

Four new scale insect species (Hemiptera: Coccomorpha) associated with coffee roots in Colombia, South America, with identification keys for genera *Newsteadia* Green, 1902, *Distichlicoccus* Ferris, 1950, and *Paraputo* Laing, 1929

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Microphotographs of female specimens of *Newsteadia andreae* n. sp.

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Four new scale insect species (Hemiptera: Coccomorpha) associated with coffee roots in Colombia, South America, with identification keys for genera *Newsteadia* Green, 1902, *Distichlicoccus* Ferris, 1950, and *Paraputo* Laing, 1929

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ABSTRACT

Coffee (Rubiaceae: *Coffea* spp.) is the host-plant of at least 214 scale insect species (Hemiptera: Coccomorpha). In this study, scale insects were collected from the roots of *Coffea arabica* Linnaeus, 1753 in five provinces of Colombia, South America, and the adult females were prepared as microscope slide mounts for identification. Four new scale species are described, based on the external morphology of the adult females: *Newsteadia andreae* n. sp. (Ortheziidae Amyot & Serville, 1843) differs from other *Newsteadia* Green, 1902 species by antennal length, presence of two spines on the trochanter, and absence of tubular ducts and groups of quadrilocular pores posterior to the vulva. *Distichlicoccus takumasae* n. sp. (Pseudococcidae Cockerell, 1905) is distinguished by having a few oral rim tubular ducts on both dorsum and venter and absence of circulus. *Paraputo nasai* n. sp. (Pseudococcidae) is characterized by having 16 pairs of cerarii, uniformity of length of its dorsal setae on all segments, and the sizes of oral collar tubular ducts. *Pseudococcus luciae* n. sp. (Pseudococcidae) is diagnosed by having few oral collar and oral rim tubular ducts, few multilocular disc pores, a small circulus and the eye not being associated with any sclerotized area or discoidal pores. The list of scale insect species on coffee roots in Colombia is updated to 65 species. Taxonomic keys to the New World species of *Newsteadia*, *Distichlicoccus* Ferris, 1950 and *Paraputo* Laing, 1902 are provided. To identify *Pseudococcus luciae* n. sp., modifications are provided for use with the existing taxonomic keys to New World and Neotropical mealybugs.

KEY WORDS

Coccoidea,
Coffea arabica,
hypogeal scale insects,
mealybugs,
Neotropical,
new species.

RÉSUMÉ

Quatre nouvelles espèces de cochenille (Hemiptera: Coccoomorpha) associées aux racines de café en Colombie, Amérique du Sud, avec des clés d'identification des genres *Newsteadia* Green, 1902, *Distichlicoccus* Ferris, 1950 et *Paraputo* Laing, 1929.

Le caféier (Rubiaceae : *Coffea* spp.) est la plante hôte d'au moins 214 espèces de cochenilles (Hemiptera : Coccoomorpha). Dans cette étude, des cochenilles ont été collectées sur des racines de *Coffea arabica* Linnaeus, 1753 dans cinq provinces de Colombie, Amérique du Sud. Les femelles adultes ont été montées sur lames pour identification. Quatre nouvelles espèces sont décrites, sur la base de la morphologie externe des femelles adultes. *Newsteadia andreae* n. sp. (Ortheziidae) se différencie des autres espèces de *Newsteadia* Green, 1902 par la longueur de ses antennes, la présence de deux épines sur le trochanter et l'absence de glandes tubulaires et de groupes de glandes quadriloculaires postérieurs à la vulve. *Distichlicoccus takumasa* n. sp. (Pseudococcidae) se distingue par la présence de très peu de glandes tubulaires à collerette sur les faces dorsale et ventrale et par l'absence de circulus. *Paraputo nasai* n. sp. (Pseudococcidae) se caractérise par la présence de 16 paires de cerarii, des soies dorsales de même taille sur tous les segments et la taille des glandes tubulaires. *Pseudococcus luciae* n. sp. est diagnostiquée par un nombre réduit de glandes à collerette et de glandes tubulaires, très peu de glandes multiloculaires, un circulus de petite taille, et l'absence de zone sclerotisée et de pores discoidaux autour de l'œil. La liste des espèces de cochenilles sur les racines de café en Colombie est mise à jour et compte 65 espèces. Des clés taxonomiques sont proposées pour les espèces du Nouveau Monde de *Newsteadia*, *Distichlicoccus* Ferris, 1950 et *Paraputo* Laing, 1902. Afin d'identifier *Pseudococcus luciae* n. sp., les clés existantes de pseudococcines néarctiques et néotropicales sont modifiées.

MOTS CLÉS

Coccoidea,
Coffea arabica,
cochenilles hypogées,
pseudococcines,
Neotropical,
espèces nouvelles.

INTRODUCTION

Coffee, *Coffea* spp. (Rubiaceae), is host-plant to 214 species of scale insects (Hemiptera: Coccoomorpha) worldwide, belonging to 78 genera in 15 families. Those in the family Pseudococcidae Cockerell, 1905 are the most diverse, with 74 species, followed by Coccidae Fallén, 1814 (55 species), Rhizoecidae Williams, 1969 (30), Diaspididae Targioni Tozzetti, 1868 (20), Cerococcidae Balachowsky, 1942 (six), Ortheziidae Amyot & Serville, 1843 (six), Monophlebidae Signoret, 1875 (four), Asterolecaniidae Cockerell, 1896 (three), Putoidae Beardsley, 1969 (three), Stictococcidae Lindinger, 1913 (three), Kerriidae Lindinger, 1937 (two), Lecanodiaspididae Targioni Tozzetti, 1869 (two), Cryptococcidae Kosztarab, 1968 (one) and Eriococcidae Cockerell, 1899 (one) (García Morales *et al.* 2016). In Colombia, there are 61 records including three species complexes, around *Dysmicoccus neobrevipes* Beardsley, 1959, *Dysmicoccus joannesiae* (Costa Lima, 1939) and *Planococcus complex citri-minor* (Kondo 2001; Kondo *et al.* 2008; Caballero *et al.* 2019). So far, 25 species have been described from coffee root samples (Table 1). This paper describes four new species of scale insect found on coffee roots in Colombia, extending the records up to 65 species. Taxonomic keys for New World species based on morphological characters are also provided.

The species described here correspond to four genera of two families: *Distichlicoccus* Ferris, 1950, *Paraputo* Laing, 1929, and *Pseudococcus* Westwood, 1840 of Pseudococcidae Cockerell, 1905 and *Newsteadia* Green, 1902 of Ortheziidae Amyot & Serville, 1843. *Distichlicoccus* is composed of 12 species and its records are restricted to New World, except by

Distichlicoccus oracelloides De Lotto, 1969 which is recorded in South Africa (McKenzie 1967; De Lotto 1969; Williams & Granara de Willink 1992; Ben-Dov 1994). Its morphology is variable, but presents similarities with *Pseudococcus* Westwood, 1840 (presence of oral rim tubular ducts), *Humococcus* Ferris, 1953 (anal ring without pores in some species) and *Chorizococcus* McKenzie, 1960 (few number of cesarii pairs) (McKenzie 1967; Williams & Granara de Willink 1992). The genus *Paraputo* has 92 species described so far, with a cosmopolitan distribution. Its systematic is still under discussion mainly because of morphological character as anal bar (absent/presence) and number of setae in the anal ring (six or more than six), affecting the definition of species between *Formicococcus* Takahashi, 1928 and *Paraputo* (Williams 2004; Danzing & Gavrilov-Zimin 2014; Zhang & Wu 2017). The number of species of *Paraputo* increased after the synonymy of *Cataenococcus* Ferris, 1955 (Tang 1992). *Pseudococcus* and *Newsteadia* are the biggest genera of each family, with 169 and 58 discovered species, respectively. In both cases, the distributions cover all the continents, except Antarctica (García Morales *et al.* 2016).

MATERIAL AND METHODS

Scale insect specimens collected manually from the roots of coffee (*Coffea arabica*) in Colombia, South America (in the departments of Antioquia, Cauca, Cundinamarca, Quindío and Tolima) were preserved in 75% ethanol and labelled with field data. Later, adult females were mounted on microscope slides according to the protocol of Sirisena *et al.*

TABLE 1. — Species described from samples collected on *Coffea* species, based on Hempel (1918); Laing (1925); Green (1933); Hambleton (1946, 1976); Balachowsky (1957); Beardsley (1970); Watson & Cox (1990); Williams & Granara de Willink (1992); Williams (2004); Granara de Willink (2009); Kondo (2013); Ramos-Portilla & Caballero (2016); Caballero *et al.* (2018); Caballero & Ramos-Portilla (2018).

Scale insect species	Author, year	Country	Host-plant
Coccidae Fallén, 1814			
<i>Toumeyella coffeae</i>	Kondo, 2013	Colombia, Venezuela	<i>Coffea arabica</i> Linnaeus, 1753
Pseudococcidae Cockerell, 1905			
<i>Dysmicoccus caribensis</i>	Granara de Willink, 2009	Colombia	<i>Coffea</i> sp.
<i>Dysmicoccus varius</i>	Granara de Willink, 2009	Colombia	<i>Coffea</i> sp.
<i>Dysmicoccus subterreus</i>	Williams, 2004	India	<i>Coffea canephora</i> Pierre ex A. Froehner, 1897
<i>Formicococcus greeni</i>	Vayssiere, 1914	Madagascar	<i>Coffea</i> sp.
<i>Planococcus fungicola</i>	Watson & Cox, 1990	Kenya	<i>Coffea arabica</i>
<i>Planococcus radicem</i>	Watson & Cox, 1990	Nigeria	<i>Coffea</i> sp.
<i>Pseudococcus cryptus</i>	Hempel, 1918	Brazil	<i>Coffea</i> sp.
<i>Pseudococcus pseudocitriculus</i>	Betrem 1937	Indonesia	<i>Coffea robusta</i> Linden, 1900
Rhizoecidae Williams, 1969			
<i>Benedictycoccina ornata</i>	Hambleton, 1946	Trinidad	<i>Coffea arabica</i>
<i>Capitsetella migrans</i>	Green, 1933	Surinam	<i>Coffea</i> sp.
<i>Coccidella globocula</i>	Hambleton, 1946	Trinidad	<i>Coffea arabica</i>
<i>Geococcus coffeae</i>	Green, 1933	Surinam	<i>Coffea liberica</i> W. Bull ex Hiern, 1876
<i>Neochavesia caldasiae</i>	Balachowsky, 1957	Colombia	<i>Coffea</i> sp.
<i>Pseudorhizoecus bari</i>	Caballero & Ramos, 2018	Colombia	<i>Coffea arabica</i>
<i>Pseudorhizoecus proximus</i>	Green, 1933	Surinam	<i>Coffea</i> sp.
<i>Rhizoecus compotor</i>	Williams & Granara de Willink, 1992	Colombia	<i>Coffea</i> sp.
<i>Rhizoecus arabicus</i>	Hambleton, 1976	Colombia	<i>Coffea arabica</i>
<i>Rhizoecus colombiensis</i>	Ramos-Portilla & Caballero, 2016	Colombia	<i>Coffea arabica</i>
<i>Rhizoecus coffeae</i>	Laing, 1925	Surinam	<i>Coffea</i> sp.
<i>Rhizoecus divaricatus</i>	Hambleton, 1976	Guatemala	<i>Coffea arabica</i>
<i>Rhizoecus moruliferus</i>	Green, 1933	Surinam	<i>Coffea liberica</i>
<i>Rhizoecus tropicalis</i>	Hambleton, 1976	Guatemala	<i>Coffea arabica</i>
<i>Ripersiella andensis</i>	Hambleton, 1946	Colombia	<i>Coffea arabica</i>
<i>Williamsrhizoecus coffeae</i>	Caballero & Ramos, 2018	Colombia	<i>Coffea arabica</i>

(2013), using a Nikon MSZ-1 stereomicroscope. A Zeiss Axion Lab A1 and Nikon Eclipse E600 phase contrast microscopes were used for species identification. Image analyses were conducted using a Lumenera Infinity 1-5C microscope camera and Image Pro Insight 8.0 software. The type materials of the new species described below are deposited in the Scale Insect Collection of the Entomological Museum at the Universidad Nacional Agronomía Bogotá, Bogotá, Colombia (UNAB) and the Muséum national d'Histoire naturelle, Paris, France (MNHN).

The species concept provided by de Queiroz (2007) is applied, so the operational criterion to delimit species in this work is based on the external morphology of the adult females. The taxonomic terminology for the descriptions of Pseudococcidae species follows Beardsley (1965) for the body segmentation, Williams & Granara de Willink (1992) for setal nomenclature on abdominal segments VIII + IX, and Gimpel & Miller (1996) for numbering the cerarii. The term “vestigial cerarius” refers to a cerarius without, or with only one conical seta, one or two auxiliary flagellate setae, and few trilocular pores. Terminology for the description of the *Newsteadia* species (Ortheziidae) follows Kozár (2004) and Gavrilov-Zimin (2018). The taxonomic illustrations follow the style of Ferris (1953) and were composed by all studied specimens.

The measurement data corresponds to mean and standard deviation calculated for all the specimens examined, with the

measurement of the holotype [in brackets] and the range of variation for the entire evaluated population (in parenthesis). Data for each cerarius gives the cerarius number followed by the number of conical setae of the holotype; number of auxiliary setae [in brackets] and then the entire evaluated population's range of conical seta number; range of auxiliary seta number (in parenthesis). For example, C₁₄ [1-3;2-3] (1-3;0-3) means that in the holotype, each cerarius XIV contains between one and three conical setae, with two or three flagellate setae; while in the entire evaluated population, each cerarius XIV has one to three conical setae and zero to three flagellate auxiliary setae.

The body width is the largest transverse measurement perpendicular to the longitudinal axis, and body length is the longest longitudinal measurement, in mm. All other measurements are given in µm. Leg length is the sum of the lengths of trochanter + femur, tibia + tarsus, and claw. The standardized measurements of anatomical features (e.g. antennal segments, leg segments, anal ring, pores) are shown in each figure. In the taxonomic illustrations, dorsal and ventral morphology is shown on the left and right sides, respectively.

ABBREVIATIONS

Institutions

MNHN

UNAB

Muséum national d'Histoire naturelle, Paris;
Entomological museum Universidad Nacional
Agronomía Bogotá, Colombia.

Morphological structures

S _{ant} I	antennal segment I;
S _{ant} II	antennal segment II;
S _{ant} III	antennal segment III;
S _{ant} IV	antennal segment IV;
S _{ant} V	antennal segment V;
S _{ant} VI	antennal segment VI;
S _{ant} VII	antennal segment VII;
S _{ant} VIII	antennal segment VIII;
S _{ant} III	antennal segment III;
S _{abd} I	abdominal segment I;
S _{abd} II	abdominal segment II;
S _{abd} III	abdominal segment III;
S _{abd} IV	abdominal segment IV;
S _{abd} V	abdominal segment V;
S _{abd} VI	abdominal segment VI;
S _{abd} VII	abdominal segment VII;
S _{abd} VIII + IX	fusion of abdominal segments VIII and IX;
C ₁	cerarii on anal lobes;
C ₂	cerarii on abdominal segment VII;
C ₃	cerarii on abdominal segment VI;
C ₄	cerarii on abdominal segment V;
C ₅	cerarii on abdominal segment IV;
C ₆	cerarii on abdominal segment III;
C ₇	cerarii on abdominal segment II;
C ₈	cerarii on abdominal segment I;
C ₉	posterior cerarii on metathoracic segment;
C ₁₀	anterior cerarii on metathoracic segment;
C ₁₁	posterior cerarii on mesothoracic segment;
C ₁₂	middle cerarii on mesothoracic segment;
C ₁₃	anterior cerarii on mesothoracic segment;
C ₁₄	posterior cerarii on prothoracic segment;
C ₁₅	anterior cerarii on prothoracic segment;
C ₁₆	ocular cerarii;
C ₁₇	frontal cerarii.

SYSTEMATICS

Family ORTHEZIIDAE Amyot & Serville, 1843
Genus *Newsteadia* Green, 1902

Newsteadia andreae n. sp.
(Figs 1; 2)

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TYPE MATERIAL. — **Holotype.** Colombia • adult ♀ (2 specimens on 1 slide, holotype situated on the left side and indicated as “Holo” on additional label); Antioquia, Barbosa, Vereda Platanito, Farm Solenia; 06°58'34.36"N, 75°23'41.32"W; 1741 m a.s.l.; 14.IX.2015; J. Agudelo leg.; ex roots *Coffea arabica* (Rubiaceae) – coffee, manual; UNAB 4630.

Paratypes. Colombia • 2 adult ♀; same data as holotype; 2 slides, 1 containing a single paratype, and the other with 1 paratype (marked as “Para”) sharing a slide with the holotype; UNAB.

ETYMOLOGY. — The specific epithet “*andreae*” is assigned in honor of Dr Andrea Ramos-Portilla, mentor and friend of the author.

DIAGNOSIS. — This species has two spines on each trochanter; antennal flagellate setae with rounded apices, and three fleshy setae on the distal part of the apical segment; S_{ant}II shorter than S_{ant}I; five pairs of abdominal spiracles; and lacks groups of quadrilocular pores posterior to the vulva, and tubular ducts.

DESCRIPTION

Pre-mounting specimens

Appearance *in situ*: not observed. Specimens preserved in 75% ethanol with milky appearance; color unchanged in 10% potassium hydroxide.

Post-mounting specimens

Slide-mounted adult female (n = 3): body oval to round (Figs 1; 2A), 1.9 ± 0.3 [1.6] (1.5–2.1) mm long and 1.5 ± 0.2 [1.3] (1.3–1.7) mm wide.

Dorsum

Wax plates (Fig. 1A). Well developed, composed of: spines, each 21.2 ± 2.7 (12–28) µm long and apically rounded (Fig. 1B); flagellate setae, each 38.4 ± 9.6 (18–58) µm long (Fig. 1C), the longest ones located at the corners of plates; quadrilocular pores of type I, each approximately 5 µm in diameter (Fig. 1D); a few simple pores, each about 3 µm in diameter (Fig. 1E). Wax plate distribution as follows: two on head; 12 on thorax arranged in four longitudinal groups, each plate subdivided into one central and two external sections; and abdomen with six central wax plates and one large external plate on each side.

Inter-plate spaces. With quadrilocular pores of type II (Figs 1F; 2B), each 4–6 µm in diameter, some pores joined in pairs (Fig. 2B); and simple pores like those on wax plate (Fig. 2B).

Tubular ducts. Absent.

Spicules on abdomen. Present.

Anal ring. 105.3 ± 3.1 [108] (101–108) µm in transverse diameter, with 6 flagellate setae each 62.5 ± 7.9 (50–73) µm long with a rounded tip, and two or three inner rows of cells (Figs 1G; 2C).

Venter

Antennae (Fig. 1H). Each 766.8 ± 23.5 (737–808) µm long, three segmented, with segment lengths and chaetotaxy as follows: S_{ant}I 180.8 ± 17.2 (162–209) µm long, with 8–9 flagellate setae each 46.7 ± 10.6 (25–62) µm long and apically rounded; S_{ant}II 125.5 ± 4.4 (120–133) µm long, 4–5 flagellate setae each 52.9 ± 7.1 (37–61) µm long and apically rounded, and one placoid sensilla; S_{ant}III 460.5 ± 6.7 (448–467) µm long with three or four fleshy setae, two apical setae, the larger 100.3 ± 22.3 (51–114) µm long (Fig. 2D, ls), the shorter one 15.3 ± 2.7 (11–18) µm long (Fig. 2D, ss), one or two subapical setae each 46.2 ± 11.5 (36–71) µm long (Fig. 2D, sa) and one distal seta 33 ± 3.2 (27–37) µm long (Fig. 3D, ds), also 18 flagellate setae each 41.5 ± 11.8 (18–55) µm long and apically rounded (Fig. 2E, fs); ratios S_{ant}I/S_{ant}II 1.4 ± 0.1 (1.3–1.6), S_{ant}III/S_{ant}I 2.6 ± 0.2 (2.2–2.8), S_{ant}III/S_{ant}II 3.7 ± 0.1 (3.5–3.8).

Eyespot. Protuberant, base 40.8 ± 1.9 (38–44) µm in diameter and 90.7 ± 7.4 (81–101) µm long, its base not fused with first antennal segment (Fig. 2F).

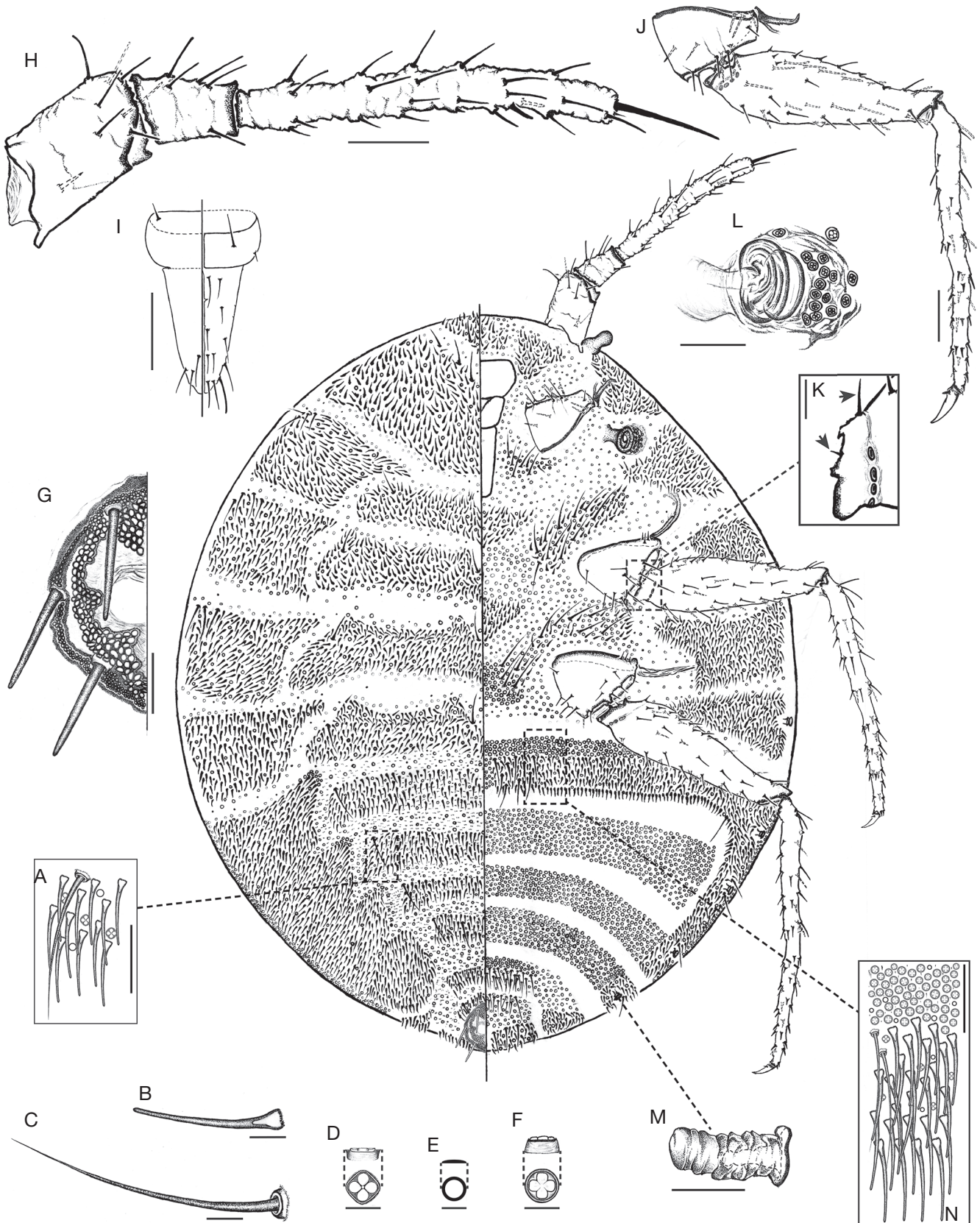


FIG. 1. — Taxonomic illustration of *Newsteadia andreae* n. sp. adult ♀: **A**, section of wax plate; **B**, spine; **C**, flagellate seta; **D**, type I quadrilocular pore; **E**, simple pore; **F**, type II quadrilocular pore; **G**, anal ring; **H**, antenna; **I**, labium in dorsal (left side) and ventral (right side) view; **J**, fore leg; **K**, trochanter with two spine-like setae (arrows); **L**, thoracic spiracle; **M**, abdominal spiracle; **N**, longitudinal section of ovisac band. Scale bars: A, M, N, 20 µm; B-D, F, 5 µm; E, 3 µm; G, K, L, 30 µm; H-J, 100 µm.

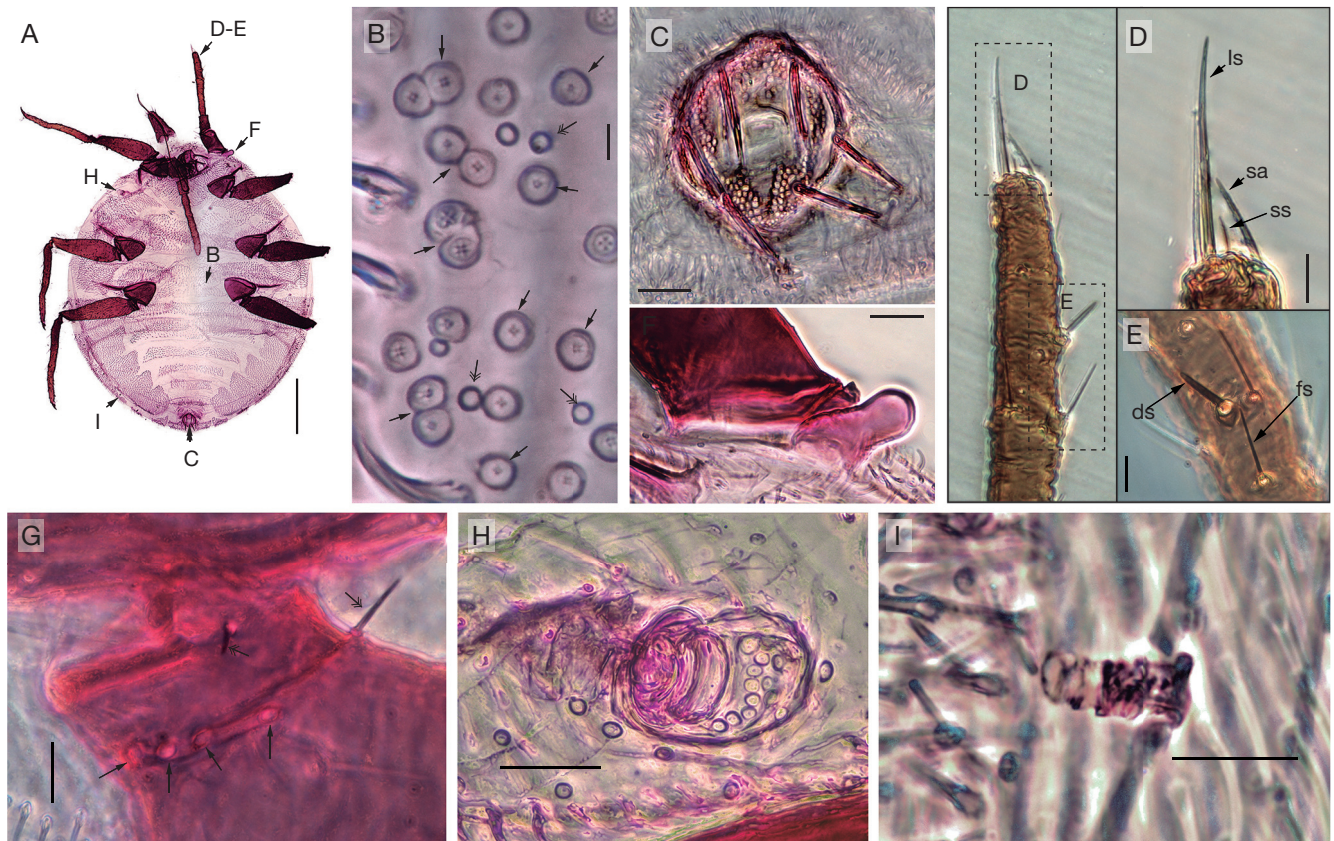


FIG. 2. — Microphotographs of female specimens of *Newsteadia andreae* n. sp.: **A**, body; **B**, quadrilocular pores in singles and pairs (single-headed arrows) and simple pores (double-headed arrows); **C**, anal ring; **D**, apex of antenna with apical longer fleshy setae (ls), subapical fleshy setae (sa), and apical shorter setae (ss); **E**, distal fleshy setae (ds) and flagellate setae (fs); **F**, eyespot separate from antennal base; **G**, mid-leg trochanter with spine-like setae (double-headed arrows) and placoid sensilla (single-headed arrows); **H**, thoracic spiracle; **I**, abdominal spiracle. Scale bars: A, 400 μ m; B, 4 μ m; C, H, 30 μ m; D, F, 40 μ m; E, G, I, 20 μ m.

Labium (Fig. 1I). 237.3 ± 6.6 (228-243) μ m long and 150.7 ± 8.1 (144-162) μ m wide, of two segments: basal segment with 3 pairs of setae and apical segment with 14 pairs.

Fore leg (Fig. 1J). 1273.4 ± 28.7 (1235-1304) μ m long; coxa 154 ± 10.3 (144-176) μ m long, depression not developed; trochanter-femur fused, 470.7 ± 23.1 (428-492) μ m long and 142.2 ± 4.4 (138-150) μ m wide; tibia-tarsus fused, 594.8 ± 13.2 (569-606) μ m long and 55.8 ± 3.1 (51-60) μ m wide; claw 62.6 ± 7.8 (57-77) μ m long; ratios: length of trochanter-femur/tibia-tarsus 0.8; trochanter-femur length/width 3.3 ± 0.2 (3.0-3.5), leg length/antenna length 1.7; fore leg chaetotaxy: coxa with 15-17 flagellate setae with rounded tips, trochanter with two spine-like setae and eight placoid sensilla, femur with 30-45 flagellate setae with rounded tips, tibia-tarsus with 5-12 flagellate setae with rounded tips, 25-28 spines and one sensilla; claw without a denticle but with two unguis spine-like digitules, each 15 ± 4.3 (11-21) μ m long.

Mid leg. 1376.3 ± 22.6 (1348-1410) μ m long; coxa 172.7 ± 8.0 (158-183) μ m long, trochanter-femur fusion 492.7 ± 15.8 (470-515) μ m long and 147.3 ± 2.4 (144-150) μ m wide; tibia-tarsus fusion 643 ± 19.9 (610-660) μ m long and 57 ± 5.4 (49-64) μ m wide; claw 64.5 ± 3.8 (60-70) μ m

long; ratios: length of trochanter-femur/tibia-tarsus 0.8; trochanter-femur length/width 3.3 ± 0.1 (3.2-3.6), leg length/antenna length 1.8; chaetotaxy: coxa with 14-20 flagellate setae with rounded tips, trochanter with 2 spine-like setae (Figs 1K; 2G arrows) and eight placoid sensilla (Fig. 2G single-headed arrows), femur with 30-45 flagellate setae with rounded tips, and tibia-tarsus with 11-16 flagellate setae with rounded tips, 28-33 spines and one sensilla; claw without a denticle, two unguis spine-like digitules each 12.3 ± 2.6 (9-16) μ m long.

Hind leg. 1513 ± 29.6 (1485-1554) μ m long; coxa 179.8 ± 4.8 (173-188) μ m long, trochanter-femur fusion 548.8 ± 20.3 (513-573) μ m long and 150.4 ± 3.4 (146-154) μ m wide; tibia-tarsus fusion 719.3 ± 33.5 (672-745) μ m long and 58.3 ± 2.1 (56-61) μ m wide; claw 65 ± 1.4 (64-67) μ m long; ratios: length of trochanter-femur /tibia-tarsus 0.8 ± 0.1 (0.7-0.9); trochanter-femur length/width 3.6 ± 0.2 (3.2-3.8), leg length/antenna length 2; chaetotaxy: coxa with 14-19 flagellate setae with rounded tips, trochanter with 2 spine-like setae and eight placoid sensilla, femur with 32-45 flagellate setae with rounded tips, tibia-tarsus with 11-17 flagellate setae with rounded tips, 33-34 spines and one sensilla; claw without a denticle, two unguis digitules spine-like, each 12 μ m long.

Spiracles. On thorax, each peritreme 43.9 ± 3.9 (39-51) μm in diameter and 76.3 ± 11.3 (63-94) μm long, with a cluster of 15-23 quadrilocular pores around the peritreme cavity, each pore about 5 μm in diameter, setae absent (Fig. 1L; 2H); abdominal spiracles numbering 5 pairs, each peritreme 11.6 ± 1.6 (9-14) μm in diameter and 21.8 ± 3.8 (15-29) μm long, with pores and setae absent from around peritreme cavity (Figs 1M; 2I).

Wax plates. Structure like that of dorsal plates, with spines each 16.3 ± 2.4 (11-22) μm long and apically rounded, flagellate setae each 40.6 ± 9.6 (20-60) μm long, and quadrilocular pores of similar diameter to those on dorsum; plates in marginal region well developed, similar to those on dorsum; plates in central region less conspicuous, composed of flagellate setae and few spines; head with three wax plates, thorax with 19, wax plates absent from abdomen. Ovisac band (Fig. 1N) surrounding the second abdominal segment, external edge composed of a

transverse cluster of quadrilocular pores of type II, like those on dorsum (Fig. 1F), each 4-5 μm in diameter, accompanied by simple pores and spicules; inner edge of band formed of clustered spines, each 21.1 ± 4.4 (14-22) μm long and apically rounded, most posterior row of spines longest, truncate; flagellate setae forming mesial cluster in anterior section of band, each seta 43.8 ± 6.9 (32-55) μm long; other setae scattered through the band; quadrilocular pores of type I and simple pores with diameter similar to those on dorsum, scattered in the cluster of spines; area enclosed by ovisac band with six transverse clusters of quadrilocular pores of type II; scattered simple pores and spicules clustered with flagellate setae, each seta 33.2 ± 4.7 (26-42) μm long; inter-cluster areas bare.

Tubular ducts. Absent.

Spicules. Present on mesothorax and posterior body segments.

IDENTIFICATION KEY TO NEW WORLD SPECIES OF *NEWSTEADIA* GREEN, 1902
(adapted from the descriptions by Morrison [1925, 1952] and Kozár [2004])

1. Antenna with 5 or more segments 2
- Antenna with 3 segments 8
2. Basal antennal segment with capitate or clavate setae 3
- Basal antennal segment without capitate or clavate setae 4
3. Antenna with 7 segments; ovisac band complete in medial area *N. floridensis* Kozár & Konczné Benedicty, 2001
- Antenna with 6 segments; ovisac band interrupted in medial area *N. tropicalis* Kozár & Konczné Benedicty, 2001
4. Ovisac band interrupted in mid-region 5
- Ovisac band complete in mid-region 6
5. Wax plates in medial area of dorsum reduced to rows, conspicuously narrower than wax plates in marginal regions *N. brasiliensis* Kozár & Konczné Benedicty, 2001
- Wax plates in medial area of dorsum as wide as those in marginal regions *N. americana* Morrison, 1925 (in part)
6. Labium with clavate setae *N. gergoei* Konczné Benedicty & Kozár, 2002
- Labium without clavate setae 7
7. Wax plates on dorsum subdivided in medial area *N. minima* Morrison, 1952
- Wax plates on dorsum in continuous bands across medial area *N. americana* Morrison, 1925 (in part)
8. Femur and tibia with setae capitate *N. borhidii* Kozár & Konczné Benedicty, 2001
- Femur and tibia with setae acute or blunt, not capitate 9
9. Venter posterior to vulva with conspicuous clusters of quadrilocular pores 10
- Venter posterior to vulva without clusters of quadrilocular pores 11
10. Apical antennal segment with slender flagellate setae *N. morrisoni* Kozár & Konczné Benedicty, 2001
- Apical antennal segment with thick spine-like setae *N. costaricaensis* Kozár & Konczné Benedicty, 2001
11. Third antennal segment without subapical seta *N. tristani* (Silvestri, 1924)
- Third antennal segment with subapical seta 12
12. Each thoracic spiracle associated with no more than 2 pores; labium up to 160 μm long; wax plates containing tubular ducts *N. trisegmentalis* Howell, 1975
- Each thoracic spiracle associated with at least 10 pores; labium at least 220 μm long; wax plates without tubular ducts *N. andreae* n. sp.

REMARKS

Based on data from Kozár (2004): *Newsteadia andreae* n. sp. is morphologically similar to several species. The closest species is *N. vietnamensis* Kozár & Konczné Benedicty, 1999, which is similar in most characters. The main differences are: antenna length, up to 808 µm in *N. andreae* n. sp. (949 µm long in *N. vietnamensis*), and tubular ducts being absent from both surfaces in *N. andreae* n. sp. (present on both surfaces in *N. vietnamensis*). Their geographical distributions and host records are different also: *N. andreae* n. sp. is recorded from the Neotropical Region (Colombia) on roots of *Coffea arabica*, whereas *N. vietnamensis* is known only from the Oriental Region (Vietnam) and has no host records.

Newsteadia andreae n. sp. also resembles *Newsteadia morrissoni* Kozár & Konczné Benedicty, 2001 but differs in having (*N. morrissoni* characters in parentheses): no groups of quadrilocular pores posterior to the vulva (quadrilocular pores posterior to vulva in groups); a ratio of $S_{ant\text{III}}/S_{ant\text{II}}$ of 3.7 (2.4); two spine-like setae on the trochanter (trochanter without spine-like setae), and each thoracic spiracle peritreme with quadrilocular pores inside (without quadrilocular pores in the peritremes).

Another species similar to *N. andreae* n. sp. is *N. monikae* Kozár & Konczné Benedicty, 2000, which also has three antennal segments, the second antennal segment longer than first one, distal fleshy setae on the antenna, flagellate setae with rounded apices on all antennal segments, and five pairs of abdominal spiracles. *Newsteadia andreae* n. sp. differs from *N. monikae* (characteristics given in parenthesis) by: spine-like setae absent from the coxa (present) and present on the trochanter (absent); apical antennal segment with fleshy longer setae and subapical setae, and apical shorter setae present (with flagellate longer setae and subapical setae, without apical shorter setae); tubular ducts absent from wax plates (present); and peritreme of each thoracic spiracle with 15–23 quadrilocular pores (pores absent).

In addition, *N. andreae* n. sp. is similar to *N. milleri* Kozár & Konczné Benedicty, 2000 in having antenna with three antennal segments, spine-like setae on the bases of trochanter and femur, an ovisac band without gaps, and five pairs of abdominal spiracles. *Newsteadia andreae* n. sp. differs from *N. milleri* (characteristics given in parenthesis) by having: all antennal segments with flagellate setae with rounded apices (all antennal segments with spine-like setae); apex of third antennal segment with subapical fleshy seta and apical short setae (apex of third antennal segment without either subapical setae or apical short setae); trochanter with two spine-like setae (one spine-like seta); and tubular ducts absent from both dorsum and venter (tubular ducts present in dorsal wax plates).

Family PSEUDOCOCCIDAE Cockerell, 1905

Genus *Distichlicoccus* Ferris, 1950

Distichlicoccus takumasae n. sp.
(Figs 3; 4)

urn:lsid:zoobank.org:act:174B1078-53DE-4AEE-9323-84D8DA99806D

TYPE MATERIAL. — **Holotype.** Colombia • adult ♀ (2 specimens on the same slide, holotype situated on the left side and indicated as “Holo” on an additional label); Cauca, El Tambo, Vereda Villanueva, Farm Patio Bonito; 1824 m a.s.l.; 5.IX.2015; J. Muñoz leg.; ex roots of *Coffea arabica* (Rubiaceae) – coffee, manual; : UNAB 4621. **Paratypes.** Colombia • 1 adult ♀; same data as holotype; marked as “Para” sharing a slide with the holotype; UNAB 4621 • 1 adult ♀; same data as holotype; paratype mounted singly on a slide; MNHN.

ETYMOLOGY. — The specific epithet “*takumasae*” is assigned in honor of Dr Takumasa Kondo, mentor of the author.

DIAGNOSIS. — Circulus absent; cerarii numbering 15–17 pairs; oral rim tubular ducts few, numbering 4–9 on dorsum and 3 or 4 on venter; and oral collar tubular ducts restricted to venter of $S_{abd\text{III-VII}}$.

DESCRIPTION

Pre-mounting specimens

Appearance *in situ*: not observed.

Post-mounting specimens

Slide-mounted adult female ($n = 3$): body oval to round (Fig. 3; 4A), length 1.5 ± 0.04 [1.5] (1.4–1.5) mm; wide 1.2 ± 0.05 [1.1] (1.1–1.2) mm.

Dorsum

Ostioles. Conspicuous, with membranous lips.

Anal ring. 66.2 ± 2.4 [68.8] (64–68.8) µm in transverse diameter, with 6 flagellate setae, each seta 104.8 ± 10.7 (83.6–122) µm long; ring containing two cells rows, external row with cells smaller than those in internal row, subquadrate and subrectangular, each cell with a spicule 2 or 3 µm long; internal row with irregular cells tending to be elongate and without spicules.

Cerarii. Numbering 15–17 pairs (Fig. 3A), C_{10} and C_{14} absent or vestigial [16 pairs in holotype, with left side C_{10} and C_{14} vestigial]; cerarian pattern C_1 [2;3–4] (2;3–4), C_2 [2;2] (2;1–3), C_3 [2;3] (2;1–3), C_4 [2;1] (2;0–2), C_5 [2;2–3] (2;0–3), C_6 [2;1–3] (2;0–3), C_7 [2–3;2–3] (2–3;1–3), C_8 [1–2;0–1] (1–2;0–1), C_9 [2;1] (2;0–1), C_{10} [abortive;0–1] (0–1;0–2), C_{11} [1;1–2] (1–2;0–2), C_{12} [2–3;0–1] (1–2;0–2), C_{13} [2;1–3] (1–2;0–3), C_{14} [0–3;0–3] (1–3;0–3), C_{15} [2–3;0–1] (2–3;0–1), C_{16} [2;1–3] (2–3;1–3), C_{17} [2;0] (0–2;0–1).

Body setae. Flagellate. Each 13.5 ± 2.5 (7.7–24.2) µm long, shorter than ventral setae, evenly distributed.

Trilocular pores. Each 3–4 µm in diameter (Fig. 3B), evenly distributed.

Multilocular disc pores. Absent.

Oral rim tubular ducts. Of one size (Fig. 3C, 4B), each 12.1 ± 1.6 (10–15) µm long and associated with 1–2 discoidal pores, some associated with setae; distributed as follows: mesothorax [1] (0–1) in lateral region, metathorax [1] (1) in submesial region, $S_{abd\text{I}}$ [3] (1–3) in marginal and submarginal regions, $S_{abd\text{II}}$ [2] (1–2) in submesial region, $S_{abd\text{III}}$ [2] (0–2) in mar-

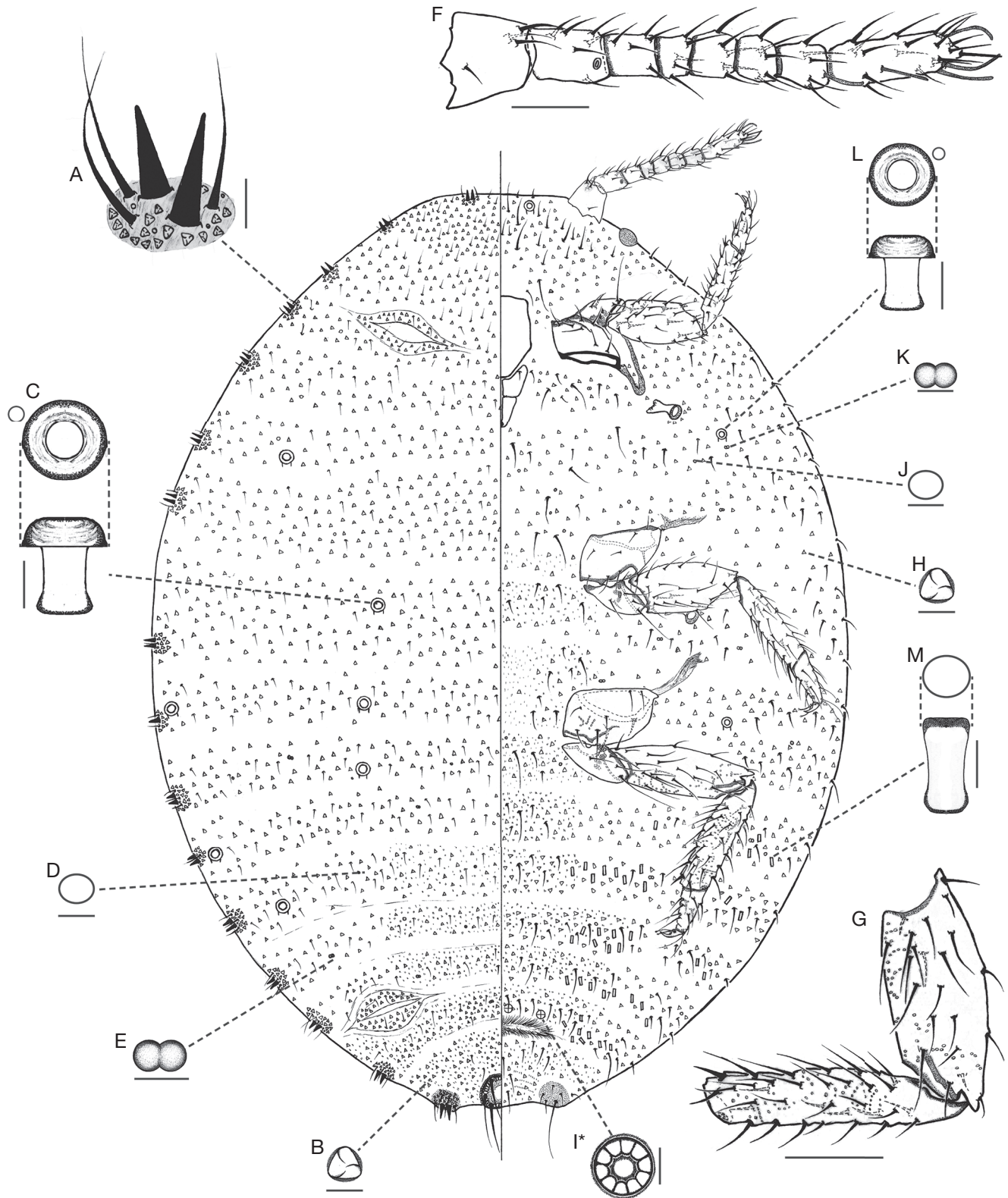


FIG. 3. — Taxonomic illustration of *Distichlicoccus takumasae* n. sp. adult ♀: enlarged details with measurements correspond to: **A**, cerarius; **B**, dorsal trilobular pore; **C**, dorsal oral rim tubular duct; **D**, dorsal simple discoidal pore; **E**, dorsal bilocular discoidal pore; **F**, antenna; **G**, hind femur and tibia; **H**, ventral trilobular pore; **I***, multilocular disc pore, present in only one paratype; **J**, ventral simple discoidal pore; **K**, ventral bilocular pore; **L**, ventral oral rim tubular duct; **M**, ventral oral collar tubular duct. Scale bars: B, D, H, J, K, 3 µm; A, C, E, I, L, M, 5 µm; F, G, 50 µm.

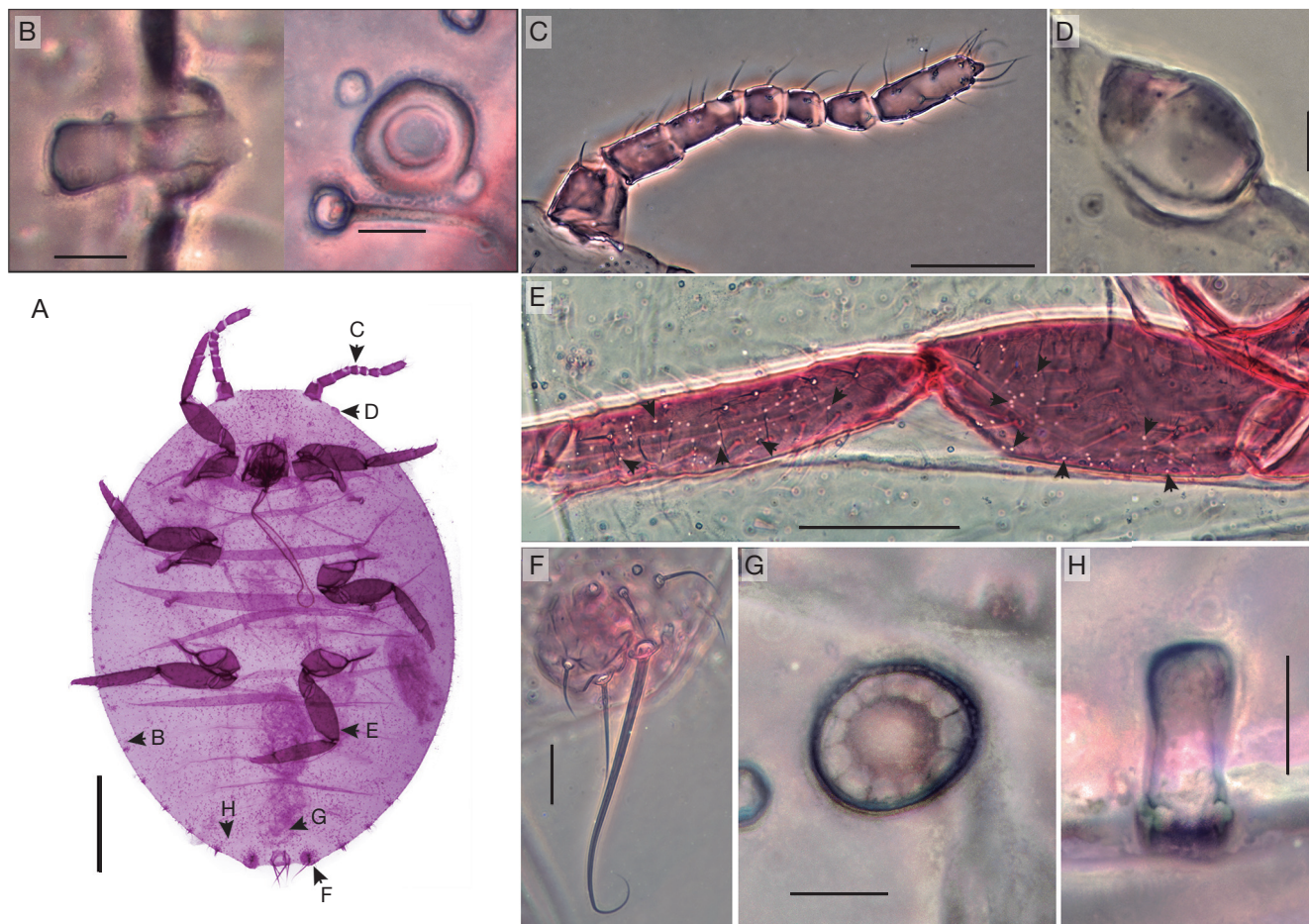


FIG. 4. — Microphotographs of female specimens of *Distichlicoccus takumasae* n. sp.: **A**, body; **B**, oral rim tubular duct in lateral and surface views; **C**, antenna; **D**, eyespot; **E**, hind leg with translucent pores (arrows); **F**, anal lobe; **G**, multilocular disc pore; **H**, oral collar tubular duct. Scale bars: A, 300 μ m; B, G, H, 5 μ m; C, 30 μ m; D, 10; E, 40 μ m; F 20 μ m.

ginal region, S_{abdIV} [0] (0-1) in submarginal region, absent from remaining segments.

Oral collar tubular ducts. Absent.

Discoidal pores. Of two types: I) with a single locule, similar size or slightly smaller than a trilocular pore, 2.9 ± 0.4 (2-5) μ m in diameter (Fig. 3D), scarce, evenly scattered; II) with two loculi, 3.5 ± 0.6 (3-5) μ m in diameter (Fig. 3E), scarce, absent from S_{abdI} , S_{abdIV} and $S_{abdVIII+IX}$. Body spicules present on head, prothorax and S_{abdIII} and posterior segments.

Venter

Antennae. Each 341 ± 13 (327-360) μ m long, 7 or 8 segmented (Fig. 3F; 4C); holotype with 7 antennal segments, one antenna with S_{antIV} and S_{antV} partially divided and other one with S_{antIII} and S_{antIV} partially divided, segment length and chaetotaxy as follows: S_{antI} 55.3 ± 4.0 (49-61) μ m long, with four flagellate setae; S_{antII} 48.4 ± 6.6 (35-53) μ m long, with six flagellate setae and one placoid sensilla; S_{antIII} 36.9 ± 10 (21-51) μ m long with six to eight flagellate setae; S_{antIV} 29.6 ± 13.5 (22-50) μ m long with four or five flagellate setae; S_{antV} 33.0 ± 9.6 (25-50) μ m long with six to eight flagellate setae;

S_{antVI} 28.1 ± 2.3 (25-32) μ m long with five or six flagellate setae; S_{antVII} 38.2 ± 1.5 (35-40) μ m long with five to seven flagellate setae and one fleshy seta; and $S_{antVIII}$ 86.7 ± 2.8 (83-92) μ m long with 18-19 flagellate setae and four fleshy setae [holotype with 11 and 15 flagellate setae].

Eyespot. 33.7 ± 2.9 (29-37) μ m in diameter, not associated with discoidal pores (Fig. 4D).

Labium. 126.3 ± 8.7 [not measured] (120-132) μ m long.

Fore leg. 499 ± 5.5 (489-504) μ m long, trochanter + femur 233.5 ± 3.2 (230-238) μ m long, femur 74.4 ± 10.4 (56-80) wide; tibia + tarsus 235.2 ± 3.3 (230-238) μ m long, tibia 35.5 ± 2.3 (32-38) μ m wide; claw 30.3 ± 1.2 (29-32) μ m long; ratio of lengths of trochanter + femur length/tibia + tarsus 1.0; ratio of trochanter + femur length/femur width 3.2 ± 0.6 (2.9-4.2), ratio of tibia + tarsus length/tibia width 6.7 ± 0.5 (6.2-7.3); chaetotaxy: coxa with nine flagellate setae, trochanter with seven, femur with 25-29, tibia with 23-29, tarsus with 11 setae and two slender and capitate tarsal digitules, each 36.4 ± 4.7 (28-39) μ m long; claw without a denticle but with two unguis digitules each 25.7 ± 1.5 (24-28) μ m long, capitate, slightly thicker than a tarsal digitule.

Mid leg. 504.7 ± 5.7 (497–512) μm long; trochanter + femur 232 ± 2.3 (229–234) μm long, femur 72.1 ± 11 (58–80) μm wide; tibia + tarsus 241.3 ± 3.6 (236–245) μm long, tibia 38.6 ± 5.9 (31–45) μm wide; claw 31.3 ± 1.9 (29–33) μm long; ratio of lengths of trochanter + femur: tibia + tarsus 1.0; ratio of trochanter + femur length: femur width 3.3 ± 0.5 (2.9–4.0), ratio of tibia + tarsus length: tibia width 6.4 ± 1.0 (5.4–7.7); chaetotaxy: coxa with 11 flagellate setae, trochanter with seven, femur with 23–26, tibia with 29–31, tarsus with 11 setae and one sensilla; tarsal digitules similar those on fore tarsus, 36.2 ± 2.1 (33–39) μm long; claw without a denticle, unguis digitules each 25.2 ± 0.8 (24.1–26) μm long, similar those on fore claw.

Hind leg. 551.7 ± 30.3 (501–574) μm long; trochanter + femur 255.2 ± 10.7 (234–263) μm long; femur 73 ± 8.7 (61–80) μm wide; tibia + tarsus 266 ± 20.6 (237–281) μm long; tibia 41.1 ± 4.4 (37–49) μm wide; claw 30.5 ± 2.7 (27–33) μm long; ratio of lengths of trochanter + femur/tibia + tarsus 1.0 ± 0.1 (0.9–1.1); ratio of trochanter + femur length/femur width 3.5 ± 0.5 (3.0–4.3), ratio of tibia + tarsus length/tibia width 6.5 ± 0.8 (5.6–7.5); translucent pores distributed as follows: coxa with 8 ± 8 [absent] (0–18), femur with 59 ± 10 (45–72), tibia with 46 ± 10 (29–59) (Figs 3G; 4E); chaetotaxy: coxa with 11 flagellate setae, trochanter with seven, femur with 20–23, tibia with 29–35, tarsus with 10 setae and one sensilla; tarsal digitules each 33.7 ± 2.2 (31.0–37.0) μm long, similar those on fore tarsus; claw without a denticle, unguis digitules each 24.0 ± 1.9 (22–26) μm long, similar to those on other legs.

Circulus. Absent.

Anal lobes (Fig. 4F). Prominent, slightly sclerotized, each with apical flagellate seta 114 ± 8 (109–120) μm long and with 2–4 auxiliary flagellate setae.

Body setae. Flagellate, lengths variable: on head, 46 ± 8 (34–58) μm long, prothorax 22 ± 8 (11–40) μm , mesothorax 34 ± 6 (28–44) μm , metathorax 23 ± 7 (15–39) μm ; on abdominal segments there are two groups setae: I) shorter setae, each 21 ± 5 (11–29) μm long, evenly distributed, II) longer setae, each 37 ± 5 (30–48) μm long, present in mesial region. Intersegmental areas lacking setae.

Obanal setae. Each 34 ± 5 (28–40) μm long.

Cisanal setae. Each 36 ± 4 (28–40) μm long.

Trilocular pores. Each 3–4 μm in diameter, evenly distributed (Fig. 3H).

Multilocular disc pores. Absent, except for one paratype, which has three pores on S_{abdVII} , each pore about 9 μm in diameter (Figs 3I; 4G).

Discoidal pores. Of two types: I) with a single loculus 3.6 ± 0.5 (2–5) μm in diameter, few, evenly distributed (Fig. 3J); II) with two loculi, pore 4.3 ± 0.4 (3–5) μm in diameter, few (Fig. 3K).

Oral rim tubular ducts. Slightly smaller than dorsal ducts, each 11 ± 1.8 (8–14) μm long, with one on anterior interantennal margin and 1 or 2 in lateral or submarginal regions of mesothorax and S_{abdI} (Fig. 3L).

Oral collar tubular ducts. Each 8 ± 3.6 (5–11) μm long (Figs 3M; 4H), distributed as follows: S_{abdIII} [3] (2–3), S_{abdIV} [18] (12–18), S_{abdV} [20] (16–20), S_{abdVI} [17] (17), and S_{abdVII} [13] (9–13).

Spicules. Present on mesothorax and posterior body segments.

IDENTIFICATION KEY TO NEW WORLD SPECIES OF *DISTICHLICOCCLUS* FERRIS, 1950

(adapted from descriptions by Cockerell [1902], Ehrhorn [1911], McKenzie [1967], and Williams & Granara de Willink [1992] and taxonomic keys by McKenzie [1967], and Williams & Granara de Willink [1992])

1. Circulus present 2
— Circulus absent 7
2. With fewer than 9 pairs of cerarii *D. sinaloanus* Williams & Granara de Willink, 1992
— With more than 9 pairs of cerarii 3
3. Oral rim tubular ducts absent from venter *D. zacapuensis* Williams & Granara de Willink, 1992
— Oral rim tubular ducts present on venter 4
4. Hind tibia with fewer than 20 translucent pores *D. arundinis* McKenzie, 1967
— Hind tibia with more than 30 translucent pores 5
5. Oral collar tubular ducts present on abdominal segment IV *D. megacirculus* McKenzie, 1967
— Oral collar tubular ducts absent from abdominal segment IV 6
6. Cerarii numbering 14 recognizable pairs; oral collar tubular ducts present on abdominal segment V
..... *D. digitariae* Williams & Granara de Willink, 1992

- Cerarii numbering 17 recognizable pairs; oral collar tubular ducts absent from abdominal segment V *D. sahuayoensis* Williams & Granara de Willink, 1992
- 7. Oral collar tubular ducts absent 8
- Oral collar tubular ducts present 9
- 8. Venter of abdomen with oral rim tubular ducts in a submarginal row 1 pore wide *D. californicus* (Ehrhorn, 1911)
- Venter of abdomen with oral rim tubular ducts in a submarginal row 2 or 3 pores wide..... *D. fontanus* Ferris, 1950
- 9. Cerarii numbering more than 10 recognizable pairs 10
- Cerarii numbering fewer than 10 recognizable pairs 11
- 10. Dorsum with oral collar tubular ducts; cerarii numbering 12 to 14 recognizable pairs..... *D. salazari* Williams & Granara de Willink, 1992
- Dorsum without any oral collar tubular ducts; cerarii numbering 15 to 17 recognizable pairs *D. takumasae* n. sp.
- 11. Anal ring situated on dorsum, separated from posterior apex of abdomen by about its own diameter; cerarii restricted to abdomen *D. alkalinus* (Cockerell, 1902)
- Anal ring situated at posterior apex of abdomen; cerarii present on head as well as abdomen *D. salinus* (Cockerell, 1902)

REMARK

Distichlicoccus takumasae n. sp. is morphologically close to *D. salazari* Williams & Granara de Willink, 1992 in lacking a circulus and in having translucent pores on both the hind femur and tibia. However, *D. takumasae* n. sp. differs from *D. salazari* (characteristics in parenthesis) by having oral rim tubular ducts few, numbering 4-9 on dorsum and 3-4 on venter (has 2-7 oral rim tubular ducts in rows across each segment on both surfaces); oral collar tubular ducts present on venter but absent from dorsum (oral collar ducts on both venter and dorsum); and hind legs with translucent pores on coxa, femur and tibia (pores only on femur and tibia) [character data of *D. salazari* taken from Williams & Granara de Willink (1992)].

Family PSEUDOCOCCIDAE Cockerell, 1905
Genus *Paraputo* Laing, 1929

Paraputo nasai n. sp.
(Figs 5; 6)

[urn:lsid:zoobank.org:act:7C8415A1-4443-4123-A524-EA5D0C82CBE8](https://zoobank.org/act:7C8415A1-4443-4123-A524-EA5D0C82CBE8)

TYPE MATERIAL. — **Holotype.** Colombia • adult ♀ (two specimens in the same slide, holotype at the right side indicated as “Holo” in additional label); Cauca, Páez, Vereda El Ciprés, Farm Naranjal, 2°42'31.54"N, 75°45'22.42"W; 1746 m a.s.l.; 12.XI.2015; A. Ibagón leg.; ex roots *Coffea arabica* (Rubiaceae)-coffee in association with *Wasmannia auropunctata* (Roger, 1863) (Hymenoptera; Formicidae), manual; UNAB 4631.

Paratypes. 12 adult ♀ on 7 slides • 1 ♀ (marked as “Para” shares a slide with the holotype); same data as holotype; UNAB 4631 • 5 ♀ (on three slides); same data as holotype; UNAB 4631 • 6 ♀ (on three slide; same data as holotype; MNHN.

ETYMOLOGY. — The specific epithet is in recognition of the aboriginal community Nasa, who inhabit the region where specimens were collected.

DIAGNOSIS. — Cerarii numbering 16 pairs; dorsal setae short, each 7-19 µm long; oral collar tubular ducts of two sizes, the smaller ones each with a diameter similar to a trilocular pore and the larger ones each with a diameter wider than that of a trilocular pore; anal bar absent; anal ring with 6 setae.

DESCRIPTION

Pre-mounting specimens

Appearance *in situ*: not observed. Specimens preserved in 75% ethanol with milky appearance; color unchanged in 10% potassium hydroxide.

Post-mounting specimens

Slide-mounted adult females (n = 8): body oval to round (Figs 5; 6A), length 1.9 ± 0.3 [1.9] (1.5-2.4) mm; wide 1.4 ± 0.3 [1.4] (1.1-1.9) mm.

Dorsum

Ostioles. Conspicuous with membranous lips and 1-8 setae and scattered trilocular pores on each lip. Anal ring, 94 ± 10.2 [84] (76-109) µm in transverse diameter, with 6 flagellate setae, each seta 89 ± 8.8 (66-104) µm long; ring containing two rows of cells, external row with cells smaller than those in internal row, subquadrate and subrectangular, each cell with a spicule 2 or 3 µm long; internal row of 72 ± 10 (59-87) cells, each cell irregular, tending to be elongate and without a spicule.

Cerarii. Numbering 16 pairs (Fig. 5A, 6B), C₁₀ absent; cerarian pattern C₁ [4-5:1-2] (2-6:1-4), C₂ [6:0] (6-10:0-3),

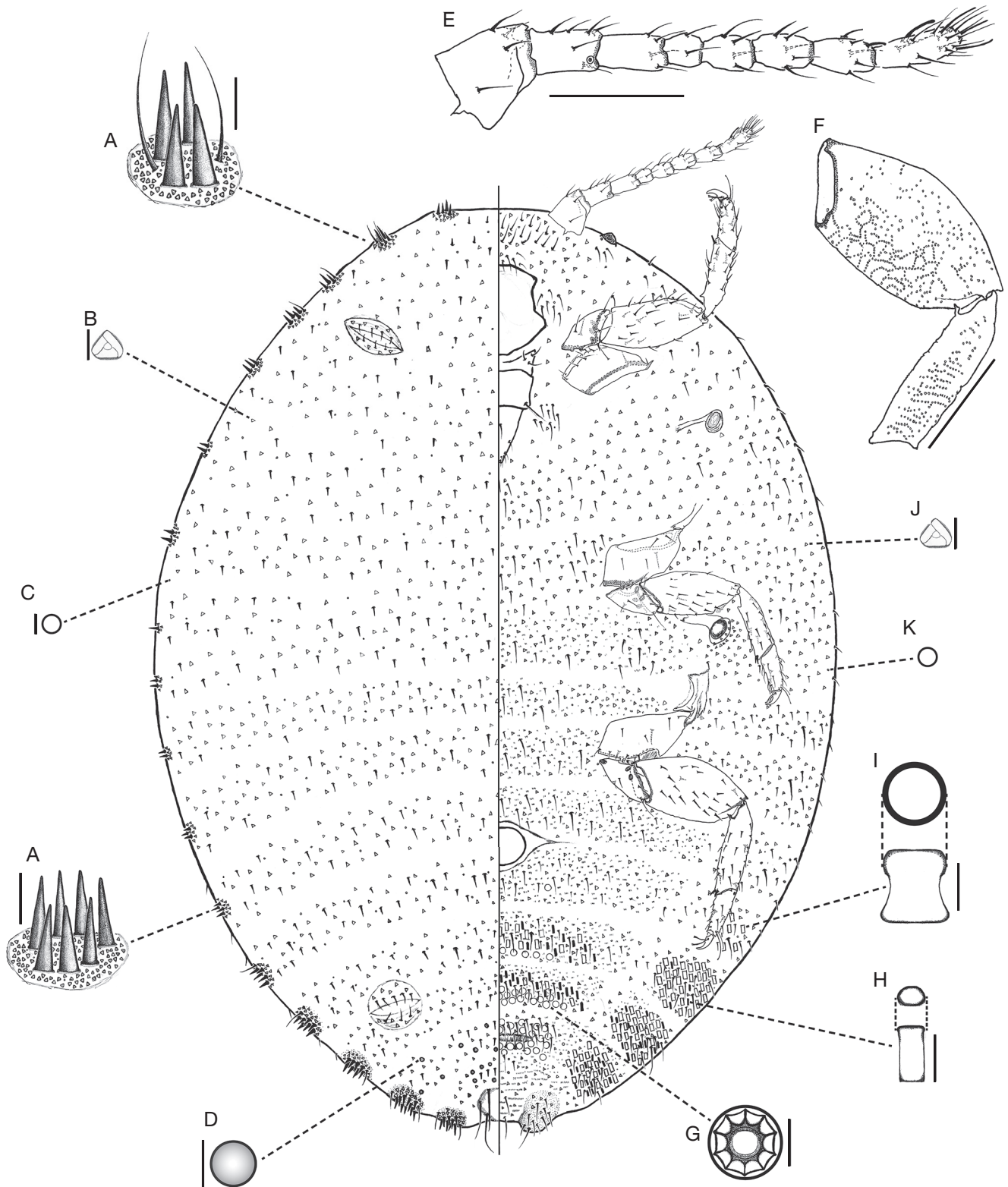


FIG. 5. — Taxonomic illustration of *Paraputo nasai* n. sp. adult ♀, with enlarged details: **A**, cerarii; **B**, trilocular pore; **C**, smaller discoidal pore; **D**, larger discoidal pore; **E**, antenna; **F**, hind femur and tibia; **G**, multilocular disc pore; **H**, smaller oral collar tubular duct; **I**, larger oral collar tubular duct; **J**, trilocular pore; **K**, discoidal pore. Scale bars: A, D, H-J, 5 µm; B, K, 3 µm; C, L, 2 µm; E, F, 100 µm.

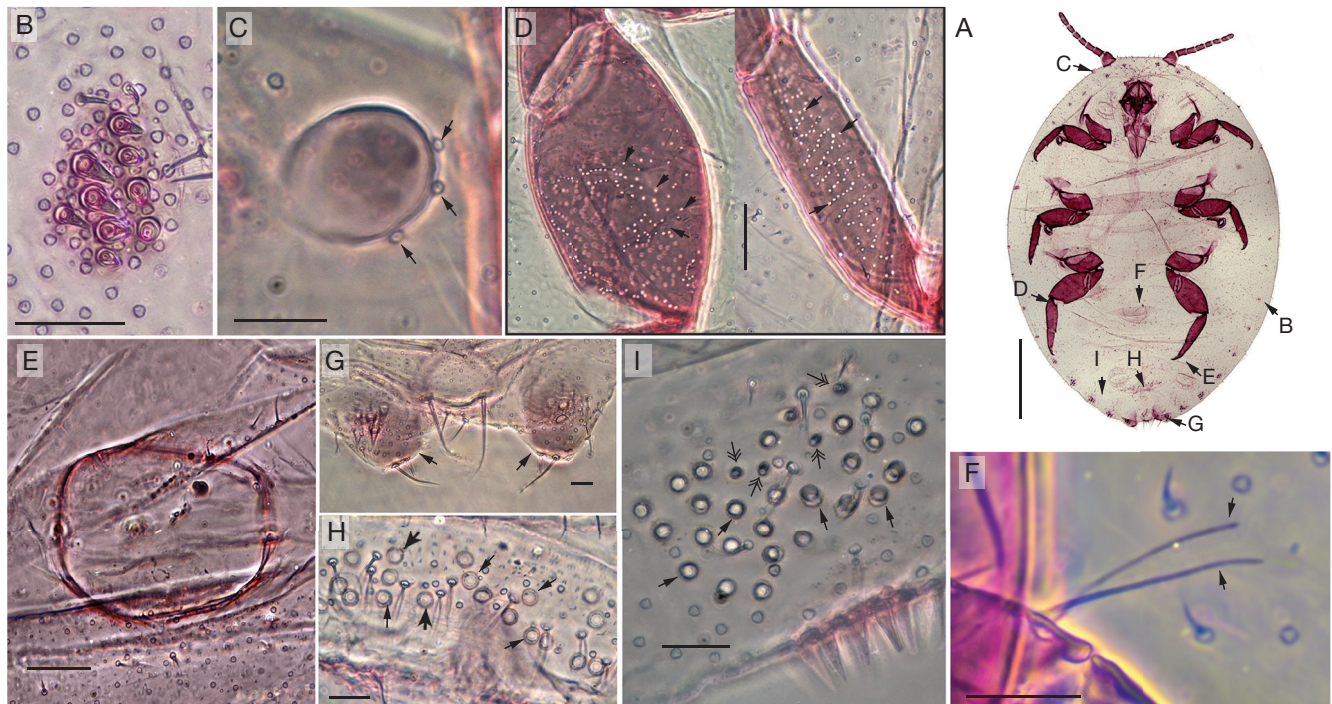


FIG. 6. — Microphotographs of female specimens of *Paraputo nasai* Caballero n. sp.: **A**, body; **B**, cerarii; **C**, eyespot associated with discoidal pores; **D**, hind femur and hind tibia with translucent pores; **E**, tarsal digitules; **F**, circulus; **G**, anal lobes; **H**, multilocular disc pores on abdominal segment VII; **I**, large oral collar tubular ducts (**one-tipped arrow**) and small oral collar tubular duct (**double-tipped arrow**) on margin of abdominal segment V. Scale bars: A, 400 μ m; B, 30 μ m; C, E, G-I, 20 μ m; D, 50 μ m; F, 40 μ m.

C_3 [7-8:0] (6-12:0-3), C_4 [4-6:1-2] (4-9:0-2), C_5 [4-5:0] (3-9:0-2), C_6 [3-4:0] (3-6:0-1), C_7 [3:0] (2-3:0-2), C_8 [2:0] (1-3:0-2), C_9 [2-3:0] (1-3:0-2), C_{10} absent, C_{11} and C_{12} [2:0] (1-3:0-1), C_{13} [2:0] (1-5:0-1), C_{14} [2-3:0] (2-4:0-3), C_{15} [3:0] (2-4:0-2), C_{16} [5-6:0-1] (3-8:0-4), and C_{17} [3-4:0] (3-8:0-1); each cerarius with trilocular pores grouped on a membranous plate.

Body setae. Flagellate, each 12 ± 2.6 (6-22) μ m long, the longest setae in mesial and submarginal regions, the shortest evenly distributed.

Trilocular pores. Each 3-4 μ m in diameter (Fig. 5B), evenly distributed throughout.

Multilocular disc pores. Absent.

Oral rim tubular ducts. Absent.

Oral collar tubular ducts. Absent.

Discoidal pores. Of two sizes: I) shorter type, each 2-3 μ m in diameter, similar diameter to or smaller than a trilocular pore (Fig. 5C), distributed from head to $S_{abd}VI$; II) longer type, each 4-5 μ m in diameter, wider than a trilocular pore (Fig. 5D) with border stout and sclerotized, distributed in $S_{abd}VII$ and $S_{abd}VIII + IX$.

Spicules. Present from mesothorax to $S_{abd}VIII + IX$.

Venter

Antennae. Each 391 ± 23.7 (351-435) μ m long, 7 or 8 segmented [holotype with 7 segments] (Fig. 5E); all specimens seem to have at least one antennal segment atrophied, so segment length and chaetotaxy vary depending on number of segments: $S_{ant}I$ 69.6 ± 5.7 (57-77) μ m long, with four flagellate setae; $S_{ant}II$ 55.1 ± 3.8 (49-61) μ m long, with three to six flagellate setae and one placoid sensilla; $S_{ant}III$ 53.8 ± 6.0 (43-65) μ m long, with one to five flagellate setae; $S_{ant}IV$ 30.9 ± 9.7 (17-52) μ m long, with one to two flagellate setae; $S_{ant}V$ 41.2 ± 6.0 (29-57) μ m long, with three to five flagellate setae; $S_{ant}VI$ 44.0 ± 3.6 (38-53) μ m long, with two to five flagellate setae and 0 or 1 fleshy seta; $S_{ant}VII$ 57.0 ± 14.6 (46-101) μ m long, with 3-16 flagellate and 0-2 fleshy setae; $S_{ant}VIII$ 67.8 ± 17.3 (31-90) μ m long, with 7-18 flagellate and 0-4 fleshy setae.

Eyespot. 35 ± 2.8 (29-39) μ m in diameter; 0-3 associated discoidal pores (Fig. 6C).

Labium. 176 ± 32.1 [186] (92-198) μ m long.

Fore leg. 533 ± 22.3 (504-569) μ m long; trochanter + femur 268 ± 12.4 (250-291) μ m long, femur 92 ± 8.4 (81-103) wide; tibia + tarsus 221 ± 11 (207-234) μ m long, tibia-tarsus union 42 ± 3.7 (36-48) μ m wide; claw 44 ± 1.4 (42-47) μ m long; chaetotaxy: coxa with nine flagellate setae, trochanter with seven, femur with 25, tibia internal margin of distal part with 6-13, tarsus with 11 setae and

two tarsal digitules, the shortest 39 ± 4.8 (30–48) μm long, the longest 54 ± 2.6 (50–57) μm long; claw digitules each 36 ± 3.2 (29–39) μm long.

Mid leg. 563 ± 18.8 (527–591) μm long; trochanter + femur 283 ± 8.5 (270–304) μm long; femur 97 ± 5.6 (90–106) μm wide; tibia + tarsus 235 ± 10.9 (218–251) μm long, tibia-tarsus union 45 ± 3.5 (38–50) μm wide; claw 45 ± 2.5 (36–48) μm long; chaetotaxy: coxa with 11 flagellate setae, trochanter with seven to eight, femur with 13–25, tibia with 10–18 setae plus two spines (as fore tibia), tarsus with 11 setae and two unequal tarsal digitules, the shortest 43 ± 4.8 (33–50) μm long, the longest 55 ± 2.5 (50–57) μm .

Hind leg. 666 ± 27.6 (629–718) μm long, trochanter + femur 332 ± 16.4 (316–371) μm long; femur 134 ± 5.6 (125–142) μm wide; tibia + tarsus 287 ± 15.2 (259–306) μm long; tibia-tarsus union 50 ± 7.2 (39–64) μm wide; claw 47 ± 2 (43–50) μm long; femur with 398–460 [398–411] translucent pores and tibia with 111–154 [111–114] translucent pores (Fig. 5F, 6D); chaetotaxy: coxa with 11 flagellate setae, trochanter with seven, femur with 14–21, tibia with 13–21 setae plus two spines (as fore tibia), tarsus with 10 setae and two unequal tarsal digitules, the shortest 40 ± 5.9 (31–48) μm long, the longest 54 ± 3.1 (49–59) μm long (Fig. 6E); claw without a denticle, with two stout capitate unguis digitules each 36 ± 6.6 (24–44) μm long. Ratios: lengths of trochanter + femur / tibia + tarsus of fore, mid and hind legs 1.2 ± 0.1 (1.1–1.3); trochanter + femur length/femur width of fore and mid leg 2.9 ± 0.2 (2.6–3.2), and hind leg 2.5 ± 0.2 (2.2–2.9); tibia + tarsus length/tibia-tarsus union width fore and mid leg 5.3 ± 0.5 (4.3–6.2), and hind leg 5.8 ± 0.9 (4.4–7.8).

Circulus. Situated across intersegmental line between S_{abdIII} and S_{abdIV} (Fig. 6F), divided by intersegmental line, 130 ± 2.3 [128] (128–132) μm in transverse diameter.

Vulvar opening. Located between S_{abdVII} and S_{abdVIII} .

Anal lobes. Without anal bars, membranous and slightly protruding, each with 6–9 flagellate setae, apical seta 38 ± 8.5 (29–47) μm long (Fig. 6G).

Spicules. Present from metathorax to S_{abdVIII} + IX.

Body setae. Flagellate, each 20 ± 5 (12–40) μm long, longest setae distributed in submesial and mesial areas, forming clusters in interantennal region, S_{abdVI} to S_{abdVIII} + IX and a few adjacent to cerarii; shortest setae evenly distributed over the entire surface.

Obanal setae. Each 18 ± 5.2 (12–24) μm long.

Cisanal setae. Each 32 ± 4.5 (25–36) μm long.

Multilocular disc pores. Each with 9 or 10 loculi (Figs 5G; 6H) and 8 ± 2 (6–10) μm in diameter, distributed as follows: S_{abdIV} [0] (0–1), S_{abdV} [3] (8–16), S_{abdVI} [20] (29–34), S_{abdVII} [12] (31–39) and S_{abdVIII} + IX [8] (10–16).

Oral rim tubular ducts. Absent.

Oral collar tubular ducts. Of two sizes: I) smaller type with diameter similar to a trilocular pore (Fig. 5H, 6I), each 3 ± 0.2 (2–3) μm in diameter and 6 ± 0.8 (6–8) μm long, forming transverse rows across S_{abdV} [1] (1–17 pores), S_{abdVI} [25] (25–47) and S_{abdVII} [26] (26–37 pores); II) larger type each with a diameter greater than a trilocular pore (Fig. 5I), 5 ± 0.2 (5–6) μm in diameter and 8 ± 0.6 (6–9) μm long, distributed in clusters in marginal and submarginal regions of S_{abdIV} [1] (1–20 ducts), S_{abdV} [52] (52–79), S_{abdVI} [47] (47–61) and S_{abdVII} [32] (32–46 ducts).

Trilocular pores. Each 3–4 μm in diameter (Fig. 5J), evenly distributed.

Discoidal pores. Each narrower than a trilocular pore, 2–3 μm in diameter, evenly distributed (Fig. 5K).

IDENTIFICATION KEY TO NEW WORLD SPECIES OF *PARAPUTO* LAING, 1929

[adapted from descriptions and taxonomic keys in Balachowsky (1959), Williams (1969), Miller & McKenzie (1973), Williams & Granara de Willink (1992) and Foldi & Kozár (2005)]

1. Circulus absent *P. guatemalensis* (Ferris, 1953)
- Circulus present 2
2. Thorax without cerarii 3
- Thorax with cerarii 6
3. Multilocular disc pores absent; hind coxa without translucent pores *P. formicarii* (Enrhorn, 1899)
- Multilocular disc pores present; hind coxa with translucent pores 4
4. Head without oral collar tubular ducts *P. taquarae* (Hempel, 1912)
- Head with oral collar tubular ducts 5
5. Dorsum without oral collar tubular ducts; venter with oral collar tubular ducts all same size *P. phoradendri* (Cockerell, 1912)

- Dorsum with oral collar tubular ducts; venter with oral collar tubular ducts of 2 sizes *P. asparodensis* (Foldi & Kozár, 2005)
- 6. Dorsum with oral collar tubular ducts 7
- Dorsum without oral collar tubular ducts 9
- 7. Cerarii separate, numbering 17 pairs *P. angustus* (Ezzat & McConnell, 1956)
- Cerarii merged into a continuous marginal band 8
- 8. Thorax with ventral oral collar tubular ducts *P. ductorum* (Williams & Granara de Willink, 1992)
- Thorax without ventral oral collar tubular ducts *P. olivaceus* (Cockerell, 1896)
- 9. Hind coxa with translucent pores 10
- Hind coxa without translucent pores 14
- 10. Hind femur and tibiae without translucent pores; anal ring setae each shorter than diameter of ring *P. taylori* (Williams & Granara de Willink, 1992)
- Hind femur and tibiae with translucent pores; anal ring setae each as long as or longer than diameter of ring 11
- 11. Anal ring with 8 setae or more *P. subcorticis* (Morrison, 1922)
- Anal ring with 6 setae 12
- 12. Cerarii merged to form a continuous marginal band *P. ingrandi* (Balachowsky, 1959)
- Cerarii separate, numbering 17 pairs 13
- 13. Hind trochanter with translucent pores; head with oral collar tubular ducts *P. larai* (Williams, 1969)
- Hind trochanter without translucent pores; head without oral collar tubular ducts *P. theobromicola* (Williams & Granara de Willink, 1992)
- 14. Thorax with multilocular disc pores *P. cualatensis* (Cockerell, 1903)
- Thorax without multilocular disc pores 15
- 15. Anal ring with 8 or more setae *P. rotundus* (Morrison, 1922)
- Anal ring with 6 setae 16
- 16. Oral collar tubular ducts clearly of 2 sizes; head without tubular ducts *P. nasai* n. sp.
- Oral collar tubular ducts all same size, with some present on head 17
- 17. Hind femoral anterior surface bearing about 21 setae; hind tibial anterior surface with 20-26 setae. Abdominal segments VII and VIII with longest dorsal seta about 30 µm long *P. podagrosus* (Green, 1933)
- Hind femoral anterior surface bearing 11-13 setae; hind tibial anterior surface with 10 or 11 setae. Abdominal segments VII and VIII with longest dorsal seta about 50 µm long *P. colombiensis* (Williams & Granara de Willink, 1992)

REMARKS

There is a debate about the generic character state that defines *Paraputo* and *Formicococcus*. As *Paraputo nasai* n. sp. has six setae in the anal ring and no anal bar, there is no conflict to put it into the *Paraputo* genus. *Paraputo nasai* n. sp. comes closest to *Paraputo colombiensis* (Williams & Granara de Willink, 1992), another species with translucent pores on the hind femur and tibia and with a circulus present. *Paraputo nasai* n. sp. differs from *P. colombiensis* (character states in parenthesis) in having oral collar tubular ducts of two distinct sizes (oral collar ducts of one size only); multilocular disc pores on $S_{abd}IV$ and posterior segments (present on $S_{abd}VI$ and posterior segments); dorsal setae of uniform length over the entire surface (dorsal setae of two sizes, the shorter ones present from head to $S_{abd}III$, the longer ones present on $S_{abd}VI$ and posterior segments); number of conical cerarian setae progressively reduced anteriorly, from 6-12 setae in each of C_1 to C_6 , to 2-3 setae

in C_7 to C_{18} (conical setae number constant amongst all the cerarii, with 4-6 setae per cerarius); and conical setae absent from marginal intercerarian spaces (conical setae present in marginal intercerarian spaces) [character data of *P. colombiensis* taken from Williams & Granara de Willink (1992)].

Family PSEUDOCOCCIDAE Cockerell, 1905
Genus *Pseudococcus* Westwood, 1840

Pseudococcus luciae n. sp.
(Figs 7; 8)

[urn:lsid:zoobank.org:act:FD789556-375E-48E7-97F1-332C3867273A](https://zoobank.org/act:FD789556-375E-48E7-97F1-332C3867273A)

TYPE MATERIAL. — **Holotype.** Colombia • adult ♀ (2 specimens in the same slide, holotype at the right side indicated as “Holo”

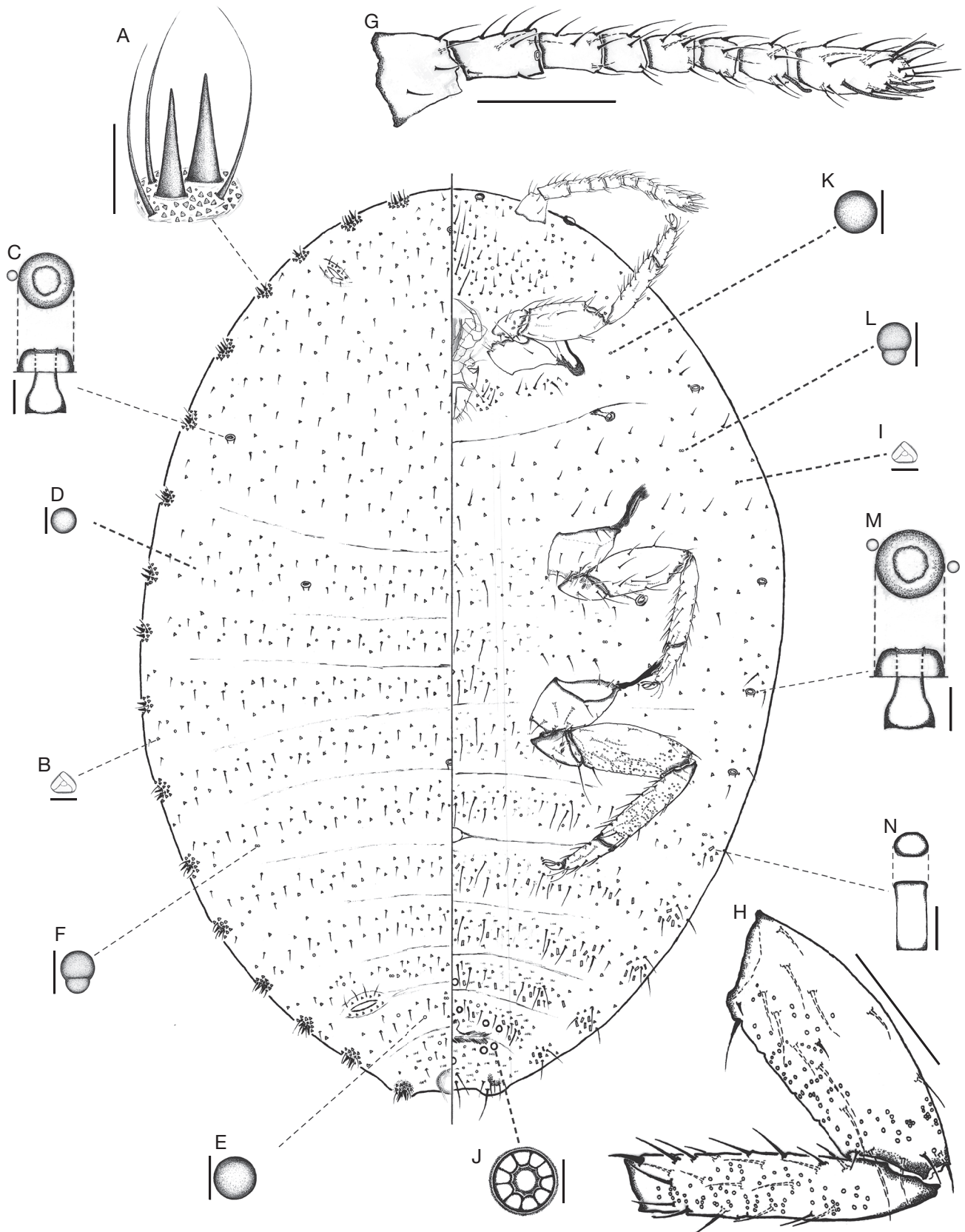


FIG. 7. — Taxonomic illustration of *Pseudococcus luciae* n. sp. adult ♀, enlarged details: **A**, cerarius; **B**, tritubular pore; **C**, oral rim tubular duct; **D**, dorsal large discoidal pore; **E**, dorsal small discoidal pore; **F**, discoidal bilocular pore; **G**, antenna; **H**, hind femur and tibia; **I**, trilocular pore; **J**, multilocular disc pore; **K**, ventral discoidal pore; **L**, ventral discoidal bilocular pore; **M**, oral rim tubular duct; **N**, oral collar tubular duct. Scale bars: A-F, H-K, 5 μm; G, 100 μm; M, N, 6 μm.



FIG. 8. — Microphotographs of female specimens of *Pseudococcus luciae* n. sp. **A**, body; **B**, oral rim tubular duct with upper view (picture above) and lateral view (picture down); **C**, discoidal bilocular pore; **D**, antenna; **E**, eyespot with upper view (picture above) and lateral view (picture down); **F**, tarsal digitules; **G**, circulus; **H**, anal lobe; **I**, multilocular disc pore; **J**, oral collar tubular duct. Scale bars: A, 300 µm; B, C, H-J, 4 µm; F, 6 µm; 10 D, E, G, 20 µm.

in additional label); Cauca, Caldono, Vereda Chindaco, Farm La Esmeralda; 02°48'36.68"N, 76°28'40.22"W; 1603 m a.s.l.; 28.XI.2015; J. Medina leg.; ex roots *Coffea arabica* (Rubiaceae) – coffee, manual; UNAB 4635.

Paratypes. 8 adult ♀ on 5 slides • 1 ♀ (marked as “Para” shares a slide with the holotype); same data as for holotype; UNAB 4635 • 1 ♀ (marked as “Para” shares a slide with an immature specimen); same data as for holotype; UNAB 4635 • 4 ♀ (on 2 slides); same data as for holotype; UNAB 4635 • 2 ♀ (on 1 slide); same data as for holotype; MNHN.

ETYMOLOGY. — The specific epithet “*luciae*” dedicated to Dr Lucia Calderón-Espinosa, Colombian herpetologist.

DIAGNOSIS. — Combination of only a few oral collar tubular ducts (<75 ducts), a few oral rim tubular ducts (<15 over entire body), and few multilocular disc pores (<12), a small circulus (<61 µm wide) and eyes not associated with either a sclerotized area nor with discoidal pores.

DESCRIPTION

Pre-mounting specimens

Appearance *in situ*: not observed. Specimens preserved in 75% ethanol with milky appearance; color unchanged in 10% potassium hydroxide.

Post-mounting specimens

Slide-mounted adult females (n = 6): body oval to round (Fig. 7; 8 A), length 1.9 ± 0.2 [2.2] (1.5–2.2) mm; wide 1.4 ± 0.3 [1.7] (0.9–1.7) mm.

Dorsum

Ostioles. Conspicuous, 20.4 ± 4.0 (13–30) µm wide, with membranous lips and 3–5 setae and scattered trilocular pores on each lip.

Anal ring. 76.1 ± 2.3 [77] (72–80) µm in transverse diameter, with 6 flagellate setae each 104.9 ± 8.9 (90–123) µm long; ring containing two rows of cells, external row with cells smaller than those in internal row, subquadrate and subrectangular, each cell with a spicule 2 or 3 µm long; internal row with 45.8 ± 4.0 (41–53) irregular cells tending to be elongate and without spicules.

Cerarii. Numbering 17 pairs (Fig. 7A); cerarian pattern C_1 [2;4] (1–2;2–6), C_2 [2;4–5] (1–2;2–6), C_3 [2;2–4] (2;1–5), C_4 [2;2] (2;1–3), C_5 [2;1–3] (1–2;1–3), C_6 [2;0–1] (2;–4), C_7 [2;1] (2;1–3), C_8 [2–3;1–2] (1–3;0–2), C_9 [2;2] (2;0–3), C_{10} [2;0–1] (1–3;0–1), C_{11} [2;1–2] (2;1–3), C_{12} [2;2–3] (1–2;0–5), C_{13} [2;1] (1–2;1–4), C_{14} [2–3;1–3] (1–3;1–3), C_{15} [2;0–2] (1–2;0–3), C_{16} [2–3;1–2] (2–4;0–3), C_{17} [2;1–2] (1–4;0–3), all cerarii situated on membranous plates.

Body setae. Flagellate, 19.1 ± 6.5 (9–45) µm long, longest setae found in mesial and submarginal regions, shortest setae evenly distributed.

Trilocular pores. Evenly distributed over entire surface (Fig. 7B), each pore 3–4 µm in diameter.

Multilocular disc pores. Absent.

Oral rim tubular ducts. All same size, each 8.6 ± 0.6 (8-10) μm in diameter and associated with 1 or 2 discoidal pores and 1 seta (Figs 7C; 8B), numbering 2.4 ± 1.5 [3] (0-5), distribution highly variable but never situated on head, thorax at the level of C_{11} or on S_{abdIII} and posterior segments.

Oral collar tubular ducts. Absent.

Discoidal pores. Of two types: type I with a single locus, present in two sizes: I) small, each 2-3 μm in diameter, smaller than a trilocular pore (Fig. 7D), distributed from head to S_{abdVI} ; and II) larger, each 3-5 μm in diameter, similar size to, or larger than a trilocular pore (Fig. 7E), distributed on S_{abdVII} and $S_{\text{abdVIII}} + \text{IX}$, with border stout and sclerotized; type II discoidal pores bilocular, each 4-5 μm in diameter (Figs. 7F; 8C).

Spicule. Present from metathorax and posterior segments.

Venter

Antennae. Each 393.8 ± 13.5 (367-419) μm long (Fig. 7G; 8D), with eight segments, segment lengths and chaetotaxy as follows: S_{antI} 61.9 ± 4.3 (55-71) μm long, with four flagellate setae; S_{antII} 63.6 ± 3.2 (58-69) μm long, with five to eight flagellate setae and one placoid sensilla; S_{antIII} 44.9 ± 3.3 (39-51) μm long, with five to seven flagellate setae; S_{antIV} 30.3 ± 2.8 (23-34) μm long, with three to five flagellate setae; S_{antV} 36.4 ± 3.7 (31-44) μm long, with six to nine flagellate setae; S_{antVI} 31.3 ± 2.4 (28-35) μm long, with five flagellate setae; S_{antVII} 39.0 ± 2.1 (33-43) μm long, with five flagellate setae and one fleshy seta; S_{antVIII} 86.4 ± 2.8 (79-91) μm long, with 18 flagellate setae and four fleshy setae; ratios $S_{\text{antI}}/S_{\text{antII}}$ 1.0 ± 0.1 (0.8-1.2), $S_{\text{antI}}/S_{\text{antIV}}$ 2.1 ± 0.2 (1.8-2.6), $S_{\text{antI}}/S_{\text{antVI}}$ 2.0 ± 0.2 (1.7-2.3), and $S_{\text{antVIII}}/S_{\text{antIV}}$ 2.9 ± 0.3 (2.5-3.7).

Eyespots. Each 39.1 ± 2.8 (33-43) μm in diameter, not associated with discoidal pores (Fig. 8).

Labium. 120.4 ± 4.6 (115-129) μm long and 114.7 ± 6.6 (101-121) μm wide, with three segments: basal segment with 3 pairs of setae; middle segment with one pair of setae; and apical segment with seven to nine pairs of setae.

Fore leg. 566.6 ± 10.8 (546-582) μm long; trochanter + femur 262.1 ± 6.3 (248-275) μm long, femur 198.0 ± 5.1 (188-205) long and 86.8 ± 4.0 (76-94) μm wide; tibia + tarsus 268.5 ± 6.6 (259-282) μm long, tibia 172.3 ± 5.2 (163-181) long and 43.9 ± 2.0 (39-47) μm wide; claw 36.1 ± 1.5 (32-39) μm long; ratios: lengths of trochanter + femur/tibia + tarsus 1.0; trochanter + femur length/femur width 3.0 ± 0.2 (2.8-3.4); tibia + tarsus length/tibia width 6.1 ± 0.3 (5.5-6.8); chaetotaxy: coxa with 10 flagellate setae, trochanter with seven setae and four placoid sensilla, femur with 17-22 setae, tibia with 18-20 flagellate setae plus two spines on internal margin of distal region; tarsus with 11-13 setae and a pair of slender

and capitate tarsal digitules of two sizes, the larger one 40.3 ± 2.3 (35-46) μm long, the shorter one 30.0 ± 4.2 (23-38) μm long; claw without a denticle, with two unguis digitules capitate, slightly thicker than tarsal digitule, each 27.9 ± 1.8 (24-30) μm long.

Mid leg. 581.4 ± 11.4 (562-601) μm long; trochanter + femur 269.3 ± 6.0 (258-282) μm long, femur 205.1 ± 4.8 (196-214) long and 89.4 ± 1.9 (87-92) μm wide; tibia + tarsus 275.3 ± 7.8 (257-288) μm long, tibia 178.2 ± 6.5 (163-191) long and 45.8 ± 2.2 (41-49) μm wide; claw 36.8 ± 1.8 (32-39) μm long; ratios: lengths of trochanter + femur/tibia + tarsus 1.0, trochanter + femur length/femur width 3.0 ± 0.1 (2.8-3.2), tibia + tarsus length/tibia width 6.0 ± 0.4 (5.2-6.9); chaetotaxy: coxa with 11 flagellate setae, trochanter with seven, femur with 16-20, tibia with 18-28 flagellate setae plus two spines (as fore tibia), tarsus with 10-13 setae and a pair of unequal tarsal digitules similar those on fore tarsus, the larger one 38.2 ± 1.9 (36-42) μm long, the shorter one 32.4 ± 2.6 (28-36) μm long; claw without a denticle, unguis digitules similar those on fore claw, each digitule 29.4 ± 2.5 (21-32) μm long.

Hind leg. 655.1 ± 11.6 (637-678) μm long; trochanter + femur 295.9 ± 5.8 (282-306) μm long; femur 228.8 ± 4.3 (219-234) μm long and 94.6 ± 3.0 (88-101) μm wide; tibia + tarsus 322.7 ± 7.3 (312-334) μm long; tibia 219.0 ± 6.0 (210-228) μm long and 44.5 ± 3.2 (37-51) μm wide; claw 37.2 ± 2.7 (30-41) μm long; ratios: lengths of trochanter + femur/tibia + tarsus 0.9-1.0; trochanter + femur length/femur width 3.1 ± 0.1 (2.9-3.4), tibia + tarsus length/tibia width 7.3 ± 0.6 (6.4-8.7), lengths of tibia/tarsus 2.1 ± 0.1 (2.0-2.2). Translucent pores on hind leg distributed as follows: absent from coxa, trochanter and tarsus, femur with 90 ± 12 (69-112) pores, tibia with 58 ± 12 (34-74) pores (Fig. 7H); chaetotaxy: coxa with 11 flagellate setae, trochanter with seven, femur with 14-17, tibia with 20-26 flagellate setae plus two spines (similar those on fore tibia), tarsus with 8-10 flagellate setae; tarsal digitules unequal, similar those on fore tarsus, the larger one 38.6 ± 3.4 (31-45) μm long, the shorter one 39.9 ± 4.6 (21-37) μm long (Fig. 8F); claw without a denticle, unguis digitules similar to those on other legs, each 29.3 ± 2.8 (21-32) μm long.

Circulus. Situated in posterior part of S_{abdIII} , 48.9 ± 6.0 [61] (41-61) μm in transverse diameter (Fig. 8G).

Anal lobes. Prominent, not sclerotized, each with apical flagellate seta 127.3 ± 11.0 (104-144) μm long, 2-7 auxiliary flagellate setae and 1-2 discoidal pores, each 4-5 μm in diameter (Fig. 8H).

Body setae. Flagellate and of variable length: 50.2 ± 21.4 (21-88) μm long on head, 31.9 ± 12.9 (14-65) μm on thorax, and 33.0 ± 14.0 (11-80) μm long on abdomen, the longest setae distributed in mesial region on all segments. Intersegmental areas lacking setae.

Obanal setae. Each 60.4 ± 5.1 (51-69) μm long.

Cisanal setae. Each 49.3 ± 5.7 (40-57) μm long.

Trilocular pores. Each 3-4 μm in diameter (Fig. 7I), evenly distributed.

Multilocular disc pores. Each 8.4 ± 0.6 (7-10) μm in diameter (Fig. 7J; 8I), numbering 5.8 ± 2.7 [3] (2-11), distributed as follows: S_{abdV} [0] (0-1), S_{abdVI} [0] (0-1), S_{abdVII} [0] (0-5) and $S_{\text{abdVIII+IX}}$ [3] (1-6).

Discoideal pores. Of two types: I) one type with a single locus each 4-5 μm in diameter, evenly distributed (Fig. 7K); II) second type bilocular, each pore 5-6 μm in diameter, scarce (Fig. 7L).

Oral rim tubular ducts. All same size, each 8.8 ± 0.9 (7-10) μm in diameter, length about 11.3 ± 1.2 (10-12), usually not associated with discoideal pores or setae; numbering 1.9 ± 2.3 [7] (0-7) (Fig. 7M), distribution highly variable but absent from S_{abdIV} and posterior segments.

Oral collar tubular ducts. All same size, each 7.4 ± 0.8 (6-10) μm long and 4.1 ± 0.4 (3-6) μm in diameter (Fig. 7N, Fig. 8J), numbering 63.1 ± 8.5 [70] (53-71), forming lateral clusters and transverse rows in mid-region as follows: S_{abdIII} [2] (0-6), S_{abdIV} [22] (11-26), S_{abdV} [29] (20-33), S_{abdVI} [30] (21-33), and S_{abdVII} [17] (12-18) ducts.

Spicules. Present on mesothorax and posterior body segments.

KEY TO *PSEUDOCOCCUS* WESTWOOD, 1840 SPECIES OF THE NEW WORLD
(divided into two parts at couplet 49, according to the presence or absence of ventral oral rim
tubular ducts posterior to the frontal cerarii)

Part I

49. Ventral OR present behind frontal cerarii (C_{17}) 50
— Ventral OR absent from behind frontal cerarii (C_{17}) 57
50. Marginal and submarginal ventral OR with broad ducts and narrow rims present in groups on SI-VII 51
— Marginal and submarginal ventral OR absent, if present on SI-VII, then singly and with narrow ducts and wide rims 52
52. Ventral multilocular pores on abdomen present anteriorly to SVI 53
— Ventral multilocular pores on abdomen absent from anterior to SVI 54a
- 54a. Dorsal oral rim tubular ducts present behind frontal cerarii 55
— Dorsal oral rim tubular ducts absent from behind frontal cerarii 54b
- 54b. Length of labium 115-130 μm ; length of hind tibia+tarsus longer than length of hind trochanter + femur
..... *P. luciae* n. sp. (in part)
— Length of labium 150-160 μm ; length of hind tibia+tarsus shorter than length of hind trochanter+femur less
than 1 *P. dendrobiorum* Williams, 1985

Part II

57. Dorsal OR present behind frontal cerarii (C_{17}) 58
— Dorsal OR absent from behind frontal cerarii (C_{17}) 72
72. Cerarii numbering 17 pairs, with cerarii on SI (C_8) well developed 73
— Cerarii numbering 16 pairs or fewer, with cerarii on SI lacking or abortive (C_8) 74
73. Ventral multilocular disc pores on abdomen present as far anteriorly as SIII-IV; dorsal OR usually present on
SVI by each posterior ostiole *P. calceolariae* (Maskell, 1879)
— Ventral multilocular pores on abdomen restricted to SVI-VIII; dorsal OR absent from SVI by each posterior
ostiole 73a
- 73a. Translucent pores restricted to hind tibia *P. prunicolus* McKenzie, 1964 (in part)
— Translucent pores present on hind femur and tibia *P. luciae* n. sp. (in part)

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23. Eye not associated with discoideal pores 23a
— Eye associated with discoideal pores 27
- 23a. C_{16} and C_{17} [C_2 and C_1 *sensu* Beardsley (1965)] without sclerotized surfaces *Ps. luciae* n. sp.
— At least C_{17} [C_1 *sensu* Beardsley (1965)] with sclerotized surface 24

TABLE 2. — Distribution and number of oral rim tubular ducts in type specimens of *Pseudococcus luciae* n. sp.

Body segment	Surface	Htype	Ptype 1	Ptype 2	Ptype 3	Ptype 4	Ptype 5	Ptype 6	Ptype 7
C ₁₇	Venter	1	0	0	0	0	0	0	0
	Dorsum	0	0	0	0	0	0	0	0
C ₁₄	Venter	0	0	0	1	0	0	0	0
	Dorsum	0	0	0	1	0	0	0	1
C ₁₃	Venter	1	0	0	0	0	0	0	0
	Dorsum	1	0	0	0	0	0	0	0
C ₁₁	Venter	0	1	1	0	0	0	0	0
	Dorsum	0	0	1	1	0	0	0	0
C ₁₀	Venter	1	1	0	0	0	0	0	0
	Dorsum	0	1	1	0	0	0	0	0
C ₉	Venter	0	0	0	0	0	0	0	0
	Dorsum	0	1	1	1	0	0	0	1
C ₈	Venter	1	1	0	0	0	0	0	0
	Dorsum	1	2	0	0	0	0	0	0
C ₇	Venter	2	1	0	0	0	0	0	0
	Dorsum	1	1	0	0	0	1	2	0
C ₆	Venter	1	0	0	0	1	0	0	0
	Dorsum	0	0	0	0	0	0	0	0
Total	Venter	7	4	1	1	1	0	0	0
	Dorsum	3	0	3	3	0	1	2	2

REMARKS

Pseudococcus luciae n. sp. is similar to *Pseudococcus dendrobiorum* Williams, 1985 and *Pseudococcus lycopodii* Beardsley, 1959 because all three species have only a few multilocular disc pores, restricted to the last three abdominal segments (< 12 in *P. luciae* n. sp., < 13 in *P. dendrobiorum* and < 15 in *P. lycopodii*); only a few dorsal oral rim tubular ducts on the dorsum (< 5 in *P. luciae* n. sp., 0 in *P. dendrobiorum* and 4–12 in *P. lycopodii*) and venter (< 7 in *P. luciae* n. sp., < 3 in *P. dendrobiorum* and 4–12 in *P. lycopodii*, absent from S_{abd}IV and posterior segments). *Pseudococcus luciae* n. sp. differs from *P. dendrobiorum* (characters in parenthesis) by having a shorter labium, less than 130 µm long (150–160 µm long), a smaller circulus, less than 60 µm of transverse diameter (100–130 µm in transverse diameter), a longer hind tibia + tarsus, around 310–340 µm long (160–200 µm long), and hind tibia + tarsus length greater than hind trochanter + femur length (hind tibia + tarsus much shorter than hind trochanter + femur). *Pseudococcus luciae* n. sp. differs from *P. lycopodii* (characters in parenthesis) by having 17 cerarii (14–16 cerarii), more than 50 collar tubular ducts (10–20) and a smaller circulus (80 µm in transverse diameter) [character data on *P. dendrobiorum* taken from Williams (1985) and on *P. lycopodii* from Beardsley (1959)].

The taxonomic character “transverse diameter of circulus” is considered to be useful for separating species groups (Gimpel & Miller 1996). *Pseudococcus luciae* n. sp. belongs to the “small-circulus” (transverse diameter less than 80 µm) group, which includes *P. apomicrocirculus* Gimpel & Miller, 1996, *P. dolichomelos* Gimpel & Miller, 1996, *P. debilis* Granara de Willink, 2018, *P. dysmicus* Gimpel & Miller, 1996, *P. eriocerei* Williams, 1973, *P. microcirculus* McKenzie, *P. neomicrocirculus* Gimpel & Miller, 1996, *P. sorghiel-*

lus (Forbes, 1885), and *P. spanocera*. Among these species, *P. luciae* n. sp. is closest to *P. neomicrocirculus* and *P. spanocera*. In addition to having a small circulus, these species have only a few oral rim tubular ducts. Morphological differences between them include absence of discoidal pores associated with eyespot (*P. neomicrocirculus* and *P. spanocera* have discoidal pores associated with eyespots), translucent pores restricted to femur and tibia (present in all segments of the hind leg in *P. spanocera*; restricted to the hind tibia in *P. neomicrocirculus*), and less than five multilocular disc pores on each abdominal segment from S_{abd}V and posterior segments (*P. neomicrocirculus* and *P. spanocera* have more than 10 multilocular disc pores on each abdominal segment) [character data of *P. neomicrocirculus* and *P. spanocera* taken from Gimpel & Miller (1996)].

VARIATIONS

The distribution and number of oral rim tubular ducts are a recurrent character used to separate species of *Pseudococcus*. In *P. luciae* n. sp. these are highly variable and overlap the ranges found in several other species. Some specimens lack ducts on the dorsum of the abdomen (see Table 2, Ptypes 2–4 and 7) like *P. dendrobiorum*; other specimens lack ducts on the venter (see Table 2, Ptypes 4–7) like *P. dasyliiriae* Gimpel & Miller, 1996 and *P. mendozi* Williams, 1985.

KEY

Recent papers by von Ellenrieder & Watson (2016) and Granara de Willink & González (2018) provided identification keys to adult female *Pseudococcus* species in the New World and the Neotropical Region, respectively. Adaptations are made to each key below, to include the new species (von Ellenrieder & Watson 2016)

DISCUSSION

The family Pseudococcidae has 256 genera and Ortheziidae has 24 (García Morales *et al.* 2016). Some of those genera have similar morphologic characters and their phylogenetic relationship is yet unclear. The species described here provide new information to discuss the generic character states, particularly of *Distichlicoccus* and *Paraputo*.

Distichlicoccus takumasae n. sp. shows morphological variations that should be considered to define the genus. The last described species for *Distichlicoccus* present highly variable taxonomic characters such as the presence and number of circulus and the number of cerarii. Until the species described by Williams & Granara de Willink (1992), the genus had only one species with circulus and the cerarii numbers were less than 14, but those new discoveries make necessary to review the generic diagnosis. Those variations fit with character states from species of genera *Chorizococcus*, *Spilococcus* Ferris, 1950, *Pseudococcus*, and to a lesser degree with *Humococcus* Ferris, 1953. *Distichlicoccus takumasae* n. sp. belongs to the no-circulus group only with most of the species of the genus but also increased the list of species with more than 14 cerarii pairs.

Paraputo nasai n. sp. and Neotropical *Paraputo* species (previously placed in the synonymized genus *Cataenococcus*) should be consider into the discussion of taxonomic definition between *Formicococcus* and *Paraputo*. So far, the studies have focused on species from Oriental (Tang 1992; Williams 2004; Zhang & Wu 2017) and Palearctic (Danzing & Gavrilo-Zimin 2014) regions. The Neotropical species do not have anal bar and the anal ring has six setae (Williams & Granara de Willink 1992).

In this paper, four new species are described, and their taxonomic locations must be confirmed by other tools besides the morphological one. Furthermore, the morphological variations found in these species could contribute to a more accurate taxonomic delimitation, especially in the cases of genera *Distichlicoccus* and *Paraputo*.

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