



Article

First record of the papaya mealybug, *Paracoccus marginatus* Williams and Granara de Willink (Hemiptera: Coccoomorpha: Pseudococcidae) in Egypt

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Future Science Association

Available online free at
www.futurejournals.org

Print ISSN: 2687-8151

Online ISSN: 2687-8216

DOI:

10.37229/fsa.fja.2023.12.23

Received: 12 November 2023

Accepted: 10 December 2023

Published: 23 December 2023

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Abstract: The papaya mealybug, *Paracoccus marginatus* Williams & Granara de Willink (Hemiptera: Coccoomorpha: Pseudococcidae) which wasn't previously recorded from Egypt, has been recorded for the first time, as a genus (*Paracoccus* Ezzat & McConnell, 1956) and species. The papaya mealybug is highly polyphagous and has been recorded on 14 plants within 14 genera belonging to 12 families. *P. marginatus* spreads rapidly, it is a cosmopolitan species, distributes to over 62 countries and causes serious injury to the host plants resulting in economic damage. Classical biological control plays a major role in managing *P. marginatus* in the regions where it has been invaded.

Key words: *Paracoccus marginatus*, papaya, distribution, host plants, damage.

INTRODUCTION

The papaya mealybug, *Paracoccus marginatus* Williams & Granara de Willink (Hemiptera: Coccoidea: Pseudococcidae) is the first record of this invasive species in Egypt. This is also the first record of this Genus *Paracoccus* Ezzat & McConnell, 1956 of fauna the mealybug in Egypt.

Paracoccus has about 94 species of varied distribution in the world. *Paracoccus* is a taxonomically challenging genus because there is considerable intraspecific variation in several character systems, making taxonomic delineation difficult (Williams and Granara de Willink, 1992).

P. marginatus was described in 1992 and redescribed by Miller and Miller in 2002 (Miller *et al.*, 2002).

The papaya mealybug is native to Central America (Mexico, Belize, Guatemala and Costa Rica).

Damage incurred by *P. marginatus* was first observed on *Carica papaya* L. Caricaceae in the Caribbean in 1995, and by 2000. It had spread throughout 13 countries in the Caribbean, (Muniappan, 2009a; Myrick *et al.*, 2014). *P. marginatus* started to distribute throughout the West and Central Pacific Islands since 2002, South and Southeast Asia in 2008, West Africa in 2010, Middle East in 2011, and East Africa in 2015. The rapidly changing climate patterns are indicated as an acceleration factor in the spread of *P. marginatus* (Finch *et al.*, 2020). Further spread to Central and East Africa and widening of its territory in Central America and Asia is due to suitability of climatic conditions and available host plants grown as crop plants (Finch *et al.*, 2020). The spread of *P. marginatus* from Central America to about 50 countries within a decade (1994–2014) affirms *P. marginatus* as an invasive. This pest has been so successful due to its quick development and prolific reproductive capacity (Amarasekare *et al.*, 2008 and Muniappan *et al.*, 2008).

P. marginatus is an intensely polyphagous insect. It attacks field crops, vegetables, fruit trees, ornamental plants and weed belonging to about 58 plant families with 189 genera belonging 281 species (García Morales *et al.*, 2021). That includes economically important crops such as papaya, citrus, mango, guava, avocado, Annona, Ananas, cherry, sweet potato, peas, beans, Okra, eggplant, cotton, red gram, tomato, pepper, cassava, hibiscus, mulberry etc. (Miller and Miller 2002 and Heu *et al.*, 2007).

This paper provides an overview of the available information on the identity, host plants, distribution and damage caused by papaya mealybug *P. marginatus* aiming to assist in the development of potential control strategies.

MATERIAL AND METHODS

The infested area was visited in September 2023 in Giza governorate. Mealybugs were collected from 3 locations for identification. Samples were collected from the aerial parts on the branches, stems, leaves and fruits of the host plants. Each sample was placed into a plastic bag and taken to the laboratory for examination.

Identification Preserved specimens and live mealybugs were studied under a binocular microscope to observe morphological and taxonomic characters for identification. The mealybugs were prepared for slide-mounting and identified to be the papaya mealybug, *Paracoccus marginatus* Williams & Granara de Willink (Hemiptera: Pseudococcidae) by Professor Fatma Moharum at the Scale Insect Department, Plant Protection Research Institute, Agriculture Research Center. Identification was based on the taxonomic keys of Williams and Granara de Willink (1992) and descriptions given by Miller and Miller (2002).

RESULTS AND DISCUSSION

The papaya mealybug, *Paracoccus marginatus* Williams & Granara de Willink is recorded for the first time in Egypt infest more than 14 host plants, including fruit trees, ornamentals and vegetables belonging to different families. The host plants which are threatened by papaya mealybug are listed in table (1). The pest was frequently recorded throughout Giza governorate. The first severely infested papaya plant (Fig 1) was recorded in Sep. 2023 at the Experimental Farm, Faculty of Agriculture, Cairo University.

The pest is also recorded from mango, avocado, guava, pomegranate, banana, mulberry, Okra, cowpea, pepper, jasmine, Castor bean, hibiscus and red tail (Fig 1).

The infestation of papaya mealybug is typically observed as clusters of cotton-like masses on underside of leaves near veins and midribs and on upper side of leaf and fruits if plant is severely infested (Fig 2).

Table (1). Recorded hosts of the papaya mealybug, *Paracoccus marginatus*

Scientific name	Common name	Family
<i>Abelmoschus esculentus</i> (L.)	Okra	Malvaceae
<i>Acalypha hispida</i> Burm.	Red tail	Euphorbiaceae
<i>Capsicum annum</i> L.	Pepper	Solanaceae
<i>Carica papaya</i> L.	Papaya	Caricaceae
<i>Hibiscus rosa sinensis</i> L.	Hibiscus	Malvaceae
<i>Mangifera indica</i> L.	Mango	Anacardiaceae
<i>Morus alba</i> L.	Mulberry	Moraceae
<i>Musa acuminata</i> Colla	Banana	Musaceae
<i>Persea americana</i> Mill.	Avocado	Lauraceae
<i>Plumeria alba</i> L.	Jasmine	Apocynaceae
<i>Psidium guajava</i> L.	Guava	Myrtaceae
<i>Punica granatum</i> L.	Pomegranate	Lythraceae
<i>Ricinus communis</i> L.	Castor bean	Euphorbiaceae
<i>Vigna unguiculata</i> Savi	Cowpea	Fabaceae

P. marginatus attacked and damaged various parts of the host plant including the leaves, stems, flowers and fruits. On lightly infested plants, papaya mealybugs looked like small pieces of cotton masses attached to the aerial parts of the plant.

The papaya mealybugs suck plant sap by inserting their stylets into the epidermis of leaves, fruits, flowers, and stems. During this feeding process, they introduce a toxic substance into the affected plant parts. Therefore, new growth on damaged plants becomes distorted due to the harmful saliva injected by the mealybugs. The infestation results in various detrimental effects, including chlorosis, stunted plant growth, deformed leaves, premature shedding of leaves and fruits, and a significant accumulation of honeydew. The honeydew, excreted by the mealybugs, promotes the development of dense sooty mold. This mold darkens the leaves, obstructing both light and air and disrupting the process of photosynthesis. In severe cases, extensive infestations can render fruits inedible due to the formation of a thick layer of white wax, ultimately leading to the demise of heavily attacked plants (**Walker et al., 2003 and Heu et al., 2007**).

P. marginatus was originally reported from the Neotropical region including Mexico, Belize, Costa Rica, Guatemala (**Williams and Granara de Willink, 1992**) and became a pest when it invaded the Caribbean region.

P. marginatus is now present in 62 countries (**García Morales et al., 2021**). It first started to spread in Dominican Republic in the 1990s, and by 2000, it had spread to Antigua, Belize, the British Virgin Islands, Costa Rica, Guatemala, Mexico, Nevis, Puerto Rico, St. Barthélemy, St. Kitts, St. Martin, and the US Virgin Islands and to the USA (Florida). In the next 10 years, it spread into the Bahamas and Guam in 2002, Palau in 2003, Hawaii in 2004, Northern Mariana Islands in 2005, and most of Asia and Africa as follows: India, Sri Lanka, Philippines in 2008, Thailand, Cambodia, Togo, Benin, Ghana, Maldives, Malaysia, Bangladesh in 2009, Jamaica in 2010, Taiwan, Oman in 2011, China, Mauritius in 2014, Tanzania, Mozambique in 2015, Israel, Gabon, Kenya in 2016, South Sudan in 2020, (**Meyerdirk**

et al., 2004; Muniappan *et al.*, 2006, 2011; Muniappan, 2008, 2009a, b; Goergen *et al.*, 2011; Mastoi *et al.*, 2011; Germain *et al.*, 2010; Chen *et al.*, 2011; Ahmed *et al.*, 2015; Mendel *et al.*, 2016; Macharia *et al.*, 2017 and Gama *et al.*, 2020) and later found Uganda in 2021, Cameroon in 2022.



Fig. (1). Host plants of papaya mealybug, *Paracoccus marginatus*



Fig. (2). Heavy infestation by papaya mealybug, *Paracoccus marginatus* on the fruits, upper side of leaf and death the plant

The live adult female of *P. marginatus* is soft, elongate oval; body yellow; legs light yellow; mealy wax covering body, not thick enough to hide yellow body, eight segmented antenna, without bare areas on dorsum, but segmental lines clearly visible; ovisac ventral; with 15 to 17 lateral wax filaments, posterior pair of filaments conspicuously longer, filaments anterior of posterior pair small, inconspicuous on thorax and head, posterior pair about 1/8 length of body (Fig 3). Primarily occurring on foliage of host. Oviparous, eggs cream or light yellow. Various stages of the papaya mealybug can be seen in a colony (Fig 4). Males are yellowish in colour in first instar and later turn to light pinkish in colour (second to third instars). They have a deep reddish body and white wings and two caudal (tail) filaments (Fig 5).



Fig. (3). The first, second instars and adult female of *Paracoccus marginatus*



Fig. (4). The first, second, third female instars and second male instar & Cotton-like masses on leaf & adult female with the ovisac of *Paracoccus marginatus*

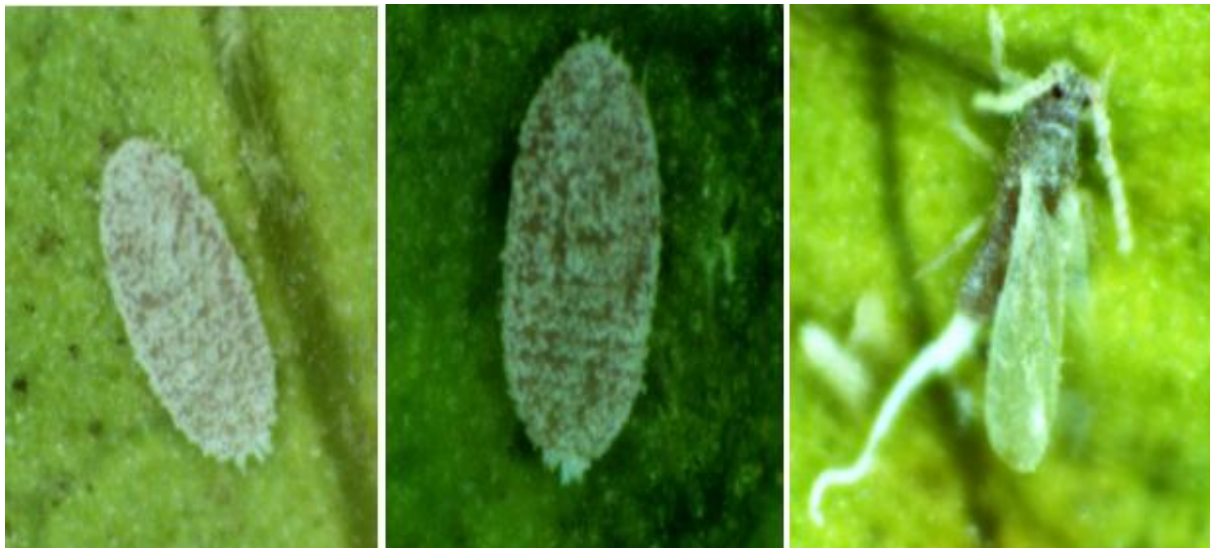


Fig. (5). The second, third instar male and adult male of *Paracoccus marginatus*

In slide-mounted adult females 2.1 -2.4 mm length and 1.4-1.5 mm width. Antenna eight segment. 17 pairs of cerarii, ventral multilocular pores absent from lateral areas of abdomen, anal bar present ventrally on each anal lobe, and dorsal setae generally equal to or shorter than conical cerarian setae.

Papaya mealybug can be distinguished by two main unique keys, presence of oral-rim tubular ducts dorsally which is only present in marginal areas of the body and presence of translucent pores only on hind coxa, no translucent pores on the hind tibia (Miller and Miller, 2002).

Adult males are smaller, 0.9 to 1.1 mm long with an elongate oval body that is widest at the thorax (0.3 mm). Adult males have ten-segmented antennae, a distinct aedeagus, a pair of lateral pore clusters occurred near the apex of the abdomen, the genital capsule was distinctly sclerotized a heavily sclerotized thorax and head, and well-developed wings (Chen *et al.*, 2011).

The life cycle of *P. marginatus* duration varies at different temperatures (**Amarasekare et al., 2008b; Munwar et al., 2016 and Laneesha, 2016**). In general, each female lays 300 to 600 greenish-yellow eggs in an ovisac which is covered with white waxy material. The eggs hatch in 4 to 7 days. Females have three nymphal instars occupying 24-26 days as against four in males extending up to 27-30 days at 25°C temperature and 65% relative humidity. The females live up to 30 to 60 days whereas the males survive for only 3 to 4 days, depending upon the environmental conditions (**Amarasekare et al., 2008 a & b and Shylesha et al., 2010**).

In general, *P. marginatus* has 11 generations/y and takes 30- 40 d to complete one generation (**Seni and Sahoo, 2014**).

The papaya mealybug, a globally invasive pest, can lead to economic losses ranging from 75% to 100% if not effectively managed (Ahmed et al., 2015). Current control measures include chemical control with profenophos 50EC (2 ml/litre), chlorpyrifos 20EC (2ml/litre), buprofezin 25EC (2ml/litre), birddimethoate 30EC (2ml/litre), thiamethoxam 25WG (0.6 g/litre), imidacloprid 17.8 SL (0.6ml /litre) ((Anonymous 1999). Additionally, biological control methods have been employed, utilizing natural enemies such as *Cryptolaemus montrouzieri* Mulsant (Coccinellidae), *Diadiplosis coccidarum* Cockerell (Cecidomyiidae) and *Chrysoperla carnea* (Stephens) (Chrysopidae) **Muniappan et al. (2006)**. Natural enemies of *P. marginatus* recorded at least 12 families including 24 genera. This method has been successfully implemented against *P. marginatus* in several countries (**Ballal, 2022**).

Also, the entomopathogenic fungi (**Mani et al. 2012**) has been practiced as one of the papaya mealybug control measures. In addition, insect Growth Regulators (IGR) (**Tunaz and Uygun 2004**).

Conclusion

Knowledge of the life history and morphology of *P. marginatus* is very helpful in predicting its development, emergence, distribution and abundance. This information can further assist in devising appropriate management tactics. Since there is a high possibility of spreading *P. marginatus* into other areas within Egypt and surroundings, it is important to study its life history of this mealybug. This paper presents a summary of information known about the papaya mealybug *P. marginatus* to facilitate any control strategies that might be contemplated. Further studies will be required to evaluate the economic importance of *P. marginatus*. Therefore, biological studies of *P. marginatus* and its natural enemies in Egypt is important to understand the forecasting and successful management of the pest.

REFERENCES

- Ahmed, M. Z.; He, R. R.; Wu, M.T.; Gu, Y. J.; Ren, J. M. and Liang, F. (2015)**. First report of the papaya mealybug, *Paracoccus marginatus* (Hemiptera: Pseudococcidae), in China and genetic record for its recent invasion in Asia and Africa. Florida Entomol., 98:1157–1162.
- Amarasekare, K. G.; Chong, J. H.; Epsky, N. D. and Mannion, C. M. (2008b)**. Effect of temperature on the life history of the mealybug *Paracoccus marginatus* (Hemiptera: Pseudococcidae). J. of Econ. Entomol., 101: 1798-1804.
- Amarasekare, K. G.; Mannion, C. M.; Osborne, L. S. and Epsky, N. D. (2008a)**. Life history of *Paracoccus marginatus* (Hemiptera: Pseudococcidae) on four host plant species under laboratory conditions. Envir. Entomol., 37: 630-635.
- Anonymous (1999)**. Control of the papaya mealybug, *Paracoccus marginatus* (Homoptera: Pseudococcidae). Envir. Assessment. Riverdale, MD.
- Ballal, C.R. (2022)**. Success Stories in Biological Control: Lessons Learnt.

- Chen, S. P.; Wong, J. Y. and Wu, W. J. (2011).** Preliminary report on the occurrence of papaya mealybug, *Paracoccus marginatus* Williams and Granara de Willink, in Taiwan. *J. Taiwan Agric. Res.*, 60: 72–76.
- Finch, E. A.; Beale, T.; Chellappan, M.; Goergen, G.; Gadratagi, B. D.; Khan, M. A. M.; Rehman, A.; Rwomushana, I.; Sarma, A. K.; Wyckhuys, K. A. G. and Kriticos D. J. (2020).** The potential global distribution of the papaya mealybug, *Paracoccus marginatus*, a polyphagous pest. *Pest Management Science* <https://doi.org/10.1002/ps.6151>.
- Gama, P. B. S.; Binyason, S. A. and Marchelo-d’Ragga, P. W. (2020).** First report of papaya mealybug, *Paracoccus marginatus* Williams and Granara de Willink (Hemiptera: Pseudococcidae), in Jubek State, South Sudan. *International Journal of Agricultural Research and Reviews*, 8: 31-46.
- García Morales, M.; Denno, B. D.; Miller, D. R.; Miller, G. L.; Ben-Dov, Y. and Hardy, N. B. (2021).** ScaleNet: A literature-based model of scale insect biology and systematics. Database. <http://scalenet.info/>
- Germain, J. F.; Pastou, D.; Lucas, E.; Minatchy, J. and Hostachy, B. (2010).** *Paracoccus marginatus*, une nouvelle cochenille sur papayer à la Réunion: Dégâts impressionnants sur les cultures. *Phytoma- Déf. Végétaux*, 633:9–10.
- Goergen, G. E.; Tamo, M.; Kyofa-Boamah, M. E.; Bokonon-Ganta, A. H. and Neuenschwander, P. (2011).** Papaya mealybug: a new invading pest in West Africa. *Biocontrol News Inf.*, 32: 9–10.
- Heu, R. A.; Fukada, M. T. and Conant, P. (2007).** Papaya mealybug, *Paracoccus marginatus* Williams and Granara de Willink (1992) (Hemiptera: Pseudococcidae). *New Pest Advisory.*, 4(3). State of Hawaii Department of Agric., Honolulu, HI.
- Laneesha, M. (2016).** Effect of thermal stress on host insect papaya mealybug, *Paracoccus marginatus* Williams and Grandara De Willink (Hemiptera: Pseudococcidae) on parasitoids *Acerophagus papayae* Noyes and Schauff PhD thesis. ICAR-Indian Agric. Res. Inst., New Delhi.
- Macharia, I.; Kimani, E.; Koome, F.; Kosiom, T.; Heya, H.; Otipa, M. and Oronje, M. (2017).** First report and distribution of the papaya mealybug, *Paracoccus marginatus*, in Kenya. *J. of Agric. and Urban Entomol.*, 33: 142-150.
- Mani, M.; Shivaraju, C. and Shylesha, A. N. (2012).** *Paracoccus marginatus*, an invasive mealybug of papaya and its biological control-an overview. *JBC.*, 26: 201–216.
- Mastoi, M. I.; Azura, A. N.; Muhammad, R.; Idris, A. B. and Ibrahim, Y. (2011).** First report of papaya mealybug *Paracoccus marginatus* (Hemiptera: Pseudococcidae) from Malaysia. *Aust J. Basic Appl Sci.*, 5: 1247–1250.
- Mendel, Z.; Watson, G. W.; Protasov, A. and Spodek, M. (2016).** First record of the papaya mealybug, *Paracoccus marginatus* Williams & Granara de Willink (Hemiptera: Coccoomorpha: Pseudococcidae), in the Western Palaearctic. *EPPO Bull.*, 46: 580–582.
- Meyerdirk, D. E.; Muniappan, R.; Warkentin, R.; Bamba, J. and Reddy, G.V. P. (2004).** Biological control of the papaya mealybug, *Paracoccus marginatus* (Hemiptera: Pseudococcidae). *Plant Protection Quarterly*, 19(3): 110-114.
- Miller, D. R.; Miller, G. L. and Watson, G. W. (2002).** Invasive species of mealybugs (Hemiptera: Pseudococcidae) and their threat to U.S. agriculture. *Proce. of Entomol. Soci. of Washington*, 104: 825-836.
- Miller, D. R. and Miller, G. L. (2002).** Redescription of *Paracoccus marginatus* Williams and Granara de Willink (Hemiptera: Coccoidea: Pseudococcidae) including descriptions of the immature stages and adult male. *Proceedings of Entomological Society of Washington*, 104(1): 1-23.

Muniappan, R. (2009a). Invasion of papaya mealybug, *Paracoccus marginatus* in Asia. Conference Paper, 57th Ann. Meeting of the Entomol. Soci. of America, 13-16 Dec, Indiana, USA.

Muniappan, R. (2011). Recent invasive Hemipterans and their biological control in Asia. Conference Paper, 5th Meeting of the Asian Cotton Research and Development Network, Lahore, Pakistan.

Muniappan, R.; Shepard B. M.; Watson, G. W.; Carner, G. R.; Rauf, A.; Sartiami, D.; Hidayat, P.; Afun, J. V. K.; Goergen, G. and Ziaur Rahman, A. K. M. (2009b). New records of invasive insects (Hemiptera: Sternorrhyncha) in Southeast Asia and West Africa. *J. Agric. Urban. Entomol.*, 26(4): 167–174.

Muniappan, R.; Meyerdirk, D.; Sengebau, F.; Berringer, D. and Reddy, G. (2006). Classical biological control of the papaya mealybug, *Paracoccus marginatus* (Hemiptera: Pseudococcidae) in the Republic of Palau. *Fla Entomol.*, 89:212–217.

Muniappan, R.; Shepard, B. M.; Watson, G. W.; Carner, G. R.; Sartiami, D.; Rauf, A. and Hammig, M. D. (2008). First report of the papaya mealybug, *Paracoccus marginatus* (Hemiptera: Pseudococcidae), in Indonesia and India. *J. of Agric. and Urban Entomol.*, 25: 37-40. <http://entweb.clemson.edu/scesweb> doi: 10.3954/1523- 5475-25.1.37

Munwar, A.; Mastoi, M. I.; Gilal, A. A.; Anjum, S.; Bhatti, A. R. and Ahmed, Z. (2016). Effect of different mating exposure timings on the reproductive parameters of papaya mealybug, *Paracoccus marginatus* (Hemiptera: Pseudococcidae). *Pakistan Entomol.*, 38: 65-69.

Myrick, S.; Norton, G. W.; Selvaraj, K. N.; Natarajan, K. and Muniappan, R. (2014). Economic impact of classical biological control of papaya mealybug in India. *Crop Protection*, 56: 82-86.

Seni, A. and Sahoo, A. K. (2014). Biology of the papaya mealybug, *paracoccus marginatus* williams and granara de willink (Hemiptera: pseudococcidae). *Inter. J. of Agric., Envir. & Biotec. Cita.: IJAEB*, 7(4): 875-881.

Shylesha, A. N.; Joshi, S.; Rabindra, R. J. and Bhumannavar, B. S. (2010). Classical Biological control of papaya mealybug. *Tech. Broch.*, National Bureau of Agriculturally Important Insects, Bangalore.

Tunaz, H. and Uygun, N. (2004). Insect growth regulators for insect pest control. *Turk. J. Agric. For.*, 28: 377–387.

Walker, A., Hoy, M. and Meyerdirk, D. E. (2003) Papaya Mealybug. Univ. Florida Featured Creatures. [http://creatures.ifas.ufl.edu/fruit/mealybugs/papaya mealybug. htm](http://creatures.ifas.ufl.edu/fruit/mealybugs/papaya%20mealybug.htm).

Williams, D. J. and Granara de Willink, M. C. (1992). Mealybugs of Central and South America. CAB International London, England 635 pp.