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## Description of the immature stages of *Kuwanina betula* Wu & Liu, with a discussion of its placement in the Acanthococcidae family group (Hemiptera: Coccoidea)

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### Abstract

The immature stages of *Kuwanina betula* Wu & Liu are described and illustrated. Based on morphological and molecular data (18S and 28S rDNA), it is argued that *K. betula* is closer to *Pseudochermes* Nitsche than to *Kuwanina* Cockerell in Fernald and so this species is transferred to *Pseudochermes* as *P. betula* (Wu & Liu) **comb. nov.**

**Key words:** Cryptococcidae, immature stages, new combination.

### Introduction

The scale insects (Hemiptera: Sternorrhyncha: Coccoidea) are small, sap-sucking true bugs sister to the Aphidoidea. The common name, scale insects, refers to the protective cover or “scale” (generally waxy) that is secreted by many species. Nearly 8000 species in approximately 50 extant and extinct families have been described in the superfamily and these include many important agricultural pests (Miller & Davidson, 1990) and invasive species (Miller *et al.*, 2005). In addition, many species exhibit varied endosymbioses (Buchner, 1965; Gruwell *et al.*, 2005, 2007), diverse sexual systems (Nur, 1980; Normark, 2003; Ross *et al.*, 2010) and sexual dimorphism (Gullan & Kosztarab, 1997). The Coccoidea are frequently divided into two informal groups, the archaeococcoids and the neococcoids (reviewed by Gullan & Cook, 2007), with the former usually considered to include 15 extant families and the latter 18 extant.

However, the relationships of the families within the neococcoids is not well resolved. Almost all authors agree that the eriococcids are not monophyletic (Cook *et al.*, 2002; Hodgson, 2002; Cook & Gullan, 2004; Gullan & Cook, 2007; Hodgson & Hardy, 2013). Phylogenetic analysis of 18S data (Cook & Gullan, 2004) recovered four groups within Eriococcidae; (i) a clade including Beesoniidae, Stictococcidae and the eriococcid taxa *Cylindrococcus* Maskell, *Eriococcus buxi* (Boyer de Foscolombe), and *E. williamsi* Danzig, generally referred to as the BSE clade; (ii) a Gondwanan group comprising Australian and New Zealand taxa; (iii) an acanthococcid group comprising species allied to *Acanthococcus* from both the northern and southern hemispheres plus the Dactylopiidae; and (iv) just *Calycicoccus* Brain. This paper considers the relationships of *Kuwanina betula* Wu & Liu within these groups of “eriococcids”.

The classification of taxa in the superfamily Coccoidea has been based primarily on morphological characteristics of the adult females. Little work has been done on the immature stages. Preliminary results showed that the taxonomy of the immature stages is helpful in determining relationships among taxa (Howell & Tippins, 1990), especially for groups with highly modified adult females. The adult female of *K. betula* was described by Wu and Liu (2009) based on material collected from Henan Province, China, on *Betula albosinensis* Burkill (Betulaceae), and it has reduced antennae and legs. Nan *et al.* (2013) provided its 18S and 28S rDNA sequences. In 2012, more material, including nymphs, was collected from the Shennongjia Forest Region [31°30'N, 110°10'E], Hubei Province, and Baiyun Mountain [34°08'N, 112°05'E], Henan Province, also on *Betula albosinensis*. The purpose of this paper is to describe the immature stages (first- and second-instar female nymphs) and, based on the

setal collar about 1/3 length of seta and a circular base, distributed in 6 longitudinal rows on dorsum. Disc pores and ducts absent.

**Margin.** Bottle-shaped setae, same size as on dorsum, distributed along margin from mesothorax to abdominal segment VII.

**Second-instar female (Fig. 3). Unmounted material.** Body oval, about 0.50 mm long, 0.26 mm wide, red, with many long white wax filaments (each about 2/3 length of body) along its margin.

**Mounted material.** Body oval, gently tapering to narrow posterior segments, 0.50–0.54 mm long and 0.28–0.33 mm wide. Antennae 3-segmented, short, length of each segment: I, 11–12 µm, II, 7–8 µm, and III, 16–19 µm; segment III with 4 fleshy setae and a pair of coeloconic sensilla. Eyespots present. Clypeolabral shield about 2 times as long as labium; labium 1 segmented, 43–48 µm long, with 6 pairs of setae. Front and mid legs absent, each hind leg replaced by a sac-like structure, about 36–37 µm long and 17–26 µm wide, with many translucent pores on ventral surface. Thoracic spiracles: each anterior spiracle with 7–9 disc pores, mainly with 5 loculi but occasionally with 4 or 7 loculi, and each posterior spiracle with 9–11 quinquelocular pores. Anal ring located at end of body, 14–15 µm in diameter, with 1 outer row of pores and 6 short setae, each about 10 µm long, surrounded by an inverted U-shaped sclerotized plate bearing 4 pairs of enlarged setae, longest seta up to 12 µm long, shortest about 5–6 µm long; also with 2 enlarged setae, each about 10 µm long behind anal ring and beyond sclerotized plate. Anal lobes slightly produced, each with a pair of apical setae, dorsal seta about 10 µm long, ventral setae about 7 µm long.

**Venter.** Ventral setae hair-like, 3–8 µm long, scattered on head and thorax and forming a transverse row on each abdominal segment except setae on segment VII thicker and longer. Disc-pores mainly with 5 loculi but occasionally with 4 or 7 loculi, each pore 4 µm in diameter, distributed throughout venter except medially. Macrotubular ducts (Wu & Liu (2009) described these ducts as invaginated disc pores) of 2 sizes: large ducts, each about 16 µm long and 7–8 µm wide and with about 14 pores at inner orifice of outer part in a ring around base, distributed in more or less a single longitudinal row along margin; and smaller ducts, each about 9 µm and 4–5 µm wide; with 4 pairs near labium.

**Dorsum.** Dorsal setae stoutly setose, each 2–6 µm long, scattered on head and thorax and forming a transverse row on each abdominal segment except those on last segment thicker and longer. Disc-pores generally with 5 loculi but occasionally with 3, 4 or 7 loculi, same size as ventral disc-pores, distributed throughout dorsum, but most abundant near margin. Macrotubular ducts of 1 size, similar to ventral large ducts, in a longitudinal row along margin and with a single duct on midline of abdominal segments III–VII.

**Biology.** This species may be parthenogenetic and ovoviviparous since no second-instar males, prepupae, pupae or adult males have been detected.

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