Sherwood, M, 2011. Management Programme for the Papaya Mealybug, *Paracoccus marginatus* Williams and Granara de Willink (Hemiptera: Pseudococcus) in Jamaica (September, 2009 - March 2011)

ABSTRACT

Introduction

In September 2010 the Papaya Mealybug, *Paracoccus marginatus* Granara de Willink was detected in St. Andrew, Jamaica, 17 years after it was found in the Caribbean in 1993. Since then the pest has been confirmed on papaya (*Carica papaya*) in St. Catherine and Portland in 2011. Before its arrival here other Caribbean islands were affected including St. Martin, St. Barthelemy, US Virgin Islands (St. Thomas, St. Croix), British Virgin Islands, Dominican Republic, Haiti, St. Kitts, Nevis and Antigua. The pest affects at least 60 plant species including crop plants (cassava, eggplant, sweet and hot pepper, sweet potato, ochro, sorrel, broad bean), fruit trees (soursop, papaya, mango, guava, plum and West Indian cherry), ornamentals (allamanda, oleander, hibiscus, ixora, ginger lily, and acalypha) and weeds (cat's tail, glyricidia, acacia, mimosa and sida). The typical damage symptoms include curling, crinkling, twisting of leaves and stem and the presence of sooty mould which may cover sections or the entire plant thereby preventing photosynthesis. Additionally, flowers become distorted, poor fruit set and fruit failure also occurs. Significant damage has been reported in cassava in Central America while papaya growers in the Pacific island of Palau had chosen to abandon papaya cultivation.

P. marginatus was detected on a sample of teak (*Tectona grandis)* collected from Jamaica's Forestry Department Office in St. Andrew. A delimiting survey has since determined that the infestation has spread beyond 10 km on residential properties around this location. The host plants already being impacted include papaya, cassava, gungo peas, West Indian cherry, hibiscus and frangipani. Though the infestation so far has been confined to residential areas the risk of spread into agricultural, tourism and natural areas is high, since the parish is an urban area with a high population density and a busy thorough fare to the rest of the island. This spread may prove devastating since agriculture, tourism and nature are important to maintaining Jamaica's national food security, economy and biodiversity respectively.

The use of cultural practices and chemical control was unsuccessfully used in Palau to manage this pest. The most proven method for managing this pest has been the use of biological control involving four parasitoid wasps, *Anagyrus loecki, Apoanagyrus californicus, Acerophagus papaya* and *Pseudleptomastix mexicana.* These can be sourced from the Puerto Rico rearing facility managed by USDA - APHIS. Reports from Dominican Republic, Puerto Rico, Guam and Palau indicate that after one year of releasing these wasps there was over 97 % reduction in the population of Papaya Mealybug. Based on the findings of the survey a local parasitoid wasp has been detected at parasitism levels under 10% providing some level of control.

The Plant Health Coordinating Committee (PHCC) has produced an action plan to address the containment and management of the Papaya Mealybug in Jamaica. The PHCC consists of members representing the Ministry of Agriculture and Fisheries (including Research and

Development, Plant Quarantine), Rural and Agricultural Development Authority (RADA), Caribbean Agricultural Development Research Institute (CARDI) and the University of the West Indies (UWI).

The main activities within the plan include surveillance, integrated biological control and public awareness. Under the biological control component activities involve the import, release and monitoring the establishment and impact of the four parasitoid wasps. Additionally, a public educational programme involving the electronic and print media will be implemented. In order to manage the pest in the existing infested areas and thereby reducing the likelihood of spread to major agricultural, tourism and natural areas this action plan needs to be sufficiently supported and implemented immediately. This requires the provision of additional funds to finance the emergency response activities, the details of which are presented in this document.

Surveillance and monitoring

- Conduct surveillance and monitoring activities to determine the distribution and populations densities of the pest.

Delimiting Survey

Plants within the Forestry nursery and the surrounding residential areas were inspected for the presence of the papaya mealybug. Suspected infestations were collected on various plant hosts, bagged, labeled and the GPS recorded. A map of the surrounding communities was used to demarcate a 5 km radius from the forestry nursery. A total of 11 persons, nine RADA and two from Plant Protection participated in the survey. Four groups were formed and each was assigned to a quadrant within the area to be surveyed. Properties within a 5 km zone were visited. After the first confirmed infestation the survey was expanded to another 5 km radius. Suspected infestations were collected on various plant hosts, bagged, labelled, GPS recorded and images taken of the damage.

In the lab the samples were processed to determine pest identification, population of papaya mealybug, presence of natural enemies, and parasitism levels. Images of the samples and specimens were also taken to the lab. The population of PM on papaya leaves were determined by counting the total number of 2^{nd} instar to mature stage and eggsacs and then converted to number of *P. marginatus* per 100 cm^2 of leaf surface. On the other plants the pest numbers (2^{nd} instar to mature stage and eggsacs) on 15 cm long twigs from the tip were counted and the mean calculated. The parasitism level were determined by encapsulating 100 mature mealybugs as well as mummies in a multiwell plate and incubating for emergence of parasitoids. Percent parasitism were determined by using the formula

$$\frac{\text{Number of mature mealybugs + mummies emerged}}{\text{Total number of mealybugs + mummies}} \times 100$$

Management

- Source and release four parasitoid wasps of *Anagyrus loecki, Apoanagyrus californicus, Acerophagus papaya* and *Pseudleptomastix* sp. to be sourced from USDA APHIS over a period of 6 months.
- Release natural enemies and determine impact on pest populations

- Determine the establishment and dispersal of each natural enemy released.
- Identify local natural enemies associated with the PM and assess the effect of the two exotic natural enemies on the populations.
- Implement appropriate cultural practices to reduce populations of the pest.
- Establish local facilities for the rearing of two natural enemies of PM, a parasitoid *Acerophagus papayae* and a ladybird beetle *Cryptolaemus montrouzieri*.
- Adapt rearing techniques for the pest and at least two natural enemies – using local resources.
- Develop legislation to assist with reducing the rate of spread of the pest.

Capacity building

- Train extension officers in releasing and monitoring the biological agent.
- Short term training of technical personnel (overseas) in the rearing of parasitoid wasps

Public awareness campaign

- Inform and educate the public on the biological control programme.

Surveillance

Delimiting Survey

A total of thirteen locations were visited in the Constant Spring, Mannings Hill Road, Hughenden and Manor Park areas. *Paracoccus marginatus* was confirmed on eight of the properties visited including Constant Spring (2), Mannings Hill Road (1), Hughenden (2) and Manor Park (3) (Table & Figure 1). Eleven plant species were sampled including fruit trees (papaya, cherry), forest trees (blue mahoe, wild tamarind), ornamentals (hibiscus, oleander, lantana, frangipani) and field crops (gungo peas, cassava, sorrel) (Table 1). *P. marginatus* was confirmed on nine plant species including fruit trees (Papaya, cherry), forest trees (wild tamarind, blue mahoe), ornamentals (hibiscus, frangipani and lantana) and field crops (gungo peas and cassava) (Table 1). Pink Hibiscus mealybug (*Maconellicoccus hirsutus*) was also detected at five of the locations. On one property at Constant Spring Grove both PHMB and PM were found on hibiscus and frangipani respectively. At the same location both PM and *Orthezia praelonga* were found coexisting on frangipanni (Figure 2 & Table 1).

On papaya the population of the 2nd – mature stage and eggsac of *P. marginatus* ranged from 0 – 5.81/ 100 cm^2 and 2.06 – 32.26/ 100 cm^2 respectively. On all other hosts the population of the 2nd – mature stage and eggsac of *P. marginatus* ranged from 0 - 8.5/ 15 cm and 1 – 5 /15 cm respectively (Table 2). The parasitism levels determined for Mannings Hill Road, Constant Spring Grove and Hughenden were 9.09 %, 5.88 % and 5.56 % respectively (Figures 3 & 4). The parasitoid wasp was tentatively identified as an *Apoanagyrus* sp. Specimens are to be sent for external identification.

Table 1: Field and Laboratory data generated on the samples collected in the delimiting survey, November 15, 2010

Name/Location	***GPS***	***Host***	***Pest Identification***	***Remarks***
Locations papaya mealybug detected				
1. Forestry Department 173 Constant Spring Road	*N18.042319 W076.795077*	*Wild Tamarind*	*Paracoccus marginatus*	*PM was first detected at this location on teak; Parasitism observed*
		Hibiscus	*P. marginatus*	*Exit holes present*
		Papaya	*P. marginatus*	*Eggsacs*
		Blue Mahoe	*P. marginatus*	*Mainly eggsacs*
2. Mary Hosang 25 Constant Spring Grove	*N 18.04174 W076.79574*	*Hibiscus*	*Maconellicoccus hirsutus*	
		Frangipani	*P. marginatus Orthezia praelonga*	*Parasitism observed*
3. Dwight Evans Off Mannings Hill Road	*N18.04432 W076.80011*	*Gungo peas*	*P. marginatus*	*Parasitism observed*
		Papaya	*P. marginatus*	*eggsacs*
		Cassava	*P. marginatus*	*eggsacs*
4. Ruby Donaldson 35 Silver Road, Hughenden	*N18.03168 W076.81781*	*Papaya*	*P. marginatus*	*Parasitism observed*
5. S. Campbell Marathon Drive, Hughenden	*N 18.03059 W076.81723*	*Cherry*	*P. marginatus*	*Eggsacs*
6. 9 Manor Park Drive	*N 18.31437 W076.474279*	*Hibiscus*	*P. marginatus*	*Old damage*
7. 5 Manor Park Drive	*N18.31135 W076.473952*	*Hibiscus*	*P. marginatus*	
8. Manor Park Plaza	*N 18.31358 W076.475533*	*Oleander*	*Scale Insects*	
		Lantana	*P. marginatus*	
Locations - Papaya Mealybug not detected				
9. Sharon Davis 26 Constant Spring Road	*N18.25658 W076.79574*	*Hibiscus*	*Maconellicoccus hirsutus*	
10. 37 Governor Terrace	*N18.25658 W076.4751*	*Hibiscus*	*Maconellicoccus hirsutus*	
11. Joan Brown,	*N18.04181*	*Sorrel*	*Maconellicoccus*	

4 Constant Spring Grove, Kgn. 8	*W076.79753*		*hirsutus*	
12. A. Reid *4 West Armor Height, Kgn. 11*	*N18.0302588* *W076.4801142*	*Hibiscus*	*Orthezia praelonga* *M. hirsutus*	
13. Manor Park area	*N18.31437* *W076.474279*	*Oleander*	*Undetermined mealybug species*	*Mealybug Specimen in Alcohol-unchanged*

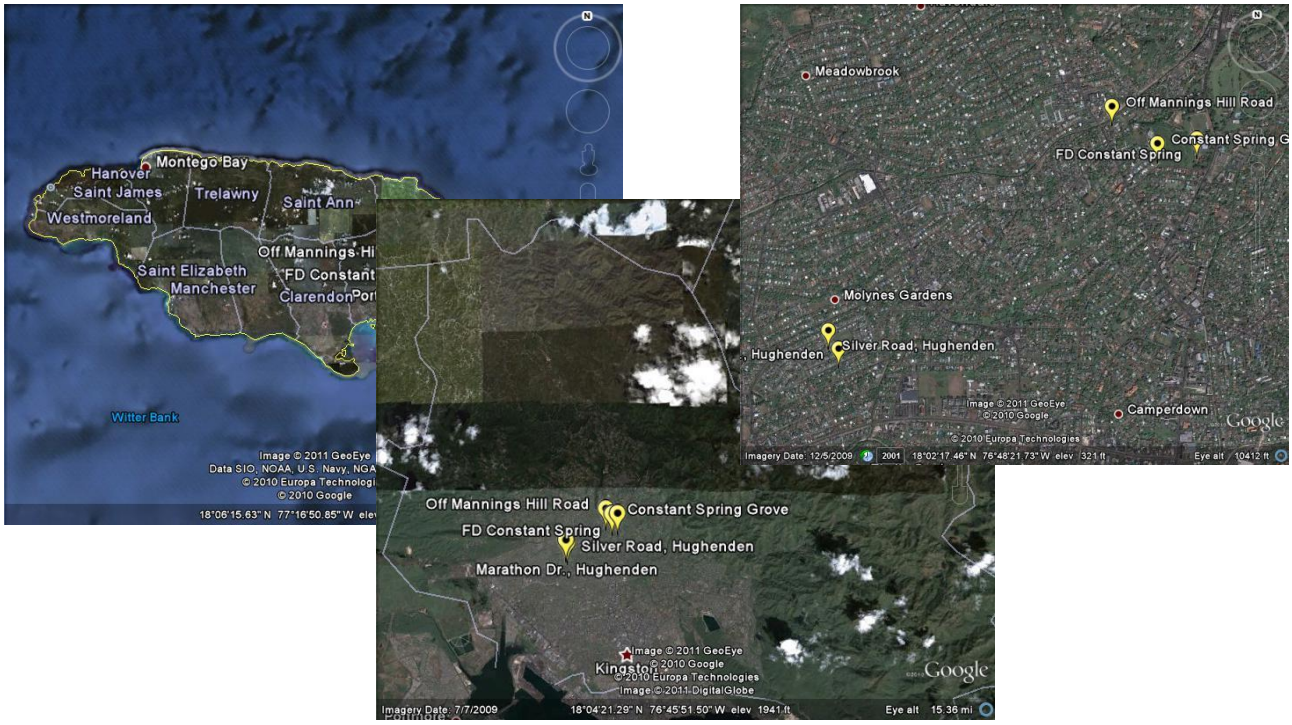


Figure 1: Distribution of Papaya Mealybug, *Paracoccus marginatus* in St. Andrew, Jamaica as at November 15, 2010

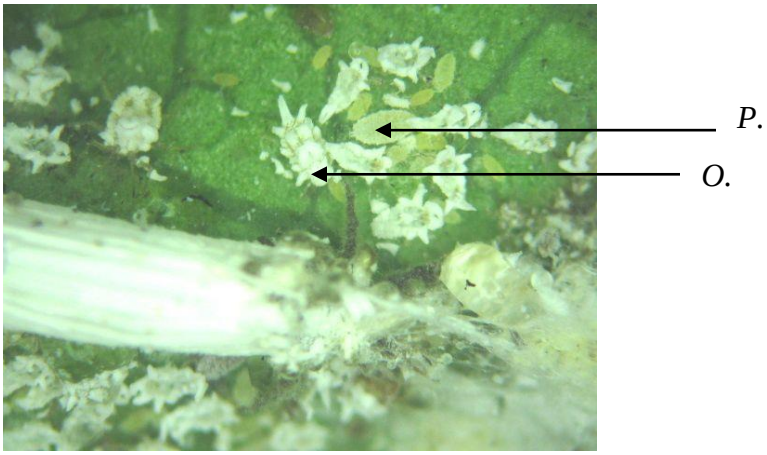
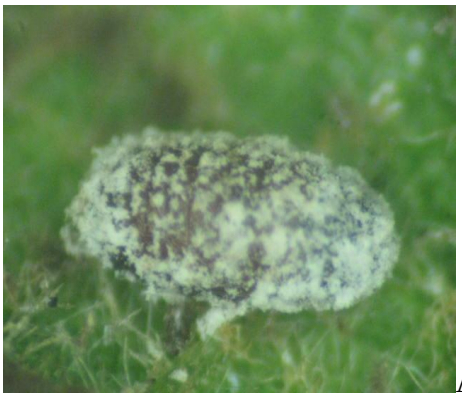


Figure 2: *P. marginatus* and *Orthezia praelonga* coexisting on frangipani plant

Table 2: The population of Papaya mealybug on each host collected in the delimiting survey, November 15, 2010

	Location	***Hosts***	***1st instar to mature***	***Eggsacs***	***Crawlers***
	Mannings Hill				
1	*Dwight Evans*	*Gungo*	*3.67/15 cm*	*4/15 cm*	*P*
		Cassava	*0*	*1/15 cm*	*A*
		Papaya	*0*	*20.65/100* cm^2	*A*
	Constant Spring				
2	*Forestry*	*Papaya*	*0*	*2.06/100* cm^2	*P*
		B. Mahoe	*0*	*1/15 cm*	*A*
		Hibiscus	*1.33/15 cm*	*0*	*A*
		Wild Tamarind	*0*	*1/15 cm*	*P*
3	*Mary Hosang*	*Frangipanni*	*8.5/ 15 cm*	*0*	*P*
	Manor Park				
4	*Manor Park Plaza*	*Lantana*	*0*	*5/15 cm*	*A*
5	*5 Manor Park*	*Hibiscus*	*2.67/ 15 cm*	*1.5/15 cm*	*P*
	Hughenden				
6	*Ruby Donaldson*	*Papaya*	*5.81/ 100* cm^2	*32.26/100* cm^2	*A*
7	*S. Campbell*	*Cherry*	*0*	*7*	*A*

P = Present A = Absent


A

B

C

Figure 3: A. Mummified PM; B. Adult wasp magnified; C. Adult wasp in the field

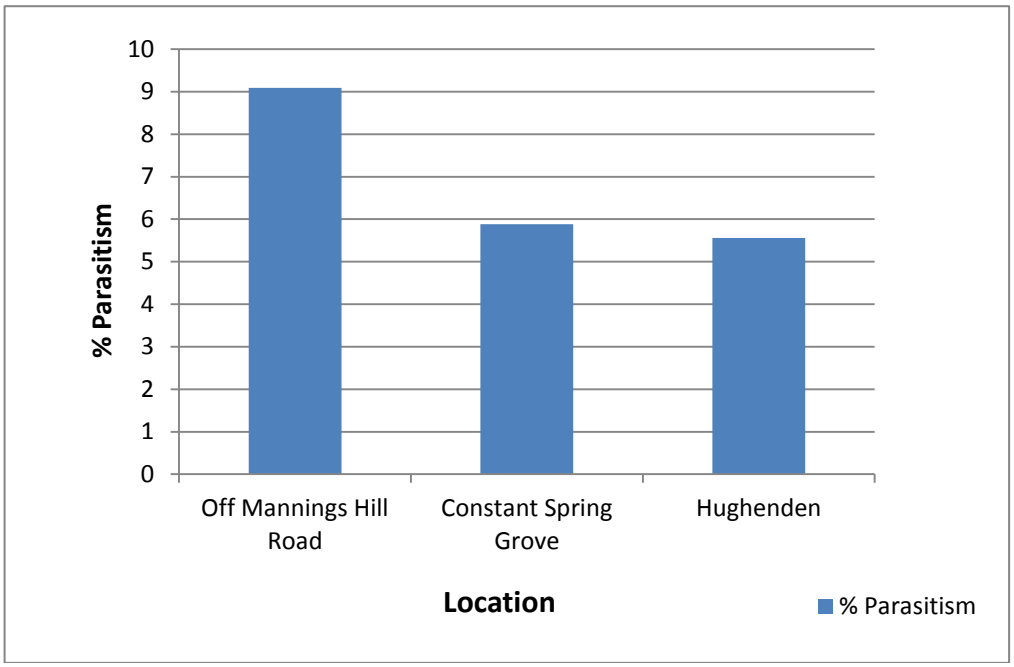


Figure 4: Parasitism levels by unknown wasp at locations visited in the Papaya Mealybug delimiting survey, November 15, 2010

In … and … samples were submitted to Plant Protection Unit by staff and RADA respectively which confirmed the pest also in St. Catherine and Portland.

Management Programme

Action Plan

An action plan was written by Mrs. Sherwood for the Plant Health Coordinating Committee which would guide the management programme. This document was finalized and circulated to all the members of the PHCC for implementation. It was also emailed to the Principal Research Director, R&D for her information.

Sourcing four species of wasp for *P. marginatus* management

Permit applications were submitted to three agencies Plant Quarantine, the National Environment and Planning Agency (NEPA) and the Pesticide Control Authority (PCA) in December 2010. Since then approval has been received from Plant Qaurantine. Requests came from NEPA and PCA for lab certification from the source in Puerto Rico. The certification request was sent through Plant Quarantine to the USDA. Up to the end of March there was no response re the lab certification request.

Natural Enemy Releases

C. montrouzieri cultures currently being reared on PHMB lab cultures at the PHMB rearing facility in Kingston was the source of cultures for the release of 30 adult ladybird beetles at one

site in Old Harbour, St. Catherine where a severe infestation of a new invasive pest, *Paracoccus marginatus* (the Papaya Mealybug) was identified.

DISCUSSION

Since the first detection in September 2011, the pest has been found in three parishes. The need to identify all infestation sites becomes critical as once permits have been received cultures of the wasp will be sourced from the Puerto Rican Facility for release at infested sites. The success of the programme will depend on finding all infested sites. Since the initial delimiting survey in November where it was determined that the infestation of *P. marginatus* extends to 10 km radius from the Forestry nursery this data has not been updated.

Paracoccus marginatus is known to be an economic pest on at least 60 plant hosts including crop plants fruit trees, ornamentals and weeds. Based on the delimiting survey and samples received to date the pest has already impacted a wide host range including a number of crops of economic importance. The high population of the pest on papaya gives an early indication of the threat to papaya groves which is a common phenomenon in affected countries.

Paracoccus marginatus originated from the Central American country of Mexico. Like Pink Hibiscus mealybug it is managed by classical biological control approach using species-specific parasitoids sourced from the origin. This approach has been successfully implemented against PMB in several countries in the Caribbean, some islands in the Pacific, Florida and Hawaii in the United States and several Asian countries including Indonesia, India and Sri Lanka, Thailand, Bangladesh and Maldives. In many of the cases 3 – 4 species of parasitoid wasps mainly, *Anagyrus loecki*, *Acerophagous papaya* and *Pseudleptomastrix mexicana* (Hymenoptera: Encyrtidae) have been sourced from the USDA APHIS parasitoid rearing facility in Puerto Rico. In 2009 India reported control within five months of initiating releases where control of PMB was recorded up to 95 to 100% (Muniappan, 2009).

It is possible that one of these species of parasitoids have fortuitously introduced to Jamaica since parasitism has been detected in all parishes surveyed so far. The natural enemy seems to be effecting some control to the pest population in the areas detected to date, however augmentation required to increase parasitism levels.

Acknowledgements

The author acknowledges the contribution of made by the Plant Health Coordinating PHMB sub-committee in planning, organizing and implementing the Action Plan which is greatly appreciated. This committee is made up of individuals from several organizations including the Ministry of Agriculture and Fisheries (Plant Quarantine, Research and Development), CARDI, UWI (Mona), and RADA which included Mrs. Marina Young and her team of extension officers in the affected areas. Also importantly the team of research assistants who have faithfully collected and processed the samples during the period Mr. Oral James and Ms. Netalie Francis.