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Morphometry of life stages and adult food preference of fruit piercing moth *Eudocima* spp. (Lepidoptera:Noctuidae)

Ramkumar Jayaraman[1*], Jegadeesan Muniandi[1], Venudevan Balaraman[2], Muthuramu Sengalan[1], Gnanasekaran Madhavan[3] Arokiamary Savariyar[4] and Vijayakumar Arumugam[1]

[1]*ICAR-Krishi Vigyan Kendra, Tamil Nadu Agricultural University, Ramanathapuram, India*
[2]*ICAR-Krishi Vigyan Kendra, Tamil Nadu Agricultural University, Virudhunagar, India*
[3]*Department of Fruits Science, Horticultural College & Research Institute, Tamil Nadu Agricultural University, Periyakulam, India*
[4]*Department of Food Science & Nutrition, Community Science College and Research Institute, Tamil Nadu Agricultural University, Madurai, India*

ABSTRACT

The primary fruit piercing moths of genus Eudocima and Rhytia cause havoc to many fruit crops. The studies on morphometry of life stages and adult food preference of Eudocima materna (Linnaeus, 1767) and Eudocima phalonia (Clerk) will help to investigate the vulnerable stages of the life cycle to formulate the management practices. The studies were carried out in the laboratory at room temperature of 25^0 C±2. The larvae of both species are fed with leaves of Tinospora cordifolia (Giloy) where whereas adult feeds ripening fruits. Eggs hatching were observed at night hours and in the early morning and hatching completes in 3.42±0.30 and 3.27±0.15 days respectively for E. materna and E. phalonia. In both species, five and six instars were observed. The instarwise (5 instars) mean head capsule width of male larva of E. materna measured 0.52±0.01, 0.95±0.02, 1.55±0.04, 2.62±0.14 and 4.23±0.03 mm, respectively and in female it was 0.51±0.02, 0.96±0.04, 1.49±0.03, 2.37±0.05, 4.16±0.05 mm, whereas the male and female larva with six instars recorded 0.51±0.01, 0.97±0.04, 1.51±0.06, 2.17±0.06, 2.89±0.05, 4.33±0.06 mm and 0.50±0.01, 0.96±0.03, 1.46±0.04, 2.23±0.09, 2.90±0.0 and 4.20±0.0 mm respectively. Similarly, mean body length of the male larvae of E. materna had five and six instars recorded 6.94, 12.16, 23.40, 43.70, 68.10 mm and 7.27, 10.32, 17.25, 25.75, 47.89, 74.86 mm, respectively. Likewise, the females having five and six instars measured 7.08, 13.62, 22.65, 40.75, 70.85 mm and 6.95, 11.0, 19.40, 26.6, 45.5, 72.0 mm, respectively. Increased larval width was noticed from 4-6 larval instars in both the sexes of E. materna. The mean length of the pupa developed from five and six instars ranged from 30.96 – 32.0 mm. The instarwise (5 instars) mean head capsule width of the male and female larva of E. phalonia was 0.56, 1.09, 1.86, 2.97, 4.35 mm and 0.56, 1.14, 1.95, 3.12 and 4.44 mm, respectively whereas the larva undergoing six instars were 0.55, 0.96, 1.63, 2.42, 3.69, 4.55 mm and 0.56, 0.96, 1.56, 2.53, 3.71, 4.67 mm, respectively. Similarly, the mean body length of male larvae had five instars was 6.72, 14.48, 27.14, 46.0 and 83.17 mm and in the female it was 6.57, 14.42, 26.15, 49.3, and 83.27 mm whereas in male and female larvae had six instars was 7.0, 13.6, 22.8, 33.14, 45.5, 82.33 mm and 6.73, 14.16, 25.06, 33.43, 46.5, 82.66 mm, respectively. As that of E. materna increased larval width was noticed from 4-6th instars. The mean length of the pupae ranged from 33.70–34.40 mm. The adult feeding preference in descending order during first and second season of E. materna was guava > apple > mandarin > grapes > banana > tomato > pomegranate > brinjal and guava > apple > grapes > mandarin > pomegranate > banana > tomato > brinjal respectively whereas in E. phalonia its was guava > mandarin > apple > grapes > pomegranate > tomato > banana > brinjal and guava > mandarin > apple > grapes > pomegranate > tomato > banana > brinjal etc.

Keywords: *Eudocima materna, Eudocima phalonia, fruit piercing moth, morphometry, adult food preference, Head capsule, larval length, larval width*

Introduction

India's diverse climate ensures the cultivation of all varieties of fruit crops. It ranks second in fruit production in the world, after China. As per National Horticulture Board, during 2023-24, India produced 112.62 million metric tonnes of fruits a 2.29% increase from 2022-23. However, it is very difficult to attain potential yield per hectare. There are some reasons for the decline in fruit production in India, including climate change, pests and diseases, lack of infrastructure (lack of planting materials, packaging facilities, and marketing networks), and high cost of cultivation etc. Among them, insect pests can cause significant yield losses in fruit production, with estimates ranging from 10% to 70% depending on the crop and the severity of the pest attack. The fruit piercing moths belonging to the genus *Eudocima* and *Rhytia* (Lepidoptera:Noctuidae) are considered very serious pests of fruit crops distributed throughout tropical and subtropical belt from Africa through Southeast Asia and Australia to the Pacific Islands [1] [2]. In India, these moths are found to attack the fruit crops *viz*., citrus, guava, pomegranate, grapes, fig, sapota, mango, papaya and tomato [3], [4], [5], [6], [7], [8], [9], [10], [11], [12], [13], [14]. In South India, there are four species of fruit piercing moths belonging to the genus *Eudocima* and one species under the

Corresponding Author:* ***Ramkumar Jayaraman*

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genus *Rhytia* cause severe damage to fruit crops [15], [16], [17], [18], [19].

The larval stages of the fruit piercing moths feed on plants belongs to the family of Menispermaceae *viz*., *Tinospora cordifolia* (Willd.), *T. smilacina* Benth., *Cocculus hirsutus* (L.), *Stephania* spp., *Tiliacora* spp., *Diploclisia glaucescens* etc. [20], [21], [22], [23], [24], [16], [17], [18] whereas in the Pacific Islands the larvae of these moths feeding on *Erythrina variegata* (Family: Fabaceae) [25], [26]. The adult moths damage the fruits in orchard during night hours by penetrating with the help of thick spines and sclerotised hooks present at the tips of the proboscis by making holes into semi-ripening and ripening fruits and sucking the juice. Hence, the affected fruits show punctured holes of penetration. Due to rotting around the puncture hole, secondary infection by the saprophytic fungi *viz*., *Oospora* sp. [27], [28], *Fusarium* sp., *Colletotrichum* sp., and certain bacteria [20] gain entry and make the fruit unfit for consumption. Finally, the affected fruits are drop down to the ground ultimately cause heavy yield loss [26]. The symptoms are sometimes mistaken by farmers for fruit fly attack and fruit rot disease as the wrong diagnosis. There is less awareness among fruit growing farmers concerning damage caused by fruit piercing moths. Hence, the present study was undertaken at Agricultural College and Research Institute (AC&RI), Madurai to study the morphometry of life stages and adult food preference of fruit piercing moth *Eudocima* spp.

Materials and Methods

Field surveys were conducted in guava and citrus orchards in and around AC&RI, Madurai campus, and in different climatic zones of Tamil Nadu for the collection of life stages of fruit piercing moths from the plant *T. cordifolia* belongs to the family Menispermaceae. The collections were done regularly at three days intervals and outside the campus once in fifteen days from July to December months for two consecutive years. The eggs and larvae found on the vines of *T. cordifolia* were brought to the laboratory and reared separately to identify different species of fruit piercing moths.

To study the morphometry and biology of fruit piercing moths, twenty five newly hatched larvae of each species of *E. materna* and *E. Phalonia* were reared in separate plastic containers (250 ml) by providing tender and fresh leaves of *T. cordifolia*. The mouth of the containers was covered by muslin cloth and it was secured by the rubber band. The young larvae were provided with tender leaves while the fourth instar larvae with the older leaves. At 24 h interval, older leaves were replaced with fresh leaves until pupation took place. Molting was observed at 12 h intervals and the width of the head capsule at each moult was measured. The length and breadth of the caterpillar were also recorded at 24 h interval. The morphometrical observations on egg was measured with the help of an ocular micrometer and head capsule, the life stages of *E. materna* and *E. phalonia* were recorded under the stereoscopic binocular microscope and measurement of larvae with the help of the vernier scale.

Adult food preference of *Eudocima* spp. was studied under laboratory condition. Three pairs (3 males and 3 females) of newly emerged moths were released in a wire meshed iron cage size of 60x60x80 cm. Fruits of guava (Variety: Lucknow 49), apple, banana (Variety: Rasthali), grapes (Variety: Muscat), pomegranate (Variety: Ganesh), brinjal (Variety: Local), tomato (variety: Local), and mandarin orange were kept at three per plastic plate inside the cage. The moths were freely allowed to feed on these fruits.

The fruits were kept at 6.00 p.m. and removed at 6.00 a.m. in the next day. The number of feeding holes on each fruit was recorded daily by keeping fresh fruits. The fruit with the maximum number of holes was considered as the most preferred fruit and it was removed in the next day by placing the remaining fruits for subsequent feeding. Same procedure was followed till the least preferred hosts are recorded. The fruit preference index was worked out by the following formula [25].

$$\text{Preference Index} = \frac{\text{Mean number of penetration (feeding holes) in test fruit / moth / 24 h}}{\text{Mean number of penetrations in most preferred fruit / moth / 24 h}} \times 100$$

Results and Discussion

Morphometrical observations on head capsule and life stages of *E. materna*

Head capsule

The instarwise mean head capsule width of male larva which had five instars measured 0.52, 0.95, 1.55, 2.62 and 4.23 mm, respectively and in the case of female it was 0.51, 0.96, 1.49, 2.37, 4.16 mm, whereas the male and female larva with six instars recorded 0.51, 0.97, 1.51, 2.17, 2.89, 4.33 mm and 0.50, 0.96, 1.46, 2.23, 2.90 and 4.20 mm, respectively (Table 1). However, [23] recorded the instars mean head width of 0.8, 1.2, 1.8, 2.7, and 4.2 mm, respectively, which was much higher width than the present findings while [17] recorded 0.5, 0.9, 1.5, 2.7 and 4.0 mm, respectively, was corroborated with the present findings.

Length and width of *E. materna*

The body length as well as width of larvae undergoing six instars, was greater than the larvae having five instars. The instarwise mean body length of the male larvae having five and six instars were 6.94, 12.16, 23.40, 43.70, 68.10 mm and 7.27, 10.32, 17.25, 25.75, 47.89, 74.86 mm, respectively (Table 2). Likewise, the females having five and six instars measured 7.08, 13.62, 22.65, 40.75, 70.85 mm, and 6.95, 11.0, 19.40, 26.6, 45.5, 72.0 mm, respectively. Regarding width, there was a considerable increase noticed in both the sexes during the fourth and fifth instar stage of larvae having five instars. In fourth instar the width of the male and female larvae measured 4.33 and 4.30 mm, respectively and in the fifth instar stage it was 8.55 and 9.3 mm, respectively. In the case of larvae having six instars, the was a noticeable increase in width found from fourth to sixth instar period. During that period the mean width measured in males and female was 3.08, 4.84, 9.62, and 2.95, 4.78, 9.56 mm, respectively (Table 2). In the present study, the mean total length and width of the grown up male larvae (final instar) which had five and six instars was 68.1, 74.9 mm and 8.55, 9.62 mm respectively while in female it was 70.9, 72.0 and 9.3, 9.56 mm respectively. [23] and [29] recorded much reduced length and width but the findings of [17] supports the present results. They measured the length and width of grown up larvae ranging 67.5–74.0 mm and 8.54 and 9.0 mm, respectively irrespective of sex and number of instars.

There was little difference was noticed both in the length and width of the pupa. When compared to pupa developed from larvae with five instars, the mean length of the pupae from larvae with six instars was more measuring 32.0 (male) and 32.70 mm (female), whereas in case of pupa developed from larva with five instars measured 30.96 mm and 31.25 mm, respectively. The mean width of the pupa measured 9.74 and 10.20 mm in case of male and female *E. materna* undergoing development in larvae with five instars and it was 10.04 and 9.40 mm, respectively incase of pupa developed from larva with

six instars (Table 2). The mean length and width of male and female pupa developed from larva with both five and six instars ranged from 30.96 – 32.70 mm and 9.40–10.20mm respectively, whereas [17] measured 29.71–30.31 mm and 9.0–9.92 mm, respectively.

Morphometrical observations on Head capsule and life stages of *E. phalonia*

Head Capsule

The mean head capsule width gradually increased in all the instars of the male and female larva was 0.56, 1.09, 1.86, 2.97, 4.35 mm and 0.56, 1.14, 1.95, 3.12 and 4.44 mm, respectively which had five instars. The instars head capsule measurements of male and female larva undergoing six instar were 0.55, 0.96, 1.63, 2.42, 3.69, 4.55 mm, and 0.56, 0.96, 1.56, 2.53, 3.71, 4.67 mm, respectively. There was a proportionate increase in head capsule recorded during each instars (Table 3). Similar results were observed by [17] in Bangalore. [30] recorded the mean head capsule width of the grown up larva of *E. phalonia* as 4.05 which is accordance with the present findings.

Length and width of life stages of *E. phalonia*

The gradual increase in the mean body length of the larva was noticed in all the instars. Instarwise length of male larvae had five instars measured 6.72, 14.48, 27.14, 46.0 and 83.17 mm and in female it was 6.57, 14.42, 26.15, 49.3, and 83.27 mm, respectively. In the case of larvae with six instars the body length measured both in male and female was 7.0, 13.6, 22.8, 33.14, 45.5, 82.33 mm, and 6.73, 14.16, 25.06, 33.43, 46.5, 82.66 mm, respectively (Table 4). Regarding width, the fourth and fifth instar larvae had an increased width measuring 4.51, 8.93 mm and 4.59, 8.63 mm, respectively in the case of male and female larvae undergoing five instars. In respect of larvae which had six instars, the last two instars (5th and 6th instars) had more width than other instars measuring 4.56 and 8.46 mm, respectively in the case of males it was 4.58 and 3.56 mm in female, respectively (Table 4). The total length and width of the grown up male larvae which had five and six instars was 83.17, 82.33 and 8.93, 8.43 mm, respectively, whereas in female it was 83.27, 82.66 and 8.63, 8.56 mm, respectively. [17] recorded the mean length and width of larvae ranging 84.00 – 85.80 and 8.65 – 9.21 mm, respectively which is corroborated with present findings. Similarly, [30] reported the mean body length and width of the grown up larva as 52.19 and 9.51 mm respective which is in accordance with the present findings.

The length of the pupae did not have a marked difference concerning larvae with had five and six instar stage. The mean length ranged from 33.70–34.40 mm. Regarding width also there was no distinct difference observed and it ranged from 9.84–10.16 mm, irrespective of larvae which had five and six instar stage (Table 4), whereas [30] recorded the mean length, and width of the pupae as 26.22 and 9.51 mm respectively which is supporting the present findings.

Adult food preference of fruit piercing moths

E. materna

The adult food preference of *E. materna* was studied consecutively for two months during August and September. During first month, the mean number of feeding holes was maximum on guava, 12.33 followed by apple 11.33 when guava was withdrawn. The moth preferred mandarin (11.75) when guava and apple were withdrawn. In the order of preference, grapes (8.75) comes to next, when guava, apple, and mandarin were withdrawn.

The adult feeding preference in descending order during this period was guava > apple > mandarin > grapes > banana > tomato > pomegranate > brinjal (Table 5).

In the similar studies during second month, the guava (10.25 feeding holes) was the most preferred fruit as in the previous season followed by apple (9.0 holes) when guava was withdrawn. When these fruits were withdrawn, grapes with 11.0 feeding holes came next in the order of preference. When guava, apple and grapes withdrawn, the most preferred fruit was mandarin (8.60) followed by pomegranate (7.50). The descending order of preference during this period was guava > apple > grapes > mandarin > pomegranate > banana > tomato > brinjal (Table 6).

The preference index was highest for guava (100) followed by apple (48.66) during the first month and similar results was observed on guava (100) followed by apple (46.34) during the September season. Least preference was noticed on pomegranate, banana, tomato and brinjal (Table 6). [17] reported that the preferred fruits were tomato and guava and the least preferred fruits were mosambi and brinjal. Their findings are corroborated with the present finding except tomato (less preferred in the present study). The variation may be due to the variety and nutritional content of the tomato used for the experiment.

E. phalonia

The experiment was conducted consecutively for two months during October and November. During first month, moths preferred guava with 13.33 feeding holes when all the fruits were exposed followed by mandarin (10.50 holes) when guava was withdrawn. Apple with 9.50 feeding holes comes in third position in the order of preference when guava and mandarin were withdrawn. The descending order of feeding preference for all the fruits was guava > mandarin > apple > grapes > pomegranate > tomato > banana > brinjal (Table 7).

During second moth, there was a slight difference noticed in the order of preference, but here also guava was the most preferred fruit with 11.0 feeding holes when all the fruits were kept for feeding. When guava withdrawn, the moth shifted to feed on apple (12.66). When guava and apple were withdrawn, the moth preferred grapes (9.0) followed by mandarin (7.26). The descending order of fruit preference was guava > mandarin > apple > grapes > pomegranate > tomato > banana > brinjal (Table 8).

In both seasons, the preference index was maximum on guava (100) followed by mandarin (46.89) during October and guava (100) followed by apple (47.73) during November. In both experiments, the least preferred fruits were tomato, banana and brinjal. The finding of present results are entirely different from the findings of [17]. They reported that the moth mostly preferred to feed on banana in 1998 and guava in 1999. The least preferred fruits were pomegranate, orange, mosambi etc. The great variation may be due to nature, variety, and nutritional content of the fruit. But [31] opined that the moth did not prefer to feed on tomato. The results of the present study were following their findings. In addition, [18] reported that moths preferred to feed on guava followed by tomato and brinjal was the less preferred fruit. The present results are in agreement with these findings except in the case of tomato.

Conclusion

In general, the larval stage of lepidopteran insects cause damage to the crops.

But incase of furit piercing moths, the adult moths cause damage to the semi-ripening and ripening fruits. The larvae of fruit piercing moth prefers to feed on *T. cordifolia* belonging to Menispermaceae family. Hence, keeping the orchards free from larval hosts resulting in minimizing the fruit piercing moth incidence. Similarly, based on the findings of adult food preference farmers can taken immediate management actions to curtail the damage caused by the fruit piercing moths.

Future scope of the study: The following future studies should be undertaken to minimize the fruit piercing moth incidence.
A). Alternate larval host plants should be identified.
B). Biointensive management strategies to be developed in future to minimize the damage caused by the fruit piercing moths.

Conflict of interest: There is no conflict of interest.

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Table 1. Head capsule measurement of larval instars of E. materna reared on T. cordifolia

Stages	Width (in mm)			
	Male		Female	
	Mean ± SD	Range	Mean ± SD	Range
Larvae with five instars				
I	0.52 ± 0.01	0.50-0.53	0.51 ± 0.02	0.49-0.52
II	0.95 ± 0.02	0.92-0.98	0.96 ± 0.04	0.90-1.00
III	1.55 ± 0.04	1.48-1.57	1.49 ± 0.03	1.44-1. 52
IV	2.62 ± 0.14	2.36-2.75	2.37 ± 0.05	2.30-2.40
V	4.23 ± 0.06	4.20-4.30	4.16 ± 0.05	4.10-4.20
Larvae with six instars				
I	0.51 ± 0.01	0.49-0.52	0.50 ± 0.01	0.49-0.51
II	0.97 ± 0.04	0.90-0.99	0.96 ± 0.03	0.92-1.00
III	1.51 ± 0.06	1.40-1.55	1.46 ± 0.04	1.40-1.49
IV	2.17 ± 0.06	2.10-2.22	2.23 ± 0.09	2.10-2.30
V	2.89 ± 0.05	2.89-2.93	2.90 ± 0.0	2.90-0.0
VI	4.33 ± 0.06	4.25-4.40	4.20 ± 0.0	4.20-0.0

No. of larvae taken for observation: 25

Larvae with **five** instars : Male : 10
Female : 9
Larvae with **six** instars : Male : 3
Female : 3

Table 2. Morphometry of life stages of E. materna reared on T. cordifolia

Stages	Length (in mm)				Width * (in mm)			
	Male		Female		Male		Female	
	Mean ± SD	Range	Mean ± SD	Range	Mean ± SD	Range	Mean ± SD	Range
Larvae with five instars								
I	6.94 ± 0.51	6.3-7.8	7.08 ± 0.41	6.6-7.7	0.81 ± 0.11	0.7-1.0	0.84 ± 0.05	0.8-0.9
II	12.16 ± 0.71	11.0-13.0	13.62 ± 0.92	12.0-15.0	0.32 ± 0.08	1.2-1.4	1.28 ± 0.08	1.2-1.4
III	23.40 ± 3.55	18.0-28.0	22.65 ± 2.56	19.0-26.0	2.24 ± 0.29	1.7-2.5	2.27 ± 0.31	1.8-2.6
IV	43.70 ± 4.90	35.0-49.0	40.75 ± 2.88	37.0-47.0	4.33 ± 0.36	3.8-4.9	4.30 ± 0.49	3.4-4.8
V	68.10 ± 2.71	63.0-71.0	70.85 ± 4.63	65.0-78.0	8.55 ± 0.84	6.9-10.0	9.30 ± 0.36	8.8-9.7
Pupa	30.96 ± 1.27	29.0-32.0	31.25 ± 1.57	28.0-33.0	9.74 ± 0.59	9.3-10.6	10.20 ± 0.51	9.4-10.8
Larvae with six instars								
I	7.27 ± 0.45	6.5-7.9	6.95 ± 0.58	6.2-7.5	0.85 ± 0.13	0.7-1.0	0.86 ± 0.10	0.7-1.0
II	10.32 ± 1.92	8.0-12.0	11.00 ± 1.58	9.0-13.0	1.22 ± 0.07	1.1-1.3	1.25 ± 0.07	1.2-1.3
III	17.25 ± 1.90	14.0-20.0	19.40 ± 2.41	16.0-22.0	1.81 ± 0.09	1.6-1.9	1.80 ± 0.10	1.7-1.9
IV	25.75 ± 1.94	22.0-28.0	26.60 ± 1.56	24.0-28.0	3.08 ± 0.16	2.8-3.3	2.95 ± 0.26	2.6-3.2
V	47.89 ± 1.54	46.0-50.0	45.50 ± 1.58	43.0-47.0	4.84 ± 0.18	4.6-5.0	4.78 ± 0.22	4.5-5.1
VI	74.86 ± 0.89	74.0-76.0	72.00 ± 1.67	69.0-73.0	9.62 ± 0.42	9.2-10.3	9.56 ± 0.36	9.0-10.0
Pupa	32.00 ± 1.58	30.0-34.0	32.70 ± 1.20	31.0-34.0	10.04 ± 0.34	9.6-10.5	9.40 ± 0.00	9.4-0.0

*measured at widest place

No. of larvae reared: 25

Larvae with **five** instars : Male : 10
: Female : 9
Larvae with **six** instars : Male : 3
: Female : 3

Table 3. Head capsule measurement of larval instars of E. phalonia reared on T. cordifolia

Stages	Width (in mm)			
	Male		Female	
	Mean ± SD	Range	Mean ± SD	Range
Larvae with five instars				
I	0.56 ± 0.02	0.53-0.58	0.56 ± 0.01	0.55-0.57
II	1.09 ± 0.07	1.00-1.15	1.14 ± 0.08	1.02-1.20
III	1.86 ± 0.06	1.79-1.92	1.95 ± 0.08	1.83-2.00
IV	2.97 ± 0.02	2.95-3.00	3.12 ± 0.07	3.00-3.20
V	4.35 ± 0.13	4.20-4.50	4.44 ± 0.12	4.30-4.62
Larvae with six instars				
I	0.55 ± 0.01	0.54-0.57	0.56 ± 0.02	0.53-0.59
II	0.96 ± 0.03	0.90-0.98	0.96 ± 0.03	0.92-1.00
III	1.63 ± 0.16	1.38-1.60	1.56 ± 0.14	1.40-1.75
IV	2.42 ± 0.25	2.00-2.60	2.53 ± 0.28	2.06-2.73
V	3.69 ± 0.37	3.05-3.98	3.71 ± 0.32	3.10-3.97
VI	4.55 ± 0.19	4.35-4.80	4.67 ± 0.22	4.40-4.95

No. of larvae taken for observation: 25

Larvae with **five** instars : Male : 9
Female : 10
Larvae with **six** instars : Male : 3
Female : 3

Table 4. Morphometry of life stages of E. phalonia reared on T. cordifolia

Stages	Length (in mm)				Width * (in mm)			
	Male		Female		Male		Female	
	Mean ± SD	Range	Mean ± SD	Range	Mean ± SD	Range	Mean ± SD	Range
Larvae with five instars								
I	6.72 ± 0.12	6.5-7.0	6.57 ± 0.32	6.0-7.0	0.83 ± 0.06	0.8-1.0	0.85 ± 0.13	0.7-1.0
II	14.48 ± 0.37	14.0-15.0	14.42 ± 0.69	13.0-15.0	1.40 ± 0.27	1.3-1.7	1.48 ± 0.19	1.3-1.8
III	27.14 ± 1.38	26.0-30.0	26.15 ± 1.29	23.0-27.0	2.38 ± 0.23	2.0-2.6	2.35 ± 0.13	2.1-2.5
IV	46.00 ± 2.14	42.0-49.0	49.30 ± 3.59	44.0-55.0	4.51 ± 0.30	4.0-5.2	4.59 ± 0.28	4.2-5.3
V	83.17 ± 1.94	80.0-85.0	83.27 ± 1.52	80.0-85.0	8.93 ± 0.15	8.8-9.2	8.63 ± 0.26	8.0-9.0
Pupa	34.17 ± 0.82	33.0-35.0	34.19 ± 0.83	34.0-35.0	9.84 ± 0.37	9.5-10.5	10.15 ± 0.34	10.0-11.0
Larvae with six instars								
I	7.00 ± 0.39	6.3-7.5	6.73 ± 0.23	6.5-7.0	0.84 ± 0.09	0.7-1.0	0.920 ± 0.11	0.8-1.1
II	13.60 ± 1.14	12.0-15.0	14.16 ± 0.67	13.0-15.0	1.45 ± 0.13	1.3-1.6	1.42 ± 0.08	1.3-1.5
III	22.80 ± 1.32	22.0-26.0	25.06 ± 1.47	22.0-27.0	2.04 ± 0.22	1.9-2.5	2.12 ± 0.24	1.8-2.5
IV	33.14 ± 1.77	31.0-36.0	33.43 ± 1.39	32.0-36.0	3.11 ± 0.32	2.5-3.7	3.12 ± 0.27	2.7-3.5
V	45.50 ± 2.07	42.0-49.0	46.50±1.65	44.0-50.0	4.56 ± 0.35	4.2-5.3	4.58 ± 0.52	4.0-5.5
VI	82.33 ± 3.20	76.0-84.0	82.66 ± 3.07	80.0-90.0	8.46 ± 0.51	7.6-9.6	8.56 ± 0.54	7.5-9.5
Pupa	33.70 ± 0.62	33.5-35.0	34.40 ± 0.38	35.0-36.0	10.0 ± 0.0	10.0-0.0	10.16 ± 0.34	10.0-11.0

* measured at widest place

No. of larvae reared: 25

Larvae with **five** instars : Male : 9
: Female : 10
Larvae with **six** instars : Male : 3
: Female : 3

Table 5. Adult food preference of E. materna (August)

Preference index (P. I)	August							
	Mean no. of feeding holes							
	Guava	Apple	Mandarin	Grapes	Banana	Tomato	Pomegranate	Brinjal
Mean ± SD	12.33 ± 2.52	6.0 ± 1.0	3.67 ± 1.15	3.33 ± 0.58	0.00	0.00	0.00	0.00
P. I[1]	**(100)**	**(48.66)**	**(29.76)**	**(27.0)**	**(0.0)**	**(0.0)**	**(0.0)**	**(0.0)**
Mean ± SD	-	11.33 ± 0.58	5.67 ± 0.58	3.0 ± 1.0	2.33 ± 0.56	0.67 ± 0.52	0.00	0.00
P. I[2]		**(100)**	**(50.04)**	**(26.47)**	**(20.56)**	**(5.91)**	**(0.0)**	**(0.0)**
Mean ± SD	-	-	11.75 ± 0.95	3.25 ± 1.26	2.0 ± 0.81	1.50 ± 1.29	0.75 ± 0.96	0.00
P. I[3]			**(100)**	**(27.66)**	**(17.02)**	**(12.76)**	**(6.38)**	**(0.0)**
Mean ± SD	-	-	-	8.75 ± 1.26	4.25 ± 0.96	2.0 ± 1.41	1.0 ± 0.82	0.00
P. I[4]				**(100)**	**(48.57)**	**(22.86)**	**(11.43)**	**(0.0)**
Mean ± SD	-	-	-	-	6.0 ± 0.82	2.0 ± 1.41	1.75 ± 0.96	0.00
P. I[5]					**(100)**	**(33.33)**	**(29.17)**	**(0.0)**
Mean ± SD	-	-	-	-	-	6.50 ± 1.0	1.50 ± 0.58	0.00
P. I[6]						**(100)**	**(23.08)**	**(0.0)**
Mean ± SD	-	-	-	-	-	-	6.75 ± 1.70	0.00
P. I[7]							**(100)**	**(0.0)**
Mean ± SD	-	-	-	-	-	-	-	0.00
P. I[8]								**(0.0)**

Preference Index [1] = For all fruits
Preference index [2] = When guava withdrawn
Preference Index [3] = When apple withdrawn
Preference Index [4] = When mandarin withdrawn
Preference Index [5] = When grapes withdrawn
Preference Index [6] = When banana withdrawn
Preference Index [7] = When tomato withdrawn
Preference Index [8] = When pomegranate withdrawn

Table 6. Adult food preference of E. materna (September)

Preference index	September							
	Mean no. of feeding holes							
	Guava	**Apple**	**Grapes**	**Mandarin**	**Pomegranate**	**Banana**	**Tomato**	**Brinjal**
Mean ± SD P. I[1]	10.25 ± 0.96 **(100)**	4.75 ± 0.96 **(46.34)**	3.33 ± 0.58 **(32.49)**	2.75 ± 0.96 **(26.83)**	1.40 ± 0.55 **(13.66)**	0 **(0.0)**	0 **(0.0)**	0 **(0.0)**
Mean ± SD P. I[2]	-	9.0 ± 2.16 **(100)**	6.75 ± 1.71 **(75.0)**	4.0 ± 1.58 **(44.44)**	2.75 ± 1.26 **(30.56)**	1.75 ± 0.96 **(19.44)**	1.0 ± 0.82 **(11.11)**	0 **(0.0)**
Mean ± SD P. I[3]	-	-	11.0 ± 0.82 **(100)**	6.33 ± 2.52 **(57.55)**	5.0 ± 2.16 **(45.45)**	3.33 ± 1.53 **(30.27)**	1.67 ± 0.58 **(15.18)**	0 **(0.0)**
Mean ± SD P. I[4]	-	-	-	8.60 ± 2.0 **(100)**	5.0 ± 2.16 **(58.14)**	3.50 ± 1.29 **(40.70)**	2.0 ± 0.82 **(23.26)**	0 **(0.0)**
Mean ± SD P. I[5]	-	-	-	-	7.50 ± 1.29 **(100)**	5.25 ± 1.26 **(70.0)**	3.25 ± 0.50 **(43.33)**	0 **(0.0)**
Mean ± SD P. I[6]	-	-	-	-	-	6.75 ± 0.96 **(100)**	3.50 ± 1.29 **(51.85)**	0 **(0.0)**
Mean ± SD P. I[7]	-	-	-	-	-	-	6.0 ± 1.0 **(100)**	0 **(0.0)**
Mean ± SD P. I[8]	-	-	-	-	-	-	-	0 **(0.0)**

Preference Index [1] = For all fruits
Preference index [2] = When guava withdrawn
Preference Index [3] = When apple withdrawn
Preference Index [4] = When grapes withdrawn
Preference Index [5] = When mandarin withdrawn
Preference Index [6] = When pomegranate withdrawn
Preference Index [7] = When banana withdrawn
Preference Index [8] = When tomato withdrawn

Table 7. Adult food preference of E. phalonia (October)

Preference index	October							
	Mean no. of feeding holes							
	Guava	**Mandarin**	**Apple**	**Grapes**	**Pomegranate**	**Tomato**	**Banana**	**Brinjal**
Mean ± SD P. I[1]	13..33 ± 1.53 **(100)**	6.25 ± 0.96 **(46.89)**	3.75 ± 1.71 **(28.13)**	3.0 ± 0.82 **(22.51)**	1.75 ± 0.96 **(13.13)**	0 **(0.0)**	0 **(0.0)**	0 **(0.0)**
Mean ± SD P. I[2]	-	10.50 ± 1.29 **(100)**	5.25 ± 0.96 **(50.0)**	3.25 ± 0.96 **(30.95)**	2.50 ± 0.58 **(23.81)**	1.60 ± 0.89 **(15.24)**	0 **(0.0)**	0 **(0.0)**
Mean ± SD P. I[3]	-	-	9.50 ± 2.08 **(100)**	6.0 ± 0.82 **(63.16)**	4.33 ± 1.15 **(45.58)**	2.75 ± 0.96 **(28.95)**	1.0 ± 0.82 **(10.52)**	0 **(0.0)**
Mean ± SD P. I[4]	-	-	-	7.04 ± 2.07 **(100)**	5.75 ± 1.50 **(81.68)**	2.75 ± 0.96 **(39.06)**	1.75 ± 0.96 **(24.86)**	0 **(0.0)**
Mean ± SD P. I[5]	-	-	-	-	7.25 ± 1.71 **(100)**	4.0 ± 0.82 **(55.17)**	3.25 ± 0.96 **(44.83)**	0 **(0.0)**
Mean ± SD P. I[6]	-	-	-	-	-	6.0 ± 0.82 **(100)**	3.50 ± 1.29 **(58.33)**	0 **(0.0)**
Mean ± SD P. I[7]	-	-	-	-	-	-	5.50 ± 2.38 **(100)**	0 **(0.0)**
Mean ± SD P. I[8]	-	-	-	-	-	-	-	0 **(0.0)**

Preference Index [1] = For all fruits
Preference index [2] = When guava withdrawn
Preference Index [3] = When mandarin withdrawn
Preference Index [4] = When apple withdrawn
Preference Index [5] = When grapes withdrawn
Preference Index [6] = When pomegranate withdrawn
Preference Index [7] = When tomato withdrawn
Preference Index [8] = When banana withdrawn

Table 8. Adult food preference of E. phalonia (November)

Preference index	November							
	Mean no. of feeding holes							
	Guava	**Apple**	**Grapes**	**Mandarin**	**Pomegranate**	**Tomato**	**Banana**	**Brinjal**
Mean ± SD P. I[1]	11.0 ± 0.82 **(100)**	5.25 ± 0.96 **(47.73)**	4.30 ± 1.11 **(39.09)**	2.75 ± 1.26 **(25.0)**	0 **(0.0)**	0 **(0.0)**	0 **(0.0)**	0 **(0.0)**
Mean ± SD P. I[2]	-	12.66 ± 1.16 **(100)**	7.06 ± 2.09 **(55.77)**	4.0 ± 1.58 **(31.60)**	1.75 ± 0.96 **(13.82)**	0.75 ± 0.96 **(5.92)**	0 **(0.0)**	0 **(0.0)**
Mean ± SD P. I[3]	-	-	9.0 ± 0.82 **(100)**	5.78 ± 1.52 **(64.22)**	3.50 ± 1.29 **(38.88)**	2.0 ± 0.82 **(22.22)**	1.0 ± 0.82 **(11.11)**	0 **(0.0)**
Mean ± SD P. I[4]	-	-	-	7.26 ± 1.71 **(100)**	5.0 ± 2.16 **(68.87)**	4.0 ± 1.41 **(55.10)**	1.75 ± 1.26 **(24.10)**	0 **(0.0)**
Mean ± SD P. I[5]	-	-	-	-	8.75 ± 1.26 **(100)**	5.50 ± 1.75 **(62.86)**	2.75 ± 0.96 **(31.43)**	0 **(0.0)**
Mean ± SD P. I[6]	-	-	-	-	-	6.0 ± 0.82 **(100)**	3.50 ± 1.29 **(58.33)**	0 **(0.0)**
Mean ± SD P. I[7]	-	-	-	-	-	-	4.33 ± 1.15 **(100)**	0 **(0.0)**
Mean ± SD P. I[8]	-	-	-	-	-	-	-	0 **(0.0)**

Preference Index [1] = For all fruits
Preference index [2] = When guava withdrawn
Preference Index [3] = When apple withdrawn
Preference Index [4] = When grapes withdrawn
Preference Index [5] = When mandarin withdrawn
Preference Index [6] = When pomegranate withdrawn
Preference Index [7] = When tomato withdrawn
Preference Index [8] = When banana withdrawn

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