

Predation Studies on *Pareuchaetes pseudoinsulata** (Lep: Arctiidae) Using ³²P Labelled Immatures**

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ABSTRACT

A defoliating insect, *Pareuchaetes pseudoinsulata* (*Ammalo insulata*) is used for the control of *Chromolaena odorata* (*Eupatorium odoratum*) (Compositae), a pernicious weed growing on coconut estates in Sri Lanka. The rate of consumption of *C. odorata* leaves by *P. pseudoinsulata* has been estimated and based on these results the requirement of *P. pseudoinsulata* per ha of weed for complete defoliation is discussed.

The sudden disappearance of large field populations of *P. pseudoinsulata* however limits the usefulness of this method for *C. odorata* control.

Field placement of ³²P labelled *P. pseudoinsulata* larvae and pupae with a view to studying parasitism and predation were undertaken.

Four methods of labelling *P. pseudoinsulata* with ³²P were tested and an appropriate method for uniform labelling was selected.

The results of initial studies on field placement of ³²P labelled *P. pseudoinsulata* are presented and discussed.

INTRODUCTION

Chromolaena odorata E. (*Eupatorium odoratum*) was introduced into the old world from the Neotropics, and is now a serious pest in many countries, e. g. India, Siam, Nigeria, (Bennet & Rao, 1968) and Sri Lanka. The plant flowers profusely during December to February each year and vegetative growth is heaviest during June to November. In Sri Lanka the plant grows luxuriantly on coconut plantations and is often the cause of heavy annual expenditure on weeding. On good land it forms a dense undergrowth with a tangled mass of stems up to ten feet in length. Under such conditions harvesting and gathering of nuts becomes almost impossible, and the ill effects on the coconut palm in the way of competition for fertilizers and soil moisture could be considerable.

Mechanical control methods adopted previously are not satisfactory as the plants resprout soon after the rains.

* Previously known as *Ammalo insulata*

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Biological control possibilities were investigated and a defoliating insect, *Pareuchaetes pseudoinsulata* (*Ammalo insulata*) (Lep: Arctiidae) was introduced into Sri Lanka in 1973 and is now firmly established in almost all parts of the country. Large tracts of *C. odorata* are frequently observed to be completely defoliated and the area found to be teeming with *P. pseudoinsulata* larvae. These large populations sometimes disappear almost completely although food is still available closeby.

P. pseudoinsulata completes its life cycle in 40-60 days and a female may lay between 150-250 eggs within a couple of days.

Bennett & Cruttwell (1973), records heavy egg parasitism by a Scelionid *Telenomus* sp. and larval parasitism by five species of Tachinids, *Calocarcelia aureocephala* Thomp., *Lespesia pollinosa* Thomp., *Pygophorinae peruviana* Towns., *Uromacquartia trinitatis* Thomps. and one unidentified species. In Sri Lanka the larval parasites *Apantales creotonoti* Vier. (Bracnidae) *Exorista* sp. (Tachinidae) and a larval predator *Sycanus* sp. (Reduviidae) (Kanagaratnam, 1976) were identified but these do not seem to be the major causes for population fluctuations.

It was therefore felt necessary to investigate further, in order to identify the major mortality factors under field conditions.

MATERIALS AND METHODS

Preliminary laboratory studies were conducted to estimate larval feeding by *P. pseudoinsulata* and the hypothetical requirement of larvae per hectare for complete defoliation. Two healthy *P. pseudoinsulata* egg masses, one from the laboratory culture and one from a field collection, were selected. Ten freshly hatched larvae from each lot were caged separately (One larva per cage) in 15 x 2½ cm. glass tubes and fresh *C. odorata* leaves with outline-drawn on calibrated tracing paper were provided every 24h. The extent of leaf eaten was estimated by tracing the eaten portion on the corresponding tracing paper, cutting out and weighing. This was done separately for each larva and the amounts eaten during each instar were calculated separately for the 10 field collected and 10 laboratory reared insects.

In order to estimate the foliage per hectare in a *C. odorata* infested coconut estate counts of the number of plants in 3 x 3 m random blocks of infested estate and the average leaves per plant were carried out. Measurements for average leaf area using randomly selected leaves were also carried out and *C. odorata* foliage per hectare estimated.

Four possible methods were studied for labelling *P. pseudoinsulata* larvae and pupae with ³²P.

- (a) dipping larvae in a ³²P Sodium orthophosphate solution.
- (b) dipping leaf in ³²P solution and allowing larvae to feed.
- (c) depositing a fixed quantity of ³²P solution on leaf and feeding to larvae.
- (d) offered as a bouquet of twigs with fresh leaves, placed in ³²P isotope solution and allowing larvae to feed.

Laboratory reared fourth instar larvae of uniform size and activity and starved for 24h were selected for the test.

Method (A)

Sodium orthophosphate ^{32}P solution of activity 0.01 mCi/ml was used. Using a long handled forceps, and rubber gloves the larvae were dipped one at a time for five seconds and transferred to a large glass cylinder provided with fresh *C. odorata* leaves.

Fresh leaves were provided as required and the larvae allowed to pupate in the glass cylinder. A total of 125 larvae were treated in the above manner and from these 114 pupae were collected. Seven days after treatment thirty randomly selected treated pupae were checked for activity using a GCS 13 Geiger Counter with an end window G. M. tube and the activity recorded as counts per minute (c.p.m.)

Method (B)

100 leaves of uniform size and shape were completely dipped, one at a time in ^{32}P solution of 0.01 mCi/ml activity and placed in a large glass trough of 30 cm diameter. 100 *P. pseudoinsulata* larvae were placed in the trough covered with muslin and allowed to feed. Fresh leaves were provided after all the treated leaves were completely eaten up, and this was continued till pupation. Activity as c.p.m. was recorded on 30 pupae.

Method (C)

15 μl of ^{32}P solution of activity 0.01 mCi/ml were placed carefully on a *C. odorata* leaf placed inside a 15 x 2½ cm glass vial. A single 4th instar larva was placed inside the vial and the vial closed using muslin cloth and rubber bands. Fresh *C. odorata* leaves were provided when the treated leaf was completely eaten. The larva was fed with fresh leaves till it pupated inside the tube. One hundred larvae were treated in this manner and 78 pupae obtained. Activity was recorded on 30 pupae as c.p.m. using the same Geiger counting system as at (A) above.

Method (D)

200 ml of ^{32}P of activity 0.005 mCi/ml were placed in a glass bottle of 400 ml capacity. Freshly picked twigs of *C. odorata* with good foliage were carefully placed in this bottle in the nature of a bouquet and the whole was placed in a 45 x 45 x 45 cm glass fronted wooden cage, 100 fourth instar larvae of *P. pseudoinsulata* were placed on the foliage and allowed to feed. When all the leaves were eaten a fresh bouquet in a new bottle with water only was placed beside the old eaten leaves to enable the larvae to complete feeding. The larvae were allowed to pupate on the floor of the cage and 87 pupae were collected. Activity was recorded on 30 pupae.

Low count rates were obtained with pupae using the treatment methods A, C and D but that for method B was much higher. This method of treatment was therefore investigated further.

Method B was repeated for 10 larvae with a slight modification in that a fixed time of only 4 hours were allowed for feeding after which the uneaten treated leaves were removed and fresh leaves added.

Pitfall traps in a *P. pseudoinsulata* populated coconut estate were maintained and the collections from these traps were sent to the Commonwealth Institute of Entomology London for identification.

Isotope labelled *P. pseudoinsulata* larvae and pupae were released in a coconut estate with a good growth of *C. odorata* but with a sparse natural population of *P. pseudoinsulata*.

Pitfall traps were set up and collections and observations made 24 h after the release of the labelled insects. The insects collected in the pitfall traps were each tested separately for activity using a GCS 13 Geiger counting system.

Attempts to trap possible vertebrate predators using domestic rat traps were unsuccessful. This will be modified and attempted once again.

RESULTS AND DISCUSSION

The feeding behaviour and the quantum of leaf area consumed per larva by the laboratory reared insects, were not significantly different from those of the field collected insects (Table 1). Thus, continued laboratory breeding over a number of generations does not seem to have affected the feeding capacity of *P. pseudoinsulata* larvae.

Table 1. Mean Leaf Area Consumed by *P. pseudoinsulata* Larvae

	Leaf area in cm ²	Difference of means	P = 0.05
Field collected Insects	182.44 ± 37.26		
		11.16	Not significant
Laboratory	193.61 ± 45.22		

Typically *P. pseudoinsulata* has five larval instars, but sometimes pupation occurs after only three larval moults. There is however no significant difference in the amount of leaf eaten by a four instar or a five instar insect (Table 2). A single larva from hatching to pupation eats an average of 184.62 cm² of leaf area (Table 3).

Table 2. Mean Leaf Area Consumed by *P. pseudoinsulata* Larvae

	Leaf area in cm ²	Difference of means	Level of significance
4 instar	191.43 ± 45.93		
		6.80	Not significant
5 instar	184.62 ± 36.69		

Table 3. Mean Leaf Area Consumed by *P. pseudoinsulata* Larvae in cm²

Instar 1	Instar 2	Instar 3	Instar 4	Instar 5	Total mean
3.47 ± 0.63	6.82 ± 4.89	15.40 ± 9.79	43.98 ± 16.19	114.91 ± 45.34	184.62 ± 36.69

In order to estimate the number of *P. pseudoinsulata* larvae required for effective defoliation of a hectare of coconut land with a heavy growth of *C. odorata* it was necessary to estimate the approximate leaf area of *C. odorata* per hectare of infested land.

These estimates (Table 4) revealed that a coconut estate with a heavy growth of *C. odorata* would have ca 22.42 x 10⁹ cm² of leaf area per ha (Table 4). A single *P. pseudoinsulata*

larva from hatching to pupation eats up an average of 184.6 cm² of leaf. This indicates that ca 12 million larvae per ha would be necessary for complete defoliation of a heavy growth of *C. odorata*.

Table 4. *C. Odorata foliage Per Hectare*

	Plant size			Total leaf area, cm ² /ha
	Large	Medium	Small	
Av. plants/ha	20,182	8,970	15,697	
Av. leaves/plant	3,467	1,252	288	
Av. leaves/ha	69.9 x 10 ⁶	11.2 x 10 ⁶	4.6 x 10 ⁶	
av. leaf area	1830.6 x 10	293.3 x 10 ⁶	117.8 x 10 ⁶	22.42 x 10 ⁸

Assuming an average egg laying capacity of 200 per female and a 1:1 sex ratio, 12 million larvae could be produced in two generations (3 months) with an initial release of ca 600-700 adult females.

For isotope tagging of *P. pseudoinsulata* larvae the method of dipping the leaves in a diluted solution of the isotope and allowing the larvae to feed on it was found to be superior to the other methods investigated viz. dipping the larvae in the radioactive solution, feeding a fixed quantity placed on a leaf and feeding on a fresh bouquet of twigs and leaves placed in an isotope solution (Table 5).

Table 5. Activity as counts per minute pupa of *P. pseudoinsulata*

	Method of treatment			
	Larva dipped	Leaf dipped	Syringe fed	Bouquet
Mean c.p.m.	19.53 ± 2.15	194.53 ± 8.44	36.5 ± 4.04	19.3 ± 1.61

When the feeding time was restricted to only 4 hours more consistent results were observed and the mean counts per minute per pupa was recorded as 119.2 ± 6.33.

The following predatory insects were among the collections recorded from the pitfall traps.

Family : Carabidae

Oxylobus minor
Macrocheilus niger
Omphra rufipes
Omphra pilosa

Family : Histeridae

Hister trigonifrons

Family : Formicidae

Odontomachus simillimus
Diacamma rugosum

None of the insects collected from the pitfall traps recorded activity on the Geiger Counter indicating that they were not predatory on *P. pseudoinsulata*. *Oxylobus minor* and *Omphra rufipes* are two insects that were suspected as possible predators on *P. pseudoinsulata* due to their presence in large numbers in *C. odorata* infested coconut estates.

These investigations reveal that it is unlikely that the sudden losses of field populations of *P. pseudoinsulata* are due to insect parasites or insect predators. It is now necessary to study vertebrate predators such as birds, lizards, etc.,. However, the ants *O. simillimus* and *D. rugosum* are large ants and are capable of carrying away fair numbers of *P. pseudoinsulata* larvae. The fact that no activity was detected on them although they were observed carrying away treated larvae indicated that the ants do not feed on the larvae soon after capture, but may be carrying them to their nest for subsequent feeding.

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