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Biology and morphometrics of cocoa mealy bug, *Planococcus lilacinus* (Cockerell)

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ABSTRACT: Investigation on the biology of Cocoa mealy bug, *Planococcus lilacinus* was carried out at College of Agriculture, Navile, UAHS, Shivamogga during 2016-17 and study revealed that the fecundity of mealy bugs ranged from 130 to 288 eggs per female with mean±SD of 216.5±47.17. Female mealy bugs had only three instars, while the males had four instars. Total nymphal duration ranged from 16 to 24 days with mean±SD of 20.17±3.52. The total life cycle of the female mealy bug, *P. lilacinus* ranged from 27 to 41 days and that of males ranged from 20 to 32 days with mean±SD of 33.83±5.54 and 26.22±5.79, respectively.

Keywords: Cocoa mealy bug, biology, fecundity, instars, life cycle

INTRODUCTION

Cocoa is the third important beverage crop next to coffee and tea, and is the third highest traded commodity in the world. Cocoa is the dried and fully fermented fatty seed of the Cocoa tree from which chocolate is made. "Cocoa" can often also refer to the drink commonly known as hot chocolate. This Cocoa has several constraints for attaining its maximum yield potential, which include the problem of pest and diseases, nutritional imbalance, water stress etc. Among these problem of pests would bring about loss in the yield to the greater extent. Though over 150 different insects are known to feed on Cocoa, only about 2 per cent are of economic importance. However, when Cocoa is introduced into a new area, a previously unrecorded pest almost invariably attacks it. Mirid bugs such as *Helopeltis antonii* Signoret, *H. bradyii* Waterhouse are the most significant and widely occurring insect pests of Cocoa. The Cocoa pod borer and mealy bugs are the major pests in South East Asia. Mealy bugs are generally not only major pest themselves, but are well known vector for viruses that are known to transmit Cocoa swollen shoot virus (Strickland, 1951). Mealy bugs are one of the destructive insect pests and damage a wide range of horticultural and agricultural crops such as Cocoa, Coffee, Guava, *Solanum* spp, citrus (Bodenheimer, 1951). There have been about 175 genera belonging to 74 families of mealy bugs described so far (Ben-Dov, 2007). But a few are known to cause more severe damage. Many species of mealy bugs (Hemiptera: Pseudococcidae) have become serious invasive pests when introduced into new areas beyond their native (or natural) distribution (Miller *et al*., 2002). *Planococcus lilacinus* Cockrell is polyphagous and is common in southern Asia where it attacks fruit trees and is often important on coffee in southern India. About ten species of mealy bugs are known to attack Cocoa crop (Campbell, 1983). There exists a sexual dimorphism in mealy bugs. Females pass through three nymphal instars and males will undergo four nymphal instars (Babu and Azam, 1987). There are no concentrated research studies on biology of cocoa mealy bug. Hence, the present research on biology of Cocoa mealy bug, *Planococcus lilacinus* (Cockerell) was undertaken.

MATERIALS AND METHODS

Collection and maintenance of culture

The laboratory experiment was conducted in the Department of Agricultural Entomology, College of Agriculture, Navile, UAHS Shivamogga. Biology of the pest was carried out on tender Cocoa pods collected from the Cocoa plants in the field. The maximum and minimum temperatures during the study period were 27.25 °C and 18.2 °C, respectively. The relative humidity morning (RH-I) and evening (RH-II) were 60.5 and 32.6 per cent, respectively.

To know the biology of mealy bug, *P. lilacinus* on Cocoa, small healthy tender pods were brought from the field and washed thoroughly with wet cotton to remove dirt and other particles on the pods. The egg mass and neonate crawlers identified in the field were brought to the laboratory (Vennila *et al*., 2010) and were released on fresh mature pod to establish pure culture, and were kept undisturbed until they attain adult stage. The full grown adult females and fourth instar males were collected and released separately on fresh cocoa pods for further studies.

Pre-oviposition period, Fecundity and Incubation period

To study the pre oviposition period we released a pair of male and female mealybugs on each pod in replications.

They were observed for the appearance of the ovisacs (mass of eggs). Later, the period up to the formation of first ovisac was considered as pre-oviposition period which was covered by cottony woolly mass.

In the above set of experiment after noting the pre oviposition period, the adult females were undisturbed and left for production of ovisacs. The ovisacs from individual females were taken separately and were observed under microscope for the number of eggs until the end of their fecundity period.

Twenty freshly laid eggs from ovisacs were collected and placed separately on tender pods with the help of Camel hair brush into the petri plates containing fresh pods. The period between egg laying to egg hatching was taken as the incubation period.

Duration of different stages

After the eggs hatched into nymphs, the duration of different nymphal instars from first to third instar nymphs was recorded by observing the moulted skin at the end of each instar (Satpute *et al*. 2011). After the end of third instar, they were observed for the presence of wing buds. If the wing buds were found, they were designated as males (Maheshkumar and Balikai, 2009), otherwise as females. Longevity of adult male and female was recorded. The morphometric data, length and width of the mealy bugs at each instar was observed with ocular lens fixed to the microscope. The weather parameters like relative humidity and temperature during the rearing period were recorded.

RESULTS AND DISCUSION

Pre-oviposition period, oviposition period and fecundity

The pre-ovipositional period of *P. lilacinus* ranged from 4 to 7 days with an average of 5.50 ± 1.41 days during summer season. Oviposition period ranged from 5 to 8 days with an average of 6.33 ± 1.22 days (Table 1). Our results were nearly similar to the results obtained by Maheshkumar and Balikai (2009) where the pre-oviposition period of *M. hirsutus* on pumpkin ranged from 6 to 7 days with an average of 6.4 ± 0.56 days.

The ovisacs from individual females were taken and were observed under microscope for the number of eggs in each ovisac until the completion of their oviposition period where each female individual laid eggs in ovisacs and sometimes in group of batches. The fecundity ranged from 130-288 eggs per female with an average of 216.5 ± 47.17 eggs (Table 1). Some females also reproduced parthenogenetically and such females produced first instar nymphs directly. Previous findings of Babu and Azam (1987) showed that *Maconellicoccus hirsutus* laid minimum of 114 eggs and maximum of 509 eggs. The parthenogenetic reproduction which was observed in our experiment was in line with the prior findings of Vennila *et al*. (2010) who reported that parthenogenesis was also dominant in cotton mealy bug, *Phenacoccus solenopsis*. Parthenogenetically reproduced females showed dynamic patterns of fecundity where in the number of crawlers per female ranged from 128 to 812 with a mean of 344 ± 82.

The fresh laid eggs were translucent yellowish or light yellow in colour. They were elongated and oval in shape. The translucent eggs became pinkish yellow in colour towards hatching. The incubation period of cocoa mealy bug varied from 3-5 days in the month of February with an average of 4.05 ± 0.86 days (Table 1). The results of Mani (1986) showed that, the average incubation period for grape mealy bug was 5.15 days and our results are quite close to their findings.

Table 1. Pre-oviposition period, fecundity and incubation period of *Planococcus lilacinus*

Pre-oviposition period		Oviposition period		Fecundity		Incubation period	
Range (days)	Mean±SD (days)	Range (days)	Mean±SD (days)	Range (Eggs/female)	Mean ±SD	Range (days)	Mean±SD (days)
4-7	5.50±1.41	5-8	6.33±1.22	130-288	216.5±47.17	3-5	4.05±0.86

Duration of nymphal period at different nymphal instars of *Planococcus lilacinus*

Nymphal stage	1st instar	2nd instar	3rd instar	4th instar (only male)	Total nymphal period
Range (days)	3-5	3-5	7-10	3-4	16-24
Mean ± SD (days)	4.40±0.49	4.16±0.50	8.11±1.83	3.5±0.70	20.17±3.52

Number of sample, n=20

Duration of nymphal stages

The results on duration of different nymphal instars on Cocoa pod observed during the experimental period are represented in Table 1. It was observed that females had only three instars while the males had four instars. The present results are in agreement with the previous findings of Seni and Sahoo (2011) who investigated the biology of mealy bug, *Rastrococcus iceryoides* (Green) on Citrus, and recorded that the female and male nymphs moulted thrice and four times, respectively. Satpute *et al*. (2011) also reported that the female mealy bugs of *P. solenopsis* had three nymphal instars whereas the males possessed a pupal stage.

Soon after the hatching of eggs, the first instar nymphs became translucent yellowish in colour, and after a day they turned to pinkish yellow. The neonate nymphs (a day old crawlers) were oval in shape and they were highly motile with diagonally held antennae. The nymphal duration of first instar ranged from 3 to 5 days with an average of 4.40 ± 0.49 days (Table 1). The mean length of first instar nymph ranged from 1.0 to 1.65 mm with an average of 1.44 ± 0.29, and the body width ranged from 0.57 to 0.93 mm with an average of 0.68 ± 0.08 (Table 2). Towards the end of first instar, the crawlers colour started turning pinkish white and were slow in movement.

Table 2. Morphometric data of Cocoa mealy bug, *Planococcus lilacinus*

Insect stage	Mean length (mm)		Mean width (mm)	
	Range	Mean ± SD	Range	Mean ± SD
1st instar	1.0-1.65	1.44±0.29	0.57-0.93	0.68±0.08
2nd instar	2.25-3.12	2.87±0.35	1.18-1.72	1.48±0.16
3rd instar	4.64-6.75	5.61±0.61	2.40-3.14	2.71±0.26
4th instar (male)	3.0-3.10	3.05±0.07	1.02-1.11	1.06±0.65
Adult female	7.0-8.84	7.94±0.75	2.75-4.10	3.76±0.92
Adult male	3.5-3.8	3.65±0.21	2.15-2.20	2.17±0.12

Number of sample, n=20

The second instar nymphs were larger in size than first instar nymphs and the body was pinkish in colour with appearance of white with waxy secretions on the body. It was sluggish and became stationary on some part of the pod. The duration of second instar nymph ranged from 3 to 5 days with a mean of 4.16 ± 0.50 days. The body length ranged from 2.25 to 3.12 mm with an average of 2.87±0.35. The body width ranged from 1.18-1.72 mm and the average was 1.48±0.16 (Table 2). The second instar nymph was pinkish in colour with mealy matter covering all over the body and settled at one place.

Soon after the moulting of second instar nymph, the third instar mealy bug increased its size and the duration of third instar nymph (last instar for female) lasted for longer time compared to other instars for 7 to 10 days and the average was 8.11 ± 1.83 (Table 1). Their mean body length ranged from 4.64 to 6.75 mm, with an average of 5.61±0.61. Similarly the body width ranged from 2.40 to 3.14 mm and the average was 2.71±0.26 (Table 2).

Fourth instar nymph was observed only in males. Since the male to female ratio in mealy bugs is very high, fewer males were found. Fourth instar period ranged from 3 to 4 days with an average of 3.5 ± 0.70. There was gradual reduction in the size of the males in this stage where the mean length ranged from 3.0 to 3.10 mm and average was 3.05 ± 0.07. The width ranged from 1.02-1.11 with a mean of 1.06 ± 0.65 (Table 2). The fourth instar had the small wing buds visible under stereomicroscope and mealy matter covered fully in the posterior region.

The present results on duration of different nymphal instars are in line with the earlier findings of Muthulingam and Vinobaba (2013) who reported that the nymphal duration of *P. solenopsis* lasted for an average of 3.24 ± 2.11, 4.75 ± 3.28, 5.20 ± 0.45 days for first, second and third instars, respectively. They also noticed that males had four instars as compared to females, which had only three instars.

Total nymphal duration ranged from 16 to 24 days and the average duration was 20.17 ± 3.52 days (Table 1). Tanwar *et al*. (2007) carried out the biology of *M. hirsutus,* and reported that the total nymphal duration of mealy bugs lasted for 22–25 days. Seni and Sahoo (2011) who worked on the biology of Citrus mealy bug, *R. iceryoides* (Green) reported that the female and male nymphs moulted thrice and four times, in 18-24 days and 16-22 days, respectively.

Adult longevity

After completion of the third instar, the newly formed adult females were large and the body was soft, distinctly segmented and settled completely at one place. Three thoracic and ten abdominal segments were clearly visible in spite of mealy matter covering the body. The head was covered with white mealy secretions. Adult males had a pair of antennae and a pair of wings, with reddish black abdomen. From the end of the abdomen, a pair of thread like filaments arised, which were clearly visible under the microscope. The longevity of adult female ranged from 8-12 days with a mean of 9.61 ± 1.16 days and for adult male it was 1-3 days with a mean of 2.0 ± 1.41 days (Table 3). Satpute *et al*. (2011) reported that the range of longevity of an adult female as 10 to 13 days on cotton twigs per leaves. Muthulingam and Vinobaba (2013) reported that, the longevity of males of *P. solenopsis* ranged from 1 to 2 days with an average of 1.5 ± 0.5 days.

Table 3. Total life cycle of *Planococcus lilacinus* on Cocoa pod

Insect stage		Range (days)	Mean ± SD (days)
Incubation period		3-5	4.05 ± 0.86
Nymphal stage		16-24	20.17 ± 3.52
Adult longevity	**Female**	8-12	9.61 ± 1.16
	Male	1-3	2.0 ± 1.41
Total Life cycle	**Female**	27-41	33.83 ± 5.54
	Male	20-32	26.22 ± 5.79

Total life cycle

The total life cycle of the female mealy bug, *P. lilacinus* ranged from 27-41 days with a mean of 33.83 ± 5.54. Total life span of the male mealy bug was in the range of 20-32 days with an average of 26.22 ± 5.79 days (Table 3). These results were in accordance with the previous findings of Muthulingam and Vinobaba (2013) who found that total life cycle of cotton mealy bug ranged from 23 to 30 days with an average of 27.41 ± 1.10 days. Varikou *et al*. (2010) also reported the mean total developmental time from egg to adults for females of *Planococcus ficus* (Signoret) (Hemiptera: Pseudococcidae) on table grape leaves as 39.87 days at 30 °C.

CONCLUSION

Present study revealed that the fecundity of mealy bugs ranged from 130 to 288 eggs per female. Female mealy bugs had only three instars, while the males had four instars. Total nymphal duration ranged from 16 to 24 days. The total life cycle of the female mealy bug, *P. lilacinus* ranged from 27 to 41 days and that of males ranged from 20 to 32 days. Since the fecundity is quite high, it is needed to tackle the pest at initial stage to avoid the menace caused by this pest to cocoa plants.

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