Ceylon Cocon. Q., (1980) **31**, 98–104
Printed in Sri Lanka

SOME STUDIES ON THE BIOLOGICAL CONTROL OF *CHROMOLAENA ODORATA* (*EUPATORIUM ODORATUM*)[1]

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ABSTRACT

Mahindapala, R., Kirthisinghe, J. K. F. and Pinto, J. L. J. G. (1980). Some studies on the biological control of *Chromolaena odorata* (*Eupatorium odoratum*), *Ceylon Cocon. Q.*, **31**, 98–104

Laboratory studies on the biology and life cycle of the defoliator insect *Ammalo insulata* Walk. (Lep. Arctiidae), introduced to Sri Lanka to control the pernicious weed *Chromolaena odorata* Robinson, indicated that the insect could complete the life cycle on the two known hosts, *C. odorata* and *Ageratum conyzoides* but preferred *C. odorata*

Fluctuations of the defoliator insect population in a locality were monitored while periodic increases of the insect coinciding with new generations were noted. Larval and pupal mortality appear to be a major constraint in the successful establishment of the insect. The larval population was also low during the dry season.

Some changes in the insect population in relation to host and climatic factors have been noted.

INTRODUCTION

Chromolaena odorata (L) King and Robertson (Compositae) (*Eupatorium odoratum L*) is a pernicious weed on coconut lands throughout Sri Lanka. When the growth is extensive, this weed hinders cultural practices and even the collection of nuts in coconut lands. If allowed to grow rank, the area infested would become a scrub jungle of *Chromolaena* bushes. Traditionally, coconut planters resorted to manual weeding as it was uneconomical to use herbicides in coconut lands. With the rising costs of labour, control of this weed has become increasingly difficult.

Investigations on the possibilities of biological *control* of *Chromolaena odorata* have been carried out at the Commonwealth Institute of Biological Control (Anon., 1974 ; Cruttwell, 1968, 1973 ; Bennett and Cruttwell, 1973). In these studies, *Ammalo insulata* Walker was selected as a potential biotic agent. Some studies on the biology, host-specificity, life-cycle etc. of *Ammalo* have already been done (Bennett and Cruttwell, 1973).

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1. Paper presented at the 36th annual session of the Sri Lanka Association for the Advancement of Science Colombo 12-17 December, 1980.

2. The taxonomic position of *A. insulata* has been reviewed and the correct identity has been established as Pareuchaetes pseudoinsulata Rego Barros Holloway, J. D. Pers. comm.

In 1974, the Coconut Research Institute, under the aegis of the Food and Agricultural Organization of the United Nations, embarked upon a programme of biological control of this weed by importing two predatory insects, *viz.*, the defoliator, *Ammalo insulata* (Lep : Arctiidae) and the flower weevil, *Apion brunneonigrum* (Col., Curculionidae). The work on the introduction of *A. insulata* has already been reported (Dharmadhikari *et. al.*, 1977). However, *A. brunneonigrum* failed to establish itself in Sri Lanka and this paper is based on some observations made on the defoliator insect, *A. insulata.*

A series of experiments was carried out to study

(a) the biology and life cycle of the insect,

(b) its behaviour in the field, with particular emphasis on its ability to colonize stands of *Chromolaena* and

(c) the defoliation rate.

It is reported elsewhere (Mahindapala, 1978) that the success of *A. insulata* in controlling *C. odorata* has been limited owing to its apparent inability to remain in a *C. odorata* stand. Once defoliated, it is likely that the plant will survive and produce a new flush of leaves with the onset of rains. By then insects would have disappeared causing the plants to flourish. If, however, repeated defoliation does occur, the plants become very weak and may succumb. The cause for this interruption of the insect activity was thought to be pupal mortality (Mahindapala, 1979) and the experiments indicated at (b) above were mainly aimed at elucidating this aspect.

MATERIALS AND METHODS

(a) Studies on the biology and life cycle

Laboratory-reared insects were allowed to mate and lay eggs on an enclosed host plant. As soon as the eggs hatched, the first instar larvae were transferred singly to separate enclosed host plants and the insect growth was observed.

The biology and life cycle studies were carried out in the laboratory on the two known hosts of *A. insulata,* namely *Chromolaena odorata* and *Ageratum conyzoides* (Compositae). The latter, as a host plant, was discovered lately.

(b) Studies on behaviour

(i) Pupal mortality

In this study, pupae were exposed in the field using the following technique: Wooden trays (17 x 17 x 10 cm) were filled with field soil and laboratory-bred pupae were placed on the surface of the soil at the rate of 30 pupae per tray. Afterwards, the exposed surface was covered with leaf litter and coconut husk segments. The trays were then buried at the site so that the soil level in those was at the same level as field soil.

In the control, the buried tray was enclosed in a wire-meshed (100 mesh/cm^2) cage.

(ii) Population fluctuations

Population counts were taken regularly starting from October, 1979, in a coconut estate 52 km east of Colombo. Out of the 60 ha coconut plantation, a block of two

Fig. 1. Defoliation index on Chromolaena leaves defoliated by Ammalo.

ha was heavily infested with *C. odorata*. Several consignments of the predatory larvae were released in this area and after a few months it was evident that the insect was well established.

Weekly population counts were taken around 08.00 hrs on 50 randomly selected plants, and caterpillars were enumerated in the three stages of development, namely, early, mid and late instar. They were observed and left undisturbed. The height of the plant and the position of larvae were also recorded.

(c) Defoliation

At each observation, 25 plants were sampled to assess the extent of *Ammalo* feeding, as evidenced from leaf damage. Each caterpillar damaged leaf was graded for the degree of damage using the key given in Fig. 1. The degree of caterpillar damage per plant was assessed by totalling the degree of damage of the individual leaves. For a comparative evaluation, the number of undamaged leaves in each plant was also recorded.

RESULTS AND DISCUSSION

The results of the life cycle studies are presented in Table. 1. During the developmental stage, *A. insulata* behaves similarly on both hosts. However, it was observed, that the adult females reared on *C. odorata* had a higher fecundity than those reared on *A. conyzoides*. Another significant aspect of this study was the hatchability of eggs laid by *A. insulata* and reared on these two host plants. Eggs laid by *Ammalo* and reared on *Chromolaena* had a higher hatchability than those from *Ageratum-fed* insects. These facts indicate that *C. odorata* is the principal host plant.

Table 1. *Life cycle of A. insulata on two host plants*

		On Chromolaena odorata		*On Ageratum conyzoides*	
		Mean body length (mm)	*Mean period (days)*	*Mean body length (mm)*	*Mean period (days)*
1st instar	..	2.0	3.2	2.0	3.1
2nd instar	..	4.1	5.8	4.1	6.3
3rd instar	..	14.3	3.7	14.4	3.4
4th instar	..	30.2	4.4	23.9	6.2
Pre-pupa	—	—	1.3	1.2	1.2
Pupa	..	—	11.7	—	11.0
Longevity	..	—	6.4	—	6.5
Fecundity eggs/female	..	167.0		130.6	
Hatchability/female	..	113.2		44.3	
Incubation period (days)	..	8.3		6.2	
Period for one generation (days)	..	37.7		39.3	

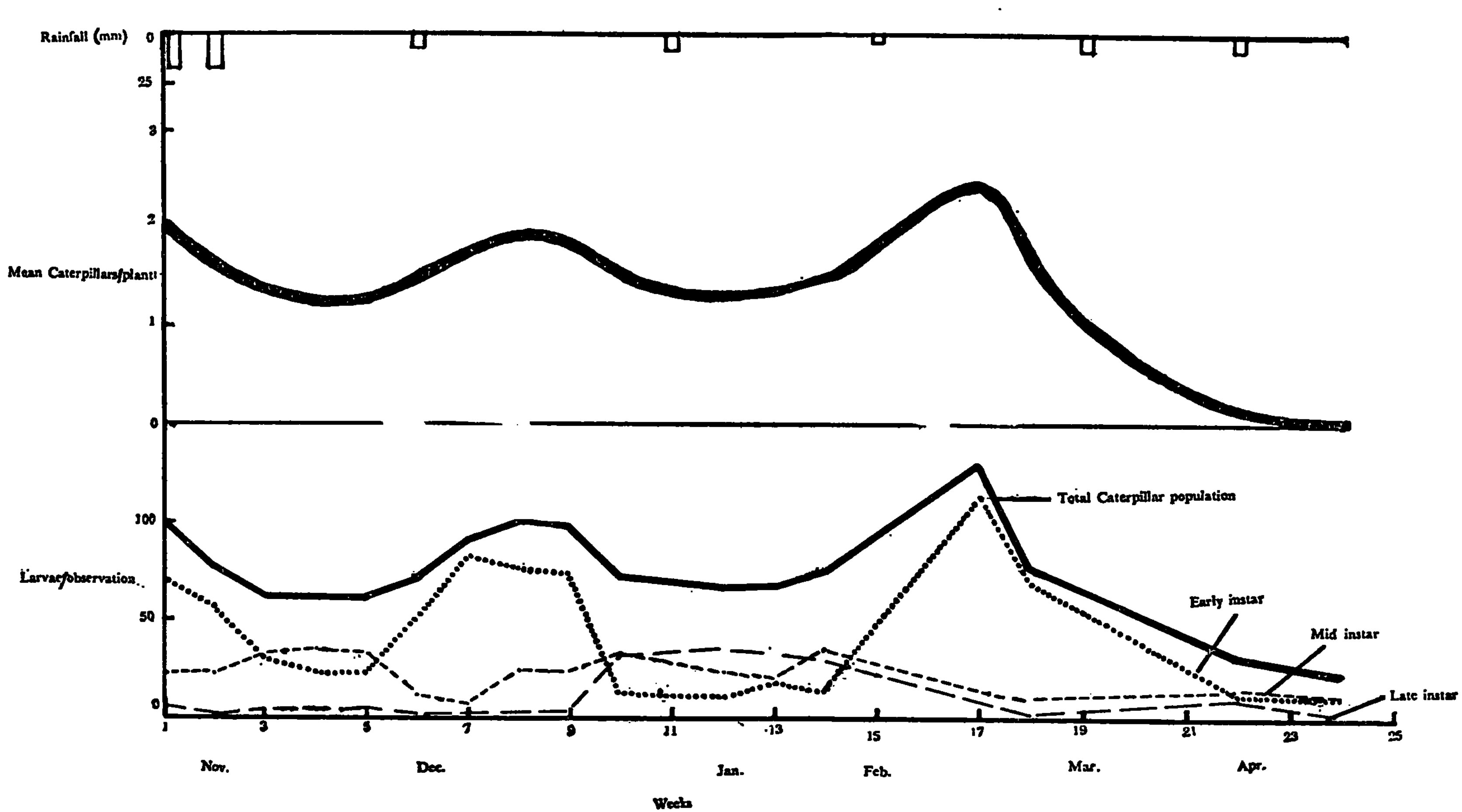

Fig. 2. Fluctuation of Ammalo population in a stand of Chromolaena.

The results of the study on population fluctuation are given in Fig. 2. The observations were started in October during the rainy season when there was a luxuriant growth of the weed. Upto about December, the population of caterpillars remained at a steady level. From Fig. 2 several slight increases of the caterpillar population are evident and these are due to the occurrence of new generations.

From the earlier study, it was noted that the insect takes about 40 days to complete the life cycle, and in Fig. 2, regular increases in the population to coincide with new generations can be observed. However, towards the latter part of the observations, the caterpillar population decreases drastically.

In Fig. 2 fluctuation of the population of early, mid and late larval instars with time has been shown. Peaks of early instar larvae are quite regular, indicating the emergence of new generations. Normally, an increase of mid/late larval instars has to be expected with the decrease of early instar populations. It is reasonable to assume this as the early instar larvae are expected to develop into late instar larvae. However, such a pattern is not clear in Fig. 2. When the population of early larval instars decreases, there is no corresponding increase of either mid or late larval instars.

It is, therefore, reasonable to assume that heavy mortality occurs in the early larval stage. Although normally, the larvae descend to the ground during the day time in search of a cool shady place, some of the early instar larvae could be seen on the petioles and on the abaxial surface of leaves. In doing so they are exposed to predators such as birds. Furthermore, two larval parasites, *viz.*, *Apanteles creatonoti* Vier (Braconidae) and *Exorista* sp. (Tachinidae) and a preadator *Sycanus* sp. (Reduviidae) have been recorded which also contribute to the larval mortality. In a heavy population of *Ammalo* larvae, a higher incidenee of parasites is to be expected.

Towards March and April the larval population was reduced appreciably and this can be attributed to very dry conditions.

These observations indicate that in a programme of augmenting predators in the field, it would be most advisable to release either the adults or mid instar larvae, within the periods post-wet and pre-dry.

The build up of the caterpillars and the cumulative effect of their feeding are evident from Table 2. The data taken from the observations of 50 plants indicate an increase of foliar damage with time. A further interesting feature is the increase of the damage rating with time indicating that a larger leaf area has been consumed. At the same time it would be noted that the number of leaves per plant has considerably decreased due to defoliation, and an increase in the damage rating at this stage would indicate heavy defoliation.

Table 2. *Increase of foliar damage with time*

	Total leaves	*Total leaves damaged*	*Damage rating*
November, 1979	1980	964	2154
December, 1979	1435	634	1758
January, 1980	1462	1007	2521
February, 1980	500	343	1150
March, 1980	805	218	472

The flowering period of the plant coincided with the dry period, resulting in a heavy supression of vagetative growth. Heavy defoliation at this stage of the plant could cause irreparable damage, even causing death. However, at this stage the larval population also decreases, partly due to the migration of moths following the relative scarcity of suitable leaves for egg laying.

Augmentation of the field release of caterpillars at this stage would also bring about beneficial effects by further defoliations and complete death of plants.

The results of pupal mortality are given in Table 3. At Sirambiyadi and Sirigampola, 100% pupal mortality has been observed. At Vanathavillu and at Katunayake a considerable number of pupae had been devoured by predators. Pupal mortality in the controls where pupae-containing dishes were enclosed in a fine-meshed cage has been considerable in all areas. At Vanathavillu, termites were seen preying on pupae in the cage. The termites had managed to enter the cage through the gaps between the door and the frame. At Sirigampola and at Katunayake ants were seen feeding on pupae. Like the termites, ants too had gained entry through gaps between the frame and the door. In fact, at Katunayake, ants carrying remnants of pupae were seen just outside the cage. At Vanathavillu and Sirambiyadi, the experimental sites had clay soils, and the termite activity was evident by the number of termite mounds at the sites.

Table 3. *Pupal mortality (%) of Ammalo at four localities*

Location	*Mortality (%)*	
	Control	*Treatment*
Vanathavillu	30	63
Sirambiyadi	37	100
Sirigampola	23	100
Katunayaka	43	70

These observations have indicated that predation of pupae in the open (treatment) can be very heavy. In one location there were signs of wild boar attack; whether these animals actually prey on pupae is, however, not certain. At Vanathavillu, garden lizards have been preying on pupae. From these observations it is evident that predation is the dominant cause of pupal mortality. The role played by ants and termites in destroying pupae is also significant. Pupal mortality can therefore be considered as the cause of regulating and depleting *Ammalo* densities in the field. It is a major constraint to the natural build up of these insects in the field which may necessitate regular field releases to achieve satisfactory control of *Chromolaena.*

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