

Study on Biology and Feeding Potential of Three Striped Ladybird Beetle, *Brumoides suturalis* (Fab.) on Cotton Mealybug, *Phenacoccus solenopsis* Tinsley

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ABSTRACT: Three striped lady bird beetle, *Brumoides suturalis* (Fab.) found to be a voracious feeder of different stages of mealybugs on agricultural and horticultural crops. The larvae and adults of this beetles feed and give good management of mealybugs. So, a laboratory study was conducted at Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal to study the biology and feeding potential of *Brumoides suturalis* (Fab.) on *P. solenopsis*. The results showed that a single female laid 137-192(av. 169.10 ± 14.91) eggs in 27 – 36(av. 32.40 ± 3.10) days. This stage lasted for 3-4 (av. 3.70 ± 0.48) days. The total larval stage in *B. suturalis* occupied 12 - 16 (av. 13.00 ± 1.74) days during which the grub passed through four instars. The adult beetle emerged out after a pupal period of 4 – 5 (av. 4.20 ± 0.42) days. The total life cycle from egg to adult emergence took 19 - 25 (av. 20.90 ± 2.64) days. The male and female ratio was 1:1.40 and adult lived for 11 – 38 (av. 23.10 ± 8.56) days. During their development first, second, third and fourth instar larvae *B. suturalis* consumed a total of 20.80 ± 4.39, 64.99 ± 11.99, 107.40 ± 10.73 and 139.80 ± 13.10 eggs of the prey, *P. solenopsis* in 2 - 3, 3 - 4, 4 - 5 and 3 - 4 days of their duration. Meanwhile, the larvae of *B. suturalis* fed on nymphs of *P. solenopsis* the first, second, third and fourth instar larvae they consumed 6.20 ± 1.23, 24.60 ± 4.43, 66.80 ± 6.70 and 78.80 ± 6.14 nymphs in 2 - 3, 3 - 4, 3 - 4 and 3 - 4 days, respectively. When the larvae of *B. suturalis* fed on *P. solenopsis* it consumed a total of 332.99 ± 40.21 eggs and 176.40 ± 18.50 nymphs in its larval period.

Keywords: Three striped ladybird beetle, fecundity, adult longevity, *P. solenopsis*.

INTRODUCTION

Mealybugs are sap-sucking insects that cause severe economic damage to a wide range of crops (Nagrare *et al.*, 2009). About 5000 species of mealybugs have been recorded from 246 families of plants throughout the world (Muniappan *et al.*, 2006). In India, more than 100 species have been reported to attack a wide variety of plant species including Citrus, Coffee, Cotton, Guava, Grapes, Sugarcane etc. (Varshney, 1985). Since 2005, *Phenacoccus solenopsis* Tinsley (Homoptera: Pseudococcidae), a possibly introduced mealybug, reported originally on ornamental and fruit crops in the United States (Tinsley, 1898) and regarded as an exotic pest in Southeast Asia, including India and Pakistan (Hodgson *et al.*, 2008; Anon., 2008; Nagrare *et al.*, 2009). In India, 22 plant species belonging to 10 families comprising 7 field and vegetable crops, 3 ornamentals and 12 weeds have been reported as hosts of *P. solenopsis* (Dhawan *et al.*, 2007). It is the predominant mealybug species, infesting cotton in Punjab, Haryana, Rajasthan, Gujarat, Maharashtra, Andhra Pradesh and Tamil Nadu (Nagrare *et al.*, 2009). In Punjab the losses caused by the mealybug were

estimated to be Rs. 159 crores to cotton growers during *kharif* season (Anonymous, 2008, 2009). Several predators contribute to mealybug control. Few are specialized on mealybugs, whereas most of them are generalistic that prey on any small, soft-bodied arthropods. Among different predators, coccinellid beetles are the dominating ones in natural agroecosystems. The family ladybird beetles, Coccinellidae comprises of more than 6,000 species (Marin *et al.*, 2010) of ladybirds and includes the predacious beetles of economically important insect pests such as aphids, thrips, mites and whiteflies (Gupta *et al.*, 2012; Hodek and Honek 1996). *Brumoides suturalis* (Fab.) is an effective biocontrol agent of some soft bodied insects in various agroecosystems and found to be most voracious predator of mature and immature stages of mealy bug on different field and vegetable crops (Khuhro *et al.*, 2012). But, the information on the biology and feeding efficiency of *B. suturalis* is meager and therefore, the present investigations on these aspects were studied in Biological Control laboratory, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal to study the biology and feeding potential of *Brumoides suturalis* (Fab.) on *Phenacoccus solenopsis* Tinsley.

MATERIALS AND METHODS

Rearing of host insect, *P. solenopsis*. Good quality potatoes were brought from market and washed under tap water to remove the dirt on the tubers. The tubers were dipped in bavistin @ 2g/lit of water for 10 minutes, removed and washed with tap water and dried under shade. Trays measuring (48cm×36cm) were filled with sterilized sand evenly and potatoes were placed on sand by exposing the eyes for sprouting. The trays were covered with black cloth for early sprouting of the tubers. The tubers were kept at room temperature and watering was done on every day. When the sprouts are at one inch 2-3 gravid females were released per tray. The mealybugs cover the sprouted potatoes after 10-12 days, which was used for rearing of coccinellid predators.

Rearing of predator, *Brumoides suturalis*. Coccinellid predator, *Brumoides suturalis* in around Mohanpur locality was collected from field. Reared in the laboratory on sprouted tubers infested with *P. solenopsis* following Gautam (2008).

Studies on biology of three striped ladybird beetle, *Brumoides suturalis* (Fab.). Males and females were collected from newly emerged adults. One pair of each male and female and they were released in glass beakers measuring (15cm ×10cm dia.) and were provided @ one pair in each beaker on 2-3 mealybug infested potato tuber. The mouth of the beakers were covered with muslin cloth and kept at 27±1°C temperature and 80% RH. The adults were inspected daily till death to record pre-oviposition period, oviposition period, adult longevity; number of eggs laid per female and the experiment was replicated 10 times.

The eggs laid on the potato sprouts, muslin cloth placed on the rearing jars and the walls of the jars were gently separated with camel hairbrush and kept in small petri dish (5cm dia.) till hatching. The period between egg laying and hatching was considered as incubation period. Newly hatched larvae were kept individually in small petri dish (5cm dia.). The larvae were provided with china rose infested with 2nd instar nymphs of mealybugs, the leaf petiole being covered with water-soaked cotton to check moisture reduction from the leaf. The larvae were provided with new mealybug nymphs daily. The coccinellid larvae were checked daily under stereo binocular microscope to record the moulting if any, which was evident from exuviae and head of the early instar. Additionally, adult emergence, larval instars total larval stage, pupal stage egg to adult was calculated. The emerged adults were examined under stereo binocular to find out the sex ratio and the developmental time (egg to adult) was recorded for every species (Chandrababu *et al.*, 1997).

Studies on feeding potential of three striped ladybird beetle, *Brumoides suturalis* (Fab.). Ten newly hatched larvae of each species of predator coccinellid were obtained from stock culture and kept individually in petri dishes (5cm diameter). The larvae were provided with china rose infested with 2nd instar

nymphs of mealybugs, the leaf petiole being covered with water-soaked cotton in order to check moisture reduction from the leaf. For studying the nymphal consumption, the first, second, third and fourth instar beetles were provided with 15, 15, 30 and 50 second instar nymphs of the mealybugs, respectively. To study the rate of consumption of eggs, the larvae were provided with eggs obtained from ovisacs with the help of a fine camel hairbrush @ 25, 35, 50 and 75 eggs per day during first, second, third and fourth instar stage, respectively. The number of nymphs or eggs consumed was checked daily and new nymphs or eggs were placed as per their requirement. The instar wise consumption during the total larval period was worked out. The experiment was replicated 10 times.

RESULTS AND DISCUSSION

A. Biology of three striped ladybird beetle, *Brumoides suturalis* (Fab.)

After the adult exclusion females of *B. suturalis* started laying eggs after 6 -7 (av. 6.30 ± 0.48) days of pre-oviposition period. A single female laid 137-192 (av. 169.10 ± 14.91) eggs in 27 - 36 (av. 32.40 ± 3.10) days. The eggs were spindle shaped, yellow in colour when freshly laid. Eggs were laid either singly or in groups of 3 - 4 eggs. This stage lasted for 3 - 4 (av. 3.70 ± 0.48) days. The total larval stage in *B. suturalis* occupied 12 - 16 (av. 13.00 ± 1.74) days during which the grub passed through four instars. The first instar larvae of *B. suturalis* were dirty cream coloured without any spine. As the larval stage progressed, black markings and spines were developed on the body. The duration of I, II, III and IV instars ranged from 2 - 3 (av. 2.20 ± 0.42), 3-4 (av. 3.30 ± 0.48), 4 - 5 (av. 4.40 ± 0.52) and 3 - 4 (av. 3.10 ± 0.32) days, respectively. For completion of total larval stage, it took 12-16 (av. 13.00 ± 1.74) days. The pupae were spindle shaped, brown in colour with tapering ends and a series of white spots on the body.

The adult beetle emerged out after a pupal period of 4 - 5 (av. 4.20 ± 0.42) days. The total life cycle from egg to adult emergence took 19 - 25 (av. 20.90 ± 2.64) days (Table 1). The male and female ratio was 1:1.40 and adult lived for 11 - 38 (av. 23.10 ± 8.56) days. Chakraborty and Korat (2013) reported the average egg, larva and pupal period of this predator as 5.12 ± 0.07, 14.54 ± 0.12 and 4.34 ± 0.08 days, respectively. Average duration of first, second, third and fourth instar larvae were 1.98 ± 0.06, 2.52 ± 0.07, 5.04 ± 0.09 and 4.36 ± 0.10 days, respectively. Male and female beetle survived for 17.72 ± 0.40 and 34.72 ± 0.60 days, respectively. Female beetle laid 102 to 205 eggs with an average of 142.84 ± 4.72 eggs during her adult period. Entire life of the predator was completed in 40 to 58 days (av. 49.18 ± 0.87 days). Sex ratio (M: F) was 1:1.48. Earlier, the details of various biological aspects, *i.e.*, copulation, pre-oviposition, oviposition and post oviposition periods, as well as egg, larval, pre-pupal and adult stages, are discussed by Ahmad *et al.* (1999).

Table 1: Biological parameters of *Brumoides suturalis* on *P. solenopsis*.

Stage	Duration (Days)
Pre oviposition (days)	6-7(6.30)
Oviposition Period (days)	27-36(32.40)
Fecundity	137-192(169.10)
Incubation period (days)	3-4 (3.70)
I instar larva	2-3 (2.2±0.42)
II instar larva	3-4 (3.30±0.48)
III instar larva	4-5 (4.40±0.52)
IV instar larva	3-4 (3.10±0.32)
Total	12- 16 (13.00±1.74)
Pupal period (days)	4-5 (4.20±0.42)
Total duration (Egg- adult) days	19-25 (20.90± 2.64)
Sex ratio	1:1.25-1:1.45 (1:1.40)
Adult longevity (days)	11-38 (23.10± 8.56)

B. Feeding potential of *Brumoides suturalis* on *P. solenopsis*

The observations on the feeding potentiality of different larval instars of coccinellid *B. suturalis* on *P. solenopsis* eggs and nymphs (Table 2) were revealed the following results. During their development first, second, third and fourth instar larvae *B. suturalis* consumed a total of 20.80 ± 4.39 , 64.99 ± 11.99 , 107.40 ± 10.73 and 139.80 ± 13.10 eggs of the prey, *P. solenopsis* in 2 - 3, 3-4, 4-5 and 3-4 days of their duration. The mean daily consumption at successive larval instars was 8.33 ± 0.47 , 18.47 ± 0.97 , 28.32 ± 0.98 and 43.87 ± 1.80 eggs of *P. solenopsis*. During entire larval period of 12 - 16 days it consumed a total of 332.99 ± 40.21 eggs (Table 2).

When the grubs of *B. suturalis* fed on nymphs of *P. solenopsis*, it consumed 176.40 ± 18.50 eggs in duration of 12-16 days total larval period. During their development the first, second, third and fourth instar larvae they consumed 6.20 ± 1.23 , 24.60 ± 4.43 , 66.80 ± 6.70 and 78.80 ± 6.14 nymphs in 2 - 3, 3 - 4, 3 - 4 and 3 - 4 days, respectively. The mean per day consumption was observed as 2.83 ± 0.40 , 7.43 ± 0.47 , 15.21 ± 0.34 and 25.47 ± 0.63 nymphs in I, II, III and IV instar, respectively. The statistical data shows that 4th stage of *B. suturalis* consumed more mealy bugs than other larval stage. The results are found to be

comparable with the findings of Chakraborty and Korat (2013) who reported that during entire life of the predator in 40 to 58 days (av. 49.18 ± 0.87 days) the beetle predated significantly maximum (177.94 ± 2.75) number of *Phenacoccus solenopsis* nymphs. Whereas Khuhro *et al.* (2012) determined the feeding potential of lady bird beetle, *Brumus suturalis* (Fab.) on cotton Mealy bug, *Phenacoccus solenopsis* in the laboratory and field conditions in Pakistan. The results revealed that *B. suturalis* was voracious feeder of Mealy bugs. The fourth instar devoured maximum mean number of Mealy bugs (55.11 ± 1.38) /day/larva followed by third instar (32.51 ± 1.09), second instar (32.5 ± 0.08) and first instar (25.1 ± 1.41) Mealy bug and the adults female devoured more number of Mealy bug (131.51 ± 2.10) than male (129.57 ± 314) per day under laboratory conditions ($26 \pm 2^\circ\text{C}$). The field results showed that, fourth instar devoured more mean number of mealy bugs / day / larvae of (34.6 ± 1.41), followed by third instar (25.0 ± 0.63), second instar (23.7 ± 0.47) and first instar (19.0 ± 0.16) Mealy bug/larva/day) and the adults female devoured more mean number (72.03 ± 6.16) than male (69.9 ± 6.31) per day. The lower consumption rate in the field may be attributed to the additional time required by the predators in searching of prey. It is also concluded that adults and larvae of predatory beetle prefer the crawlers of mealy bugs.

Table 2: Mean number of eggs and nymphs of *P. solenopsis* consumed by *B. suturalis*.

Predator stage	Mean number of eggs consumed in its larval period	Mean number of nymphs consumed in its larval period
I	20.80 ± 4.39	6.20 ± 1.2
II	64.90 ± 11.99	24.60 ± 4.43
III	107.40 ± 10.73	66.80 ± 6.70
IV	139.80 ± 13.10	78.80 ± 6.14
Total	332.99 ± 40.21	176.40 ± 18.50

CONCLUSIONS

The results of the laboratory experiments conducted revealed that the predominant coccidophagous predatory coccinellids *B. suturalis* have been the most effective as biological control agents for management of *P. solenopsis*. When the grubs of *B. suturalis* fed on nymphs of *P. solenopsis*, it consumed 176.40 ± 18.50 eggs in duration of 12-16 days total larval period. Meanwhile, it consumed a total of 332.99 ± 40.21 eggs

in its total larval period. The predatory potential of *B. suturalis* on eggs and nymphs of *P. solenopsis* increased in the successive larval instars.

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Conflict of Interest. None.

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