STUDY ON THE BIOLOGICAL CONTROL OF THE WEED *CHROMOLAENA ODORATA*[1]

A.F. Musico, P.M. Pontillas, K. König

Philippine-German Biological Plant Protection Project, Bureau of Plant Industry, 692 San Andres St., Malate, Metro Manila 1004, Philippines

INTRODUCTION

One of the most serious weeds in the Philippines is *Chromolaena odorata*, a compositae originated in Central America. It has spread during the past few decades all over the tropics and is presently causing tremendous harm in Philippine plantation crops and pasture lands.

This weed, locally called hagonoy inhabits and dominates readily open land. It causes not only much damage in plantation crops due to higher weeding expenses but renders open pasture land useless for cattle raising due to its high level of nitrogen, poisoning especially young cattle.

To control the weed by mechanical measures or by herbicides can be considered too costly considering the vast areas involved and the limited profit gained from pasture land. Therefore, the focus of the agriculturists was set on classical biological control e.g. establishment of limiting bioagents. A 6-year study of the Chromolaena problem in Central America, where *C. odorata* is originated, revealed the arctiid moth *Pareuchaetes pseudoinsulata* as one of the dominant controlling agents (SIEBERT 1989). The larvae of this nocturnal moth attack the leaves gregariously and defoliate the weed totally.

In 1985 some moths of this species have been found on *C. odorata* in Palawan (ATERRADO 1987). Most likely, they have spread from Sabah where field releases of moths of the Sri Lankan strain (Central America --> Sri Lanka --> Sabah, Guam) have taken

.....

1. This study was carried out in the framework of the Philippine-German Biological Plant Protection Project (PGBPPP), a cooperation between Bureau of Plant Industry and Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH, funded by the German Government

place in the early seventies. Unfortunately, this local strain seems to be not able to control successfully the weed. Likewise, failure to establish *P. pseudoinsulata* in the early 1970s were reported from India, Nigeria and Ghana (SIMONDE 1976). On the other hand, there is evidence of a successful establishment of the Trinidad strain in Sri Lanka (DHARMADHIKARI et al. 1977) and also in Guam, where the abundance of *C. odorata* could be reduced.

Therefore, the Crop Protection Division of Bureau of Plant Industry (BPI) has imported a strain of *P. pseudoinsulata* from Guam (also originated from Sri Lanka), where *C. odorata* is reported to be controlled successfully by the arctiid. Since there was no contact between the local strain and the newly imported strain there are chances that the newly imported strain is possibly more efficient and can reach results like in Guam and Sri Lanka.

But being a herbivorous insect special precaution has to be observed before any decision concerning introduction and establishment in a new environment is made. There is always the possibility that an insect intended to be a beneficial bioagent attacks also agricultural crops and turns into a new pest. Therefore, host specifity tests to evaluate the host plant range are an absolutely must before release takes place. In case of *P. pseudoinsulata* it seems that the risk of becoming a pest is very low. Host preference tests reported by BENNETT & CRUTTWELL (1973) showed that feeding is restricted to a few members of the genus *Eupatorium*. This was confirmed further by tests in India, Sabah and Malaysia. Nevertheless, before releases can take place the presented study on the biology and host preference had to be done to ensure a successful rearing and a save introduction in the environment later on.

MATERIALS AND METHODS

A Biology of *Pareuchaetes pseudoinsulata*

One hundred (100) pupae were placed in a screened emergence cage (91x62x79 cm) under laboratory conditions with a room temperature of 28 ± 2°C and RH of 65 to 75%. After emergence, oviposition took place during the night hours on leaves of plant cuttings kept in vases inside the cage. These plant cuttings were exchanged everyday with fresh ones.

Leaves with eggs on it were placed inside acrylic pans[1] together with fresh leaves to feed the emerging larvae during their first 3 larval stages. To keep the larvae inside the big, screened emergence cage was not possible since they could escape easily from the cage due to their small size. The larvae were transferred every 2 to 3 days into new pans to avoid contamination with pathogens and to feed them with new leaves. Upon reaching fourth instar rearing continued in a screened cage of the same size as described above for emergence. Plant cuttings placed on the bottom of the cage served as feeding material as well as cover for pupation.

After reaching a sufficient chitinized cuticula (dark color) the pupae were collected while doing the daily general cleaning. About 10% of them were used for continuation of the rearing, the others were stored for up to one week at 10°C. Longer storage under this temperature is not advisable since it damages the pupae and reduces considerably the rate of emergence and egglaying.

Determination of total number of eggs per female

Twenty pairs of newly hatched adult moths (male and female) were placed each in cages with *C. odorata* plants for oviposition. The number of eggs of each female laid on plants or onto the screen were counted up to the time the female died.

Longevity

Twelve pairs of newly hatched adult moths (male and female) were placed in cages with *C. odorata* plants for oviposition. The life span of each moth (male and female) was recorded to evaluate the lifespan of male and female *P. pseudoinsulata*.

1. Ø 20 cm, depth 8 cm, screened lid for aeration

Sex ratio

One hundred pupae were collected from the mass rearing and examined by using a binocular microscope to determine their gender.

Sex related differences in pupae

Twenty pupae each of male and female gender were weighted to evaluate whether there is any difference in weight between the genders.

B Host preference test

All host preference tests were conducted under laboratory condition (28°C, 70% RH, normal daylight period) using different test plants such as cereals, vegetables, ornamentals, fruit trees and other food crops including weeds to find out whether *P. pseudoinsulata* will feed and develop on these plants.

Raising of tests plants

Plants were raised in plant pots at BPI or in case of ornamentals obtained from Economic Garden, Los Baños. The decision which plant species had to - and will - be tested was based on the economic importance as well as on the degree of relation to *C. odorata*. When the plants were big enough (before reaching maturity) 5 plants for each test were transferred into screened cages.

Host preference test with *P. pseudoinsulata* in egg stage

Papers with 10 mature eggs previously laid on it inside the emergence cage of *P. pseudoinsulata* were fixed on each of the 5 test plants. This test put the possibility into account that *P. pseudoinsulata* larvae will be adapted to a non-host plant by having the first feeding on it.

Feeding behavior of the emerging larvae and damage on the test plants was observed over a period of 10 days.

Host preference test with *P. pseudoinsulata* in 1st larval stage

Ten 1st-instar larvae previously reared on *C. odorata* were placed on each of the 5 test plants and feeding behavior of the larvae and the damage on the test plants was observed over a period of 5 days.

Host preference test with *P. pseudoinsulata* in 4th larval stage

Ten 4th-instar larvae previously reared on *C. odorata* were placed on each of the 5 test plants and feeding behavior of the larvae and the damage on the test plants was observed over a period of 5 days.

RESULTS

Female adults deposit up to 450 eggs in groups of about 30 eggs (Table 1). The round eggs are creamy-yellowish at the beginning and change gradually to a grayish color during their development.

P. pseudoinsulata undergoes 5 larval stages which last 4 to 5.5 days each (Table 2). The 1st-instar larvae are brownish in color. As their size increases they become darker to blackish in color, with an orange line on each side and yellowish pigmented spots between the segments. The whole body is hairy but this diminishes during the pre-pupal stage.

The pupae are dark brownish in color and reach an average size of 13.4 mm. The average weight for female pupae is 0.19 g, for male pupae 0.18 g. At the pupal stage the gender can already be distinguished (Figure 1).

Adult *P. pseudoinsulata* are approximately 16.6 mm in length and of a creamish-yellowish color. The lower part of the thorax and the upper part of the abdomen is orange in color with 3 black dots on each of the first 6 abdominal segments - one on each side where the orange upper part ends and the yellowish lower part of the abdomen starts and one in the centerline of the upper abdominal part. Female adults can be easily differentiated from the male by their bulging abdomen opposite to the abdomen of the males which is more slender. A more exact sign - but only to be seen by handling the moth - is the existence of a hook-

Table 1. Number of eggs laid by *P. pseudoinsulata* during observation period under laboratory conditions (26°C, 70% RH)

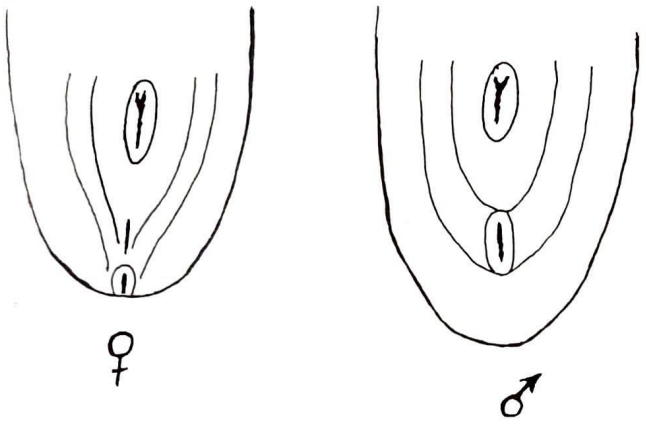
Day	Female# 1	2	3	4	5	6	7	8	9	10	11	12
1	193	38	94	82	104	108	96	83	50	76	191	87
2	75	97	35	61	95	94	108	115	95	51	64	61
3	131	86		53	36	30	120	95	77	77	71	30
4	58	91		38	33	37	45	40	61	34		35
5		36			34							
6		30			39							
7												
TOTAL	457	378	129	234	351	239	361	333	283	228	326	213

Table 2. Duration of different development stages of *P. pseudoinsulata* under laboratory conditions (26°C, 70% RH)

Stage		completed after .. days (additive)	Mean (days) per single stage	Range (days)
Egg		4.5	4.5	3-6
Larvae (5 instars)			23.5	21-26
	L1	8.0	3.5	3-4
	L2	12.5	4.5	4-5
	L3	18.0	5.5	5-6
	L4	23.5	5.5	5-6
	L5	28.0	4.5	4-5
Pupae		33.5	5.5	5-6
Adult:	female:	39.0	5.5	4-7
	male:	37.5	4.0	3-5

like structure on the base of the lower side of the forewing in the male gender whereas the females show there only a field of hairs.

Figure 1. Sex determination of *P. pseudoinsulata* pupae



All host specifity tests so far resulted in negative acceptance (Table 3) by *P. pseudoinsulata* of the plant materials introduced as potential food source; except for the two ornamental plants *Cosmos sulphureus* and *Chrysanthemum coronarium* (both compositae) where slight feeding on leaves were observed. But even in these cases no larvae survived a period of one week starting from test begin. In general, larvae were moving around the cage in search of food and had to be transferred daily onto the test plants again. In most cases the larvae died of hunger within the test period. The results of our tests conducted up to now indicate that *P. pseudoinsulata* has a very restricted food source and narrow selectivity for hagonoy as a preferred host plant.

Table 3. Host preference test on *Pareuchaetes pseudoinsulata*

Family	Scientific Name	Common Name	Remarks
Compositae	Lactuca sativa L.	Lettuce	NF[1]
Cruciferae	Brassica oleracea L.	Cabbage	NF
Cucurbitaceae	Momordica charantia L.	Ampalaya	NF
Gramineae	Oryza sativa L.	Rice	NF
Gramineae	Saccharum officinarum L.	Sugarcane	NF
Gramineae	Zea mays L.	Corn	NF
Labiatae	Pogostemon cablin BENTH	Kabling	NF
Leguminosae	Arachis hypogaea L.	Peanut	NF
Leguminosae	Vigna sinenses L.	Cowpea	NF
Malvaceae	Abelmochus esculentus L.	Okra	NF
Piperaceae	Piper nigrum L.	Black Pepper	NF
Rutaceae	Citrus microcarpa BUNGE	Kalamansi	NF
Solanaceae	Lycopersicon esculentum MILL.	Tomato	NF
Solanaceae	Solanum melongena L.	Eggplant	NF
Sterculiaceae	Theobroma cacao L.	Cacao	NF
Umbelliferae	Apium graveolens L.	Kinchai	NF
Begoniaceae	Begonia sp.	Begonia	NF
Compositae	Artemisia vulgaris L.	Damong Maria	NF
Compositae	Gerbera jamesonii BOLUS	African Daisy	NF
Compositae	Chrysanthemum coronarium L.	Chrysanthemum	feeding[2]
Compositae	Aster puniceus TAYLOR	Aster	NF
Compositae	Cosmos sulphureus CAV.	Cosmos	feeding
Palmae	Adonidia merrillii BECC.	Bunga de China	NF

1 NF means no feeding
2 Only slight feeding was observed; larvae died

REFERENCES

ATERRADO, E.D., 1987: *Pareuchaetes pseudoinsulata* caterpillar on *Chromolaena odorata*: A new Philippine record. Phil. J. coconut studies 11 (2), 59-60.

BENNETT, F.D., CRUTTWELL, R.E., 1973: Insects attacking *Eupatorium odoratum* in the Neotropics. 1. *Ammalo insulata* (WALK.)(Lep: Arctiidae), a potential biotic agent for the control of *Eupatorium odoratum* L. (Compositae). CIBC Tech. Bull. 16, 105-115.

DHARMADHIKARI, P.R., PERERA, P.A.C.R. & HASSEN, T.M.F., 1977: The introduction of *Ammalo insulata* for the control of *Eupatorium odoratum* in Sri Lanka. CIBC Tech. Bull. 18, 129-135.

SEIBERT, T. F., 1989: Biological Control of the weed *Chromolaena odorata* (Asteraceae) by *Pareuchaetes pseudoinsulata* (Lepidoptera: Arctiidae) in Guam and the northern Mariane islands. Entomophaga 34, 531-539.

SIMMONDS, F.J., 1976: Some recent puzzles in biological control. Entomophaga 21 (4), 327-332.