Morphometric study of Greater wax moth (*Galleria mellonella* L.) under laboratory condition

Abstract

The present study was carried out in PG Laboratory, Department of Entomology, Faculty of Agricultural Sciences, Siksha 'O' Anusandhan Deemed to be University, Bhubaneswar, Odisha on morphometry of greater wax moth (*G. mellonella* L.). Under laboratory condition, we observed the incubation period of greater wax moth was 8.55±0.42 days. The seven successive larval instars lasted for the following number of days *i.e.*,4.64±0.36, 5.04±0.51, 6.05±0.62, 7.07±0.41, 8.15±0.59, 8.41±0.52 and 9.12±0.47 days. Prepupa and pupa lasted, 1.69±0.52 and 8.63±0.38 days,respectively. Adult males lived for 16.79±1.48 days on average, compared to 6.92±0.49 days for females. Females had pre-ovipositional, ovipositional and post-ovipositional durations of 1.13±0.33, 3.78±0.43 and 1.19±0.28 days, respectively. On average females lay 784.01±42.77eggs per female and 167.91±43.64 eggs per female on each day.

Keywords: Morphometric, *Galleria mellonella* L., larval period, instar, fecundity

Introduction

"Beekeeping has evolved into a potential business that is also gaining popular as one of the components of integrated agro-ecosystem. There is significant potential for expanding bee colonies for honey and wax production, as well as pollination services. Despite its profitability, potential and larger growth opportunities. Indian beekeeping has several inherent challenges. One such key issue is the presence of several natural enemies, which cause significant losses to the beekeeping sector.Greater wax moth(*Galleria mellonella* L.), a well-known pest of honey bee colonies, is found all over the world. The wax moth larvae did not cause direct harm to honeybees at any stage of development, but it is extremely damaging to combs. They consume comb wax as well as other related components such as pollen, propolis, dead bees, and bee pupal cases. Wax moth larvae drill into the combs and create tunnels in the centre. Later, black excrement may be seen in the web.Weak bee colonies flee as a result of severe infestation, whereas robust colonies have their bee population rapidly decreased and colonies completely destroyed" (Hanumantha Swamy, 2000). "It caused significant damage to honey bee colonies, resulting in significant financial losses to beekeepers" (Kapil and Sihag, 1983). "The greater wax moth often poses no damage to healthy or robust bee colonies; nevertheless, weak colonies are invaded and all unused beeswax is destroyed" (Chauvin and Chauvin, 1985). The larvae consume the beeswax once the eggs hatch. Feeding on the leftover pupal skin, pollen and other contaminants present in the comb cells of the beeswax.The bees cannot use the comb because of the feeding damage, so the combs must be rebuilt.According to William (2000), the greater wax moth has about seven instars and goes through its entire life cycle from egg to adult stage at 30°C in about 6-7 weeks.

Materials and Methods

This experiment was conducted at the PG lab., Department of Entomology, FAS, Siksha "O" Anusandhan (Deemed to be University), Bhubaneswar, Odisha during the year

2023. Greater wax moth initial culture was gathered in *Apis cerana indica* F. colonies from DepartmentApiary unit and cultivated in the lab. The eggs from the lab culture were preserved in separate containers, inspected every 24 hours, and the length of incubation was noted. Eggs' length and width were also measured using a stereo zoom binocular microscope with an eyepiece-mounted ocular micro-meter (Satapathy & Mandal, 2022). After hatching, routine observations were undertaken to count the number of instars and moults that occurred during the larval development. The durations of the larval, pre-pupal, and pupal stages as well as their length and breadth were measured. Male and female moth couples were released separately into plastic containers with large mouths after emerging as adults to lay eggs. Every 24 hours, the paper strips were removed, and any eggs were counted under a stereo zoom binocular microscope. The paper strips were thereafter preserved in plastic vials for incubation. The pre-oviposition, oviposition and post-oviposition times were simultaneously noted. For females, fecundity and egg production per day were calculated.

Results and Discussion

Egg

Wax moths are laid whitish, tiny and oval shaped eggs; however, they turn creamy when they come into contact with air. There are many wavy lines running diagonally across the eggshell. Under laboratory conditions, eggs were laid in groups and adhered to the inner side of paper strips provided for egg lying although occasionally under nest conditions a few eggs were also laid in cracks and crevices of hives. Additionally, a few eggs were seen on the combs of weaker colonies. Oviposition took place between midnight and three in the morning. The pronounced black head of the pre-emerged larva was seen inside the egg shell just before hatching as it developed inside the egg. Most egg hatching was recorded between the hours of 8:00 and 11:00 in the morning. During the summer, the hatch rate was around 100 percent. Eggs measured 0.46 ± 0.08 mm long and 0.32 ±0.03 mm broad, and the duration was 8.55 ±0.42 days (Table 1). According to El-sawaf (1950) the egg stage lasted for 9-10 days and Swamy (2008) revealed that the egg stage lasted for 8.70 days the reasons for variation may be attributed to the possible differences in the ecological conditions that prevailed during the study period.These studies were also in line with the statement of Ellis *et al.* (2013).

Larva

The larva of a wax moth is yellowish and light emerging from its egg. It feeds on bee combs and digging into the cell wall's outer border. As it grows, it changes colour to dirty grey. Growth is influenced by temperature and food type. Older or darker combs have faster growth, while white or fresh combs are slower. Infested combs are destroyed within a week. The larvae stop eating and shed exuvae separately. The seven subsequent larval instars were4.64±0.36, 5.04±0.51, 6.05±0.62, 7.07±0.41, 8.15±0.59, 8.41±0.52 and 9.12±0.47 days. The total larval duration was 48.48±3.48 days in the present investigation. The mean length of seven successive larval instars was 1.43±0.33, 2.77±0.53, 4.72±0.63, 9.57±0.44, 15.78±0.41, 21.83±0.38 and 26.05±0.90 mm respectively. The mean breath of seven larval instars recorded were 0.25±0.06, 0.45±0.06, 1.27±0.45, 1.59±0.54, 2.62±0.64, 3.36±0.57 and 4.85±0.32 mm respectively. The mean size of head capsule of the larval instars was 0.23±0.06, 0.33±0.07, 0.53±0.06, 1.17±0.41, 1.31±0.42, 1.54±0.40 and 2.37±0.49 mm

respectively. Similar findings were also reported by Anderson and Mignat (1970) and Swamy (2008).

Prepupa and cocoon

Fully grown larvae reach the seventh instar, they begin to move in search of a suitable location for pupation. Just prior to pupation, the larvae begin to scrape the surface. For pupation in the apiary, the larvae penetrated the hive's fissures. The fully fed larva slightly shrinks in size and builds the cocoon from the silk and waste by staying within. The cocoon is elongated, spindle-shaped, stiff, and leathery. When the moth emerged, a thin layer of silken material that had been covering the exit hole of the broader anterior portion of the cocoon was pushed away. Prepupa lasted for 1.69±0.52 days. The cocoon's average length and width were 23.47±0.81 mm and 8.29±0.83mm respectively. During this study we observed that these results were also acquiesce with the finding of Swamy (2008).

Pupa

The newly created pupa had an oval shape was first light in colour and eventually turned dark brown as it neared adulthood. Just behind the head and extending to the abdomen segment was a row of tiny spines. The pupa's average lifespan was 8.63±0.38 days. The pupal duration, however, varied between 6.5-8.00 days (Sehnal, 1966).The results were also consistent with Swamy 2007, with a few slight deviations possibly resulting from climatic conditions. The pupae had an average length and width of 13.78±0.49 and 4.35±0.38 mm, respectively.

Adult

With ash grey wings and a bronze front wing, the moth emerges during the night and late evening. The amount of food consumed during the larval stage affects the moth's size and colour. Fresh combs create lighter, smaller moths while dark brown combs yield darker adults. Adults are smaller and have smooth, notch-free labial palpi in females and a semilunar notch in males. Males had wingspan of 24.76±0.55 mm while females had wingspan of 26.15±0.87 mm. Female adult life expectancy was just 6.92 days, compared to males' 16.79±1.48 days (Table 1).Adult male lifespan was found to be 21–30 days, while adult female longevity was found to be 8–15 days (El-sawaf, 1950). This variance may be due to changes in ecological conditions and the caliber of the food taken during the larval stage, whereas Swamy (2008) observed that males lived an average of 16.4 days and females an average of 6.90 days in the adult stage. The results of the current investigation are consistent with those of Swamy (2008).

Morphological characteristics of female

One day after emerging, the moths start to lay their eggs, and they can continue doing so for up to a week. The moths lay their eggs in clusters at night. Females had pre-oviposition, oviposition, and post-oviposition durations of 1.13±0.33, 3.78±0.43 and 1.19±0.28 days, respectively. In total, females produced 167.91±43.64 eggs per day on average, or 784.01±42.77 eggs per female (Table 1). These findings corroborated Swamy's (2008) claim that wax moth females lay an average of 760 eggs during the course of their lifetime.

Table 1. Morphometry of greater wax moth *Galleria mellonella* under laboratory condition

Life stages	Duration (days) Mean±sd	Morphometry of grater wax moth			
		Length(mm) Mean±sd	Breadth(mm) Mean±sd	Head capsule width(mm) Mean±sd	Wing expanse(mm) Mean±sd
Egg	8.55±0.42	0.46±0.08	0.32±0.03		-
Larva					
1st instar	4.64±0.36	1.43±0.33	0.25±0.06	0.23±0.06	-
2nd instar	5.04±0.51	2.77±0.53	0.45±0.06	0.33±0.07	-
3rd instar	6.05±0.62	4.72±0.63	1.27±0.45	0.53±0.06	-
4th instar	7.07±0.41	9.57±0.44	1.59±0.54	1.17±0.41	-
5th instar	8.15±0.59	15.78±0.41	2.62±0.64	1.31±0.42	-
6th instar	8.41±0.52	21.83±0.38	3.36±0.57	1.54±0.40	-
7th instar	9.12±0.47	26.05±0.90	4.85±0.32	2.37±0.49	-
Prepupa/ cocoon	1.69±0.52	23.47±0.81	8.29±0.83	-	-
Pupa	8.63±0.38	13.78±0.49	4.35±0.38	-	
Adult male	16.79±1.48	-	-	-	24.76±0.55
Adult female	6.92±0.49				26.14±0.87
Pre-oviposition	1.13±0.33	-	-	-	-
Oviposition	3.78±0.43	-	-	-	-
Post oviposition	1.19±0.28	-	-	-	-
Fecundity					
Eggs/ F	784.01±42.77	-	-	-	-
Eggs/F/day	167.91±43.64	-	-	-	-

Conclusion

The greater wax moth is a great global challenge to the bee health and the beekeeping industry and also scanty research attention it has received to other global bee pests and parasites. In conclusion, we must more focused to develop new techniques to avoid the infestation caused by this moth in our apiary. More importantly, there is no better indemnity against the scourge of the greater wax moth than to observe best apiary management practices that keep away the moth.

References

1. Anderson MA and Mignat EC. 1970. The number of larval instars of greater wax moth (*Galleria mellonella* L.)with characters for identification of instars. *J. Georgia Entomol. Soc*. **5**(2): 65-68.
2. Chauvin G and J Chauvin 1985. The influence of relative humidity on larval development and energy content of *Galleria mellonella* L. (Lepidoptera: Pyralidae). *Journal of Stored Product Research*. **21** (2): 79-82.

3. Ellis JD, Graham JR, Mortensen A. 2013. Standard methods for wax moth research. *J. Apic. Res*. **52**: 1–17.
4. El-sawaf, S.K., 1950, the life history of the greater wax moth (*Galleria mellonella*) in Egypt with special reference to the morphology of the mature larva (Lepidoptera: Pyralidae). *Bull. Soc. Fouad. Ier. Ent*.**34**: 247-297.
5. Kapil RP and Sihag RC. 1983. Wax moth and its control. *Indian Bee J*ournal. **45**: 47-49.
6. Satapathy, Satya Narayan and Mandal SMA. 2022. Morphometry of different life stages of *Chrysoperla zastrowi sillemi* (Esben-Peterson) influenced by adult diets. *Ecology, Environment and Conservation*, 28-S: S11-S16.
7. Sehnal F 1966. Critical study of the bionomics and biometrics of the wax moth (*Galleria mellonella*) reared under different conditions. *J. Wiss. Zool*. **174**:53-82.
8. Swamy BCH. 2008. Bionomics and biometrics of greater wax moth (*Galleria mellonella* L.). *Asian Journal of Biological Science*, 3: 49-51.
9. Venkatesh Hosamani, Swamy BC Hanumantha, KN Kattimani and Kalibavi CM 2017. Studies on Biology of Greater Wax Moth (*Galleria mellonella* L.). *International Journal of Current Microbiol Applied Science*. **6**(11): 3811-3815.
10. William FL 2000. Rearing greater wax moths, *Galleria mellonella* L. *Ohio State University Extension Factsheet*. **96**: 1-3.