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Effect of Food on Bionomics of Greater Wax Moth, *Galleria mellonella* L. under Laboratory Conditions

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ABSTRACT

For the management of greater wax moth (*Galleria mellonella* L.), the experiment was carried out during 2019-20 under different conditions. In the morphometry of wax moth, the size of the egg was 0.38±0.03 mm and the early instar size was 3.96±0.20 mm. The fifth instar size was noticed as 26.70±0.42 mm and the sizes of the pre-pupal stage and pupal stage were recorded as 25.5±0.59 and 13.12±0.47 mm, respectively. Adult male moths were smaller than females. The male and female adult moth size was 10.98±0.49 and 13.84±0.35 mm, respectively. The average fecundity and incubation period were 140.21 eggs and 10.80 days, respectively. The mean larval and pupal period was 19.73 and 29.08 days, respectively. The mean developmental period and the longevity of wax moth were 59.28 and 11.34 days, respectively. During the period of study, fecundity, incubation period, larval period, pupal period and adult longevity showed considerable variation under room temperature with excess food (187 eggs, 5.87, 18.15, 12.21 and 13.66 days), with adequate food (125.66 eggs, 13.20, 16.75, 34.52 and 10.50 days) and with inadequate food (107.96 eggs, 13.32, 24.30, 40.52 and 9.87 days), respectively.

Key words : Bee enemy, bionomics, greater wax moth, honeybee

INTRODUCTION

Beekeeping is one of the most important agro-based industries and honey bees are known for their valuable products. In beekeeping, the major constraints found are the pollen and nectar source availability, environmental conditions, natural enemies and diseases. Among all constraints, natural enemies are the major one and create great damage to colonies and honey bees. Their infestation makes the honey bees to disappear or swarm from the beekeeping area to other safer places (Dabessa and Belay, 2015). The availability of bee products like honey, beewax, beebread, propolis, royal jelly and favourable condition paves the way for enemy's invasion inside the comb. The major natural enemies of honey bees are wax moth, wasp, ants, spiders, lizards, hive beetles, birds and mites (Wojda *et al.,* 2020). Among these natural enemies, greater wax moth was considered as very problematic pest of honey bees which causes huge loss to the colony (Kwadha *et al.,* 2017). The wax moths cause a considerable loss in bee industry at different regions of the world. Out of the two wax moth species, the greater wax moth, *Galleria mellonella* L. results in heavy loss as compared to lesser wax moth, *Achroia grisella* F. It is more pronounced in tropical climate than in the temperate region (Kumar *et al.*, 2021). It tunnels the comb and pupates by forming a cocoon. Owing to the damage caused by wax moth, the bees are forced to waste both time and labour in building new combs which results in weakening of colonies. A severe infestation by *G. mellonella* leads to dwindling of honey bee colonies and responsible for heavy loss to beekeepers throughout the world (Jorjao *et al.*, 2018). The wax moth life stages include, egg, larval, pupal and adult stages. The newly hatched larvae tunnel into the combs, leaving a complex of silken galleries behind and pupate inside the hive (Lalita *et al.,* 2018).

The weather parameters like temperature and relative humidity play a vital role in the growth and development of bees in a colony. The total population of the wax moth is determined by the weather conditions. Knowledge on the bionomics of the major pest of honey bee i.e. greater wax moth, *G. mellonella* helps to determine their growth and development rate under different climatic conditions in the tropics (Kavitha *et al.,* 2021). Hence, the present study was carried out to study the bionomics of greater wax moth, *G. mellonella* under laboratory conditions.

MATERIALS AND METHODS

The bionomics and the developmental period of greater wax moth, *G. mellonella* was studied at the laboratory from August 2019 to January 2020 under different conditions at Department of Entomology, Faculty of Agriculture, Annamalai University.

Infested colonies of Indian honey bees, *A. cerana indica* were examined and the *G. mellonella* larvae were collected. The older and the broken combs from hives were also collected and the larvae were allowed in plastic trays (26 x 21 x 5 cm) and fed with the broken combs. Five larvae of the same age were separated, based on the width of the head capsule of the larvae and kept in the plastic trays. The larvae were reared under laboratory condition (temperature 32±5°C and relative humidity 65±5%) for the adult emergence. The adults were left in a glass container fortified with uninfected waxes. They were allowed to mate inside the jar and the female moths laid batches of egg (Zyl and Malan, 2015; El-Gohary *et al.,* 2018; Devi, 2021).

The eggs were transferred into trays. During the study period, the morphometry analysis and longevity of various stages of *G. mellonella* were recorded.

The morphometry included the size of the different stages of *G. mellonella*. Further, fecundity of the adult moths, incubation period of eggs, larval period, pupal period and longevity of male and female moths under room temperature with excess food, adequate food and inadequate food were also recorded. The observations were made daily throughout the experiment.

The data were analyzed using the OPISTAT software and significance test was done by using Duncan's rule. Standard error was used for the bionomics study of *G. mellonella.*

RESULTS AND DISCUSSION

The bionomics of greater wax moth, *G. mellonella* was recorded at laboratory conditions as it was the potential natural enemy by causing serious damage to the hive, when compared to all other enemies recorded in the study period (Table 1; Fig. 1). The size of the wax moth egg was 0.38±0.03 mm (Fig. 1a). The larval stage of the greater wax moth had five instars. The average size of the early instar size was 3.96±0.20 mm (Fig. 1b) and the fifth instar size was 26.70±0.42 mm (Fig 1c). The larval instars of the moth viz., second, third and fourth were not differentiated much in this experiment. The size of the pre-pupa stage of the wax moth was recorded as 25.5±0.59 mm, while 13.12±0.47 mm was the size of the greater wax moth pupa (Fig. 1d). Sexual dimorphism was noted in adult wax moth. The adult male had well-developed labial pulp and rudimentary in female moth. The size of adult male moth was smaller than the female moth. The size of adult female moth was 13.84±0.35 mm (Fig. 1e) and the male adult moth size was 10.98±0.49 mm (Fig. 1f).

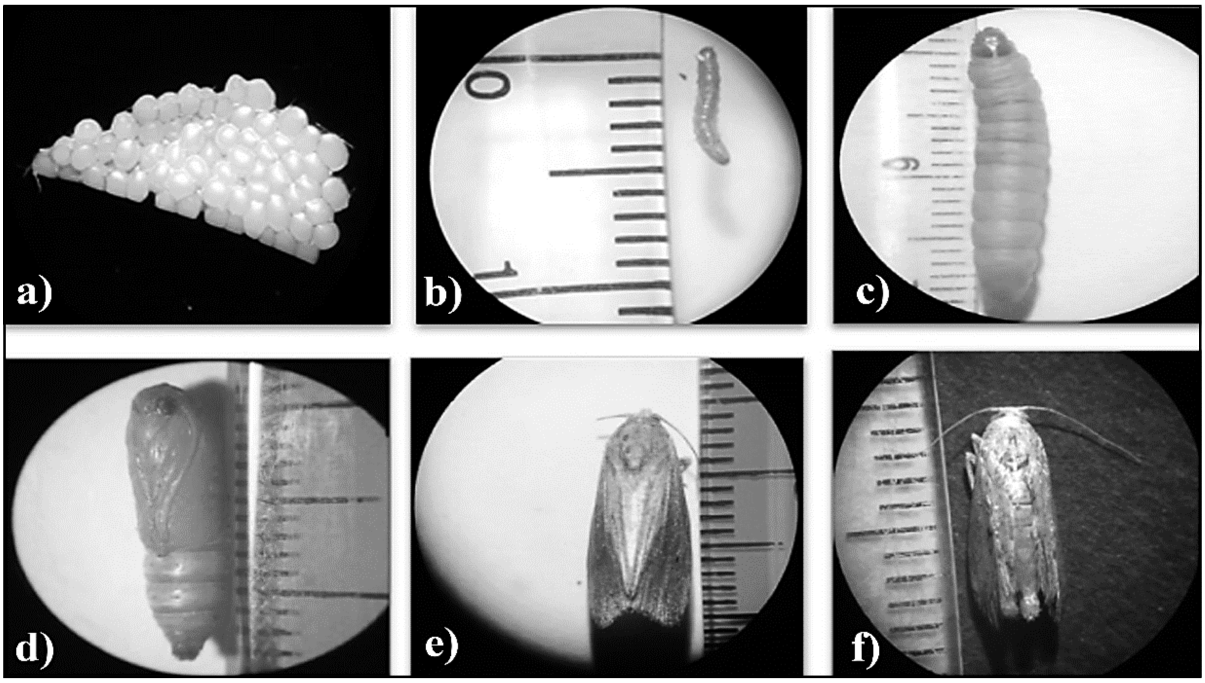
Table 1. Morphometry of greater wax moth, *G. mellonella* under laboratory conditions

S. No.	Developmental stages	Size (mm) Mean±SE*
1.	Egg	0.38±0.03
2.	**Larva**	
	I instar	3.96±0.20
	V instar	26.70±0.42
3.	Prepupa	25.5±0.59
4.	Pupa	13.12±0.47
5.	**Adult**	
	Male	10.98±0.49
	Female	13.84±0.35

Values followed by ± refer to the standard error.
*Values are mean of five replications.

The life cycle of greater wax moth under different conditions was also done and the results on the fecundity, incubation period of eggs, larval period, pupal period and the adult moth longevity are furnished in Table 2. The fecundity of greater wax moth was higher (187 eggs) with excess food. The fecundity was highly reduced and low fecundity (107.96 eggs) was noted under inadequate food condition. With adequate food, the fecundity of moth was recorded as 125.66 eggs. The experiment with the excess food condition was significantly different from the other two conditions with adequate food and inadequate food, respectively.

The highest incubation period (13.32 days) was recorded with inadequate food followed by adequate food supplied. The incubation period of the eggs was reduced to 5.87 days which was noticed with excess food. The experiments conducted with adequate and inadequate food supplied were at par with each other. When the temperature was high and the food was excessively available, the incubation period of



(a) Egg mass, (b) First instar larvae, (c) Fifth instar larvae, (d) Pupa, (e) Adult moth (♀) and (f) Adult moth (♂).
Fig. 1. Bionomics of greater wax moth, *G. mellonella.*

Table 2. Developmental period of greater wax moth, *G. mellonella* under laboratory conditions

Treatments/Conditions	Fecundity	Incubation period (days)	Larval period (days)	Pupal period (days)	Total developmental period from egg to adult emergence (days)	Longevity of adults (days)
Under room temperature with excess food	187 (13.67)[c]	5.87 (2.42)[a]	18.15 (4.29)[a]	12.21 (3.49)[a]	36.23 (6.01)[a]	13.66 (3.69)[a]
Under room temperature with adequate food	125.66 (11.64)[b]	13.20 (3.49)[b]	16.75 (4.35)[a]	34.52 (5.82)[b]	64.47 (8.02)[b]	10.50 (3.24)[a]
Under room temperature with inadequate food	107.96 (10.38)[a]	13.32 (3.50)[b]	24.30 (7.19)[c]	40.52 (7.48)[c]	78.14 (8.78)[c]	9.87 (3.14)[a]
S. Ed	0.14	0.05	0.05	0.08	0.84	0.44
C. D. (P=0.05)	0.28	0.10	0.10	0.16	1.68	0.88

Values in parentheses are square root transformed.
Values followed by superscripts show significance among the treatments according to DMRT.

the eggs was reduced to 5.87 days. The larval period was longer under inadequate food supply and recorded as 24.30 days followed by excess food condition as 18.15 days. The lowest larval period (16.75 days) was recorded with adequate food supplied. These results were supported by the findings of Mahmoud and Abdel-Rahman (2021) that the larval period was about 20±0.54 and 23.8±0.86 days. The findings of Kumar and Khan (2018) also supported the current results, who found that the larval period was 21.5 days. The pupal period was reduced (12.21 days) under excess food supplied and the same was extended to 40.52 days with inadequate food supplied followed by 34.52 days with adequate food condition. Then the total developmental period was recorded high (78.14 days) with inadequate food supplied followed by adequate food given (64.47 days). The total developmental period was recorded less (36.23 days) in excess food condition. Singh *et al.* (2019) reported the developmental period (egg to adult) of 62 days. Jorjao *et al.* (2018) reported that developmental period from pupa to moth was 1 to 8 weeks. The findings of Kumar and Khan (2018) reported the pupal period of 40-70 days and supported the current study.

The longevity of adult moths varied at different conditions. The adult moth had short life span of 9.87 days with inadequate food was given followed by adequate food supplied (10.50 days). Maximum longevity of 13.66 days was recorded with excess food condition. The longevity found during the experiment was at par with each other. Vijayakumar *et al.* (2019) mentioned that the larval and pupal duration was from 35 to 45 and 14 to16 days and the longevity of adult males and females was 16.50 and 6.88 days on honey-based diet, respectively. This variation could be due to shift in the quality of the food consumed in their larval stage. Mahmoud and Abdel-Rahman (2021) reported that male and female longevity was 13.0±.44 and 11.4±0.68 days, respectively, for larvae that had fed on bee wax only. The current findings were supported by the results of Kumar and Khan (2018), who stated that the longevity of adult moth was 8-15 days.

CONCLUSION

The mean developmental period from egg laying to adult emergence and the longevity of wax moth was found high with 78.14 and 13.66 days under room temperature 32±5°C and relative humidity 65±5% of inadequate food and excess food supplied, respectively. It was concluded that the total developmental period from egg to adult emergence was significantly high in inadequate food given and less in excess food condition. The results of this experiment will supply the information pertaining to the development of wax moths in different climatic conditions may be useful to safeguard the bee hives maintained under various climatic zones and to keep the wax moths at bay following suitable management techniques.

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