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Report of new invasive scale insects (Hemiptera: Coccoidea), *Crypticerya multicicatrices* Kondo and Unruh (Monophlebidae) and *Maconellicoccus hirsutus* (Green) (Pseudococcidae), on the islands of San Andres and Providencia, Colombia, with an updated taxonomic key to iceryine scale insects of South America

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Report of new invasive scale insects (Hemiptera: Coccoidea), *Crypticerya multicicatrices* Kondo and Unruh (Monophlebidae) and *Maconellicoccus hirsutus* (Green) (Pseudococcidae), on the islands of San Andres and Providencia, Colombia, with an updated taxonomic key to iceryine scale insects of South America

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Abstract. The multicicatrices fluted scale, *Crypticerya multicicatrices* Kondo and Unruh (Hemiptera: Coccoidea: Monophlebidae) is reported from the islands of San Andres and Providencia, Colombia, as a recent invasive species. This scale insect is polyphagous, and attacks numerous plants of economic importance such as avocado, breadfruit, mango, papaya and tropical ornamental plants. A compiled list of 95 host plant species of *C. multicicatrices* is given. A diagnosis of the adult female of *C. multicicatrices* and a revised taxonomic key to the species of the tribe Iceryini (Hemiptera: Monophlebidae) known from South America is provided. The pink hibiscus mealybug, *Maconellicoccus hirsutus* (Green) (Hemiptera: Coccoidea: Pseudococcidae), also is reported for the first time from the island of San Andres, where it is found commonly on *Hibiscus* spp. and *Malvaviscus arboreus* Cav. The need for the implementation of a classical biological control program in the archipelago in order to control invasive scale insect pests is discussed.

Key words. Classical biological control, fluted scale, insect pest, invasive species, pink hibiscus mealybug.

Resumen. Se reporta la cochinilla acanalada *Crypticerya multicicatrices* Kondo and Unruh (Hemiptera: Coccoidea: Monophlebidae) en la Isla de San Andrés, Colombia, como una reciente especie invasora. Este insecto escama es polífago y ataca numerosas plantas de importancia económica como el aguacate, árbol del pan, coco, mango, papaya y plantas tropicales ornamentales. Se provee una lista de 95 plantas hospederas de *C. multicicatrices*. Se provee una diagnosis de la hembra adulta de *C. multicicatrices* y se incluye una clave taxonómica revisada para las especies actualmente incluidas en la tribu Iceryini (Hemiptera: Monophlebidae) de Sur América. *Maconellicoccus hirsutus* (Green) (Hemiptera: Coccoidea: Pseudococcidae) también se reporta por primera vez para la isla de San Andrés, donde se encuentra comúnmente sobre *Hibiscus* spp. y *Malvaviscus arboreus* Cav. Se discute la necesidad de implementar un programa de control biológico clásico en el archipiélago para el control de insectos escama plagas invasores.

Palabras clave. Cochinilla acanalada, cochinilla rosada del hibisco, control biológico clásico, especies invasoras, insecto plaga.

Introduction

Invasive iceryine scale insects have become a problem in various parts of the world in recent years. For example, *Crypticerya genistae* (Hempel) (Hemiptera: Coccoidea: Monophlebidae) has been reported as a pest in the State of Espírito Santo, Brazil (Culik et al. 2007), on the island of Guadeloupe (Etienne and Matile-Ferrero 2008) and in the State of Florida, USA (Hodges 2008; Hodges et al. 2008). *Icerya imperatae* Rao has been recorded as a grass pest in the Republic of Palau and also reported from Australia, Brunei, Fiji and Malaysia (Williams et al. 2006; Hodgson and Lagowska 2011). More recently, *Icerya aegyptiaca* (Douglas) has been found in the Sakishima Islands of the Ryukyu Archipelago, Japan, where it was reported from 36 plant species belonging to 23 families (Uesato et al. 2011). The cottony

cushion scale *Icerya purchasi* Maskell was introduced to the Galapagos in 1982 on incoming ornamental plants and by 1996, it was reported as a serious pest invading 15 islands in the archipelago and affecting 62 native or endemic plant species (Causton 2004). In 2002, the first biological control program was implemented in the Galapagos Islands with the release of the vedalia beetle, *Rodolia cardinalis* Mulsant (Coleoptera: Coccinellidae) (Calderón-Alvarez et al. 2012). A study carried out on Santa Cruz Island on white mangrove, *Laguncularia racemosa* (L.) C.F. Gaertn. (Combretaceae) showed a 99–100% decline in the population of *I. purchasi*, three months after the release of *R. cardinalis*, suggesting that *R. cardinalis* played a key role in this decline, possibly in combination with high rainfall (Calderón-Alvarez et al. 2012).

The multicicatrices fluted scale, *Crypticerya multicicatrices* Kondo and Unruh, was described based on specimens collected in the Departments of Antioquia, Tolima and Valle del Cauca, of mainland Colombia (Kondo and Unruh 2009). This species is well established as a pest on the island of San Andres (see below) and now also is found on the island of Providencia where it also has become a pest (AR, personal observation). In the original description, *C. multicicatrices* was reported on 11 host plants, namely an undetermined palm (Arecaceae), mango (*Mangifera indica* L.), soursop (*Annona muricata* L.), sacred bamboo (*Nandina domestica* Thunb.), madrono (*Rheedia madruno* (Kunth) Planch. and Triana), *Caesalpinia peltophoroides* Benth., *Calliandra* sp., the golden shower tree (*Cassia fistula* L.), royal poinciana (*Delonix regia* (Bojer ex Hook.) Raf.), Madras thorn (*Pithecellobium dulce* (Roxb.) Benth.) and *Ficus* sp. (Kondo and Unruh 2009). In 2010, *C. multicicatrices* was reported as a serious pest on San Andres Island, Colombia, affecting 13 plant species, namely coconut (*Cocos nucifera* L.), coral tree (*Erythrina* sp.), hibiscus (*Hibiscus* sp.), Indian laurel (*Ficus* sp.), mango, mangrove (*Conocarpus erectus* L.), Manila palm (*Veitchia* sp.), noni (*Morinda citrifolia* L.), papaya (*Carica* sp.), pigeon pea (*Cajanus cajan* (L.) Huth), soursop, Tahiti lime (*Citrus* sp.) and tamarind (*Tamarindus indica* L.) (ICA 2010). Quiroga et al. (2011) collected specimens of *C. multicicatrices* infested with a fungus *Paecilomyces* sp. (Eurotiales: Trichocomaceae) on mango and conducted pathogenicity tests on specimens found on *A. muricata*, *C. fistula*, *Citrus grandis* (L.) Osbeck (as *C. sinensis*), coconut, *Codiaeum variegatum* (L.) Rumph. ex A. Juss., *Psidium guajava* L. and *T. indica*, increasing the known number of plant hosts of *C. multicicatrices* to 25 plant species. Here we add an extensive list of new host plants for *C. multicicatrices* and give information on the relative infestation levels observed on 82 host plants on San Andres Island. We have made emendations to the taxonomic key to iceryine scale insects published by Kondo and Unruh (2009) based on new observations on *C. multicicatrices*, *C. similis* (Morrison) and *C. zeteki* (Cockerell) in order to separate *C. multicicatrices* from other species in the tribe Iceryini. We also provide an updated diagnosis of *C. multicicatrices* based on our new observations. Furthermore, we report the pink hibiscus mealybug, *Maconellicoccus hirsutus* (Green) (Hemiptera: Coccoidea: Pseudococcidae) for the first time from San Andres Island and discuss the need for the implementation of a classical biological control program in order to mitigate the ecological impact of these invasive scale insects.

Materials and Methods

The third author (AR) conducted a survey of invasive scale insects in the islands of San Andres and Providencia during May 5–7, 2010. *Crypticerya multicicatrices* was identified by PG based on material collected during this first study. On April 6 and 7, and 25–28; and during June 6–9, 2012, TK conducted three field trips to the island of San Andres in order to determine the level of damage caused by *C. multicicatrices* and its host range on the island. The identification of the plant hosts was carried out through photographs taken during the field trip, which were later compared to various plant descriptions and literature such as those by Brickell (2002), Lowy (2000), Ruiz and Fandiño-Orozco (2007), Milliken et al. (2010) and Tokura et al. (1996). Plant scientific names were checked against The Missouri Botanical Garden's VAST (VAScular Tropicos) nomenclatural database (Missouri Botanical Garden: "w3TROPICOS" 2012).

Slide-mounted type material of *C. multicicatrices* is deposited at the Bohart Museum of Entomology, University of California, Davis, California, USA (**BME**), the United States National Entomological Collection, U.S. National Museum of Natural History, Washington, D.C., USA (**USNM**), and the Museo de Entomologia, Universidad del Valle, Cali, Colombia (**UVCO**); type material of *C. zeteki* is deposited in the BME and that of *C. similis* in the USNM.

Material studied. *Crypticerya multicicatrices* Kondo and Unruh. **COLOMBIA: San Andrés Island:** Base Naval ARC, El Cove, 12°31'37"N, 81°43'49"W, 0 m, on undetermined weed, A. Ramos-Portilla, 5.v.2010; Base Naval ARC, El Cove, 12°31'37"N, 81°43'49"W, 0 m, on leaves and leaf axils of *Carica papaya*, A. Ramos-Portilla, 5.v.2010; Base Naval ARC, El Cove, 12°31'37"N, 81°43'49"W, 0 m, on leaves, twigs and stem of *Hibiscus rosa-sinensis*, A. Ramos-Portilla, 5.v.2010; Base Naval ARC, El Cove, 12°31'37"N, 81°43'49"W, 0 m, on leaves, twigs and branches of *Conocarpus erectus*, A. Ramos-Portilla, 5.v.2010; Base Naval ARC, El Cove, 12°31'37"N, 81°43'49"W, 0 m, on leaves of *Mangifera indica*, A. Ramos-Portilla, 5.v.2010; Base Naval ARC, El Cove, 12°31'37N, 81°43'49"W, 0 m, on twigs of *Morinda citrifolia*, A. Ramos-Portilla, 5.v.2010; Base Naval ARC, El Cove, 12°31'37"N, 81°43'49"W, 0 m, on twigs of *Ixora* sp., A. Ramos-Portilla, 5.v.2010; Base Naval ARC, El Cove, 12°31'37"N, 81°43'49"W, 0 m, on leaves and twigs of *Tamarindus indica*, A. Ramos-Portilla, 5.v.2010; Bowie Bay, San Luis, 12°29'15", 81°43' 32"W, 1 m, on leaves of *Cajanus cajan*, A. Ramos-Portilla, 6.v.2010; Sukey Bay, 12°31'42"N, 81°43'55"W, 0 m, on leaves and twigs of *Cajanus cajan*, A. Ramos-Portilla, 6.v.2010; Sukey Bay, 12°31'42"N, 81°43'55"W, 0 m, on twigs of *Mangifera indica*, A. Ramos-Portilla, 6.v.2010; Sukey Bay, 12°31'42"N, 81°43'55"W, 0 m, on undetermined plant, A. Ramos-Portilla, 6.v.2010; Sukey Bay, Villarosa, 12°19'11"N, 81°26'27"W, 1 m, leaves of *Cocus nucifera*, A. Stephens and E. Wilson, 07.v.2010, 1(1); Sukey Bay, Villarosa, 12°19'11"N, 81°26' 27"W, 1 m, leaves of *Annona muricata*, A. Stephens and E. Wilson, 07.v.2010, 1(1); Sukey Bay, Villarosa, 12°19'11"N, 81°26' 27"W, 1 m, on leaves of *Veitchia merrillii*, A. Stephens and E. Wilson, 07.v.2010; Sukey Bay, Villarosa, 12°19'11"N, 81°26'27"W, 1 m, leaves and leaf axils of *Carica papaya*, A. Stephens and E. Wilson, 7.v.2010; Sukey Bay, Villarosa, 12°19'11"N, 81°26' 27"W, 1 m, leaves and twigs of *Ficus* sp., A. Stephens and E. Wilson, 7.v.2010; Sukey Bay, Villarosa, 12°19'11"N, 81°26' 27"W, 1 m, leaves and twigs of *Citrus latifolia*, A. Stephens and E. Wilson, 07.v.2010.

Other material studied for construction of key. *Crypticerya similis* (Morrison). Type material. **Holotype:** adult female, "Icerya ~~zeteki~~ Ckll/~~montserratensis~~ R.+H./similis/on Coconut leaves/ Cocoplum, near Bocas/del Toro, Panama/John R. Johnston, Coll./Rec'd Feb. 9, 1922". **Paratypes:** adult female, "Icerya similis (?)/Morr./~~montserratensis~~ R.+H./~~zeteki~~/Ckll/On Clusia alba/Port of Spain, Trinidad." (USNM); adult female, "Icerya ~~zeteki~~/ ~~montserratensis~~/ R.+H. / on unknown / fruit tree/ similis / Scarborough / Tobago / H. Morrison/Nov. 7, 1918/A–922" (USNM); adult female, 4 1st-instar nymphs, 1 embryo (nymphs and embryo on one slide), "Icerya similis Morr/~~montserratensis~~/R + H./On Clusia alba/Port of Spain, Trinidad/#4708" (USNM); 2 adult females (one slide), "Icerya ~~zeteki~~/Ckll./similis/on Cassia/fistula/St. Clair, Port-/of-Spain, Trin./H. Morrison./Nov. 4, 1918./A–881" (USNM).

***Crypticerya zeteki* (Cockerell). Lectotype:** adult female, "Icerya Type material/zeteki Ckll./ From undetermined/host/Panama Canal Zone/J. Zetek, coll./From Ckll. 1918/Entomological Laboratory/ Stanford University/G.F.F." (BME). **Paralectotypes:** 2 slides, 3 adult female (same data as lectotype); 2 adult females, "Icerya zeteki Ckll./On undetermined plant./Panama Canal Zone./J. Zetek, col./Part of type material, received/from Ckll. 1919" barcode 74 24 107432 (dry material) (BME).

Results and Discussion

A. The multicicatrices fluted scale, *Crypticerya multicicatrices*

Taxonomy

***Crypticerya multicicatrices* Kondo and Unruh, 2009**
(Figures 1–3)

Icerya brasiliensis Hempel: Kondo 2001: 31. Misidentification, discovered by Kondo and Unruh 2009: 99.
Crypticerya sp.: Kondo 2008: 27.
Crypticerya multicicatrices Cockerell: Quiroga et al. 2011: 10. Incorrect authorship.

Figure 1. Adult females (center) and nymphs (on each side) of *Crypticerya multicicatrices* on coconut leaf. Notice empty egg chorions on median slit (arrowed) on ovisac from where first-instar nymphs exit ovisac.

Diagnosis of adult female (adapted from Kondo and Unruh 2009).

Unmounted material. (Fig. 1). "Adult female elliptical; antennae, legs and eyes brownish-black; body orange-red, covered dorsally by white wax, with one long caudal tuft (up to 20.5 mm long, usually less than 15 mm long, but always longer than cephalic tuft), one shorter cephalic tuft protruding anteriorly, a marginal row of nine waxy tufts on each side, mealy wax abundant around dorsal submargin just above row of lateral waxy processes and forming a thick elevated submarginal ridge, with a median longitudinal waxy ridge composed of about five short tufts; waxy processes on each side of the caudal and cephalic tufts longer than other marginal processes. Ovisac elongate, white, distal end narrow, often curved upwards, appearing fluted, with 14 or 15 longitudinal furrows. Caudal and cephalic tufts with about four longitudinal furrows. Ovisac with about 120 eggs, each egg elliptical, about 0.8 mm long; ovisac slit on dorsomedial line, where crawlers escape" (Kondo and Unruh 2009: 95).

Slide-mounted material (Fig. 2). Body elongate to oval, 4.7–5.6 mm long, 2.8–3.5 mm wide.

Venter. Antennae 11-segmented, rarely 10 segmented. Eyes dark, present at base of antennae. Mouthparts normal for iceryines, labium three segmented. Legs well developed; forelegs shorter than mid- and hindlegs. Thoracic spiracles with metathoracic pair usually larger than posterior pair. Abdominal spiracles in three pairs on posterior abdomen. Ovisac band well developed, formed by multilocular pores of two types: (i) larger pores with trilocular center (sometimes bilocular) and 10–12 outer loculi, forming inner edge of ovisac band, 3 or 4 pores wide, and (ii) smaller pores with cruciform or star-shaped center forming outer edge of ovisac band, 2 or 3 pores wide. Vulvar opening on ventromedial abdomen. Ventral cicatrices usually numbering 9–13 (holotype has 11 cicatrices, usually with 11–13, but smaller non-type specimens with as few as 9 cicatrices), arranged in a U-shape behind vulva in ovisac cavity. Hair-like setae scattered on head and thorax and outside of ovisac band on abdomen, but sparse in ovisac cavity; longer setae between antennae and also marginally, longest and densest towards abdominal apex. Flagellate setae scattered, sparse, across all body segments. Multilocular pores with bilocular or trilocular center and 10–12 outer loculi, scattered on submarginal to marginal areas of all body areas, becoming densest towards margin. Multilocular pores with cruciform or star-shaped center and 4–7 outer loculi (rarely 0–2), forming clusters of 10–12 anterolateral to coxal articulations of all legs. Multilocular pores with reniform center and 4 outer loculi, scattered across medial to ventromedial abdomen. Slightly sclerotized patches forming patchy segmental lines across ventromedial abdomen.

Dorsum. Hair-like setae scattered in transverse rows on all body segments; hair-like setae and flagellate setae scattered amongst multilocular pores on all segments. Simple multilocular pores with bilocular or trilocular center and 9–12 outer loculi, densely scattered across all body segments, forming

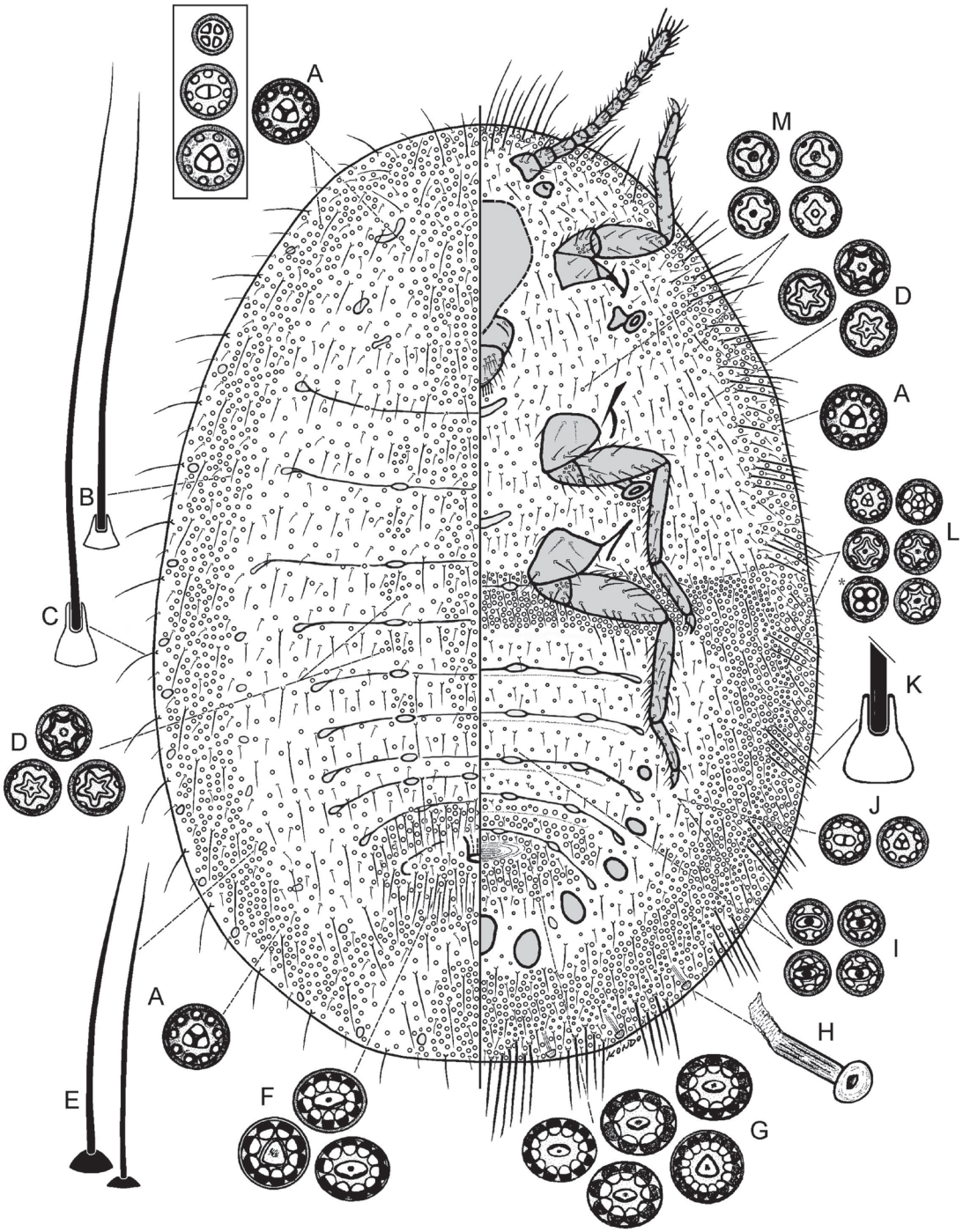

Figure 2. *Crypticerya multicicatrices* Kondo and Unruh, adult female (modified from Kondo and Unruh (2009), with copyright permission from the journal *Neotropical Entomology*). **A**, Simple multilocular pores, with bilocular or trilocular center and 6–8 (very rarely 0) outer loculi. **B**, Short hair-like seta. **C**, Long hair-like seta. **D**, Various types of simple multilocular pores, each with star-shaped center and 4–6 outer loculi. **E**, Flagellate seta. **F**, Simple multilocular pores surrounding anal opening, each with bilocular or trilocular center and 8–10 elongate outer loculi. **G**, Simple multilocular pores surrounding vulva, with bilocular or trilocular center and each with 8–14 elongate outer loculi. **H**, Abdominal spiracle. **I**, Simple multilocular pores on ventromedial abdomen, with reniform center and 4–6 outer loculi. **J**, Simple multilocular pores, with bilocular or trilocular center and 8–10 outer loculi. **K**, Enlargement of setal base. **L**, Various types of simple multilocular pores, with triangular, cruciform or star-shaped center and 4–7 (very rarely 0) outer loculi. **M**, Various types of simple multilocular pores present on ventral abdomen, with triangular or cruciform center and 3–6 outer loculi.

dense medial clusters on head, thorax and anterior abdomen. Smaller multilocular pores with cruciform (quadrate) or star-shaped (5-rayed) center and 4–8 outer loculi (rarely 0–2), forming clusters of 6–8 on submedial head, thorax and anterior abdomen. Small, sclerotized patches forming longitudinal rows on medial, submedial, intermediate and submarginal thorax and abdomen. Anal ring simple, sclerotized.

Notes. According to Kondo and Unruh (2009), slide-mounted adult females of *C. multicicatrices* can be easily separated from other iceryine species occurring in the New World by the following combination of features (with our observations in square brackets): (i) presence of 11–13 [smaller specimens with as few as 9] cicatrices forming a U-shape on the ventral abdomen; (ii) presence of an ovisac band; (iii) absence of dense flagellate setae in the ovisac band; (iv) absence of spiniform setae on the dorsal surface; (v) absence of open-center pores; and (vi) presence of three pairs of abdominal spiracles. This species was included in the *Crypticerya montserratensis* group (Unruh and Gullan 2008) because of the shape and distribution of the derm pores (Kondo and Unruh 2009). For a detail description of *C. multicicatrices* see Kondo and Unruh (2009).

Key to the adult females of South American iceryine species (modified from Kondo and Unruh 2009)

1. In life, with long glassy filaments present on dorsal surface. Derm of slide-mounted specimens with open-center pores (multilocular pores with a large central opening and thick rim formed by a variable number of smaller loculi); pores on derm variable, with bilocular or trilocular center and 6–12 outer loculi **2**
– In life, long glassy filaments absent from dorsal surface. Derm of slide-mounted specimens without open-center pores; pores on derm variable, with a bilocular, trilocular, quadrilocular, reniform, cruciform or star-shaped center and 0–12 outer loculi **3**

2(1). Open-center pores restricted to marginal clusters. Abdominal spiracles in two pairs ..... ***Icerya purchasi*** **Maskell**
– Open-center pores in marginal clusters and in medial clusters on at least dorsal head and thorax. Abdominal spiracles in 3 pairs ..... ***Icerya seychellarum*** **(Westwood)**

3(1). In life, never with ovisac present at posterior abdomen. Slide-mounted specimens without an ovisac band of pores on ventral abdomen **4**
– In life, long white waxy ovisac present at posterior abdomen of mature females. Slide-mounted specimens with an ovisac band of pores on ventral abdomen **5**

4(3). Dorsal surface and margins densely covered in spiniform setae. Cicatrices numbering >30, forming 1 or 2 semicircles on ventral abdomen ..... ***Echinicerya anomala*** **Morrison**
– Dorsal surface and margins without spiniform setae. Cicatrices numbering 3, forming a transverse row on ventral abdomen ..... ***Crypticerya abrahami*** **(Newstead),** ***C. pimentae*** **(Newstead) and** ***C. rosae*** **Riley and Howard** [These three species are apparently morphologically indistinguishable in the adult stage, but differ genetically and are found in different regions, i.e., *C. abrahami* in Colombia and Guyana, *C. pimentae* in Jamaica and *C. rosae* in Mexico and USA (Florida)]

5(3). Simple multilocular pores with a quadrilocular (appearing cruciform) or quinquelocular (appearing star-shaped) center and 4–8 outer loculi present submarginally and marginally on head and thorax. Ovisac band without a dense mass of flagellate setae. With 3 or more cicatrices **6**
– Simple multilocular pores with a quadrilocular or quinquelocular center and 4–8 outer loculi absent marginally and submarginally on head and thorax. Ovisac band with dense mass of flagellate setae. With 3 cicatrices **11**

6(5). With 3 cicatrices **7**
– With 5 or more cicatrices **10**

7(6). Long hair-like setae sparsely scattered on posterior abdomen, not forming marginal clusters. Short hair-like setae very sparsely scattered across all body segments..... ***Crypticerya subandina*** **(Leonardi)**
– Long hair-like setae forming marginal clusters. Short hair-like setae scattered on derm..... **8**

8(7). Simple multilocular pores forming inner ovisac band 6–8 pores wide ..... ***Crypticerya flava*** **(Hempel)**
– Simple multilocular pores forming inner ovisac band >8 pores wide **9**

9(8). Long hair-like setae in clusters of 3–5 around margin.... ***Crypticerya brasiliensis*** **(Hempel)**
– Long hair-like setae in clusters of 1–3 around margin ..... ***Crypticerya montserratensis*** **(Riley and Howard)**

10(6). With 5–7 cicatrices..... ***Crypticerya similis*** **(Morrison) and *C. zeteki* (Cockerell)**
– Usually with 11–13 cicatrices, but smaller specimens with as few as 9 cicatrices ..... ***Crypticerya multicicatrices*** **Kondo and Unru**

11(5). Body very small (length <2.5 mm). Setae and pores on dorsal surface very sparse, not forming a dorsal medial longitudinal band ..... ***Crypticerya minima*** **(Morrison)**
– Body not especially small (length >3.0 mm). Setae and pores covering dorsal surface, dense across all surfaces and densest in medial and submarginal longitudinal bands..... ***Crypticerya genistae*** **(Hempel)**

Notes. Key couplet 5 in the taxonomic key by Kondo and Unruh (2009) was in error having the presence or absence of multilocular pores marginally and submarginally on head and thorax inverted, thus rendering wrong all subsequent couplets. *Crypticerya similis* and *C. zeteki*, which were both described from Panama, are morphologically very similar and have been separated by a purported difference in the number of cicatrices, namely 5 in *C. similis* and 7 in *C. zeteki* (Morrison 1927; and the keys by Unruh and Gullan 2008; Kondo and Unruh 2009). In their redescription of *C. similis*, but not in their key to *Crypticerya* species, Unruh and Gullan (2008) erroneously state that 7 cicatrices are present in *C. similis*; however, the type specimens in the USNM have 5 cicatrices (D.R. Miller, personal communication), as described in the original description by Morrison (1927). Cockerell (1914) in his original description of *C. zeteki* (as *Icerya zeteki*) did not mention the number of cicatrices, but the type specimens of *C. zeteki* in the BME have 5 cicatrices, not 7 as recorded by Morrison (1927) and in the redescription by Unruh and Gullan (2008). However, there is a recently collected specimen of either *C. similis* or *C. zeteki* from Panama that has 7 cicatrices and so the number of cicatrices may be variable, perhaps in relation to body size. Furthermore, while studying numerous specimens of *C. multicicatrices* from San Andres Island, we noticed that smaller adult females could have as few as 9 cicatrices, in comparison to 11–13 cicatrices observed on larger specimens, including the holotype and paratypes. Thus we have emended the key to accommodate this new finding.

Host plants of *C. multicicatrices*

The following list of 95 host plants distributed in 75 genera in 37 families of *C. multicicatrices* is based on a compilation from several sources, as follows: Kondo and Unruh (2009) listed 11 plant species in 7 families, ICA (2010) listed 13 plant species in 10 families, and Quiroga et al. (2011) listed 8 species in 7 families (see Introduction); 13 species recorded by AR on San Andres (see Material studied above), field observations by TK who recorded 82 spp. on San Andres (see Fig. 3 and Table 1); and two hosts recently recorded by TK from the Department of Valle del Cauca, namely *Arachis pintoi* in Palmira (also recorded in San Andres) and *Licania tomentosa* in the city of Cali.

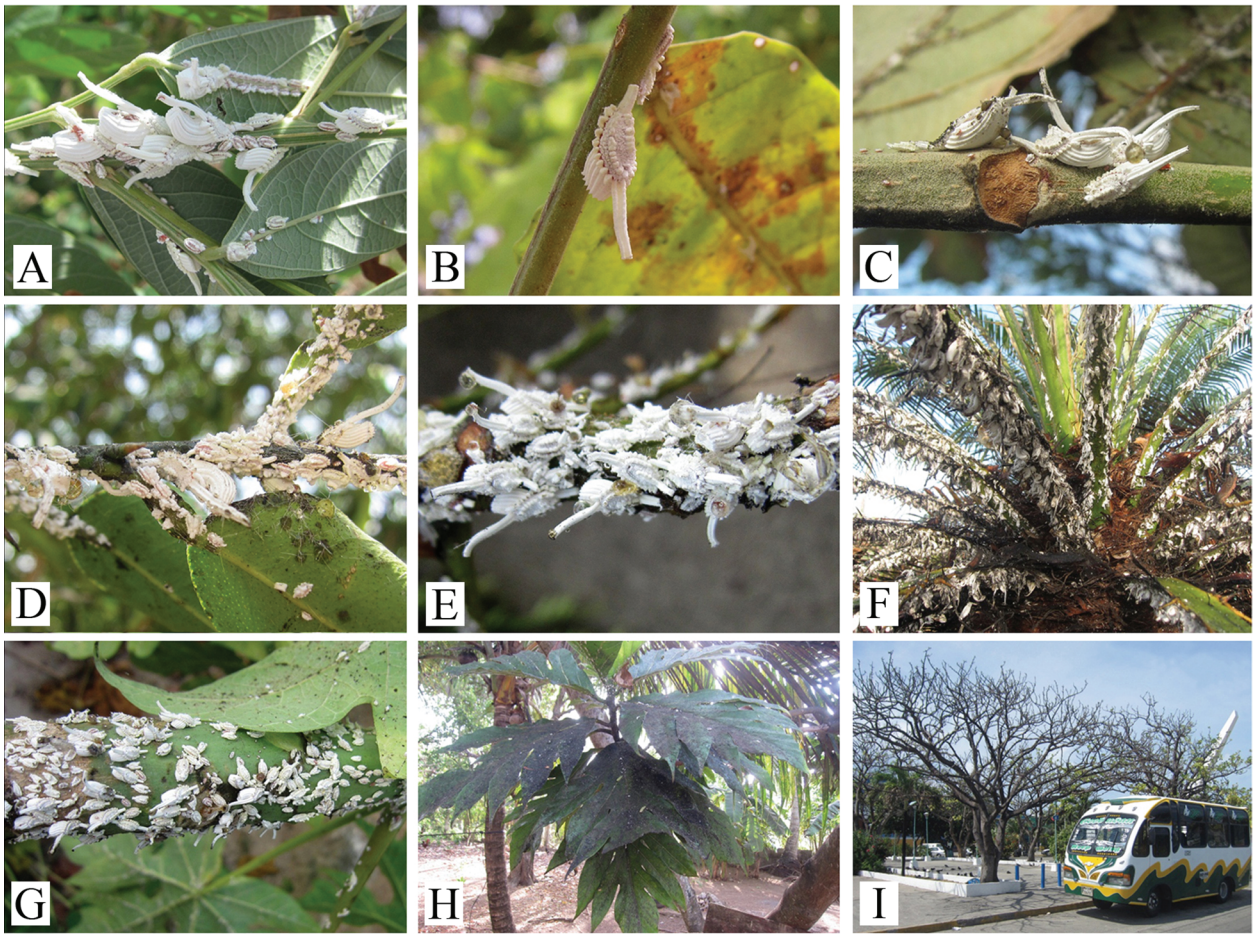

Figure 3. *Crypticerya multicicatrices*. **A.** On *Cajanus cajan*. **B.** On *Spondias purpurea*. **C.** On *Tectona grandis*. **D.** On *Citrus latifolia*. **E.** On *Delonix regia*. **F.** On a palm. **G.** On *Carica papaya*. **H.** On *Artocarpus altilis*. Notice sooty mold on leaves. **I.** Dieback of *Erythrina variegata* street trees.

Host plants. Acanthaceae: *Avicennia germinans* (L.) L., *Dicliptera assurgens* (L.) Juss., *Graptophyllum pictum* (L.) Griff. **Amaranthaceae:** *Achyranthes* sp. **Anacardiaceae:** *Mangifera indica* L., *Spondias mombin* L., *Spondias purpurea* L. **Annonaceae:** *Annona cherimola* Mill., *Annona muricata* L. **Araceae:** *Anthurium cubense* Engl., *Epipremnum aureum* (Linden and André) G.S. Bunting. **Arecaceae:** *Caryota* sp., *Cocos nucifera* L., *Cocos nucifera* L. "Malayan dwarf", *Dypsis lutescens* (H. Wendl.) Beentje and J. Dransf., *Phoenix roebelenii* O'Brien, *Pritchardia pacifica* Seem. and H. Wendl., *Veitchia merrillii* (Becc.) H.E. Moore, *Veitchia* sp., Species not determined. **Asparagaceae:** *Cordyline terminalis* (L.) Kunth. **Asteraceae:** *Emilia sonchifolia* (L.) DC. **Berberidaceae:** *Nandina domestica* Thunb. **Bignoniaceae:** *Crescentia cujete* L. **Bixaceae:** *Bixa orellana* L. **Calophyllaceae:** *Mammea americana* L. **Caricaceae:** *Carica papaya* L. **Chrysobalanaceae:** *Licania tomentosa* (Benth.) Fritsch. **Clusiaceae:** *Rheedia madruno* (Kunth) Planch. and Triana. **Combretaceae:** *Conocarpus erectus* L. **Euphorbiaceae:** *Acalypha wilkesiana* Müll. Arg., *Codiaeum variegatum* (L.) Rumph. ex A. Juss., *Euphorbia aphylla* Brouss. ex Willd., *Euphorbia hirta* L., *Jatropha gossypiifolia* L., *Jatropha integerrima* Jacq., *Manihot esculenta* Crantz. **Fabaceae:** *Albizia lebbeck* (L.) Benth., *Arachis pintoi* Krapov. and W.C. Greg., *Caesalpinia peltophoroides* Benth., *Cajanus cajan* (L.) Huth, *Calliandra pittieri* Standl., *Calliandra* sp., *Cassia fistula* L., *Cassia grandis* L. f., *Delonix regia* (Bojer ex Hook.) Raf., *Erythrina variegata* L., *Erythrina* sp., *Flemingia strobilifera* (L.) R. Br., *Leucaena leucocephala* (Lam.) de Wit, *Gliricidia sepium* (Jacq.) Kunth ex Walp., *Phaseolus* sp. (weed), *Pithecellobium dulce* (Roxb.) Benth., *Tamarindus indica* L. **Lamiaceae:** *Ocimum sanctum* L., *Tectona grandis* L. f. **Lauraceae:** *Persea americana* L. **Musaceae:**

Musa × *paradisiaca* L., *Musa* x *sapientum* L. **Lythraceae:** *Lagerstroemia indica* L. **Malvaceae:** *Ceiba pentandra* (L.) Gaertn., *Guazuma ulmifolia* Lam., *Hibiscus rosa-sinensis* L., *Hibiscus* sp., *Malvaviscus arboreus*, *Thespesia populnea* (L.) Sol. ex Corrêa. **Moraceae:** *Artocarpus altilis* (Parkinson) Fosberg, *Ficus benjamina* L., *Ficus elastica* Roxb. ex Hornem., *Ficus lyrata* Warb., *Ficus microcarpa* L. f., *Ficus* sp. **Myrtaceae:** *Pimenta dioica* (L.) Merr., *Psidium guajava* L., *Psidium* sp., *Syzygium samarangense* (Blume) Merr. and L. M. Perry. **Nyctaginaceae:** *Bougainvillea* sp. **Orchidaceae:** *Brassavola nodosa* (L.) Lindl. **Oxalidaceae:** *Averrhoa carambola* L. **Poaceae:** *Poa* sp. **Polygonaceae:** *Coccoloba uvifera* (L.). **Rubiaceae:** *Ixora coccinea* L., *Morinda citrifolia* L. **Rutaceae:** *Citrus* × *aurantiifolia* (Christm.) Swingle, *Citrus grandis* (L.) Osbeck, *Citrus latifolia* Tanaka, *Citrus* × *limon* (L.) Osbeck, *Citrus reticulata* Blanco, *Swinglea glutinosa* (Blanco) Merr. **Sapindaceae:** *Melicoccus bijugatus* Jacq. **Sapotaceae:** *Manilkara zapota* (L.) P. Royen. **Smilacaceae:** *Smilax spinosa* Mill. **Solanaceae:** *Capsicum chinense* Jacq. (Habanero pepper), *Capsicum* sp., *Cestrum nocturnum* L., *Solanum melongena* L. **Urticaceae:** *Cecropia peltata* L.

Biology. *Crypticerya multicicatrices* is found commonly on the twigs and leaves of its host, but may occur on the tree trunk and fruit when populations are high, and often is tended by various species of ants. *Crypticerya multicicatrices* have four growth stages, i.e., three nymphal stages and the adult stage. Usually all stages can be found in a single population. No males are known, and the species is probably hermaphroditic, similar to the closely related species *C. zeteki* (Hughes-Schrader and Monahan 1966). *Crypticerya multicicatrices* can be found throughout the year, but is most abundant during dry periods (TK, personal observation). Kondo and Unruh (2009) reported that *C. multicicatrices* was not observed associated with sooty molds in observations carried out on mainland Colombia, however, on San Andres Island *C. multicicatrices* is often associated with sooty molds, especially when populations are high. It is likely that the honeydew produced by *C. multicicatrices* has low sugar content, because generally no sooty mold is observed when populations are low.

Distribution. Neotropical region. **Colombia:** Antioquia, Providencia Island, San Andres Island, Tolima, Valle del Cauca.

Infestation levels of *C. multicicatrices* on San Andres Island

Infestation levels of *C. multicicatrices* on different host plants on San Andres Island were arbitrarily determined from "snapshot" observations made by TK on three field trips carried out during April 6–7 and 25–28, and June 6–9, 2012 (Table 1). A low infestation level indicates that few to several specimens were observed on a host; a mild infestation level indicates that there were many individuals on a host, but no particular damage was observed; and a high infestation level indicates a high number of individuals on a plant, often covering branches and in many cases associated with sooty mold, defoliation and dieback.

Host Preferences of *Crypticerya multicicatrices* on San Andres Island

The most common hosts of *C. multicicatrices* on San Andres Island include essentially all palm species (Arecaceae), breadfruit (*Artocarpus altilis* (Parkinson) Fosberg), *Citrus* spp., guava (*Psidium* spp.), all leguminous trees and weeds (Fabaceae), *Ficus* spp., *Mammea americana*, *Melicocca bijuga* and *Spondias* spp. The dieback of street trees, particularly *Erythrina variegata* L. (Fig. 31) and *Pithecellobium dulce*, was observed. See also Table 1.

Based on field observations, it can be said that, in general, *C. multicicatrices* does not infest plants of the families Cactaceae and Cupressaceae. Also it was not observed on *Araucaria excelsa* (Lamb.) R. Br. (Araucariaceae), *Calotropis procera* (Aiton) W.T. Aiton, *Cordia sebestena* L. (Boraginaceae), *Citrullus lanatus* (Thunb.) Matsum. & Nakai (Cucurbitaceae), *Gossypium* sp. (wild cotton) (Malvaceae), *Nerium oleander* L. (Apocynaceae), *Passiflora edulis* fo. *flavicarpa* O. Deg. (Passifloraceae), *Pedilanthus tithymaloides* (L.) Poit., *Ricinus communis* L. (Euphorbiaceae), *Phyllanthus acidus* (L.) Skeels (Phyllanthaceae), *Tabebuia* sp. (Bignoniaceae) and *Terminalia catappa* L. (Combretaceae). *Cordia sebestena* and *T. catappa* are very common on the island of San Andres, but *C. multicicatrices* appears to avoid these

Table 1. Infestation levels of *Crypticerya multicicatrices* on different host plant species on San Andres Island. Abbreviations for the "Notes" section are as follows: **BP:** Found just below or near heavily infested palm, thus may not be a true host, **DF:** Defoliation was observed on some plants/trees, **DB:** Dieback was observed on some plants/trees, **HI:** Heavy infestations common. **VL:** Very low numbers.

HOST PLANTS	Infestation level			Notes
Species and Family	Low	Mild	High	
Acalypha wilkesiana Müll. Arg. (Euphorbiaceae)			X	
Achyranthes sp. (Amaranthaceae)		X		
Albizia lebbeck (L.) Benth. (Fabaceae)		X		
Annona cherimola Mill. (Annonaceae)	X			
Annona muricata L. (Annonaceae)		X		
Anthurium cubense Engl. (Araceae)	X			
Arachis pintoi Krapov. and W.C. Greg. (Fabaceae)		X	X	Mild to high
Artocarpus altilis (Parkinson) Fosberg (Moraceae)			X	HI
Averrhoa carambola L. (Oxalidaceae)			X	
Avicennia germinans (L.) L. (Acanthaceae)		X		
Bixa orellana L. (Bixaceae)	X			
Bougainvillea sp. (Nyctaginaceae)	X			VL
Brassavola nodosa (L.) Lindl. (Orchidaceae)	X			
Cajanus cajan (L.) Huth (Fabaceae)		X		
Calliandra pittieri Standl. (Fabaceae)			X	
Capsicum chinense Jacq. (Habanero) (Solanaceae)	X			
Capsicum sp. (Solanaceae)	X			
Carica papaya L. (Caricaceae)			X	HI
Caryota sp. (Arecaceae)			X	
Cassia grandis L. f. (Fabaceae)			X	
Cecropia peltata L. (Urticaceae)	X			VL
Ceiba pentandra (L.) Gaertn. (Malvaceae)			X	DB, DF
Cestrum nocturnum L. (Solanaceae)	X			
Citrus grandis (L.) Osbeck (Rutaceae)			X	HI
Citrus latifolia Tanaka (Rutaceae)			X	HI
Citrus × *limon* (L.) Osbeck (Rutaceae)			X	
Citrus reticulata Blanco (Rutaceae)			X	HI
Coccoloba uvifera (L.) (Polygonaceae)	X			BP
Cocos nucifera L. (Arecaceae)			X	DB, HI
Cocos nucifera L. "Malayan dwarf" (Arecaceae)			X	DB, HI
Codiaeum variegatum (L.) Rumph. ex A. Juss. (Euphorbiaceae)	X			
Cordyline terminalis (L.) Kunth (Asparagaceae)		X		
Crescentia cujete L. (Bignoniaceae)	X			BP
Delonix regia (Bojer ex Hook.) Raf. (Fabaceae)			X	DB, HI
Dicliptera assurgens (L.) Juss. (Acanthaceae)		X		
Dypsis lutescens (H. Wendl.) Beentje and J. Dransf. (Arecaceae)			X	HI
Emilia sonchifolia (L.) DC. (Asteraceae)		X		
Epipremnum aureum (Linden and André) G.S. Bunting (Araceae)		X		
Erythrina variegata L. (Fabaceae)			X	DB, DF
Euphorbia aphylla Brouss. ex Willd. (Euphorbiaceae)	X			BP

HOST PLANTS	Infestation level			Notes
Species and Family	Low	Mild	High	
Euphorbia hirta L. (Euphorbiaceae)	X			BP
Ficus benjamina L. (Moraceae)			X	DF, HI
Ficus elastica Roxb. ex Hornem. (Moraceae)	X			
Ficus lyrata Warb. (Moraceae)		X		
Flemingia strobilifera (L.) R. Br. (Fabaceae)			X	
Gliricidia sepium (Jacq.) Kunth ex Walp. (Fabaceae)			X	HI
Graptophyllum pictum (L.) Griff. (Acanthaceae)		X		
Guazuma ulmifolia Lam. (Malvaceae)			X	HI
Hibiscus rosa-sinensis L. (Malvaceae)		X		
Ixora coccinea L. (Rubiaceae)	X			BP, VL
Jatropha gossypiifolia L. (Euphorbiaceae)	X			
Jatropha integerrima Jacq. (Euphorbiaceae)			X	
Lagerstroemia indica L. (Lythraceae)			X	HI
Leucaena leucocephala (Lam.) de Wit (Fabaceae)	X			
Licania tomentosa (Benth.) Fritsch (Chrysobalanaceae)	X			
Malvaviscus arboreus Cav. (Malvaceae)	X			
Mammea americana L. (Calophyllaceae)			X	HI
Mangifera indica L. (Anacardiaceae)			X	
Manihot esculenta Crantz (Euphorbiaceae)	X			BP, VL
Manilkara zapota (L.) P. Royen (Sapotaceae)			X	
Melicoccus bijugatus Jacq. (Sapindaceae)			X	HI
Morinda citrifolia L. (Rubiaceae)	X			BP
Musa × *paradisiaca* L. (Musaceae)	X			
Musa × *sapientum* L. (Musaceae)	X			
Ocimum sanctum L. (Lamiaceae)		X		
Phaseolus sp. (weed) (Fabaceae)			X	
Persea americana L. (Lauraceae)			X	HI
Phoenix roebelenii O'Brien (Arecaceae)			X	
Pimenta dioica (L.) Merr. (Myrtaceae)	X			
Pithecellobium dulce (Roxb.) Benth. (Fabaceae)			X	DB, DF, HI
Poa sp. (Poaceae)		X		BP, SA
Pritchardia pacifica Seem. and H. Wendl. (Arecaceae)			X	
Psidium guajava L. (Myrtaceae)			X	HI
Psidium sp. (Myrtaceae)			X	
Smilax spinosa Mill. (Smilacaceae)		X		
Solanum melongena L. (Solanaceae)		X		
Spondias mombin L. (Anacardiaceae)		X		
Spondias purpurea L. (Anacardiaceae)		X		
Swinglea glutinosa (Blanco) Merr. (Rutaceae)	X			BP, VL
Syzygium samarangense (Blume) Merr. and L.M. Perry (Myrtaceae)	X			
Tamarindus indica L. (Fabaceae)			X	HI
Tectona grandis L. f. (Lamiaceae)			X	DB, DF
Thespesia populnea (L.) Sol. ex Corrêa (Malvaceae)		X		

hosts. Although common on the island of San Andres and listed above as host plants of *C. multicicatrices*, *Bougainvillea* sp., *Coccoloba uvifera*, *Crescentia cujete*, *Euphorbia aphylla*, *Manihot esculenta*, *Morinda citrifolia* and *Swinglea glutinosa*, do not seem to be favored hosts of *C. multicicatrices*, since these plants were usually found free of this scale insect. The record of these latter seven species was based on plants that were planted near or below highly infested palm trees.

Natural enemies of *C. multicicatrices* on San Andres Island

A fungus identified as *Paecilomyces* sp. (Eurotiales: Trichocomaceae), isolated from specimens of *C. multicicatrices* collected on a mango tree on the island of San Andres was reported recently as a natural control agent of *C. multicicatrices* in pathogenicity tests on different plant species (Quiroga et al. 2011). In the first phase of the experiment conducted by Quiroga et al. (2011), individuals of *C. multicicatrices* found on branches of *Codiaeum variegatum* and *Cassia fistula* were inoculated with the fungus in two different ways, i.e., 1) by using a garden sprayer, and 2) with a brush soaked with macerated individuals of *C. multicicatrices* that were infected by the fungi. The branches with *C. multicicatrices* were covered with a plastic bag soon after inoculation to prevent contact with wind or rain; and the infested branches were irrigated daily to prevent desiccation and subsequent abscission (Quiroga et al. 2011). The mortality rate was 80% in specimens inoculated with the garden sprayer and 30% in specimens inoculated with a brush (Quiroga et al. 2011). On the second phase of the experiment, infestation rates were determined on six plant species by spraying 10^6 conidia/ml, resulting in a mean mortality rate of 88.1% (Quiroga et al. 2011). The experiment by Quiroga et al. (2011) was carried out under high moisture conditions, i.e., daily irrigation of the branches and a plastic bag surrounding the infested branches, which could explain the high mortality rate of *C. multicicatrices*. The fungus identified as *Paecilomyces* sp. by Quiroga et al. (2011), has now been identified as *Isaria* sp. (L. M. Hoyos, personal communication).

Introduction of *C. multicicatrices* to the archipelago of San Andres, Providencia and Santa Catalina

The Archipelago of San Andrés, Providencia and Santa Catalina is a southwestern Caribbean Department of Colombia, composed of an extensive area of islands, banks and cays in the western Caribbean, located about 700 km northwest of mainland Colombia, and 250 km east of Nicaragua (Geister and Diaz 1997; Hartnoll et al. 2006). In other words, San Andres Island is closer to Nicaragua (and other Central American countries) than to Colombia. However, despite the geographical proximity of the archipelago of San Andres, Providencia and Santa Catalina to Central America, *C. multicicatrices* was likely introduced to the islands of San Andres and Providencia on infested ornamental plants brought from continental Colombia since this is the only place from where it has been reported previous to its introduction to the archipelago [Kondo 2001 (as *Icerya brasiliensis* Hempel); Kondo 2008 (as *Crypticerya* sp.); Kondo 2009; Kondo and Unruh 2009], and there is intensive trade between the islands and mainland Colombia.

Potential for biological control of *C. multicicatrices*

Neither parasitoids nor predators of *C. multicicatrices* have been found on the islands of San Andres and Providencia, with exception of the larvae of a species of Chrysopidae which are commonly found feeding on nymphs of *C. multicicatrices* on San Andres Island (TK, personal observation). Under laboratory conditions it has been observed that individuals of the mealybug destroyer, *Cryptolaemus montrouzieri* Mulsant (Coleoptera: Coccinellidae), which occur on the island of Providencia and are effective predators of the pink hibiscus mealybug, do not feed upon *C. multicicatrices* nor even attempt to consume it (P. Sarmiento, personal communication).

Crypticerya multicicatrices is a common scale insect in the Department of Valle del Cauca, and is frequently found on ornamental palms (Arecaceae) and on twigs of *Caesalpinia peltophoroides* and *Pithecellobium dulce* (Fabaceae), but it can be found on many other plants. On mainland Colombia, *C. multicicatrices* have been reported as an occasional pest on mango (Kondo and Unruh 2009; Kondo

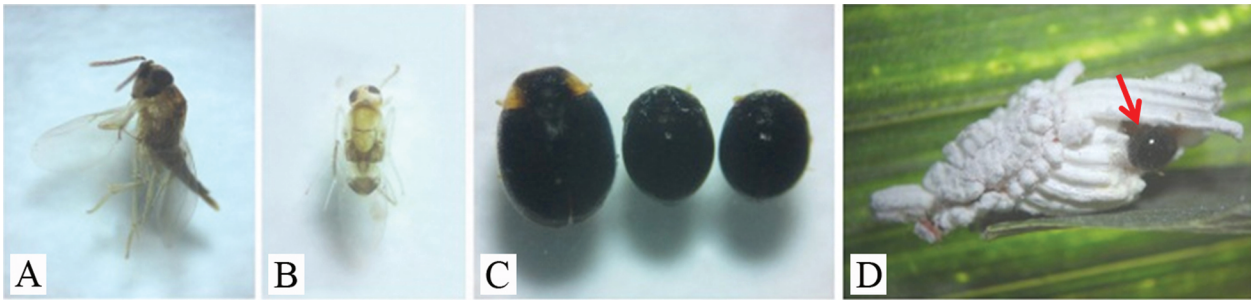

Figure 4. Natural enemies of *C. multicicatrices*. **A.** Encyrtid sp. 1. **B.** Encyrtid sp. 2. **C. Left.** *Diomus*? sp. **Center and Right.** *Delphastus*? sp. **D.** *Delphastus*? sp. on ovisac of *C. multicicatrices* preying upon eggs (see arrow). Photos A–C by TK; D by R. L. Bermúdez.

2009) and soursop (Kondo 2008). In both situations, *C. multicicatrices* were found in commercial orchards where pesticide control may have reduced the natural enemies of the scale insect, resulting in their high populations.

Historically, the use of natural enemies in classical biological control programs have proven to be effective against invasive scale insect species, e.g., the vedalia beetle, *R. cardinalis* and the parasitoid fly, *Cryptochetum iceryae* (Williston) (Diptera: Cryptochetidae), to control the cottony cushion scale, *I. purchasi,* in California from 1889 onwards (Gullan and Cranston 2010); the parasitoid *Apoanagyrus lopezi* De Santis (Hymenoptera: Encyrtidae) to control the cassava mealybug, *Phenacoccus manihoti* Matile-Ferrero (Pseudococcidae), in Africa in the 1980s (Neuenschwander 2001); the parasitoid *Gyranusoidea tebygi* Noyes (Hymenoptera: Encyrtidae) to control the mango mealybug *Rastrococcus invadens* Williams (Pseudococcidae) in Africa in the late 1980s and early 1990s (Boavida and Neuenschwander 1995); and more recently, various natural enemies against the pink hibiscus mealybug, *M. hirsutus* (see Section B below).

Besides the entomopathogenic fungi *Paecilomyces* sp. (now identified as *Isaria* sp.) discovered on San Andres Island, no other natural enemies have been reported for *C. multicicatrices*. The vedalia beetle, *R. cardinalis*, which is an effective predator of *I. purchasi,* also is able to feed on the ground pearl, *Margarodes similis* Morrison (Causton 2004), an insect belonging to the closely related family Margarodidae. Considering that *I. purchasi* and *C. multicicatrices* belong to the tribe Iceryini, it is likely that *R. cardinalis* could feed on the latter species, but this remains to be tested. However, *R. cardinalis* is highly specialized on *I. purchasi*, thus the use of native natural enemies of *C. multicicatrices* is the preferred option for a biological control program (M. S. Hoddle, personal communication). According to the "Universal Chalcidoidea Database", there are two primary parasitoids of the closely related species, *C. brasiliensis*, namely *Brethesiella abnormicornis* Girault and *B. longipes* Blanchard (Hymenoptera: Encyrtidae) (Noyes 2012). *Brethesiella longipes* was described from Argentina and *B. abnormicornis* has been reported from Barbados, Bermuda, Brazil (Sao Paulo), São Tomé and Principe, Trinidad and Tobago, and Uruguay (Noyes 2012), so it is likely that *B. abnormicornis* may occur in Colombia and parasitize *C. multicicatrices*.

Furthermore, on mainland Colombia, several unidentified natural enemies of *C. multicicatrices* have been found, including at least two hymenopterous parasitoids extracted from the adults and two small coccinellids that feed on eggs and nymphs (R. L. Bermúdez, personal observation). Based on photographs (Fig. 4), the parasitoids appear to belong to the family Encyrtidae (G. A. Evans, personal communication), and the two coccinellids appear to belong to the genera *Delphastus* Casey and *Diomus* Mulsant (G. González, personal communication). Of the two coccinellids, *Delphastus*? sp. was the most common, and adult beetles were usually found inside the ovisacs feeding on the eggs of *C. multicicatrices* (R. L. Bermúdez, personal observation). More recently, in Palmira, in the Department of Valle del Cauca, the larvae of a species of Chrysopidae were found feeding on nymphs and adults; and in the near city of Cali, the larvae of a species of fly (Phoridae) were found feeding on eggs inside the ovisacs of *C. multicicatrices* (E. M. Quintero, personal communication). It should be noted that the chrysopid species found in Palmira has much larger individuals than that found on San Andres Island. In a classical biological control program, these insects may have a potential use in the control of outbreaks

of this iceryine pest on the islands of San Andres and Providencia, by using the encyrtid parasitoids against the adults and the coccinellids and phorid flies against the eggs and first-instar nymphs. The chrysopids could be used to control all growth stages of *C. multicicatrices*.

B. Pink hibiscus mealybug, *Maconellicoccus hirsutus* (Green)

First report of *M. hirsutus* on San Andres Island

The pink hibiscus mealybug (PHM) has been reported previously for the neighboring island of Providencia (ICA 2010). Herein we report for the first time the presence of *M. hirsutus* on the island of San Andres, where it is found commonly on *Hibiscus* spp. and *Malvaviscus arboreus*. The mealybug destroyer, *C. montrouzieri*, has been observed feeding on *M. hirsutus* on the island of Providencia, however, this was not found on the island of San Andres in the present study. No parasitoids have been detected so far associated with *M. hirsutus* on the islands of San Andres and Providencia.

The spread of the *M. hirsutus* in the New World and its successful control

The spread of the PHM in the New World is well documented (Kondo et al. 2008). According to Michaud and Evans (2000), the PHM was first recorded from Grenada in 1993 (Persad 1995), Trinidad in 1995 (Jones 1996), St. Kitts in 1995 (Thomas and Edwards 1996), sixteen islands of the Lesser Antilles in 1997 (Meyerdirk 1997), the island of Vieques (Puerto Rico) in 1997, mainland Puerto Rico in 1997, Isla Margarita (Venezuela) in 1999, mainland Venezuela in 2000 (Cermeli et al. 2002), California in 1999, and Florida, U.S.A. in 2002 (Hodges and Hodges 2006).

It is not surprising that the PHM has invaded (or has been introduced into) the islands of San Andres and Providencia, as this mealybug species has spread rapidly through the Caribbean and now also is present on mainland Colombia, particularly those Departments along the Caribbean coast (Kondo et al. 2008). According to Kondo et al. (2008), the earliest samples of *M. hirsutus* in Colombia were collected in 2006, but they discussed that judging by the records of *M. hirsutus* in neighboring Venezuela in 2000, and by its presence in four Departments along the Caribbean coast of Colombia, it is likely that the introduction of the PHM into mainland Colombia occurred sometime in the early 2000s, about the same time or soon after it was introduced into Venezuela. According to Ramos and Serna (2004), there was a phytosanitary surveillance program by ICA in 2003 and *M. hirsutus* was not found in Colombia in 2004, thus the mealybug could have been introduced into Colombia after 2004. But according to M. A. Alterio (ICA, Cucuta) (personal communication), *M. hirsutus* was introduced into Colombia in 2003. The PHM was reported on Providencia for the first time in 2010 (ICA 2010), and it is likely that it was introduced from mainland Colombia on ornamental plants because of the constant trade between the islands and mainland Colombia.

The control of the PHM has become the most recent example of a successful classical biological control program. Williams (1996) described the biology and relationships of two other species of *Maconellicoccus* Ezzat, and indicated that the key parasitoid of *M. hirsutus* is *Anagyrus kamali* Moursi (Hymenoptera: Encyrtidae), a species presumed to be of Asian origin. The combination of the natural enemies, i.e., the predator *C. montrouzieri* and the hymenopteran parasitoids *A. kamali* and *Gyranusoidea indica* Shafee, Alam and Agarwal (Hymenoptera: Encyrtidae) have significantly reduced the initial populations of *M. hirsutus* and maintained the subsequent populations below damaging levels in the Caribbean and the United States (Chong 2009). On the Marianna Islands, *C. montrouzieri*, *A. kamali*, and *Allotropa* sp. nr. *mecrida* (Walker) (Hymenoptera: Platygasteridae) have successfully suppressed populations of *M. hirsutus* below the economic threshold (Reddy et al. 2009). 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). *Anagyrus kamali* is such an efficient parasitoid in Puerto Rico, that mass rearing is no longer necessary since the wasp is well established there (J.C. Rodrigues, personal communication).

As part of a classical biological control program, the introduction of natural enemies, particularly *A. kamali* and *G. indica* are recommended to control the PHM on San Andres Island and Providencia,

as has been done in many other countries in the Caribbean, as well as in Mexico and the USA. The mealybug destroyer *C. montrouzieri* also should be incorporated into a biological control program as it is an effective predator of mealybugs and it is already present on the neighboring island of Providencia.

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Literature Cited

Boavida, C., and P. Neuenschwander. 1995. Population dynamics and life tables of the mango mealybug, *Rastrococcus invadens* Williams, and its introduced natural enemy *Gyranusoidea tebygi* Noyes in Benin. Biocontrol Science and Technology 5 (4): 489–508.

Brickell, C. 2002. The American Horticultural Society encyclopedia of plants and flowers. DK Publishing; New York, NY, USA. 720 p.

Calderón Alvarez, C., C. E. Causton, M. S. Hoddle, C. D. Hoddle, R. van Driesche, and E. J. Stanek. 2012. Monitoring the effects of *Rodolia cardinalis* on *Icerya purchasi* populations on the Galapagos Islands. Biocontrol 57 (2): 167–179. DOI: 10.1007/s10526-011-9429-8.

Causton, C. E. 2004. Predicting the field prey range of an introduced predator, *Rodolia cardinalis* Mulsant, in the Galápagos. p. 195–223. *In*: R. G. Van Driesche and R. Reardon (eds.). Assessing host ranges for parasitoids and predators used for classical biological control: a guide to best practice. FHTET-2004-03, United States Department of Agriculture Forest Service; Morgantown, West Virginia, USA. 242 p.

Cermeli, M., P. Morales, F. Godoy, R. Romero, and O. Cárdenas. 2002. Presencia de la cochinilla rosada de la cayena *Maconellicoccus hirsutus* (Green) (Hemiptera: Pseudococcidae) en Venezuela. Entomotropica 17 (1): 103–105.

Chong, J. 2009. First Report of the pink hibiscus mealybug, *Maconellicoccus hirsutus* (Green) (Hemiptera: Pseudococcidae), in South Carolina. Journal of Agricultural and Urban Entomology 26 (2): 87–94.

Cockerell, T. D. A. 1914. A new cotton scale from Panama. Journal of Economic Entomology 7: 148.

Culik, M. P., D. S. Martins, J. A. Ventura, A. L. B. G. Peronti, P. J. Gullan, and T. Kondo. 2007. Coccidae, Pseudococcidae, Ortheziidae, and Monophlebidae (Hemiptera: Coccoidea) of Espírito Santo, Brazil. Biota Neotropica 7 (3): 1–5.

Etienne, J., and D. Matile-Ferrero. 2008. *Crypticerya genistae* (Hempel), nouveau danger en Guadeloupe (Hemiptera, Coccoidea, Monophlebidae). Bulletin de la Société Entomologique d'Egypte 113 (4): 517–520.

Geister, J., and J. M. Diaz. 1997. A field guide to the oceanic barrier reefs and atolls of the southwest Caribbean (Archipelago of San Andres and Providencia, Colombia). p. 235–262. *In*: H. A. Lessios and I. G. Macintyre (Eds). Proceedings of the 8th International Coral Reef Symposium Vol. 1. Smithsonian Tropical Research Institute; Panama. 2119 p.

Gullan, P. J., and P. S. Cranston. 2010. The insects: an outline of entomology. 4th edition. Blackwell Publishing; Oxford, UK. 584 p.

Hartnoll, R. G., M. S. P. Baine, Y. Grandas, J. James, and H. Atkin. 2006. Population biology of the black land crab, *Gecarcinus ruricola*, in the San Andres archipelago, western Caribbean. Journal of Crustacean Biology 26 (3): 316–325.

Hodges, G. S. 2008. *Icerya genistae* Hempel (Hemiptera: Margarodidae): an emerging pest in south Florida. p. 157. *In*: M. Branco, J. C. Franco, and C. J. Hodgson (Eds). Proceedings of the XI International Symposium on Scale Insect Studies, Oeiras, Portugal, 24–27 September 2007. ISA Press; Lisbon, Portugal. 322 p.

Hodges, A., and G. Hodges. 2006. Pink hibiscus mealybug identification. Plant Health Progress 1–7.

Hodges, G. S., A. C. Hodges, and C. M. Unruh. 2008. A new exotic pest for Florida's natural areas: *Crypticerya genistae* (Hemiptera: Monophlebidae). Florida Entomologist 91 (2): 335–337.

Hodgson, C. J., and B. Lagowska. 2011. New scale insect (Hemiptera: Sternorrhyncha: Coccoidea) records from Fiji: three new species, records of several new invasive species and an updated checklist of Coccoidea. Zootaxa 2766: 1–29.

Hughes-Schrader, S., and D. F. Monahan. 1966. Hermaphroditism in *Icerya zeteki* Cockerell, and the mechanism of gonial reduction in iceryine coccids (Coccoidea: Margarodidae Morrison). Chromosoma 20: 15–31.

ICA [Instituto Colombiano Agropecuario]. 2010. Plan para el manejo y mitigación del riesgo ocasionado por la cochinilla rosada (*Maconellicocus hirsutus*) y la chinche acanalada (*Crypticerya multicicatrices*) en las islas de San Andrés y Providencia. Subgerencia de protección vegetal dirección técnica de epidemiologia y vigilancia fitosanitaria; gerencia seccional San Andrés y Providencia. Julio 2010. 15 p.

Jones, M. T. 1996. Status of the hibiscus mealybug *Maconellicoccus hirsutus* (Green) in Trinidad and Tobago. Regional Meeting of the Technical Advisory Committee, 4th October, 1995, Grenada. Ministry of Agriculture, Land and Marine Resources; Trinidad and Tobago. 8 p.

K**ondo, T. 2001.** The scale insects of Colombia (Hemiptera: Coccoidea). Biota Colombiana 2 (1): 31–48.

Kondo, T. 2008. Las escamas de la guanabana: *Annona muricata* L. Novedades Técnicas, Revista Regional, Corpoica, Centro de Investigación Palmira. Año 9/No. 10/Septiembre/2008: 25−29.

Kondo-Rodríguez, D. T. 2009. Los insectos escama (Hemiptera: Coccoidea) del mango, *Mangifera indica* L. (Anacardiaceae) en Colombia. Novedades Técnicas, Revista Regional. Corpoica, Centro de Investigación Palmira. Año 10/No.13/Diciembre/2009: 41−44.

Kondo, T., and C. Unruh. 2009. A new pest species of *Crypticerya* Cockerell (Hemiptera: Monophlebidae) from Colombia, with a key to species of the tribe Iceryini found in South America. Neotropical Entomology 38 (1): 92–100.

Kondo, T., A. A. Ramos-Portilla, and E. V. Vergara-Navarro. 2008. Updated list of mealybugs and putoids from Colombia (Hemiptera: Pseudococcidae and Putoidae). Boletín del Museo de Entomología de la Universidad del Valle 9 (1): 29–53.

Lowy, P. D. 2000. Flora vascular terrestre del archipiélago de San Andrés y Providencia. Biota Colombiana 1 (1): 109–124.

Meyerdirk, D. 1997. Look out for the pink hibiscus mealybug. Program Aid (USDA, Animal and Plant Health Inspection Service (APHIS) No. 1606. 11 p.

Michaud, J. P., and G. A. Evans. 2000. Current status of pink hibiscus mealybug in Puerto Rico including a key to parasitoid species. Florida Entomologist 83: 97–101.

Milliken, W., B. Klitgård, and A. Baracat (Eds). 2010. Neotropikey - Interactive key and information resources for flowering plants of the Neotropics. www.kew.org/neotropikey (accessed April 9–11th, 2012).

Missouri Botanical Garden. "w3TROPICOS". 2006. The Missouri Botanical Garden's VAST (VAScular Tropicos) nomenclatural database and associated authority files. [Online] http://www.tropicos.org (accessed 16 April, 2012).

Morrison, H. 1927. Descriptions of the genera and species belonging to the coccid family Margarodidae. Proceedings of the Biological Society of Washington 40: 99–109.

Neuenschwander, P. 2001. Biological control of the cassava mealybug in Africa: a review. Biological Control 21 (3): 214–229.

Noyes, J. S. 2012. Universal Chalcidoidea Database. World Wide Web electronic publication. [Online] http://www.nhm.ac.uk/chalcidoids (accessed 4 May, 2012).

Persad, C. 1995. Preliminary list of host plants of *Maconellicoccus hirsutus* (Green) hibiscus or pink mealy bug in Grenada. Caribbean Agricultural Research and Development Institute; Grenada. 6 p.

Quiroga, I. A., M. F. Maya, A. S. Martínez, and L. M. Hoyos. 2011. *Paecilomyces* sp. como alternativa de control biológico de la cochinilla acanalada (*Crypticerya multicicatrices* Cockerell) en San Andrés (Colombia). Boletín del museo entomológico Francisco Luís Gallego 3 (4): 10–17.

Ramos-Portilla, A. A., and F. J. Serna-Cardona. 2004. Coccoidea de Colombia, con énfasis en las cochinillas harinosas (Hemiptera: Pseudococcidae). Revista Facultad Nacional de Agronomía, Medellín 57 (2): 2383–2412.

Reddy, G. V. P., R. Muniappan, Z. T. Cruz, F. Naz, J. P. Mamba, and J. Tenorio. 2009. Present status of *Maconellicoccus hirsutus* (Hemiptera: Pseudococcidae) in the Mariana Islands and its control by two fortuitously introduced natural enemies. Journal of Economic Entomology 102: 1431–1439.

Ruiz, J., and M. C. Fandiño-Orozco. 2007. Plantas leñosas del bosque seco tropical de la isla de Providencia, Colombia, Caribe sur occidental. Biota Colombiana 8 (1): 87–98.

Thomas, J. and A. I. Edwards. 1996. The pink hibiscus mealybug in St. Kitts. Caraphin News 13: 3.

Tokura J., M. A. Rondón, G. Villanueva, and L. F. Botero. 1996. KUN. Especies forestales del Valle del Cauca. Lemer Ltda.; Bogota, Colombia. 349 p.

Uesato, T., T. Kondo, C. Unruh, and D. J. Williams. 2011. Establishment and host records of *Icerya aegyptiaca* (Douglas) (Hemiptera: Coccoidea: Monophlebidae) in the Sakishima islands in the Ryukyu Archipelago, Japan, with notes on its World Distribution. Entomological Science 14: 49–77.

Unruh, C. M., and P. J. Gullan. 2008. Identification guide to species in the scale insect tribe Iceryini (Coccoidea: Monophlebidae). Zootaxa 1803: 1–106.

Williams, D. J. 1996. A brief account of the hibiscus mealybug *Maconellicoccus hirsutus* (Hemiptera: Pseudococcidae), a pest of agriculture and horticulture, with descriptions of two related species from southern Asia. Bulletin of Entomological Research 86: 617–628.

Williams, D. J., P. J. Gullan, K. Englberger, and A. Moore. 2006. Report on the scale insect *Icerya imperatae* Rao (Hemiptera: Coccoidea: Margarodidae) seriously infesting grasses in the Republic of Palau. Micronesica 38 (2): 267–272.

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