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Feeding potential of *Scymnobius sordidus* Horn (Family: Coccinellidae) on cotton mealybug, *Phenacoccus solenopsis* (Tinsley)

Anita Singh, Dolly Kumar

Abstract
During 2008-2011 five natural enemies against mealybug *Phenacoccus solenopsis* were recorded from agriculture fields of Vadodara. Out of these natural enemies *Scymnobius sordidus* was used for recording feeding potential against mealybug. The result shows that the fourth instar larvae were voracious feeder. It was feeding around 36.2± 0.42 number of mealybug nymphs and 2.8 ± 0.2 number of mealybug adults. In its life cycle, the larva stages consumed around 61.6±0.48 nymphs and 7.6±0.48 adults of mealybug. Hence, *S. sordidus* is having good potential as bio control agents against mealybug.

Keywords: *Phenacoccus solenopsis*, *Scymnobius sordidus*, Natural enemies

1. Introduction
Today management of mealybug *P. solenopsis* is major concern in the agricultural fields. *P. solenopsis* is the major menace in many tropical and subtropical countries; attacking 159 hosts plant species (agricultural and horticultural crops) belonging to 21 different families [24, 3]. In India this *P. solenopsis* is taken prime position in North India (Punjab, Haryana and Rajasthan), whereas it shows moderate incidence of damage in Central India (Gujarat and Maharashtra) and South India [9]. It cause yield loss by direct and indirect infestation. In direct mode of infestation they feed on leaves, stems, fruits and roots of host plants. Whereas in indirect mode of infestation they secrete honey dew which causes development of sooty mould which inhibit photosynthesis which leads to host plant death [23]. Due to this direct and indirect infestation by mealybug causes huge yield loss; reducing the cotton yield by up to 40-50 % in infested fields [16]. This yield loss leads the grower to protect their crops by applying synthetic chemical insecticides such as organophosphates, carbonates, synthetic pyrethroids and nicotinoids [17]. Although indiscriminate use of these chemicals are showing direct impacts on natural enemies life span, fecundity and ability to locates hosts which encourages the use of biorational alternatives for minimizes the load of pesticides [6, 1, 10, 21]. Therefore present study was conducted for identification of various natural enemies against mealybugs. Further the consumption rate of one of the predator, *Scymnobius sordidus* Horn was recorded in laboratory to know its feeding potential so that it can be used in future.

2. Materials and methods
Observations for naturally found bio-control agents associated with mealybugs were recorded from the selected agricultural sites in Vadodara from 2008 to 2011 at weekly interval from 25 randomly selected plants having infestation.

Collection, preservation and identification of bio control agents associated with mealybug
Each of the study sites was visited twice a month. On each day the sampling was done twice once in morning hrs (7 am to 9 am) and second time during evening hrs (5 pm to 7 pm). Collection was done by sweeping and hand picking methods. Insects were killed using killing jars with chloroform. Collected insects are pinned accordingly. Collected larval stages were transferred in to vials having 70-90% ethyl alcohol, brought to the laboratory, mounted on slides and then observed and identified. Identification and labeling was done using keys available in standard taxonomic literature [2, 5].

Mass multiplication of *Phenacoccus solenopsis* [20]

The rearing and breeding of *P. solenopsis* was carried at room temperature (24.3-31.2 °C, 48.9-71.7% R.H.) in the laboratory. The cotton twigs, harboring *P. solenopsis* colonies, were collected from the fields and brought to the laboratory. The mealybugs present on these cotton twigs were gently removed with the help of soft camel hair brush and were released on the cotton twigs (Twigs end was wrap with wet cotton) kept in plastic box (20 x 15 cm^2) in laboratory. Newly hatched crawlers were collected from the ovipositing female of laboratory culture and were placed onto the cotton twigs for mass rearing. Culture obtained was used for further experiments.

Mass Multiplication of *Scymnobius sordidus*

A predator stock culture was obtained from *P. solenopsis* collected from cotton and okra fields in Vadodara. The predatory larva was reared on *P. solenopsis* grown on hibiscus leaves and twigs in plastic cages as described above for rearing of mealybugs. 5 pairs of male and female were transferred into a small plastic cage containing 3 instars and virgin females of mealybug. Culture was maintained at 28 ± 1 °C, 60 ± 5% RH, under a photoperiod of 16:8 L: D.

To assess the feeding potential

After hatching 25 nymphs and adults of *P. solenopsis* were offered to 1st, 2nd, 3rd, 4th larval stage of *S. sordidus* separately. 10 insects were added daily after 1st day. Single larva of *S. sordidus* was released after one hour of release of nymphs and adults in each petri plate (after settling of mealybugs). The predatory potential was recorded by counting the number of mealybugs fed by 1st, 2nd, 3rd, 4th larval stage of *S. sordidus* up to pupation.

3. Results and Discussion

The survey to the study sites shows that 5 species of biological control agents have been recorded feeding on cotton mealybugs in the agricultural fields of Vadodara (Figure 1A, 1B, 1C, 1D, & 1E).

Figure 1A, 1B, 1C, 1D, 1E: Natural enemies collected from Vadodara agriculture field

1A. Larvae of *Scymnobius sordidus* Horn

1B. *Aenasius bambawalei* Hayat & its cocoons

1C. *Sympherobius fallax* (Navas)

1D. *Chrysoperla zastrowi Arabica* (Henry)

1E. *Cheilomenes sexmaculata* Fab.

These field collected natural enemies was from three different orders (coleoptera, Neuroptera, hymenoptera) and 4 different families (Table 1).

Table 1: Biocontrol agents recorded for *Phenacoccus solenopsis* from agriculture field of Vadodara

Order	Family	Scientific name	Status
Neuroptera	Hermerobiidae	*Sympherobius fallax* (Navas)	Predator
	Chrysopidae	*Chrysoperla zastrowi Arabica* (Henry)	
Coleoptera	Coccinellidae	*Cheilomenes sexmaculata* (Fab.)	
		Scymnobius sordidus (Horn)	
Hymenoptera	Encyrtidae	*Aenasius bambawalei* Hayat	Parasitoid

Similarly, seven species of predatory coccinellid beetles belonging to sub family Scymninae from vegetable field of Kerala associated with sucking pest was reported [12]. All collected species are having great potential against mealybugs. *Aenasius bambawalei* is reported as good natural enemy of mealybug *P. solenopsis* in Gujarat and Haryana [13, 11]. It is having high parasitism potential against invasive mealybug *P.*

solenopsis [7]. Predators such as lacewing *Crysoperla carnia* and *Sympherobius fallax* are having high capability for controlling mealybug *P. solenopsis* [18, 8, 15]. Although during field visit it was also recorded that the farmers were driven to extensive usage of insecticides against mealybug in Vadodara [22]. These practices were showing pest resurgence, secondary pest outbreak and adverse effect on natural enemies (non-target effects) of the pest. The adverse effect of broad spectrum insecticides like chlorpyrifos caused adverse effect on *Coccidoxenoides peregrinus* (Timberlake) (Hymenoptera: Encyrtidae) of *Planococcus ficus* (Signoret) [25]. Similarly in South Africa use of contact insecticides like synthetic pyrethroid (Cypermethrin), Carbamate (Mancozeb) against Vine mealybugs showed adverse effect on the development of parasitoids *Anagyrus sp*. and *Coccidoxenoides perminutus* [14]. These negative impacts on non target insects make chemical control as less desirable option and insist on development of proper strategies to control the *P. solenopsis* by slowly weaning away the farmers from use of pesticides to a more ecofriendly pest management like use of bio-control agents.

Out of all identified natural enemies the *Scymnobius sordidus* Horn was used for evaluation of its feeding potential. The result shows that the fourth instar larvae were voracious feeder. This stage was feeding around 36.2 ± 0.42, 2.8±0.2 number of mealybug nymphs and adults respectively. Larvae were mainly preferred nymph then adult of mealybug. The total number of *P. solenopsis* nymph, adult consumed by the larvae of *S. sordidus* during its life cycle was 61.6±0.48 and 7.6±0.48 respectively (Table 2).

Table 2: Consumption of different stages of *Phenacoccus solenopsis* Tinsley by different instars of *Scymnobius sordidus*

Mealybug Stages	*Scymnobius sordidus* Larval Instars (Mean ±SE)				
	1st	2nd	3rd	4th	Total
Nymphs	5.8±0.13	7.2±0.2	12.4±0.16	36.2±0.42	61.6±0.48
Adults	1.4±0.16	1.6±0.16	1.8±0.13	2.8±0.2	7.6±0.48

Similar result was reported by many Coccinelid species such as *Cryptolaemus montrozieri*, *Brumus suturalis* which preferred nymph stage than adult of *Phenacoccus solenopsis* [4, 10, 18, 19]. The high potential of predatory nature gives good indication to use *Scymnobius sordidus* Horn as bio-control agent for *Phenacoccus solenopsis*.

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