

# \* STUDIES ON THE ECOLOGY AND CAUSES OF OUTBREAKS OF *ECTROPIS BHURMITRA* WKR. (GEOMETRIDAE), THE TWIG CATERPILLAR OF TEA IN CEYLON

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The leaf-eating twig caterpillar (*Ectropis bhurmitra* Wkr. = *Boarmia bhurmitra* Wlk.) is known to cause considerable damage, leading to full defoliation and death of some of the affected tea bushes. In Ceylon, the first major outbreak occurred in 1900 but after that this species did not regain serious pest status until 1963 when outbreaks covering 68 acres were reported from two widely separated tea plantations. By 1965, the problem became more widespread, and these investigations were initiated to determine the causes of the resurgence of this pest and to find methods to control it (Danthanarayana 1966a).

## ORIGIN OF OUTBREAKS

In 1961, the Tea Research Institute made recommendations to control Ceylon's major pest of tea, *Xyleborus fornicatus* Eichh. (Scolytidae), by spraying the insecticide dieldrin on pruned frames (Cranham 1961). Dieldrin was applied at the rate of 1.5 lb ai/acre per pruning cycle (approximately 3 years). In order to avoid residues of dieldrin in tea, the spraying was carried out on pruned frames, immediately after pruning and before new buds emerged through the bark. Dieldrin treatment was extremely effective against *Xyleborus* and since this method of control gave very good financial return, it became a routine practice in most affected tea plantations. Dieldrin, however, had an important limitation in that it caused outbreaks of the leaf-eating tortrix caterpillar (*Homona coffearia* Nietn.), by eliminating its parasite *Macrocentrus homonae* Nixon (Baptist 1956). When the twig caterpillar outbreaks became serious in 1965, it was suspected that this too was a side effect of dieldrin spraying because all outbreaks originated in fields treated with dieldrin. In order to obtain quantitative data to support this, a questionnaire was sent to all tea estates (plantations) at the end of 1967. Sixty-seven per cent of the estates co-operated with this project and the data so obtained are summarized in Table 1. Figures in Table 1, are, therefore, roughly two-thirds the actual amounts involved. It will be seen that all three caterpillar pests increased in incidence with the increased use of dieldrin. In further support, investigations were made on the quantities of dieldrin and DDT (the recommended insecticide against tea tortrix and twig caterpillar) purchased by Ceylon's tea plantations during this period, and these data are presented in Table 2. The side-effect problems became so alarmingly acute in 1966 that it was decided to suspend dieldrin spraying and recommendations to this effect were made in December 1966 (Danthanarayana 1966b). The decision to suspend dieldrin spraying was almost immediately rewarded with a sharp reduction in the number and extent of the twig caterpillar and tortrix outbreaks, as indicated by Tables 1 and 2. Since then, the twig caterpillar has ceased to be a serious problem and in, 1968, only two mild outbreaks have been reported.

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Usually occurring with the twig caterpillar, but in smaller numbers, is another geometrid caterpillar known as the tea looper (*Biston suppressaria* Gn. = *Buzura strigaria* Mo.). The number of tea looper outbreaks was less and is shown in Table 1. The tea looper had not been recorded previously on tea in Ceylon, but is regarded as one of the most destructive pests of tea in north-east India (Das 1965).

During these studies, a parasite belonging to *Charops* sp. (*Ichneumonidae*) was bred from *Ectropis bhurmitra* collected from different localities and another parasite identified as *Apanteles* sp. (*glomeratus* group—*Braconidae*) was bred from specimens of *Biston suppressaria*. It is possible that the wide use of dieldrin against shot-hole borer (*Xyleborus*) had a detrimental effect on the parasites of twig caterpillar, tea looper and tea tortrix.

TABLE 1 — Relation between dieldrin spraying and caterpillar outbreaks on tea plantations in Ceylon from 1960 to 1967

Year	Acreage sprayed with dieldrin	Twig caterpillar ( <i>Ectropis bhurmitra</i> )		Looper caterpillar ( <i>Biston suppressaria</i> )	Tea tortrix ( <i>Homona coffearia</i> )
		No. of outbreaks	Acreage	No. of outbreaks	Acreage
1960	1145	0	0	0	551
1961	2739	0	0	0	2520
1962	6160	0	0	0	4778
1963	9763	2	68	0	8727
1964	12899	3	354	1	9147
1965	15606	19	1699	9	10366
1966	10049	28	3528	10	7771
1967	3500	5	315	0	2706

TABLE 2— Consumption of dieldrin and DDT on tea plantations in Ceylon from 1960 to 1967 and the calculated acreage sprayed (NB: total tea acreage in Ceylon is about 600,000 (Tea Commission 1968,))

Year	Consumption (Imperial gallons)		Estimate of acreage sprayed	
	Dieldrin	DDT	Dieldrin	DDT
1960	1641	2817	2188	3756
1961	4094	5207	5459	6942
1962	8498	8680	11330	11573
1963	11630	12002	15506	16002
1964	14979	17329	19972	23105
1965	19825	23335	26433	31113
1966	8217	28575	10939	38100
1967	252	10743	342	14324

### THE LIFE HISTORY

There are six generations of *Ectropis* a year. The complete life cycle from egg to egg lasts from 8 to 9 weeks. The female moth lays its eggs in batches in the crevices of the bark on shade trees such as *Grevillea* sp., *Albizia* sp. and *Gliricidia* sp. The eggs are minute, bluish-green in colour and measure 0.5 × 0.75 mm. They are laid in masses of 64.33 ± 21.65 (95% fiducial limits) and are covered with buff-coloured fluffy hairs. Dissections of twenty-eight laboratory emerged females gave a mean fecundity of 301 ± 50. The distribution of egg masses on *Grevillea robusta* is shown in Fig. 1. These results show that over 70% of the eggs are laid up to a height of 5 m above ground level, and most between 2 and 4 m, ie well above the level of tea bushes, which are approximately 0.8 m high.

The eggs hatch after an incubation period of 8 or 9 days. The newly emerged larva eats its way out of the egg, crawls on the bark of the shade tree for a while and then drops on a silk thread down onto the tea bushes. Some larvae are dispersed by wind. Others crawl down to the ground and then onto tea bushes. The larvae feed profusely on tea leaves, and undergo five distinct larval stages (Table 3) during the next 4-5 weeks. They then drop onto the soil under tea bushes to pupate 3-5 cm below the soil surface. The moths emerge in about 2 weeks.

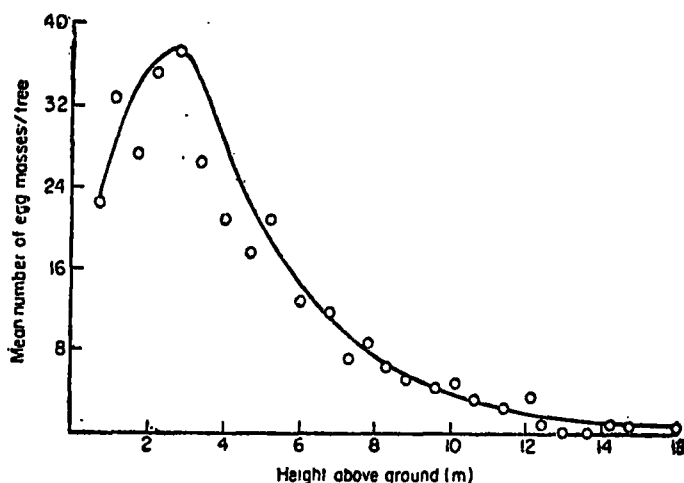


FIGURE 1—The distribution of egg masses of *Ectropis bhurmitra* on *Grevillea robusta*

TABLE 3 — Measurements of body lengths and head-capsule widths of larvae of *Ectropis bhurmitra*, together with their 95% fiducial limits

Instar	Body length (cm)	Width of head (mm)
1	0.28 ± 0.01	0.52 ± 0.02
2	0.79 ± 0.02	0.95 ± 0.01
3	1.47 ± 0.02	1.60 ± 0.02
4	2.34 ± 0.03	2.32 ± 0.04
5	3.34 ± 0.01	3.04 ± 0.05

The moth is pale brown, speckled and spotted with darker markings which form indistinct wavy lines across the wings. The males have a wing expanse of 3-5 cm and the females 4-7 cm. The moths are generally sluggish and rest during the day, flattened against tree trunks or rocks with wings expanded. There is no evidence of feeding by moths, and eggs are already developed in newly emerged females. Pairing takes place on the day of emergence and egg laying takes place on the second or third day after copulation and is continued for 3-5 days. The males die within about 3 days and the females as soon as the last batch of eggs is laid.

#### MATERIALS AND METHODS

The experimental site was a  $\frac{1}{2}$ -acre area within a field at Goorookoya Estate, Nawalapitiya. This field had been treated with dieldrin in October 1964 and a twig caterpillar outbreak was first noticed in November 1965. The experimental area consisted of tea bushes planted in cross rows 1 m apart. *Grevillea robusta* had been planted as shade at a spacing of 5.6 × 6.1 m. The *Grevillea* trees were mostly

mature and over 18 m high. The experimental block consisted of forty-four rows with forty tea bushes in each. The rows and bushes were numbered and the sampling of larvae on tea was carried out at weekly intervals. This was done by recording the total number of larvae found on a single bush selected at random from each row. Thus in all, forty-four bushes were sampled on each occasion, the search for larvae being carried out by two people (see Table 4).

TABLE 4 — *The reliability of the sampling method for larvae (numbers of Ectropis bhurmitra larvae collected on forty-four tea bushes, with standard errors, and estimates of population by this method)*

Date	Larvae/bush	Population density/acre
24 November 1965	0.23 ± 0.08	960
7 December	7.50 ± 3.80	23700
15 December	13.11 ± 3.65	46150
23 December	6.18 ± 0.92	18513
10 January 1966	1.89 ± 0.27	6640
25 January	0.20 ± 0.05	711
8 February	2.91 ± 1.19	10240
23 February	1.02 ± 0.29	3555
9 March	1.11 ± 0.25	3871
21 March	0.32 ± 0.07	1120
5 April	1.41 ± 0.89	4960
28 April	0.43 ± 0.09	1520
13 May	0.07 ± 0.04	240
13 June	0.14 ± 0.07	474

TABLE 5 — *Numbers of Ectropis bhurmitra first instar larvae caught on sticky traps, with standard errors and estimates of the population deposited on tea during the first generation*

Date	Larvae/trap	No. deposited/acre
4 December 1965	0.74 ± 0.18	32192
7 December	1.60 ± 0.58	69608
10 December	1.06 ± 0.30	46116
15 December	0.80 ± 0.24	34804
18 December	0.94 ± 0.32	40894
23 December	0.06 ± 0.06	2610
29 December	0.06 ± 0.06	2610
4 January 1966	0.80 ± 0.14	34804
7 January	0	
10 January	0	

Total 263638

The deposition of newly hatched larvae onto the tea bushes was determined by sticky traps. These consisted of 0.093 sq. m wooden platforms supported horizontally, level with the tops of the tea bushes. The upper surfaces of these platforms were smeared with the sticky compound 'Ostico' (Plant Protection Ltd, UK). Altogether thirty such traps were used, at the rate of five in every sixth row. The larvae deposited on these traps were counted and removed at approximately 3-day intervals (Table 5). The rates of pupation and emergence of moths were determined by placing 10 cm high wooden trays filled with soil beneath the tea bushes. Each tray occupied approximately one-quarter of the area beneath a bush, and thirty such trays were used in all. The soil in these trays was searched after pupation had occurred, and the number of pupae and the empty pupal cases was noted (Table 6 and

7). The distribution of egg masses on the *Grevillea* was studied by felling five trees selected from outside the experimental area (but in the same field) and counting the number of egg masses found on each 0.61 m segment. Parasitism of larvae by *Charops* was determined by laboratory dissections. The different larval stages were identified by the width of the head-capsule (Table 3).

TABLE 6 — *Numbers of Ectropis bhurmitra pupated in thirty soil trays, and estimates of population by this method*

Date	No. of pupae	Population density/acre
25 January 1966 (first generation)	14	6571
21 March 1966 (second generation)	3	1408

TABLE 7 — *Numbers of Ectropis bhurmitra emerged from thirty soil trays and estimates of population by this method*

Date	No. of empty pupal cases	No. of moths emerged/acre
1 February 1966 (first generation)	9	4224
29 March 1966 (second generation)	2	939

#### CONSTRUCTION OF LIFE TABLES

Life tables were prepared only for the first two generations, since the numbers of individuals found during the later generations were too low for analysis (Fig. 2).

Since oviposition occurs on shade trees and not on tea, it was rather difficult to estimate the initial egg population. A rough estimate of the total number of eggs per acre in the first generation only was obtained from the knowledge of the total number of egg masses found in the five felled *Grevillea* trees and the mean number of eggs per mass, and this was related to the number of *Grevillea* trees per acre (Table 8).

Changes in the larval population (all instars) on tea during the period under study (November 1965-November 1966) are illustrated in Fig. 2. It will be noted that the heavy outbreak that developed in December 1965 diminished drastically during the succeeding months. Only five distinct generations are indicated in Fig. 2, but there are, in fact, six generations per year. The numbers of larvae of different stages found during the first generation are given in Fig. 3, and the rate of deposition of first-instar larvae on sticky traps during this period in Table 5. These data indicate that the oviposition and hatching are staggered over a period of several weeks. Since the number of any one instar is being reduced by moulting and death, and at the same time is being increased by hatching or moulting, many of the larval instars occur simultaneously.

Estimation of recruitment of individuals to the population and of mortality in each stage is based on the slope of the fall in the population after the peak in numbers has been reached (Richards & Waloff 1954 ; Dempster 1956). Using logarithms, the

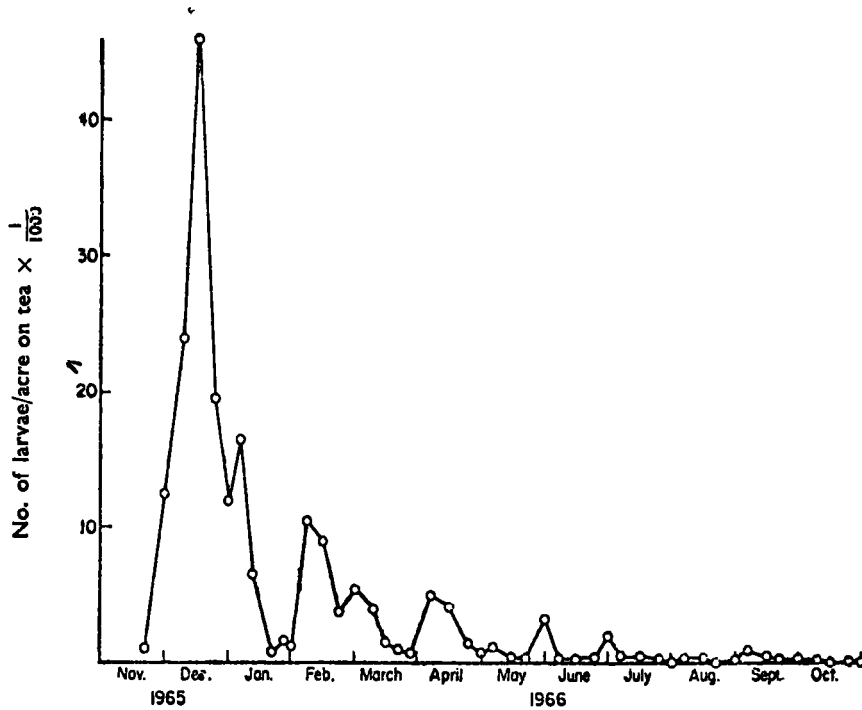


FIGURE 2—Changes in the numbers of *Ectropis bhurmitra* larvae on tea from November 1965 to October 1966

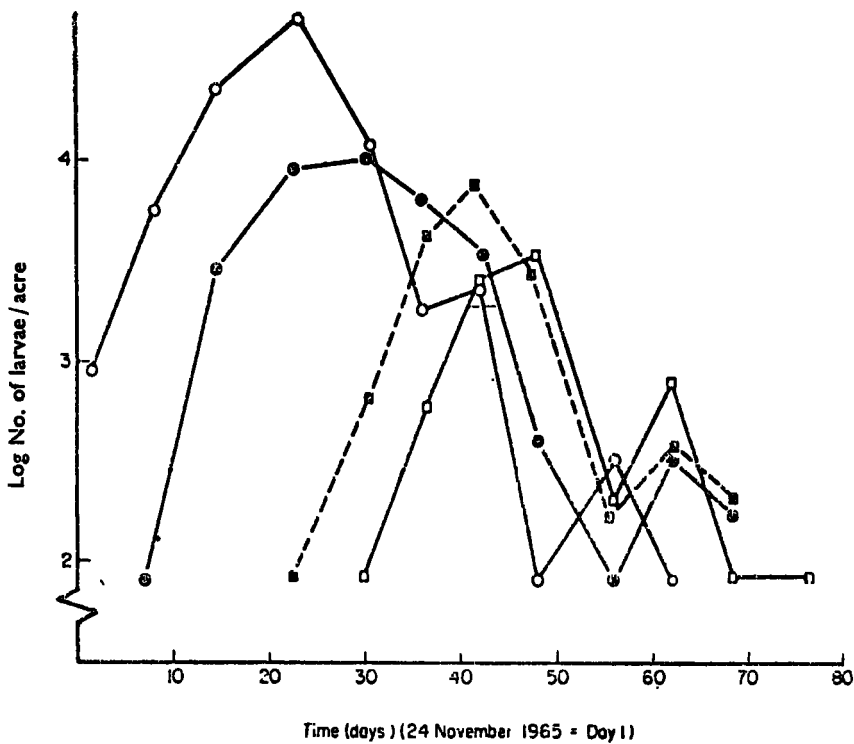


FIGURE 3—Number of *Ectropis bhurmitra* larvae on tea during the first generation. O, Instar I; ●, instar II and III; ■, instar IV; □, instar V

fall-off becomes approximately linear, and by extrapolation back to the beginning of the generation, the mortality and the initial number of individuals can be estimated. The method works well for populations in which there is a rapid build-up and a well-defined peak in numbers.

A regression calculation based on the accumulated totals of first- to fifth-instar of this stage larvae found on tea, gave an estimate of the initial number of larvae on tea. The numbers of second- and third-instar larvae found in the samples were not consistent and therefore this method of analysis was not found to be applicable when these two stages were taken separately. This was overcome by treating these two stages as one. The regression calculation based on the accumulated totals of second- to fifth instar larvae gave an estimate of the number that entered the second instar. The difference between this value and the initial number of first-instar larvae gave mortality of the latter stage. By the same method, the number of fourth- and fifth-instar larvae and their mortality were obtained.

TABLE 8 — *Number of Ectropis bhurmitra egg masses per Grevillea tree, and eggs per mass with standard error, and the estimate of egg population in the first generation*

Date	Egg masses/ <i>Grevillea</i> tree	Eggs/mass	Egg population/acre
10 December 1965	305 ± 79	64.33 ± 21.65	1941538

TABLE 9 — *Life table for Ectropis bhurmitra (first generation) at Goorookoya, November 1965—February 1966*

Stage	No. entering stage	No. dying	% of stage dying	% of initial egg No.
Moth (M + F)	12926			
Egg	1941538	1624018*	83.6	83.64
Instar I	317520	115680	36.4	5.96
Instars II - III	201840	184768	91.5	9.51
Instar IV	17072	2776	16.2	0.14
Instar V	14296	7725	54.0	0.39
Pupae	6571	2347	35.7	0.12
Moth	4224			
Total				99.76

\* Mostly attributed to losses to the population on tea, resulting from wind dispersal of larvae, soon after hatching on shade trees (see text).

The pupal population and the number of moths that emerged were estimated by relating the total number of pupae and empty pupal cases in the soil trays to the number of tea bushes per acre (Tables 6 and 7). The difference between the number of fifth-instar larvae and pupae gave the mortality of the former stage. The difference in the number of pupae and empty pupal cases provided the figure for pupal mortality.

The initial number of moths in the first generation was estimated by dividing the total egg population (from the *Grevillea* tree data, Table 8) by the mean number of eggs per moth (as calculated from the laboratory dissections) and multiplying this

by two (since the sex ratio was 1.1 M : 1.0 F). For the second generation, the initial number of eggs was determined as the product of the number of female moths that emerged at the end of first generation and the mean fecundity. Life tables prepared by these means are presented in Tables 9 and 10.

In the case of the first instar, a second estimate of the total number can be obtained by relating the total area of the sticky traps (2.8 sq. m) to the experimental area. Altogether 182 and 12 larvae were trapped during the first and the second generations respectively. The total estimate of the first-instar larvae per acre by the two methods are compared in Table 11. Although the results of the two methods compare fairly well in both generations, the numbers actually found feeding on tea bushes (regression method) are greater than the estimated numbers deposited through the air (sticky trap method). This would indicate that some of the larvae that hatch find their way onto the tea by crawling off the shade trees to the ground, and this, in fact, was observed to occur. These data suggest that about three-quarters of the larvae are air borne onto the tea and the rest crawl down the shade trees to the ground, and then find their way to the tea plants.

TABLE 10 — *Life table for Ectropis bhurmitra (second generation) at Goorookoya, February—March 1966*

Stage	No. entering stage	No. dying	% of stage dying	% of initial egg No.
Moth (M + F)	4224			
Egg	635712	611000*	96.1	96.11
Instar I	24712	13272	53.7	1.99
Instars II-III	11440	7686	67.2	1.30
Instar IV	3754	1827	48.6	0.29
Instar V	1927	519	36.8	0.08
Pupae	1408	469	33.3	0.07
Moth	939			
Total				99.84

\* Mostly attributed to losses to the population on tea, resulting from wind dispersal of larvae, soon after hatching on shade trees (see text)

TABLE 11 — *Comparison of estimates of instar I by the two methods of assessment*

	First generation	Second generation
Regression method	317520	24712
By sticky traps	263638	17533
Difference	53882	7179

## MORTALITY FACTORS

Since the eggs are laid within crevices in the bark and are covered with hairs, they are probably well protected from parasites, predators and weather. No parasites emerged from eggs brought into the laboratory from the field. Sterility as a mortality factor was found to be negligible in these samples. Although the life tables show that there is heavy mortality during the egg stage (83.6 and 96.1% during the first and second generations respectively), there is no field evidence to support this. Since oviposition and hatching occur on shade trees, it is more likely that the greater part

of this loss results from first-instar larvae failing to reach the tea below. This is supported by the fact that the first instar is mostly air-borne and is therefore likely to be blown or dispersed away from the habitat. The greater part of egg mortality indicated in the life tables would then appear to be caused by losses resulting from wind dispersal or deaths during this movement of the first-instar larvae, *ie* after hatching.

In the larvae, four definite causes of loss were determined, *ie* parasitism, predation, drowning and dispersal. The most noticeable cause of larval death was parasitism by *Charops*. The adult parasite lays its eggs in second-instar caterpillars. The larva feeds inside the caterpillar until it is fully grown, when it leaves its host to pupate. At this stage the caterpillar is killed, before it attains the fourth instar. To pupate, the parasite constructs a papery egg-shaped cocoon which is generally found connected by a short thread to the dead caterpillar or to a tea leaf. Only one larva develops per host. In the first and second generations, parasitism of third-instar *Ectropis* was 75.86% and 45.83% respectively.

TABLE 12 — *Rainfall at Goorookoya (in.) for the period November 1965-November 1966*

	First week	Second week	Third week	Fourth week	Total
November 1965	2.87	3.96	2.00	4.18	13.01
December	1.86	2.49	2.46	0.37	7.18
January 1966	0	1.59	0.93	0.33	2.85
February	0	0.81	0.10	0	0.91
March	3.88	1.66	2.18	1.51	9.23
April	0.94	0.63	7.45	5.20	14.22
May	0.60	0	0	1.10	1.70
June	3.77	0.38	2.50	4.39	11.04
July	2.06	2.58	4.24	0.66	9.54
August	3.95	3.58	1.72	1.34	10.59
September	0.70	0.67	0.43	28.71	30.51
October	2.18	3.26	3.12	3.90	12.46
November	5.11	6.63	2.33	0.16	14.23
Total					137.47

Bird predators constituted a second cause of larval mortality. All larvae from second to fifth instar were observed to be eaten by birds, specially the sparrow (*Passer domesticus confucius* Baker), magpie (*Cissa ornata* Legge) and mynah (*Acridotheres tristis melanosternus* Bakar). No quantitative data on predation by birds are available.

It was noticed that drowning was a cause of mortality in the first instar during and after rain. The first instar is minute (Table 3) and is easily drowned or washed off the tea leaves by heavy rain; practical difficulties did not permit quantitative assessments to be made, however. The amount of rainfall in the experimental area during the period of study was very high and is shown in Table 12. Dispersal by wind, as shown earlier, was another major cause for the loss of first-instar larvae.

During this study, the pupal populations were too small to yield much information on their mortality factors (Tables 6 and 7). No parasites emerged from pupae brought from the field to the laboratory for observation. As the pupal mortality is indicated by numbers that are completely missing, it would appear that these deaths are probably due to predation.

## DISCUSSION

*Ectropis bhurmitra*, like other members belonging to the same genus (Schimitschek 1957 ; Kolomietes 1965) is a forest insect with a wide range of host plants, *eg Aleurites montana, Artemisia vulgaris, Bombax malabaricum, Lantana aculeata, Phoebe lanceolata, Shorea robusta* and *Tectona grandis* (Beeson 1941). These studies showed that it can exist as a pest of tea only if tea is grown under shade (under forest-like conditions). This is because shade trees are required for oviposition; egg laying does not occur on tea. Outbreaks of this pest have occurred only in tea fields treated with dieldrin and shaded by trees (*eg Grevillea, Albizzia* or *Gliricidia*). Thus two factors are involved in causing outbreaks, *ie* presence of shade trees and dieldrin spraying. Dieldrin spraying during the years 1961-66 had been detrimental to many species of hymenopterous parasites of tea pests (*cf* Danthanarayana 1967), and in the case of *Ectropis*, there is evidence to show that the parasite involved was *Charops*.

This is the first population study of *Ectropis bhurmitra* to be carried out. Because of the nature of the problem and practical difficulties encountered, it was not possible to study thoroughly all of the mortality factors involved. From the available data, life tables for two generations have been prepared; but after the second generation the numbers were too small to provide reliable estimates of population size (Fig. 2). Any discussion of the population dynamics of this pest must, therefore, be very limited and somewhat tentative. With the suspension of dieldrin spraying against the shot-hole borer (*Xyleborus fornicatus* Eichh.) at the end of 1966, *Ectropis* ceased to be a serious problem, and it is unlikely that any further opportunities will arise when it will be possible to make similar studies on this pest.

In both generations the majority of the population (89.6% and 98.2%) did not survive beyond the first larval stage. This might be expected in an insect of this type, in which oviposition occurs on one host (site) and feeding and the rest of development on another. It was evident that many of the larvae hatching are unable to find their way onto the tea. Losses in the first instar were probably mainly caused by wind dispersal away from the habitat, but drowning during and after rain could account for some deaths.

During the rest of the developmental period, parasitism of the second and third instars by *Charops* was important and predation of all stages by birds was noted. Mortalities during the second and third instars (treated together) were heavy, amounting to 91.5% and 67.2% during the first and second generations respectively. Of these, 75.9% and 45.8% were caused by *Charops* in the two generations, indicating that the parasite has an important influence on the population. Although the mortalities during the following stages (instar IV—pupae) were fairly high, the numbers entering (or recruited to) these stages were very low. It is likely then that the pest status of *Ectropis* is determined primarily by the degree of mortality during the first, second and third instars. As parasitism by *Charops* is heavy, any adverse effect on the parasite, such as dieldrin spraying, could contribute to the development of outbreaks of the pest; although in this study the rate of parasitism by *Charops* did not increase as the effects of dieldrin wore off. The life tables show that the main difference between generations was the poorer survival of the first-instar larvae in the second generation. The reasons for this difference in first-instar mortality are not known. One possibility is that there may be other arthropod natural enemies, particularly predators of the first instar. If this is so then dieldrin may have reduced these predators, in addition to *Charops*. To determine the effect of predators such as staphylinids, carabids, phalangids and other arthropods on the first-instar larva would require a more exhaustive investigation. It must also be

noted that this is a study of an induced population of *Ectropis*, rather than a natural one, because the field had been treated with dieldrin. The fact that the population was reduced to negligible proportions with time, as the adverse effects of dieldrin wore off, indicate that under natural conditions *Ectropis* exists only in small numbers and is unnoticed as a pest.

Results obtained here have been helpful in designing control measures for this pest. When outbreaks occur, chemical control is essential to prevent serious damage to tea. It has been found advantageous to spray chemicals when the larvae are in their second and third instars because at this time it is possible to kill many larvae before they can do much damage to the tea plants (Danthanarayana 1966a). Insecticide applications on shade trees may be helpful in reducing initial larval populations. The removal of shade trees from tea fields could eliminate the pest status of *Ectropis* on tea; but there are other agronomic reasons why shade trees should not be removed from tea fields. The value of shade trees is at present a very controversial subject (cf Joachim 1961; Visser 1961a, b; McCulloch *et al* 1965, 1966). Some tea plantations have, however, on our advice resorted to the removal of shade for the purpose of controlling the twig caterpillar and have been able to eliminate the pest in this way.

#### ACKNOWLEDGMENTS

We wish to express our appreciation to Mr J. R. Medd, Superintendent, Goorookoya Estate for granting permission to carry out these experiments on his estate and the Director, Commonwealth Institute of Entomology for identifying the pests and the parasites.

#### SUMMARY

(1) Twig caterpillar (*Ectropis bhurmitra* Wkr.) outbreaks in Ceylon from 1963 to 1966 were caused as a side effect of dieldrin spraying of tea against the shot-hole borer (*Xyleborus fornicatus* Eichh.) from 1961 to 1966.

(2) *Ectropis* lays its eggs in crevices in the bark of shade trees (*Grevillea robusta*) and the larvae that hatch mostly reach the tea plant by dropping on threads. The fecundity is 300 eggs/female, and the eggs are laid in several batches containing an average of sixty-four eggs each. The distribution of egg masses on *Grevillea* was studied and it was found that about 70% are located up to a height of 5 m from the ground, and predominantly at 2-4 m, which is well above the level of the tea.

(3) The complete life cycle from egg to egg lasts from 8 to 9 weeks so that six generations can occur a year. Life tables were prepared for two generations. These showed that the majority of the population (89.6% and 98.2% respectively for the two generations) did not survive beyond the first larval stage. The main loss to the population was caused by wind dispersal of newly hatched larvae. Other causes of mortality were drowning of the first instar during rain and predation of all larval stages by birds. Parasitism of second and third instar by *Charops* sp. appeared to be an important mortality factor of *Ectropis* populations. Mortality in the second and third instar, during the two generations, amounted to 91.5% and 67.2% respectively; of which 75.8% and 45.8% respectively was caused by *Charops*.

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