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

Alejandro CABALLERO
Sistemática Insectos Agronomía, Museo entomológico UNAB, Universidad Nacional de Colombia, Bogotá (Colombia)
lacaballeror@unal.edu.co

Submitted on 6 October 2020 | Accepted on 17 December 2020 | Published on 24 June 2021

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.
INTRODUCTION

Coffee, *Coffea* spp. (*Rubiaceae*), is host-plant to 214 species of scale insects (*Hemiptera: Coccoidea*) 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), Rhizococcidae Williams, 1969 (30), Diaspididae Targioni Tozzetti, 1868 (20), Cercococcidae Balachowsky, 1942 (six), Ortheziidae Amoyt & Serville, 1843 (six), Monophlebidae Signoret, 1875 (four), Asterothelyciidae Cockerell, 1896 (three), Putoidea Beardsley, 1969 (three), Stictococcidae Lindinger, 1913 (three), Kerriidae Lindinger, 1937 (two), Lecanodiapidae 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 of scale insects (*Hemiptera: Coccoidea*), with 15 genera and four families: *Distichlicoccus* Ferris, 1950, *Paraputo* Ferris, 1950 et *Newsteadia* Ferris, 1950 et Paraputo Laing, 1929. 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 scale insects: *Distichlicoccus* Ferris, 1950, *Paraputo* Ferris, 1929, and *Newsteadia* Ferris, 1950 et *Cataenococcus* Ferris, 1902, restricted to New World, except by *Newsteadia* Ferris, 1950 and *Paraputo* Ferris, 1950 et Paraputo Laing, 1929. 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 scale insects: *Distichlicoccus* Ferris, 1950, *Paraputo* Ferris, 1929, and *Newsteadia* Ferris, 1950 et *Cataenococcus* Ferris, 1902, restricted to New World, except by *Newsteadia* Ferris, 1950 and *Paraputo* Ferris, 1950 et Paraputo Laing, 1929. 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 scale insects: *Distichlicoccus* Ferris, 1950, *Paraputo* Ferris, 1929, and *Newsteadia* Ferris, 1950 et *Cataenococcus* Ferris, 1902, restricted to New World, except by *Newsteadia* Ferris, 1950 and *Paraputo* Ferris, 1950 et Paraputo Laing, 1929. 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.
Four new scale insects from Colombia

Table 1.—Species described from samples collected on Coffea species, based on Hempel (1918); Laing (1925); Green (1933); Hambleton (1946, 1976); Balthoweysky (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          |
|-------------------------------|--------------|------------------|---------------------|
| Coccidiae Fallén, 1814        |              |                  |                     |
| Tourmeyella coffeae           | Kondo, 2013  | Colombia, Venezuela | Coffea arabica Linnaeus, 1753 |
| Pseudococcidae Cockereill, 1905 |              |                  |                     |
| Dysmicoccus caribensis        | Granara de Willink, 2009 | Colombia | Coffea sp.          |
| Dysmicoccus varius            | Granara de Willink, 2009 | Colombia | Coffea sp.          |
| Dysmicoccus subterreus        | Williams, 2004 | India           | Coffea canephora Pierre ex A. Froehner, 1897 |
| Formococcus greeni            | Vayssiére, 1914 | Madagascar      | Coffea sp.          |
| Planococcus fungicola         | Watson & Cox, 1990 | Kenya           | Coffea arabica      |
| Planococcus radicum           | Watson & Cox, 1990 | Nigeria         | Coffea sp.          |
| Pseudococcus cryptus          | Hempel, 1918  | Brazil           | Coffea sp.          |
| Pseudococcus pseudocitrulinus | Betrem 1937   | Indonesia        | Coffea robusta Linden, 1900 |
| Rhizoeidae Williams, 1969     |              |                  |                     |
| Benedictyuccina ornata        | Hambleton, 1946 | Trinidad         | Coffea arabica      |
| Capitisetella migrans         | Green, 1933   | Surinam          | Coffea sp.          |
| Coccidella globulosa          | Hambleton, 1946 | Trinidad         | Coffea arabica      |
| Geococcus coffeae             | Green, 1933   | Surinam          | Coffea liberica W. Bull ex Hiern, 1876 |
| Neochavesia caldasiae         | Balachowsky, 1957 | Colombia        | Coffea sp.          |
| Pseudorhizoecus barri         | Caballero & Ramos, 2018 | Colombia | Coffea arabica      |
| Pseudorhizoecus proximus      | Green, 1933   | Surinam          | Coffea sp.          |
| Rhizoecus compotor            | Williams & Granara de Willink, 1992 | Colombia | Coffea sp.          |
| Rhizoecus arabicus            | Hambleton, 1976 | Colombia         | Coffea arabica      |
| Rhizoecus colombiensis        | Ramos-Portilla & Caballero, 2016 | Colombia | Coffea arabica      |
| Rhizoecus coffeae             | Laing, 1925   | Surinam          | Coffea sp.          |
| Rhizoecus divaricatus         | Hambleton, 1976 | Guatemala        | Coffea arabica      |
| Rhizoecus moriliferus         | Green, 1933   | Surinam          | Coffea liberica     |
| Rhizoecus tropicalis          | Hambleton, 1976 | Guatemala        | Coffea arabica      |
| Ropersiella andensis          | Hambleton, 1946 | Colombia         | Coffea arabica      |
| Williamsrhizoecus coffeae     | Caballero & Ramos, 2018 | Colombia | Coffea arabica      |

(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 taxonomic illustration for the species described here 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, C 14 [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       | Abbreviation |
|--------------------|--------------|
| MNHN               | MNHN         |
| UNAB               | UNAB         |

ZOOSYSTEMA • 2021 • 43 (18)
Morphological structures

| Lobe          | Antennal segment |
|---------------|-----------------|
| SannI         | antennal segment I; |
| SannII        | antennal segment II; |
| SannIII       | antennal segment III; |
| SannIV        | antennal segment IV; |
| SannV         | antennal segment V; |
| SannVI        | antennal segment VI; |
| SannVII       | antennal segment VII; |
| SannVIII      | antennal segment VIII; |
| SannIX        | antennal segment IX; |
| SabdI         | abdominal segment I; |
| SabdII        | abdominal segment II; |
| SabdIII       | abdominal segment III; |
| SabdIV        | abdominal segment IV; |
| SabdV         | abdominal segment V; |
| SabdVI        | abdominal segment VI; |
| SabdVII       | abdominal segment VII; |
| SabdVIII + IX | fusion of abdominal segments VIII and IX; |

Cerarii

| Cerarii      | Location |
|--------------|----------|
| C1           | frontal cerarii. |
| C2           | anterior cerarii on prothoracic segment; |
| C3           | posterior cerarii on prothoracic segment; |
| C4           | anterior cerarii on mesothoracic segment; |
| C5           | middle cerarii on mesothoracic segment; |
| C6           | posterior cerarii on mesothoracic segment; |
| C7           | anterior cerarii on metathoracic segment; |
| C8           | posterior cerarii on metathoracic segment; |
| C9           | posterior cerarii on thoracic segment; |
| C10          | anterior cerarii on thoracic segment; |
| C11          | posterior cerarii on thoracic segment; |
| C12          | anterior cerarii on thoracic segment; |
| C13          | posterior cerarii on thoracic segment; |
| C14          | posterior cerarii on thoracic segment; |
| C15          | ocular cerarii; |
| C16          | frontal cerarii. |
| C17          | frontal cerarii. |

SYSTEMATICS

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

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

Pre-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.

Post-mounting specimens

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: SannI 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; SannII 125.5 ± 4.4 (120-133) µm long, 4-5 flagellate setae each 46.7 ± 10.6 (25-62) µm long and apically rounded; and three or four fleshy 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, ss), also 18 flagellate setae each 41.5 ± 11.8 (18-55) µm long and apically rounded (Fig. 2E, ss); ratios SannI/SannII 1.4 ± 0.1 (1.3-1.6), SannIII/SannI 2.6 ± 0.2 (2.2-2.8), SannII/SannIII 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).
Four new scale insects from Colombia

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.
Labium (Fig. 1I). 237.3 ± 6.6 (228-243) µm long and 150.7 ± 8.1 (144-162) µm 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) µm long; coxa 154 ± 10.3 (144-176) µm long, depression not developed; trochanter-femur fused, 470.7 ± 23.1 (428-492) µm long and 142.2 ± 4.4 (138-150) µm wide; tibia-tarsus fused, 594.8 ± 13.2 (569-606) µm long and 55.8 ± 3.1 (51-60) µm wide; claw 62.6 ± 7.8 (57-77) µm 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; 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, two ungual spine-like digitules each 12.3 ± 2.6 (9-16) µm long.

Mid leg. 1376.3 ± 22.6 (1348-1410) µm long; coxa 172.7 ± 8.0 (158-183) µm long, trochanter-femur fusion 492.7 ± 15.8 (470-515) µm long and 147.3 ± 2.4 (144-150) µm wide; tibia-tarsus fusion 643 ± 19.9 (610-660) µm long and 57 ± 5.4 (49-64) µm wide; claw 64.5 ± 3.8 (60-70) µm 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 ungual spine-like digitules each 12.3 µm long.

Hind leg. 1513 ± 29.6 (1485-1554) µm long; coxa 179.8 ± 4.8 (173-188) µm long, trochanter-femur fusion 548.8 ± 20.3 (513-573) µm long and 150.4 ± 3.4 (146-154) µm wide; tibia-tarsus fusion 719.3 ± 33.5 (672-745) µm long and 58.3 ± 2.1 (56-61) µm wide; claw 65 ± 1.4 (64-67) µm 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 ungual digitules spine-like, each 12 µm 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. 1I; 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 .............. N. andreae n. sp.
   — 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. borhidii Kozár & Konczné Benedicty, 2001

*Four new scale insects from Colombia*
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 *Coffee arabica*, whereas *N. vietnamensis* is known only from the Oriental Region (Vietnam) and has no host records.

*Newsteadia andreae* n. sp. also resembles *Newsteadia morrisoni* Kozár & Konczné Benedicty, 2001 but differs in having (*N. morrisoni* characters in parentheses): no groups of quadri-locular pores posterior to the vulva (quadri-locular pores posterior to vulva in groups); a ratio of $S_{III}/S_{II}$ of 3.7 (2.4); two spine-like setae on the trochanter (trochanter without spine-like setae), and each thoracic spiracle peritreme with quadri-locular pores inside (without quadri-locular 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 that 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 spiral with 15–23 quadri-locular 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 setae 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)

---

**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 *Coffee arabica* (Rubiacae) — coffee, manual; : UNAB 4621.

**Paratypes.** Colombia • adult ♀; same data as holotype; marked as “Pará” 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.** — Cirrus absent; ceraria 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 *SabdIII–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 ± 0.95 [12.1–12.9] 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, $S_{abdI}$ [3] (1–3) in marginal and submarginal regions, $S_{abdII}$ [2] (1–2) in submesial region, $S_{abdIII}$ [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 trilocular 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 trilocular 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, F, I, L, M, 5 µm; F, G, 50 µm.
ginal region, $S_{ab/l}$IV [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, $2.9 \pm 0.4$ (2-5) $\mu$m in diameter (Fig. 3D), scarce, evenly scattered; II) with two loculi, $3.5 \pm 0.6$ (3-5) $\mu$m in diameter (Fig. 3E), scarce, absent from $S_{ab/l}$I, $S_{ab/l}$IV and $S_{ab/l}$VIII + IX. Body spicules present on head, prothorax and $S_{ab/l}$III and posterior segments.

**Venter**

**Antennae.** Each $341 \pm 13$ (327-360) $\mu$m long, 7 or 8 segmented (Fig. 3F; 4C); holotype with 7 antennal segments, one antenna with $S_{ant}$IV and $S_{ant}$V partially divided and other one with $S_{ant}$III and $S_{ant}$IV partially divided, segment length and chaetotaxy as follows: $S_{ant}$I 55.3 ± 4.0 (49-61) $\mu$m long, with four flagellate setae; $S_{ant}$II 48.4 ± 6.6 (35-53) $\mu$m long, with six flagellate setae and one placoid sensilla; $S_{ant}$III 36.9 ± 10 (21-51) $\mu$m long with six to eight flagellate setae; $S_{ant}$IV 29.6 ± 13.5 (22-50) $\mu$m long with four or five flagellate setae; $S_{ant}$V 33.0 ± 9.6 (25-50) $\mu$m long with six to eight flagellate setae; $S_{ant}$VI 28.1 ± 2.3 (25-32) $\mu$m long with five or six flagellate setae; $S_{ant}$VII 38.2 ± 1.5 (35-40) $\mu$m long with five to seven flagellate setae and one fleshy seta; and $S_{ant}$VIII 86.7 ± 2.8 (83-92) $\mu$m long with 18-19 flagellate setae and four fleshy setae [holotype with 11 and 15 flagellate setae].

**Eyespot.** $33.7 \pm 2.9$ (29-37) $\mu$m in diameter, not associated with discoidal pores (Fig. 4D).

**Labium.** $126.3 \pm 8.7$ [not measured] (120-132) $\mu$m long.

**Fore leg.** $499 \pm 5.5$ (489-504) $\mu$m long, trochanter + femur $233.5 \pm 3.2$ (230-238) $\mu$m long, femur $74.4 \pm 10.4$ (56-80) wide; tibia + tarsus $235.2 \pm 3.3$ (230-238) $\mu$m long, tibia $35.5 \pm 2.3$ (32-38) $\mu$m wide; claw $30.3 \pm 1.2$ (29-32) $\mu$m long; ratio of lengths of trochanter + femur length/tibia + tarsus 1.0; ratio of trochanter + femur length/femur width $3.2 \pm 0.6$ (2.9-4.2), ratio of tibia + tarsus length/tibia width $6.7 \pm 0.5$ (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 $36.4 \pm 4.7$ (28-39) $\mu$m long; claw without a denticle but with two ungual digitules each $25.7 \pm 1.5$ (24-28) $\mu$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, ungual digitules each 24.0 ± 1.9 (22-26) 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 11 ± 1.8 (8-14) µm long, with one on anterior interanal margin and 1 or 2 in lateral or submarginal regions of abdominal areas lacking setae.

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 SabdVII, 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. 3); 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 SabdI (Fig. 3L).

Oral collar tubular ducts. Each 8 ± 3.6 (5-11) µm long (Figs 3M; 4H), distributed as follows: SabdIII [3] (2-3), SabdIV [18] (12-18), SabdV [20] (16-20), SabdVI [17] (17), and SabdVII [13] (9-13).

Spicules. Present on mesothorax and posterior body segments.

Identification key to new world species of Distichilococcus 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
Paratypes. 12 adult ♀ on 7 slides • 1 ♀ (marked as "Para" shares a
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)

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. Ibáñez
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.

Remark
Dististhlicoccus takumase n. sp. is morphologically close to
$D$. salazari Williams & Granara de Willink, 1992 in lacking
a circular and in having translucent pores on both the hind
femur and tibia. However, $D$. takumase 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 dorsal); and hind legs with translucent pores on
coxa, femur and tibia (pores only on femur and tibia) [char-
acter data of $D$. salazari taken from Williams & Granara de
Willink (1992)].

Etymology. — The specific epithet is in recognition of the abo-
riginal 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 contain-
ing 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; cer-
arian 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.
C₃ [7-8:0] (6-12:0-3), C₄ [4-6:1-2] (4-9:0-2), C₅ [4-5:0] (3-9:0-2), C₀₆ [3-4:0] (3-6:0-1), C₇ [3:0] (2-3:0-2), C₈ [2:0] (1-3:0-2), C₉ [2-3:0] (1-3:0-2), C₁₀ absent, C₁₁ and C₁₂ [2:0] (1-3:0-1), C₁₃ [2:0] (1-5:0-1), C₁₄ [2-3:0] (2-4:0-3), C₁₅ [3:0] (2-4:0-2), C₁₆ [5-6:0-1] (3-8:0-4), and C₁₇ [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) µm long, the longest setae in mesial and submarginal regions, the shortest evenly distributed.

**Trilocular pores.** Each 3-4 µm 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 µm in diameter, similar diameter to or smaller than a trilocular pore (Fig. 5C), distributed from head to S₅abdVI; II) longer type, each 4-5 µm in diameter, wider than a trilocular pore (Fig. 5D) with border stout and sclerotized, distributed in S₅abdVII and S₅abdVIII+IX.

**Spicules.** Present from mesothorax to S₅abdVIII+IX.

**Venter.**

**Antennae.** Each 391 ± 23.7 (351-435) µm 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; S₅antI 69.6 ± 5.7 (57-77) µm long, with four flagellate setae; S₅antII 55.1 ± 3.8 (49-61) µm long, with three to six flagellate setae and one placoid sensilla; S₅antIII 53.8 ± 6.0 (43-65) µm long, with one to five flagellate setae; S₅antIV 30.9 ± 9.7 (17-52) µm long, with one to two flagellate setae; S₅antV 41.2 ± 6.0 (29-57) µm long, with three to five flagellate setae; S₅antVI 44.0 ± 3.6 (38-53) µm long, with two to five flagellate setae and 0 or 1 fleshy seta; S₅antVII 57.0 ± 14.6 (46-101) µm long, with 3-16 flagellate and 0-2 fleshy setae; S₅antVIII 67.8 ± 17.3 (31-90) µm long, with 7-18 flagellate and 0-4 fleshy setae.

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

**Fore leg.** 533 ± 22.3 (504-569) µm long; trochanter + femur 268 ± 12.4 (250-291) µm long, femur 92 ± 8.4 (81-103) wide; tibia + tarsus 221 ± 11 (207-234) µm long, tibia-tarsus union 42 ± 3.7 (36-48) µm wide; claw 44 ± 1.4 (42-47) µm 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 14-25, 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 (50-75) 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 (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 43 ± 4.8 (33-50) µm long, the longest 55 ± 2.5 (50-75) µm.

**Vulvar opening.** Located between SabdVII and SabdVIII.

**Circulus.** Situated across intersegmental line between SabdIII and SabdIV (Fig. 6F), divided by intersegmental line, 130 ± 5.8 (125-135) µm in diameter, evenly distributed (Fig. 5K).

**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_{abd}VIII + 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_{abd}VI to S_{abd}VIII + 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_{abd}IV [0] (0-1), S_{abd}V [3] (8-16), S_{abd}VI [20] (29-34), S_{abd}VII [12] (31-39) and S_{abd}VIII + 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_{abd}V [1] (1-17 pores), S_{abd}VI [25] (25-47) and S_{abd}VII [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_{abd}IV [1] (1-20 ducts), S_{abd}V [52] (52-79), S_{abd}VI [47] (47-61) and S_{abd}VII [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 cerarri ....................................................... 3
   — Thorax with cerarri ........................................................ 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. asporodensis (Foldi & Kozár, 2005)

6. Dorsum with oral collar tubular ducts ........................................................................................................ 6
— 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 ...........
— Hind femur and tibiae with translucent pores; anal ring setae each as long as or longer than diameter of ring ...

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. theobromica (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. pallescens (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 Formicoecoccus. 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 circular 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 cerarias, 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)].
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.
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, subquadrat 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 C₁ [2;4] [1-2;2-6], C₂ [2;4-5] [1-2;2-6], C₃ [2;2-4] [2;1-5], C₄ [2;2] [2;1-3], C₅ [2;1-3] [1-2;1-3], C₆ [2;0-1] [2;4], C₇ [2;1] [2;1-3], C₈ [2;3-1;2] [1-3;0-2], C₉ [2;2] [2;0-3], C₁₀ [2;0-1] [1-3;0-1], C₁₁ [2;1-2] [2;1-3], C₁₂ [2;2-3] [1-2;0-5], C₁₃ [2;1] [1-2;1-4], C₁₄ [2;3-1;3] [1-3;1-3], C₁₅ [2;0-2] [1-2;0-3], C₁₆ [2;3-1;2] [2;4;0-3], C₁₇ [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 C₁ or on SabdIII and posterior segments.

**Oral collar tubular ducts.** Absent.

**Discoidal pores.** Of two types: type I with a single loculus, present in two sizes: I) small, each 2-3 µm in diameter, smaller than a trilocular pore (Fig. 7D), distributed from head to SabdVI; and II) larger, each 3-5 µm in diameter, similar size to, or larger than a trilocular pore (Fig. 7E), distributed in mesial region on all segments. Intersegmental level of C₁ or on SabdIII and posterior segments.

**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: S₁ 61.9 ± 4.3 (55-71) µm long, with four flagellate setae; S₂ 63.6 ± 3.2 (58-69) µm long, with five to eight flagellate setae and one placoid sensilla; S₃ 44.9 ± 3.3 (39-51) µm long, with five to seven flagellate setae; S₄ 30.3 ± 2.8 (23-34) µm long, with three to five flagellate setae; S₅ 36.4 ± 3.7 (31-44) µm long, with six to nine flagellate setae; S₆ 31.3 ± 2.4 (28-35) µm long, with five flagellate setae and one fleshy seta; S₇ 39.0 ± 2.1 (33-43) µm long, with five flagellate setae and one fleshy seta. SabdVIII 86.4 ± 2.8 (79-91) µm long, with 18 flagellate setae and four fleshy setae; ratios S₅/S₁ 1.0 ± 0.1 (0.8-1.2), S₆/S₅ 2.1 ± 0.2 (1.8-2.6), S₇/S₆ 2.0 ± 0.2 (1.7-2.3), and S₈/S₇/S₆/S₅ 2.9 ± 0.3 (2.5-3.7). All same size, each 8.6 ± 0.6 (8-10) µm long.

**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 ungual 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, tarsus 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, ungual 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, ungual digitules similar to those on other legs, each 29.3 ± 2.8 (21-32) µm long.

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

**Anal lobes.** Prominent, not sclerotized, each with apical flagellate setae 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), numbering 5.8 ± 2.7 [3] (2-11), distributed as follows: Sabd[V] [0] (0-1), Sabd[VI] [0] (0-1), Sabd[VII] [0] (0-5) and Sabd[VIII] + IX [3] (1-6).

Discoidal pores. Of two types: I) one type with a single loculus 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 discoidal pores or setae; numbering 1.9 ± 2.3 [7] (0-7) (Fig. 7M), distribution highly variable but absent from Sabd[IV] 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. 8I), numbering 63.1 ± 8.5 [70] (53-71), forming lateral clusters and transverse rows in mid-region as follows: Sabd[III] [2] (0-6), Sabd[IV] [22] (11-26), Sabd[V] [29] (20-33), Sabd[VI] [30] (21-33), and Sabd[VII] [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 (C17) ................................................................. 50
— Ventral OR absent from behind frontal cerarii (C17) ......................................................... 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 ....
— Length of labium 150-160 µm; length of hind tibia+tarsus shorter than length of hind trochanter+femur less than 1 ......................................................... P. luciae n. sp. (in part)

Part II

57. Dorsal OR present behind frontal cerarii (C17) ................................................................. 58
— Dorsal OR absent from behind frontal cerarii (C17) ........................................................... 72

72. Cerarii numbering 17 pairs, with cerarii on SI (C9) well developed ........................................ 73
— Cerarii numbering 16 pairs or fewer, with cerarii on SI lacking or abortive (C9) ..................... 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. calcicolariae (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)

GRANARA DE WILLINK & GONZÁLEZ’S (2018) KEY

23. Eye not associated with discoidal pores ........................................................................ 23a
— Eye associated with discoidal pores ............................................................................. 27

23a. C16 and C17 [C2 and C3 sensu Beardsley (1965)] without sclerotized surfaces ............ P. luciae n. sp.
— At least C17 [C1 sensu Beardsley (1965)] with sclerotized surface .................................. 24
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. abdIV* and posterior segments). *Pseudococcus microcirculus* 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. lycopodi* (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. lycopodi* 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. dyemicus* Gimpel & Miller, 1996, *P. eiroceri* Williams, 1973, *P. microcirculus* McKenzie, *P. neomicrocirculus* Gimpel & Miller, 1996, *P. sorgbiel-

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. dasyliriae* Gimpel & Miller, 1996 and *P. mandoi* 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 takumase 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 circus and the number of cerarii. Until the described species by Williams & Granara de Willink (1992), the genus had only one species with circus 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 takumase n. sp. belongs to the no-circus 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 Cattaenococcus) 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 & Gavrilov-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.

Acknowledgements

The author wishes to thank the Federación Nacional de Cafeteros and its Rural Extension Services; and Centro de Investigaciones del Café – CENICAFE and its researchers, Zulma Nancy Gil and Pablo Benavides, for funding, logistics and field sampling. Thanks are also due to the entomological museum Universidad Nacional Agronómica Bogotá and the Faculty of Agricultural Sciences of Universidad Nacional de Colombia for supplying infrastructure and equipment for this study. Finally, the author gives special thanks to Gillian W. Watson (Department of Life Sciences, The Natural History Museum, London, UK) for reviewing and correcting the manuscript and Danièle Matile for the French translation of the abstract. This research was financed by the Ministerio de Ciencia, Tecnología e Innovación (Colombia, South America) (National Program on Basic Sciences, Grant N°110165843233, contract FP44842-004-2015). The MNHN gives access to the collections in the framework of the RECOLNAT national Research Infrastructure.

REFERENCES

Balachowsky A. S. 1957. — Sur un nouveau genre aberrant de cochenille radicole myrmécophile nuisible au caféier en Colombie. Revue de Pathologie Végétale et d’Entomologie Agricole de France 36 (1): 157-164.

Balachowsky A. S. 1959. — Nuevas cochinillas de Colombia I. Revista de la Academia Colombiana de Ciencias Exactas, Físicas y Naturales 10 (41): 337-361.

Beardsley J. H. 1959. — New species and new records of endemic hawaiian mealybugs (Homoptera: Pseudococcidae). Proceedings of the Hawaiian Entomological Society 16 (1): 39-55.

Beardsley J. W. 1965. — Notes on the pineapple mealybug complex, with descriptions of two new species (Homoptera: Pseudococcidae). Proceedings of the Hawaiian Entomological Society 19 (1): 55-68.

Beardsley J. W. 1970. — Three new species of Chatresia Balachowsky from Tropical America (Homoptera: Coccoide). Proceedings of the Hawaiian Entomological Society 20: 509-520.

Ben-Dov Y. 1994. — A systematic catalogue of the mealybugs of the world (Insecta, Homoptera, Coccoidea, Pseudococcidae and Putoidea): with data on geographical distribution, host plants, biology, and economic importance. UK, Intercept Limited Andover, 686 p.

Caballero A. & Ramos-Porcell A. A. 2018. — Hypogal scale insects (Hemiptera: Coccomorpha) of the coffee agro-system in Chiapea state, Mexico, with description of a new species of Williamsrhizococcus Kozár and Konczné Benedyct (Rhizococcidae). The Journal of Basic and Applied Zoology 79 (41): 1-7. https://doi.org/10.1186/s41936-018-0054-2

Caballero A., Ramos-Porcell A. A., Gil Z. N. & Benavides P. 2018. — Insectos escama (Hemiptera: Coccomorpha) en raíces del Café (Coffea arabica) en Colombia, con registros de asociados ant (Hymenoptera: Formicidae). Ciencia y Tecnología Agropecuaria 20 (1): 93-116. https://doi.org/10.21930/rcta.vol20_num1_art:1250

Cockrell T. D. A. 1902. — Two new mealybugs from New Mexico. The Canadian Entomologist 34 (12): 315-316. https://doi.org/10.4039/Ent34315-12

Danzing E. M. & Gavrilov-Zimin I. A. 2014. — Palearctic mealybugs (Homoptera: Coccinea: Pseudococcidae). Part I Subfamily Phenacococcinae. St. Petersburg, ZIN RAS. 678 p. (Fauna of Russia and neighbouring countries.; New series, N°148).

De Lotito G. 1963. — The mealybugs of South Africa (Homoptera: Pseudococcidae). II. Entomology Memoirs, Department of Agricultural Technical Services, Republic of South Africa 20: 1-30.

De Queiroz K. 2005. — New species of Cataenococcus and Puto from Brazil and Venezuela, with data on other species (Hemiptera, Coccoidea), N.S. Nouvelle Revue d’Entomologie 22 (4): 305-312.

Ehrhorn E. M. 1911. — New Cocciidae with notes on other species. The Canadian Entomologist 43 (8): 275-280. https://doi.org/10.4039/Ent43275-8

Ferris G. F. 1953. — Atlas of the scale insects of North America. The Pseudococcidae (Part II) Vol. VI. California, Stanford University Press, 506 p.

Folli J. & Kozar F. 2005. — New species of Cattaenococcus and Puto from Brazil and Venezuela, with data on other species (Hemiptera, Coccoidea), N.S. Nouvelle Revue d’Entomologie 22 (4): 305-312.

García Morales M., Denno B., Miller D. R., Miller G. L., Ben-Dov Y. & Hardy N. B. 2016. — ScaleNet: A literature-based model of scale insect biology and systematics. Database: 1-5. Available from: http://scalenet.info (accessed 24 September 2020) https://doi.org/10.1093/database/bav118
Four new scale insects from Colombia

Gavrilov-Zimin I. 2018. — Ontogenesis, morphology and higher classification of archaeococcids (Homoptera: Coccinea: Orthezioidae). Zoosystematica Rossica Supplementum 2: 1-264.

Gimpel W. F. & Miller D. R. 1996. — Systematic analysis of the mealybugs in the Pseudococcus maritimus complex (Homoptera: Pseudococcidae). Contributions on Entomology, International 2 (1): 1-163.

Granada de Willink M. C. 2009. — Dysmicoccus de la Región Neotropical (Hemiptera: Pseudococcidae). Revista de la Sociedad Entomológica Argentina 68 (1-2): 11-95.

Granada de Willink M. C. & González P. 2018. — Revisión taxonómica de Pseudococcus Westwood (Hemiptera: Pseudococcidae) de Centro y Sudamérica con descripciones de especies nuevas. Insecta Mundi 0673: 1-117.

Green E. E. 1933. — Notes on some Coccididae from Surinam, Dutch Guiana, with descriptions of new species. Stylops 2 (3): 49-58. https://doi.org/10.10111/j.1365-3113.1993.tb00969.x

Hambleton E. J. 1946. — Studies of hypogaeic mealybugs. Revista de Entomología, Rio de Janeiro 17 (1): 1-77

Hambleton E. J. 1976. — A revision of the New World mealybugs of the genus Rhizoecus (Homoptera: Pseudococcidae). United States Department of Agriculture Technical Bulletin 1522: 1-88.

Hempel A. 1918. — Descripción de sete novas espécies de coccidas. Revista do Museu Paulista 10: 193-208.

Kondo T. 2001. — Las cochinillas de Colombia (Hemiptera: Coc-cocidae). Bista Colombiana 2 (1): 31-48.

Kondo T. 2013. — A new species of Toumeya Cockerell (Hemip-tera: Coccocidae: Coccocidae) on coffee roots, Coffea arabica L. (Rubiacae), from Colombia and Venezuela. Ciencia y Tecnología Agropecuaria. 14 (1): 39-51.

Kondo T., Ramos A. A. & Vergara E. 2008. — Updated list of mealybugs and putoïds from Colombia (Hemiptera: Pseudococcidae and Putoïdae). Boletín del Museo de Entomología de la Universidad del Valle 9 (1): 29-53.

Kozar E. 2004. — Ortheziidae of the World. Budapest, Plant Protection Institute, Hungarian Academy of Science, 525 p.

Laing F. 1925. — Descriptions of two species of Coccidae feeding on roots of coffee. Bulletin of Entomological Research 15 (1): 383-384. https://doi.org/10.1017/S00074853000056157

McKenzie H. L. 1967. — Mealybugs of California with taxonomy, biology and control of North American species (Homoptera: Coccocidae: Pseudococcidae). Berkeley and Los Angeles, University of California Press, 525 p.

Miller D. R. & McKenzie H. L. 1973. — Seventh taxonomic study of North American mealybugs (Homoptera: Coccoidea: Pseudo-coccidae). Hilgardia 41 (17): 489-542. https://doi.org/10.3733/hilg.v41n17p489

Morrison H. 1925. — Classification of Scale Insects of the Subfam-ily Ortheziinae. Journal of Agricultural Research 30 (2): 97-154.

Morrison H. 1952. — Classification of the Ortheziidae: Supple-ment to classification of scale insects of the subfamily Orthezii-nae. United States Department of Agriculture Technical Bulletin 1052: 1-80.

Ramos-Portilla A. A. & Caballero A. 2016. — Rhizoecus colombiensis Ramos & Caballero, a new species of hypogaeal mealybug (Hemiptera: Coccopomorph: Rhizoecidae) and a key to the species of Rhizoecus from Colombia. Zootaxa 4092 (1): 55-68. https://doi.org/10.11646/zootaxa.4092.1.3

Sirsena U. G. A., Watson G. W., Hemachandra K. S. & Wijayagunasekara H. N. 2013. — A modified technique for the preparation of specimens of Sternorrhyncha for taxonomic studies. Tropical Agricultural Research 24 (2): 139-149.

Tang F. D. 1992. — The Pseudococcidae of China. Taigu, China, Shanxi Agricultural University, 768 p.

von Ellenrieder N. & Watson G. 2016. — A new mealybug in the genus Pseudococcus Westwood (Hemiptera: Coccopomorph: Pseudococcidae) from North America, with a key to species of Pseudococcus from the New World. Zootaxa 4105 (1): 65-87. https://doi.org/10.11646/zootaxa.4105.1.3

Watson G. W. & Cox J. M. 1990. — Identity of the African coffee root mealybug, with descriptions of two new species of Planococcus (Homoptera: Pseudococcidae). Bulletin of Entomological Research 80 (1): 99-105. https://doi.org/10.1017/S0007485300045971

Williams D. J. 1969. — A new species of Cataenococcus Ferris (Hom., Coccoidea, Pseudococcidae) on banana in Costa Rica. Bulletin of Entomological Research 59 (1): 101-104. https://doi.org/10.1017/S0007485300030727

Williams D. J. 1985. — Pseudococcus mandio sp. n. (Hemiptera: Pseudococcidae) on cassava roots in Paraguay, Bolivia and Bra-zil. Bulletin of Entomological Research 75: 545-547. https://doi.org/10.1017/S0007485300004644

Williams D. J. & Granada de Willink M. C. 1992. — Mealybugs of Central and South America. London, UK, CAB International, 635 p.

Zhang J. T. & Wu S. A. 2017. — A study of the genus Paraputo Laing, 1929 of China, with description of two new species (Hemiptera, Sternorrhyncha, Coccopomorpha). Zootaxa 709: 57-70. https://doi.org/10.3897/zootaxa.709.15161