

## **BIBLIOGRAPHY**

MISLANG, GINALYN B. APRIL 2009. Life Cycle of Eggplant Flea Beetle (*Epitrix fuscula* Crotch) (Coleoptera:Chrysomelidae). Benguet State University. La Trinidad, Benguet.

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## **ABSTRACT**

The study was conducted at the Benguet State University Experimental Area, Balili La Trinidad, Benguet from March to August 2008. The study aimed to determine the duration and morphological description of the different growth stages of eggplant flea beetle, feeding and mating behavior, fecundity of female flea beetle and the longevity period of adult male and female flea beetle.

The insect undergo complete metamorphosis. The incubation period of egg ended with an average of  $11.2 \pm 0.58$  days. The larva sustained two molting to complete their larval stages. The first instar had an average of  $14.75 \pm 0.21$  days, second instar had an average of  $16.9 \pm 0.22$  days and third instar had an average of  $9.6 \pm 0.27$  days while the pre-pupa and matured pupa had an average mean of  $9.6 \pm 0.36$  and  $12.5 \pm 0.37$  days respectively. The fully grown adult had an average of  $8.45 \pm 0.33$  days.

In terms to morphological description, the egg is tiny, smooth, and oval in shape and yellowish in color with a mean length of  $0.5 \pm 0.02$  mm and a width of  $0.2 \pm 0.01$  mm. The larvae are white in color with brown head and three pairs of legs. The first instar had a body length of  $1.55 \pm 0.10$  mm and width of  $0.24 \pm 0.01$  mm, second instar with  $2.3 \pm 0.07$

mm long and a width of  $0.45 \pm 0.01$  mm and the third instar was  $3.6 \pm 0.11$  mm long and a width of  $0.75 \pm 0.01$  mm. The pre-pupa had a body length of  $2.23 \pm 0.05$  mm and width of  $0.94 \pm 0.02$  mm and the pupa had a body length of  $2.68 \pm 0.11$  mm and a width of  $1.2 \pm 0.05$  mm. While a fully grown adult flea beetle had a body length of  $2.73 \pm 0.07$  mm and a width of  $1.59 \pm 0.03$  mm. Adult flea beetle is pure black or bluish in color.

The larva feed on the roots and leaves of the host plant while the adult feed on the leaves of the host plant and produces small pits or shot holes. The beetle feed mostly during early morning and late afternoon, although they were observed eating at mid-morning and mid-afternoon.

Mating lasted for 15 to 20 minutes. Male can mate 2 to 5 time's a day with different female adults.

Female beetles laid an average of  $42 \pm 2.49$  eggs through out their reproductive stage.

Adult female and male can survive for 3 to 6 days with a mean of  $4 \pm 0.23$  and  $4.25 \pm 0.28$  respectively with out food, and 4 to 12 days with a mean of  $7.5 \pm 0.55$  and  $7.45 \pm 0.56$  respectively with food.

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## INTRODUCTION

Flea beetle is applied to variety of small beetles which have the hind legs enlarged and jump vigorously when disturbed. When flea beetles are abundant, the foliage of garden plant may be so badly eaten that it can no longer function and it dies. Since they are small and also rather active, they do not take much food in one spot; their injury consists of very small rounded or irregular holes eaten through or into the leaf, so that leaves looks as through they had been peppered with fine shuts. These small holes give an opportunity for the entrance of destructive plant disease, and the beetles may carry this disease organism from one plant to another and spread them as they feed.

Some flea beetles are rather general feeders, but perhaps the majority attacks on plant of the closely related crops of a single plant. One of the most destructive garden species is the Eggplant flea Beetle (*Epitrix Fuscula* crotch) which commonly seen in eggplant production. Considering that eggplant is a common vegetable in the Philippines particularly in the lowland areas, the study of this *Epitrix fuscula* crotch is necessary as advance technology is also going on hybernutry/ hybreeding of eggplant varieties in the Philippines.

The life cycle of *Epitrix fuscula* crotch is then important to note the adaptation of certain control measures, considering the fact that pest are grove enemy of farmers during cropping seasons.

With regards to its biology, these are also important to guide us in monitoring and controlling its population. For future researchers, this will serve as basis for conducting similar studies about this beetle.



The study aimed to:

1. determine the duration and morphological description of the different development stages of *Epitrix fuscula* Crotch;
2. determine how the insect feed and mate
3. record the total number of eggs deposited by female *Epitrix fuscula* crotch; and
4. observed the longevity of the female and male adults.

The study was conducted at the BSU Experimental Area, Balili La Trinidad Benguet from March to August 2008.



## REVIEW OF LITERATURE

### Life History

The life cycle of eggplant flea beetle has not been studied in North Carolina but in Indiana they emerge from hibernation in mid-to late march. Weedy host such as horsenettle and pokeweed are infested until crop host become available. Eggs laid in soil near the bases of plants hatch in about one week. Larvae emerge from the eggs and feed on roots or tubers for 2 to 3 weeks. After developing through three instar, larvae pupate in the soil. The pupal stage last 7 to 10 days. Beetles emerge from the pupal skins, makes their way out of the soil, and feed on leaves for 2 months or more. As a rule, flea beetles complete one to four annual generations (Metcalf *et al.*, 1962).

### Morphological Characteristics

Generally, Adult flea beetle are small ( $\frac{1}{4}$  inch or smaller, often  $\frac{1}{6}$  inch long) leaf beetle with a segment (femora) of the hind legs enlarged for jumping. When disturbed these beetles actively jump. Adult eggplant flea beetle (*Epitrix fuscula* crotch) are black and oval in shape for about 2 mm long. Its antennae are  $<$  to  $\frac{2}{3}$  the length of its body. This species resembles the potato flea beetle but has black legs and slightly hair wing covers.

Eggs, are generally elliptical in shape, the eggs is about 0.4 mm long, 0.2 mm wide and pointed at one end. Though white at first, it gradually becomes yellowish- gray. Flea beetle larva is white with brown head and three pairs of brown legs near its head. This species are 4 to 5 mm long when fully grown. The pupa also shaped roughly like



adults, pupa is found in the soil. They are white at first but gradually become darken in color (Alford 1999).

#### Distribution, Host and Control

Flea beetles ( *Epitrix fuscula* crotch) are occurring through out most of this country, this species tend to be most common in southern states. Moreover, this species has a narrow host range. Reports of its occurrences haven limited to eggplant.

In terms to control measures, cultural practices such as destruction of crop residue, weed control and late planting help minimize flea beetle problems. The removal of crop residue reduces the number of favorable over wintering site for flea beetles. Causing plant bed and destroying trash around them also beneficial. Control of weeds such as horsenetle and pokeweed around garden sites eliminates important early beetle food sources. Delayed planting also favors the development of host plant over the establishment of flea beetles (Flint, 1951).

#### Feeding Behavior

Knodel (2002) stated that flea beetles emerge when temperature warm up to 57 F (14 Celsius) in early spring. They feed on volunteer host plants such as wild mustard and move newly planted eggplant as it emerged, depending on temperature. It may take up to three weeks for adult flea beetle to leave there over wintering sites, warm clam and dry weather promotes flea beetle flight feeding through out the field simultaneously slowing plant growth. Further more, Knodel explained that bin contrast cool, rainy and windy conditions reduce flight activity and flea beetle walks or hop leading to concentrations in the field margins. Female oviposit up to 25 eggs in the soil in June. The over wintered



adult continue to remain active until June and begin to die off in early July, larvae hatch from eggs about 12 days and feed on the secondary roots of plants.





## **MATERIALS AND METHODS**

### Materials

The materials that were used in the study are the following; seeds of eggplant, 15x15 diameter plastic pot, garden soil, multi-purpose plastic containers, plastic cups with cover, tissue, floral foam, foot ruler, dissecting microscope, monocular microscope, and eggplant flea beetle specimen.

### Maintenance of the Host Plant

Fifty plastic pots measuring 15 x 15 cm were used in the planting of eggplant seeds. Weeding, removing of dried leaves and watering were done to maintain the good vigor of the plant. The roots of the plant served as the food of the larva while completing its larval stage, while the leaves also served as food for the adult beetle.

### Maintenance of the Host Insect

Collection of adult eggplant flea beetle at the field was done during early morning and late afternoon. Adult flea beetles were cultured in multi-purpose plastic containers and were given food to maintain their growth.

### Life Cycle Study

From the cultured adult flea beetle, the laid eggs were separated and placed in a multi-purpose plastic container (CP16) with floral foam and tissue. The newly hatched larvae were again separated in another container with floral foam inside and marking the container as identification of the different stages. The larvae of flea beetle were supplied with fresh eggplant leaves and roots as their food. Changes of different larval stages were



noted. The size of the different development stages was done using the monocular microscope; one representative sample of each growth was measured. After the pupa turned to adult male and female, these were observed and recorded according to their size and antennae because the 5<sup>th</sup> antennae of the male are distinctly thickened.

The duration and morphological characteristics of the different life stages were observed and recorded.

### Behavioral Studies

The feeding behavior of flea beetle was observed during the larval stage and adult stage and mating behavior of the adult flea beetle was observed by gathering the frequency of mating by male adult beetle.

The fecundity of the insect was observed until all the eggs are laid. The numbers of eggs laid by the female flea beetle were listed and counted until it ceased on laying eggs.

The longevity of the adult's life span were observed and recorded according to food availability. The newly emerged adult male and female were given food while the other treatments have no food.

### Data Gathered

A. Duration and Morphological characteristics of the different development stages;

1. Eggs. incubation period, color , shape and size ( length and width of the egg).
2. Larva. duration of development, color and size ( length and width).



3. Pupa. duration of development, size ( length and width )
4. Adult. color, size of the body (length and width) and longevity.

B. Behavior

1. Feeding. The manner of feeding
2. Mating. The frequency and time of mating.

C. Fecundity. number of eggs laid by female beetle, throughout its reproduction period.

D. Longevity period of adult male and female flea beetle.



## RESULTS AND DISCUSSION

### Duration of Different Growth Stages

Table 1 present the duration stages of the Eggplant flea Beetle from egg to Adulthood. The incubation of egg lasted for 7–14 days from laying to hatching with a mean of  $11.2 \pm 0.58$  days.

Larvae. The larvae sustained two molting to complete their larval stage. The first instar is ranges from 14-17 days with a mean of  $14.75 \pm 0.21$  days, second instar is ranges from 15-19 with a mean of  $16.9 \pm 0.22$  days and the third instar larvae ranges from 18-22 days with a mean of  $20.15 \pm 0.27$  days.

Pre-pupa. The pre- pupa period ranges from 7-11 days with a mean of  $9.6 \pm 0.36$  days.

Pupa. The pupa period show a ranged from 10-14 days with a mean of  $12.5 \pm 0.37$  days.

Table 1. Duration of different growth stages of eggplant flea beetle from April to July.

DEVELOPMENTAL STAGES	DURATION DAYS	
	Range	Mean
Egg incubation	7-14	$11.2 \pm 0.58$
Larvae		
1 <sup>st</sup> instar	14-17	$14.75 \pm 0.21$
2 <sup>nd</sup> instar	15-19	$16.9 \pm 0.22$
3 <sup>rd</sup> instar	18-22	$20.15 \pm 0.27$
Pre-Pupa	7-11	$9.6 \pm 0.36$
Pupa	10-14	$12.55 \pm 0.37$
Adult	7-11	$8.45 \pm 0.33$



Adult. The fully grown as adult beetle is ranges from 7–11 days with a mean of  $8.35 \pm 0.33$  days.

### Distinct Morphological Characteristics

Table 2 present the morphological features of the different growth stages of eggplant flea beetle.

Egg. The egg is tiny, smooth, and white at first and gradually become yellowish in color, oval in shape with pointed narrow tip (Figure 1). The egg has a width ranged from .2–.3 mm with an average mean of  $0.2 \pm 0.01$  mm, while its length ranged from .4–.6mm with a mean average of  $0.5 \pm 0.02$  mm. This collaborate nearly to the finding of Alford (1999) that eggs of the egg plant flea beetle are generally elliptical in shape, it measures about 0.4 mm long, 0.2mm wide and pointed at the end.

Table 2. Length and width of different growth stages of eggplant flea beetle from April to July

DEVELOPMENTAL STAGES	LENGTH (mm)		WIDTH (mm)	
	Range	Mean	Range	Mean
Egg	0.4 -0.6	$0.5 \pm 0.02$	0.2-0.3	$0.2 \pm 0.01$
Larvae				
1 <sup>st</sup> instar	1-2	$1.55 \pm 0.10$	0.2-3	$0.24 \pm 0.01$
2 <sup>nd</sup> instar	2-3	$2.3 \pm 0.07$	0.4-5	$0.45 \pm 0.01$
3 <sup>rd</sup> instar	3.0-4.5	$3.6 \pm 0.11$	0.7-8	$0.75 \pm 0.01$
Pre-Pupa	2.0-2.6	$2.23 \pm 0.05$	0.8-1	$0.94 \pm 0.02$
Pupa	2.0-3.5	$2.68 \pm 0.11$	1-1.5	$1.2 \pm 0.05$
Adult	2.5-3	$2.7 \pm 0.07$	1.4-1.8	$1.59 \pm 0.03$





Figure1. Egg of female eggplant flea beetle

Larvae. The newly hatched larva is white with brown head and three pairs of brown legs near its head but gradually become slightly darker as the instar increases. This species are 3–4.4 mm in length and .7-.8 mm in width when a larva is fully developed.

The first instar had a body length of 1-2 mm with a mean of  $1.55 \pm 0.10$  mm and width of .2-.3 mm with a mean of  $0.24 \pm 0.01$  mm (Figure 2), second instar had a body range of 2-3 mm in length with a mean of  $2.3 \pm 0.07$  mm and width of .4 -.5 mm with a mean of  $0.45 \pm 0.01$  mm (Figure 3). While the third instar ranged to 3 -4.4 mm in length and .7-.8 mm with a mean of  $3.6 \pm 0.11$  mm and width of  $0.75 \pm 0.01$  mm (Figure 4).





Figure 2. First instar larvae of eggplant flea beetle



Figure 3. Second instar larvae eggplant flea beetle



Figure 4. Third instar larvae of eggplant flea beetle



Pre-pupa. Show a body length and width of 2–2.6 mm and 0.8–1mm with a mean of  $2.23 \pm 0.05$  mm and  $0.94 \pm 0.02$  mm (Figure 5).

Pupa. The fully developed pupa had the body length and width of 2 – 3.5 mm and 1-1.5 mm with a mean of  $2.68 \pm 0.11$  mm and  $1.2 \pm 0.05$  mm respectively. The pupa is whitish or translucent in color (Figure 6). In this stage we can see the alike appearance of the beetle when it fully developed as adult beetle, wings are present, antenna and legs that are horizontally fixed. Alford (1999), pointed out that pupa also shaped roughly like adults, pupa are found in the soil. They are white at first but gradually become darken in color.



Figure 5. Pre-pupa



Figure 6. Pupa







Figure 7. Adult female flea beetle



Figure 8. Adult male flea beetle



Adult. Adult flea beetle had a body length of 2.5 mm to 3mm with a mean of  $2.7 \pm 0.07$  mm long and a width of 1.4 mm to 1.8 mm with a mean of  $1.59 \pm 0.03$  mm wide. The body is oval shape, black in color as a dominant; others are brown, dark green and navy blue. The adult has hind legs that enable to jump and has chewing mouthparts (Figure 7 and 8).

Moreover, it was observed that the abdomen of female flea beetle is bigger and extended when it is about to deposit egg. The antenna of the male is broader in the fifth segment while the female has straight pectinate antenna.

### Behavioral Studies

Feeding. The flea beetle mostly observed feeding at early morning and late afternoon, they most likely to feed on the young leaves of the host plant. After feeding they leave small pits or shot holes appearance on the leaf of host plant. It attacks the host plant even at early growth stage.

This collaborates to Knodel (2002), stated that flea beetles emerge when temperature warm up to 57 F (14 Celsius) in early spring and they feed on volunteer host plants such as wild mustard and move newly planted eggplant as it emerged, depending on temperature. It may take up to three weeks for adult flea beetle to leave there over wintering sites, warm clam and dry weather promotes flea beetle flight feeding through out the field simultaneously slowing plant growth. Further more, Knodel explained that bin contrast cool, rainy and windy conditions reduce flight activity and flea beetle walks or hop leading to concentrations in the field margins.

Mating. In mating it was observed that the flea beetle mate anytime during the day. Pairing and copulation lasted for 15 to 20 minute. Male adult mate 2-5 times a day



Table 3. Total number of laid eggs by a female eggplant flea beetle

SAMPLE	TOTAL NUMBER OF EGGS LAID
1	49
2	35
3	38
4	43
5	45
TOTAL	210
MEAN	42 $\pm$ 2.49

when offered virgin females. Knodel (2002) noted that, after selecting a host plant and feeding commenced, male flea beetle mate repeatedly.

#### Fecundity

The total number of egg laid by the female Eggplant Flea beetle is shown in table 3. A female flea beetle can lay 35-49 eggs during its lifetime with a mean of 42  $\pm$ 2.49 eggs. Further noted that, female can lay eggs about 4 to 5 in a day.

#### Longevity

Table 4 shows the result of longevity period of adult flea beetle treated with food and with out food. This treatment was done to determine the endurance or life span of adult flea beetle concerning on food availability. Generally result revealed that, male and female flea beetles had a minimum survival rate of 3-6 days with a mean of 4.25  $\pm$ 0.28 days and 4  $\pm$ 0.23 days respectively with out food. While the life span male flea beetle ranges to 4-12 days and 3 to 11 days in female with a mean of 7.45  $\pm$ 0.56 days and 7.5



$\pm 0.55$  days respectively with food. According to a source gathered from the internet adult flea beetle can survive for two months with food normally (Anonymous, undated).

Table 4: Longevity period of adult eggplant flea beetle

SAMPLE	WITH OUT FOOD DAYS		WITH FOOD DAYS	
	Range	Mean	Range	Mean
Male	3-6	4.25 $\pm$ 0.28	4-12	7.45 $\pm$ 0.56
Female	3-6	4 $\pm$ 0.23	3-11	7.5 $\pm$ 0.55



## SUMMARY AND CONCLUSION

### Summary

The study aimed to determine the duration and morphological description of the different developmental stages of flea beetle; determine how the insect feed and mate; number of eggs deposited by female eggplant flea beetle and to observe the longevity of the female and male adults. It was conducted at the Benguet State University Experimental area, Balili La Trinidad Benguet from March to August 2008.

The final appearance of the egg shows a mean of  $11.2 \pm 0.58$  days. The larvae sustains two molting to complete there larval stage where in the first instar shows a mean of  $14.75 \pm 0.21$  days, second instar shows a mean of  $16.9 \pm 0.22$  days , and the third instar shows a mean of  $20.15 \pm 0.27$  days. The pre-pupa shows a mean of  $9.6 \pm 0.36$  days while the pupa shows a mean of  $12.5 \pm 0.37$  days. The adult shows a mean of  $8.45 \pm 0.33$  days.

The egg is tiny, smooth, and white at first and gradually become yellowish in color, oval in shape with pointed narrow tip, measuring  $0.5 \pm 0.02$  mm length and a width of  $0.2 \pm 0.01$  mm. The larvae are white with brown head, 3 pairs of brown legs near its head but gradually become slightly darker as the instar increases. The first instar had a body length of  $1.55 \pm 0.10$  mm with a width of  $0.24 \pm 0.01$  mm, second instar had a body length of  $2.3 \pm 0.07$  mm and a width of  $0.45 \pm 0.01$  mm, and the third instar was  $3.6 \pm 0.11$  mm and a width of  $0.75 \pm 0.01$  mm. The pre-pupa had a body length of  $2.23 \pm 0.05$  mm long and a width of  $0.94 \pm 0.02$  while the pupa had a body length of  $2.68 \pm 0.11$  mm and mean width of  $1.2 \pm 0.05$  mm. While the fully grown adult flea beetle had a body length of  $2.73 \pm 0.07$  mm and a width of  $1.59 \pm 0.03$  mm.



The larvae feed on the roots and leaves of the host plant while the adult also feed on the leaves of the host plant and produces small pits or shot holes. The beetle feed mostly during early morning and late afternoon, although they were observed eating at mid-morning and mid- afternoon.

Mating lasted for 15 to 20 minutes and male can mate up to 2 to 5 times day when offered female adults..

The female beetles lay 35 – 49 eggs with a mean of  $42 \pm 2.49$  eggs, through out their reproductive stage.

Adult male survive with food up to 4 to 12 days with a mean of  $7.45 \pm 0.56$  days and 3 to 11 days for female with a total mean of  $7.5 \pm 0.55$  days which is closely similar to the male beetles. While male beetle survive with food in 3 to 6 days with a mean of  $4.25 \pm 0.28$  days, and female beetle also survive up to 3 to 6 days with a mean of  $4 \pm 0.23$  days.

### Conclusion

The duration days and morphological characteristics of egg to adult take two months. They feed mostly during early morning and late afternoon and mating and copulation lasted for 15 to 20 minutes. The total number of eggs laid by female flea beetle was 35-49 eggs during its lifetime or upon reaching its reproduction period.



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## APPENDICES

Appendix Table 1. Number of days the egg hatch

SAMPLE	LAYING TO HATCHING
1	14
2	11
3	7
4	8
5	14
6	12
7	13
8	14
9	9
10	7
11	10
12	11
13	14
14	14
15	7
16	14
17	13
18	12
19	11
20	9
<b>TOTAL</b>	<b>224</b>
<b>MEAN</b>	<b>11.2</b>





Appendix Table 2. Measurement of Eggs (mm)

SAMPLE	WIDTH	LENGTH
1	.2	.5
2	.3	.5
3	.2	.4
4	.3	.6
5	.2	.5
6	.3	.5
7	.3	.6
8	.2	.6
9	.2	.6
10	.2	.4
11	.2	.5
12	.2	.4
13	.2	.5
14	.2	.6
15	.3	.6
16	.2	.5
17	.2	.4
18	.2	.6
19	.3	.5
20	.2	.5
<b>TOTAL</b>	<b>4.7</b>	<b>10.3</b>
<b>MEAN</b>	<b>0.2</b>	<b>0.5</b>



Appendix Table 3. Number of days 1<sup>st</sup> instar to third instar larva fully grown

SAMPLE	NUMBER OF DAYS		
	1 <sup>ST</sup> INSTAR	2 <sup>ND</sup> INSTAR	3 <sup>RD</sup> INSTAR
1	14	16	18
2	16	18	20
3	14	16	18
4	14	16	18
5	14	16	21
6	16	18	20
7	17	19	21
8	15	17	20
9	14	15	20
10	16	18	21
11	14	16	18
12	14	17	21
13	15	17	21
14	16	18	21
15	15	17	21
16	14	17	22
17	14	16	20
18	15	17	21
19	15	17	21
20	14	16	20
TOTAL	295	338	403
MEAN	14.75	16.9	20.15



Appendix Table 4. Measurement of the 1<sup>st</sup> instar larvae (mm)

SAMPLE	WIDTH	LENGTH
1	.3	1
2	.3	1
3	.3	1
4	.3	2
5	.2	2
6	.2	2
7	.3	1
8	.2	1
9	.3	2
10	.2	1.5
11	.2	1.5
12	.2	1.0
13	.2	1.5
14	.3	2
15	.3	1.5
16	.2	1.5
17	.2	2
18	.2	2
19	.2	2
20	.2	1.5
TOTAL	4.8	31
MEAN	0.24	1.55



Appendix Table 5. Measurement of the 2<sup>nd</sup> instar larvae (mm)

SAMPLE	WIDTH	LENGTH
1	.4	2
2	.4	2
3	.5	2
4	.5	2.3
5	.4	2
6	.5	2
7	.4	2.5
8	.5	2
9	.5	2.5
10	.4	2
11	.4	2.5
12	.4	3
13	.5	2.8
14	.4	2.5
15	.5	2.4
16	.5	2.2
17	.4	2
18	.4	2.5
19	.5	2
20	.4	2.8
TOTAL	8.9	46
MEAN	0.45	2.3



Appendix Table 6. Measurement of 3rd instar larvae (mm)

SAMPLE	WIDTH	LENGTH
1	.7	3.5
2	.8	3.8
3	.7	3.5
4	.8	3.5
5	.8	3.5
6	.7	3
7	.7	3
8	.7	3.5
9	.8	4
10	.8	3.5
11	.7	3
12	.8	4
13	.7	3.5
14	.8	4.4
15	.8	4.4
16	.7	3.5
17	.8	3
18	.7	3
19	.8	3.9
20	.8	4.5
TOTAL	15.1	72
MEAN	0.75	3.6



Appendix Table 7. Number of days of the pupa

SAMPLE	PRE-PUPA	PUPA
1	11	14
2	11	13
3	10	13
4	11	14
5	7	10
6	10	14
7	11	13
8	10	14
9	10	14
10	7	10
11	7	10
12	8	11
13	8	10
14	10	13
15	11	13
16	11	13
17	11	14
18	7	10
19	11	13
20	10	14
TOTAL	192	250
MEAN	9.6	12.5



Appendix Table 8. Measurement of the pre-pupa (mm)

SAMPLE	WIDTH	LENGTH
1	.8	2
2	.8	2
3	.9	2
4	1	2
5	1	2
6	.8	2.5
7	.8	2.2
8	.9	2
9	1	2.5
10	1	2.6
11	1	2.4
12	.9	2.1
13	.9	2.3
14	1	2.6
15	1	2.5
16	1	2.4
17	.9	2.1
18	1	2.4
19	1	2
20	1	2
TOTAL	18.7	44.6
MEAN	0.935	2.23



Appendix Table 9. Measurement of the pupa (mm)

SAMPLE	WIDTH	LENGTH
1	1.3	3
2	1.5	3.5
3	1	3.5
4	1.5	2.8
5	1.3	2.5
6	1.2	2.9
7	1.5	3
8	1	3
9	1.5	2.5
10	1	2.0
11	1	2.5
12	1	2.0
13	1.2	2.8
14	1.5	3.5
15	1	2.5
16	1	2
17	1	2
18	1.5	3
19	1	2.5
20	1	2
TOTAL	24	53.5
MEAN	1.2	2.68





Appendix Table 10. Number of days the adult flea beetle fully grown

SAMPLE	FROM PUPA TO ADULT
1	7
2	8
3	8
4	7
5	11
6	10
7	10
8	7
9	8
10	7
11	7
12	8
13	7
14	8
15	11
16	7
17	8
18	10
19	10
20	10
TOTAL	169
MEAN	8.45



Appendix Table 11. Longevity period of adult flea beetle

SAMPLE	WITH OUT FOOD DAYS		WITH FOOD DAYS	
	FEMALE	MALE	FEMALE	MALE
1	3	4	7	8
2	3	6	11	8
3	4	3	3	8
4	3	3	7	10
5	3	5	7	6
6	5	5	5	12
7	4	4	4	10
8	5	3	7	6
9	3	3	7	6
10	4	3	8	8
11	4	4	11	8
12	6	6	10	10
13	6	6	9	6
14	5	5	6	4
15	3	6	9	5
16	5	3	3	12
17	3	4	9	4
18	4	3	8	7
19	4	3	11	7
20	3	6	8	4
TOTAL	80	85	150	149
MEAN	4	4.25	7.5	7.45



Appendix Table 12. Measurement of the adult (mm)

SAMPLE	WIDTH	LENGTH
1	1.6	3.0
2	1.8	2.9
3	1.4	2.4
4	1.4	2.1
5	1.8	3.3
6	1.8	2.9
7	1.7	3.0
8	1.8	3.1
9	1.5	2.5
10	1.5	2.5
11	1.8	3.0
12	1.5	2.7
13	1.5	2.7
14	1.6	3.0
15	1.4	2.5
16	1.6	2.8
17	1.5	2.5
18	1.7	3.0
19	1.4	2.2
20	1.5	2.4
TOTAL	31.8	54.5
MEAN	1.59	2.73



Appendix Table 13. Total number of laid eggs by a female flea beetle

SAMPLE	TOTAL NUMBER OF EGG LAID
1	49
2	35
3	38
4	43
5	45
TOTAL	210
MEAN	42

