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Study on adult emergence, female calling and mating behaviour in *Maruca vitrata* F. (Lepidoptera: Crambidae) in Kerala, India

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ABSTRACT: Behavioural studies on the legume spotted pod borer, *Maruca vitrata* was done at 27±2°C, 65-70% RH and photoperiod of 12L: 12D. Adult emergence occurred throughout the day. Emergence of moths during scotophase (6 pm - 5 am) was 70%, which constitutes 63% of males and 76% of females. During photophase, (6 am - 5 pm) emergence was 30%, which constitutes 36% for males, and 24% for females. Highest emergence peak for male was observed at 4 pm (photophase) and for females, at 10 pm (scotophase). Calling behaviour of *M.vitrata* females observed from one to eight days. Female started calling from 2nd hour of scotophase (7 pm) and terminated at 3 am (scotophase). The mean percentage of calling was maximum at 6th hour of scotophase in 3-day old moth with 44%. None of the females called during first hours of scotophase. Mating of *M. vitrata* observed throughout scotophase up to 8 days and highest mating occurred in 3-day-old moths with 26%. © 2019 Association for Advancement of Entomology

KEY WORDS: Adult emergence, female calling, mating behavior, *Maruca vitrata*

INTRODUCTION

The legume spotted pod borer *Maruca vitrata* (Fabricius, 1787) is an important pest because of its extensive distribution, wide host range, and destructiveness (Taylor, 1967). It is a specific key pest of cowpea (Jackai, 1995). The Indo-Malaysian region is considered as the most probable center of origin for the genus *Maruca*, including *M. vitrata,* which is found throughout the tropics (CABI, 2002). It shows broad range of dispersal throughout Africa, South America, southern states of Australia, and Asia (Singh and Emden, 1979). The larvae are voracious feeders of flower buds, flowers, and young pods (Jackai and Singh, 1983). Thus, infestation can occur at all stages of crop from seedling to pod forming stage. The infested pod with bored holes plugged with excreta render the pods unmarketable and leads to considerable yield loss up to 20-80%. In the order Lepidoptera, adult emergence and sexual behaviour occur in a specific period of the day and season. In females, sexual behaviour consists of production and release of sex

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pheromones through calling behaviour, leading to attraction of potential mates, and the receptivity to males that attempt mating (Kingan *et al*., 1993). The knowledge of adult emergence, female calling, and mating behaviour helps in implementation of semio-chemical based pest management methods. The present study is an attempt to understand adult emergence, female calling, and mating behaviour of *M. vitrata.*

MATERIALS AND METHODS

Rearing of insects

Larvae of *M. vitrata* were collected from infested flowers and young pods of cowpea. Larvae were maintained in rearing room at the temperature of 27±2°C and relative humidity of 65-70%, photoperiod of 12L: 12D in the department of Entomology, College of Agriculture, Padannakkad. Larvae were reared individually to prevent cannibalism by keeping them in transparent plastic containers of 7 cm diameter and 12 cm height size with absorptive paper. First and second instar larvae were provided with flowers and flower buds of cowpea as food. Later instars were fed with pods, flower and flower buds. After pupation, pupae were separated based on genital characters and kept in separate boxes.

Adult emergence pattern

Well developed silken cocooned late pupa (N=160) were selected and kept in separate containers individually on tissue paper (Ke *et al*., 1985). The pattern of emergence was recorded at hourly records from 0-24 hours. The number of emerged moths were recorded per unit time for each sex (12L: 12D). Observations were taken during scotophase with help of LED lamp of 2 to 3 watts, which was covered with red cellophane. Emerged moths were separated in to males and females based on abdominal features (Fig.1 A, B). Mean percentage of moths emerged per hour was recorded.

Female calling behaviour

Twenty female moths of one day old (0-24h) were confined to a transparent cylindrical plastic container of 12.5 cm diameter; 24 cm height size individually and provided with ventilation. Moths were provided with 10% honey soaked cotton ball as food. The calling of the female moths of 1-8 day old were observed throughout scotophase (lights off at 18:00 and on at 06:00 h) within every 15 minutes interval. Females exhibiting extrusion and protrusion of pheromone gland scored as calling females. Light was provided using LED 3w lamp with red cellophane during scotophase. ANOVA was used to analyze the results.

Mating behaviour

Soon after the emergence, 15-30 active pairs of one day old moths were selected and placed individually in clear ventilated cylindrical plastic containers of 12.5 cm diameter; 24 cm height size and left to mate. Observations were initiated instantly after pairing at every 15 min interval up to 8 days. Moist filter paper was provided to maintain humidity and honey soaked cotton balls in the containers. Number of pairs initiated to mate were observed for every 15 min and calculated for each hour. In addition, onset time of mating and duration of mating for each pair recorded. The courtship behavior such as male advancement towards female, exposing its hair pencils and mating position were observed. Virgin males with mated females and mated males with virgin females were observed separately to know the possibility of multiple mating.

RESULTS

In adult emergence studies both the sexes were observed throughout the day for emergence, it was observed that 30% of moths emerged during photophase (6am-5pm) and 69.68% of moths emerged during scotophase (6 pm – 5 am). Moths emerged during photophase had a gender distribution of 36.25% males and 23.75% females whereas during scotophase it was 63.12% males and 76.25% females. Peak emergence of males was observed at 4 pm with 11.88% during photophase but for female it was 9.38% during scotophase. There was peak emergence at 10 pm for females with 26.25% but for males, it was 17.5%. Another small peak of emergence was observed during 2-3 am (scotophase) with18.12%

Fig. 1 A. Male moth with forked abdomen tip

Fig. 1 B. Female with tapered abdomen

Table 1. Mean emergence pattern of *M.vitrata* (N=160 F=80; M=80)

Time of emergence (0-24h)	Mean% of male moths emerged	Mean% of female moths emerged
6:00 am	0	0
7:00 am	0	0
8:00 am	0	0
9:00 am	0	0
10:00 am	0	0
11:00 am	0	0
12:00 pm	0.625	0
1:00 pm	5.625	1.875
2:00 pm	10	7.5
3:00 pm	8.75	5
4:00 pm	11.875	9.375
5:00 pm	0	0
6:00 pm	2.5	0
7:00 pm	6.25	8.125
8:00 pm	1.875	3.75
9:00 pm	0	0
10:00 pm	17.5	26.25
11:00 pm	2.5	1.25
12:00 am	1.875	0
1:00 am	5	5.625
2:00 am	9.375	11.875
3:00 am	8.75	11.25
4:00 am	7.5	8.125

for males and 23.12% for females. For males, least percentage of emergence recorded with 5.63% at 1 pm (photophase) and 2.5% at 6 pm during scotophase, whereas for females least emergence recorded with 1.25% at 1 pm of photophase and 11 pm of scotophase (Table 1).

Calling pattern of one to eight day old moths were observed. Calling was initiated during 2nd hour of scotophase and reached maximum at 6th hour of scotophase in third day old moth**.** Calling females of *M. vitrata* were correlated with their age. There was no calling observed during the first hour of scotophase irrespective of the moth age. Single calling peak was observed at sixth hour for the moths of all age groups except for three day old where additional peak of calling at 5th and 7th hour of scotophase were observed. There was gradual reduction from fourth, fifth, sixth, seventh and eighth day old moths (26.25; 16.67; 11.67, 5 and 3 %). Similar trend of calling were recorded in all age groups of moths. There was minimum percent of calling in initial hours and gradually increase in proceeding hours. However, there was a decrease after 7th hour of scotophase. Peak calling of 43.5 % was recorded in three-day-old moths during sixth hour of scotophase, which was statistically significant from four-day-old moths. The female calling percentage was maximum during 6th hour of scotophase (11 pm) for one to eight day old females (Table 2).

The response of *M. vitrata* males to calling females was signalized by constant antennal swing,

Table 2. Calling behaviour of one to eight day old *M. vitrata* moths in different scotophase periods with percent of calling females

Age of females	6pm	7pm	8pm	9pm	10pm	11pm	12pm	1am	2am	3am	4am	5am
One day old	0 (00)	1.3 (1.67)	4.3 (5.42)	7 (8.75)	9 (11.17)	13 (14.58)	10.3 (12.92)	7.3 (8.75)	2.6 (3.33)	0 (00)	0 (00)	0 (00)
Two day old	0 (00)	6 (7.50)	11.6 (14.58)	16.3 (20.42)	15 (24.58)	23.6 (31.67)	23 (29.58)	19.3 (22.50)	12.3 (15.42)	0.6 (0.83)	0 (00)	0 (00)
Three day old	0 (00)	0 (7.50)	6 (12.92)	10.3 (23.33)	20.3 (39.58)	31.6 (43.75)	35 (38.33)	33 (40.00)	34.3 (21.25)	17 (00)	0 (00)	0 (00)
Four day old	0 (00)	4.3 (5.42)	7.6 (9.58)	10.3 (12.92)	17.6 (22.08)	21 (26.25)	15.6 (19.58)	13 (15.00)	8 (10.00)	0 (00)	0 (00)	0 (00)
Five day old	0 (00)	1.3 (1.67)	6 (5.83)	77.3 (8.75)	10.3 (12.92)	13.33 (16.67)	11.33 (14.17)	8.66 (10.42)	6.6 (7.08)	0 (00)	0 (00)	0 (00)
Six day old	0 (00)	0.3 (2.5)	3.6 (4.17)	5.33 (5.83)	7 (9.17)	15 (11.67)	11.6 (7.92)	9 (5.42)	3.3 (4.17)	0 (00)	0 (00)	0 (00)
Seven day old	0 (00)	0.3 (00)	1.6 (1.25)	3.6 (2.92)	5.33 (3.75)	6.66 (5.42)	3 (2.50)	2.6 (1.67)	2 (0.420	0.00	0 (00)	0 (00)
Eight day old	0 (00)	0 (00)	0 (00)	1.6 (1.67)	2.3 (2.08)	2.6 (2.92)	1.6 (1.67)	1.6 (0.42)	0.3 (00)	0.00	0	0

Values parentheses are in percentage

Table 3. Details of mating pattern of *Maruca vitrata*

Age of moths	No of pairs observed	No of pairs mated	Time of pairing	Duration of mating	Percentage of mating
One day old	15	0	0	0	0
Two day old	15	2	11:15 pm	45 min	16.6
Three day old	15	4	12:15 pm	60 min	26.6
Four day old	15	1	1:00 pm	45 min	6.6
Five day old	15	0	-	-	0
Six day old	15	0	-	-	0
Seven day old	15	0	-	-	0
Eight day old	15	0	-	-	0

movement of their head in circular manner, rubbing of legs and exposed hair pencil. Before commencement of mating, males advance towards females from sideways and over the body and get close by walking. Whereas female settled down at the base of substrate wall. Once paired, they pose their body in opposite direction. Highest mating frequency was occurred in 2nd and 3rd day old moths during 11-12th hour and 12-13th hour respectively (Table 3).

DISCUSSION

Luo *et al.* (2004) reported that adult emergence of lepidopterans did not occur in precise time of the day, as moths were sensitive to the external factors of the environment like temperature and photoperiod. They also observed that the daily emergence rhythm for *Liriomyza huidobrensis* and *L. sativae* is strongly influenced by temperature. As temperature increases, the emergence period are shortened. However, the peak emergence for females was more than males during photophase. In another study Lu *et al.* (2007) showed that *M.vitrata* emergence was seen throughout the day under 14L: 10D condition in which 73% of males and 86% of females emerged during scotophase.

In lepidopterans, the calling behaviour and mating behaviour are age dependent and maintained by a circadian rhythm that is usually influenced by exogenous factors (photoperiod and temperature) and physiological factors (Turgeon and McNeil, 1982).The extrusion of theovipositor beyond the abdominal tip to expose the pheromone glands is the main sign of the calling posture, as in case of other lepidopterans (West *et al.,* 1984). The pattern of calling is different in other moth species such as *Sesamia nonagrioide*s (Schal *et al*., 1987) and *Virbinia lamae* (Babilis and Mazomenos, 1992) where with increase in age, there was increased calling percentage. This dissimilarity might be due to the physiological difference in different species.

The third day old *M. vitrata* showed highest mating percentage with 26.6% and second day old moth showed 16.6% of mating and least mating percentage recorded for fourth day old moths (Table.3). A similar result was obtained for the study conducted by Huang and Peng (2001) and Lu *et al*. (2007) on *M. vitrata* where highest mating frequency was found on 3rd night after emergence. However, mating of most nocturnal moths occurred during scotophase and very few of them reported on latter phase of the photophase and scotophase.

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