

ORIGINAL ARTICLE

Taxonomy and biology of the mealybug genus *Plotococcus* Miller & Denno (Hemiptera: Pseudococcidae) in Brazil, with descriptions of two new species

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Abstract

Two new species of Brazilian mealybugs, *Plotococcus capixaba* Kondo sp. n. and *Plotococcus hambletoni* Kondo sp. n. (Pseudococcidae), are described and illustrated. *Plotococcus capixaba* is a newly recognized pest from the leaves of the jaboticaba tree, *Myrciaria jaboticaba* (Vell.) O. Berg (Myrtaceae), from Espírito Santo and from *Leandra erinacea* Cogn. (Melastomataceae) from São Paulo. *Plotococcus hambletoni* was collected in São Paulo on a myrtaceous plant. A revised key to the species of *Plotococcus* Miller & Denno, and a key to the different growth stages of *P. capixaba* are provided. All female instars are described for *P. capixaba*, but only the adult female is known for *P. hambletoni*. The biology of *Plotococcus* is discussed, with emphasis on *P. capixaba*.

Resumo

São descritas e ilustradas duas novas espécies de cochonilhas encontradas no Brasil: *Plotococcus capixaba* Kondo sp. n. e *Plotococcus hambletoni* Kondo sp. n. (Pseudococcidae). *Plotococcus capixaba* é uma praga recentemente reconhecida nas folhas da jaboticabeira, *Myrciaria jaboticaba* (Vell.) O. Berg (Myrtaceae), no estado do Espírito Santo, e de *Leandra erinacea* Cogn. (Melastomataceae) em São Paulo. *Plotococcus hambletoni* foi coletada em São Paulo, em uma planta da família Myrtaceae. Uma chave revisada para as espécies de *Plotococcus* Miller & Denno, e uma chave para os diferentes estádios de *P. capixaba* são fornecidas. Todos os estádios das fêmeas são descritos para *P. capixaba*, mas somente a fêmea adulta é conhecida para *P. hambletoni*. A biologia de *Plotococcus* é discutida, com ênfase para *P. capixaba*.

Keywords: Brazil, Hemiptera, new species, *Plotococcus*, Pseudococcida

Introduction

About 435 species of scale insects (Hemiptera: Coccoidea) in 14 families have been recorded from Brazil, of which the family Pseudococcidae or mealybugs comes in third place in species richness with 64 species, after the Coccidae or soft scales (159 species) and Diaspididae or armored scales (150 species) (Ben-Dov et al., 2004). A number of mealybug species have been recorded as pests of agricultural and horticultural plants in Brazil. These pests include *Antonina graminis* (Maskell) on grasses, *Saccharicoccus sacchari* (Cockerell) on sugarcane, and several polyphagous mealybugs such as *Dysmicoccus brevipes* (Cockerell), *Ferrisia virgata* (Cockerell), *Geococcus coffeae* Green, *Nipaecoccus nipae* (Maskell),

Planococcus citri (Risso), *Plotococcus minutus* (Hempel), *Pseudococcus comstocki* (Kuwana) and *Pseudococcus longispinus* (Targioni Tozzetti), that attack a variety of fruit crops and ornamental plants (Costa Lima, 1942; Williams & Granara de Willink, 1992). *Plotococcus minutus* has been recorded only from citrus in Brazil (Hempel, 1932; Vernalha, 1953; Williams & Granara de Willink, 1992; Ben-Dov, 1994), but another *Plotococcus* species, *P. neotropicus* Williams & Granara de Willink, which currently is not known from Brazil, occurs on a wide range of host plants in central and South America (Williams & Granara de Willink, 1992).

The mealybug genus *Plotococcus* was erected for *P. eugeniae* Miller & Denno collected from species of *Eugenia* (Myrtaceae), *Ligustrum* (Oleaceae) and

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Nectandra (Lauraceae) in Florida (Miller & Denno, 1977). Williams and Granara de Willink (1992) subsequently transferred *Trionymus minutus* Hempel to *Plotococcus* and described the third species, *P. neotropicus*. The adult females of all *Plotococcus* species have small bodies ranging from 1.2 to 3.0 mm in length and unusually long, slender antennae and legs (Miller & Denno, 1977; Williams & Granara de Willink, 1992). *Plotococcus* appears most closely related to the monotypic Neotropical genus *Macrocepicoccus* Morrison and the Australasian and Oriental genus *Leptococcus* Reyne (Miller & Denno, 1977; Williams, 2004). Mealybugs in these three genera feed on the leaves of their host plants and have similar biology and morphology.

A heavy infestation of mealybugs on the fruit tree jaboticaba, *Myrciaria jaboticaba* (Vell.) O. Berg (Myrtaceae) was noted during 2004 in the municipality of Alfredo Chaves, Espírito Santo, Brazil. The mealybugs were noticed because their presence was associated with copious white waxy material, sooty mold and noticeable symptoms of leaf death and leaf drop. Periodic outbreaks of a pest causing similar symptoms on these trees had been observed prior to 2004, but because the symptoms seemed similar to those caused by *Praelongorthezia praelonga* (Douglas) (Ortheziidae), “ortézia”, a common pest on other crops in this region (Martins et al., 1989; Parra et al., 2003), the outbreaks were attributed to the ortheziid. Specimens were collected in 2004 to verify the identity of the pest. The mealybugs involved were found to belong to a new species of *Plotococcus* Miller & Denno, which is described and illustrated here based on the adult female, third-instar female, second-instar female and first-instar nymph. An identification key to all instars of this new species and information on its field biology and pest status are provided. The new species was compared to *Plotococcus* material deposited in the United States National Museum of Natural History Coccoidea Collection (USNM), where another specimen of the same species was found on a second host, *Leandra erinacea* Cogn. (Melastomataceae). In studying the USNM material, a second undescribed species was recognized and is here described based on the adult female. A revised key to *Plotococcus* is provided to accommodate the two new species.

Materials and methods

Taxonomic methods

Descriptions were based on multiple specimens mounted on microscope slides. Specimens were slide-mounted using the methods of Williams and Granara de Willink (1992), except that xylene was used instead of clove oil. The material studied is listed

as the number of slides with the total number of specimens and the growth stage in parentheses. For example, one slide with three specimens, of which two are adult females and one is a second-instar male, is represented as follows: 1 (3: 2 adult females + 1 second-instar male). This is followed by the collection data and the depositories in parentheses. The instar is not specified when all specimens on the slide(s) are adult females. Measurements were made using an ocular micrometer in a compound microscope. The number of specimens measured for each instar is given in parentheses for each description. Drawings are generalizations of several specimens and were made with the assistance of a camera lucida attached to an Olympus BX40 compound microscope. Each figure shows an entire insect with the venter depicted on the right side of the illustration and the dorsum shown on the left. Special features of the specimen are enlarged to the side of each illustration. The terms used to describe these pseudococcids largely follow those of Williams and Granara de Willink (1992).

In addition to newly prepared slide-mounts, a number of slide-mounted specimens of *Plotococcus* from two museums in the USA were examined. All specimens studied were borrowed from or have been deposited in one of the following institutions: BME: the Bohart Museum of Entomology, Department of Entomology, University of California, Davis, California, USA; MRGC: Museu de Entomologia Professor Ramiro Gomes Costa, FEPAGRO, Porto Alegre, Rio Grande do Sul, Brazil; MZSP: Museu de Zoologia da Universidade de São Paulo, São Paulo, Brazil; UFES: Universidade Federal do Espírito Santo, Vitória, Espírito Santo, Brazil; and USNM: United States National Museum of Natural History Coccoidea Collection, Beltsville, Maryland, USA. An effort was made to designate holotypes from their country of origin, however, no material of one of the two new species was found at the Brazilian Institutions where specimens might have been deposited, i.e., the Instituto Biológico, São Paulo (IBSP) and the MZSP, and thus we have designated the holotype of one species from specimens belonging to the USNM.

Plotococcus material studied for comparison with the new species

Plotococcus eugeniae Miller & Denno: USA: Paratype: 1 (1), Florida, Lignumvitae Key, 18.V.1974, T. Eisner, Exp. No. 755 (BME); 3 (3), Florida, Key Largo, Tavernier, 93600 Overseas Highway, Florida Keys Wild Bird Center, 22.IX.2002, P.J. Gullan (BME).

Plotococcus minutus (Hempel): Brazil: 1 (6), São Paulo, Pinheiros, 19.I.1935, E.J. Hambleton, No. 50-3333 (USNM); 1 (4: 2 adult ♀♀ + 1 third-instar ♀ + 1 adult ♂), São Paulo, Pinheiros, 19.I.1935, E.J.

Hambleton, No. 50-3334 (USNM); 1 (9), locality not given, labeled as *Trionymus*, ex. *R. guyanensis*, No. 72-22-1-35 (USNM); 2 (8: 3 adult ♀♀ + 1 pharate adult ♀ + 3 first-instar nymphs + 1 adult ♂), São Paulo, 28.X.1934, H. Compere, ex. Orange (BME); 2 (18: 8 adult ♀♀ + 2 second instar ♀♀ + 5 first-instar nymphs + 1 adult ♂ + 1 ♂ pupa + 1 second-instar ♂), same data as previous except 27.X.1934 (BME).

Field methods

Field observations and collections of the new species from jaboticaba were conducted by JAV and MPC. The host species, *Myrciaria jaboticaba*, was kindly confirmed by Dr. Luciana Dias Thomaz, UFES, where voucher specimens have been deposited.

Jaboticaba trees infested with this insect were first noticed in a row of approximately 12 trees located along the entrance road of the Instituto Capixaba de Pesquisa, Assistência Técnica e Extensão Rural (INCAPER) research farm Fazenda Experimental de Alfredo Chaves (FEAC), Alfredo Chaves municipality, Espírito Santo, Brazil. Most specimens used for the taxonomic work were collected from foliage samples taken from these trees in March, April, and July 2004. To determine if the species was present in other parts of the state, leaf samples were collected from two other areas: Manguinhos (Serra municipality) and São João de Petrópolis (Santa Teresa municipality), located approximately 100 km north-east and 100 km north, respectively, of the FEAC collection site. These leaf samples were collected and examined from individual trees located at two private homes in Manguinhos, one of which was sampled in July and September 2004 and the other sampled in July 2004 only, and from a home in São João de Petrópolis in July 2004. Samples of leaves from trees at all localities were placed in plastic bags and transported to the INCAPER headquarters in Vitória for examination under a dissecting microscope to remove and preserve specimens and make observations. Additional observations were made at the FEAC site in December 2004.

Results and discussion

Taxonomy

Plotococcus Miller and Denno

Plotococcus Miller and Denno 1972, p.146.

Type species *Plotococcus eugeniae* Miller & Denno, by original designation and monotypy.

Diagnosis (adapted from Miller & Denno, 1972; Williams & Granara de Willink, 1992). Body of

adult female elongate, apex of abdomen protruding. Antennae and legs unusually long in relation to size of body; antennae each with eight or nine segments. Legs with ratio of length of each hind trochanter + femur to width of femur 5.2–8.8; claws long and slender without a denticle. Cerarii numbering 7–17 pairs, each with trilocular pores sparse or crowded; complex cerarii with conical setae, auxiliary setae and usually numerous trilocular pores either present on all body segments or confined to anal lobes or anal lobes plus penultimate segment. Dorsal setae slender, with elevated bases. Multilocular pores present, sometimes on venter only, often of two or three sizes. Trilocular pores present in cerarii, scattered on dorsum or associated with dorsal setae; on venter either absent or restricted to body margins. In *P. capixaba* and *P. minutus*, an additional smaller type of trilocular pore is present in one, or rarely two, small groups on each side of labium. Tubular ducts present, sometimes with indefinite and protruding rims. Simple disc pores present or absent. Circulus present or absent. Ostioles present in one or two pairs. Anal ring apical.

Key to the species of *Plotococcus* based on adult females

(adapted from Williams & Granara de Willink, 1992)

1. Antennae each 9-segmented. All cerarii complex, with conical setae, auxiliary setae and usually numerous trilocular pores.....2
- Antennae each 8-segmented. Complex cerarii present only on anal lobe or anal lobe and penultimate lobe, rest of cerarii each with one or two conical to narrowly-conical to slender setae, with a few trilocular pores and lacking auxiliary setae3
2. Circulus present. Multilocular disc pores all of one size, present on dorsum and venter
..... *neotropicus* Williams & Granara de Willink
- Circulus absent. Multilocular disc pores of two sizes, present on venter only
..... *eugeniae* Miller & Denno
3. Complex cerarii present on last two abdominal segments, with those on other abdominal segments composed of single conical seta and one or two trilocular pores. Large multilocular pores with a protruding central locus, when seen sideways sombrero-like *hambletoni* Kondo sp. n.
- Complex cerarii present only on anal lobes, rest of cerarii composed of one or two slender setae and a few trilocular pores. Large multilocular pores without a protruding central locus.....4
4. Ventral multilocular disc pores around spiracular openings about half size of other pores on thorax,

ratio of width of smaller pores around spiracles to other pores on thorax 0.50–0.67. Dorsal multilocular disc pores scattered throughout dorsum and present near margin *minutus* (Hempel) –Ventral multilocular disc pores around spiracular openings about same size as other pores on thorax or only slightly smaller, ratio of width of pores around spiracles to other pores on thorax 0.86–1.00. Dorsal multilocular disc pores rather few, absent from body margin *capixaba* Kondo sp. n.

***Plotococcus capixaba* Kondo sp. n.**

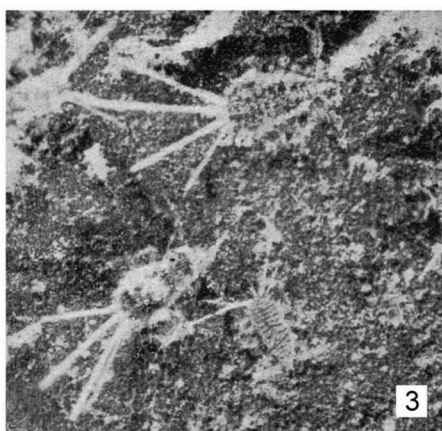
Type material

Holotype: adult ♀, Brazil: Espírito Santo, Alfredo Chaves, INCAPER, Fazenda Experimental de Alfredo Chaves, 15 asl, (20°37'48"S 40°43'48"W), 13.IV.2004, J.A. Ventura, ex *Myrciaria jaboticaba*, 1 slide 2 specimens (1 adult ♀: holotype + 1 second-instar ♂: paratype; holotype clearly labeled on slide) (MZSP). Paratypes: Brazil: 20 slides (32: 15 adult ♀♀

+ 1 third-instar ♀ + 3 second-instar ♀♀ + 9 first-instar nymphs + 1 adult ♂ + 1 pharate adult ♂ + 2 second-instar ♂♂), same data as holotype (BME, MRGC, MZSP, UFES, USNM); 13 (24: 1 adult ♀ + 2 pharate adult ♀♀ + 2 third-instar ♀♀ + 1 pharate third-instar ♀ + 2 second-instar ♀♀ + 2 ♂♂ pupae + 2 ♂♂ prepupae + 1 pharate ♂ prepupa + 6 second-instar ♂♂ + 5 first-instar nymphs) same data as holotype except 6.vii.2004 (BME, MRGC, MZSP, USNM); 1 (3) same data as holotype except 23.iii.2004 (MZSP); 2 (3: 1 adult ♀ + 1 ♂ pupa + 1 adult ♂), Espírito Santo, Serra, Manguinhos, 2 m asl (20°11'34"S 40°12'34"W), 11.VII.2004, M.P. Culik, ex *Myrciaria jaboticaba* (UFES); 1 (4), São Paulo, São Paulo city, 14.I.1935, E.J. Hambleton, ex *Leandra erinacea* (USNM).

Key to the instars of *Plotococcus capixaba* Kondo sp. n. (Figures 1, 2, 4–7)

1. Insect with wings or wing buds
..... adult male and male pupa/prepupa, respectively



Figures 1–3. *Plotococcus* spp. (1) Typical infestation of *Plotococcus capixaba* Kondo sp. n. on underside of leaves of *Myrciaria jaboticabae*; (2) Close-up of *P. capixaba* showing two long terminal waxy filaments with a shorter median filament (photographs 1 and 2 by MPC); (3) *Plotococcus hambletoni* Kondo sp. n. on underside of leaf of a Myrtaceae plant (photograph reproduced from Hambleton (1935): Plate 15, Figure E).

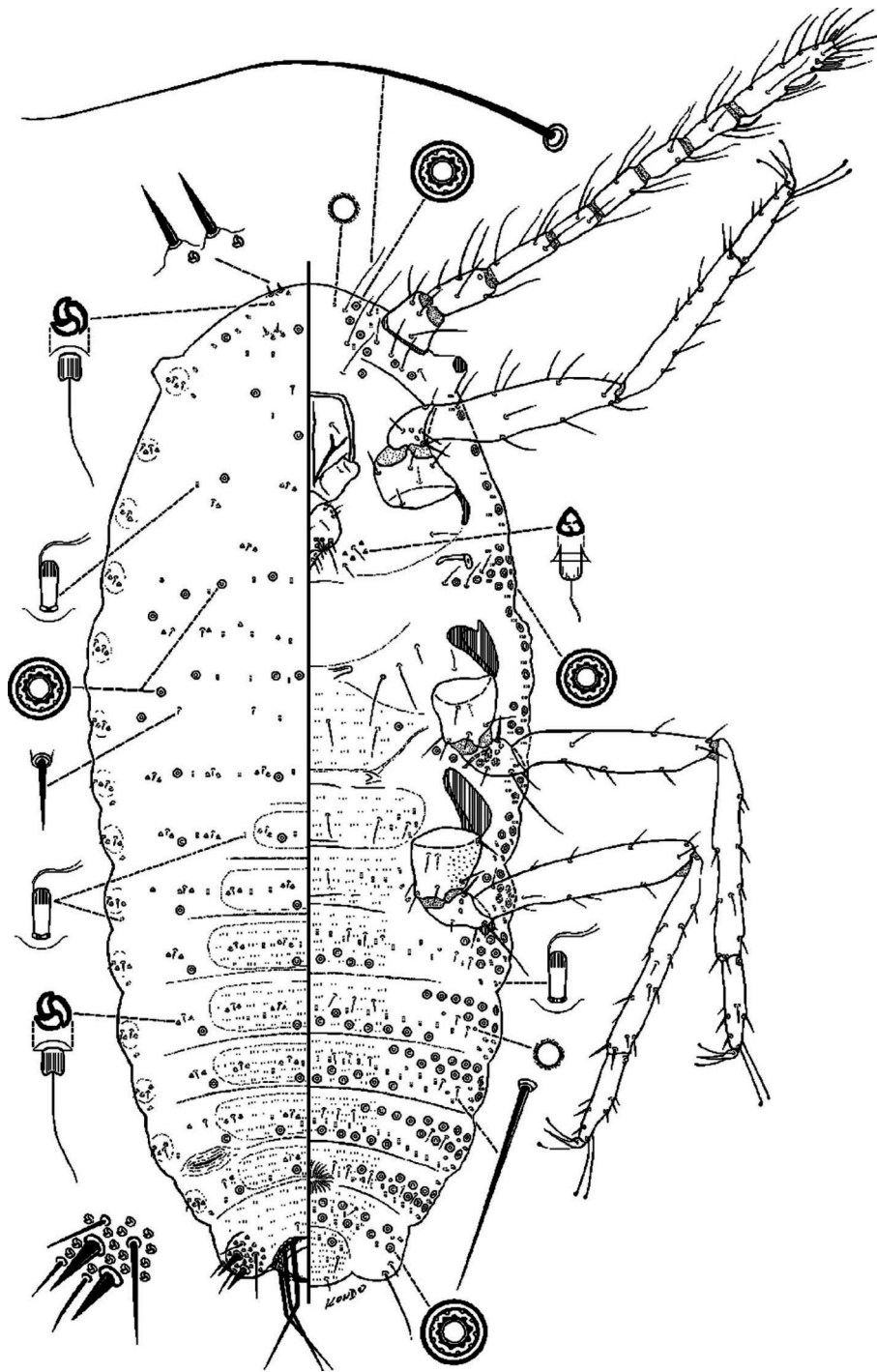


Figure 4. *Plotococcus capixaba* Kondo sp. n., adult female.

– Insect without wings 2
 2. Antennae 6-segmented 3
 – Antennae with 7 or more segments 5
 3. Multilocular disc pores absent
 first-instar nymph*
 – Multilocular pores present 4
 4. Dorsum with a pair of longitudinal parallel rows
 of tubular ducts second-instar male

– Dorsum without tubular ducts
 second-instar female
 5. Antennae 7-segmented. Vulva absent
 third-instar female
 – Antennae 8-segmented. Vulva present
 adult female

*No sexual dimorphism was observed amongst first-instar nymphs of *P. capixaba*.

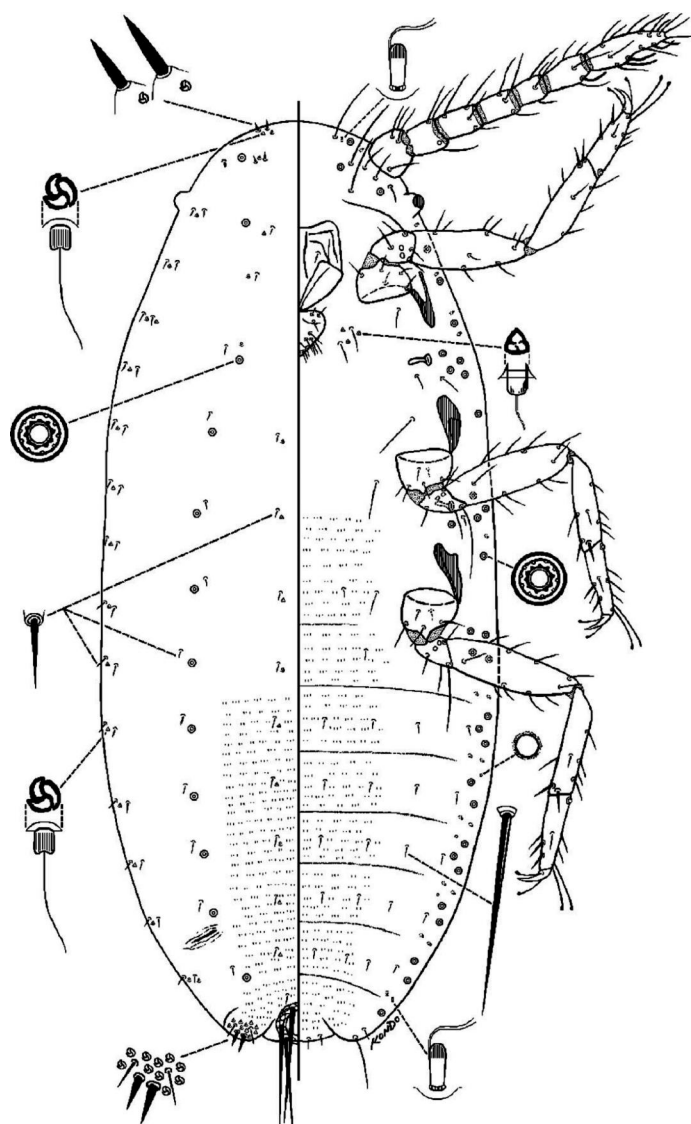


Figure 5. *Plotococcus capixaba* Kondo sp. n., third-instar female.

Field recognition (Figures 1 and 2)

Mealybugs of *P. capixaba* generally occur on the undersides of leaves and secrete large amounts of white, powdery wax that resembles clusters of cotton (Figure 1). Individuals, especially nymphs, are active when disturbed.

Adult females and nymphs: body color generally pale yellow (ranging from pinkish to greenish-yellow), usually lightly covered ("dusted") with white powdery wax (occasionally densely covered with white powdery wax); with a pair of long terminal abdominal wax filaments (usually at least half as long as body) and a shorter apical abdominal wax filament (produced by anal ring) between longer filaments (Figure 2). The most noticeable feature of nymphs and adult females in addition to their unusually small size is the pair of long terminal abdominal wax

filaments that may serve as a field characteristic to distinguish this species from other scale insects that infest jaboticaba.

Eggs: oval, yellow, apparently laid within an ovisac composed of waxy secretions (apparent eggs were observed within waxy secretions at apex of abdomen of sedentary female collected in July 2004).

Males: pupation occurs within a cocoon (a male with wing buds was found in a cocoon from a sample collected in July 2004); winged pinkish-red adult males of typical male mealybug form were observed on infested leaves.

Diagnosis of adult female

Small, with relatively long legs and antennae compared to body size. Antennae 8-segmented. Anal

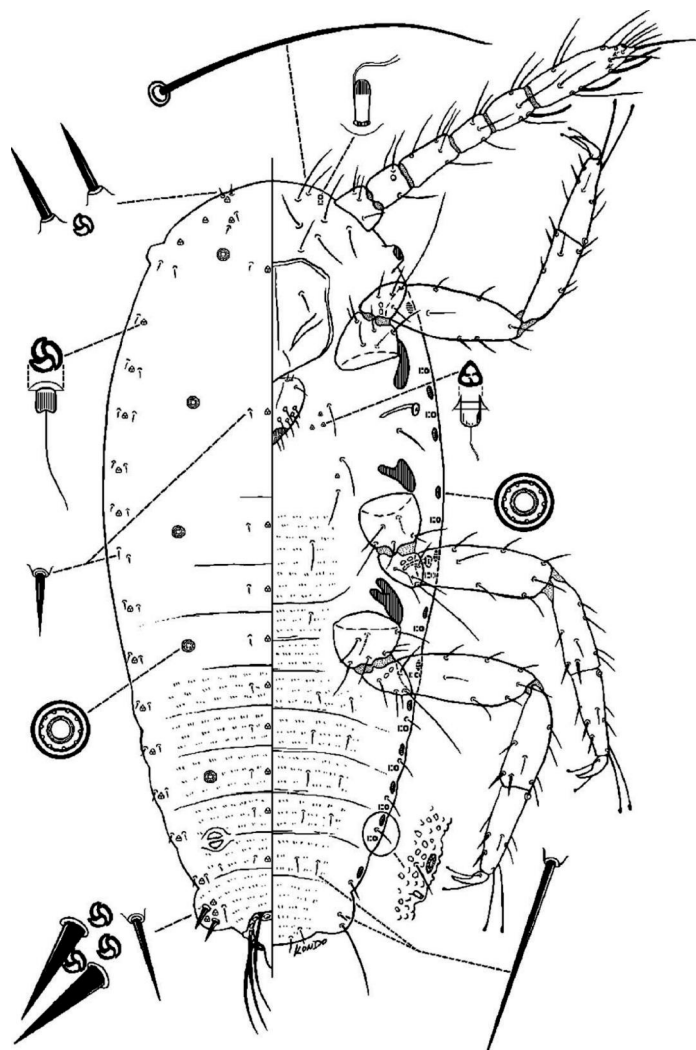


Figure 6. *Plotococcus capixaba* Kondo sp. n., second-instar female.

lobe cerarii complex, rest of cerarii simple, composed of two setae (rarely one) and two trilocular pores; head region with a pair of cerarii located submarginally, just posterior to frontal cerarius. Multilocular pores on venter generally of one size, with pores around spiracles either of same diameter as other pores on venter or only slightly smaller; multilocular pores present on dorsum, but absent from marginal areas. Trochanter on hind legs with a well-developed bifid protrusion. Trilocular pores on dorsum scarce; those on venter different in shape and size, present in one or two small groups laterad to labium and associated with two or more setae. Posterior ostioles present.

Plotococcus capixaba differs from other species of *Plotococcus*, by having complex cerarii in the anal lobe only, a feature only shared with *P. minutus* from which it can be separated by having one size of multilocular disc pores on venter, whereas *P. minutus* has very small multilocular disc pores around the spiracles and larger pores elsewhere.

Description of adult female (Figure 4)

Slide-mounted material ($n = 7$). Body small, elongate oval, 0.7–0.8 mm long, 0.3–0.4 mm wide, abdominal apex protruding, with well-developed anal lobes; segmentation pronounced on abdominal segments. Antennae each 335–405 μm long, with eight segments; apical segment longest, 75 μm long, 18–20 μm wide. Legs long and slender; hind trochanter + femur 180–205 μm long; hind femur 33–35 wide; hind tibia + tarsus 220–240 μm long; claw long and slender, 25–28 μm long, about 8 μm wide at base; claw denticle absent. Ratio of length of hind trochanter + femur to width of femur 5.45–5.86; ratio of lengths of hind tibia + tarsus to hind trochanter + femur 1.17–1.20; ratio of lengths of hind tibia to tarsus 1.86–2.27. Translucent pores minute, present on hind coxa only. Apex of hind trochanter with a bifid protuberance. Spine-like setae present at distal end of tibiae and on tarsi. Clypeolabral shield 88–93 μm long, 73–80 μm

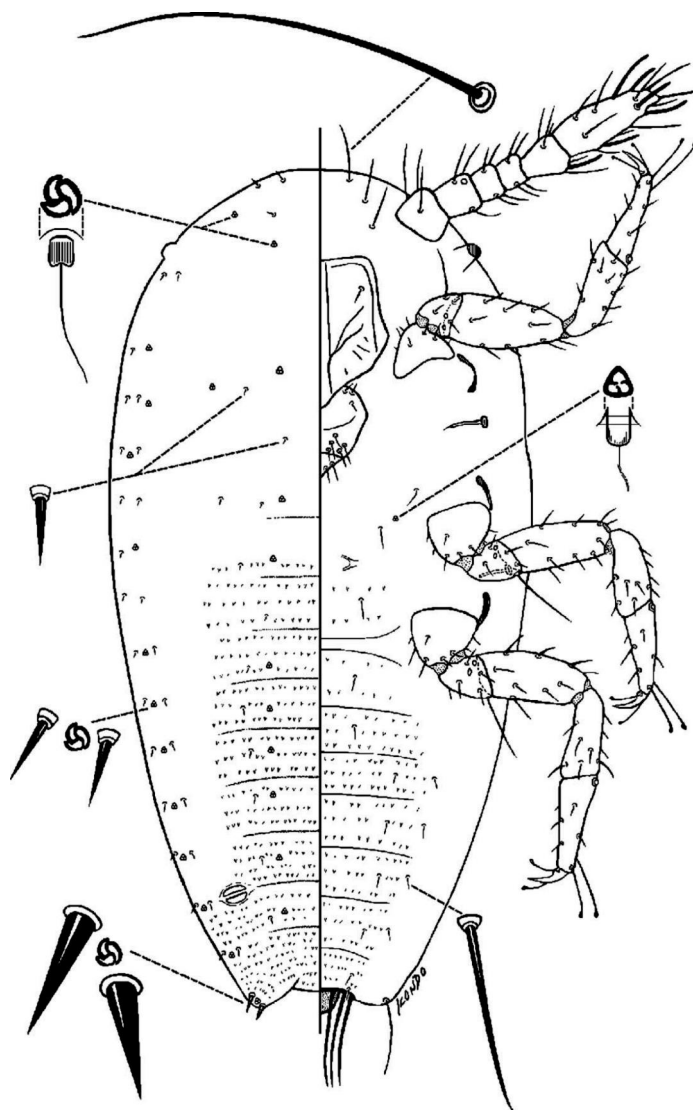


Figure 7. *Plotococcus capixaba* Kondo sp. n., first-instar nymph.

wide. Labium 3-segmented, but segmentation indistinct, 40–63 μm long, 40–50 μm wide; labial setae as follows: two or three pairs on basal segment, one pair on second segment, 6–7 pairs on apical segment. Spiracular peritremes 10–14 μm wide, 25–30 μm long. Circulus absent. Ostioles represented by posterior pair only, as sclerotized slits, lacking pores and setae. Anal ring 53–58 μm wide, with 6 setae, each about 98–113 μm long. Anal lobe seta 58–75 μm long, accompanied by 1–3 short, hair-like ventral setae. Cerarii numbering 17 pairs, including one pair located submarginally on head. Anal lobe cerarii each with two enlarged conical setae, each 15–17 μm long, about four auxiliary setae and a group of trilocular pores, all on an oval slightly sclerotized area. Anterior cerarii each with two small narrowly conical setae or occasionally one seta, each about 5 μm long, accompanied by 1–2 trilocular pores, auxiliary setae lacking; frontal

cerarian setae and submarginal cerarii on head slightly thicker, 7.5 μm long. Eyespots present on margin, each on a protuberance just posterior to antennal scape.

Dorsal surface with small sharply spinose setae, each 5–8 μm long, scattered or in irregular transverse rows on head and thorax, in a segmental transverse row on each abdominal segment except only one pair of setae on VIII. Trilocular pores scarce, usually 1–2 associated with each dorsal seta, each pore about 3 μm in diameter. Multilocular disc pores, each 6.5–7.0 μm in diameter, few, scattered on head, in irregular rows on thorax, in more or less single rows at posterior edges of abdominal segments, absent from dorsal body margin. Discoidal pores not detected on dorsum. Oral collar tubular ducts small, about 2 μm in diameter, 4 μm long, present in more or less single transverse rows on abdominal and thoracic segments, scarce and

scattered on head. Microtrichia present on medial to submedial area of each abdominal segment.

Ventral surface with slender setae, each seta with an elevated setal collar; setae shortest on abdomen, 10–18 μm long; 18–43 μm long on thorax; 23–53 μm long on head. Derm on ventral submargin often rugose on abdomen, but smooth on some specimens. Trilocular pores absent from venter except for one, or rarely two small groups of 3–4 trilocular pores next to labium; each pore about 2 μm wide, different in shape and size from trilocular pores on dorsum. Multilocular disc pores of two or three sizes; largest pores in transverse rows on abdominal segments, each 7.5–8.5 (mostly 8) μm in diameter; rest of multilocular disc pores 6.0–6.5 μm in diameter, present marginally or submarginally on thorax and head; pores around spiracles usually slightly smaller, each about 6.0 μm in diameter. Ratio of smallest to largest multilocular disc pores 0.80–0.86. Discoidal pores few, small, each 2.0 μm in diameter, present on marginal and submarginal areas of abdomen, with an occasional pore on margins of thorax and head. Oral collar tubular ducts, same as on dorsum, in a transverse row on each of abdominal segments III–VIII, in a submedial cluster on metathorax and abdominal segment I medial to hind leg, and in a marginal zone mingled with multilocular disc pores. Microtrichia present on medial to submedial area of each abdominal, mesothoracic and metathoracic segment.

Description of third-instar female (Figure 5)

Slide-mounted material ($n = 3$). Body small, elongate oval, 0.56–0.78 mm long, 0.22–0.35 mm wide; abdominal apex slightly protruding, with well-developed anal lobes; segmentation pronounced on abdominal segments. Antennae each 250–270 μm long, with seven segments, apical segment longest, 70–75 μm long, 20–25 μm wide. Legs normal; hind trochanter + femur 145–150 μm long; hind femur 35–40 μm wide; hind tibia + tarsus 163–165 μm long; claw long and slender, 23–25 μm long, about 7–10 μm wide at base; claw denticle absent. Ratio of length of hind trochanter + femur to width of femur 3.75–4.14; ratio of lengths of hind tibia + tarsus to hind trochanter + femur 1.10–1.12; ratio of lengths of hind tibia to tarsus 1.48–1.56. Translucent pores absent from legs. Spine-like setae present at distal end of tibiae and on tarsi. Clypeolabral shield 78–85 μm long; 70–80 μm wide. Labium 3-segmented, but segmentation indistinct, 45–48 μm long; 43–45 μm wide; labial setae as follows: two pairs on basal segment, one pair on second segment, 6–7 pairs on apical segment. Spiracular peritremes 8–9 μm wide; 23–25 μm long. Circulus absent. Ostioles represented by

posterior pair only, as sclerotized slits, lacking pores and setae. Anal ring 40–43 μm wide, with six setae, each about 70–78 μm long. Anal lobe seta 43–55 μm long, accompanied by 1–3 short, hair-like ventral setae. Cerarii numbering 17 pairs, including one pair located submarginally on head. Anal lobe cerarii each with two enlarged conical setae, each 14–16 μm long, about two auxiliary setae and a group of trilocular pores. Anterior cerarii each with two small sharply spinose setae or occasionally one seta, each about 4–6 μm long, accompanied by one trilocular pore, but penultimate cerarii often with two pores, auxiliary setae lacking; frontal cerarian setae and submarginal cerarii on head slightly thicker, 6–7 μm long. Eyespots present on margin, each on a protuberance posterior to antennal scape.

Dorsal surface with small sharply spinose setae, each 4–5 μm long, scattered or in irregular transverse rows on head and thorax, in a segmental transverse row on each abdominal segment except only one pair of setae on VIII. Trilocular pores scarce, usually 1–2 associated with each dorsal seta, each pore about 3 μm in diameter. Multilocular disc pores, each 6.0–7.0 μm in diameter, present in a single submedial longitudinal row on each side of dorsum, pore numbers variable. Discoidal pores not detected on dorsum. Oral collar tubular ducts absent. Microtrichia present on medial to submedial area of each abdominal segment.

Ventral surface with slender setae, each with an elevated setal collar; setae shortest on abdomen, 8–12 μm long, 11–30 μm long on thorax, 15–45 μm long on head. Derm on ventral submargin often rugose on abdomen, but smooth on some specimens. Trilocular pores absent from venter except for one small group of 3–4 trilocular pores next to each side of labium; each pore about 2 μm wide, different in shape and size from trilocular pores on dorsum. Multilocular disc pores 6.0–7.0 μm in diameter, present marginally or submarginally. Discoidal pores few, small, each 2.0 μm in diameter, present on marginal and submarginal areas of abdomen. Oral collar tubular ducts small, about 2 μm in diameter, 4 μm long, present marginally in pairs on each of abdominal segments II–VIII, on head and thorax singly in a marginal zone mingled with multilocular disc pores. Microtrichia present on medial to submedial area of each abdominal, mesothoracic and metathoracic segment.

Description of second-instar female (Figure 6)

Slide-mounted material ($n = 5$). Body small, elongate oval, 0.39–0.46 mm long; 0.17–0.20 mm wide; abdominal apex protruding; with well-developed anal lobes; segmentation pronounced on abdominal segments. Antennae each 160–185 μm long; with

six segments; apical segment longest; 58–60 μm long, about 20 μm wide. Legs well-developed; hind trochanter + femur 95–100 μm long; hind femur 28–35 μm wide; hind tibia + tarsus 105–118 μm long; claw long and slender, 18–20 μm long, about 6–8 μm wide at base; claw denticle absent. Ratio of length of hind trochanter + femur to width of femur 2.86–3.39; ratio of lengths of hind tibia + tarsus to

hind trochanter + femur 1.11–1.18; ratio of lengths of hind tibia to tarsus 1.10. Translucent pores absent from legs. Spine-like setae present at distal end of tibiae and on tarsi. Clypeolabral shield 58–70 μm long, 60–65 μm wide. Labium 3-segmented, but segmentation indistinct, 33–35 μm long, 33–35 μm wide; labial setae as follows: 1–2 pairs on basal segment, one pair on second segment, 6–7 pairs on

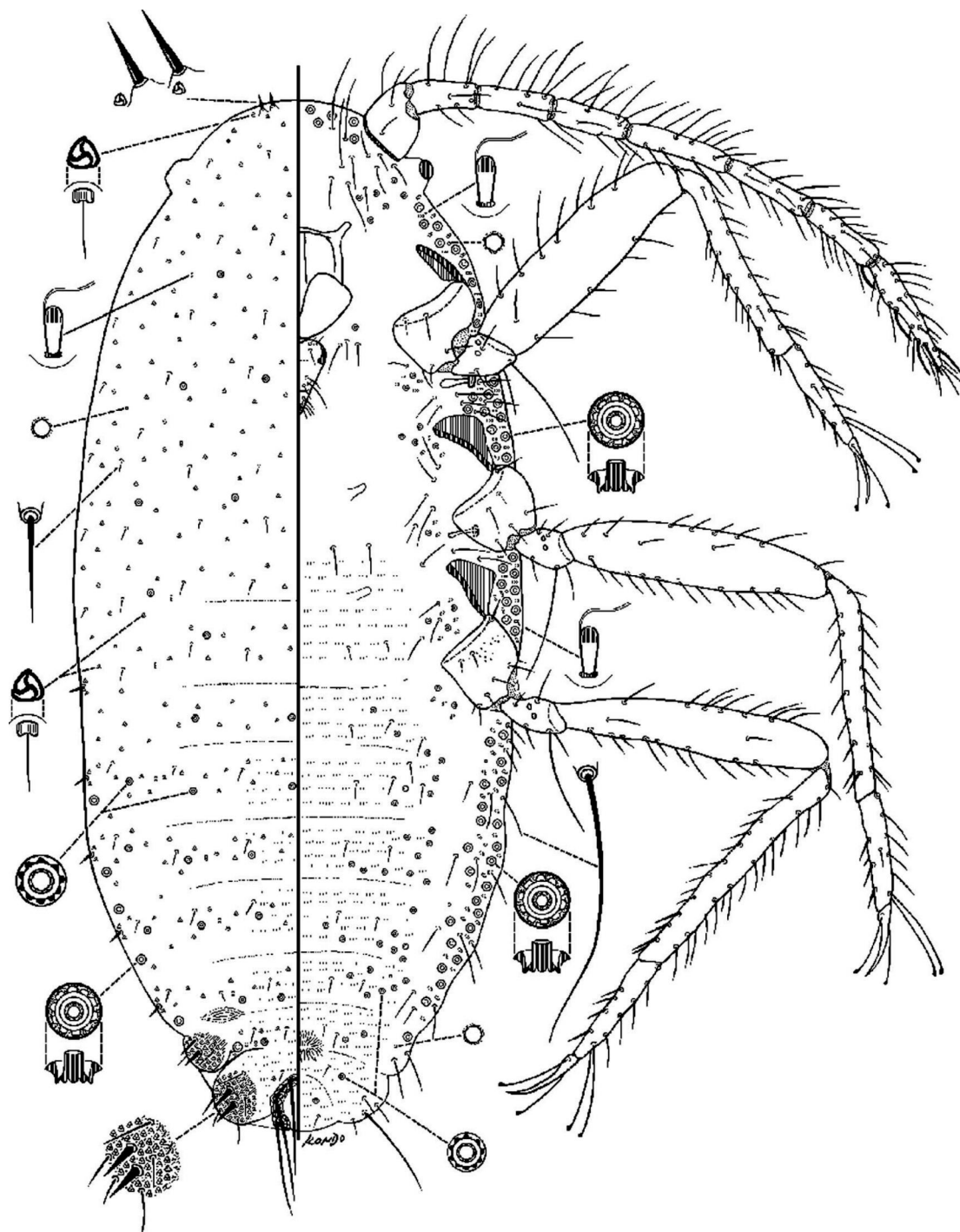


Figure 8. *Plotococcus hambletoni* Kondo sp. n., adult female.

apical segment. Spiracular peritremes 7–8 μm wide, 21–23 μm long. Circulus absent. Ostioles represented by posterior pair only, membranous, lacking pores and setae. Anal ring 33–39 μm wide, with six setae, each about 50–58 μm long. Anal lobe seta 38–45 μm long, accompanied by one short ventral seta. Cerarii numbering 17 pairs, including one pair located submarginally on head. Anal lobe cerarii each with two enlarged conical setae, each 10–13 μm long, with one auxiliary seta and a group of three or four trilocular pores. Anterior cerarii each with two minute sharply spinose setae or occasionally one seta, each about 3–5 μm long, usually accompanied by one trilocular pore, auxiliary setae lacking. Eyespots present on margin, each on a protuberance posterior to antennal scape.

Dorsal surface with small sharply spinose setae, each 4–5 μm long, present in two medial longitudinal rows. Trilocular pores scarce, usually a pore associated with each dorsal seta, each pore about 3 μm in diameter. Multilocular disc pores, each about 6 μm in diameter, present in a submarginal row of 4–6 pores on each side of body. Discoidal pores absent. Oral collar tubular ducts absent. Microtrichia present on medial to submedial area of each abdominal segment.

Ventral surface with slender setae, each with an elevated setal collar; setae shortest on abdomen, 6–8 μm long, 10–35 μm long on thorax, 20–35 μm long on head. Derm on ventral submargin often rugose on abdomen, but smooth on some specimens. Trilocular pores absent from venter except for a small group of 3–4 trilocular pores on each side of labium, and one or two pores between labium and each mesothoracic coxa; each pore about 2 μm wide, different in shape and size from trilocular pores on dorsum. Multilocular disc pores about 6 μm in diameter, present marginally, often in a side-ways position. Discoidal pores absent. Oral collar tubular ducts small, about 2 μm in diameter, 4 μm long, present singly in a marginal zone mingled with multilocular disc pores. Microtrichia present on medial to submedial area of each abdominal, mesothoracic and metathoracic segment.

Descriptions of first-instar nymph (Figure 7)

Slide-mounted material ($n=10$). Body small, elongate oval, 0.30–0.40 mm long, 0.10–0.20 mm wide, abdominal apex protruding, with well-developed anal lobes; segmentation pronounced on abdominal segments. Antennae each 125–133 μm long; with six segments, apical segment longest, 50–53 μm long; about 20 μm wide. Legs well-developed; hind trochanter + femur 70–75 μm long, hind femur 23–25 μm wide, hind tibia + tarsus 83–85 μm long; claw long and slender, 15–18 μm long;

6–8 μm wide at base, claw denticle absent. Ratio of length of hind trochanter + femur to width of femur 3.00–3.04; ratio of lengths of hind tibia + tarsus to hind trochanter + femur 1.13–1.19; ratio of lengths of hind tibia to tarsus 1.65. Translucent pores absent from legs. Clypeolabral shield 55–58 μm long, 50–53 μm wide. Labium 3-segmented, but segmentation indistinct, 30–35 μm long, 33 μm wide; labial setae as follows: 1–2 pairs on basal segment, one pair on second segment, 6–7 pairs on apical segment. Spiracular peritremes 5 μm wide, 20–23 μm long. Circulus absent. Ostioles represented by posterior pair only, membranous, lacking pores and setae. Anal ring 28 μm wide, with six setae, each about 43–53 μm long. Anal lobe seta 30–40 μm long, not accompanied by any ventral setae. Cerarii numbering 16 pairs, those on head region often poorly developed. Anal lobe cerarii each with two enlarged conical setae, each 8–10 μm long, with no auxiliary seta and a single trilocular pore. All other cerarii each with two minute sharply spinose setae or occasionally one seta, each about 3–5 μm long, usually accompanied by one trilocular pore, auxiliary setae lacking. Eyespots present on margin, each on a protuberance posterior to antennal scape.

Dorsal surface with small sharply spinose setae, each 4–5 μm long, present in two medial longitudinal rows, with an extra partial row on thoracic region. Trilocular pores scarce, usually a pore associated with each dorsal seta, each pore about 2.5 μm in diameter. Multilocular disc pores absent. Discoidal pores absent. Oral collar tubular ducts absent. Microtrichia present on medial and submarginal area of meso- and metathorax, and all of posterior segments.

Ventral surface with slender setae, each with an elevated setal collar; setae shortest on abdomen, 6–7 μm long, 8–13 μm long on thorax, 20–25 μm long on head. Trilocular pores absent from venter except for a single pore mesad to each mesothoracic coxa; pore about 2 μm wide, different in shape and size from trilocular pores on dorsum. Multilocular disc pores absent. Discoidal pores absent. Oral collar tubular ducts absent. Microtrichia present on medial to submedial area of each abdominal, mesothoracic and metathoracic segment. Derm membranous throughout, not showing any marginal rugosity as often seen in other stages.

Etymology

This species is named after the region from which this mealybug was first recognized as a new species. Capixaba is an indigenous (Tupi) word for small farms or gardens, now used commonly in Brazil to refer to anything belonging to or of the state of Espírito Santo, and is pronounced “cap - ee - sha - ba”.

Distribution and biology of Plotococcus capixaba sp. n.

After the initial identification of the new species at FEAC, it was found to be present on jaboticaba at one of the two sites sampled in Manguinhos but was not found in the sample collected from São João de Petrópolis. Additional research is needed to verify the extent to which this pest is distributed in Espírito Santo, as well as other parts of Brazil. However, the fact that this new species was relatively easily found with little effort at the second location sampled (Manguinhos) and has also been collected in São Paulo, suggests that the species is common and more widely distributed, especially as jaboticaba is found throughout southern Brazil from Rio Grande do Sul to Minas Gerais (Poppenoe, 1974). In Brazil in the past, most agricultural properties planted jaboticaba trees for their fruit, especially farms and small properties in the vicinity of São Paulo (Lepage & Giannotti, 1943). Thus, *Plotococcus capixaba* may not have been noticed previously because jaboticaba is not generally produced commercially on a large scale and natural infestations of the mealybug may normally remain at low levels. In contrast to the heavy, obvious infestation at FEAC, the infestation at Manguinhos was relatively light with the mealybugs hardly noticeable. Possibly dust from the road next to the trees at FEAC contributed to heavy outbreaks of the pest at this site in contrast to the relatively light infestation observed on the jaboticaba in a home garden at Manguinhos. At both sites where the new species was found, as well as the other sites sampled, the jaboticaba trees apparently receive little or no management (i.e. no pesticide applications). Mealybug mummies with hymenopteran parasitoid exit holes were apparent and the larva of a predatory coccinellid was observed preying upon mealybugs on infested leaves from FEAC, indicating that the mealybugs may be subject to attack by a variety of parasitoids and predators under natural conditions.

Plotococcus capixaba is capable of producing heavy infestations with large, noticeable quantities of white waxy material on the lower surfaces of leaves, resulting in leaf death and extensive leaf drop from trees. The mealybugs do not appear to commonly infest the trunk, branches, or stems of jaboticaba even under conditions of heavy infestations on leaves.

Individuals of *P. capixaba* were never observed to produce honeydew, despite detailed examination of many foliage samples and live mealybug specimens. However, extensive sooty mold (commonly known as “fumagina” in Brazil) appeared to be associated with the *Plotococcus* infestation at FEAC and it is not clear in what way, if any, these mealybugs stimulate the development of the sooty mold. A few whiteflies

(Aleyrodidae) and other scale insects (Diaspididae, Coccidae) also were observed on some of the foliage samples collected in March to July, but these insects were not considered to have contributed significantly to the symptoms of sooty mold and leaf drop because they were present at very low levels in comparison to the mealybugs. However, in December 2004, unripe jaboticaba fruit heavily infested with aphids that were attended by ants was observed at the FEAC site, so perhaps a similar aphid infestation in early 2004 contributed to the sooty mold observed in March to July. Also, in this area it is not uncommon for sooty mold to occur even in the absence of insects, because of high humidity and perhaps other factors (e.g. sugars from ripe fruit). Also, it appears that *P. capixaba* is not attended by ants, based on field observations from infestations in Manguinhos and FEAC, and examination of foliage samples from FEAC. Together these observations suggest that *P. capixaba* feeds from the parenchyma of the leaf, rather than from the phloem.

Live mealybugs of *P. capixaba* are easily disturbed and very active in their movements. This behavior is also characteristic of *P. eugeniae* (Miller & Denno, 1977) and at least one species in the related genus *Leptococcus* (Williams, 2004). High activity is likely to correlate with parenchyma feeding because the stylets of parenchyma-feeding mealybugs can probably be inserted and retracted readily compared with the mouthparts of phloem-feeding mealybugs that must be inserted more deeply into leaves to access the vascular tissue. Most mealybugs feed from the phloem, but parenchyma-feeding has been reported for a few mealybug species (Entwistle & Longworth, 1963; Yadava, 1966) and has been suggested for mealybugs of *Leptococcus tanycnemus* Williams based on high mealybug activity when disturbed and lack of ant attendance (Williams, 2004). In the original description of *P. eugeniae*, adult females, when disturbed, were observed to float through the air like snow flakes (Miller & Denno, 1977), however, this behavior was not observed in *P. capixaba*.

Although *P. capixaba* has been recorded only from *Leandra erinacea* and *M. jaboticaba*, Gomes Costa and Redaelli (1948) reported a mealybug that they tentatively identified as “*Trionymus minutus*?” from a myrtaceous plant called guabijú (*Eugenia pungens* O. Berg.). The field description of the mealybugs given by Gomes Costa and Redaelli (1948) could apply to either *P. capixaba* or *P. minutus*, and without a description of the microscopic characters it cannot be certain which of the two species they found on *E. pungens*, although there have been no confirmed records of *P. minutus* on *Eugenia*. Hambleton (1935) reported *P. minutus* on *Leandra erinacea*, however, this was a misidentification of *P. capixaba*. Silva et al. (1968) listed all three hosts (citrus, guabijú and

L. erinacea) for *T. minutus*, apparently based on Hempel (1932), Hambleton (1935) and Gomes Costa and Redaelli (1948).

At least 23 species of scale insects have been recorded as attacking the jaboticaba tree in Brazil: six of Eriococcidae: *Capulinia jaboticabae* Ihering, *C. crateraformis* Hempel, *Carpochloroides viridis* Cockerell, *Eriococcus lanatus* Hempel, *E. perplexus* Hempel; nine species of Coccidae: *Ceroplastes janeirensis* (Gray), *Edwallia rugosa* Hempel, *Mesolecanium jaboticabae* (Hempel), *Pendularia pendens* Fonseca, *Pseudokermes nitens* (Cockerell), *Pulvinaria eugeniae* Hempel, *Saissetia coffeae* (Walker), *S. discoides* (Hempel), *Stictolecanium ornatum* (Hempel); three species of Pseudococcidae: *Brasiliputo grandis* (Hempel), *Dysmicoccus brevipes* (Cockerell), *Pseudococcus viburni* (Signoret); five species of Diaspididae: *Anidiella eugeniae* (Hempel), *Hemiberlesia rapax* (Comstock), *Melanaspis jaboticabae* Hempel, *Myctaspis personata* (Comstock), *Pseudanidia trilobitiformis* (Green); and one species of Kerriidae: *Tachardiella* sp. (Ben-Dov, 1994; Ben-Dov et al., 2004; Bueno, 1908; Claps et al., 2001; Fonseca, 1927, 1929, 1934, 1936, 1938; Hempel, 1898, 1899, 1900, 1918; Hodgson, 1994; Hoy, 1963; Ihering, 1898; Lepage, 1938; Lepage & Giannotti, 1943; Silva et al., 1968; Williams & Granara de Willink, 1992). [Note: Only valid names have been used in the list, with synonyms not included.] The scale insects *Ceroplastes janeirensis* (Gray) (Coccidae) and *Capulinia jaboticabae* are considered to be key pests of *M. jaboticaba* in Brazil (Picanço et al., 2002). The three mealybug species, *B. grandis*, *D. brevipes* and *P. viburni* recorded from *M. jaboticaba* (Silva et al., 1968), are not known as common pests of this plant in Brazil (Picanço et al., 2002). Our work on *P. jaboticaba* adds a fourth species to the list of mealybugs feeding on jaboticaba in Brazil.

***Plotococcus hambletoni* Kondo sp. n. (Figures 3 and 8)**

Type material

Holotype: adult ♀, Brazil: São Paulo, Jabaquara, 5.i.1935, E.J. Hambleton, ex Myrtaceae? 1 (2) (USNM). Paratype: adult ♀, same slide as holotype (USNM). The holotype is mounted farthest from the original data label and is in the best condition of the two specimens (the body of the paratype is distorted slightly).

Field recognition (Figure 6)

The following text is translated from Hambleton (1935, p. 118), who identified this species only as *Trionymus* sp. and provided a photograph of the live

adult female mealybugs. "This is a small species found on the underside of the leaves of a myrtaceous plant in Jabaquara (São Paulo, January 1935). In life, these insects are surrounded by a flocculent secretion. The body of the adult female is pyriform, yellowish to light brown in color. The caudal filaments of the last 4 to 5 abdominal segments are well-developed, the last two pairs long, reaching twice the length of the body, the extremities (of the waxy filaments) being widely separated. Legs and antennae are extremely long".

Diagnosis of adult female

Small, with relatively long legs and antennae compared to body size. Antennae 8-segmented. Anal lobe and penultimate cerarii complex, rest of cerarii on abdomen composed of a slender conical seta and one or two trilocular pores; cerarii absent from thorax, with a pair of simple frontal cerarii composed of two setae and one or two trilocular pores. Multilocular disc pores on venter generally of two sizes, with pores on median, submedian and submarginal areas much smaller than those on margin. Trilocular pores on dorsum distributed more or less on mid areas of segments; absent on venter. Posterior ostioles present.

Plotococcus hambletoni differs from other species of *Plotococcus*, by having complex cerarii in the anal lobe and penultimate cerarii only, and by having multilocular pores with a protruding central loculus, that make the pores look sombrero-like when viewed sideways.

Description of adult female (Figure 7)

Slide-mounted material ($n = 2$). Body small, elongate oval, 0.92 mm long, 0.35 mm wide, abdominal apex protruding, with well-developed anal lobes; segmentation visible on abdominal segments. Antennae very long, each 600–620 μm long, with eight segments; apical segment longest, 120–125 μm long, 23 μm wide. Legs very long and slender; hind trochanter + femur 300–310 μm long; hind femur 50 wide, hind tibia + tarsus 350–375 μm long; claw long and slender, 53–55 μm long, about 8–10 μm wide at base; claw denticle absent. Ratio of length of hind trochanter + femur to width of femur 6.0–6.2; ratio of lengths of hind tibia + tarsus to hind trochanter + femur 1.17–1.21; ratio of lengths of hind tibia to tarsus 1.92–2.26. Translucent pores minute, present on hind coxa only. Hind trochanter normal, without a bifid protuberance. Spine-like setae present at distal end of tibiae and on tarsi. Clypeolabral shield 108–113 μm long, 93–100 μm wide. Labium 3-segmented, but segmentation indistinct, 63–68 μm long, 58–60 μm wide; labial setae as follows: about

two pairs on basal segment, one pair on second segment, 6–7 pairs on apical segment. Spiracular peritremes 32–33 μm long, 14–15 μm wide. Circulus absent. Ostioles represented by posterior pair only, as membranous slits, lacking pores and setae. Anal ring 58–61 μm wide, with six setae, each about 93–113 μm long. Anal lobe seta 108–114 μm long, accompanied by 3–5 short, hair-like ventral setae. Cerarii numbering 7–8 pairs; anal lobe cerarii each with two enlarged conical setae, each 18–20 μm long, about 3–5 auxiliary setae and a group of trilocular pores, all on an oval slightly sclerotized area; penultimate cerarii well developed, but smaller than anal lobe cerarii. Anterior cerarii on abdomen each with a single, narrowly conical seta and about two trilocular pores, without auxiliary setae; cerarii not detected elsewhere, except for one pair on apex of head, composed of two small, narrowly conical setae, accompanied by 1–2 trilocular pores, auxiliary setae lacking. Eyespots present on margin, each on a protuberance just posterior to antennal scape.

Dorsal surface with slender setae, each 10–12 μm long, scattered or in irregular transverse rows on head and thorax, in a segmental transverse row on each abdominal segment except only one pair of setae on VIII. Trilocular pores scattered, each pore about 3 μm in diameter. Multilocular disc pores of two types: large multilocular disc pores present on margins of abdominal segments, each about 10 μm in diameter, with central loculus protruding, sombrero-like when seen sideways; smaller multilocular disc pores scattered throughout dorsum, absent from body margin, each pore 6–7 μm in diameter. Discoidal pores present near body margin, scarce, each about 2 μm wide. Oral collar tubular ducts scarce, small, about 2 μm diameter, 4 μm long. Microtrichia present on medial area of abdominal segments.

Ventral surface with slender setae, each seta with an elevated setal collar; setae 10–16 μm long on submedian areas, 28–44 μm long on abdominal margin and submargin; 20–53 μm long on thorax, 30–70 μm long on head. Trilocular pores absent. Multilocular disc pores of 2 sizes; large pores present around body margin, absent from anal lobe, each 10–11 μm diameter; small pores present submedially on abdomen, and submarginally near coxal bases and area mesad to eyes, each 5–6 μm in diameter. Ratio of smallest to largest multilocular disc pores 1.83–2.20. Discoidal pores few, small, each 2.0 μm in diameter, present marginally and submarginally. Oral collar tubular ducts, same as on dorsum, present in a marginal zone mingled with large multilocular disc pores, and also mingled with small multilocular disc pores on thorax. Microtrichia present on medial to submedial

area of each abdominal, mesothoracic and metathoracic segment.

Etymology

This species is named after the late coccidologist, Mr. Edson Jorge Hambleton, who first collected the mealybug and recognized it as a congener of *P. minutus* (then *Trionymus minutus*). Mr. Hambleton worked largely in the field of applied entomology, particularly on the pests of cotton, but he had a primary, enduring interest in systematic studies, especially of the Hemiptera (Russell, 1981). He was a world authority on the taxonomy of *Rhizoecus* Künckel d'Herculais and closely related genera of mealybugs.

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