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A New Mealybug Species (Hemiptera: Coccoidea: Pseudococcidae) from the Ant-Plant *Hydnophytum* sp. (Rubiaceae) in Fiji

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Abstract. The adult female of a new species of Fijian mealybug, *Neosimmondsia hydnophytum* **n. sp.,** from inside the domatium of a species of the ant-plant genus *Hydnophytum* (Rubiaceae: Rubioideae: Psychotrieae) is described. A key is provided to the adult females of the species of *Neosimmondsia* Laing.

INTRODUCTION

Twenty-three species of mealybugs (Pseudococcidae) have been recorded from Fiji (Ben-Dov *et al.,* 2007). Some are cosmopolitan pests, e.g. *Pseudococcus longispinus* Targioni Tozzetti, *Ferrisia virgata* (Cockerell), and *Planococcus minor* (Maskell), but fourteen species are known only from islands in the south Pacific. Of these, five species are known only from Fiji: *Fijicoccus casuarinae* Williams &Watson; *Leptococcus gralator* Williams & Watson; *Paracoccus dendricola* Williams & Watson; *P. trichospermi* Williams & Watson; and *Paraputo aracearum* Williams. In August 2006, myrmecologist Philip S. Ward collected mealybugs from inside an ant-plant in the genus *Hydnophytum,* while collecting in mossy rainforest along an old logging track on Viti Levu, Fiji. These mealybugs represent an undescribed species, sharing several features with the south Pacific genus *Neosimmondsia* Laing.

The genus *Neosimmondsia* was erected by Laing (1930) for a single species, *N. hirsuta* Laing, found feeding on coconut (*Cocos nucifera*) in the Solomon Islands (Malaita). Takahashi (1939) described a second species, *N. esakii*, which feeds on palms and *Pandanus* on the Micronesian island Pohnpei (formerly Ponape) in the Caroline Islands (Beardsley, 1966). Williams (1960) redescribed and illustrated *N. hirsuta*, and Williams & Watson (1988) provided a key to the adult females of the 2 species of *Neosimmondsia.* The two described species of *Neosimmondsia* are characterized by having (1) the dorsum strongly convex; (2) the body outline nearly circular; (3) very poorly developed anal lobes with sclerotic areas on the ventral surface; (4) a dorsal anal ring with 6 setae, positioned ca. its own length from the margin; (5) antenna 6-segmented; (6) well-developed legs; (7) claw without a denticle; (8) anterior and posterior ostioles present; (9) recognizable cerarii absent; and (10) oral collar ducts and multilocular pores restricted to the venter. The undescribed species from *Hydnophytum* sp. shares all but 3 of these features: (1) the antenna is 7-segmented; (2) the anal ring has 10–12 setae; and (3) cerarii are present.

Species of *Hydnophytum* are part of a clade of myrmecophytic epiphytes that have domatia in the form of a multi-chambered tuber. The chambers have entrance holes for the

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ants, and regions lined with "warts," which are able to absorb nutrients from ant refuse piles (Huxley, 1978). Huxley & Jebb (1991) placed the genera *Anthorrihiza*, *Hydnophytum, Mymecodia*, *Mymephytum*, and *Squamellaria* in the subtribe Hydnophytinae (Rubiaceae: Rubioideae: Psychotrieae); however, the classification of this group lags far behind current phylogenetic knowledge. Nepokroeff *et al.* (1999) found the extremely diverse *Psychotria* (1000–1500 described species) to be broadly paraphyletic with respect to more than ten genera, including those comprising Hydnophytinae. Hydnophytine ant-plants are distributed from Thailand to Fiji, with the highest diversity in Papua New Guinea. The only previous record of a scale insect from a hydnophytine ant-plant is *Psoraleococcus browni* Lambdin & Kosztarab (Lecanodiaspididae) from a species of *Mymecodia* in Papua New Guinea (Lambdin & Kosztarab, 1988). This pit scale also apparently lives inside the tuber of the host plant in association with ants, but the identity of the ants is not known.

Here I describe and illustrate the adult female of a new species of *Neosimmondsia*, the sixth mealybug species known only from Fiji, and the second scale insect known to feed on a hydnophytin ant-plant. I also revise the generic description of *Neosimmondsia* to include this new species and provide an updated key to the adult females of the species of *Neosimmondsia*.

MATERIALS AND METHODS

Freshly collected specimens were slide-mounted, with one female per microscope slide. The slide-mounting method of Gullan (1984) was used. Measurements were made using an ocular micrometer attached to a compound microscope. Values given for leg segments are lengths in µm. The morphological terms for Pseudococcidae follow those of Williams (1985). Draft illustrations were prepared with a drawing tube and then scanned and edited on a Macintosh computer using the Adobe programs Photoshop CS and Illustrator CS. Following the convention for scale insects, each figure displays the dorsal body surface on the left side of the page, and the ventral surface on the right; however, since the adult females of this new *Neosimmondsia* species are highly convex, the lateral-most areas of the dorsum, including the marginal fringe and cerarii, are shown on the right side of the figure. Enlargements of diagnostic features are located around the margin of the main figure; the sizes of these structures are provided in the text. The holotype adult female and one paratype third-instar female have been temporarily placed in the Bernice P. Bishop Museum, Honolulu (BPBM), and later will be deposited permanently in the Fiji National Insect Collection, Suva. Two further paratypes (one adult female and one third-instar female) have been deposited in the Bohart Museum of Entomology, University of California, Davis, California (BME). Specimens of the new species were compared with the published descriptions of the other two species of *Neosimmondsia* (Takahashi 1939; Williams 1960; Williams & Watson 1988) and with four slide-mounted specimens of *N. esakii* on one slide, labelled as follows: "Neosimmondsia / esakii Tak. / Ninani, Ponape I. / Caroline Is. / Aug. 1, 1950 / P. A. Adams / #1" (BME).

SYSTEMATICS

Neosimmondsia Laing

Neosimmondsia Liang, 1930: 19; Williams 1960: 414; Beardsley 1966: 420. Type species *Neosimmondsia hirsuta* Liang, by original designation and monotypy

Generic description. Body outline of slide-mounted female subcircular to circular. Antenna 6- or 7-segmented. Claw without denticle. Circulus rectangular. Anterior and posterior pairs of ostioles present. Anal ring dorsal, situated ca. its own length from margin, bearing 6–12 setae. Trilocular pores abundant. Multilocular pores present on venter. Tubular ducts restricted to venter. Cerarii present or absent, if present, each cerarius containing 2–5 small conical setae. Translucent pores restricted to hind coxae, which are more or less enlarged. Anal lobes weakly developed, each with distinct, broad sclerotization on ventral surface. Feeding on palms or inside tubers of *Hydnophytum* in the tropical south Pacific.

KEY TO ADULT FEMALES OF SPECIES OF *NEOSIMMONDSIA* LAING
(modified from Williams & Watson, 1988)

1. Marginal fringe of numerous elongate, flagellate setae present; trilocular pores concentrated along margin; multilocular disc pores only present on venter of abdomen 2
–. Marginal fringe of elongate flagellate setae absent; trilocular pores not concentrated along margin; multilocular disc pores present on ventromedial areas of both thorax and abdominal segments ..... **hirsuta** Laing
2. Antenna 7-segmented; cerarii, each containing 2–5 short conical setae, present along margin in addition to elongate flagellate setae .... **hydnophytum** Hardy, **sp. n.**
–. Antenna 6-segmented; cerarii absent, only elongate flagellate setae present along margin ..... **esakii** Takahashi

Neosimmondsia hydnophytum Hardy, **new species**
(Fig. 1)

Type. Fiji. Holotype adult female from FIJI: **Viti Levu**: 1.75 km SE of Waimoque Settlement, 17°40'S, 178°00'E, 850 m, ex nest of *Pheidole* sp., *knowlesi* complex, ants inside tuber of *Hydnophytum*, 28.viii.2006, P.S. Ward, accession #15763 (BPBM). Paratypes. 1 adult female (BME) and 2 third-instar females [1 slide BPBP, 1 slide BME (DNA voucher NH121)], same data as holotype.

Description. Adult female (n = 2): Body strongly convex, outline circular; length of slide-mounted adult female 1.9–2.0 mm (holotype 2.0 mm), greatest width 1.6–2.0 mm (holotype 2.0 mm). Anal lobes very poorly developed, but each with conspicuous ventral sclerotization. Eyes each ca. 40 µm wide. Antenna 7-segmented; length 485–580 µm; with 3 or 4 hair-like setae on segment I, 7–13 hair-like setae on segment II, 7–10 hair-like setae on segment III, 9 or 10 hair-like setae on segment IV, 6 or 7 hair-like setae on segment V, 5–7 hair-like setae + 1 fleshy seta on segment VI and 13–17 hair-like setae + 4 fleshy setae on segment VII. Tentorial box 370–410 µm long, ca. 350 µm wide. Labium 3-segmented, 325–350 µm long, ca. 170 µm wide, with 3 pairs of hair-like setae on basal segment, 1 pair of hair-like setae on medial segment, and 5 pairs of hair-like setae + 4 pairs of fleshy setae on the apical segment. Spiracles each 120–145 µm long, 70–90 µm wide across atrium. Circulus rec-

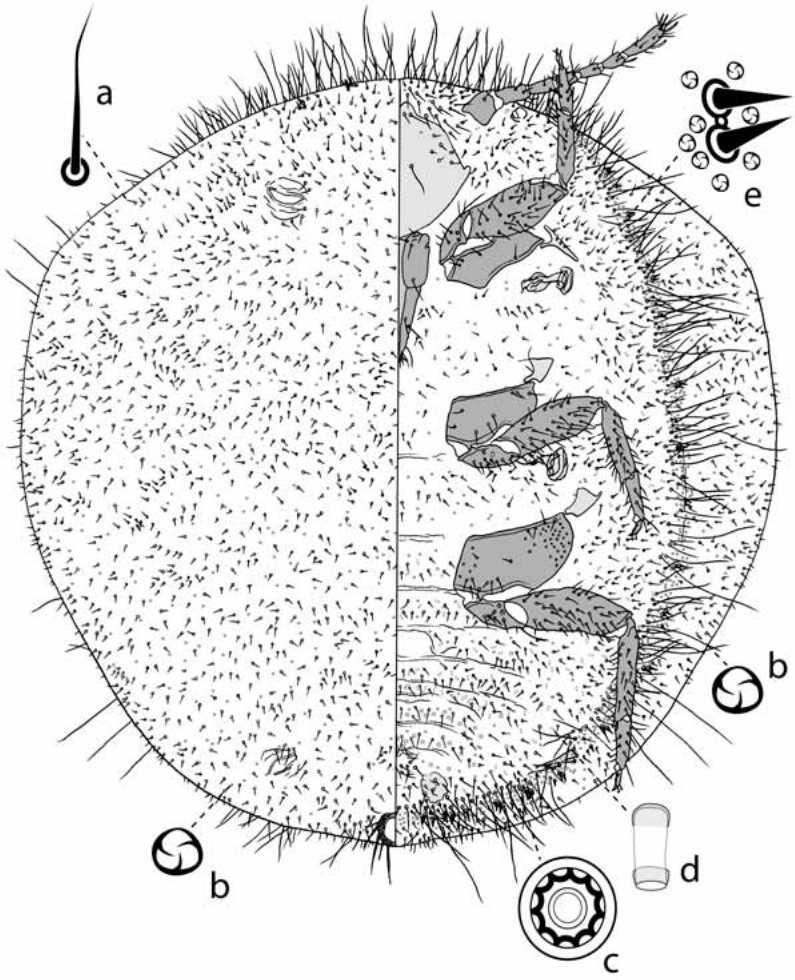

Figure 1. Adult female of *Neosimmondsia hydnophytum* sp. n.: (**a**) dorsal seta; (**b**) trilocular pore; (**c**) multilocular pore; (**d**) oral collar duct; (**e**) cerarius.

tangular, ca. 75 µm long and ca. 200 µm wide, located between abdominal segments III and IV. Legs increasing in size caudad; fore legs: coxa ca. 125 µm, trochanter + femur 310–380 µm, tibia 185–225 µm, tarsus 115–125 µm; mid legs: coxa ca. 145 µm, trochanter + femur 330–420 µm, tibia 195–230 µm, tarsus 120–130 µm; hind legs: coxa ca. 170 µm, trochanter + femur 380–445 µm, tibia 235–260, tarsus 130–150 µm; all legs each with: claw 45–55 µm long; tarsal digitules each 45–65 µm long, with minute apical knob, claw digitules each 40–50 µm long, with well-developed apical knob; coxa with 12–19 setae, trochanter with 16–23 setae, femur with 50–70 setae, tibia with 40–45 setae, tarsus with 15–20 setae. Translucent pores restricted to hind coxae, each with 100–150 pores on dorsal surface and 60–80 pores on ventral surface, each pore minute, ca. 1 µm wide. Ostioles each ca. 75

μm wide, with inner margins of lips sclerotized, each lip with ca. 15 trilocular pores and 10–15 setae. Anal ring 105 μm wide, with 10–12 anal ring setae, each 40–105 μm long.

Dorsum. Derm membranous, delimited by dense marginal fringe of elongate flagellate setae; longest marginal setae each ca. 350 μm long, most marginal setae each 100–150 μm long. Dorsal setae (Fig. 1a) flagellate, each 20–80 μm long, scattered uniformly over dorsum. Trilocular pores (Fig. 1b) each ca. 3 μm in diameter, scattered over dorsum, concentrated along margin near bases of elongate marginal setae. Cerarii numbering 18 pairs; each cerarius containing 2–5 conical setae, each ca. 12 μm long; each anal lobe cerarius containing 4–5 conical setae in transverse row surrounded by dense concentration of ca. 70 trilocular pores; anterior cerarii (Fig. 1e) on abdomen and thorax each containing 2–3 conical setae, cerarii on head each with 3–4 conical setae; a number of small conical setae present along margin in addition to those in cerarii.

Venter. Ventral setae each 10–125 μm long, covering entire venter. Multilocular pores (Fig. 1c) each ca. 9 μm in diameter, with ca. 11 loculi, confined to medial areas of posterior abdominal segments. Trilocular pores similar to those on dorsum, densely distributed over venter. Oral collar ducts (Fig. 1d) each ca. 8 μm long with dermal opening ca. 3 μm in diameter and with oral collars ca. 2 μm long, distributed in transverse rows across abdominal segments anterior to multilocular pores, and throughout margin and submargin.

Etymology. The species name is taken from that of its host plant. It is a noun in apposition.

DISCUSSION

The adult female of *Neosimmondsia hydnophytum* is superficially most similar to that of the Micronesian species *N. esakii*, in that both species have a dense marginal fringe of setae and trilocular pores, and multilocular pores are restricted to the ventroposterior abdominal surface. Adult females of *N. hydnophytum* can be distinguished from those of *N. esakii* by the presence of cerarii (absent in *N. esakii*); 7-segmented antennae (6-segmented in *N. esakii*); ventral oral collar ducts present in transverse bands across abdominal segments anterior of the multilocular pores and scattered along the margin and submargin (ventral oral collar ducts confined to submedial clusters on posterior abdominal surface in *N. esakii*); and relatively small ostioles, each ca. 75 μm wide, each lip with ca. 15 trilocular pores and 10–15 setae (ostioles in *N. esakii* are each ca. 230 μm wide, each lip with ca. 50 trilocular pores and ca. 30 setae). Adult females of *N. hydnophytum* will not key properly in the key to genera of tropical south Pacific Pseudococcidae provided by Williams & Watson (1988), because their key relies on a concept of *Neosimmondia* in which all the species lack cerarii.

The DNA of *N. hydnophytum* was sequenced as part of a phylogenetic study of the Pseudococcidae (N.B. Hardy, unpublished data) and *N. hydnophtum* is part of the tribe Pseudococcini (Downie & Gullan, 2004). The other species of *Neosimmondsia* were not available for sequencing.

In his field notebook, P.S. Ward noted that in the same large (30 cm diameter) plant of *Hydnophytum* in which the mealybugs were associated with the brood of *Pheidole* sp., *knowlesi* complex, he found ants of three other species, *Campanotus maudella s.l., C. vitiensis,* and *Tetramorium pacificum*. The plant was growing on a partially-felled tree. He also opened four other plants of *Hydnophytum* sp. at the same locality and found ants of various species in three of them, but no further mealybugs, including none in another nest of the same *Pheidole* species as his collection #16763 that housed the mealybugs described above.

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LITERATURE CITED

Beardsley, J.W. 1966. Insects of Micronesia, Homoptera: Coccoidea. *Insects of Micronesia* **6:** 377–562.

Ben-Dov, Y., Miller, D.R. & Gibson, G.A.P. 2001. ScaleNet, Scales in a Country Query Results. 8 May 2007. Available at: http://www.sel.barc.usda.gov/scalenet/scalenet.htm.

Downie, D.A. & Gullan, P.J. 2004. Phylogenetic analysis of mealybugs (Hemiptera: Coccoidea: Pseudococcidae) based on DNA sequences from three nuclear genes, and a review of the higher classification. *Systematic Entomology* **29:** 238–259.

Gullan, P.J. 1984. A revision of the gall-formingcoccoid genus *Apiomorpha* Rubsaaman (Homoptera: Eriococcidae: Apiomorphinae). *Australian Journal of Entomology Supplemental Series* **97:** 1–203.

Huxley, C.R. 1978. The ant-plants *Myrmecodia* and *Hydnophytum* (Rubiaceae), and the relationships between their morphology, ant occupants, physiology and ecology. *New Phytologist* **80:** 231–268.

———**. & Jebb, M.H.P.** 1991. The tuberous epiphytes of the Rubiaceae 1: A new subtribe – the Hydnophytinae. *Blumea* **36**: 1–20.

Laing, F. 1930. A new genus and two new species of Coccidae from the Solomon Islands. *Bulletin of Entomological Research* **21:** 19–21.

Lambdin, P.L. & Kosztarab, M. 1988. *Psoraleococcus browni*: a new species of pit scale from Papua New Guinea (Homoptera: Coccoidea: Lecanodiaspididae). *Annals of the Entomological Society of America* **81:** 724–727.

Nepokroeff, M., Bremer, B. & Sytsma, K.J. 1999. Reorganization of the genus *Psychotria* and the tribe Psychotrieae (Rubiaceae) inferred from ITS and rbcL sequence data. *Systematic Botany* **24:** 5–27.

Takahashi, R. 1939. Some Aleyrodidae, Aphididae, and Coccidae from Micronesia (Homoptera). *Tenthredo* **2:** 234–272.

Williams, D.J. 1960. The Pseudococcidae (Coccoidea: Homoptera) of the Solomon Islands. *Bulletin of the British Museum (Natural History), Entomology* **8:** 387–430.

———**.** 1985. *Australian mealybugs*. British Museum (Natural History), London, 431 pp.

———**. & Watson, G.W.** 1988. *The Scale Insects of the Tropical South Pacific Region, Part 2, The mealybugs (Pseudococcidae)*. C.A.B. International, Wallingford, UK. 260 pp.