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Bionomics of predatory butterfly, apefly (*Spalgis epius*) (Lepidoptera: Lycaenidae) on mealybug, *Paracoccus marginatus* (Hemiptera: Pseudococcidae) in cocoa

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Abstract
Apefly, *Spalgis epius (*Westwood) (Lepidoptera: Lycaenidae) is a small aphytophagous butterfly and their larvae feeds on the insects of Pseudococcidae, Hemiptera. In the present study, development of immature stages and life cycle of this predatory butterfly was observed on mealybugs, *Paracoccus marginatus* (Williams and Granara de Willink) (Hemiptera: Pseudococcidae) in cocoa under the laboratory conditions. The morphometry results indicated that the diameter of the egg was 0.52 ± 0.06 mm and the they were collected and kept in the laboratory at 25-30°C and 40-80% Relative Humidity. The eggs were greenish blue in colour and disk shaped, sculptured and both the top and bottom compacted with micropylar despair in the top and hatched in 4.16 ± 0.29 days. It undergoes four larval instars and the total larval period lasts 13.1 ± 0.12 days. The upper surface of the larval body was fully developed with wax coating. The duration of the pre pupal stage was 3.00 ± 0.17 days. The mold on the hard dorsal side of the pupa resembled on the face of a monkey structure. The prepupal larva shrunk and turned toward dull black colour of the surface of body. The pupal period was recorded as 10.00 ± 0.04 days. The total duration from egg to adult emergence was noticed as 30.30 ± 0.33 days. In adults, the patch is bigger in females than that in the males. The knowledge of development and life cycle of *S. epius* on factitious/natural hosts on various crops is advantageous to develop and standardize the mass culturing techniques for exploration of this potential species for predation of mealybugs.

Keywords: Biology, Cocoa, Lycaenidae, Mealybugs, Predator, *Spalgis epius*

INTRODUCTION

Butterflies are taxonomically well studied group, which have received a reasonable amount of attention throughout the world and around 18,000 species of butterflies are estimated to be there in the world and India alone has recorded 1,501 species (Kehimkar, 2008). The larva of the Apefly, *Spalgis epius* (Westwood) (Lepidoptera: Lycaenidae, Miletinae) a hemipterophagous butterfly were found feeding on eggs, nymphs and adults of papaya mealybug, *S. epius* is a member of the entirely entomophagous lycaenid subfamily Miletinae, most species of which feed on Hemiptera (Perice *et al.,* 2002). The several species of mealybugs are serious pests of economically important crops worldwide (Browning 1992 and Franco *et al.,* 2001). In Indian region, the larva of *S. epius* has been reported as a possible predator of *Planococcus citri* in coffee plantation and *Maconelli hirsutus* in mulberry gardens (Gowda *et al.,* 1996; Mani, 1995 and Rahiman and Vijayalakshmi, 1998). The *S. epius* lays its eggs near a mealy bug colony, on hatching the caterpillar moves into the colony to feed on the mealy bugs. The caterpillar disguises itself by covering its back with the mealy bug skins after feeding on them. The small pupa has a remarkable resemblance to the monkey face structure (Singh, 2011). There are only two species found in Peninsular India, the Apefly *S. epius* and the mottle (*Logania distani* Semper). These are small dull brown and white butterflies and inhabitants of wooded areas. The caterpillars are remarkable in the feeding habitat. They didn't feed on plants but small often powdery relatives of bugs, the mealy bugs and scale insects found on crop plants. Though, the biology of Apefly was studied on the same host on other crops like papaya (*Carica papaya L.), Cassava (Manihot esculenta* Crantz*), Plumeria (Plumeria sp.) and Hibiscus (Hibiscus rosa-sinensis L.) (Walker et al., 2006).* In this context, an attempt was made to

study the development and life cycle of the potential predatory butterfly on mealybug, *Paracoccus marginatus* in cocoa plantations so that the knowledge could be utilized in mass multiplication of this butterfly for further exploration.

MATERIALS AND METHODS

The present study was carried out in the Department of Entomology, Annamalai University during January to June 2017. The mealybug, *Paracoccus marginatus* infected cocoa plants growing in Thondamuthur area of Coimbatore District were thoroughly surveyed and the *S. epius* was collected by using a camel hair brush to establish a laboratory culture and allowed to lay eggs on the mealy bug reared on cocoa fruit. The *Paracoccus marginatus* was recognized with the body elongate oval, somewhat flattened dorsoventally covered with mealy wax, not thick enough to hide yellow body, legs light yellow, without bare areas on dorsum, ovisacs on ventral side with 15 to 17 lateral wax filaments, posterior pair of filaments conspicuously longer (Miller and Miller, 2002) (Plate 1).

In the present study, eggs of *S. epius* were collected from the host insect and kept individually in petri dishes of 4.5 cm diameter and provided with stages of mealybugs. The petri dishes were observed daily for larval eclosion. The caterpillar developed in the petri dishes was daily cleaned and the fecal matter and remains of dead mealybug stages were removed. The fresh mealybug stages were given as food to *S. epius* larvae daily. The growth of *S. epius* larva was monitored and the moulting stage was noted to arrive at the larval stadia. Close observations on the larval instars, prepupa, pupal stage and adult development period and number of instar in a life cycle were recorded. The egg and each stage of larva, 1st instar, 2nd instar, 3rd instar, 4th instar, prepupa and pupa were measured using micrometric techniques. The cages each with three pairs of *S. epius* adult butterflies were kept under the laboratory conditions. To study the longevity, three males and three females that emerged in the laboratory were released in wooden cages of size 30 x 30 x 30 x cm. Three numbers of mealybug infested cocoa were hung inside the cage for the butterflies to either lay or feed on the honeydew secreted by the mealybugs. The cages were observed daily for mortality of butterflies. Cotton balls of one cm diameter soaked in 1:1 honey: water solution was hung inside the cage to feed the butterflies. The mealybug culture was maintained under the laboratory conditions at 25-30°C and 40-80% RH. The developmental stages were photographed using Carl Zeiss Stemi DV_4 Stereomicroscope. The data obtained from the laboratory experiments were analysed statistically by using Standard Error (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

The results of the development and life cycle of S. epius on Mealy bug in Cocoa in laboratory condition are furnished below.

Egg: Egg colour was greenish blue and become whitish before hatching as neonate larva (Plate 2). It was disc shaped, sculptured and both the top and bottom compacted with micropylar despair in the top. The diameter of the egg was 0.52 ± 0.06 mm (Table 1) and the eggs were hatched in 4.16 ± 0.29 days in the laboratory conditions (Table 2). The results are in tune with the earlier findings of Hall et al. (2007) who reported that the egg of *S. epius* was disc shaped, greenish-blue in colour and sculptured. It is supported by Minno *et al.* (2005) who found that the egg of another predatory Lycaenidae, *Ferniseca tarquinius* was also greenish-white and spherical with faint sculpturing.

First instar larva: During this stage, the larval body was pale white and had dark brown head, fringed with fine white setae (Plate 2). It measured 0.98 ± 0.16 mm in the length and a width of 0.24 ± 0.04 mm (Table 1). The first stage larva lasted for 2.80 ± 0.15 days (Table 2). Similar findings were also observed by Vinod Kumar *et al.* (2006) who reported that the first instar larva measured 1.14 ± 0.07 mm in length and width of 0.25 ± 0.08 mm in the laboratory at a temperature range of 26 to 32° C and relative humidity range of 40 to 60%. The first instar stage lasted for 2.91 ± 0.07 days. Venkatesha *et al.* (2004) stated that the surface of the larval body of *S. epius* was with white wax coating which are camouflaged with the mass of mealybugs. Further, Dinesh and Venkatesha (2012) reported a significant negative correlation between *S. epius* population and temperature indicated that *S. epius* population decreases with increasing temperature.

Second instar larva: The larval head becomes dark brown in colour and the body looks grey with white and mid dorsal area slightly covered with a white wax coating (Plate 2). It measured 2.77 ± 0.19 mm in mean length and a width of 0.67 ± 0.29 mm (Table 1).

Third instar larva: The dorsal line was covered with thick wax coating (Plate 2). The size of the third instar stage of the caterpillar measured in length with a mean of 5.80 ± 0.15 mm and the width was 1.56 ± 0.06 mm (Table 1). This stage

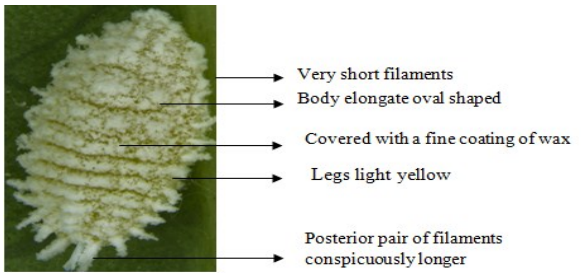


Plate 1. *Mealybug, Paracoccus marginatus*

Table 1. Morphometry of various stages of *Spalgis epius* on *Paracoccus marginatus in Cocoa.*

Stages	Length (mm)*	Width (mm)*
	Mean ± SE	Mean ± SE
Egg	0.52 ± 0.06 (Diameter)	
I instar	0.98 ± 0.16	0.24 ± 0.04
II instar	2.77 ± 0.19	0.67 ± 0.29
III instar	5.80 ± 0.15	1.56 ± 0.06
IV instar	9.99 ± 0.17	3.73 ± 0.27
Pre-pupa	9.23 ± 0.13	4.52 ± 0.21
Pupa	6.28 ± 0.27	3.65 ± 0.21

* Mean of 10 individuals, *SE- Standard Error

lasts 3.40 ± 0.01 days for completion (Table 2).

Fourth instar larva: The larva of this stage was short and found with a setae than third instar (Plate 2) and it measured 9.99 ± 0.17 mm. The mean width was 3.73 ± 0.27 mm (Table 1) and lasts 3.40 ± 0.05 days (Table 2). The size of four larval instars of S. epius is similar to those reported in other species of Lycaenidae namely, *Paralucia pyrodiscus* (Braby, 1990) and *Lycaeides melissa samuelis* (Herms *et al.,* 1996). They reported that the length of fourth instar stage of the caterpillar was 10.16 ± 0.23mm and a mean width was 4.08 ± 0.15 mm. The duration of this stage was observed with a mean of 3.80 ± 0.07 days.

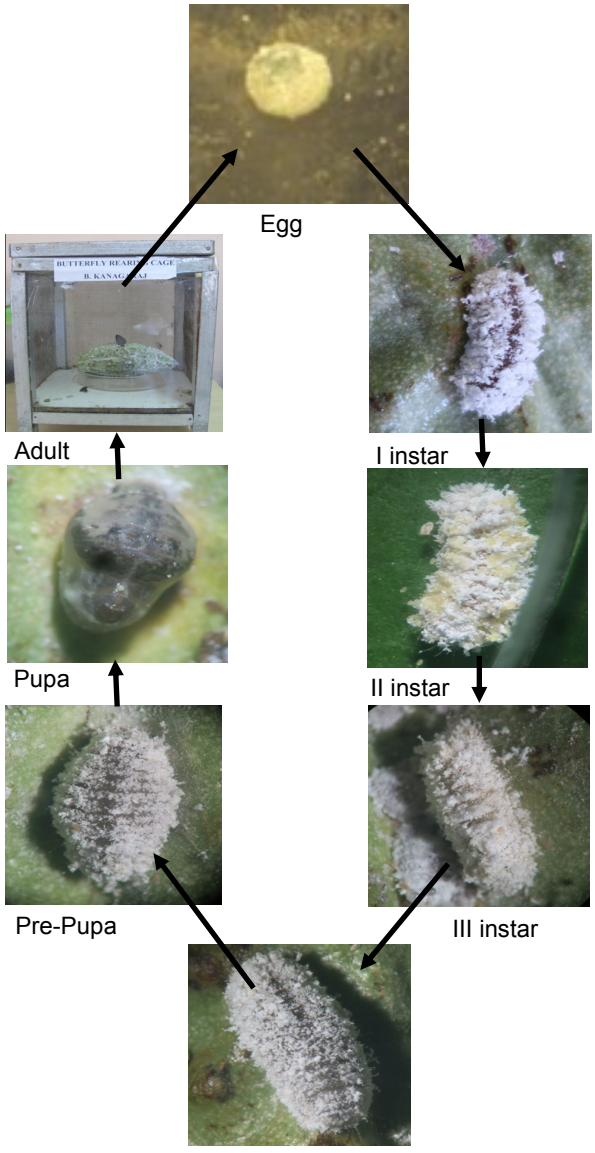


Plate 2. *Life cycle of predatory butterfly Apefly, Spalgis epius on mealybug, Paracoccus marginatus in Cocoa.*

Table 2. Developmental time of different stages of Spalgis epius reared on mealybug, *Paracoccus marginatus in Cocoa in the laboratory.*

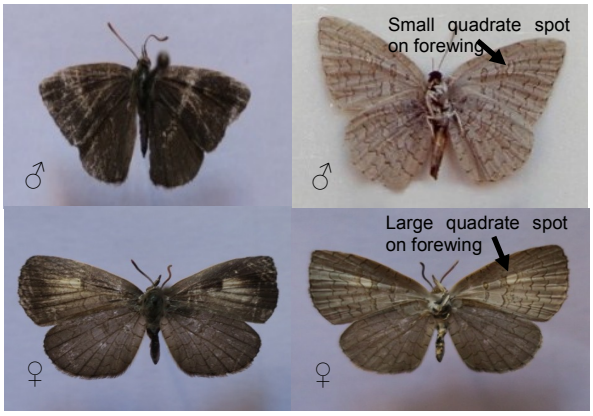
Stages	Mean ± SE* (Days)
Egg	4.60 ± 0.29
I instar	2.80 ± 0.15
II instar	3.50 ± 0.02
III instar	3.40 ± 0.01
IV instar	3.40 ± 0.05
Total larval period	13.10 ± 0.12
Pre-pupa	3.00 ± 0.17
Pupal period	10.00 ± 0.04
Total period of development	30.30 ± 0.33

* Mean of 10 individuals, *SE- Standard Error

Total larval period: The mean total larval period was observed as 13.10 ± 0.12 days (Table 2).

Pre pupa: The prepupal stage of the caterpillar became more convex in shape and the hair like setae on the body was observed and considerably less in numbers. The median dark line on the dorsal surface of the body was clear (Plate 2)**.** It was measured a mean length of 9.23 ± 0.13 mm and a width of 4.52 ± 0.21mm (Table 1). The pre pupal period was 3.00 ± 0.17 days (Table 2).

Pupa: The pupal stage looks naked and the surface was smooth. It had an appearance like the face of a monkey. The dorsal and lateral side had light brown and whitish grey. The mold on the hard dorsal side view of the pupa resembled the face of a monkey. The dorsal side of the pupa was found clear with spots of eyes, nose and cheeks gradually darkened with the development (Plate 2). The mean length and width of pupa were 6.28 ± 0.26



Dorsal view **Ventral view**

Plate 3. *Dorsal and vental view of Spalgis epius.*

mm and 3.65 ± 0.21 mm respectively (Table 1). The peculiar monkey faced pupa of *S. epius* was similar to that *Ferniseca tarquinius* as reported by Hall *et al.* (2007). Balduf (1939) considered the monkey faced appearance of some lycaenid pupa as a means of protection but not clearly states its significance. The results are same with the findings of Dinesh *et al.* (2010) who stated that the *S. epius* completed its cycle during 23.80 ± 1.50 days under the mean maximum temperature of 29.00 ±1.80° C, and a mean minimum temperature of 26.50 ± 1.40° C, mean relative humidity 44.40 ± 6.70%. The combined duration of the *S. epius* larval and pupal stages was reported as 14.83 ± 0.44 days by Thangamalar *et al.* (2010), as 19.8 ± 1.39 days in Dinesh *et al.* (2010).

Total period of development: The mean total period of development from egg to adult emergence was 30.30 ± 0.33 days (Table 2). The results are in accordance with the findings of Vinod Kumar *et al.* (2006) who reported that the *S. epius* mean total developmental period from egg to adult was 29.86 ± 0.59 days was also studied in the laboratory condition using the mealybug, *P. citri* reared on pumpkins.

Adults: Hind wings of the adult *S. epius* was tailless (Plate 3). Dainty little butterfly which has grey under with several fine wavy vertical lines. Both sexes have brown on upper with diffuse or well defined discal patch at end cell on upper forewing. The forewings of male have acute apex and straight termen but female has round apex and termen. Male forewing has prominent small quadrate spot at the cell in end, whereas it is larger in female. In the case of the male marking the discal patch was small in size and sharp in features. In the case of the female, the discal patch was dull white in colour and bigger in size. This was very clear if the butterfly wings were held against a strong source of light, when the white patch was more easily visible in the case of the females.

Conclusion

It is concluded that the mean total developmental period of *S. epius* on *P. marginatus* in cocoa from egg to adult was 30.30 ± 0.33 days. The egg was greenish in colour, disk shaped and sculptured. The body of the larva is covered with a thick coating of white wax and the pupa resembled the face of a monkey. The knowledge of life cycle of *S. epius* on factitious/natural hosts on various crops is advantageous to develop and standardize the mass culturing techniques for exploration of this potential species in the biocontrol programme and also to be incorporated in Integrated Pest Management.

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