



## A new ortheziid (Hemiptera: Coccoidea) from Australia associated with *Acropyga myops* Forel (Hymenoptera: Formicidae) and a key to Australian Ortheziidae

JOHN S. LAPOLLA<sup>1</sup>, CHRIS BURWELL<sup>2</sup>, SEÁN G. BRADY<sup>3</sup> & DOUGLASS R. MILLER<sup>4</sup>

<sup>1</sup>Department of Biological Sciences, Towson University, 8000 York Road, Towson, Maryland 21251, USA.

E-mail: jlapolla@towson.edu

<sup>2</sup>Biodiversity Program, Queensland Museum, P.O. Box 3300, South Brisbane 4101, Queensland, Australia.

E-mail: chris.burwell@qm.qld.gov.au

<sup>3</sup>Department of Entomology and Laboratories of Analytical Biology, Smithsonian Institution, 4210 Silver Hill Road, Suitland, Maryland 20746, USA. E-mail: bradys@si.edu

<sup>4</sup>Systematic Entomology Laboratory, Agricultural Research Service, U.S. Department of Agriculture, Beltsville, Maryland 20705, USA. E-mail: dmiller@sel.barc.usda.gov

### Abstract

A peculiar new genus of Ortheziidae is described from Queensland, Australia. *Acropygorthesia williamsi* LaPolla & Miller, **n. gen. & sp.** was discovered in two localities in the nests of *Acropyga myops*. Descriptions and illustrations are provided for the adult female, adult male, first-instar nymph, prepupa, and pupa; descriptions only are provided for the second- and third-instar nymphs. Prior to this study, *Acropyga* ants were known to enter into trophobiotic relationships only with mealybugs (Hemiptera: Pseudococcidae). Therefore, this study represents the first non-mealybug association between a scale insect and *Acropyga*. The new ortheziid genus has a number of unusual morphological attributes: no definite wax plates; no ovisac; an anal ring lacking setae and pores, located dorsally in the middle of the abdomen; simple, large metasternal and mesosternal apophyses; numerous spines over the body, and various instars that are so similar that they are difficult to separate. These characteristics may represent adaptations to its relationship with ants. A key is provided to the Australian Ortheziidae.

**Key words:** mealybug, trophobiosis, trophophoresy

### Introduction

We report here the first non-mealybug trophobiotic association of ants in the genus *Acropyga* Roger (Hymenoptera: Formicidae). Investigations of nests of *Acropyga myops* Forel in Australia led to the discovery of a morphologically peculiar new ortheziid genus that is apparently a trophobiont of the ants. Ortheziids are best known for their adornment with thick wax patches or plates that cover most of their body and a thick waxy ovisac that is attached to the body of the adult female (Miller, 1991). There have been only scattered reports of ortheziids associated with ants. For example, *Orthezia olivacea* Cockerell has been found in the nest of a *Lasius* sp. (Cockerell, 1905) and *Orthezia occidentalis* (Douglas) has been found in a nest of *Formica integra* Nylander in Colorado (Morrison, 1925). More specifically, associations of ortheziids with *Acropyga* were first suggested by Bünzli (1935) when he found *Mixorthesia reynei* (Laing) (formerly *Ortheziopa reynei*) living in *Acropyga* nests in Brazil. Interestingly, a single specimen of this same ortheziid species was collected along with mealybugs from a nest of *Acropyga ayanganna* LaPolla from Guyana (LaPolla, 2004; Williams, 2004). Whether or not it was associated with the *Acropyga* is unclear, but given Bünzli's observations it is certainly possible.

The trophobiotic relationships of *Acropyga* and mealybugs (Hemiptera: Pseudococcidae) are well documented, but despite many observations of mealybugs and ants together, the details of their interactions remain poorly understood (LaPolla, 2004). The most spectacular aspect of the relationship between *Acropyga* and their trophobionts is that virgin queens emerge from nests carrying a mealybug for their mating flight and subsequent colony founding, a behavior termed trophophoresy (LaPolla *et al.*, 2002). Most *Acropyga*-associated mealybugs belong in the subfamily Rhizoecinae, tribe Xenococcini, including the genera *Eumyrmococcus* Silvestri, *Neochavesia* Williams & Granara de Willink, and *Xenococcus* Silvestri (Williams, 2004). All of these genera appear to be obligate myrmecophiles with trophophoresy having been observed in several species (LaPolla, 2004).

*Acropyga* species have been reported with several additional mealybugs: *Capitisetella* Hambleton, *Dysmiococcus* Ferris, *Geococcus* Green, *Pseudorhizoecus* Green, and *Rhizoecus* Künckel d'Herculais (summarized from Johnson *et al.*, 2001 and LaPolla, 2004), but only in *Geococcus* (Bünzli, 1935) and *Rhizoecus* (Williams and LaPolla, 2004; Smith *et al.*, 2007) has trophophoresy been confirmed. *Acropyga myops* has been found previously only associated with *Eumyrmococcus taylori* Williams (Williams, 1998; LaPolla, 2004). Interestingly, this same mealybug also is reportedly associated with *Acropyga pallida* (Donisthorpe) (Johnson *et al.*, 2001).

This paper reports the discovery of a morphologically peculiar new genus and species of ortheziid that appears to be associated with *A. myops*. We describe and illustrate the adult female, adult male, first-instar nymph, prepupa and pupa of this ortheziid; we also include descriptions of the hypothesized second- and third-instar nymphs. We provide a key to the Australian species of Ortheziidae, and discuss possible morphological adaptations of the new ortheziid for living with *A. myops*.

## Material and methods

Specimen preparation follows the procedures given for the Sternorrhyncha at the Systematic Entomology Laboratory web site (Anonymous, 2006). Terminology in the descriptions follows that of Miller and Kozár (2002). Measurements and numbers are given as a range. The illustrations follow the format given by Miller and Kozár (2002), with the right half showing details of the venter and the left half those of the dorsum. Spines are so abundant on this species that actual numbers could be as much as 10 times greater than that shown on the drawing.

Depositories of specimens are: Australian National Insect Collection, CSIRO Entomology, Canberra, Australia (ANIC); Bohart Museum of Entomology, University of California, Davis, California, United States (BME); The Natural History Museum, London, United Kingdom (BMNH); Queensland Museum, Brisbane, Australia (QMBA) (holotype depository); United States National Entomological Collection, U.S. National Museum of Natural History, Beltsville, Maryland, United States (USNM).

## Systematic treatment

Ten species of ortheziids are known at present from Australia (Kozár 2004):

*Acropygorthezia williamsi* LaPolla & Miller, **n. gen. & sp.**

*Insignorthezia insignis* (Browne)

*Newsteadia australiensis* Kozár & Konczné Benedicty

*N. endroedyi* Kozár & Konczné Benedicty

*N. gullanae* Kozár & Konczné Benedicty

*N. martini* Kozár & Konczné Benedicty  
*N. tasmaniensis* Kozár & Konczné Benedicty  
*Nipponorthezia tasmaniana* Kozár & Konczné Benedicty  
*Nipponorthezinella guadalcanalia* (Morrison)  
*Orthezia urticae* (Linnaeus)

### Key to Australian Ortheziidae (based on adult females)

- 1a. Tibia and tarsus fused or only weakly divided .....2  
 1b. Tibia and tarsus clearly divided..... *Insignorthezia insignis*  
 2a (1a). First, or first and second, antennal segments conspicuously enlarged .... 3 (*Newsteadia* Green species)  
 2b. First, or first and second, antennal segments not conspicuously enlarged .....7  
 3a (2a). Antennae 6- or 7-segmented.....4  
 3b. Antennae 4-segmented..... *Newsteadia martini*  
 4a (3a). Antennae 6-segmented.....5  
 4b. Antennae 7-segmented..... *Newsteadia gullanae*  
 5a (4a). Anterior thoracic spiracle without pores in atrium .....6  
 5b. Anterior thoracic spiracle with pores in atrium ..... *Newsteadia tasmaniensis*  
 6a (5a). Hind tibia with a sensory seta..... *Newsteadia australiensis*  
 6b. Hind tibia without a sensory seta..... *Newsteadia endroedyi*  
 7a (2b). Antennae 3-segmented; anal ring situated near apex of abdomen; eyes large and protruding.....8  
 7b. Antennae 2-segmented; anal ring situate on dorsum near center of abdomen; eyes absent.....  
 ..... *Acropygorthezia williamsi*  
 8a (7a). Anterior portion of ovisac band well developed..... *Nipponorthezinella guadalcanalia*  
 8b. Anterior portion of ovisac band absent..... *Nipponorthezia tasmaniana*

### *Acropygorthezia* LaPolla & Miller, n. gen.

Type species: *Acropygorthezia williamsi* LaPolla & Miller

**Generic Diagnosis: Adult female, and third-, second-, and first-instar nymphs.** Wax plates and ovisac band absent; mesosternal and metasternal apophyses large and simple [not bifurcate]; antennae reduced in size; eyes absent; trochanter and femur fused; 2 pairs of sensoria on trochanter; tibial sensoria absent; tibia and tarsus fused; abdominal spiracles dorsal; without setae or pores in anal ring; anal ring located dorsally in middle of abdomen; labium 3-segmented; dome-shaped setae present on body; quadrilocular pores few.

**Prepupa.** As above, except labium reduced or absent, genital area ventral and represented by sclerotized protrusion near abdominal apex; anal ring well developed but without pores and setae.

**Pupa.** As for adult female, except labium reduced or absent, genital area ventral and represented by sclerotized penial sheath and with a ventromedial lobe protruding slightly from abdominal apex; anal ring well developed.

**Adult male.** As for adult female, except labium reduced or absent, genital area ventral and represented by sclerotized penial sheath and elongate coiled aedeagus, penial sheath hinged near apex of abdomen; anal ring well developed.

**Comments:** The unusual morphology of this genus makes it difficult to discuss possible similarities with other ortheziids. Characters in this species that are unlike any found in other ortheziids include: the struc-

ture and position of the anal opening; the size and shape of the antennae; the structure of the mesosternal and metasternal apophyses; the lack of both wax plates and an ovisac band, and the occurrence of only 2 sensoria on each surface of the trochanter. The adult male is unique by having the aedeagus situated ventrally and oriented anteriorly, with a hinge structure near the apex of the abdomen. Characters that might be useful in discovering affinities between *Acropygorthezia* and other genera include: the number of abdominal spiracles; the position of the abdominal spiracles, and the fusion of the tibia and tarsus. Genera that contain species with a fused tibia and tarsus include *Newsteadia*, *Matileortheziola* Kozár and Foldi, *Mixorthezia* Morrison, *Nipponorthezia* Kuwana, and *Ortheziola* Šulc. Genera that contain species with dorsal abdominal spiracles include *Arctorthezia* Cockerell, *Graminorthezia* Kozár, *Insignorthezia* Kozár, *Matileortheziola*, *Orthezia* Bosc d'Antic, and *Praelongorthezia* Kozár. Genera that have species with 7 pairs of abdominal spiracles include *Arctorthezia*, *Graminorthezia*, *Insignorthezia*, and *Praelongorthezia*.

### *Acropygorthezia williamsi* LaPolla & Miller, n. sp.

**Field Appearance.** *In alcohol.* Specimens egg or bean-shaped; white; without wax; legs and mouthparts yellowish brown; antennae short and stub like; anal ring darker than legs, yellowish brown, located dorsally near center of abdomen; vulva large, located near posteroventral end of abdomen, some specimens with vulva stretching laterally across body; dorsal and ventral segmentation often visible.

**Mounted adult female** (Fig. 1) (based on 10 specimens). Holotype adult female 0.99 mm long (paratypes 1.23–1.71 mm); holotype 0.76 mm wide (paratypes 0.93–1.25 mm). Antennae 2-segmented, holotype 60  $\mu\text{m}$  long (paratypes 55–77  $\mu\text{m}$ ); apical segment with 2 enlarged setae, 2 filamentous setae, and 1 basiconic sensillum; basal segment without setae (paratypes sometimes with 1 seta).

**Venter.** Labium truncate apically, holotype with medial and apical segments combined 125  $\mu\text{m}$  long (paratypes 127–156  $\mu\text{m}$ ), basal segment with 1 pair of setae, medial segment with 1 pair, apical segment with 6 pairs (paratypes 5–6 pairs). Legs elongate, hind leg of holotype about 460  $\mu\text{m}$  long (paratypes 593–642  $\mu\text{m}$ ), hind trochanter+femur of holotype 180  $\mu\text{m}$  long (paratypes 169–224  $\mu\text{m}$ ), tibia+tarsus of holotype 204  $\mu\text{m}$  long (paratypes 237–274  $\mu\text{m}$ ); claw of holotype 63  $\mu\text{m}$  long (paratypes 61–77  $\mu\text{m}$ ), legs with rows of conspicuous setae, some of setae on outer margin of trochanter+femur and tibia+tarsus apically capitate. Spines on body of 2 sizes: longer spines in medial areas surrounding legs, less dense than marginal spines; shorter spines unusually abundant in submarginal and marginal areas. Setae of 2 types: filamentous setae scattered in small numbers over surface, dome-shaped setae scattered over surface but most abundant on submargin and margin. Quadrilocular pores protruding from derm, of 2 sizes; larger size in medial areas between legs, smaller size in marginal areas. Small sclerotized pores present in marginal areas.

**Dorsum.** Spines, 10–15  $\mu\text{m}$  long, unusually abundant over surface, present everywhere except in intersegmental areas and in anal area. Setae present in small numbers along body margin and in segmental rows, longest about 20  $\mu\text{m}$  long. Quadrilocular pores of small size only, arranged in 3 pairs of longitudinal lines (lateral, mediolateral, and medial). Small sclerotized pores scattered over surface. Anal ring without obvious opening. Abdominal spiracles inconspicuous, 7 pairs in submarginal areas from segments I to VII, with sclerotized vestibule.

**Mounted third-instar nymph** (based on 1 specimen). Same as adult female except as follows. Body 1.29 mm long; 0.87 mm wide. Antennae 60  $\mu\text{m}$  long.

**Venter.** Labium with medial and apical segments 135  $\mu\text{m}$  long. Hind leg 545  $\mu\text{m}$  long, hind trochanter+femur 190  $\mu\text{m}$  long, tibia+tarsus 240  $\mu\text{m}$  long; claw 65  $\mu\text{m}$  long.

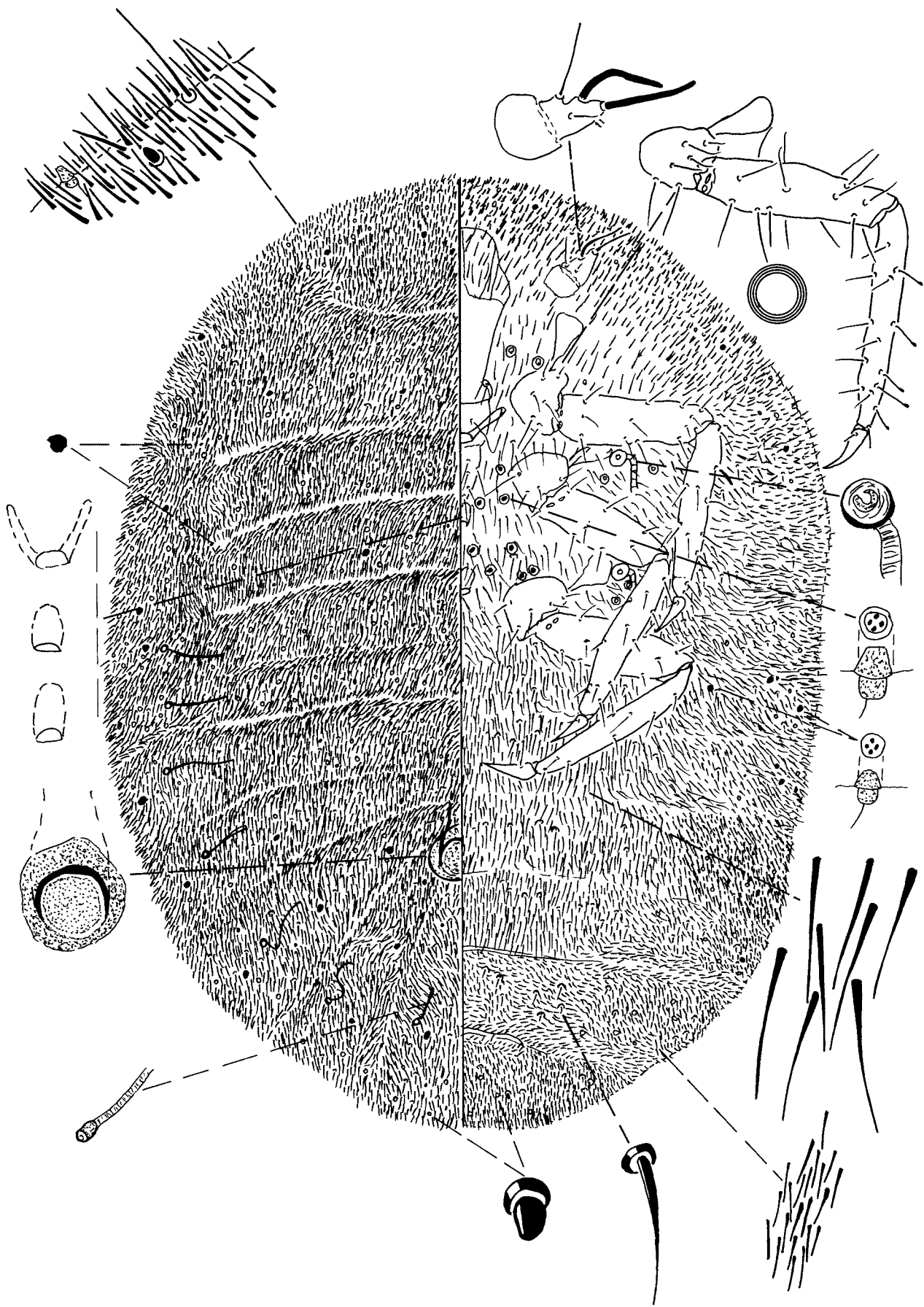


FIGURE 1. Adult female, *Acropygorthesia williamsi*, n. sp. LaPolla and Miller.

**Mounted second-instar nymph** (based on 6 specimens). Same as adult female except as follows. Body 0.78–1.10 mm long; 0.65–0.93 mm wide. Antennae 40–50  $\mu\text{m}$  long.

*Venter*. Labium with medial and apical segments 130–135  $\mu\text{m}$  long. Hind leg 440–505  $\mu\text{m}$  long, hind trochanter+femur 175–185  $\mu\text{m}$  long, tibia+tarsus 215–230  $\mu\text{m}$  long; claw 55–62  $\mu\text{m}$  long.

**Notes:** For differences between third and second-instar nymphs see discussion below.

**Mounted first-instar nymph** (Fig. 2) (based on 9 specimens). Body 0.64–0.93 mm long; 0.51–0.76 mm wide. Antennae 2-segmented, 46–48  $\mu\text{m}$  long; apical segment with 2 enlarged setae, and 1 filamentous seta; basal segment without setae.

*Venter*. Labium 3 segmented, with apex slightly rounded or truncate, medial and apical segments 109–126  $\mu\text{m}$  long, basal segment with 1 pair of setae, medial segment with 1 pair, apical segment with 6 pairs. Legs elongate, hind leg 426–437  $\mu\text{m}$  long, hind trochanter+femur 140–160  $\mu\text{m}$  long, tibia+tarsus 170–210  $\mu\text{m}$  long; claw 56–60  $\mu\text{m}$  long, legs with rows of conspicuous setae, some of setae on outer margin of trochanter+femur and tibia+tarsus apically capitate. Spines of 2 sizes: longer spines in medial areas surrounding legs, less dense than marginal spines; shorter spines unusually abundant in submarginal and marginal areas. Setae of 2 types: filamentous setae scattered in small numbers over surface, dome-shaped setae scattered over surface but most abundant on submargin and margin. Quadriocular pores protruding from derm, of 1 size; present in medial areas between legs and in marginal areas. Small sclerotized pores apparently absent.

*Dorsum*. Spines unusually abundant over surface, present everywhere except in intersegmental areas and in anal area, 12–18  $\mu\text{m}$  long. Setae, longest 7–15  $\mu\text{m}$  long, present in small numbers along body margin and in segmental rows. Quadriocular pores scattered over surface of abdomen. Small sclerotized pores apparently absent. Anal ring without obvious opening. Abdominal spiracles apparently absent.

**Notes:** Characteristics of the first instar of this species that are atypical of other scale insects are: the presence of numerous spines, reduced antennae, an anal ring that is located in the middle of dorsum that lacks setae and pores, and fused tibia and tarsus.

**Mounted adult male** (Fig. 3) (based on 3 specimens). Body 1.10–1.16 mm long; 0.95–0.98 mm wide. Antennae 2-segmented 112–120  $\mu\text{m}$  long; apical segment with 2 enlarged setae, 10–12 filamentous setae, and with or without basiconic sensillum; basal segment without setae.

*Venter*. Mouthparts reduced and non-functional. Legs elongate; hind leg 688–701  $\mu\text{m}$  long; hind trochanter+femur 258–260  $\mu\text{m}$  long; tibia+tarsus 303–304  $\mu\text{m}$  long; claw 47–49  $\mu\text{m}$  long; legs with rows of conspicuous setae, some of setae on outer margin of trochanter+femur and tibia+tarsus apically capitate. Spines of 2 sizes: longer spines in medial areas surrounding legs, less dense than marginal spines; shorter spines unusually abundant in submarginal and marginal areas. Setae of 2 types: filamentous setae scattered in small numbers over surface, dome-shaped setae scattered over surface but most abundant on submargin and margin. Quadriocular or discoidal pores present near thoracic spiracles. Small sized pores present near posterior margin of abdomen. Penial sheath hinged near posterior apex of abdomen, ventral part of penial sheath 497–532  $\mu\text{m}$  long; 176–179 wide  $\mu\text{m}$  long (measured at widest point at base); aedeagus 785–857  $\mu\text{m}$  long; aedeagus annulated except towards base where it appears more heavily sclerotized.

*Dorsum*. Spines unusually abundant over surface, present everywhere except in intersegmental areas and in anal area, 6–10  $\mu\text{m}$  long. Setae present in small numbers along body margin and in segmental rows, longest about 21  $\mu\text{m}$  long. Quadriocular pores absent. Small sclerotized pores and small clear pore present posteriorly. Anal ring well developed but without pores, setae, or obvious opening. Abdominal spiracles inconspicuous, 6 pairs in submarginal areas from segments I to VI, with sclerotized vestibule. Penial sheath not visible from dorsum.

**Notes:** The genital structure is quite unusual in that it is strictly ventral and is hinged near the base of the abdomen so that it does not protrude posteriorly. Another characteristic that is atypical of male scales is that the anal ring appears to be well developed and the anus may be functional.

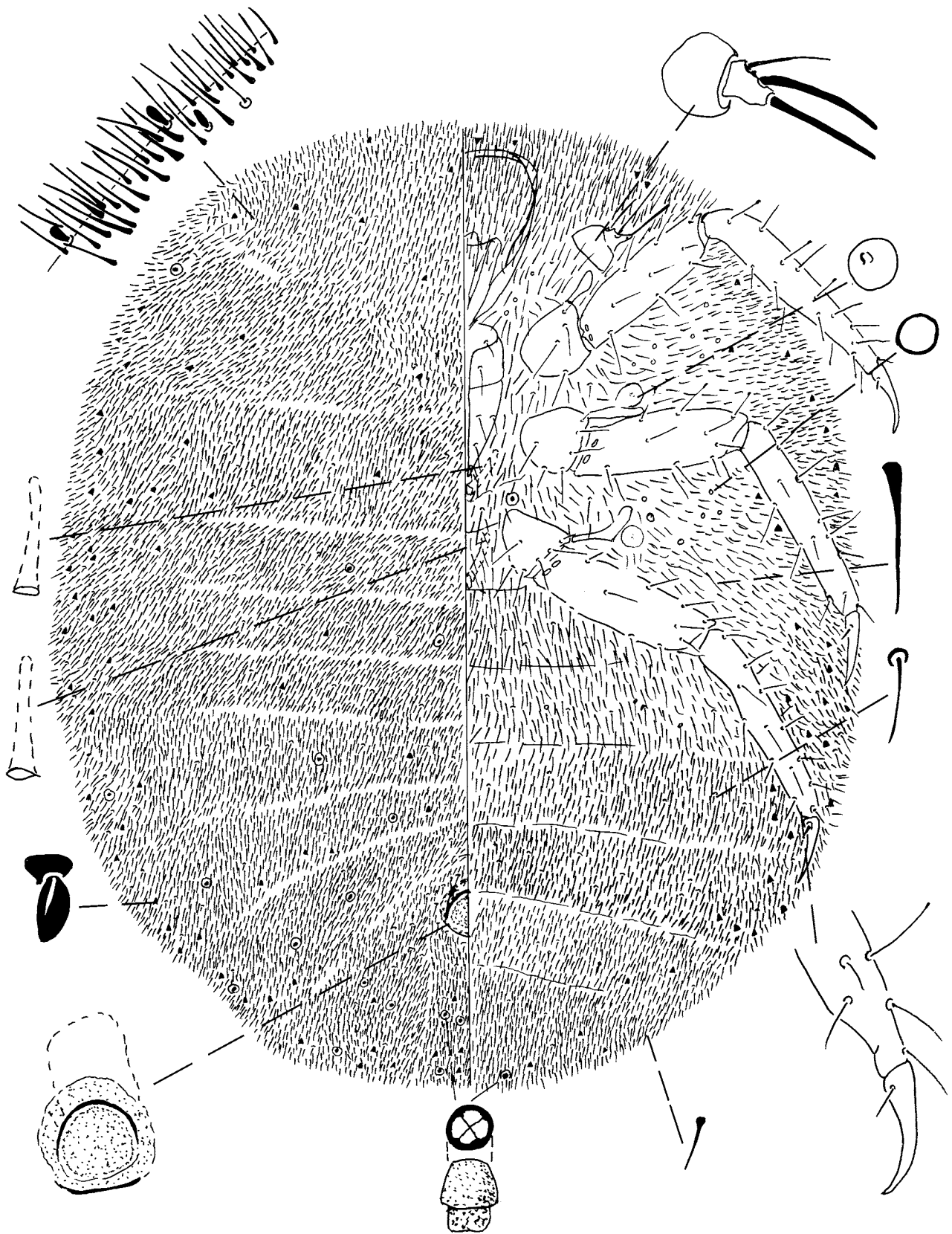
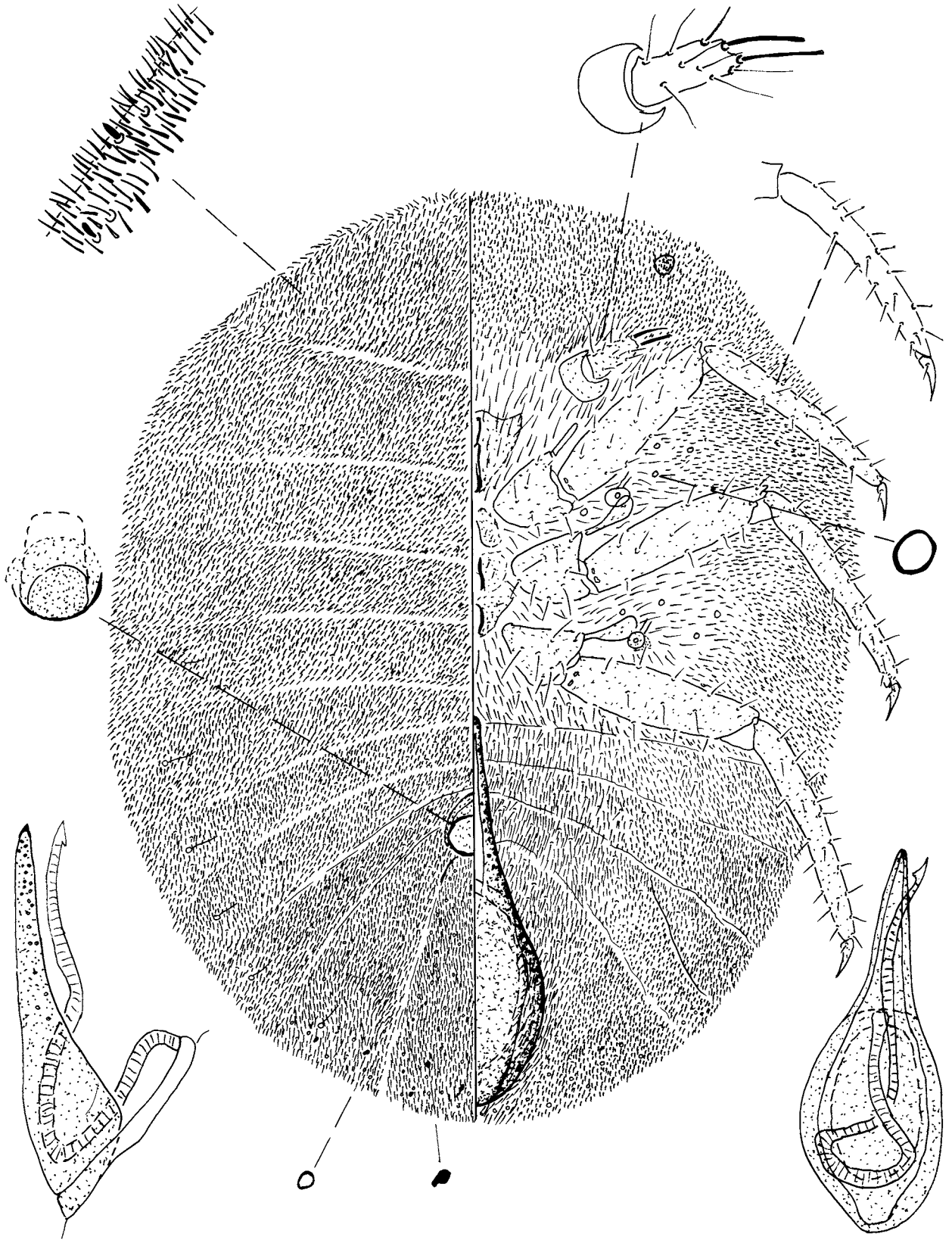
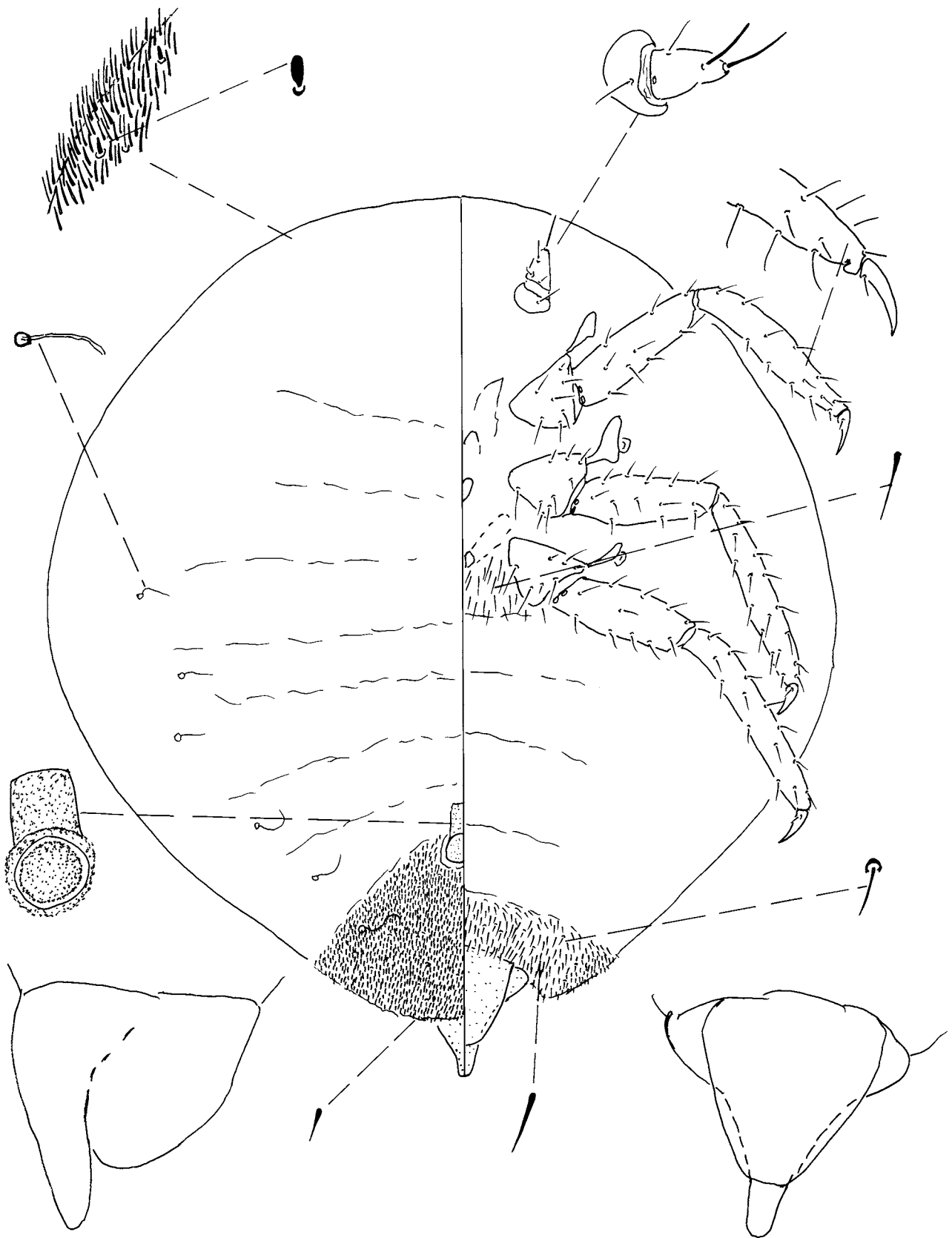


FIGURE 2. First instar nymph, *Acropygorthezia williamsi*, n. sp. LaPolla and Miller.



**FIGURE 3.** Adult male, *Acropygorthezia williamsi*, n. sp. LaPolla and Miller.





**FIGURE 4.** Pupal male, *Acropygorthesia williamsi*, n. sp. LaPolla and Miller. Note: Spines only shown on posterior regions in drawing, but a similar density covers the entire dorsum and venter of the pupal male.

**Mounted pupal male** (Fig. 4) (based on 2 specimens). Body 1.07 and 1.20 mm long; 0.88 and 0.89 mm wide. Antennae 2-segmented, about 75  $\mu\text{m}$  long; apical segment with 2 enlarged setae, 2–4 filamentous setae, and 0–1 basiconic sensillum; basal segment with or without 1 seta.

**Venter.** Mouthparts reduced and non-functional. Legs elongate, hind leg 556 and 557  $\mu\text{m}$  long, hind trochanter+femur 174 and 210  $\mu\text{m}$  long, tibia+tarsus 243 and 269  $\mu\text{m}$  long; claw about 51  $\mu\text{m}$  long, legs with rows of conspicuous setae, all appear apically acute. Spines of 2 sizes: longer spines in medial areas surrounding legs, less dense than marginal spines; shorter spines unusually abundant in submarginal and marginal areas. Setae of 2 types: filamentous setae scattered in small numbers over surface, dome-shaped setae scattered over surface but most abundant on submargin and margin. Quadriocular pores and small sclerotized pores apparently absent. Genital area primarily ventral, with triangular ventral lobe and apically acute penial sheath; ventral lobe 118 and 131  $\mu\text{m}$  long, about 132  $\mu\text{m}$  long; penial sheath 165 and 170  $\mu\text{m}$  long, about 178  $\mu\text{m}$  wide.

**Dorsum.** Spines unusually abundant over surface, present everywhere except in intersegmental areas, genital region, and anal area, about 5  $\mu\text{m}$  long. Setae present in small numbers along body margin and in segmental rows, longest about 10  $\mu\text{m}$  long. Quadriocular and small sclerotized pores apparently absent. Anal ring without obvious opening. Abdominal spiracles inconspicuous, apparently with 6 pairs in submarginal areas from segments I to VI, with sclerotized vestibule.

**Notes:** Many features are difficult to see, especially the spiracles, pores, and segmentation. It is possible that quadriocular pores are present, but are confused with broken setal bases, and that there is 1 more pair of spiracles. Characteristics of the pupa of this species that are atypical of those of other scale insects are the presence of well-developed legs and the anal structure.

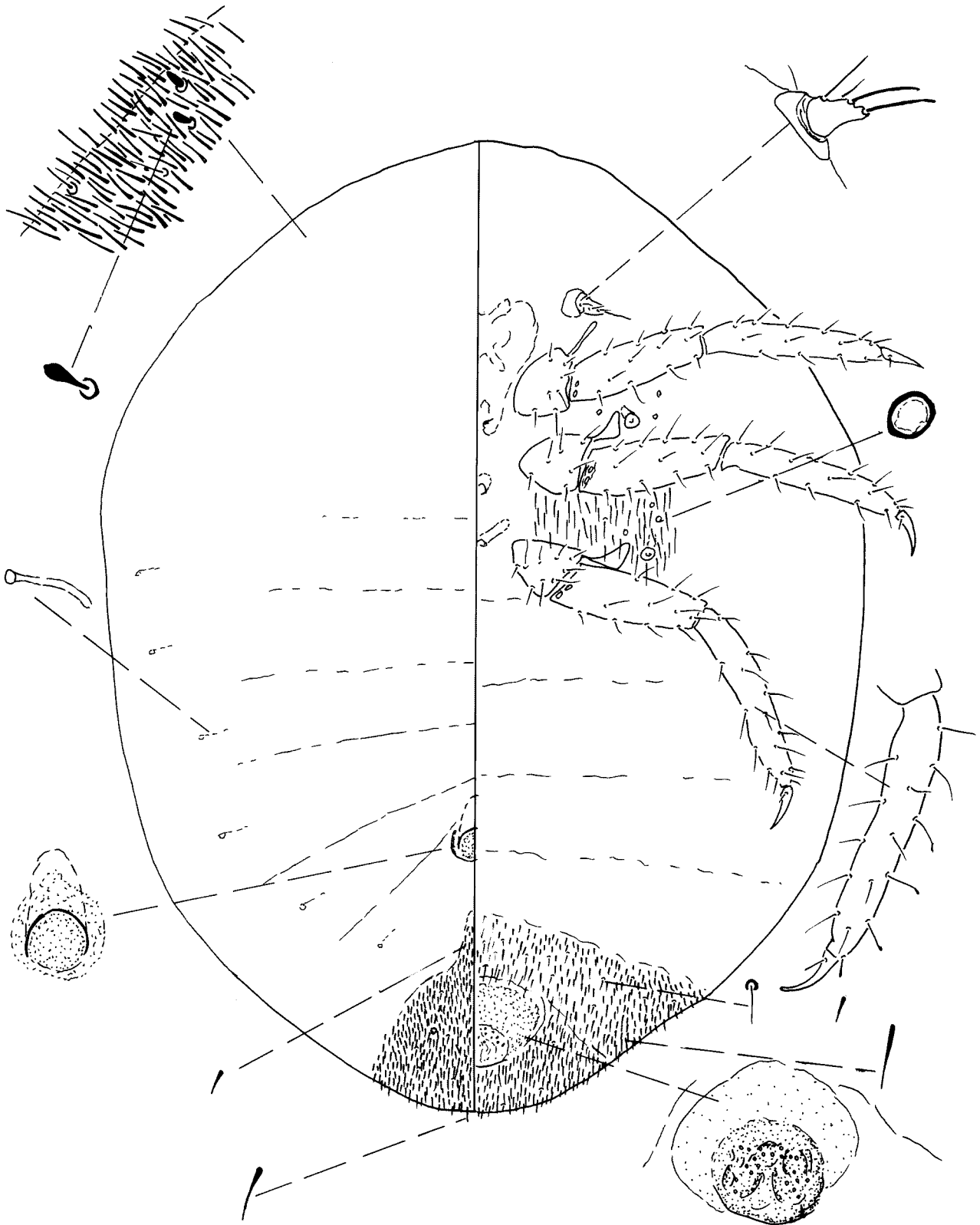
**Mounted prepupal male** (Fig. 5) (based on 2 specimens). Body 1.56 and 1.19 mm long; 0.92 and 0.95 mm wide. Antennae 2-segmented, 62 and 59  $\mu\text{m}$  long; apical segment with 2 enlarged setae, 2–4 filamentous setae, and apparently without basiconic sensillum; basal segment with or without 1 seta.

**Venter.** Mouthparts reduced and non-functional. Legs elongate, hind leg 513 and 528  $\mu\text{m}$  long, hind trochanter+femur 196 and 181  $\mu\text{m}$  long, tibia+tarsus 251 and 236  $\mu\text{m}$  long; claw 54 and 58  $\mu\text{m}$  long, legs with rows of conspicuous setae, setae on outer margin of tibia slightly capitate. Spines of 2 sizes: longer spines in medial areas surrounding legs, less dense than marginal spines; shorter spines unusually abundant in submarginal and marginal areas. Setae of 2 types: filamentous setae scattered in small numbers over surface, dome-shaped setae scattered over surface but most abundant on submargin and margin. Quadriocular pores or discoidal pores located near thoracic spiracles; small sclerotized pores apparently absent. Genital area ventral, with central conical area and outer flat area with few sensilla on conical area.

**Dorsum.** Spines unusually abundant over surface, present everywhere except in intersegmental areas, genital region, and anal area, about 10  $\mu\text{m}$  long. Setae present in small numbers along body margin and in segmental rows, longest about 10  $\mu\text{m}$  long. Quadriocular and small sclerotized pores apparently absent. Anal ring without obvious opening. Abdominal spiracles inconspicuous, apparently with 7 pairs in submarginal areas from segments I to VII, with sclerotized vestibule.

**Notes:** Many features are difficult to see, especially the abdominal spiracles, abdominal segmentation, and pores. Characteristics of the prepupa of this species that are atypical of those of other scale insects are the presence of well-developed legs and the anal structure.

**Material examined. Holotype:** Adult female mounted on slide with 3 paratype adult females; a map is given on the label of position of holotype on slide, **AUSTRALIA**, Queensland, Bulimba Creek, Carindale, Brisbane, 27° 30' 02.09" S, 153° 06' 32.09" E, patch of dry forest, under small log in nest of *Acropyga myops*, VIII-2006, C. Burwell, SGB1061 (QMBA). **Paratypes:** 19 adult females, 1 third-instar female, 4 second-instar nymphs, 4 first-instar nymphs from same locality and date as holotype; also 3 first-instar nymphs, 4 adult males, 2 pupae, and 2 prepupae from same locality but collected 14-II-2008 (ANIC, BMNH, QMBA,



**FIGURE 5.** Prepupal male, *Acropygorthezia williamsi*, n. sp. LaPolla and Miller. Note: Spines only shown on posterior regions in drawing, but a similar density covers the entire dorsum and venter of the prepupal male.

BME, USNM); 6 adult females, 2 second-instar nymphs, 2 first-instar nymphs from AUSTRALIA, Queensland, Chelsea Road Bushland Reserve, Ransome, Brisbane, 27° 29' 01.4"S, 153° 10' 54.1"E, VIII-2006, C. Burwell, SGB1063 (ANIC, QMBA, USNM).

**Etymology.** The generic name *Acropygorthezia* is a feminine noun and is a combination of the names of the attending ant, *Acropyga*, and the scale suffix *Orthezia*. The species epithet is given to honor Dr. Douglas J. Williams (Natural History Museum, London), for his numerous contributions to the systematics of mealybugs associated with ants. His works serve as the foundation of our knowledge on the mealybug aspects of the fascinating interactions between pseudococcids and ants.

### Observations on the interactions between the ortheziids and *Acropyga* ants.

#### Type locality description

The type locality is a small rectangular remnant of riparian vegetation and open woodland along Bulimba Creek within the Brisbane suburb of Carindale (figure 6A), bordered by housing and roads on three sides and a golf course on the fourth. The dominant trees are Flooded Gums (*Eucalyptus grandis*), Black She-oaks (*Allocasuarina littoralis*) and wattles (*Acacia* spp.). The site has been unburnt for several years and has a thick understorey of rank grasses and introduced lantana (*Lantana camara*) interspersed with bare areas.



**FIGURE 6.** A) Bulimba Creek, type locality of *Acropygorthezia williamsi*. B–D) Observations on the interactions between the ortheziids and *Acropyga* ants. B) Ortheziids feeding on roots inside a nest of *Acropyga myops*. Arrow notes a droplet of honeydew emerging from the ortheziid's anal area. Insert shows close-up of ortheziid and honeydew droplet. C) *Acropyga* worker carrying an ortheziid. Arrow indicates the ortheziid between ant's mandibles. D) Nest chamber containing both ant brood and ortheziids of various instars (note that the ortheziids are the individuals with legs and non-sclerotized heads). See text for further details concerning pictures.

## Description of ant nest and the scales within

Nest tunnels and galleries of *Acropyga* were most common in the top 10–15 cm of the sandy-loam soil beneath a thick layer of leaf litter. Ortheziids were observed feeding on roots (presumed to be those of *Allocasuarina littoralis*) within the ant tunnels (figure 6B). Ortheziids left exposed on roots were forcibly detached and removed by the *Acropyga* workers. Loose ortheziids that were encountered by the worker ants also were picked up quickly and carried off (figure 6C). It is interesting to note that worker ants hold the ortheziids dorsally with the ortheziid head facing forward. This appears to be the predominant way in which *Acropyga* hold mealybugs as well (J.S. LaPolla, unpublished data; D.J. Williams 1998).

Distinct chambers were encountered during excavation of the ant's nests. Some contained ant brood, including pupae and larvae of various instars, together with ortheziids of various instars (figure 6D). Other chambers that contained only *Acropyga* pupae did not have any ortheziids. Several ortheziids were observed with a drop of honeydew at the anal ring (figure 6B) and on one occasion an *Acropyga* worker was seen to ingest a droplet.

The nests contained both alate male and queen ants, but we did not observe any nuptial flights and cannot confirm whether trophophoresy occurs in this species.

## Discussion

*Acropygorthezia williamsi* is an unusual ortheziid since it apparently is closely associated with the ant *Acropyga myops* (figure 6), the adult female lacks an ovisac and all instars lack wax plates, have an anal opening that is without pores and setae, and have only 2 sensoria on each surface of the trochanter. *A. williamsi* can be recognized as an ortheziid because it has quadrilocular pores that protrude from the derm, abdominal spiracles, dome-shaped setae, and numerous spines. Several morphological attributes appear to be adaptations for its close association with *A. myops*, including the lack of wax; an anal ring that is located dorsally in the middle of the abdomen; metasternal and mesosternal apophyses that are simple and large; claws that are unusually long, and spines that are remarkably abundant on both body surfaces.

The lack of wax plates in *A. williamsi* is not surprising given that many species of scales associated with ants no longer produce wax. In fact, the absence of wax plates provides another piece of evidence that these scales have indeed entered into obligate myrmecophily. Wax production is thought to provide some level of protection to scales from water loss, parasitoids and pathogens, and from contamination with their own honeydew (Gullan & Kosztarab, 1997). However, obligate myrmecophilous scales usually do not produce wax, perhaps because the ants offer the same protective benefits as wax, and the wax would make it difficult for the ants to collect the honeydew and carry the scales. An interesting feature of scales associated with *Acropyga* (in particular xenococcine mealybugs and *Acropygorthezia*) is that they are covered in a dense layer of appressed setae. It has been suggested that this dense covering serves a function similar to wax if some honeydew does get onto their bodies by allowing the honeydew to bead off (D.J. Williams, pers. comm.). The dense layer of setae also is found on the venter of these scales, and this may indicate a need to protect themselves from the wet surfaces found in the soil where they live.

Another interesting feature of *Acropygorthezia* is the placement of the anal ring dorsally in the middle of the abdomen. All xenococcine mealybugs have a tapered abdomen where the anal ring is found distally. However, most species curl their abdomens upwards and forward, which places the anal ring roughly dorsally in the middle of the abdomen. The positioning of the anal ring may facilitate the harvesting of honeydew by the ants. This remains unclear, but it is interesting to note that both xenococcines (after bending their abdomens upwards and forwards) and *Acropygorthezia* display this unusual placement of the anal ring. The Stictococcidae also have the anal ring in the center of the dorsum, and many species in this African family are attended by ants (Way, 1954; Strickland, 1947; Richard, 1976), but this family has not been found in association with *Acropyga*.

One other observation merits mention. The various instars all have a very similar morphology and are difficult to separate. Even the prepupa, pupa, and adult male are remarkably similar to the adult female, with only the presence of the primarily ventral genital capsule separating them. The first-instar nymphs have a remarkably large number of spines similar to those of the adult. The length of the hind leg segments and labium were the best characteristics to separate the instars, e.g., the lengths of the trochanter+femur were as follows: first instar 140–160 µm, second instar 175–185 µm, third instar 190 µm, and adult female 169–224 µm. We were unable to distinguish the male and female in their first and second instars.

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