

Research Article

Biology and potential of pentatomid predator, *Eocanthoeona furcellata* (Wolff) (Hemiptera: Pentatomidae) on fall armyworm, *Spodoptera frugiperda* (Smith)

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ABSTRACT: Studies on the biology and feeding potential of *Eocanthoeona furcellata* (Wolff) on *Spodoptera frugiperda* (Smith) were carried out at NBAIR, Bengaluru. Experimental results revealed that the total developmental period from egg to adult for male and female were 27.92±2.87 and 39.62±3.28 d, respectively. The life cycle of male and female passed through first, second, third, fourth and fifth nymphal instars (male: 2.42±0.51 d, 3.25±0.45 d, 3.25±0.45 d, 4.00±0.60 d, 4.42±0.51 d) and (female: 2.54±0.52 d, 3.46±0.52 d, 4.00±0.71 d, 4.38±0.65 d, 5.08±0.49 d), respectively. Total nymphal period is about 17.83±1.34 d for male and 19.46±1.20 days for female, respectively. Adult longevity of male is lower (10.25±2.96 d) compared to that of female (20.15±3.39 d). The pre-mating period and mating period of adult *E. furcellata* was 2.33±0.50 days and 6.44±2.24 hrs, respectively. The pre-oviposition period, oviposition period of adult female was 2.89±0.60 and 11.22±1.72 days, respectively. The average number of eggs laid by the female was 209.29±28.11 in a single mated system. Egg incubation period was about 5.42±0.51 days. The predation rates of second, third, fourth, fifth instar nymphs, adult female and male on 2nd, 4th, 6th instar prey of *E. furcellata* were (16 ±0.95, 27 ±4.06, 55±4.67, 68 ±5.41, 126 ± 4.76, 97 ± 2.85), (7±1.34, 24±2.77, 40±3.39 45±0.71, 88±1.37, 51±1.60) and (4±0.82, 9±1.64, 21±2.81, 38±1.03, 69±1.32, 36±2.73), respectively.

KEY WORDS: Biology, developmental period, *Eocanthoeona furcellata*, predatory potential, *Spodoptera frugiperda*

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INTRODUCTION

The invasive fall armyworm, *Spodoptera frugiperda* (Smith) was reported in India recently and is spreading fast in the subcontinent. *Eocanthoeona furcellata* (Wolff) (Hemiptera: Pentatomidae) is a potential generalist predator on lepidopteran, coleopteran and heteropteran insects. It has been identified as an effective biological control agent against various lepidopteran pests. In India *E. furcellata* had been an important predator on several important caterpillar pests, such as larvae of *Earias* sp. (Pant, 1960), *Spodoptera litura* (F.) on daincha (Cherian and Brahmachari, 1941), *Eutectona machaeralis* (Walker), *Hyblaea puera* (Cramer), *Plecoptera reflexa* (G.), *S. litura* (F.) (Ahmad *et al.*, 1996), rice leaf folder, *Cnaphalocrocis medinalis* Guenee (Kumar and Singh, 2007), *Helicoverpa armigera* Hubner, *Spilarctia obliqua* (W.) and *Trichoplusia ni* (Hubner) on sunflower (Basappa, 2011) and *Maruca vitrata* Geyer on pigeonpea (Nebapure and Agnihotri, 2011). It can be easily reared on laboratory hosts, *Galleria melonella* and *Corcyra cephalonica*. The biology

and predatory potential of *E. furcellata* has been done on several lepidopteran pests but there is no report on the *S. frugiperda*. Hence, this study is aimed to understand the biological parameters and predatory potential of *E. furcellata* on emerging pest, *S. frugiperda*.

MATERIALS AND METHODS

Rearing of *Spodoptera frugiperda* (Smith)

The rearing of *Eocanthoeona furcellata* and experiments regarding the biology and predatory potential were conducted in the laboratory, National Bureau of Agricultural Insect Resources, in the year 2018-2019. The culture of *Spodoptera frugiperda* was maintained at 26 ± 2 °C and 60 % RH. The first and second instar larvae of *S. frugiperda* were reared on the castor and maize leaves. For stock culture the 3rd instar larvae of *S. frugiperda* were transferred to the individual vials (4×3 cm) containing cut pieces of 5 days old sun-dried potatoes to avoid cannibalism and vials were plugged with non-absorbent cotton (Plate 2). The larvae for experimental

purpose were drawn from the culture that reared on the castor and maize leaves.

Rearing of *Eocanthecona furcellata* (Wolff)

Adult bugs of *E. furcellata* were collected from University of Agricultural Sciences, Bangalore and farmer fields. For rearing of *E. furcellata*, (Plate 1) the temperature and relative humidity were maintained as $26^{\circ} \pm 2^{\circ}\text{C}$ and 65 ± 5 per cent, respectively. The bugs were kept in plastic jars (30×25 cm) along with bouquet of castor leaves for egg laying and nutrition. Jar was lined with blotting paper and covered with muslin cloth for aeration. Eggs deposited by female bugs on the leaves were separated and kept in small breeding dishes (5×5 cm) with sieve cap or mesh. Immediately after hatching the first instar nymphs were provided with the moist cotton ball as the first instar nymphs are not predaceous. Later nymphal instars of *E. furcellata* were provided with larvae of *Spodoptera frugiperda* as they are predatory in nature. Nymphs from third instar were kept in groups of 20 numbers in plastic jars (15x10 cm) with *S. frugiperda* larvae along with castor leaves and folded paper sheets to avoid cannibalism between nymphs and *S. frugiperda* larvae.



Plate 1a

Plate 1b

Plate 1c

Plate 1. Mass rearing of *Eocanthecona furcellata* (a) Egg clutches (b) Nymphal instars (c) Adults of *E. furcellata*

For biology studies, second instar nymphs (n=30) were separated in individual plastic jars (5×5 cm) till the completion of total life cycle. The data of male and females were separated to analyse the mean and SE values. In order to determine the feeding potential of *E. furcellata* on *S. frugiperda*, one nymph of each predatory bug instar (*i.e.*, II, III, IV and V) were kept in breeding dishes along with twenty *S. frugiperda* larvae (II, IV and VI instar). The number of consumed larvae was recorded daily and fresh larvae were provided for further feeding. Predation of each nymphal instar was recorded. Similarly, the adults of predatory bug were kept in different vials along with prey, *S. frugiperda* larvae (II, IV and VI instar). Predation of *S. frugiperda* was recorded for total adult longevity period of the predatory bug, *E. furcellata*. Each experiment was replicated thrice (Plate 3).



Plate 2

Plate. 3

Plate 2. Rearing of *Spodoptera frugiperda* for stock culture on potatoes

Plate 3. Experimental set up to determine the predatory potential of *Eocanthecona furcellata* on *S. frugiperda*

RESULTS AND DISCUSSION

Experimental results revealed that the total developmental period from the egg to adult for male and female was 27.92 ± 2.87 d and 39.62 ± 3.28 d respectively. The life cycle of male and female passed through first, second, third, fourth and fifth nymphal instars (male: 2.42 ± 0.51 d, 3.25 ± 0.45 d, 3.25 ± 0.45 d, 4.00 ± 0.60 d, 4.42 ± 0.51 d) and (female: 2.54 ± 0.52 d, 3.46 ± 0.52 d, 4.00 ± 0.71 d, 4.38 ± 0.65 d, 5.08 ± 0.49 d), respectively. Total nymphal period is about 17.83 ± 1.34 d for male and 19.46 ± 1.20 days for female, respectively (Table. 1). Adult longevity of male is lower 10.25 ± 2.96 d compared to that of female 20.15 ± 3.39 d. Female bugs were bigger and had more longevity compared to male bugs. The pre-mating period and mating period of adult *Eocanthecona furcellata* is 2.33 ± 0.50 days and 6.44 ± 2.24 hrs, respectively. The pre-oviposition period, oviposition period of adult female 2.89 ± 0.60 and 11.22 ± 1.72 days, respectively. The average number of eggs laid by the female was 209.29 ± 28.11 in a single mated system. The egg incubation period is about 5.42 ± 0.51 days. The total number

Table 1. Biology of the predatory bug, *Eocanthecona furcellata* on *Spodoptera frugiperda* under laboratory conditions

Biological parameters	Duration in days (Mean ± SE)	
	Male	Female
First instar	2.42±0.51	2.54±0.52
Second instar	3.25±0.45	3.46±0.52
Third instar	3.75±0.45	4.00±0.71
Fourth instar	4.00±0.60	4.38±0.65
Fifth instar	4.42±0.51	5.08±0.49
Total nymphal period	17.83±1.34	19.46±1.20
Total development period (Egg- Adult)	23.25±1.85	24.88±1.71
Adult longevity	10.25±2.96	20.15±3.39

Table 2. Reproductive parameters of the predatory bug, *Eocanthecona furcellata* on *Spodoptera frugiperda* under laboratory conditions

Particulars	(Mean ± SE)
Pre mating period (Days)	2.33±0.50
Mating period (Hrs)	6.44±2.24
Pre-oviposition period (Days)	2.89±0.60
Oviposition period (Days)	11.22±1.72
Fecundity / female (Nos)	209.29±28.11
Egg incubation period (Days)	5.42±0.51
No of eggs/clutch (Nos)	40.69±16.97
No of egg clutches/female (Nos)	3.78±0.44

of eggs/clutch/female and number of egg clutches/female is 40.69±16.97 and 3.78±0.44, respectively (Table 2).

The results in the present study are in variation with the results of Vanitha *et al.* (2018) who reported that the incubation period of *E. furcellata* lasted for 7 days and five nymphal instars being completed in 15-19 days and cannibalism was not recorded. In the present study cannibalism was observed in 3rd, 4th, 5th and adults of *E. furcellata*. Mean fecundity was 314 eggs on greater wax moth, *Galleria melonella*. The incubation period, nymphal duration and total developmental period from egg to adult on *Corcyra cephalonica* were 8.0±0.45 d, 16.0±3.24 and 22.0±4.20 d, respectively. Pre-oviposition, oviposition and longevity of male and female stink bug were 3.20±0.38, 17.60±1.86, 42.40±1.94, 37.00±3.18 d respectively (Lenin *et al.*, 2016). Siddaiah *et al.* (2015) analysed the biology of *E. furcellata* on vapourer tussock moth larvae showed that the total number of eggs of the predatory stink bug was 44±8 days, incubation period 6±1.05 days and the life cycle passed through five nymphal instars with a total nymphal period of about 16±0.64 days. Male and female longevity were 12±1.05 days and 14±1.09days, respectively and total longevity period for male and female lasted 32±0.19 and 36±1.90 days, respectively. Yi *et al.* (2000) reported average number of eggs laid by female was 371 and the total life cycle

from egg to adult was 24-36 days.

The predation rates of second, third, fourth, fifth nymphal instars on 2nd, 4th, 6th instar prey, *Spodoptera frugiperda* were (16±0.95, 27±4.06, 55±4.67, 68±5.41), (7±1.34, 24±2.77, 40±3.39 45±0.71) and (4±0.82, 9±1.64, 21±2.81, 38±1.03) respectively. By comparison, the predation rates of the adult female on 2nd, 4th, 6th instar prey, *S. frugiperda* were 126±4.76, 88±1.37, 69±1.32 respectively. These values were higher than the corresponding male predation rates, 97±2.85, 51±1.60 and 36±2.73 respectively (Table 3). The predation rate of *E. furcellata* suggests that females require more prey than males in order to prepare for egg production and longevity in the adult stage. These results are in variation with the results of Pillai *et al.* (2013) who reported that there is a significant difference in predation of different instars of *E. furcellata* which attacked different instars of *Maruca vitrata*. The trend of predation gradually increased from the 2nd instar to 5th instar nymphs. The per cent predation was 7.60, 17.20, 35.60, 43.60, 56.40 and 50.33 by 2nd, 3rd, 4th and 5th instar nymph, female and male adults respectively (Nebupare *et al.*, 2011). The predation rates of female N2-N5 nymphs, and adults on *Plutella xylostella* were 13.5, 8.1, 60.6 and 670.0 larvae, respectively. The present study results are in agreement with the predation rates of the female N2-N3, N4, and N5 nymphs fed on *S. litura* were 7.6, 19.3, and 57.1 larvae (Tuan *et al.*, 2016). These values are much lower than the values of present study.

Preliminary studies on biology and predatory potential of *E. furcellata* suggests that it has good predatory potential on *S. frugiperda*. The augmentative studies of the predatory bug, *E. furcellata* in field against *S. frugiperda* should be further explored and could be promoted for the release under pest outbreaks situations.

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Table 3. Feeding potential of the predatory bug, *Eocanthecona furcellata* on *Spodoptera frugiperda*

Stages of host, <i>S. frugiperda</i>	Stages of predator, <i>E. furcellata</i> (Mean ± SE)					
	Second instar	Third instar	Fourth instar	Fifth instar	Adult female	Adult male
Second instar (no.)	16±0.95	27±4.06	55±4.67	68±5.41	126±4.76	97±2.85
Fourth instar (no.)	7±1.34	24±2.77	40±3.39	45±0.71	88±1.37	51±1.60
Sixth instar (no.)	4±0.82	9±1.64	21±2.81	38±1.03	69±1.32	36±2.73

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