

A REPORT OF NATURAL ENEMIES OF PAPAYA MEALYBUG, *PARACOCCLUS MARGINATUS* (HEMIPTERA: PSEUDOCOCCIDAE) IN PENINSULAR MALAYSIA

¹*M. I. Mastoi, ²A. N. Azura, ²R. Muhamad, ³A. B. Idris, ⁴B. K. Solangi, ⁴A. G. Arfan, ⁵M. I. Bhatti and ⁴F. N. Khoso

¹National IPM Programme, DPEP, NARC, Park Road Islamabad, Pakistan.

²Department of Plant Protection, Faculty of Agriculture, Universiti Putra Malaysia.

³Faculty of Science and Technology, Universiti Kebangsaan Malaysia.

⁴Faculty of Crop Protection, Sindh Agriculture University Tandojam, Pakistan.

⁵Pakistan Museum of Natural History, Shakarparian, Islamabad, Pakistan.

*Corresponding author: Muhammad Ishaque Mastoi Email: ishaqnscri@yahoo.com

ABSTRACT: *Papaya mealybug* is notorious pest of papaya & other horticultural crops. Keeping in mind the role of parasitoids and predators in pest management, an exploratory study was conducted on the availability of natural enemies of recently introduced papaya mealybug, *Paracoccus marginatus* in Selangor and Negeri Sembilan states of Peninsular Malaysia. Results revealed the presence of two predators (*Cryptolaemus montrouzieri* and *Apertochrysa* sp.), one primary parasitoid (*Acerophagus papayae*) and three hyperparasitoids (*Chartocerus* sp., *Marietta leopardina* and *Cheiloneurus* sp.). Among all natural enemies recorded, populations of *C. montrouzieri* and *A. papayae* were frequently recorded from all sampled locations of the two states. Accordingly, these two species should be exploited for their potential to manage populations of *P. marginatus* below threshold levels.

Key words: Natural enemies, mealybug, *Paracoccus marginatus*, predator, parasitoids, Peninsular Malaysia

INTRODUCTION

The papaya mealybug, *Paracoccus marginatus* Williams and Granara de Willink 1992 (Hemiptera: Pseudococcidae) is an exotic polyphagous pest [1]. It originated from Mexico [2] and recently has been accidentally introduced in many countries of the oriental region including Malaysia [3,4]. The pest has high reproductive potential under favourable conditions [5]. In its native habitats, it never remained a threat as its population is managed by the availability of its endemic natural enemies [6]. Accordingly, three of its encyrtid parasitoids i.e., *Acerophagus papayae*, *Anagyrus loecki*, and *Pseudleptomastix mexicana* has frequently been introduced in its introduced locations to manage its populations especially in Guam, Palau (Islands in Western Pacific Ocean), USA (Florida and Hawaii), India and Sri Lanka [3,6,7]. *Cryptolaemus montrouzieri*, is a specialized predator of mealybugs reported from Guam, Palau and Florida, USA [6,7,8]. Moreover, Apefly, *Spalgis epius* Westwood (Lepidoptera: Lycaenidae, Miletinae) has also been reported as a potential predator of various mealybug species in their nymphal stages [9,10,11]. Two predaceous coccinellids, *Scymnus* sp. from North Karnataka, India and *Sasajiscymnus quinquepunctatus* from Thailand were also documented as potential predators of papaya mealybug [9,11].

Keeping in mind the establishment and potential threats of *P. marginatus* in Malaysia [4] and role of different natural enemies in management of its population, a preliminary study was conducted in Selangor and Negeri Sembilan states of Peninsular Malaysia on the availability of its natural enemies. The objective of study was to document available natural enemies of *P. marginatus* that are available in Malaysia and suggest to papaya growers to exploit their presence to control papaya mealybug spread and damage.

MATERIALS AND METHODS

Survey for the availability of natural enemies of *P. marginatus* was conducted in Selangor and Negeri Sembilan

states of Peninsular Malaysia as mealybug infestation was only recorded from these two states [2]. A comprehensive survey of papaya plants infested with *P. marginatus* was made throughout two states. A total of 400 papaya plants were sampled from the two sampling states. A sample of one severely infested leaf per plant was collected and put in a plastic bag and labeled adequately. The collected samples were brought to the Entomology Laboratory, Department of Plant Protection, Universiti Putra Malaysia. Sweep net was also used to collect the predators of *P. marginatus*. The immature stages of predators were further reared on papaya mealybugs till the adult emergence. The mummies from the infested leaves were collected using "o" size camel hair brush and were kept in separate glass vials covered with muslin cloth until the emergence of adult parasitoids. Total of 7965 mummies were collected from the infested leaves to observe diversity of parasitoids of *P. marginatus*. The identification of collected specimens of predators and parasitoids were done according to available literature of [12,13,14]. The specimens of natural enemies were also sent to Plant Pest Diagnostics Centre (PPDC), California Department of Food and Agriculture (CDFA), USA and Natural History Museum London, UK for authoritative confirmation.

RESULTS AND DISCUSSION

Based on the collected specimens, total of six natural enemies were identified in the sample collected from two States of Peninsular Malaysia (Table 1). Two predators (*Cryptolaemus montrouzieri* and *Apertochrysa* sp.), one primary parasitoid (*Acerophagus papayae*) and three hyper-parasitoids (*Chartocerus* sp., *Marietta leopardina* and *Cheiloneurus* sp.) were recorded.

Among predators, *Apertochrysa* sp. (2.77 ± 0.55 / plant) was more abundant and widely distributed than *C. montrouzieri* (1.21 ± 0.22 / plant) (Table 2), whereas *A. papayae* (95.2%) was the dominant parasitoid emerged from the mealybug mummies (Table 3).

Table 1. Natural enemies of Papaya mealybug recorded in Selangor and Negeri Sembilan States of Peninsular Malaysia

Sr. #	Scientific name	Family	Order	Type
1.	<i>Cryptolaemus montrouzieri</i>	Coccinellidae	Coleoptera	Predator
2.	<i>Apertochrysa</i> sp.	Chrysopidae	Neuroptera	Predator
3.	<i>Acerophagus papayae</i>	Encyrtidae	Hymenoptera	Primary Parasitoid
4.	<i>Chartocerus</i> sp.	Signophoridae	Hymenoptera	Hyperparasitoid
5.	<i>Marietta leopardina</i>	Aphelinidae	Hymenoptera	Hyperparasitoid
6.	<i>Cheiloneurus</i> sp.	Encyrtidae	Hymenoptera	Hyperparasitoid

Table 2: Mean population of predators of Papaya mealybug recorded in Selangor and Negeri Sembilan States of Peninsular Malaysia

Sr. #	Scientific name	Mean Population (per leaf)
1.	<i>Cryptolaemus montrouzieri</i>	1.21 ± 0.22
2.	<i>Apertochrysa</i> sp.	2.77 ± 0.55

Table 3: Percentage emergence of parasitoids from Papaya mealybug mummies (n=7924)

Sr. #	Scientific name	Mean Population (per leaf)
1	<i>Acerophagus papaya</i>	7584 (95.2%)
2	<i>Chartocerus</i> sp.	241 (3.0%)
3	<i>Marietta leopardina</i>	82 (1%)
4	<i>Cheiloneurus</i> sp.	17 (0.2%)

Predators

1. *Cryptolaemus montrouzieri*

It is commonly known as Australian ladybird or mealybug destroyer. During sampling, its population was recorded from the both sampling states (Negeri Sembilan and Selangor). The adult female lays eggs inside ovisacs of papaya mealybugs and after hatching larvae start feeding on the eggs. Larvae secreted a white waxy filaments due to continuous feeding on mealybugs, hence difficult to differentiate from mealybugs. Larvae and adult of predator are recorded to feed on mealybug eggs. Adults of predators are shiny black with head and pronotum orange in color (Figure 1). *Cryptolaemus montrouzieri* is endemic to Queensland and New South Wales, Australia. It has been imported to many regions of the world for management of different mealybug species on citrus, mango, guava, coffee, cocoa, rubber, mulberry etc. [15].

Apertochrysa sp.

The population of this predator was only recorded from Selangor state. The predator is commonly known as green lacewing. Its larvae possess pincers like tongue to suck fluid content of the host. Larvae voraciously feed on all stages of papaya mealybug (Figure 2). Alasady *et al.* [16] reported populations of *Apertochrysa* sp. from 18 different host plants from Serdang, Selangor as it was the first documented record from Malaysia.

**Figure 1. *Cryptolaemus montrouzieri* adult feeding on *P. marginatus***



Figure 2. *Apertochrysa* sp. larva feeding on *P. marginatus*

Parasitoids

1. *Acerophagus papayae*: *Acerophagus papayae* (Hymenoptera: Encyrtidae), the primary parasitoid of papaya mealybug (Figure 3), spends a significant portion of its life cycle attached with a single host viz. *P. marginatus*. The body length of female parasitoid is 1.0 mm, male is smaller in size (0.6-0.7 mm). The color generally pale orange except brown marks on the neck of pronotum. The parasitoid has greenish compound eyes and ocelli red. Antennal club three segmented with five funicles and 5th funicle segment is smaller and dusky in colour [12].



Figure 3. *Acerophagus papayae* adult parasitizing *P. marginatus*

Three hyperparasitoids were also emerged from *P. marginatus* mummies (Figure 4). The higher population frequency (3%) of *Chartocerus* sp. was noticed. Similarly, *Marietta leopardina* and *Cheiloneurus* sp. had very low population frequencies, 1% and 0.2% respectively (Table 3).

1. *Chartocerus* sp.

Chartocerus sp. adults are glossy black colored and about 0.5 mm long. The antennal club of *Chartocerus* sp. is longer than remaining parts and un-segmented.

2. *Marietta leopardina*

Marietta leopardina adults are 0.5 mm in length and possessed striking patterns on head, thorax including forewings and legs and abdomen.

3. *Cheiloneurus* sp.

Cheiloneurus sp. had 0.8 mm body length, tuft of setae stalked on the scutellum apex, forewings infuscate, gaster tapering. All *Cheiloneurus* spp. were reported as hyperparasites in other members of Encyrtidae family [17].

CONCLUSIONS

Two predators, one primary parasitoid and three hyperparasitoids of papaya mealybug were collected and identified from Selangor and Negri Sembilan states of Peninsular Malaysia. Availability of natural enemies of papaya mealybug suggested that growers of papaya in Peninsular Malaysia should focus on management of *P. marginatus* using its natural enemies with minimum dependence on pesticides.

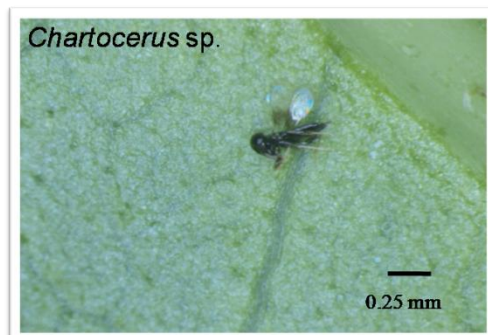


Figure 4. Three hyperparasitoids emerged from *P. marginatus* mummies

REFERENCES

- [1] Selvaraju, N. G. & Sakthivel, N. Host plants of papaya mealybug (*Paracoccus marginatus* Williams and Granara de Willink.) in Tamil Nadu. *Karnataka Journal of Agricultural Sciences*, 24(4), 567-569 (2011).
- [2] Miller, D. R., Williams, D. J. & Hamon, A. B. Notes on a new mealybug (Hemiptera: Coccoidea: Pseudococcidae) pest in Florida and the Caribbean: the papaya mealybug, *Paracoccus marginatus* Williams and Granara de Willink. *Insecta Mundi*, 13(3-4), 179-181 (1999).
- [3] Muniappan, R., Shepard, B. M., Watson, G. W., Carner, G. R., Rauf, A., Sartiami, D., . . Rahman, A. K. M. Z. New Records of Invasive Insects (Hemiptera: Sternorrhyncha) in Southeast Asia and West Africa. *Journal of Agricultural and Urban Entomology*, 26(4), 167-174 (2009).
- [4] Mastoi, M. I., Azura, A. N., Muhamad, R., Idris, A. B., & Y. Ibrahim. First report of papaya mealybug *Paracoccus marginatus* (Hemiptera: Pseudococcidae) from Malaysia. *Australian Journal of Basic and Applied Sciences*, 5(7), 1247-1250 (2011).
- [5] Mastoi, M. I., Azura, A. N., Muhamad, R., Idris, A. B., Arfan, A. G. & Y. Ibrahim. Life table and demographic parameters of papaya mealybug, *paracoccus marginatus* (hemiptera: pseudococcidae) on *hibiscus rosa-chinensis*. *Science Inetnational-Lahore* 26(5): 2343-2349 (2014).
- [6] Meyerdirk, D., Muniappan, R., Warkentin, R., Bamba, J., & Reddy, G. Biological control of the papaya mealybug, *Paracoccus marginatus* (Hemiptera: Pseudococcidae) in Guam. *Plant Protection Quarterly*, 19, 110-114 (2004).
- [7] Muniappan, R., Meyerdirk, D. E., Sengebau, F. M., Berringer, D. D., & Reddy, G. V. P. Classical Biological Control of the Papaya Mealybug, *Paracoccus marginatus* (Hemiptera: Pseudococcidae) in the Republic of Palau. *Florida Entomologist*, 89(2), 212-217(2006).
- [8] Amarasekare, K. G., Mannion, C. M., & Epsky, N. D. Efficiency and establishment of three introduced parasitoids of the mealybug *Paracoccus marginatus* (Hemiptera: Pseudococcidae). *Biological Control*, 51(1), 91-95 (2009).
- [9] Patil, R. R., Patil, R. K., Pawar, B., Chandaragi, M., & Rayar, S. G. Record of papaya mealy bug (*Paracoccus marginatus* W. and G.) and its natural enemies from north Karnataka. *Karnataka J. Agric. Sci*, 24(5), 692-693 (2011).
- [10] Venkatesha, M. G., & Dinesh, A. S. Mass rearing of *Spalgis epius* (Lepidoptera: Lycaenidae), a potential predator of mealybugs (Hemiptera: Pseudococcidae). *Biocontrol Science and Technology*, 21(8), 929-940 (2011).
- [11] Saengyot, S., & Burikam, I. Bionomics of the apefly, *Spalgis epius* (Lepidoptera: Lycaenidae), predatory on the papaya mealybug, *Paracoccus marginatus* (Hemiptera: Pseudococcidae), in Thailand. *Songklanakar Journal of Science and Technology*, 34 (2012).
- [12] Noyes, J. S., & Schauff, M. E. New Encyrtidae (Hymenoptera) from papaya mealybug (*Paracoccus marginatus* Williams and Granara de Willink) (Hemiptera: Sternorrhyncha: Pseudococcidae). *Proc. Entomol. Soc. Wash*, 105, 180-185 (2003).
- [13] Noyes, J. S. Universal Chalcidoidea Database. World Wide Web electronic publication(2012).www.nhm.ac.uk/entomology/chalcidooids/index.html.
- [14] Booth, R. G., & Pope, R. D. A review of the genus *Cryptolaemus* (Coleoptera: Coccinellidae) with particular reference to the species resembling *C. montrouzieri* Mulsant. *Bulletin of entomological research*, 76(04), 701-717 (1986).
- [15] Mishra, B. K. Biology of the papaya mealy bug, *Paracoccus marginatus* Williams and Granara de Willinks and its predator *Cryptolaemus montrouzieri* Mulsant. *Journal of Plant Protection and Environment* 8(1), 26-30 (2011).
- [16] Alasady, M., Omar, D., Ibrahim, R., & Y. Ibrahim. The Survey of Green Lacewings and Occurrence of *Apertochrysa* sp. (Neuroptera: Chrysopidae) on Various Plants in Malaysia. *Journal of Entomology*, 8(8), 240-249 (2011).
- [17] Noyes, J. S., & Chua, T. H. Description of two new species *Cheiloneurus* from Malaysia (Hymenoptera: Encyrtidae). *Oriental Insects*, 11(4), 541-546 (1977).