determined during this investigation, namely parasitism, disease and drowning. The main cause of larval death was the Braconid parasite, *Apanteles* sp. (*glomeratus* group). The adult parasite lays its eggs in the third instar caterpillars. The larvae feed inside the caterpillar until they are fully grown, and leave to pupate at the end of the fifth instar of its host (Fig. 7). At this stage, the caterpillar is killed. For pupation, *Apanteles* larvae spin yellowish silken cocoons which are found in masses of about 30 to 200 on the dead caterpillars (Fig. 8). From each parasitized host, 80 ± 19 (95% fiducial limits) parasites emerge (Fig. 9). In dissections, the lowest number of parasites found within a host was 5 and the highest 272. The results of the dissections carried out are given in Table 4 and 5, where the total number of all larvae and that of the fourth and fifth instar larvae and percentage parasitism are given. These results show that *Apanteles* is an extremely effective parasite since it is able to cause maximum parasitism of the fourth and fifth instars. It is clear, therefore, that the parasite has the potential to act as a population regulatory factor. It must also be noted from Tables 4 and 5 that although at any one time, a high percentage of the fourth and fifth instar caterpillars may contain the parasite, in terms of larvae of all instars, the percentage attacked is less. It is also clear from this data that the degree of parasitism was low at the beginning of the outbreaks at both sites, but increased to 100 per cent in fourth and fifth instars at Sapumalkande, and to 80 per cent at Mohamedi towards the end of the period of observations (also see Figures 5 & 6). At the same time, the population level at Sapumalkande decreased from 1264 caterpillars per acre on 25th February 1966 to 237 caterpillars per acre on 10th February 1967; at Mohamedi the caterpillar population dropped from 19008 caterpillars per acre on 18th March 1966 to 528 caterpillars per acre on 11th February 1967.

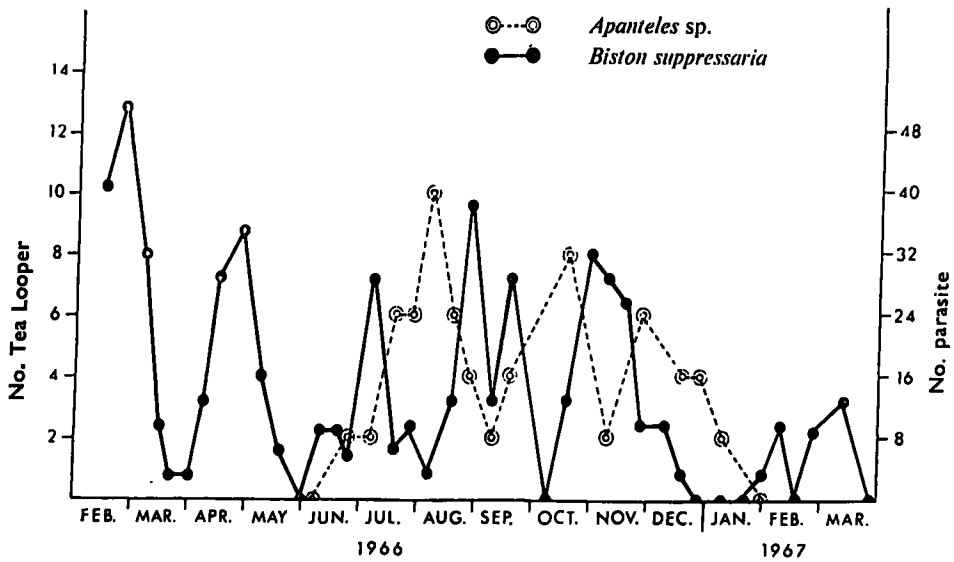


FIGURE 5—Seasonal changes in tea looper caterpillar and parasite (*Apanteles* sp.) numbers on tea at Sapumalkande

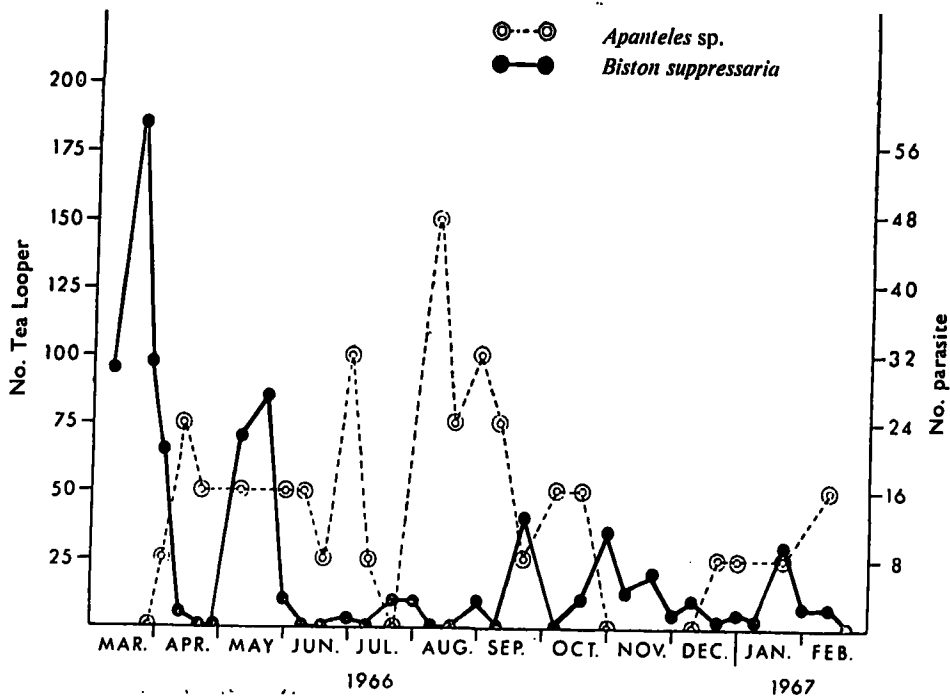


FIGURE 6—Seasonal changes in tea looper caterpillar and parasite (*Apanteles* sp.) numbers on tea at Mohamedi

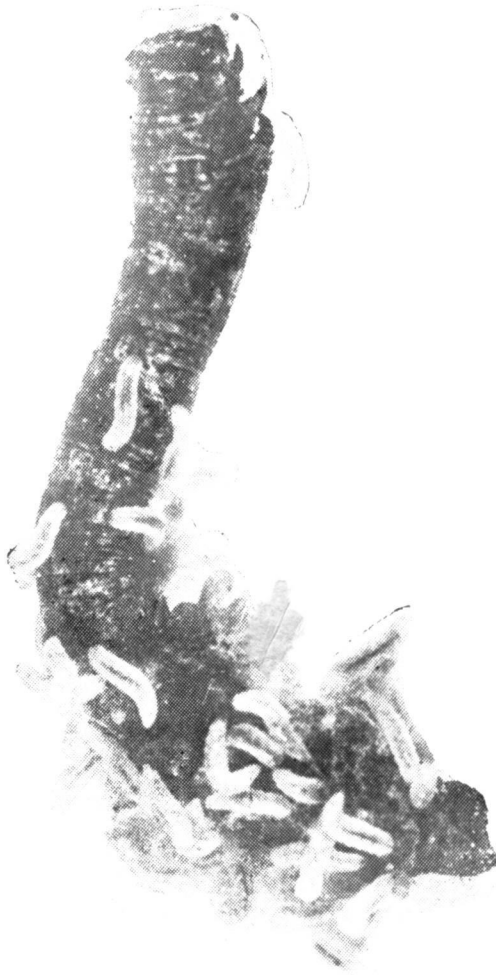


FIGURE 7—*Apanteles* larvae emerging from Tea Looper Caterpillar

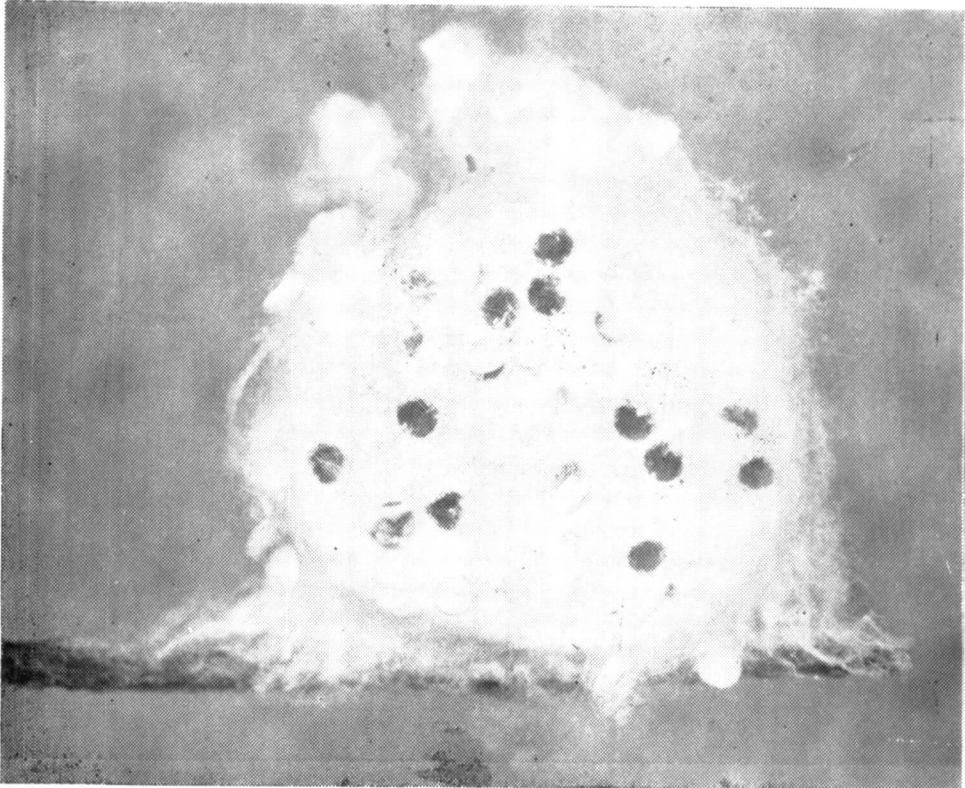


FIGURE 8—*Apanteles* larvae pupating

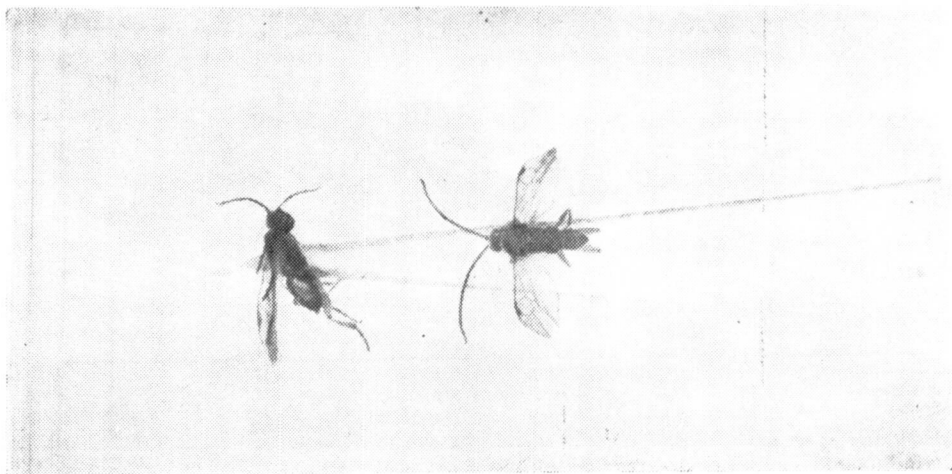


FIGURE 9—*Adult Apanteles parasite*



FIGURE 10—*A diseased Tea Looper Caterpillar*

TABLE 4 — *Parasitism of Tea Looper larvae by Apanteles sp. at Sapumalkande*

Date	All larvae		Larvae of instars 4 and 5	
	Population density per acre	% parasitism	Population density per acre	% parasitism
25 February 1966	1264	6.3	1027	7.7
5 March 1966	790	10.0	632	12.5
10 March 1966	237	33.3	237	33.3
19 May 1966	158	50.0	79	100.0
29 July 1966	237	33.3	158	50.0
17 August 1966	316	25.0	79	100.0
16 November 1966	632	12.5	79	100.0
8 December 1966	237	66.7	158	100.0
10 February 1967	237	33.3	79	100.0

TABLE 5 — *Parasitism of Tea Looper larvae by Apanteles sp. at Mohamedi*

Date	All larvae		Larvae of instars 4 and 5	
	Population density per acre	% parasitism	Population density per acre	% parasitism
18 March 1966	19008	1.9	4752	5.4
8 April 1966	792	66.7	528	75.0
20 July 1966	1144	23.1	1144	23.1
30 July 1966	880	40.0	880	40.0
10 October 1966	264	33.3	88	100.0
30 November 1966	440	40.0	352	50.0
9 December 1966	1144	15.4	176	100.0
21 January 1967	2904	3.0	1078	6.2
31 January 1967	880	20.0	528	33.3
11 February 1967	528	66.7	440	80.0

A second cause of larval death was a granulosis-type virus disease (Fig. 10). The larvae subjected to this disease were very few and occasional, and it seemed unlikely that this disease would be an important factor in the population dynamics of the pest. The infected larvae cease to feed, become sluggish and swell slightly. They are usually found in a flaccid condition, suspended from a twig or a leaf, and with the body contents decomposed and filling the lower end of the body. There was evidence that climatic factors such as wind and rain can cause losses to the population. The effect of wind had already been mentioned. Drowning of first instar larvae during and after rain was an important mortality factor. Since the first instar larva is minute (Table 1), it is easily washed off or drowned but no estimate of this mortality could be obtained although it is likely to be large.

Discussion

Dieldrin spraying against the Shot-hole Borer during the years 1961 to 1966 was detrimental to many species of hymenopterous parasites of tea pests (Baptist 1956; Danthararayana 1967). These investigations showed that in the case of Tea Looper, the parasite involved was *Apanteles* sp. Development of tea looper and twig caterpillar outbreaks in Ceylon was invariably connected with dieldrin spraying against the Shot-hole Borer (Danthararayana & Kathiravetpillai 1969). Both experimental sites where the outbreaks occurred in early 1966 had been treated with dieldrin in early 1965. The gradual reduction of the pest numbers and the increase in the degree of parasitism during 1966 indicate that the parasite was able to re-establish itself as the effects of dieldrin wore off. By 1967, the pest was found in small numbers as it reverted to its normal way of existence under the influence of *Apanteles*. The parasite *Apanteles* thus appears to be the main factor responsible for the regulation of tea looper populations.

The Tea Looper produces five to six generations per year. It has a great reproductive potential and each female is capable of laying from four to nine hundred eggs. The fact that it is able to generate such large numbers and that the larvae are extremely voracious makes it a potentially dangerous pest. The larva is able to attain a very large size and in the process consumes vast quantities of tea leaves. It is known that several larvae can completely defoliate a tea bush during their development. The damage caused by this pest is somewhat comparable to the depredations of locusts on other crops. All this indicate that tea looper outbreaks should not be allowed to get out of hand and, therefore, control measures must be taken promptly ; also conditions for the development of outbreaks must not be created.

B. suppressaria, like many other members belonging to the same genus (Beeson 1941 ; Borisova 1954), is a forest insect which is polyphagous. It has a wide range of host plants such as *Acacia modesta* and *A. catechu*, *Aleurites montana*, *Bauhinia variegata*, *Cassia auriculata* and *C. diffusa*, *Dodonaea viscosa*, *Lagerstroemia indica*, *Dalbergia assamica*, *Derris robusta*, *Albizia chinensis* and *A. odoratissima*, *Cajanus indicus* and *Priotropis cytisoides* (Beeson 1941 ; Das 1965). The fact that egg laying occurs on shade trees and not on tea bushes shows that Tea Looper could exist as a pest of tea only if shade trees are interplanted with tea, or if tea is grown under forest-like conditions. It is also likely that tea fields close to forests are more susceptible to looper outbreaks because the pest has many host plants which are forest trees. Andrews (1931) is of the opinion that the Looper Caterpillar became a pest of tea in India only after the introduction of shade trees. His generalization is supported to some extent by the present investigation. It is also significant that in Ceylon, the original outbreaks occurred only in tea fields that were treated with dieldrin and shaded by trees such as *Grevillea robusta*, *Albizia moluccana* and *Gliricidia sepium* (Danthanarayana & Kathiravetpillai 1969). Thus, two factors are involved in tea looper outbreaks: the presence of shade trees and dieldrin spraying. Finally, these investigations have provided further evidence in support of the view that tea plantations harbour many potentially dangerous pests which are normally kept in check by natural controlling factors. Therefore, when new chemical control methods or agronomic practices are introduced, it must be ensured that the delicate 'natural balance' that exists between tea pests and their parasites and predators is not disturbed.

Summary

- 1 — Studies on the bionomics of Tea Looper (*Biston suppressaria* Guen.) were carried out at Sapumalkande Group, Dehiowita, and at Mohamedi Group, Latpandura.
- 2 — The moths lay their eggs in the crevices of bark on shade trees, and the larvae that hatch are mostly airborne onto tea. The fecundity is 482 ± 205 eggs per female; these are laid in several batches and then covered with fluffy hairs.
- 3 — The complete life cycle from egg to egg lasts from seven and a half to nine weeks so that five to six generations of this pest can occur in a year.
- 4 — The main mortality factor of the mature larvae was the parasite *Apanteles* sp. (*glomeratus* group). The parasite lays its eggs in the third instar caterpillar, and the mature parasite grubs emerge from the fifth instar larvae. Each parasitized host generates 80 ± 19 adult parasites. Parasitism of the fourth and fifth instar caterpillars by *Apanteles* could be as high as 100 per cent indicating that the parasite may be responsible for keeping the natural looper populations under control.

- 5 — The two tea looper outbreaks investigated were caused as a result of dieldrin spraying against the Shot-hole Borer (*Xyleborus fornicatus* Eichh.). It was evident that dieldrin spraying had adverse effects on *Apanteles* populations and this caused the pest to increase in numbers. As the effects of dieldrin wore off, the parasite was able to re-establish itself and consequently the caterpillar ceased to be a pest.

Acknowledgements

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