STUDY ON THE BIOLOGY OF *APANTELES PLUTELLAE* KURDJ. AND TESTING ON ITS EFFECTIVITY UNDER LABORATORY CONDITION.

by

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ABSTRACT

Laboratory studies were conducted to determine some of the attributes of *Apanteles plutellae* Kurdj. , a native parasite to control diamond back moth, *Plutella xylostella* L. (DBM).

The egg-larval period ranged from 6-10 days with mean of 8.33 days. The pupal stage ranged from 6-10 days with a mean of 6.66 days. The life span of the parasitoid when fed with a 30 per honey-water solution was up top 31 days with a mean of 18 days for females and a mean of 12.85 days for males. When fed only with water or no food at all the life span was reduced to 4-5 days.

The average number of DBM larvae parasitized by a mated female was 49.8 and for virgin females 9.8. The different larva stage of the host received a varying parasitization with 32% of parasitism in the 1st instar, 44% in the 2nd instar, 6% in the 3rd instar and 5% in the 4th instar.

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INTRODUCTION

The diamondback moth (*Plutella xylostella* L. (Lepidoptera : Yponomeutidae) is a major pest of crucifers in the tropics. If not controlled by various pest management methods it renders growing of cabbage impossible both in highland and lowland.

The utilization of synthetic pesticides is the most common solution farmers take to cope with pest problem. But during the last few decades pest control have become more and more difficult. DBM showed to develop rapidly resistance to all available insecticides. Farmers countered this development with an increase in the number of application (2-3 times a week) and utilized amount, and in the application of 2 and more pesticides (cocktail) during an application. As a result, we face a heavy contamination of the environment with a dramatic decrease of wildlife (including the natural enemies of the pest) as well as an increase of health problems due to poisoning during the process of spraying or the consumption of vegetables contaminated with residue.

A possible solution to achieve pest control without the problems connected with pesticides could be the use of classical biocontrol. The introduction and establishment of natural opponents of pest species proved worldwide to be not only the least harmful but also- if effective- the most economical method available. In case of DBM parasitoids *Apanteles* and *Diadegma* showed to be the most effective ones. Sudarwohadi on a consultancy visit to the BPI in 1990 recommended the introduction and preservation of *Apanteles plutellae* Kurdj. (Hymenoptera: Braconidae) as a possible alternative to chemical control in areas where excessive use of pesticides has eliminated endemic beneficial organism. The introduction of *A. plutellae* and *Diadegma collaris*

(Hymenoptera : Ichneumonidae) into Zambia have led to an 80% reduction in damage caused by DBM. In Trinidad, *A.plutellae* was introduced and is now well established.

But there is also reports on failures to establish the *A. plutellae* sufficient for pest control. The environment differs with each country. Therefore, it is necessary to check about the biological requirements of the parasitoid prior to field releases.

REVIEW OF LITERATURE

Studies on the biology of *A. plutellae* have been undertaken and published in Yugoslavia (Deluchi, 1954), Taiwan (Fan and Ho, 1974), Malaysia (Lim and Ko, 1975). Lesser Antilles and British Honduras (Bennett & Yassen, 1972) and in the Philippines (Velasco, 1982).

In Malaysia field parasitism by *A. plutellae* after establishment of the beneficial insect reached high levels due to its ability to adapt to local conditions, its tolerance to pesticides and the high female ration in its progeny (Chua and Ooi, 1986). Also Lime and Ko (1975) state that field surveys of parasitoids of diamondback moth have indicated that *A. Plutellae* has a suppressing effect and contribute substantially to the suppression of the diamondback moth.

Field observation at the BPI Baguio National Crop Research and Development Center shows that *A. plutellae* and the entomophagus fungus *Erynia radicans* Brefell are the dominate biotic mortality agents of diamondback moth (Velasco,1982).

OBJECTIVE

To understand the biology/life cycle of the parasitoid in order to develop an efficient mass rearing and release method.

To determine the percentage of parasitism under laboratory condition.

METHODOLOGY

The rearing and the study on the biology of *A. plutellae* was carried out in the laboratory of the BPI in Manila. Temperature during the period varied from 23 to 31(C, the relative humidity from 52 to 80 percent. The initial stocks of DBM and *A. plutellae* for the rearing and experiments came from field collected larvae and pupae. The further rearing of DBM as done on potted two-months old cabbage plants raised for this particular purpose. *A. plutellae* was multiplied on DBM larvae reared on potted cabbage plants. For this purpose, 4 potted cabbage potted plants infested with DBM larvae (200) in 2nd and 3rd instar stage were exposed to A. plutellae (150 cocoons every two weeks) inside a screened cage (60x60x70cms) for a period of 24 hours. After this period the plants were exchange with new ones and stored on a table for another 9-12 days. About 9 days after parasitization the first cocoons of the parasitoids could be found and collected. Collected parasitoids and DBM cocoons were stored in a refrigerator at 5-10 degree until needed.

1. Duration from egg to prepupal stage

Cabbage plants with DBM larvae in the 2nd and 3rd instar stage were exposed to mate parasitoids for 6 hours. Afterwards, the plants with the parasitized larvae were placed inside a screened cage for an undisturbed development of the

parasitoid up to pupation. The number of days it took for the parasitoid to pupation stage were noted.

2. **Duration of pupal stage and adult stage**

Fifty new formed *A. plutellae* were isolated in test tubes and the number of days to emergence of the adults were recorded.

To evaluated the influence of food (30% honey-water solution, water, none) on the life span, for each treatment 100 newly emerged adult parasitoids were isolated in single test tubes to determine their life span. Since it was expected that males and females have different life span the duration up to death was recorded according to sex.

3. **Number of progeny of unmated female parasitoids**

To avoid mating each parasitoid cocoon was placed in a single test tube for emergence. To ensure optimum conditions each test insect was fed immediately after emergence with 30% honey-water solution.

Cabbage plants infested with 100 DBM larvae in the 2nd and 3rd instar were exposed for 24 hours to 5 newly emerged unmated females. The plants were replaced everyday with new ones until all the females have died. The plant with parasitized DBM larvae were kept in a screened cage to avoid parasitization up to pupation of the parasitoids. The number of progeny and the sex ratio of the emerging adults were recorded.

4. Number of progeny of mate female parasitoids

The procedure as described above (33) were followed.

To ensure mating, emergence took place inside a screened cage (60x60x70 cm). A 30% honey-water solution was provided as food.

5. Susceptibility of Different DBM larval instar to parasitism

For each instar stage four (4) potted cabbage plants holding 300 DBM larvae were placed inside a screened cage together with 10 pairs of newly emerged parasitoids for 24 hours. The number and sex of progeny was noted. The test was repeated twice.

RESULTS AND DISCUSSIONS

1. Life Cycle

The braconid *A. plutellae*, a solitary endoparasitoid deposits one egg free into the hemocoele of DBM larvae. The parasitoid develops by feeding first on the body fluids and the adipose tissue, later on important organs of its host. The egg of prepupal duration varied from 6-10 days with an average of 8.33 days.

At maturity the parasitoid larva usually emerges from the host through a laterally cut circular hole and immediately forms its puparium just outside its host. In the beginning the puparium is whitish in color but later it becomes grayish and gradually attains a dark gray color by the time of emergence. The adult emerges from the cephalic and of the puparium by

cutting an operculum that remains hinged to the puparium. The pupal stage varied from 6-10 days with an average of 6.66 days.

The wasp is approximately 7 mm long, slender, dark brown in color and very mobile. Copulation took place during daytime about 1 hour after emergence. Searching DBM larvae and parasitization started about 1 hour later.

Males lives up to 4 days (mean 2.75) without food fed only with water (mean 3.34), but up to 30 days (mean 13.14) when a 30% honey - water solution was provided. The female life span was similar. When no food (mean 2.53) or only water (mean 3.04) was available, the beneficial died within 2-4 days. With 30% honey - water solution as food, the life span increased to 31 days (mean 16.56) (Table 1.)

Table 1. Duration of different development stages and adult longevity of *Apanteles plutellae* Kurdj., BPI, Manila, 1992.

ADULT LONG	with 30% honey	Female	5-31	18	
		Male	5-31	12.85	
	without water	Female	2-5	3.04	
		Male	2-4	2.53	
	without food	Female	2-5	3.04	
		Male	2-4	2.75	
PUPAL STAGE			6-10	6.66	
EGG LARVAL STAGE			6-10	8.33	

2. **Parasitization :**

Number of Progeny of unmated female parasitoids

A much lower number of progeny in case of unmated female was observed compared to mated females. Also, the offspring are male
since *A. plutellae* is an arrhenotokus specie (Table 2)

The average number of progeny based on three trials varied from 8-11 offspring's per female with an average of 9.5.

Table 2 : Reproduction of *Apanteles plutellae* Kurdj. females, BPI, Manila, 1992

Trial	Longevity: Days	Oviposition period: days	Progeny: M	Progeny: F	Sex Ratio: M	Sex Ratio: F	Parasitism: (Present)
1	15	10	178	100	1.7	1	58.15
2	9	8	132	88	1.5	1	46.8
3	12	9	138	112	1.2	1	54.58
Total	36	27	448	300	4.2	3	159.53
Mean	12	9	149.33	100	1.4	1	53.17

Number of progeny of mated female parasitoids

Mating of the parasitoids resulted in a 5 - fold increase of progeny compared to the unmated parasitoids (Table 3).

Table 3. Reproduction data of *Apanteles plutellae* Kurdj. unmated females, BPI, Manila, 1992

Trial	Longevity Days	Oviposition period Days	Progeny M	Progeny F	Parasitism (Present)
1	12	5	40	0	8.16
2	18	6	55	0	12.08
3	16	7	48	0	10.52
Total	46	18	143	0	30.76
Mean	15.33	6	47.6	0	10.25

The average number of progeny based on three trials varied from 44 to 56 offspring per female with an average of 49.9. The average sex ratio of the offspring was 1:4:1 in favor of the males.

Susceptibility of different DBM larva instar to parasitism

The results (Table 4) show that the 2nd instar stage of DBM was preferred with 55% parasitism followed by Ist instar stage with 32% parasitism. The 3rd instar stage (6%) and the 4th instar stage (5%) were the least preferred stages for oviposition which may be explained that bigger larvae have greater ability to resist *Apanteles* oviposition.

Table 4. Percentage Parasitism of *Apanteles plutellae* Kurdj. on the different larval instar of *Plutellae*, BPI.

DBM Larval instar	PERCENTAGE PARASITISM			
	Trial	Trial 2	Trial 3	Mean
First	38	20	40	32
Second	50	60	55	55
Third	8	4	6	6
Fourth	7	4	5	5

Result differs slightly from the findings of Velasco (1982) who reported the absence of parasitism on the 4th instar stage of DBM larvae by *A. plutellae* in the Philippines.

CONCLUSION AND RECOMMENDATION

The test have shown that a successful rearing depends on four important factors:

Feeding - Parasitoids reared without much food or only provided with water showed not much activity and died after 2-5 days as soon as their reserves have been used up. Feeding with a 30% honey - water solution was essential for parasitization as well as for prolonging the life span of about 30 days.

2. **Successful mating** - Since *A. plutellae* is an arhenotokous specie mating is essential for the development of female offspring. It is therefore important to allow enough time

for the parasitoids to mate before utilization of them for rearing purposes.

3. **Proper larval stage of DBM for parasitization** - The test show that *A. plutellae* clearly differentiates between the different larval stage were considered appropriate for parasitization. Later stages were only marginal parasitized. This finding makes a proper timing of the introduction of host larvae to the parasitoid crucial in order to achieve a high parasitization rate.

4. **Well running plant raising and DBM rearing** - The study revealed also that the average period from egg laying to the emergence of the adult parasitoid is under the prescribed rearing conditions only about two weeks. This can be considered very favorable because it ensures life span and active period of the adult parasitoid. Even under the favorable conditions in the laboratory and, when fed with 30% honey - water solution, the average life span reached only 16 days.

Considering the short development and oviposition period of the parasitoid it is very important that there is an unrestricted supply of DBM larvae (hence supply of cabbage for DBM rearing) for the rearing of the parasitoid. Therefore, a rearing cannot focus only on the "end product *Apanteles*" but must observe importance for all steps (plant raising, DBM rearing) of the mass rearing process.

The study considered *A. plutellae* a very promising biocontrol agent due to its short generation cycle and its quite high reproductivity. Nevertheless, findings about the influence of food are very disturbing if the target is release and establishment of the parasitoid in the field. The efficiency as well as life span of *A. plutellae* depends fully on the availability of carbohydrates (honey etc.) as food in

surroundings. Since the lack of flowers or "sugar providing" pests (aphids etc.) are quite characteristic of highly agricultural land we cannot ensure exploitation of the whole of the whole potential of the beneficial. It is recommend therefore, that in close vicinity of cabbage fields areas with flowering plants are maintained to provide food for *A. plutellae* and other beneficial. A similar effect would have a less efficient pest management on honey dew producing pests. A balance between the expected damage by these insects and the benefit they deliver in form of source of food should be found.

Another point of concern is the short life span, even under optimum feeding conditions. First releases of parasitoid must therefore be timely coordinated with the availability of the DBM larvae. A pre-release of parasitoids before pest attack as precaution will most likely result in a failure.

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