

## Bionomics of papaya mealybug, *Paracoccus marginatus* and its predator *Spalgus epius* in mulberry ecosystem

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**Abstract:** Papaya mealybug, *Paracoccus marginatus*, the invasive pest from Central American countries has caused havoc in agricultural and horticultural crops in India ever since its first report from Coimbatore during 2007. The search for the effective parasitoids in India is still elusive. Attention has been focused on the conservation of native predators of the pest. *Spalgus epius* was recorded as a potential predator of different species of mealybugs and scales. As mulberry ecosystem provides a suitable niche for colonization of the predator owing to limited use of chemicals, investigations were taken up to explore the utility of this Lycaenid as a biological control agent of *P. marginatus* in mulberry. Photomicrograph aided investigations have thrown light on the peculiar feeding behaviour of the predatory larvae. Ex situ confinement studies have shown that the fifth instar larvae consumed as much as 18 to 26 ( $22.33 \pm 3.21$ ) ovisacs and 112 to 132 ( $121.66 \pm 8.86$ ) nymphs and adults of the mealy bugs. During the whole larval period the predatory larvae devoured about 42 to 53 ( $48.15 \pm 4.08$ ) ovisacs and 196 to 222 ( $210.99 \pm 10.77$ ) nymphs and adults of *P. marginatus*.

**Key words:** Papaya mealybug, *Paracoccus marginatus*, predator, *Spalgus epius*, mulberry ecosystem

### Introduction

Papaya mealybug, *Paracoccus marginatus* Williams and Granara de Willink (Hemiptera: Pseudococcidae) a native to central America/Mexico has spread to more than 50 countries ever since the first report of the pest in Caribbean islands. In India, the pest was first reported from Coimbatore during 2007 infesting papaya and since then the list of agricultural and horticultural crops damaged/infested by this invasive pest is growing at an alarming rate.

*S. epius* was recorded as a potential predator of different species of mealybugs and scales. The adults of *S. epius* congregate the plants infested with the hemipteroid insects. The lycaenid predator was commonly associated with the natural control of *Phenococcus iceryoides*, *P. glomeratus*, *Pseudococcus lilacinus*, *P. citri* infesting cotton, *Pithocolobium saman*, Chinese Rose and *Dolichos lablab* and Sesbania (Ramakrishnan Ayyar, 1929). Pushpaveni *et al.* (1973) recorded natural control of *Macnelicoccus hirsutus* on Mesta while Mani and Krishnamoorthy (1998) recorded *S. epius* as a natural enemy of mango green shield scale. Recently papaya mealy bug incidence was noticed on mulberry crop in western parts of Tamil Nadu. It is important to know the life history and bionomics of the pest and its natural enemies for planning strategies to control this pest. Details of biology and bionomics of this pest are limited. This paper deals with the biology and bionomics of the host and its predator in its natural ecosystem. Biometric observations were recorded on eggs and different instars using photomicrographs and image analysis.

### Material and methods

Seasonal distribution of *S. epius* was recorded on mulberry during June – December, 2009. Random samples were taken from ten plants and the population of *S. epius* larvae and the mealy bug *P. marginatus* was recorded.

*S. epius* was maintained on the mealy bug, *P. marginatus* infested pumpkin fruits in the laboratory at 25-28°C and 60-70% relative humidity as outlined by Chacko *et al.* (1978). Observations were recorded by conforming well grown larvae of *S. epius* into known number of ovisacs and crawlers of *P. marginatus* to assess the feeding potential. The number of eggs/nymphs consumed by the predator in each larval instar was recorded. Simultaneously observations were also recorded in field cages by confirming known member of *S. epius* larvae on *P. marginatus* infested mulberry shoots.

Efficacy of *S. epius* in the suppression of *P. marginatus* was studied in Victory-1 mulberry variety. Plants infested with mealy bugs were chosen and tagged for study. In growing tip of the plant mealy bug population per 15 cm were selected for recording the data.

### Results and discussion

Periodical observations were recorded on the populations of papaya mealybug, *P. marginatus* and its lycaenid predator, *S. epius* on mulberry shoots in V1 mulberry garden during June to November, 2009. The mealybug population was on the rise during June to September with the peak incidence of the pest observed during second fortnight of July. During June to October, activity of other natural enemies could not be seen in the mulberry garden with the Lycaenid predator, *S. epius* being the dominant predator feeding on the ovisacs, nymphs and adult mealy bugs. During October and November months, presence of coccinellids like *Cryptolaemus montrouzieri*, *Scymnus* sp. could be noticed in the mulberry gardens and the population of *S. epius* was on the decline (Table 1).

Table 1. Population of the mealy bug, *Paracoccus marginatus* and its predator *Spalgus epius* in mulberry garden (June to December, 2009)

Table 1. Population of the mealy bug, *Paracoccus marginatus* and its predator *Spalgus epius* in mulberry garden (June to December, 2009)

Sl.No.	Date of observation	Population / Shoot	
		<i>Paracoccus marginatus</i>	<i>Spalgus epius</i>
1	30 <sup>th</sup> June	2.46 ± 56.86	2.00 ± 1.00
2	20 <sup>th</sup> July	50.60 ± 23.79	1.30 ± 0.57
3	30 <sup>th</sup> August	34.33 ± 5.03	2.00 ± 0.75
4	15 <sup>th</sup> September	24.22 ± 2.44	1.5 ± 0.55
5	2 <sup>nd</sup> October	16.33 ± 4.50	0.66 ± 0.57
6	20 <sup>th</sup> November	8.00 ± 4.36	0.33 ± 0.58

The values are mean ±SD of 10 shoots

Observations were recorded by confining the larvae of *S. epius* by netting the *P. marginatus* infested mulberry plants. The adult female mealybug *P. marginatus* laid eggs (approximately about 150 to 200 eggs) inside the ovisacs. Eggs were pink coloured, grain like measuring 0.120 cm. Newly hatched larvae of *S. epius* are pale pink in colour measuring about 0.129±0.0028 cm, remained inside the ovisac devouring the eggs of the mealy bug. While, the creamy white second instar larvae (0.249±0.022 cm), coming out of the ovisac, eggs of the mealy bugs clung between the tubercles of the larva and the larva appeared as though creamy yellow in colour. Biometric measurements show the sizes of the third, fourth and fifth instar larvae were of the size (length) 4.64±0.55 mm, 10.24±0.57mm and 16.22±0.19 mm, respectively. The total life cycle lasted for 14.83 ± 0.44 days with the larval life span of 9.83±2.39 (I instar : 2.5±0.5 days; II instar : 1.75±0.25 days; III instar : 1.41±0.38 days; IV

Table 2. Developmental stages of *S. epius*

Sl. No.	Growth stages	Developmental period (days)
1	Larval stages	---
2	I	2.50 ± 0.5
3	II	1.75 ± 0.25
4	III	1.41 ± 0.38
5	IV	2.0 ± 0.50
6	V	2.1 ± 0.76
7	Pupae	5.45 ± 0.50
	Total	14.83 ± 0.44

instar : 2±0.5 days; V instar : 2.1±0.76 days). The larvae pupate on the under surface of the leaves to form the characteristic rhesus monkey face chrysalis. The pupal period was about 5.45 ±0.50 (Table 2; Plate 1)

*S. epius* is a well known representative of carnivorous butterfly feeding on various species pseudococcids and coccids. Early account of description of *S. epius* as given by Green (1905) was incorporated in the description of Lycaenids of Ceylon by Deniceville (1891). Aitken (1890) observed the life history and gave a detailed account on the complete morphology of mature larvae and pupa of *S. epius*. As, the larvae were slug like coated with wax coating, *S. epius* camouflaged with mealy bug population, it is very difficult to distinguish the predator from its prey.

Plate 1. Life stages of *Spalgus epius*

Table 3. Predatory potential of *Spalgis epius* on papaya mealybugs infesting mulberry

Sl. No.	Feeding potential of <i>S. epius</i>		
	<i>Spalgis epius</i> life stages	No. of ovisacs consumed	No. of nymphs consumed
1	I	*	*
2	II	3.16 ± 0.29	16.33 ± 4.16
3	III	4.33 ± 1.53	23.00 ± 0.50
4	IV	18.33 ± 3.05	50.00 ± 6.25
5	V	22.33 ± 3.21	121.66 ± 8.86
	Total	48.15 ± 4.08	210.99 ± 10.77

\*The predatory potential could not be ascertained exactly as the larvae

Conceals inside the ovisacs of *P. marginatus*

Values are means of 5 replications

Although detailed descriptions of the matured larvae and pupae were given by several authors, photo micrograph techniques capture vividly the eggs and first instar larvae of *S. epius* inside the ovisacs of mealybugs giving a glimpse of the feeding behaviour of *S. epius*

The first instar larvae of *S. epius* preferred to feed on the ovisacs, while the second through fifth instar larvae devoured eggs, nymphs and adults of papaya mealy bugs. Ex situ confinement studies have shown that the fifth instar larvae consumed as much as 18 to 26 (22.33±3.21) ovisacs and 112 to 132 (121.66 ± 8.86) nymphs and adults of the mealy bugs. During the whole larval period the predatory larvae devoured about 42 to 53 (48.15±4.08) ovisacs and 196 to 222 (210.99 ± 10.77) nymphs and adults of *P. marginatus*.

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pest in guava orchard. Mani and Krishnamoorthy (1998) recorded *S. epius* as a natural enemy of Mango Green shield scale. *Spalgis* spp have been recorded as a commonly occurring natural enemy on pseudococcid pests of different crops. Although, *S. lemolea* was a common natural enemy of *Phenococcus madeirensis* infesting Cassava in Africa (Herren and Neuenschwander, 1991) but its potential utility as an effective biological control agent was thwarted by its erratic occurrence.

The papaya mealy bug, *P. marginatus* has been spreading fast across globe in over 50 countries ever since its first record in the Caribbean islands during 2003. This invasive pest has been reported to infest major crops of economic importance in Southern India ever since the description of the pest from Coimbatore during 2007. Although classical biological control through parasitoids like *Anagyrus loecki*, *Pseudleptomastix mexicana*, *Acerophagus papayae* have been reported to keep the pest under check in the Carribbean islands (Muniappan *et al.*, 2006), the search for the effective parasitoids in India is still elusive. As *S. epius* was recorded as a potential predator of different species of mealybugs and scales, investigations were taken up to explore the utility of this Lycaenid as a biological control agent of *P. marginatus* in mulberry. As Lycaenids are sensitive to the action of chemicals, these natural predators have been scarcely found in crops like cotton because of regular spray of pesticides. In contrast mulberry ecosystem provides a suitable niche for colonization of the predator owing to limited use of chemicals for the sensitivity of the harmful pesticides against silkworms. Regular surveys show the occurrence of *S. epius* as a common natural enemy in mulberry ecosystem and confinement studies have revealed that the Lycaenids are effective natural enemy of *P. marginatus* in mulberry ecosystem. With the refinement of conservation techniques, there is a scope for utilizing *S. epius* larvae as a potential biological control agent of *P. marginatus* in mulberry ecosystem.

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