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Seasonal Occurrence and Predatory Efficiency of *Spalgis epius* (Westwood) on Mealy Bug, *Paracoccus marginatus* (Williams and Granara De Willink) infesting Cotton

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***Spalgis epius* (Westwood) is a lycaenid predator of the mealy bug *Paracoccus marginatus*. Seasonal occurrence of *S. epius* in cotton field and its predatory efficiency on *P. marginatus* were studied. Peak activity of this predator was observed during the months of June and July. Mean occurrence of *S. epius* was more in cotton compared to alternate hosts. Significantly higher number of mealy bug crawlers was predated by the 3rd instar larvae of the predator followed by 2nd instar and 4th instar larvae. Percentage of predation by *S. epius* was directly proportional to the level of infestation of mealy bug indicating the pest-density dependent behaviour of the predator.**

Keywords: Mealy bug; *Paracoccus marginatus*; lycaenidSpalgis epius; Seasonal occurrence; Predatory efficiency; Cotton

Several economically important crops are infested by various species of mealy bugs across the world (Browning, 1992; Franco *et al*., 2001). The papaya mealy bug, *Paracoccus marginatus* (Williams and Granara de Willink) is a polyphagous pest causing damage to a large number of crops such as papaya, tapioca, pigeon pea, cotton, okra, tomato, brinjal, silk cotton, jatropha, mulberry and plumeria; numerous weeds including *Parthenium hysterophorus*, *Sida acuta*, *Acalypha indica*, *Eupatorium adenophorum* and *Cassia sericea*; and some forest trees like teak, rain tree and prosopis. Dhara Jothi *et al*. (2008) reported *P. marginatus* for the first time on cotton in Coimbatore district, Tamil Nadu. The toxic substance injected into the leaves while feeding results in chlorosis, plant stunting, leaf deformation, early leaf drop and death of the plant (Galanihe *et al.,* 2010).

The parasitoids, *Anagyrus loecki* Noyes, *Pseudleptomastix mexicana* Noyes and Schauff and *Acerophagus papayae* Noyes and Schauff (Hymenoptera: Encyrtidae) were imported from Puerto Rico and released into field in Palau for the control of *P. marginatus* and successful control was achieved with *A. loecki* and *A. papayae* (Muniappan *et al.,* 2006).

Paracoccus marginatus was reported to be predated by *Spalgis epius* (Westwood) (Lepidoptera: Lycaenidae: Miletinae) (Thangamalar *et al.,* 2010). *S. epius* has been recorded as a predator of many species of mealy bugs, namely, *Dactylopius sp., P. lilacinus* (Ckll.), *Planococcus citri* (Risso), *Ferrisia virgata* (Ckll.) and *M. hirsutus* (Green) (Dinesh and Venkatesha, 2011 a,b,c; Pushpaveni *et al.,* 1973). Aitken (1894) reported *S. epius* as a predator of mealy bugs from India. It has an egg, two larval stages and an adult stage (Fig. 1).

The predatory activity of *S. epius* on the mealy bug, *Paracoccus lilacinus* infesting citrus, pomegranate, ber and guava has been reported in Southern India (Mani and Krishnamoorthy, 1998). Feeding efficacy of *S. epius* was observed on the mealy bugs, *Paracoccus citri* (Vinodkumar *et al.,* 2008) and *P. marginatus* (Thangamalar *et al.* 2010). Larvae of *S. epius* have been found to feed voraciously on *P. marginatus* (Dharajothi *et al.,* 2009) (Fig. 2).

Vinodkumar *et al.* (2008) described the characteristics of *S. epius*. The pupa exhibits a characteristic appearance like the face of a monkey hence it is commonly called 'Ape fly'. Although many studies were carried out on the control of *P. marginatus*, accounts on endemic biocontrol agent for this pest infesting cotton are meagre. This study reports the seasonal occurrence of *S. epius* in cotton field and alternate hosts and the predatory efficiency on *P. marginatus*.

Materials and Methods

Seasonal occurrence of S. epius on cotton and alternate hosts

Seasonal occurrence of *S. epius* on cotton and other alternate hosts namely parthenium, glyricidia, crotons, hibiscus, guava, papaya, silk cotton, banana and Ixora was recorded from the experimental fields of Central Institute for Cotton Research (CICR), Regional Station, Coimbatore during 2008-11. Weekly observations were made on the predator activity on cotton and other hosts. Ten plants were tagged and twigs of 15 cm length were observed for

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the population of *S. epius* larvae and the infestation grade of mealy bug.

Natural occurrence of S. epius on cotton

Under field conditions, the predatory efficiency of *S. epius* was recorded on the mealy bug infested cotton plants in an area of half an acre, which was divided into nine strips each with 42 rows. The number of healthy plants, mealy bug infested plants and mealy bug infested and predated plants were recorded and the percentage of mealy bug infestation as well as predation was calculated.

Predatory efficiency of S. epius on P. marginatus

Rearing of S. epius and P. marginatus

Both *S. epius* and *P. marginatus* were collected from the experimental field of the Central Institute for Cotton Research, Regional station, Coimbatore and cultured in laboratory. *P. marginatus* was mass cultured using potato sprouts under laboratory condition at 25 ± 1 ˚C and 65 ± 2 % RH and 14:10 (L:D) photoperiod adopting the methodology of Branigan (1916). Potatoes with many eyes were kept in wet gunny bags under dark condition for four to five days to induce sprouting. The tubers were sown in plastic bucket (23×18 cm), filled with sterile moist sand. When the sprouts reached a height of 15 to 20 cm, the crawlers from the infested papaya leaves collected from the field were introduced onto the green sprouts using a camel hair brush (Series No. 68). Larval instars of *S. epius* collected from the cotton field were reared individually on *P. marginatus* grown on potato sprouts.

Predatory efficiency

Laboratory experiments were conducted to evaluate the predatory efficiency of *S. epius* on *P. marginatus*. The larval instars of the predator were released individually in Petri plates at 10/plate and prey was provided. Second, third and fourth instar larvae of the predator were provided with 500 mealy bug crawlers and observations on predation were made at 1, 24 and 48 h after releasing. In another experiment, second and third instar larvae of the predator were provided with 20 egg masses/day and observation on predation was taken at 24 h. Total number of crawlers and egg masses fed by each larval instar was recorded by counting the remaining prey stages in the Petri dishes. Each experiment was replicated ten times. Data on the predation on crawlers were subjected to ANOVA followed by Student-Newman-Keuls test (SPSS 16.0. 2007).

Results

Seasonal occurrence of S. epius on cotton and other alternate hosts

Periodical observations during 2009-10 on cotton (summer crop) and other hosts revealed that there was no activity of the *S. epius* during March and April and the activity resumed during the month of May. Peak activity of this predator was observed on cotton during the month of July. Highest number of *S. epius* was recorded on cotton followed by *parthenium*, crotons, *hibiscus*, guava and *glyricidia* (Fig.3).

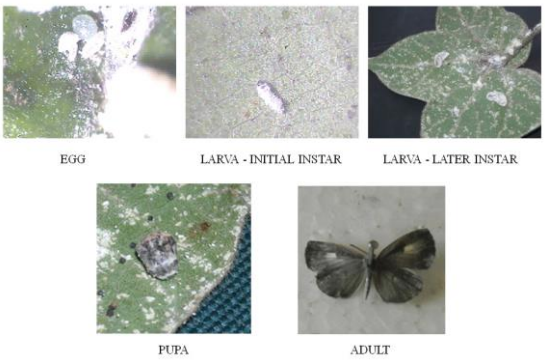

Fig. 1. Life stages of *S. epius*

During 2010, mealy bug infestation grade ranged from 1 to 3 among the different hosts. parthenium and *Tridax porcumbens* recorded maximum level of grade III. Maximum population of *S. epius* was recorded in Hibiscus followed by parthenium (Fig.4). Seasonal dynamics of *S. epius* was recorded from June to January. *S. epius* occurred from June to September and no population was recorded thereafter up to January. Maximum population was recorded during the month of June on hibiscus followed by parthenium and *Annona squamosa* (Fig.5).

Natural occurrence of *S. epius* on cotton

Infestation of mealy bug was observed in all the strips with the highest infestation of 98.29 in the second strip followed by first strip with 98.01%. The percent predation gradually decreased in the subsequent strips from 1 to 9. Activity of the predator was intense in the first four strips and it gradually decreased towards 9^{h}strip. As the percentage mealy bug infestation gradually decreased from first to ninth strip, percentage of predation also decreased and became nil in the last strip (Table 1). This clearly depicts the density dependent behaviour of the predator in predation.

Predatory efficiency of *S. epius* on *P. marginatus*

Significantly higher number of mealy bug crawlers was predated by the 3rdinstar larvae of the predator followed by 2ndinstar larvae and the least number of crawlers by 4 thinstar (Table 2). Among the 2 ndand 3rdinstar larvae of the predator, 3 rdinstar predated significantly more number of egg masses per day compared to 2ndinstar (Table 3).

Discussion

In the present study, maximum population was recorded during the month of July on cotton and hibiscus and it is in agreement with the report of Thangamalar *et al.* (2010) who stated that *S. epius* was the dominant predator feeding on mealy bugs during June to October. Venkatesha *et al.* (2004) reported that the first instar larvae fed only on the egg masses of the mealy bugs, while the second instar

larvae fed on the egg masses as well as young nymphs and the third and fourth instar larvae voraciously fed on all stages of the mealy bugs. In the present study, it was observed that among the 3 stages of the predator larvae, 3 rdinstar larvae consumed significantly more number of crawlers followed by 2 ndand 4 thinstar larvae. The significant decrease in the prey consumption of the fourth instar larvae might be due to the time taken for the preparation for the pre-pupal stage.

Mealy bug infested plant

Plant Showing residue of predated mealy bugs

Fig. 2. Mealy bug infestation and predation by *S. epius*

Preliminary observations made on *S. epius* in the field revealed that a full grown larva consumed 300 nymphs of *M. hirsutus* per day (Pushpaveni *et al.,* 1973). Though the predator recorded its voracious feeding behaviour on the mealy bug, natural control of the pest by the predator did not take place in cotton because of many reasons. Cotton cropping system is pesticide dependent and the lycaenids are sensitive to the insecticides. These predators were scarce in cotton because of regular spray of pesticides (Thangamalar *et al.,* 2010). In the present study, the occurrence of the predator was not observed during the cropping season (February-May) due to the application of pesticides for the management of sucking pests. The peak activity of the pest was observed during June to July which was the end of the cropping season and predator coincided with the peak pest activity. Density dependant behaviour of the predator was evident from the level of occurrence and the pest infestation status on different hosts.

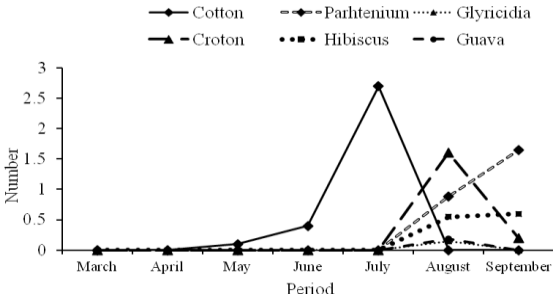

Fig. 3. Spalgis on various alternate hosts (2009-10)

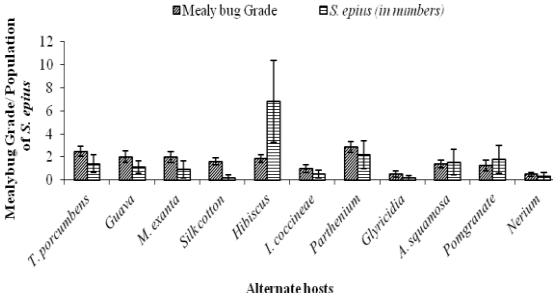

Fig. 4. Occurrence (Mean±SE) of *S. epius* in alternate hosts during June-January (2010-11)

Table 1. Percentage infestation of mealy bug *P. marginatus* and predation of *S. epius*

	I-S	II-S	III-S	IV-S	V-S	VI-S	VII-S	VIII-S	IX-S
Percentage infestation	98.01	98.29	90.37	92.42	93.29	97.12	92.88	86.76	79.66
Percentage predation	55.06	64.70	60.82	66.66	13.0	4.93	0	0	0

*I-S to IX-S indicates one time observation in different strips under field condition, to indicate the level of infestation and predation.

Table 2. Predatory efficiency of *S. epius* on mealy bug crawlers

Sl.No.	larval stage of *S. epius*	No. of crawlers consumed/tolerance Mean±SE*		
		1 hour	24 hour	48 hour
1.	2ndinstar	31.3±1.7 a	306.5±8.0 a	402.0±8.1 a
2.	3rdinstar	53.4±6.8 b	464.5±7.5 b	526.2±17.8 b
3.	4thinstar	29.6±5.7 a	277.0±33.7 a	382.6±46.7 a

Means within the same column followed by same letters are not significantly different at $P<0.05$, Student-Newman-Keuls test.

Table 3. Predatory efficiency of larval stages of *S. epius* on egg masses of mealy bug

larval stage of *S. epius*	No. of egg masses consumed/day tolerance Mean±SE*
2nd instar	6.3±0.4 (2.49)b
3rd instar	9.6±0.3 (3.09)a
SEd	0.09
CD (0.05)	0.19

Means within the same column followed by same letters are not significantly different at (P=0.05) by DMRT

As the predators are always density dependant, high infestation level is preferred by the predator. Under cotton ecosystem mealy bug population is monitored and controlled through need based spray

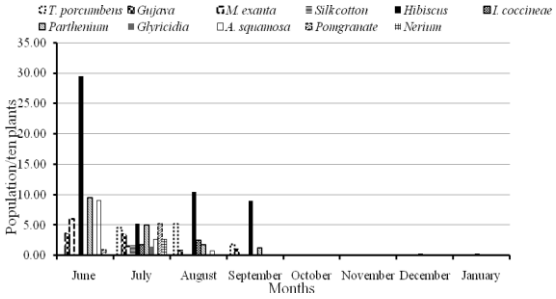

Fig. 5. Seasonal dynamics of *S. epius* larval 2010-11

application hence the build up of the predator is not facilitated. Males of the predator outnumbered the female which influences the number of eggs laid. Rearing of the predator under artificial conditions is not successful because of the fact that the females do not oviposit under captivity. The adoption of integrated pest management strategies with more emphasis on biocontrol methods instead of using chemical pesticides alone may facilitate the conservation of this predator in the field.

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