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First report of *Anagyrus kamali* Moursi and *Gyranusoidea indica* Shafee, Alam and Agarwal (Hymenoptera: Encyrtidae), parasitoids of the pink hibiscus mealybug *Maconellicoccus hirsutus* (Green) (Hemiptera: Pseudococcidae), on San Andres Island, Colombia

Primer reporte de *Anagyrus kamali* Moursi y *Gyranusoidea indica* Shafee, Alam y Agarwal (Hymenoptera: Encyrtidae), parasitoides de la cochinilla rosada del hibisco *Maconellicoccus hirsutus* (Green) (Hemiptera: Pseudococcidae) en la isla de San Andres, Colombia

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RESUMEN

Se reporta por primera vez la presencia de *Anagyrus kamali* Moursi y *Gyranusoidea indica* Shafee, Alam y Agarwal (Hymenoptera: Encyrtidae), parasitoides de la cochinilla rosada del hibisco (CRH), *Maconellicoccus hirsutus* (Green) (Hemiptera: Pseudococcidae) en la Isla de San Andrés, Colombia. Se proveen notas breves para diferenciar las dos especies de parasitoides.

Palabras clave: enemigos naturales, control biológico, morfología, nuevos registros de distribución

ABSTRACT

Here we report for the first time the presence of *Anagyrus kamali* Moursi and *Gyranusoidea indica* Shafee, Alam and Agarwal (Hymenoptera: Encyrtidae), parasitoids of the pink hibiscus mealybug (PHM), *Maconellicoccus hirsutus* (Green) (Hemiptera: Pseudococcidae), on San Andres Island, Colombia. Brief notes are provided to allow differentiation of the two parasitoid species.

Keywords: natural enemies, biological control, morphology, new distribution record

INTRODUCTION

The pink hibiscus mealybug (PHM), *Maconellicoccus hirsutus* (Green) (Hemiptera: Pseudococcidae) (Figure 1), is now widespread throughout the Caribbean islands. The taxonomy of mealybugs is based on the morphology as seen on slide-mounted specimens studied under a compound microscope. *Maconellicoccus hirsutus* has 9-segmented antennae, cerarii usually numbering 4–6 pairs (only on posterior abdominal segments), a circulus, and oral rim tubular ducts on both dorsum and venter (Kawai, 1980; Williams, 2004; Williams and Watson, 1988). It has a huge host range and occurs in all of the zoogeographic regions of the world (Ben-Dov *et al*., 2013). On mainland Colombia, *M. hirsutus* was originally reported from the Departments of Atlántico, Cesar, Guajira and Magdalena (Kondo *et al*., 2008). In the Department of "San Andres, Providencia and Santa Catalina", it was first reported in 2010 on the island of Providencia (ICA, 2010). More recently it was reported on San Andres Island where it is common on *Hibiscus* spp. and *Malvaviscus arboreus* (Kondo *et al*., 2012).

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Figure 1. An aggregation of *Maconellicoccus hirsutus* (Green) on leaf axils of *Hibiscus rosa-sinensis*, San Andres Island, Colombia. Photo by T. Kondo

Despite the vicinity of San Andres to Central America, the PHM was likely introduced to San Andres from mainland Colombia on ornamental plants because of the constant trade between the island and mainland Colombia (Kondo *et al*., 2012). High populations of the PHM can result in prolific production of honeydew, subsequently causing sooty mold growth, and heavy populations may cause host-plant wilting; the mealybug injects a toxic saliva during feeding, which can cause a characteristic symptom known as bunchy top in hibiscus (Hodges and Hodges, 2006).

The control of the PHM is the most recent example of a successful classical biological control program. Williams (1996) indicated that the key parasitoid of the PHM is *Anagyrus kamali* Moursi (Hymenoptera: Encyrtidae), a species that is likely of Asian origin. Reddy *et al*. (2009) reported that on the Marianna Islands, *A. kamali*, *Allotropa* sp. nr. *mecrida* (Walker) (Hymenoptera: Platygasteridae) and *Cryptolaemus montrouzieri* Mulsant (Coleoptera: Coccinellidae) have successfully suppressed populations of the PHM below the economic threshold. According to Chong (2009), the combination of natural enemies, namely, the mealybug destroyer *C. montrouzieri* and the parasitoids *A. kamali* and *Gyranusoidea indica* Shafee, Alam and Agarwal (Hymenoptera: Encyrtidae), significantly reduced the initial populations of *M. hirsutus* and maintained subsequent populations under damaging levels in the Caribbean and the USA. The parasitoid rearing program at the Division of Plant Industry in Gainesville, Florida, USA, recently ended as the parasitoids now are well established in that state (A.J. Fox, personal communication, *apud* Kondo *et al*., 2012). *Anagyrus kamali* is such an efficient parasitoid on Puerto Rico, that mass rearing is no longer necessary because the wasp is now well established there (J.C. Rodrigues, personal communication, *apud* Kondo *et al*., 2012). In Egypt, the encyrtid *A. kamali* is known to provide good control (Williams, 1986).

Anagyrus kamali has been recorded for various scale insects, namely: *Coccus hesperidum* L. (Coccidae), *Ferrisia virgata* (Cockerell), *Ferrisia* sp., *M. hirsutus*, *Trabutina serpentina* (Green), *Nipaecoccus viridis* (Newstead), *Nipaecoccus* sp., *Phenacoccus hirsutus* Granara de Willink, *Formicococcus robustus* (Ezzat and McConnell), *Planococcus citri* (Risso), *P. halli* Ezzat and McConnell, and *Pseudococcus* sp. (Pseudococcidae) (Noyes, 2012). However, *A. kamali* appears to be specialized on the PHM. Sagarra *et al*. (2001) conducted susceptibility, preference and suitability tests on eight mealybug species, namely, *Dysmicoccus brevipes* (Cockerell), *M. hirsutus*, *Nipaecoccus nipae* (Maskell), *P. citri*, *P. halli*, *Leptococcus neotropicus* (Williams and Granara de Willink), *Pseudococcus elisae* Borchsenius, *Puto barberi* (Cockerell), and *Saccharicoccus sacchari* (Cockerell), and determined that of the nine studied species, *M. hirsutus* was the only suitable mealybug host. According to the Chalcidoidea database (Noyes, 2012), *A. kamali* is widespread and has been reported from the Antilles, Bangladesh, Belize, Caribbean (including West Indies), Egypt, Grenada, Hawaii, India, Indonesia, Jordan, Montserrat, Pakistan, Peoples' Republic of China, Puerto Rico, Saint Lucia, Sri Lanka, St. Christopher (Kitts) and Nevis, Trinidad and Tobago, and the US Virgin Islands.

We also reared *Gyranusoidea indica* from PHM on San Andres Island. This species was described from India and has been introduced into Australia, Egypt, Guyana, Trinidad, various Caribbean countries (Noyes, 2012), and California, USA (Goolsby *et al*., 2002). *Gyranusoidea indica* has been recorded as a parasitoid of *M. hirsutus* (Meyerdirk and Warkentin, 1999; Abd-Rabou, 2001), *F. virgata* (Cockerell) (Abd-Rabou, 2001), *N. viridis* (Newstead) (Sharaf and Meyerdirk, 1987) and *Pseudococcus longispinus* (Targioni Tozzetti) (Abd-Rabou, 2001).

MATERIALS AND METHODS

The mealybug host was identified as *M. hirsutus* by GE and TK using the taxonomic keys by Kawai (1980), Williams (2004), and Williams and Watson (1988). Scale insect hosts of *A. kamali* listed in the Chalcidoidea database (Noyes, 2012) included some older names and synonyms, thus, the currently accepted names listed in the scale insect database ScaleNet (Ben-Dov *et al*., 2013) were used in the introduction section above.

Samples of encyrtid parasitoids were reared from the PHM feeding on twigs of *Hibiscus rosa-sinensis* L. (Malvaceae) by MFMA. The encyrtid parasitoids were identified as *A. kamali* and *G. indica* by GE using the original descriptions (Moursi, 1948; Shafee *et al*., 1975) and additional comments by Noyes (1980) and Michaud and Evans (2000). Studied material is deposited at the United States National Museum of Natural History, Beltsville, Maryland, USA (USNM). Other material studied and collected by MSG was identified by JAQ to the genus level

using the keys by Gibson *et al.* (1997) and Noyes (1980), and is deposited at the Museo Entomológico Francisco Luis Gallego, Universidad Nacional de Colombia, Sede Medellín, Medellín, Colombia (MEFLG).

Studied material

Anagyrus kamali Moursi. Colombia: San Andres Island: 12°32'10.3''N, 81°42'30.1''W, 5 m, 08.ix.2011, coll. Maria Fernanda Maya, ex *Maconellicoccus hirsutus* on *Hibiscus rosa-sinensis* L. (Malvaceae), 1 female and 1 male on microscope slide (USNM). *Gyranusoidea indica* Shafee, Alam and Agarwal. Colombia: San Andres Island: 12°32'10.3''N, 81°42'30.1''W, 5 m, 08.ix.2011, coll. Maria Fernanda Maya, ex *M. hirsutus* on *H. rosa-sinensis* L. (Malvaceae), 1 female on microscope slide (USNM).

Other studied material

Anagyrus sp. (likely *A. kamali* Moursi). 12°32'10.3''N, 81°42'30.1''W, 5 m, 19.ix.2012, coll. Marcela Silva Gómez, ex *M. hirsutus* (on *H. rosa-sinensis* L. (Malvaceae), 60 females and 19 males in vial (MEFLG); 12°32'14.7''N, 81°42'39.6''W, 42 m, 23.ix.2012, coll. Marcela Silva Gómez, ex *M. hirsutus* on *Guazuma ulmifolia* (Malvaceae), 11 females and 13 males in vial (MEFLG); 12°34'59.1''N, 81°41'23.7''W, 2 m, 13.x.2012, coll. Marcela Silva Gómez, ex *M. hirsutus* (on *Cordia sebestena* (Boraginaceae), 1 female in vial (MEFLG).

RESULTS AND DISCUSSION

Anagyrus kamali is superficially similar to *G. indica*, but can be distinguished by having the postmarginal vein of the forewing short, less than 0.5x as long as the stigmal vein (Figure 2A); frons dark brown, flagellum yellow with first segment dark brown in the female (Figure 2B), and the male with a dark spot at the apex of the antennal club. In *G. indica*, the postmarginal vein of the forewing is long, about 2x as long as the stigmal vein (Figure 2C); frons orangish, flagellum light brown in the female (Figure 2D); the male lacks the dark spot at the apex of the antennal club. In addition, most *Anagyrus* species can be separated from *Gyranusoidea* species by having conspicuous, moderately dense white setae on the face and irregular sculpture on the frontovertex, whereas *Gyranusoidea* species have pale setae on the face, but never conspicuous, and regular, polygonal sculpture on the frontovertex. For other differences, also see Montes-Rodríguez (2012).

The two parasitoids were recently reported in two municipalities in the Department of Norte de Santander, in mainland Colombia, on *M. hirsutus* infested shoots of *H. rosa-sinensis* (Montes-Rodríguez, 2012). According to Montes-Rodríguez (2012), *A. kamali* and *G. indica* probably came to Colombia by crossing the border from Venezuela, since the two parasitoids have been produced commercially and released by individuals and personnel from state-

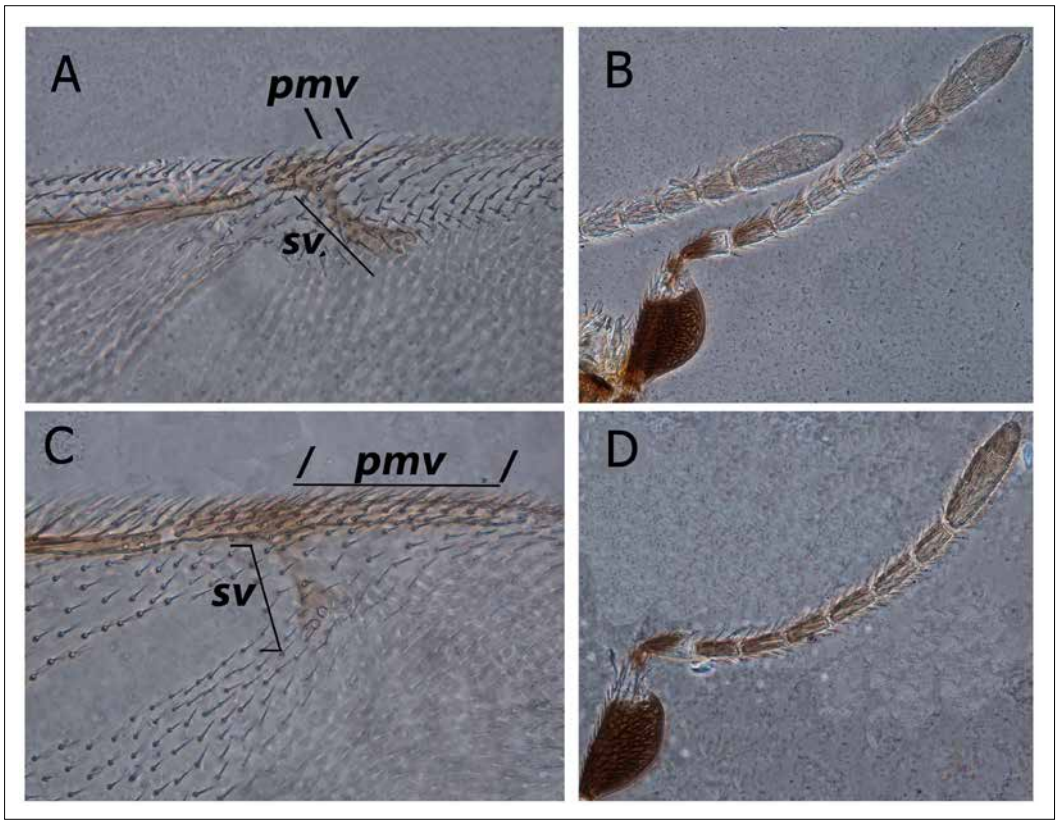

Figure 2. *Anagyrus kamali*: A. Wing venation. B. Antenna. *Gyranusoidea indica*: C. Wing venation. D. Antenna. Photos by G. Evans.

owned institutions in that country as a mean of biological control of the PHM (Cermeli *et al*., 2002). In Venezuela, the two parasitoids have been released in Zulia and Táchira, states that are located along the border with Colombia (Torres *et al*., 2007, *apud* Montes-Rodríguez, 2012).

The PHM generally becomes a pest when introduced into a new environment, and that was the case when first introduced onto the island of Providencia (ICA, 2010). However, on San Andres Island the PHM is not a serious pest, probably because the encyrtid parasitoids *A. kamali* and *G. indica* and other natural enemies are keeping it under control. The two parasitoids were probably introduced to San Andres from mainland Colombia along with *M. hirsutus*.

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