

A New Species of *Paracoccus* Ezzat and McConnell (Hemiptera: Pseudococcidae) from Southern Brazil

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Abstract

The worldwide mealybug genus *Paracoccus* Ezzat & McConnell (Hemiptera: Coccomorpha: Pseudococcidae) has eight described Neotropical species, including two species known from Brazil. In this article, we describe a third species from Brazil: *Paracoccus galzeræ* Pacheco da Silva & Kaydan sp. n., based on the morphology of adult females collected on the roots of *Conyza bonariensis* (Asteraceae) in vineyards in Bento Gonçalves City, Rio Grande do Sul. A revised identification key including the new species is provided for the Neotropical region.

Introduction

Scale insects (Hemiptera: Sternorrhyncha: Coccomorpha) are small sap-sucking insects that occur associated with many plant families worldwide. In the Neotropical region, 1310 species have been recorded, with the families Coccidae, Diaspididae, and Pseudococcidae having the largest number of species and causing the most economic damage (García *et al* 2016).

The family Pseudococcidae, commonly called mealybugs, contains the second-largest number of scale insect species in the world. This family comprises a total of 2020 species, in two subfamilies with 260 genera (García *et al* 2016). In the Neotropical region, 44 genera have been recorded, of which *Pseudococcus* Westwood, *Dysmicoccus* Ferris, and *Phenacoccus* Cockerell are the most speciose (García *et al* 2016). In Brazil, 77 mealybug species have been recorded, with *Pseudococcus* and *Dysmicoccus* having the most species (García *et al* 2016).

Mealybugs are characterized by the presence of waxy and powdery secretions on the body surface. In general, they

have an oval, elongated to rounded body, often dorsoventrally compressed, pinkish to grayish in color, and covered by white powdery wax in life (Cox & Pearce 1983). Mealybugs are pests of many crops in all regions of the world, mostly because they produce honeydew that promotes the development of sooty mold, and also transmit plant viruses (Franco *et al* 2009, Daane *et al* 2012).

Hardy *et al* (2008) and Kaydan *et al* (2015) found that the family Pseudococcidae can be divided into two subfamilies, Phenacoccinae and Pseudococcinae. Adult females of Pseudococcinae are characterized by (i) tarsal digitules apically knobbed, (ii) claws either without denticle or, if present, with denticle poorly developed, (iii) quinquelocular pores usually absent, (iv) antennae generally with eight or fewer segments, and (v) anal ring with setose-like spinules (Hardy *et al* 2008, Kaydan *et al* 2015). In this subfamily, there are 13 genera with oral rim tubular ducts (or mushroom-type tubular ducts): *Atrococcus* Goux (with 26 species), *Brasiliputo* Williams & Granara de Willink (1 species), *Chorizococcus* McKenzie (57 species), *Colombiacoccus* Williams & Granara de Willink (1 species), *Distichlicoccus* Ferris (12 species), part

of *Humococcus* Ferris (17 species), part of *Leptococcus* Reyne (10 species), *Maconellicoccus* Ezzat (8 species), *Moystonia* Williams (2 species), *Paracoccus* Ezzat & McConnell (89 species), *Pseudococcus* Westwood (154 species), *Spilococcus* Ferris (47 species), and *Vryburgia* De Lotto (10 species). The exceptions are two genera that include species with and without oral rim tubular ducts: four species of *Mirococcopsis* Borchsenius and two species of *Iberococcus* Gómez-Menor Ortega have oral rim tubular ducts.

The genus *Paracoccus* differs from other genera sharing oral rim tubular ducts in having an anal lobe bar. The genus is well distributed worldwide, with 23 species in the Afrotropical region, 37 in the Australasian region, 12 in the Oriental region, 3 in the Palearctic region, 18 in the Nearctic region, and 8 in the Neotropical region excluding Mexico, but only 2 species, *Paracoccus ascius* Williams & Granara de Willink and *Paracoccus decorus* Williams & Granara de Willink, in Brazil (Williams & Granara de Willink 1992, García *et al* 2016). At present, three groups of *Paracoccus* are recognized worldwide, the Neotropical, Afrotropical, and Australasian groups (Hardy *et al* 2008). In their worldwide phylogenetic tree, Hardy *et al* (2008) placed these three different groups in three different and unrelated clades (with *Paracoccus nothofagicola* Cox endemic in Australasia, *Paracoccus marginatus* Williams & Granara de Willink and *Paracoccus juniperi* (Ehrhorn) from the Americas, and the type species *Pseudococcus burnerae* (Brain) from the Afrotropical region). Thus, it is likely that *Paracoccus* is not monophyletic, as reported by Hardy *et al* (2008), and further studies are needed to clarify the status of these three zoogeographical groups.

In this study, a new *Paracoccus* species collected on roots of *Conyza bonariensis* L. (Asteraceae) in vineyards in southern Brazil is described and illustrated, based on adult female morphology. We also present an updated identification key to the species of *Paracoccus* found in the Neotropical region.

Material and Methods

Sample collection

Mealybugs were collected on roots of the weed *Conyza bonariensis* (Asteraceae), in a vineyard in Bento Gonçalves City, Serra Gaúcha Region, Rio Grande do Sul, Brazil, in two periods during the years 2014 and 2015. Roots with mealybugs were taken to the laboratory for examination.

Morphological identification

Female adult mealybugs were slide-mounted at the Plant Protection Department of Çukurova University, Adana, Turkey, and Anses, Laboratoire de la Santé des

Végétaux, Montferrier-sur-Lez, France, using the methods proposed by Kosztarab & Kozár (1988) with modifications (using sterile water after KOH to clean the specimens with a fine brush). The specimens were identified using the keys of Williams & Granara de Willink (1992) and Williams (2004).

The slides are stored in the Çukurova University Coccoidea collection, Adana, Turkey (KPTC) and at Anses, Laboratoire de la Santé des Végétaux, Montferrier-sur-Lez, France (ANSES/LSV). The holotype and one paratype are deposited in the Coccoidea Collection of the Museum Ramiro Gomes Costa (MRGC), Porto Alegre, Brazil.

Morphometric methods

The mealybugs were measured, and the main taxonomic characters were quantified under a Leica DM2500 phase-contrast compound microscope. All available material was measured. The morphological terms used here are based on Williams (2004) and Williams & Granara de Willink (1992). All measurements are maximum dimensions (e.g., body width was recorded at the widest part) and are expressed as a range. Tarsal length excludes the claw. Setal lengths include the setal base. Cerarii are numbered after Williams & Granara de Willink (1992), with cerarius 1 being on the head, anterior to the antenna, and cerarius 17 being on segment VIII.

The illustration and description were prepared by MBK and VCPS. The drawing represents a generalized individual based on several specimens used for the description. Each illustration is divided longitudinally, with the left half representing the dorsum and the right half the venter. Structural details are shown as enlargements around the central drawing and are drawn to different scales. Although translucent pores on the hind legs are located mostly on the dorsal surface, they are illustrated ventrally on the main drawing for convenience.

Results

Genus *Paracoccus* Ezzat & McConnell

Paracoccus Ezzat and McConnell 1956: 37. Type species: *Pseudococcus burnerae* Brain, by original designation

Synonym: *Gossypina* Salazar 1972: 293. Type species: *Gossypina glauca* Salazar, by monotypy and original designation

Diagnosis (adapted from Williams & Granara de Willink 1992, Williams 2004): Adult female. Body normally broadly oval, 1.2–4.7 mm long, 1.1–2.3 mm wide. Antennae normally 8-segmented. Labium 3-segmented, always longer than

wide. Circulus present or absent, when present divided by an intersegmental line. Legs well developed, claw without a denticle; translucent pores usually present on hind coxa and tibia. Anterior and posterior ostioles present, anterior ostioles sometimes more weakly developed than posterior pair. Anal lobes usually well developed, each with ventral anal lobe bar. Anal ring typically with 6 anal ring setae.

Dorsum. Cerarii numbering up to 18 pairs (4–18), rarely absent entirely (*Paracoccus reductus* (Ferris)); each cerarius with usually 2 conical setae, except on head or thorax with occasionally 3 or 4 setae; auxiliary setae present on anal lobe cerarii only. Anterior and posterior ostioles present. Dorsal setae short and stiff, flagellate or short flagellate, sometimes slightly curved. Trilocular pores evenly distributed on dorsum, often in a cluster associated with each cerarius. Minute discoidal pores scattered, rarely not observed, of 2 sizes or present mainly on cerarii. Oral rim tubular ducts often present on margins of body, but also present medially and submedially, rarely entirely absent on dorsum. Oral collar tubular ducts rarely present; if present, located on margin of abdominal segments. Multilocular disc pores rarely present (*P. ascius*).

Venter. Body setae flagellate. Trilocular pores evenly distributed. Minute discoidal pores sparse, rarely not observed. Oral rim tubular ducts frequently present. Oral collar tubular ducts of one or more sizes, varying in length and width. Multilocular disc pores present on abdominal segments, seldom on thorax, and rarely on head.

Key to adult females of *Paracoccus* found in the Neotropical region excluding those known only from Mexico

(Adapted from the key prepared by Williams & Granara de Willink (1992))

1. Abdominal cerarii numbering 7 pairs or fewer 2
 - Abdominal cerarii numbering 8 pairs 6
2. Multilocular disc pores present on venter of thorax . . . 3
 - Multilocular disc pores absent from venter of thorax . . . 5
3. Oral rim tubular ducts on dorsum few, present on abdomen only . . . *Paracoccus turriabensis* Williams & Granara de Willink
 - Oral rim tubular ducts on dorsum more numerous, present in rows across thorax and abdomen 4
4. Oral collar tubular ducts of only one size; clusters of oral collar tubular ducts next to anal lobe cerarii absent
 - *P. decorus* Williams & Granara de Willink
 - Oral collar tubular ducts on ventral abdominal segments of two sizes; clusters of oral collar tubular ducts next to anal lobe cerarii present *Paracoccus galzeriae* sp. n.
5. Oral collar tubular ducts present on ventral margins of thorax *Paracoccus lycopersici* Ezzat & McConnell

- Oral collar tubular ducts absent from ventral margins of thorax *Paracoccus solani* Ezzat & McConnell
- 6. Multilocular disc pores present on ventral lateral margins of thorax. *P. ascius* Williams & Granara de Willink
 - Multilocular disc pores absent from ventral lateral margins of thorax 7
- 7. Oral rim tubular ducts absent from dorsum of anal lobe segment 8
 - Oral rim tubular ducts present on dorsum of anal lobe segment
 - . . . *Paracoccus myrtacearum* Williams & Granara de Willink
- 8. Dorsal oral rim tubular ducts present on margins only . . .
 - *P. marginatus* Williams & Granara de Willink
 - Dorsal oral rim tubular ducts present in rows across the segments
 - *Paracoccus herreni* Williams & Granara de Willink

Discussion

Paracoccus galzeriae Pacheco da Silva & Kaydan sp. n. (Figs 1 and 2)

Material studied: *Holotype* adult female: Brazil, Bento Gonçalves, Rio Grande do Sul; S: 29°11'8.96", W: 051°35'25.0"; on *Conyza bonariensis* L. (Asteraceae), 14.iv.2014 and 24.ii.2015, coll: V.C. Pacheco da Silva and Elisangela Caroline W. Galzer, MRGC: 2269. Paratypes: seven adult females, same data as holotype, ANSES/LSV 2 slides, MBK 1 slide, MRGC 1 slide (2270) and 3 slides in the collection of the first author.

Adult female

Appearance in life. Body oval, length up to 2.3 mm at maturity, yellowish, covered in thin layer of white wax (Fig 1). No filaments observed on margin of body

Description. Adult female. Body oval, 1.60–2.35 mm long, 0.90–1.32 mm wide. Eye marginal, 25–35 µm wide. Antenna 8-segmented, 260–370 µm long, with 4 fleshy setae, each 20.0–27.5 µm long; apical segment 75–95 µm long, 22.5–27.5 µm wide, with apical setae 23.5–30 µm long. Tentorium 113–130 µm long, 100–125 µm wide. Labium 3-segmented, 80–95 µm long, 65–78 µm wide. Anterior spiracles 42.5–57.5 µm long, 17.5–25 µm wide across atrium; posterior spiracles 42.5–55.0 µm long, 22.5–30.0 µm wide across atrium. Circulus absent. Legs well developed; length data for posterior legs: coxa 112.5–167.5 µm, trochanter + femur 190–235 µm, tibia + tarsus 205–240 µm, claw 25.0–27.5 µm. Ratio of lengths of tibia + tarsus to trochanter + femur 1.01–1.13:1; ratio of lengths of tibia to tarsus 1.69–2.20:1;

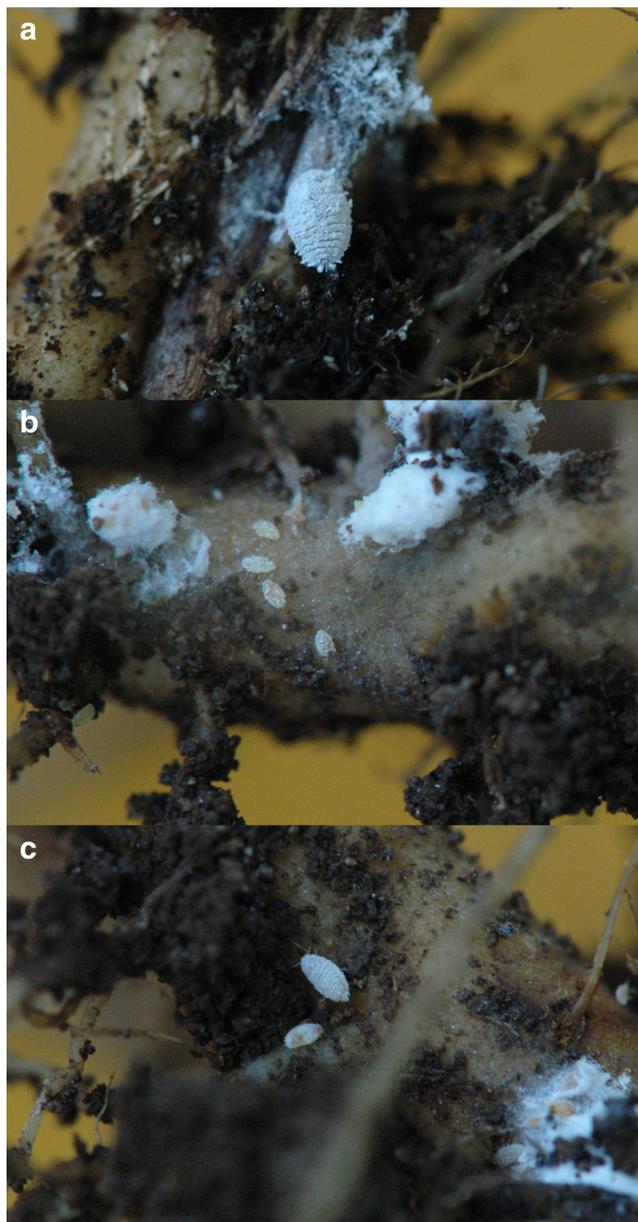


Fig. 1 *Paracoccus galzeriae* Pacheco da Silva & Kaydan sp. n. in life. **A** adult female; **B** first-instar nymphs; **C** second-instar nymphs.

ratio of length of hind trochanter + femur to greatest width of femur 3.62–4.47:1. Tarsal digitules capitate, each 32.5–47.5 μm long. Claw digitules capitate, each 22.5–27.5 μm . Translucent pores present on venter and dorsum of hind coxa and tibia, numbering 106–203 on coxa and 6–17 on tibia. Both pairs of ostioles present; anterior ostioles each with a total for both lips of 14–25 trilocular pores and 2–3 setae; posterior ostioles each with a total for both lips of 12–46 trilocular pores and 3–5 setae. Anal ring 45–60 μm wide, with 6 setae, each seta 85–143 μm long

Dorsum. Derm membranous, with 6–7 pairs of cerarii around body margin, each cerarius with 2 cerarian setae,

12.5–22.5 μm long; cerarius on abdominal segment II weakly developed with cerarian setae more slender than those of more posterior segments. Anal lobe cerarius with 15–20 trilocular pores associated with cerarian setae and 3–5 spine-like auxiliary setae. Dorsal body setae short flagellate, 5–20 μm long, scattered on head and thorax, in single rows on abdominal segments. Trilocular pores 2.5–5.0 μm in diameter, scattered over entire body. Minute discoidal pores 2.0–2.5 μm in diameter, also scattered over entire body. Oral rim tubular ducts totaling 111–141 on dorsum, each duct 8.8–12.5 μm long, 2.5–3.8 μm wide at mid-width, rim of duct opening 2.5–5.0 μm wide and distal width 5–8.8 μm , 31–43 on head and thorax, and all abdominal segments (except last abdominal segment) as follows: I 11–13, II 11–14, III 10–15, IV 12–16, V 10–17, VI 6–9, VII 10–17. Multilocular disc pores on abdominal segments as follows: V 0–6; VI 0–8; VII 2–4, 4–5 μm in diameter

Venter. Setae flagellate, 7–100 μm long, longest setae medially on head. Apical setae of anal lobe 125–160 μm long. Trilocular pores and minute discoidal pores scattered over entire venter. Trilocular pores 2.5–3.8 μm . Oral collar tubular ducts concentrated on body margin and in single rows across all abdominal segments, of 2 sizes: larger ducts, 6.3–10.0 μm long and 2.5–3.8 μm wide in submarginal areas and across abdominal segments; and smaller ducts 5.0 μm long and 2.5 μm wide, across abdominal segments as follows: I–III 7–15 ducts, IV 22–38, V 66–109, VI 83–120, VII 60–87, VIII + IX 13–30. Oral rim tubular ducts totaling 65–73 on venter, absent on head, 22–37 ducts on thorax, and on abdominal segments as follows: I–III 20–28, II 7–11, III 4–8, IV 4–7, V 4–7, VI 5–7, VII 4–12. Multilocular disc pores in rows on abdominal segments as follows: II–III 18–36, IV 34–74, V 81–128, VI 85–109, VII 74–108, VIII + IX 50–76; and 3–12 on thorax and head; each pore 5.0–6.3 μm in diameter

Comments. *Paracoccus galzeriae* is similar to *P. decorus* in (i) lacking a circulus and (ii) having multilocular disc pores present on the venter of the thorax. *P. galzeriae* can be distinguished from *P. decorus* in having (i) two sizes of oral collar tubular ducts on the ventral abdominal segments (one size in *P. decorus*), (ii) clusters of oral collar tubular ducts next to the anal lobe cerarii (absent in *P. decorus*), and (iii) oral rim tubular ducts on the dorsal head (absent in *P. decorus*). *P. galzeriae* is closest to *P. solani* in (i) having two sizes of oral collar tubular ducts on the ventral abdominal segments, (ii) lacking oral collar tubular ducts on the ventral margins of the thorax, and (iii) having oral rim tubular ducts in rows across most abdominal segments of dorsum. However, *P. galzeriae* can be readily distinguished from *P. solani* in having (i) multilocular disc pores on the dorsum (absent in *P. solani*), (ii) multilocular disc pores on the venter of the thorax and on

mealybugs develop, and/or the feeding site on the plant (roots versus stems or crowns) can affect the number of oral collar tubular ducts, multilocular disc pores, and other pores on the body surface (Charles *et al* 2000, Cox 1983; Marotta & Tranfaglia 1995), the positions of the features are important to delineate the taxa. Although the number of multilocular disc pores can change with environmental conditions, the position of the pores is consistent in each species.

Distribution. Brazil, Rio Grande do Sul State, Bento Gonçalves City

Host plant. *Conyza bonariensis* L. (Asteraceae)

Etymology. This species is named after one of the collectors, Elisângela Caroline Weber Galzer (Embrapa Grape and Wine, Bento Gonçalves, RS, Brazil).

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