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A new species of grass-infesting felt scale (Hemiptera: Coccomorpha: Eriococcidae), with descriptions of all life stages and a key to the adult female *Acanthococcus* Signoret of Florida, U.S.A.

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Abstract

All life stages (adult female, second-instar female, first-instar crawler, adult male, fourth-instar male pupa, third-instar male prepupa, second-instar male) of a new species of felt scale insect (Hemiptera: Coccomorpha: Eriococcidae), *Acanthococcus orzo* Deeter, Miller & Powell, **sp. nov.**, on *Muhlenbergia capillaris* (Lam.) Trin. (Poales: Poaceae) in Florida, USA, are described and illustrated, with notes on ecological associations. The species is diagnosed based on the adult female anal-ring setae, setae on the hind tibia, the absence of microtubular ducts, and the morphology of the enlarged setae. Comparisons are given with similar species for all stages. Diagnoses are given for the adult female and adult male. A diagnostic key to the adult females of *Acanthococcus* Signoret species of Florida is provided. Analysis of DNA extractions from this new species is also performed and the results produced distinctive COI and 18S data.

Key words: Sternorrhyncha, Coccoidea, scale insect, immature instars, pupa, prepupa, crawler, male, female, *Muhlenbergia capillaris*, muhly grass

Introduction

The felt scales (Hemiptera: Coccomorpha: Eriococcidae) are a group of small herbivorous insects named for the felt-like wax coverings secreted by most of its members. Adult females of the genus *Acanthococcus* (Signoret, 1875) produce a cocoon-like ovisac, enclosing the adult female and her eggs, with only a small hole for the female's mouthparts and a small posterior opening for first-instar nymphs or "crawlers" to emerge (Miller & Miller 1993). Like all scale insects (Hemiptera: Coccomorpha), this group exhibits extreme sexual dimorphism, with wingless neotenic adult females and winged males (Kosztarab 1996).

The Eriococcidae is the fourth largest family of scale insects (Hemiptera: Coccomorpha), containing around 680 species in over 100 genera (García Morales *et al.* 2016), and includes several economically important pest species, such as *Acanthococcus lagerstroemiae* (Kuwana, 1907) and *Gossyparia spuria* (Modéer, 1778) (Miller & Miller 1993; Gu *et al*. 2014). Members of the Eriococcidae are known to feed on a diverse range of plant hosts, however, there is a diversity of felt scales that are host-specific to grasses (Poales: Poaceae) with convergent morphologies. These grass-infesting species often have elongated bodies and lack the large dorsal setae seen in many of the species that feed on other hosts. This is likely a result of convergent evolution, allowing them to fit within tight areas such as grass leaf-sheaths and nodes, often on subterranean parts of the plant. Other grass-infesting species may be

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conspicuously exposed on the leaf blades (Miller & Miller 1993), such as *Anophococcus insignis* (Newstead, 1891), which is considered a pest on ornamental grasses in parts of the United States (Gill 1993).

This paper presents a newly discovered species of felt scale in North Florida, *Acanthococcus orzo* **sp. nov**., found during a survey for grass scales. It has a cryptic feeding habit, living completely hidden within the involute blades of muhly grass, *Muhlenbergia capillaris* (Lam.) Trin. (Poales: Poaceae). The morphology of all the life stages (adult female, second-instar female, first-instar crawler, adult male, fourth-instar male pupa, third-instar male prepupa, second-instar male) are described and illustrated, along with diagnoses for the adult female and male. Comparisons to similar species are given for all stages. Species comparisons for the adult male are focused on other grass-infesting eriococcids for which male descriptions are available. A key to the adult females of *Acanthococcus* species is adapted from Miller & Miller (1993), diagnosing all 17 species found in Florida, U.S.A.

DNA extractions were performed on multiple life stages of paratype specimens, producing six identical COI sequences and one 18S sequence. Analysis of DNA extractions produced distinctive COI and 18S data with no near matches in the National Center for Biotechnology Information (NCBI) GenBank nucleotide database or Barcode of Life Data Systems (BOLD). However, these data are inconclusive due to the current lack of comparative molecular data for the Eriococcidae.

Materials and methods

Collection

Specimens were collected in Florida from three locations in Gainesville and one location in Quincy (see Material Examined). *Muhlenbergia capillaris* samples were also collected at several other locations in North and Central Florida, including St. Johns and Orange counties, but no additional *Acanthococcus orzo* **sp. nov.** infestations were found at these localities. Ornamental plantings of *M. capillaris* were the focus for collection. Observed infestations of *Ac. orzo* were inconspicuous. Infested plants lacked typical symptoms of felt scale infestation such as visible sooty mold or wax, but special attention was given to hosts with readily observable infestations of armored scales (Hemiptera: Diaspididae) or mealybugs (Hemiptera: Pseudococcidae).

Host plants were first inspected by plucking a leaf from the base and prying open the involute leaf blades using a fingernail or forceps, splitting or flattening the leaf to check for any insects inside. If suspect insects were observed, handfuls of grass were cut from the base of the plant and collected in plastic bags. These were then inspected under a Leica MS5 dissection microscope, where individual specimens could be found and placed in 75% ethanol for subsequent slide mounting. An alternative, less arduous method involved removing specimens from bulk samples of plant material by agitation in 75% ethanol. Handfuls of infested grass were cut into approximately 6-inch lengths, placed in a gallon-sized plastic bottle (Thermo Scientific Catalog No. 11-815-11B) to which about 500 mL of 75% ethanol was added. The covered bottle was shaken vigorously by hand for about 10 minutes, allowed to sit for at least 30 minutes, then shaken again. The alcohol was then decanted through a 45 μm sieve (Endecotts Ltd. London, England, ASTM E11 Altern. No. 325), which collected any scale insect specimens, including first-instar nymphs. The sieve was rinsed with 75% ethanol into a petri dish to remove any insects, and the alcohol and specimens were then saved in a glass vial for subsequent slide-mounting. Some specimens were stored in 100% ethanol to be used for DNA sequencing.

The three adult male specimens studied were reared from hand-collected pupae from the same infestation as the holotype. Each pupa was placed in a small glass vial with a cotton covering and incubated in a humidity chamber made from a glass mason jar with a small amount of 50% salt water solution.

Processing

Slide-mounting procedures followed those of Wilkey (1962). Specimens were mounted singly on individual slides. The best mounted specimens resulted from soaking in double stain (BioQuip #6379B) for 24–48 hours.

Each collection event was recorded and given a sample number in the FDACS-DPI databases. Sample numbers are provided in the text in the form of E-[submission year]-[sample number]. Individual slides were given unique identifier FSCA barcodes, provided in the text in brackets in the form of (FSCA_[barcode number]).

Specimen depositories

CSCA—California State Collection of Arthropods, Sacramento, California, U.S.A.
FSCA—Florida State Collection of Arthropods, Gainesville, Florida, U.S.A.
NCSU—North Carolina State University, Raleigh, North Carolina, U.S.A.
UCD—R.M. Bohart Museum, University of California, Davis, California, U.S.A.
USNM—National Museum of Natural History, Washington, D.C., U.S.A.

Descriptions and figures

Illustrations were made using a camera lucida with a Leica DMRB compound light microscope with 10×, 20×, 40×, and 100× objectives. Rough pencil drawings were made using the camera lucida and the 40× objective for whole specimens, and the 100× objective for enlargements, unless otherwise noted. Due to their small size and minute details, multilocular pores were not drawn to scale—they were traced under 100× and arbitrarily enlarged for sufficient viewing. Final ink drawings were traced onto vellum paper using a Sakura Pigma Micron™ 005 archival ink pen, scanned, and then edited in the GNU Image Manipulation Program (GIMP) 3.0.2. Enlargements of caudas and preantennal pores were not drawn to scale, and were traced in GIMP 3.0.2 from images taken with a Zeiss Axio Imager.M2 using ZEN 3.7 Pro software.

Measurements for descriptions were acquired from 10–15 type specimens per life stage, except for male prepupa, pupa, and adults, of which fewer specimens were available. Leg measurements were taken from the outer margins of leg segments. Type specimens of adult females, second-instar males, second-instar females, and first-instar nymphs were measured using a Leica DM2500 compound light microscope with 2.5×, 5×, 10×, 20×, 40×, and 100× objectives and a Jenoptik Gryphax Microsoft camera and software. Adult males, third-instar prepupae, and fourth-instar pupae were measured using a Zeiss Axio Imager.M2 using ZEN 3.7 Pro software, and illustrations were made with a Leica DMRB compound light microscope with 10×, 20×, 40×, and 100× objectives.

The holotype data are listed with "/" indicating the line breaks on the slide labels, and "//" indicating a new separate label. In the description of the adult female, the measurement of the holotype is given first, followed by a range of measurements from paratypes, followed by the mean value. In descriptions of other stages, we provide the range of measurements of paratypes, followed by the mean of paratype measurements. Range measurements are given as follows: small number–large number (mean).

Photographs of slide-mounted specimens were acquired and stitched with a Zeiss Axio Imager.M2 using ZEN 3.7 Pro software, stacked with Helicon Focus 8.2.2, and edited with GIMP 2.10.38. Habitus photographs were taken with a Canon EOS 6D Mark II and a 65mm Canon MP-E f/2.8 1–5× macro lens, except for Fig. 2c, which was taken with an iPhone XR through the eye piece of a Leica MS5 dissection microscope.

The morphological terminology of all life stages follows that of Miller & Stocks (2022), except for the term "tail-forming pore cluster," which is instead referred to here as "glandular pouch," as used by Hodgson (2020). For brevity in the description sections, abdominal segments are designated with Roman numerals: e.g., abdominal segment 8 is simply "segment VIII." In descriptions of legs, the terms "dorsal" and "ventral" refer to the leg surfaces of the slide-mounted specimens, not how the leg surfaces orient in life. Illustrations of the different types of setae of *Acanthococcus orzo* are provided in Fig. 1.

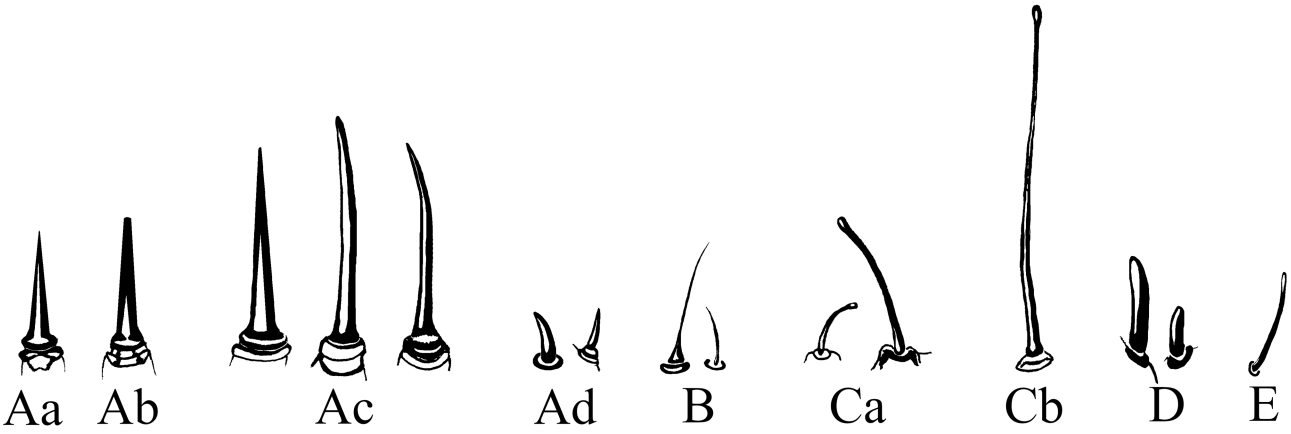

FIGURE 1. Setal morphology of *Acanthococcus orzo* Deeter, Miller & Powell, **sp. nov. A**=enlarged setae: **Aa**, apical enlarged seta, first instar; **Ab**, apical enlarged seta, adult ♀; **Ac**, large-sized enlarged setae, adult ♀; **Ad**, small-sized enlarged setae, adult ♀; **B**=flagellate setae with acute apices, found on adult ♀, second-instar ♀, first-instar nymph, adult ♂ and second-instar ♂; **C**=capitate setae: **Ca**, flagellate setae with capitate apices, found on third and fourth-instar ♂; **Cb**, capitate antennal seta, adult ♂; **D**=fleshy setae, adult ♂; **E**=sensory seta, found on adult ♀, second-instar ♂, second-instar ♀ and first-instar nymph.

DNA extraction and sequencing

Whole specimens of multiple life stages (adult female, second-instar male, first-instar nymph) of *Ac. orzo* **sp. nov.** (FLORIDA: Gadsden Co., Quincy, 2 VII 2024, on *M. capillaris* (Poaceae), L. Deeter, E-2024-06962-1), collected in association with the holotype, were used to extract DNA using the Qiagen Blood and Tissue Kit (Hilden, Germany) per the manufacturer's protocol. Recovered specimen cuticles were slide-mounted following the procedure of Wilkey (1962). Slides were labelled as molecular vouchers, deposited in the FSCA (FSCA_00073768–FSCA_00073772, FSCA_00073796–FSCA_00073797) and included in the paratype series for *Ac. orzo*. The methods for the polymerase chain reactions (PCRs), primer sets, and thermocycler conditions for 18S ribosomal RNA (18S) and cytochrome c oxidase subunit 1 mitochondrial gene (COI) followed those in Ahmed *et al.* (2020), with primers 18S2880 and 18SB used for 18S, and PCOF1 and HCO2198 for COI. All PCRs and cycle sequencing reactions were performed with Applied Biosystems MiniAmp Plus Thermal Cyclers. Resulting DNA sequences were assembled and trimmed in Geneious Prime® 2025.0.3 and then aligned in MEGA7 (Kumar *et al.* 2016) with the default parameters of MUSCLE (Edgar 2004). Newly generated sequences were queried to the NCBI GenBank nucleotide database using the standard nucleotide Basic Local Alignment Search Tool (BLAST) (Altschul *et al*. 1990) and were deposited in GenBank (COI: PV266719–PV266724, 18S: PV268268).

Results

Molecular analysis

COI sequences were identical among the six specimens that yielded data. BLAST searches of the COI sequence suggested the highest sequence similarity (82.12%) to *Acanthococcus azaleae* (Comstock, 1881). 18S sequence data were produced for one specimen, with BLAST searches finding a 98.8% similarity to *Acanthococcus coccineus* (Cockerell, 1894) and a 98.68% sequence similarity to *Ovaticoccus agavium* (Douglas, 1888).

Morphological analysis

Eriococcidae

***Acanthococcus orzo* Deeter, Miller & Powell, sp. nov.**

Proposed common name: muhly grass felt scale

Material examined

Holotype: adult ♀, slide-mounted singly. FLORIDA: Gadsden Co. / Quincy / 30.545026, -84.594270 / 2 JUL 2024 / Lily Deeter / Ex. Muhlenbergia capillaris / E-2024-06962-1// FSCA_00073761. (FSCA)

Paratypes: FLORIDA, all on *M. capillaris* (Poaceae), collected by L. Deeter: **Alachua Co.:** Gainesville, Depot Park, (29.6450, -82.3230), 16.III.2024, E-2024-02816-1, (1 ad. ♀ (FSCA_00073752), 1 second-instar ♂ (FSCA_00073801) on 2 slides) (FSCA); Gainesville, Depot Park, (29.64494, -82.322757), 29.III.2024, E-2024-03057-1, (4 second-instar ♀♀ (FSCA_00073763, FSCA_00073765, FSCA_00073767, FSCA_00073777), 3 first-instar nymphs (FSCA_00073790, FSCA_00073793–FSCA_00073794), 3 second-instar ♂♂ (FSCA_00073802, FSCA_00073807–FSCA_00073808) 1 fourth-instar ♂ (FSCA_0073813) on 11 slides) (FSCA); Gainesville, Doyle Conner Building, 1911 SW 34th St, 3.IV.2024, E-2024-03431-1, (4 second-instar ♀♀ (FSCA_00073780–FSCA_00073782), 2 first-instar nymphs (FSCA_00073787–FSCA_00073788), 1 second-instar ♂ (FSCA_00073799), 1 fourth-instar ♂ (FSCA_00073812) on 8 slides) (FSCA); Gainesville, Depot Park, (29.64489, -82.32273), 29.IV.2024, E-2024-04442-1, (1 ad. ♀ (FSCA_00073753), 2 second-instar ♀♀ (FSCA_00073766, FSCA_00073778, 1 first-instar nymph (FSCA_00073789), 1 second-instar ♂ (FSCA_00073809), 1 third-instar ♂ (FSCA_00073811) on 6 slides) (FSCA); Gainesville, Doyle Conner Building, 1911 SW 34th St, 21.V.2024, E-2024-05582-1, (3 ad. ♀♀ (FSCA_00073758, FSCA_00073754, FSCA_00073774), 2 second-instar ♀♀ (FSCA_00073764, FSCA_00073776), 1 second-instar ♂ (FSCA_00073800) on 6 slides) (FSCA); Gainesville, Doyle Conner Building, 1911 SW 34th St, 11.VI.2024, E-2024-06221-1, (3 ad. ♀♀ (FSCA_00073773, FSCA_00073759- FSCA_00073760), 3 second-instar ♀♀ (FSCA_00073783–FSCA00073785), 3 first-instar nymphs (FSCA_00073786, FSCA_00073791–FSCA_00073792, FSCA_00073795), 4 second-instar ♂♂ (FSCA_00073803–FSCA_00073806) on 12 slides) (8 FSCA, 4 USNM); Gainesville, Swamp Head Brewery, 3650 SW 42nd Ave, 14.VI.2024, E-2024-06374-1, (1 second-instar ♂ (FSCA_00073798) on 1 slide) (FSCA); Gainesville, Swamp Head Brewery, 3650 SW 42nd Ave, 27.VI.2024, E-2024-07317-1, (3 ad. ♀♀ (FSCA_00073750–73751, FSCA_00073775) on 3 slides) (FSCA); **Gadsden Co.:** Quincy, 2.VII.2024, E-2024-06962-1, (7 ad. ♀♀ (FSCA_00073755–73757, FSCA_00073769–FSCA_00073772), 2 first-instar nymphs (FSCA_00073796–FSCA_00073797), 2 second-instar ♂♂ (FSCA_00073768, FSCA_00073810), 1 fourth-instar ♂ (FSCA_00073814), 3 ad. ♂♂ (FSCA_00073815–FSCA_00073817) on 14 slides) (10 FSCA, 1 USNM, 1 CSCA, 1 NCSU, 1 UCD).

Other, non-paratype material examined: FLORIDA, all on *M. capillaris* (Poaceae), collected by L. Deeter unless otherwise specified: **Alachua Co.:** Gainesville, Doyle Conner Building, 1911 SW 34th St, 13.V.2021, coll. S. Halbert & L. Deeter, E-2021-2274-1, (2 ad. ♀♀ (FSCA_00073825–FSCA_00073826), 1 second-instar ♂ (FSCA_00073827) on 3 slides) (FSCA); Gainesville, Doyle Conner Building, 1911 SW 34th St, 21.V.2021, coll. K. Schnepp & L. Deeter, E-2021-2585-1, (1 ad. ♀ (FSCA_00073828) on 1 slide) (FSCA); Gainesville, Doyle Conner Building, 1911 SW 34th St, 21.VI.2021, E-2021-3509-1, (1 second-instar ♂ (FSCA_00073829) on 1 slide) (FSCA); Gainesville, Swamp Head Brewery, 3650 SW 42nd Ave, 26.VIII.2021, coll. J. Brambila, E-2021-4233-1, (1 ad. ♀ (FSCA_00073831), 1 second-instar ♀ (FSCA_00073830) on 2 slides) (FSCA); Gainesville, Depot Park, (29.64494, -82.322757), 29.III.2024, E-2024-03057-1, (1 parasitized ad. ♀ (FSCA_00073823) on 1 slide) (FSCA); Gainesville, Depot Park, (29.64489, -82.32273), 29.IV.2024, E-2024-04442-1, (1 parasitized ad. ♀ (FSCA_00073824) on 1 slide); Gainesville, Doyle Conner Building, 1911 SW 34th St, 21.V.2024, E-2024-06221-1, (1 ad. ♀ (FSCA_00073822) on 1 slide) (FSCA); Gainesville, Swamp Head Brewery, 3650 SW 42nd Ave, 14.VI.2024, E-2024-06374-1, (2 ad. ♀♀ (FSCA_00073820–FSCA_00073821) on 2 slides) (FSCA); **Gadsden Co.:** Quincy, 2.VII.2024, E-2024-06962-1, (1 ad. ♀ (FSCA_00073818), 1 first-instar nymph (FSCA_00073819) on 2 slides) (FSCA).

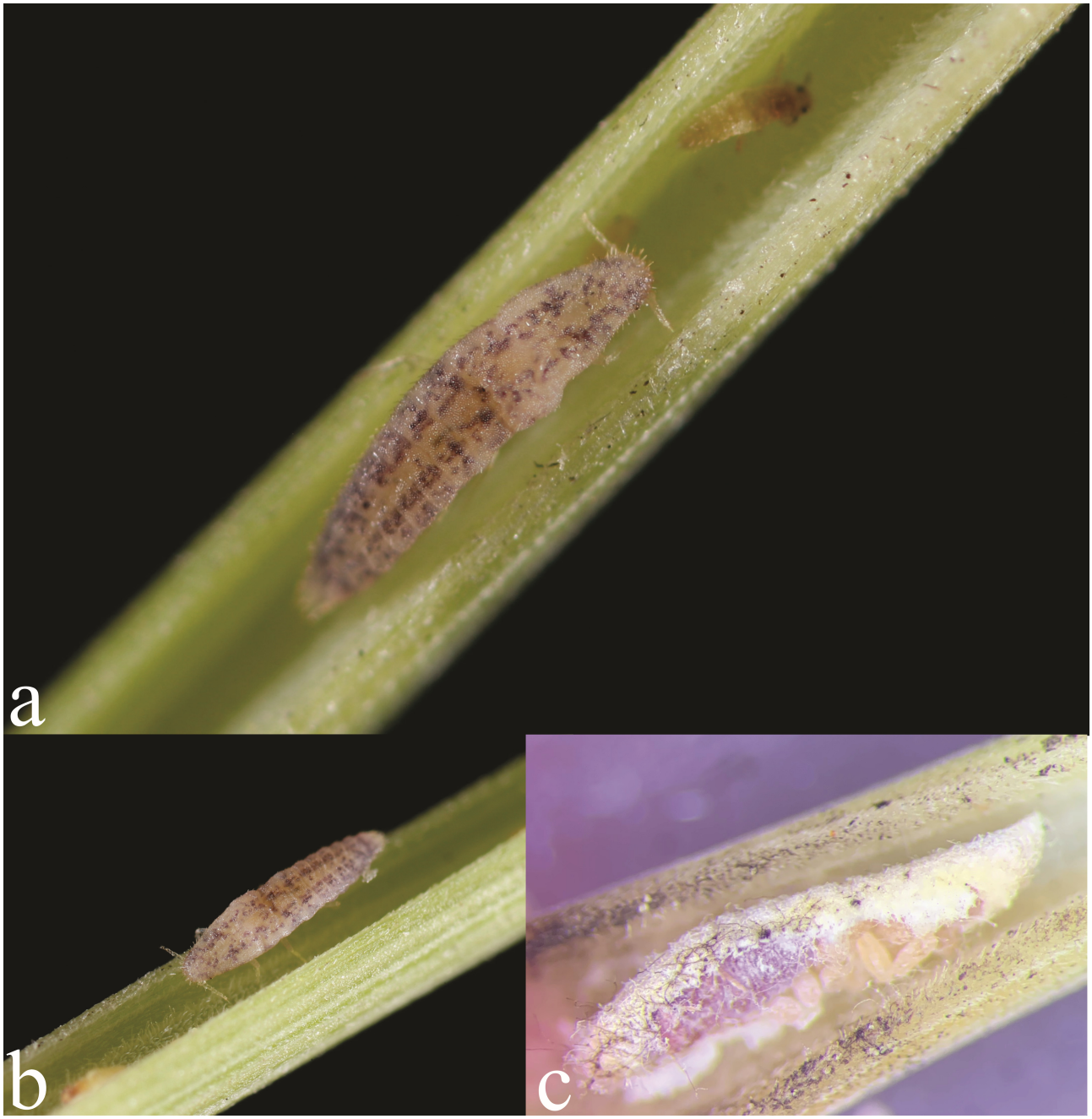

FIGURE 2. *Acanthococcus orzo* Deeter, Miller & Powell, **sp. nov.**, FLORIDA, Gainesville. **(a)** Live adult female and immature nymph inside opened involute leaf blade of *Muhlenbergia capillaris*, Depot Park (29.64494, -82.322757), 29.III.2024, on *M. capillaris* (Poaceae), coll. L. Deeter, E-2024-03057-1. **(b)** Live adult female and immature nymph inside opened involute leaf blade of *M. capillaris*, same collection data. **(c)** Adult female flipped on side to show ventral surface and eggs, Doyle Conner Building, 1911 SW 34th St, 21 V 2024, on *Muhlenbergia capillaris* (Poaceae), coll. L. Deeter, E-2024-05582-1.

Field features: Only observed on *M. capillaris*, never feeding within leaf sheath but always above ligule, within tubular space created by tightly involute leaf blade. Specimens seem to prefer area directly above ligule but can be found anywhere within length of blade. Body oblong elliptical, white to yellow in first-instar nymphs, yellow to mottled with purple in second-instar nymphs and adult females (Figs 2a–b), and purple in gravid adult females (Fig. 2c). Short crystalline wax rods present on dorsum and body margins, curving posteriorly except for those on the head, which are straight. Venter with light dusting of white wax. Mature adult female situated within a long white felted ovisac, with yellow to purple eggs. First ovisac with eggs observed in May (Fig. 2c) and male pupae first observed in March (2024-03057-1, FSCA_0073813).

Etymology: The specific epithet "*orzo*" is a name for ellipsis-shaped pasta, referring to the shape of the adult female and immature stages, and is used as a noun in apposition.

Adult female (Figs 3–4)

Description: Holotype, slide-mounted specimen 1.7 (1.45–3.15 (2.02)) mm long, 0.4 (0.34–0.86 (0.52)) mm across widest part of thorax. Body oblong-elliptical. Anal lobes strongly protruding and marginally sclerotized, each with 3 dorsal elongate-conical enlarged setae with acute apices, anteromedial seta 29 (27–39 (32)) μm, posteromedial seta 35 (33–50 (40)) μm, lateral seta longest 40 (36–50 (43)) μm, without microtubular ducts; each lobe with 3 ventral flagellate setae including anal-lobe setae (not including suranal setae) and 3 5-locular pores on left lobe, 2 5-locular pores on right lobe 2 (2–4 (2)) 5-locular pores on right lobe.

Dorsum with some marginal flagellate setae on anterior abdomen and thorax (these appear dorsal on slide-mounted specimens, though in life are likely ventral due to the ventrally concave body shape and relatively flat dorsum). Enlarged setae of 2 variable sizes: large-sized enlarged setae in single row along margin, except for apical setae on head with 4 regular rows at apex between antennal bases. Segment VII of holotype with 3 large-sized enlarged setae on each margin, remaining abdominal segments each with 4 on each margin; segment VII in paratypes with 3–5 (mostly 4) marginal enlarged setae. Middle marginal seta of each segment usually slightly larger, except segment VII with all of similar size. Marginal enlarged setae elongate conical with acutely rounded apices, directed posteriorly at approximately 45º from margin in young specimens, often with slight concave curve. Apical large-sized enlarged setae on head straight, each perpendicular to cuticle, forming 4 regular rows parallel to apical margin. Apical setae each with slightly truncate apex. Largest lateral seta 43 (36–57 (45)) μm long, decreasing in size towards anterior. Shortest large-sized enlarged marginal seta 16 (11–20 (18)) μm long. Small-sized enlarged setae acute conical, stout, with apices pointing in various directions but mostly posteriorly; small-sized enlarged setae absent from segment VIII, but scattered in irregular rows on medial to sublateral dorsum of other segments; segment V with 11 (11–17 (14)) small-sized enlarged setae on each entire segment. Macrotubular ducts large, about 15–18 μm long, with orifice 3–4 μm wide, slightly larger than a ventral macrotubular duct, scattered on surface of each segment, with 30–32 scattered across each of segments II–VII. Microtubular ducts absent. Multilocular pores absent. Cauda anterior to anal ring with irregular posterior margin, with varying numbers of projections. Areolate texture present on entire dorsum of younger specimens but absent from larger, post-gravid specimens.

Anal ring apical, bearing 3 pairs of setae each about 105 (86–128 (110)) μm long. Suranal setae flagellate, about 38 (32–54 (44)) μm long. Anal tube without sclerotization.

Venter with longest submedial setae on segment VII about 48 (46–77 (62)) μm long, about 41 (41–56 (47)) μm long on segment II; marginal flagellate seta on segment VII about 38 (31–50 (39)) μm long, about 14 (7–11 (9)) μm long on segment II; each abdominal segment with 3–5 pairs of flagellate setae forming 1 irregular transverse row; flagellate setae present in submedial pairs on thoracic segments, with about 11 pairs on head. Each anal lobe with 3 anal-lobe setae and suranal seta present; apical anal-lobe setae about 200 (170–223 (192)) μm long; suranal setae about 40 (33–55 (44)) μm long. Head with single pair of enlarged setae, aligned with rows on margin of dorsal head apex. Macrotubular ducts scattered over entire surface, slightly smaller (about 10 μm long, orifice 2–3 μm wide) than those on the dorsum and less abundant, segments II–VII each with about 10–12 scattered across each segment. Microtubular ducts absent. Multilocular pores with 3–7 (mostly 5) loculi, scattered over entire surface, most abundant on abdomen (with about 15–23 across each segment), present on medial and marginal thorax and head; with a cluster of about 5 around mouthparts on each side; multilocular pores scarcest in mediolateral areas of thorax; multilocular pores around vulva mostly 5-locular. Cruciform pores scattered, most abundant in marginal areas from segment VII to head. Legs with translucent pores on dorsum in proximal lateral area of only the hind coxa; each femur with 5 setae; translucent pores absent from femora; each tibia with 4 distal setae, without pores and without seta in middle of length; length of hind tibia/length of hind tarsus 0.88 (0.79–0.96 (0.88)); claw with minute denticle near tip; tarsus with digitules capitate, extending beyond claw. Antennae each 7 segmented, about 190 (179–229 (201)) μm long, segments of about same size, 3rd or 4th segments slightly larger than others; flagellate setae present on all antennal segments; distal 3 antennal segments with both flagellate setae and slender sensory setae, each slightly thicker than a flagellate seta and with rounded apex. Frontal lobes absent. Minute preantennal pore present on each side. Eyes each with irregular sclerotized rim. Microtrichia present from segment VIII to mesothorax and on ventral surface of all coxae.

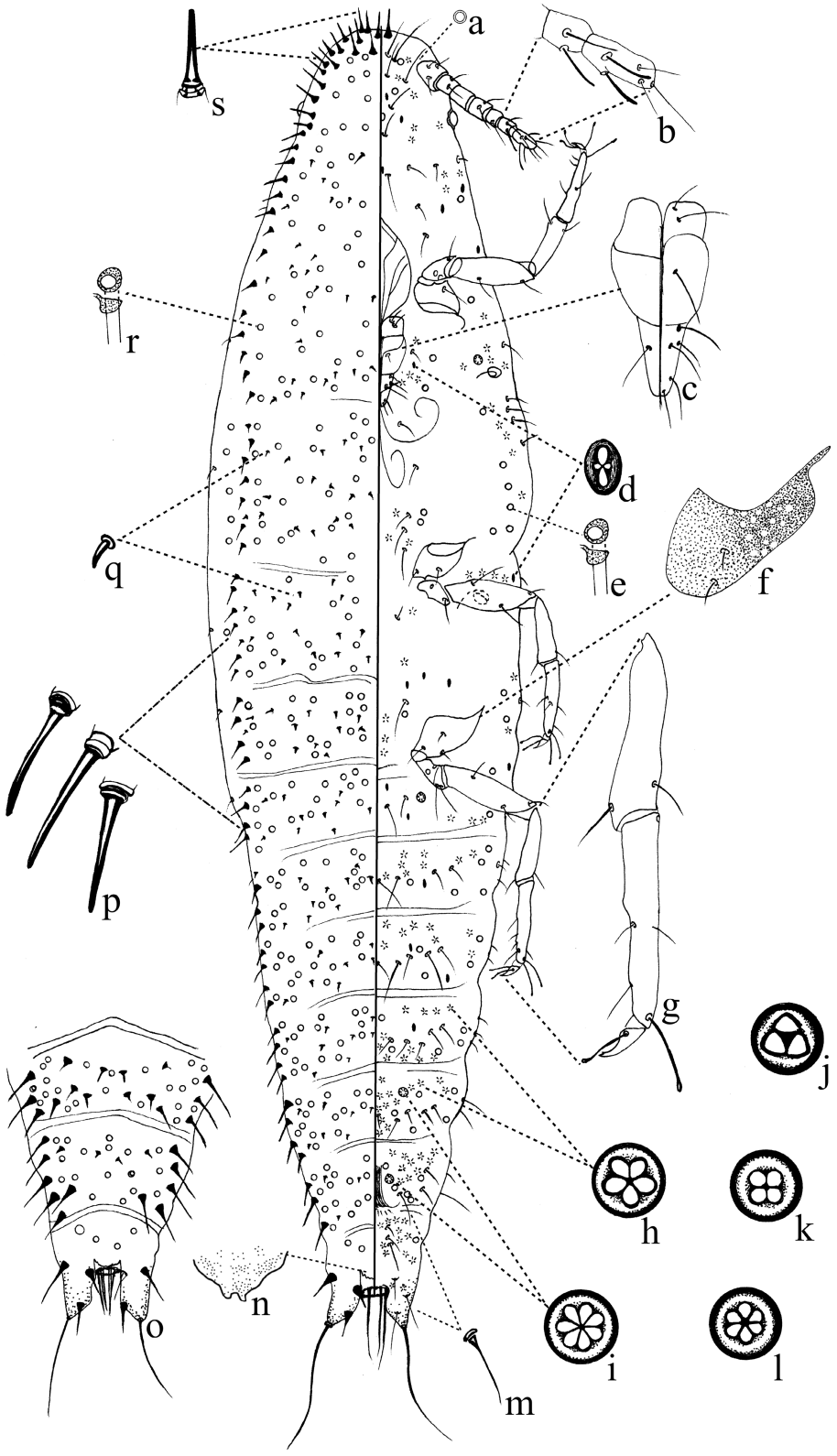

FIGURE 3. *Acanthococcus orzo* Deeter, Miller & Powell, **sp. nov.**, adult female holotype illustration. FLORIDA, Gadsden Co., Quincy, 2.VII.2024, on *Muhlenbergia capillaris* (Poaceae), coll. L. Deeter, E-2024-06962-1, FSCA_00073761. **a**=preantennal pore; **b**=apical and subapical antennal segments with flagellate and sensory setae; **c**=dorsal (left) and ventral (right) labium; **d**=cruciform pore; **e**=macrotubular duct; **f**=hind coxa with translucent pores; **g**=dorsal surface of hind tibia, tarsus, and claw; **h**=5-locular pore; **i**=7-locular pore; **j**=3-locular pore; **k**=4-locular pore; **l**=6-locular pore; **m**=flagellate seta; **n**=cauda; **o**=variation of submarginal enlarged setae on abdominal segment VII (see description); **p**= marginal large-sized enlarged setae with variation, straight to slightly curved; **q**= small-sized enlarged setae; **r**=macrotubular duct; **s**=apical large-sized enlarged setae.

FIGURE 4. *Acanthococcus orzo* Deeter, Miller & Powell, **sp. nov.**, adult female holotype slide-mounted specimen. FLORIDA: Gadsden Co., Quincy, 2.VII.2024, on *Muhlenbergia capillaris* (Poaceae), coll. L. Deeter, E-2024-06962-1, FSCA_00073761.

Variation: The submarginal pair of dorsal enlarged setae on segment VII are variable and can be either large-sized (seen in 11 out of 15 type specimens) or small-sized. In one instance, there is one large-sized enlarged seta on only one submargin of segment VII. In some cases (five out of 15 type specimens), submarginal setae on segments anterior to segment VII are slightly enlarged, but progressively decrease in size anteriorly until around segment III, where they are small-sized.

Diagnosis: *Acanthococcus orzo* differs from other described eriococcids by having: (i) four setae on each hind tibia, lacking a seta in the middle of the tibia length; (ii) three pairs of anal-ring setae; (iii) three to five (mostly four) large-sized enlarged setae on the margins of each abdominal segment; (iv) enlarged setae elongate-conical with acute to slightly rounded or slightly truncate apices, curved to straight, present on margins or dorsal submargins of posterior abdominal segments; and (v) microtubular ducts absent.

Notes: This description is based on 15 specimens from three localities. *Acanthococcus orzo* is superficially similar in morphology to many grass-infesting eriococcids. Feeding in tight, flat spaces within sheaths and blades of grass has likely selected for convergent traits such as an elongated body with restriction of enlarged setae to the margins. Species most similar to *Ac. orzo* are discussed below, and include *Ac. actius* Miller & Miller, *Anophococcus oblongus* (Borchsenius, 1949), *An. insignis, Ac. dennoi* D. Miller & G. Miller, and *Ac. danthoniae* (Maskell, 1891).

The adult female of *Ac. orzo* is most similar to that of *Ac. actius*, another grass-infesting species found in Florida, in having the following character states: (i) large-sized enlarged setae restricted to dorsal margins; (ii) four setae on each hind tibia, lacking a seta in the middle of the tibia length; (iii) small denticle near tip of tarsal claw; (iv) multilocular pores around vulva mostly with 5 loculi; and (v) elongate body shape. However, they differ from each other as follows (*Ac. actius* character states in brackets): (i) four setae on front tibiae (five setae on front tibiae); (ii) three pairs of anal-ring setae (four or five pairs of anal-ring setae); and (iii) microtubular ducts absent (zero to three microtubular ducts on dorsum of anal lobes) (Miller & Miller 1993).

The adult female of *Ac. orzo* is also similar to that of *Anophococcus oblongus*, which is known to occur in China and Tajikistan (Borchsenius 1949; Tang & Hao 1995; Hua 2000; García Morales *et al*. 2016). These species are similar in having the following features: (i) large-sized enlarged setae restricted to the body margins, with small-sized enlarged setae scattered across the dorsum (Kozár *et al.* 2013); (ii) each abdominal segment with up to five marginal enlarged setae on each side, with two larger than the rest (Danzig 1962); (iii) venter with cruciform pores; (iv) 7-segmented antennae; (v) hind coxae with translucent pores; (vi) small-sized enlarged setae on the dorsum; (vii) dorsum of anal lobes each with three large-sized enlarged setae; (viii) cauda present above anal ring; and (ix) claw with small denticle. They differ from each other as follows (*An. oblongus* character states in brackets): (i) with only four setae on each hind tibia, lacking one in the middle (five setae on each hind tibia, with one in the middle of tibia length); (ii) translucent pores absent from hind femur (present); (iii) frontal lobes absent (frontal lobes developed); (iv) microtubular ducts absent (microtubular ducts scattered across dorsum, few across venter); and (v) anal ring bearing three pairs of setae (anal ring bearing four pairs of setae) (Borchsenius 1949; Kozár *et al.* 2013).

The adult female of *Ac. orzo* is similar to that of *Anophococcus insignis*. The latter species reportedly infests 16 host families including Poaceae and is present in Europe and the United States (California, Idaho, Minnesota, New York, and Washington) (Miller & Miller 1992; García Morales *et al*. 2016). These species are similar in having the following: (i) large-sized enlarged setae restricted to the body margins, with small-sized enlarged setae scattered across the dorsum (Danzig 1962; Kozár *et al.* 2013); (ii) translucent pores present on hind coxa; (iii) cauda present above anal ring; and (iv) claw with a denticle (Kozár *et al.* 2013). However, they differ as follows (*An. insignis* character states in brackets): (i) body yellow to purple in life (bright red); (ii) multilocular pores with 5 loculi most abundant (7-locular pores most abundant); (iii) microtubular ducts absent (microtubular ducts scattered across dorsum, and a few across venter); (iv) anal ring bearing three pairs of setae (anal ring bearing four pairs of setae); and (v) four setae on each hind tibia, lacking one in the middle (five setae on each hind tibia, with one in the middle of tibia length) (Miller & Miller 1992; Kozár *et al.* 2013).

Furthermore, the adult female of *Ac. orzo* is somewhat similar to that of *Ac. dennoi*, and keys out to this species in Miller & Miller (1993) in having the following character states: (i) four setae on each hind tibia, lacking a seta in the middle of the tibia length; (ii) large-sized enlarged setae restricted to the body margins; and (iii) large-sized enlarged setae straight to slightly curved. They differ as follows (*Ac. dennoi* character states in brackets): (i) with four to five large-sized enlarged setae on margins of abdominal segments (two, sometimes one, large-sized enlarged setae on the margins of each segment); (ii) four regular rows of large-sized enlarged setae on apex of head

(two irregular rows of large-sized enlarged setae at apex of head); (iii) dorsal 5-locular pores absent (dorsal 5-locular pores present or absent from posterior abdomen); and (iv) anal ring bearing three pairs of setae (anal ring bearing four pairs of setae) (Miller & Miller 1993).

Acanthococcus orzo also bears some similarity to *Ac. danthoniae* (Maskell, 1891), and keys out to this species in Hoy (1962). *Acanthococcus danthoniae* is known from the South Island of New Zealand, from only two collections, one of which was from a "narrow-leaved native grass." The species are similar in having an elongated body with the restriction of large-sized enlarged setae to the margins. They differ from each other as follows (*Ac. danthoniae* character states in brackets): (i) *Ac. orzo* with three to five marginal large-sized enlarged setae per abdominal segment (three marginal enlarged setae per abdominal segment); (ii) anal ring bearing three pairs of setae (anal ring bearing four pairs of setae); (iii) body shape elongate elliptical (body elongate oval); and (iv) microtubular ducts absent (microtubular ducts present in small numbers across dorsum) (Maskell 1891; Hoy 1962).

Second-instar female (Fig. 5)

Description: Bodies of slide-mounted specimens 0.9–1.4 (1.2) mm long, 0.25–0.4 (0.3) mm across widest part of thorax, oblong-elliptical with protruding anal lobes. Anal lobes apically acute, with lightly to moderately sclerotized margins. Each lobe with 3 large-sized enlarged setae, each elongate conical in shape, with lateral pair slightly longer (each seta about 32 μm long) than anteromedial and posteromedial pairs (each seta about 25 μm long); each lobe ventrally with 3 flagellate setae including apical anal-lobe setae, and lacking multilocular pores.

Dorsum with 1 small flagellate seta on margin of each segment from segment VI to head, each seta about 7 μm long (these appear dorsal on slide-mounted specimens, though in life are likely ventral due to the ventrally concave body shape and relatively flat dorsum). Enlarged setae forming 1 transverse row per body segment, and 3 or 4 pairs of longitudinal lines down segments I–VII (submedial, mediolateral, and submarginal pairs). Enlarged setae of 2 sizes: (i) larger-size setae present along entire body margin, 30–40 μm long; with 2 on margin of each abdominal segment, except for segment VII with 3; and (ii) small-sized enlarged setae present in submarginal to medial areas; largest small-sized enlarged setae 8–14 (12) μm long; marginal setae about twice as long as medial setae on same segment; marginal setae straight to slightly curved, slender, with acute to slightly rounded apices, directed posteriorly at approximately 45º from margin; apical large-sized enlarged setae on head straight, set perpendicular to cuticle, with slightly truncate apices, in 2–3 regular marginal to submarginal rows, parallel with apical margin; medial setae straight to slightly curved conical, with acute to slightly rounded apices. Microtubular ducts absent. Cauda anterior to anal ring with irregular posterior margin, with varying numbers of projections. Microtrichia present from segment VIII to metathorax. Derm with areolate texture.

Anal ring apical, bearing 3 pairs of setae 73–87 (84) μm long. Suranal setae flagellate, each about 33 μm long. Anal tube without sclerotization.

Venter with flagellate setae present singly on margin of each segment from segment VII to thorax; marginal setae on segment II 3–8 (6) μm long; those on segment VII 20–35 (28) μm long; with transverse rows of 1–3 pairs of flagellate setae on each body segment, forming 1–3 pairs of longitudinal lines down abdomen. Single pair of large-sized enlarged setae present on head, aligned with rows on margin/dorsum of head's apex between antennal bases. Macrotubular ducts and microtubular ducts absent. Multilocular pores with 3–7 loculi, distributed as follows: (i) 5-locular pores (Fig. 5f) most abundant, usually present on all body segments, sometimes 1 on anal lobe segment, with 3–6 on each abdominal segment, and scattered on thorax and head; pores on abdomen variable; (ii) 7-locular and 6-locular pores rare, each seen on abdomen in only 1 of 10 specimens observed; (iii) 4-locular pores occasionally present on abdomen and head; and (iv) 3-locular pores occasionally present singly near spiracles, medially on abdomen and head. Single cruciform pores present on submargin of each segment from segment VI to thorax, and 1 or 2 medially on head. Spiracles usually associated with 5-locular pores but occasionally with 3- to 8-locular pores; also with 4–6 multilocular pores associated with each spiracle. Legs with hind coxae each with 2 dorsal translucent pores, each about 2.5 μm in diameter; each tibia with 4 setae on distal end, lacking seta in middle of tibia length; length of hind tibia/length of hind tarsus 0.66–0.83 (0.74). Claw with small denticle near tip; tarsus with digitules capitate, extending beyond claw. Antennae each 6-segmented, 131–153 (142) μm long, third segment longest; flagellate setae present on all antennal segments; distal 3 antennal segments each with both flagellate setae and slender sensory setae, these slightly thicker than flagellate setae, with rounded apices. Frontal lobes absent;

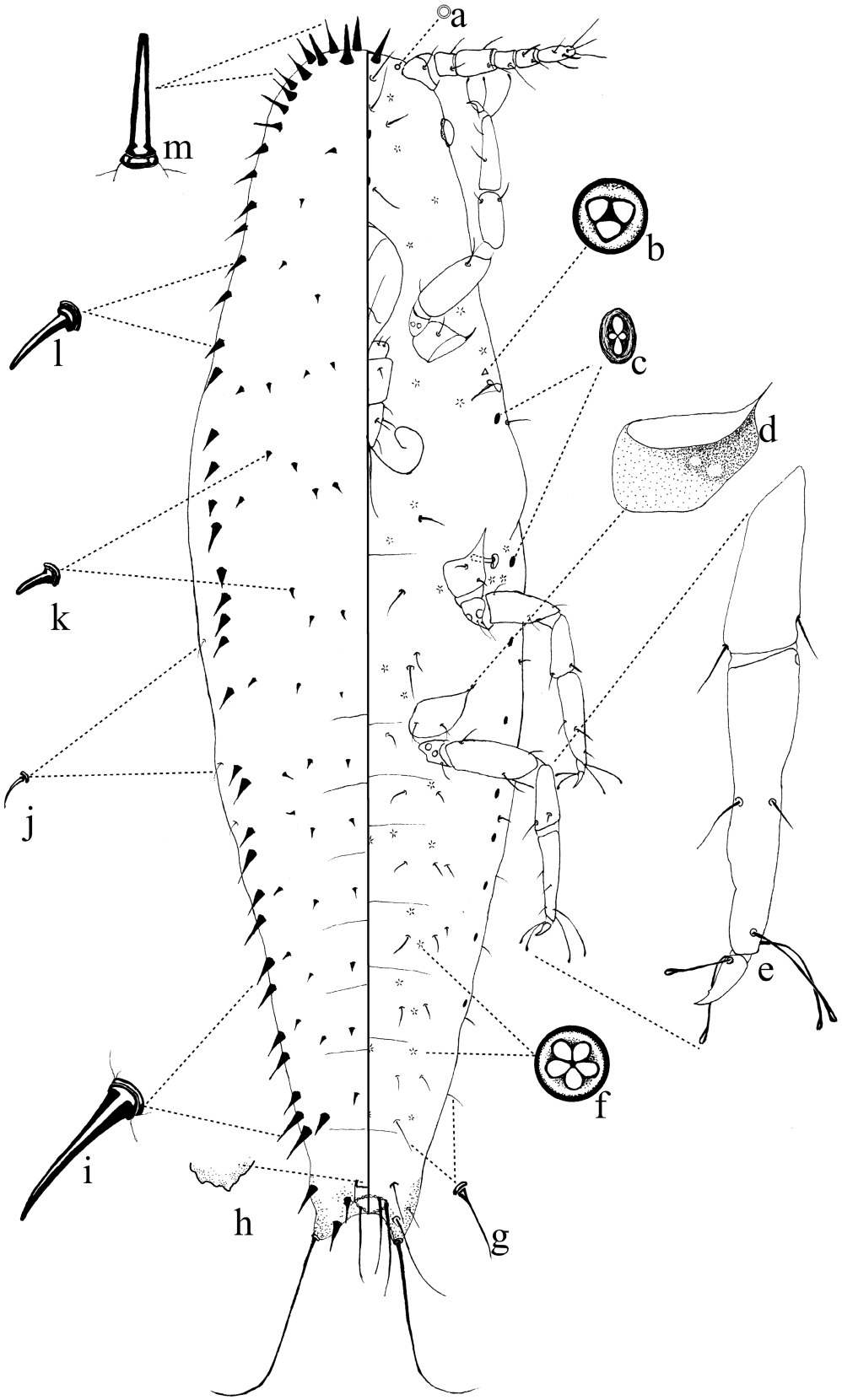

FIGURE 5. *Acanthococcus orzo* Deeter, Miller & Powell, **sp. nov.**, second-instar female. FLORIDA: Alachua Co., Gainesville, Depot Park, (29.64494, -82.322757), 29.III.2024, on *Muhlenbergia capillaris* (Poaceae), coll. L. Deeter, E-2024-03057-1, FSCA_00073767. **a**=preantennal pore; **b**=3-locular pore; **c**=cruciform pore; **d**=hind coxa with translucent pores; **e**=dorsal surface of hind tibia, tarsus, and claw; **f**=5-locular pore; **g**=flagellate seta; **h**=cauda; **i**=marginal large-sized enlarged seta; **j**=flagellate seta; **k**=small-sized enlarged seta; **l**=large-sized enlarged seta; **m**=apical large-sized enlarged seta.

preantennal pore present on each side. Microtrichia present from segment VIII to mesothorax. Eyes each with sclerotized rim.

Variation: The submarginal pair of dorsal enlarged setae on segment VII are variable and can be either large-sized (seen in four out of 10 specimens) or the typical small-size. In one instance, a large-sized enlarged seta is present on only one side of segment VII, with a small-sized seta on the other side. When the submarginal setae on segment VII are large-sized, the rest of the small-sized enlarged setae are larger on average, particularly on the head.

Notes: This description is based on 10 specimens from two localities. The second-instar female of *Ac. orzo* is most similar to that of *Ac. hoyi* Miller & Miller, 1992, another grass-infesting species in the United States, in having the following character states: (i) large-sized enlarged setae restricted to margins; (ii) two large-sized enlarged setae per segment on segments II–VI; and (iii) anal-ring with three pairs of setae. The second-instar female nymphs of these species differ from each other as follows (*Ac. hoyi* character states in brackets): (i) front and hind tibiae each with four setae, each lacking a seta in the middle of tibia length (tibiae each with five setae, middle seta present); and (ii) enlarged setae more slender, elongate conical, with acute to slightly rounded apices (enlarged setae more cylindrical-conical, with distinctly blunt apices) (Miller & Stocks 2022).

First-instar nymph (Fig. 6)

Description: Bodies of slide-mounted specimens 0.56–0.94 (0.74) mm long, 0.18–0.29 mm across widest part of thorax, elongate elliptical with protruding anal lobes. Each anal lobe apically rounded or slightly acute, lightly sclerotized; with 3 enlarged setae on dorsum (anteromedial pair usually shorter than posteromedial and lateral pairs); microtubular ducts absent, and 3 flagellate setae on venter, including apical setae. Tubular ducts absent.

Dorsum with 1 small flagellate seta on margin of each segment from segment VI to prothorax (these appear dorsal on slide-mounted specimens, though in life are likely ventral due to the ventrally concave body shape and relatively flat dorsum). Enlarged dorsal setae in 3 distinct pairs of longitudinal lines (lateral, mediolateral and submedial). Enlarged setae all about same size and shape, elongate conical with acute apices. Longest setae located on apex of head, with longest seta about 26 μm long, each elongate conical. Enlarged setae on anal lobes and margins of segment VII of similar size and shape, usually slightly shorter than setae on head, largest anal-lobe seta about 24 μm long. Enlarged setae occurring from segment VII to thorax slightly smaller than setae on head and anal lobes. Enlarged setae becoming progressively smaller from margin to median area, with length of submedial setae (each about 8 μm long) as little as half as long as submarginal setae on same segment (each about 16 μm long); smallest setae occurring in abdominal submedial lines. Enlarged setae generally slightly curved and directed posteriorly, except for those on head straight. Microtrichia present from segment VIII to mesothorax. Macrotubular and microtubular ducts absent.

Anal ring apical, marginal, bearing 3 setae and 8 pores on each side. Flagellate suranal setae each about 23 μm long. Anal tube without sclerotization.

Venter with flagellate setae numbering 3 pairs on each segment, longest on segments II–VII, each about 15 μm long. Apical anal-lobe setae about 160–205 (185) μm long. Enlarged setae and tubular ducts absent. Multilocular pores with 3 or 5 loculi; 3-locular pores present submedially on each segment from segment VI to prothorax; 5-locular pores present in pairs between eyes and each side of clypeus. Anterior and posterior spiracles each associated with one 3- or 5- locular pore. Cruciform pores (sometimes 3-locular pores) present singly on each margin of each segment. Macrotubular ducts and microtubular ducts absent. Legs without translucent pores; each femur with 5 setae; each tibia with 4 setae, without seta in middle; length of hind tibia/length of hind tarsus 0.61–0.76 (0.70); claw with small denticle near tip; tarsus with digitules capitate, extending beyond claw. Antennae each 6-segmented, 99–114 (105) μm long; with flagellate setae on all antennal segments, and distal 3 segments each with both flagellate and slender sensory setae, with sensory setae slightly thicker than flagellate setae and with rounded apices. Frontal lobes absent. Preantennal pore present on each side. Microtrichia present from segment VIII to mesothorax. Eyes each with sclerotized rim.

Notes: This description is based on 10 specimens from three localities.

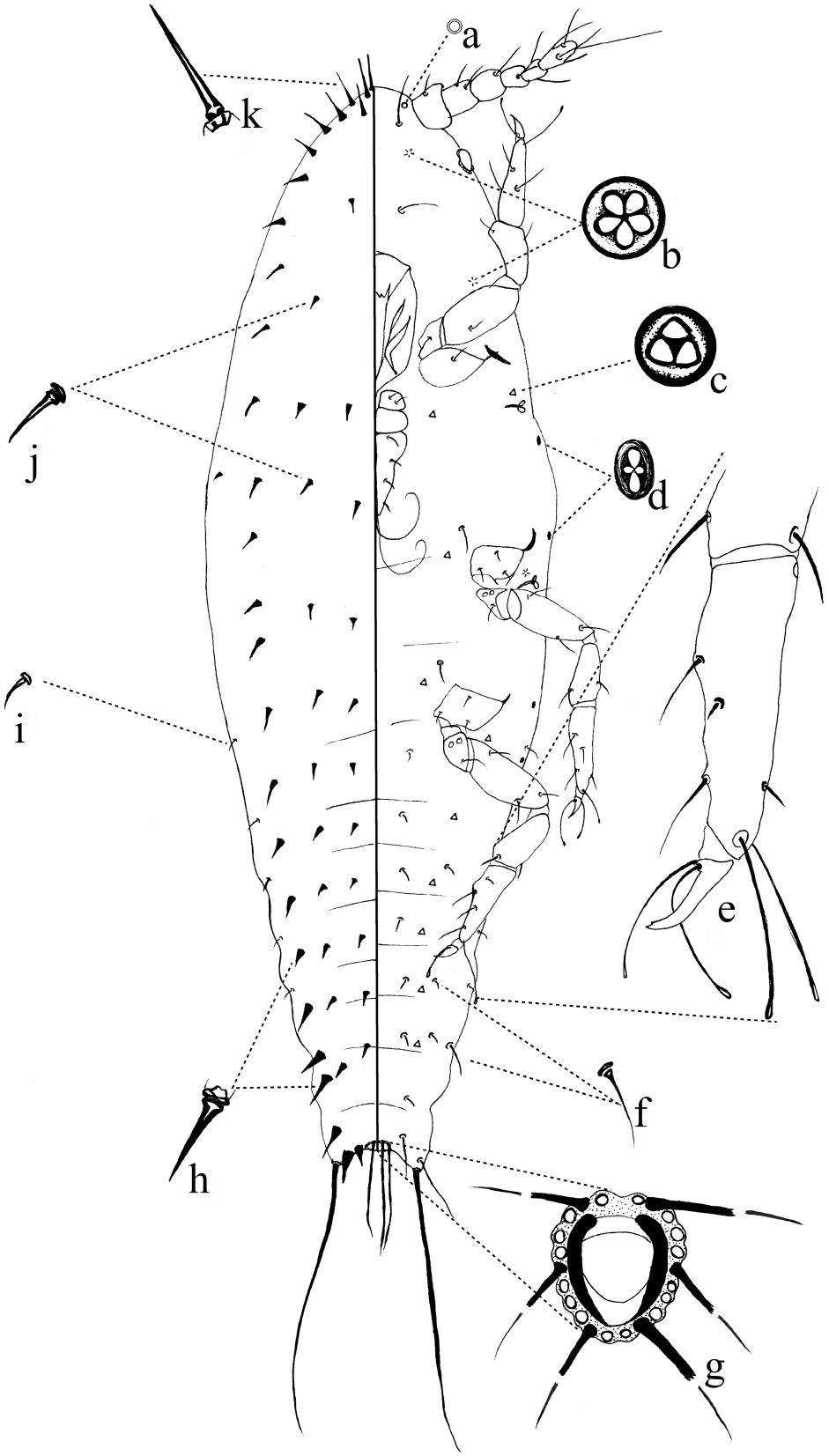

FIGURE 6. *Acanthococcus orzo* Deeter, Miller & Powell, **sp. nov.**, first-instar crawler illustration. FLORIDA: Alachua Co., Gainesville, Doyle Conner Building, 1911 SW 34th St, 11.VI.2024, on *Muhlenbergia capillaris* (Poaceae), coll. L. Deeter, E-2024-06221-1, FSCA_00073786. **a**=preantennal pore; **b**=5-locular pore; **c**=3-locular pore; **d**=cruciform pore; **e**=dorsal surface of distal end of hind tibia, tarsus, and claw; **f**=flagellate seta; **g**=apical view of anal ring bearing 3 pairs of setae; **h**=marginal enlarged seta; **i**=flagellate seta; **j**=medial enlarged seta; **k**=apical enlarged seta.

Acanthococcus orzo first-instar nymphs are similar to those of *Ac. dennoi* in having: (i) front and hind tibiae each with four setae, lacking a seta in the middle of the tibia's length; (ii) cruciform pores present on ventral thoracic submargins; and (iii) abdominal enlarged setae arranged in three pairs of longitudinal lines. They can be differentiated from each other as follows (*Ac. dennoi* character states in brackets): (i) multilocular pores near spiracles usually 3- or 5-locular (multilocular pores near spiracles each usually 7- or 9-locular); and (ii) multilocular pores on abdomen predominantly 3-locular (multilocular pores on abdomen predominantly 5-locular) (Miller & Stocks 2022).

Acanthococcus orzo first-instar nymphs are also similar to those of *Ac. pennyae* Miller & Stocks 2022 in having: (i) front and hind tibiae each with four setae, lacking a seta in the middle of each tibia's length; (ii) multilocular pores on abdomen with mainly 3 loculi; and (iii) abdominal enlarged setae arranged in three pairs of longitudinal lines. They can be differentiated from each other as follows (*Ac. pennyae* character states in brackets): (i) multilocular pores near spiracles either 3- or 5- locular (multilocular pores near spiracles only 5-locular); and (ii) cruciform pores present (cruciform pores absent) (Miller & Stocks 2022).

Adult male (Fig. 7)

Description: Bodies of slide-mounted specimens about 1.19 mm long, 0.25 mm across widest part of thorax, elongate, with segment VIII slightly produced laterally. Wingspan slightly greater than total body length; each wing about a quarter as wide as long. Body with short flagellate setae; antennae with fleshy setae and capitate setae on most segments; legs with fleshy setae on tibia and tarsus.

Head: Dorsum with about 10 pairs of setae anterior to postoccipital ridge (por), including about 7 pairs between antennal bases. X-type pores absent between antennae. Postoccipital ridge (por) well developed, sclerotized, with posterior arm and well-developed anterior arm. Dorsal arm of midcranial ridge (dmcr) thin, almost reaching postoccipital ridge; connected to lateral midcranial ridge (lmcr) arms anteriorly. Lateral ocellus (o) present where ventral and dorsal postocular ridges reach margins of head, not touching postocular ridge (pocr). Ocular sclerite (ocs) strongly sclerotized, circling the dorsal eyes (de). Dorsal eyes 24–30 (27) μm in diameter. *Venter* with about 2 pairs of flagellate setae between antennal bases, and 1 pair of setae between ventral eyes. Mouth tubercule (mt) present. Preoral ridge (pror) strongly sclerotized. Cranial apophysis (ca) developed. Ventral midcranial ridge (vmcr) present, reaching preocular ridge (procr). Postocular ridge (pocr) strongly sclerotized. Ventral ocular sclerite (ocs) large and sclerotized, giving mask-like appearance around ventral eyes, with dorsal and ventral ocular sclerites not connected. Ventral eyes (ve) 23–27 (25) μm in diameter.

Antennae: In all 3 specimens studied, antenna with 10 segments, except 1 paratype with 10 segments on left side and 9 on right; antennae 689–782 (727) μm long, with third segment longest, about 2 times longer than apical segment; apical segment oval; fleshy setae (fs) present on all antennal segments except basal segment, about 12 μm long, increasing in length from basal to distal segments. Capitate setae (a) present on third antennal segment to apical segment. Antennal bristles (ab) about 35 μm long, present on 3 apical segments.

Thorax: Dorsum with 3 setae on each tegula (teg), 1 pair of setae on prescutum (prsc), and 2 pairs of setae on scutellum. Metapostnotal sclerite (pn3) weakly developed. Scutellar ridge (sclr) well developed. Scutum (sct) sclerotized throughout. Prescutum (prsc) with a transverse posterior margin and round to oval anterior margin. Prescutal suture (pscs) well developed. Pronotal ridges (prnr) developed. Pronotal sclerites absent. Hamulohalteres absent. Each wing with alar lobe (al), alar sclerites (alsc) and veins (wv), but without setae or sensoria; individual wing width 950–1025 (997) μm long. *Venter* with 2 pairs of setae between hind coxae. Metasternal sclerite (stn3) weakly developed. Mesosternal sclerite (stn2) well developed, with large furca (f). Mesepisternum (eps2) partially sclerotized. Lateropleurites (lpl) on mesothorax triangular. Prosternum (stn1) triangular and sclerotized. Metapleural ridge (plr3) well developed. Legs with prothoracic pair of coxae 83–87 (85) μm long; metathoracic coxae 77–83 (83) μm long; prothoracic femur 134–145 (139) μm long; metathoracic femur 138–147 (143) μm long; prothoracic tibia 189–196 (193) μm long; metathoracic tibia 188–205 (198) μm long; prothoracic tarsus 71–83 (75) μm long; metathoracic tarsus 71–79 (75) μm long. Fleshy setae (fs) present on outer distal half of each tibia and outer portion of each tarsus; legs with 2–5 (3) on tibia, 2–3 (2) on tarsus. Two spurs on inner distal margin of tibia. Claw with minute denticle near tip; digitules on tarsus and claw all capitate. Spiracles without associated pores or setae.

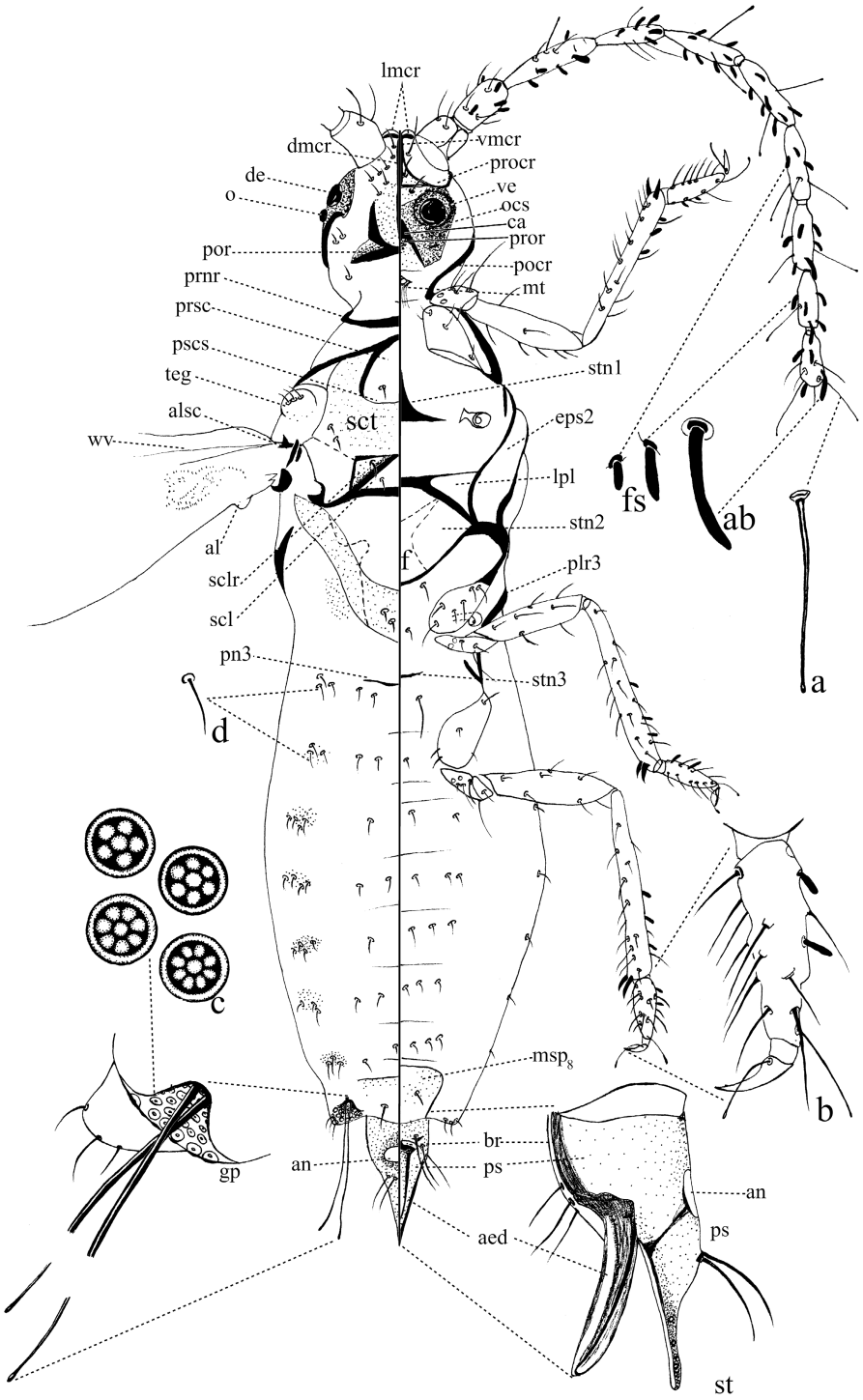

FIGURE 7. *Acanthococcus orzo* Deeter, Miller & Powell, **sp. nov.**, adult male. The illustration utilized three paratypes from the same collection: FLORIDA: Gadsden Co.: Quincy, 2.VII.2024, on *Muhlenbergia capillaris* (Poaceae), coll. L. Deeter, E-2024-06962-1, FSCA_00073815–FSCA_00073817. **a**=capitate antennal seta; **ab=**antennal bristles; **al**=alar lobe; **alsc**=alar sclerites; **an**=anal opening; **b=** dorsal surface of hind tarsus and claw; **br**=basal rod of aedeagus; **c**=multilocular pores with variation of 5–8 loculi; **ca**=cranial apophyses; **d**=flagellate body seta; **de**=dorsal eye; **dmcr**=dorsal midrcranial ridge; **eps2**=mesepisternum; **f**=furca; **gp**=glandular pouch; **lmcr**=lateral arm of midcranial ridge; **msp$_8$**=medial sternal plate of segment VIII; **mt**=mouth tubercle; **o**=ocellus; **ocs**=ocular sclerite; **plr3=**metapleural ridge; **pn3**=metpostnotal sclerite; **pocr**=postocular ridge; **por**=postoccipital ridge with posterior and anterior arms; **prnr**=pronotalridge; **procr**=preocular ridge; **prsc**=prescutum; **ps**=penial sheath; **pscs**=prescutal suture; **scl**=scutellum; **sclr**=scutellar ridge; **sct**=scutum; **st**=style with papillae; **stn1**=prosternum; **stn2**=mesosternal sclerite; **stn3**=metasternal sclerite; **teg**=tegula; **ve**=ventral eye; **vmcr**=ventral midcranial ridge; **wv**=wing veins.

Abdomen: Dorsum with 1 pair of glandular pouches (gp), each pouch containing 2 apically capitate setae of approximately equal lengths, 128–150 (137) μm long, and about 35 tightly clustered multilocular pores in each pouch surrounding setae; diameter of pore clusters 30–40 (35) μm; multilocular pores with 5–8 (mostly 6, occasionally 8) loculi. Flagellate setae slender with acute apices, curved, approximately same size as setae on venter; segments II–VII each with 1 pair of submarginal clusters of 3–4 pleural setae situated on slightly sclerotized patches, 1 pair of mediolateral setae and 1 pair of submedial setae. Microtrichia present on segments II–VIII. *Venter* with abdominal flagellate setae with acute apices, present marginally, medially and submedially to mediolaterally, becoming less abundant on anterior abdominal segments; pleural setae on segment VIII 13–19 (16.5) μm long. Abdomen membranous except for sclerotization on median sternal plate of segment VIII (msp_8).

Penial sheath (ps) elongate, 122–123 μm long, 63–64 μm wide at base; about equally sclerotized throughout. Style (st) straight, apically with papillae. Dorsal surface with 2 setae on each side; ventral surface with 3 setae on each side. Basal rod (br) of aedeagus small, not reaching anterior margin of penial sheath. Anal opening (an) 17–22 (20) μm in diameter, dorsal, anterior margin 25–27 (26) μm from anterior margin of sclerotized capsule of penial sheath.

Diagnosis: Adult males of *Ac. orzo* can be distinguished from other described adult male eriococcids known to infest grasses by having the following combination of character states: (i) ventral ocular sclerite large and sclerotized, with dorsal and ventral ocular sclerites not connected, giving mask-like appearance around ventral eyes; (ii) a large, sclerotized postoccipital ridge with anterior and posterior arms developed; (iii) hamulohalteres absent; (iv) fleshy setae present on tibia and tarsus; and (v) fleshy setae present on all antennal segments anterior to base (scape) and capitate setae on third segment to apical segment.

Notes: This description is based on three specimens from one locality. Specimens were reared from pupae collected from the same infestation as the female holotype. Other eriococcids reported from grass with adult males described include *Acanthococcus tenuis* (Green, 1922), *Anophococcus pseudinsignis* (Green, 1921), *Gossyparia spuria*, and *Rhizococcus munroi* (Boratyński, 1962).

Acanthococcus orzo adult males are most similar to those of *R. munroi* in having (i) fleshy setae on all antennal segments anterior to basal segment; (ii) a well-developed sclerotized postoccipital ridge with anterior and posterior arms developed; and (iii) fleshy setae present on tibia and tarsus. They differ from each other as follows (*R. munroi* character states in brackets): (i) hamulohalteres absent (hamulohalteres present); (ii) ventral ocular sclerite large and sclerotized, giving mask-like appearance around ventral eyes, but unconnected to dorsal sclerites (ventral and dorsal ocular sclerites connected around the lateral areas of head); and (iii) fleshy setae absent from coxae and femur (fleshy setae present on coxae and femur) (Hodgson 2005).

Hodgson (2005) described the adult male of *An. pseudinsignis* from eight specimens collected without associated females, and speculated that their identity was *An. pseudinsignis* as it is the only eriococcid species recorded in Greenland. These species can be differentiated as follows (*An. pseudinsignis* character states in brackets): (i) hamulohalteres absent (hamulohalteres present); (ii) fleshy setae present on all antennal segments except basal segment (fleshy setae restricted to three distal antennal segments); and (iii) fleshy setae present on tibia and tarsus (fleshy setae absent from legs) (Hodgson 2005).

Gossyparia spuria is a pest of elm and other hosts in the United States and has been reported from grass (Hoy 1963; García Morales *et al.* 2016), although it is not likely a preferred host. *Acanthococcus orzo* adult males can be differentiated from the macropterous male form of *G. spuria* as follows (*G. spuri*a character states in brackets): (i) X-type pores absent from head (one or two X-type pores present at apex of head); (ii) hamulohalteres absent (hamulohalteres present); (iii) fleshy setae present on tibia and tarsus (fleshy setae absent from legs); and (iv) segment VIII with short pleural seta, 15–20 (16.5) μm long, much less than half as long as a glandular pouch seta (segment VIII with long pleural setae, each about half as long as a glandular pouch seta) (Afifi 1968; Hodgson 2020).

Jancke (1955) gave a short description of the adult male of *Ac. tenuis* with a partial illustration. It is a grass-infesting species known only from Sri Lanka (Green 1922). The species is similar to *Ac. orzo* in lacking hamulohalteres. These species can be differentiated as follows (*Ac. tenuis* character states in brackets): (i) fleshy setae present on antennae (fleshy setae absent from antennae) (Green 1922; Jancke 1955); and (ii) fleshy setae present on tibia and tarsus (fleshy setae absent from tibia and tarsus) (Jancke 1955).

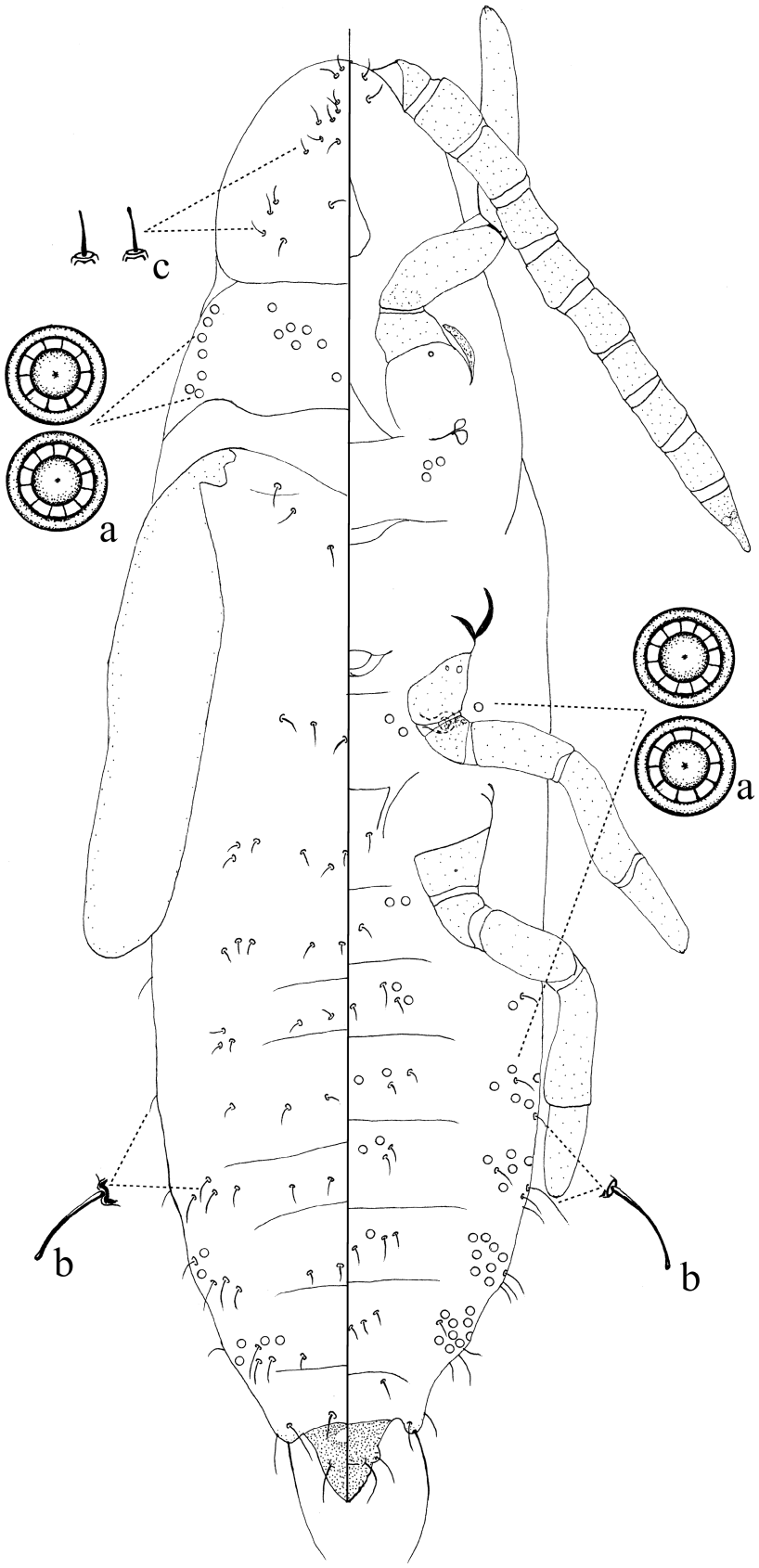

FIGURE 8. *Acanthococcus orzo* Deeter, Miller & Powell, **sp. nov.**, fourth-instar male pupa. FLORIDA: Gainesville, Doyle Conner Building, 1911 SW 34th St, 3.IV.2024, on *Muhlenbergia capillaris* (Poaceae), coll. L. Deeter, E-2024-03431-1, FSCA_00073812. **a**=multilocular pores with most common variants of 10–12 loculi; **b**=long flagellate setae; **c**=short apical flagellate setae with rounded to capitate apices.

Fourth-instar male (pupa) (Fig. 8)

Description: Bodies of slide-mounted specimens 1.1–1.2 mm long, 0.31–0.34 mm across widest part of thorax, elongate oval with small protruding anal lobes on segment VIII.

Dorsum with flagellate setae, each apically rounded to slightly capitate; forming 3 pairs of longitudinal lines down abdomen, and with 1 seta on base of each lobe on segment VIII; also present in submarginal clusters on segments V–VII, and singly on segment IV and more anterior segments; head with 13–15 pairs of setae from apex to genal area; setae absent from prothorax. Multilocular pores present in marginal setal clusters on segments IV–VII; prothorax with 7–9 on each side on margins, and 5–7 on each side in submedial areas. Multilocular pores with 9–13 (mostly 10 and 12) loculi. Discoidal pores absent. Protruding lobes on segment VIII membranous or lightly sclerotized. Hind wing buds absent. Front wing buds 393–447 (422) μm long, medially membranous but partially sclerotized in lateral areas. Ocular sclerite absent. Microtrichia present on segments III–VIII.

Penial sheath lightly sclerotized, with 1 pair of dorsal setae and 2 pairs of ventral setae. Anal opening appearing as small unsclerotized patch near base of sheath, genital opening observed as small ventral wrinkle closer to apex of sheath.

Venter with flagellate setae apically rounded or capitate; in 2–3 pairs of longitudinal lines in medial to submedial areas on abdomen; in marginal clusters on segments II–VI, progressively decreasing in quantity and length anteriorly; longest seta on segment VII 24–31 (28) μm long. Lobes on segment VIII each with 3 setae, with apical setae longest, 92–117 (105) μm long, with apex acute to rounded. Multilocular pores with 9–13 (mostly 10 or 12) loculi, 2 or 3 pores present near each spiracle; 1 or 2 pairs in submedial regions of segments II–VI, also in marginal setal clusters on segments VII–III, progressively decreasing in abundance anteriorly. Mouth tubercle present. Legs partially developed, with sclerotized segments present but setae absent. Antennae each with 10 segments, total length 454–523 (493) μm, with apical segment constricted. Microtrichia present from segment VIII to prothorax.

Notes: This description is based on three specimens from three localities. The presence of multilocular pores along the dorsal prothoracic margin (7–9 on each side) and submedial areas (6–8 on each side) of the pupa seems to be different from other described eriococcid pupae. Other eriococcid species with the pupa described, with similar body and aedeagus size and shape, include *Hypericicoccus hyperici* (Ferris 1955) (macropterous form) (Miller & Stocks 2022); *Ovaticoccus variabilis* Miller *in* Miller & McKenzie 1967; *Pseudotectococcus rolliniae* Hodgson & Gonçalves *in* Hodgson *et al.* 2004; and *Acanthococcus melnikensis* (Hodgson & Trencheva 2008). The pupa of each of these species differs from the pupa of *Ac. orzo* by lacking dorsal prothoracic multilocular pores submedially (Hodgson *et al.* 2004; Hodgson & Trencheva 2008; Miller & Stocks 2022).

Third-instar male (prepupa) (Fig. 9)

Description: Bodies of slide-mounted specimens 1.2–1.9 mm long, 0.30–0.37 mm across widest part of thorax, elongate-oval with small protruding anal lobes.

Dorsum with flagellate setae, each with rounded to capitate apex; setae present in 3 pairs of longitudinal lines on abdomen (submedial, mediolateral, and submarginal pairs), scattered on thorax and head, present singly on margins of each body segment, and abundant (about 13) on anterior margin of head. Multilocular pores, with 10–12 loculi, sparse, with 1 submarginal pair on segment VI, 1 submedial pair on segment V, and 1 pair on each of metathorax and prothorax. Discoidal pores absent. Derm membranous. Front wing buds marginally sclerotized, 166–171 μm long. Hamulohalteres absent. Microtrichia present on all body segments.

Penial sheath absent. Anal opening not developed, represented by faint wrinkles dorsally. Genital opening present ventrally. Apex of abdomen with 2 pairs of flagellate setae.

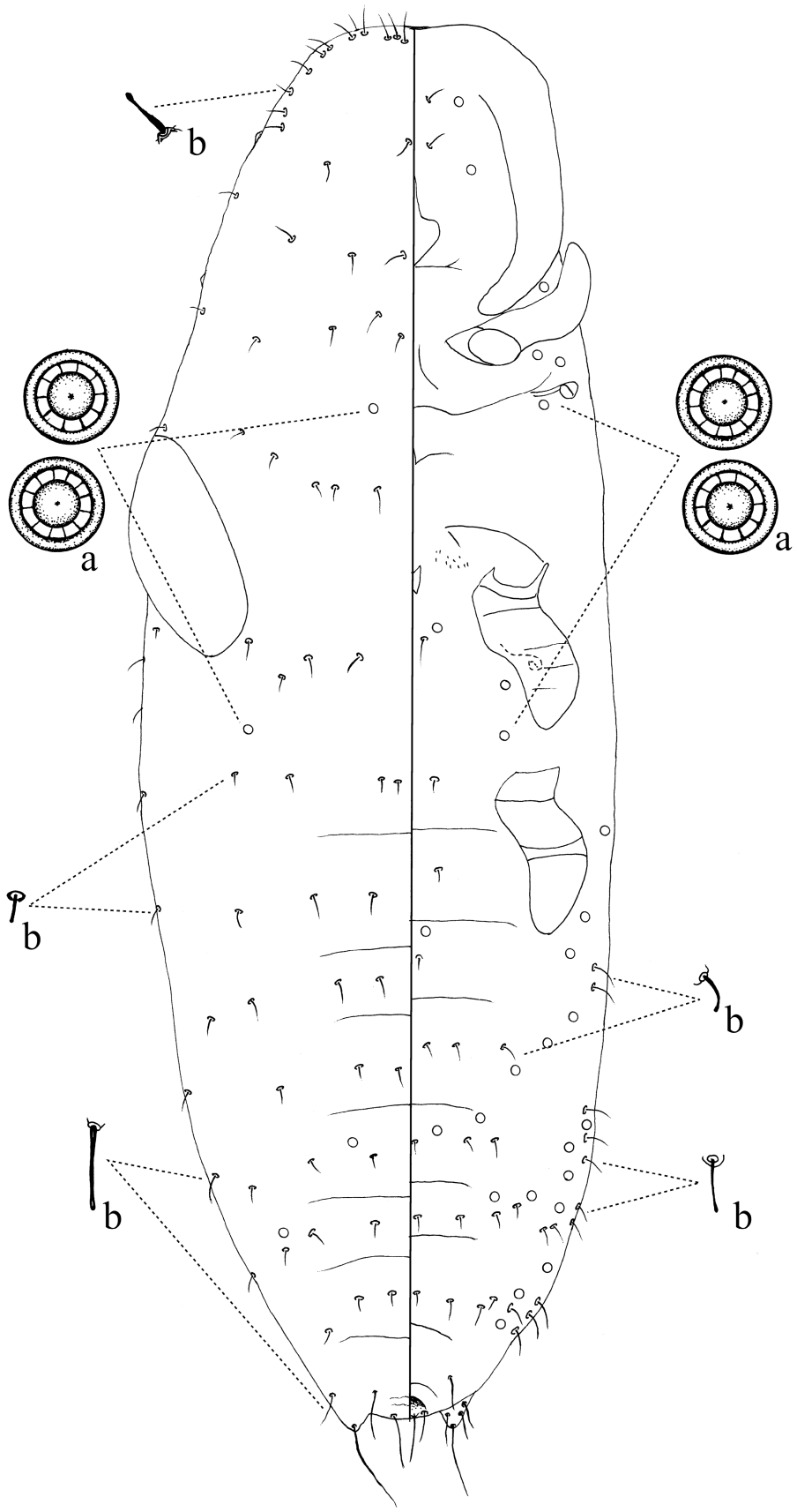

FIGURE 9. *Acanthococcus orzo* Deeter, Miller & Powell, **sp. nov.**, third-instar male prepupa. Gainesville, Depot Park, (29.64494, -82.32276), 29.III.2024, on *Muhlenbergia capillaris* (Poaceae), coll. L. Deeter, E-2024-03057-1, FSCA_00073811. **a**= multilocular pores with variation of 10–12 loculi; **b**=flagellate setae.

Venter with flagellate setae, each with apex rounded to acute, present in pleural clusters with associated multilocular pores on segments III–VII; setae present on abdominal segments in 1–3 longitudinal lines on each side, progressively decreasing in abundance anteriorly; longest pleural seta on segment VII about 20 μm long. Multilocular pores present in marginal to submarginal setal clusters and scattered on venter; with 2 submedial pairs on segment V, 1 submedial pair on segment III, 2 or 3 near each spiracle, 1 submedial pair on metathorax, and 2 pairs on head between mouth tubercle and antennal bases. Legs partially developed, with lightly sclerotized segments, without setae. Mouth tubercle present. Antennae each without segments, lightly sclerotized, 190–194 μm long. Microtrichia present from segment VII to mesothorax. Eyes absent.

Notes: This description is based on two specimens from one locality, one specimen being a pharate prepupa shedding the second-instar skin where details were difficult to see or measure. The prepupa of *Ac. orzo* is similar to those of *Hypericicoccus hyperici* and *Pseudotectococcus rolliniae*, but has multilocular pores with 10 or more loculi, while prepupae of each of the latter species have multilocular pores mostly with fewer than 10 loculi (Hodgson *et al.* 2004; Miller & Stocks 2022).

Second-instar male (Fig. 10)

Description: Bodies of slide-mounted specimens 0.9–1.2 (1.1) mm long, 0.24–0.34 (0.29) mm across widest part of thorax, elliptical, with protruding anal lobes. Anal lobes apically acute; enlarged anal lobe setae slightly truncate, anterolateral setae longest, anteromedial seta shortest; each lobe with 4 ventral flagellate setae including suranal setae and elongate apical anal-lobe setae; without microtubular ducts.

Dorsum with 1 small flagellate seta on margin of each segment from segment VII to prothorax (these appear dorsal on slide-mounted specimens, though in life are likely ventral due to ventrally concave body shape and relatively flat dorsum). Enlarged setae forming 1 transverse row per body segment, also forming 2 or 3 pairs of longitudinal lines (submedial, mediolateral, and submarginal pairs) from segment I to VII. Enlarged setae of 2 sizes: larger size present along entire body margin, with 2 on margin of each abdominal segment, except segment VII with 3 on margin; smaller size present in submarginal to medial areas; largest marginal enlarged seta 23–30 (26) μm long; largest small-sized enlarged setae 7–19 (13) μm long; marginal setae about twice as long as medial setae on same segment. Enlarged setae straight to slightly curved, slender, with acute to slightly rounded apices, each directed posteriorly at approximately 45º from body margin; apical large-sized enlarged setae on head straight with slightly truncate apices, each set perpendicular to the cuticle, forming 2 or 3 regular marginal to submarginal rows parallel with apical margin. Macrotubular ducts about 15–16 μm long, with orifices about 7–8 μm wide (slightly larger than ventral macrotubular ducts), scattered on surface of each body segment, with 2–8 across each entire segment on segments II–VII. Microtubular ducts absent. Cauda present anterior to anal ring, sometimes not visible in specimens with anal ring on dorsum. Microtrichia present from segment VIII to metathorax. Derm with areolate texture.

Anal ring marginal or dorsal, bearing 3 pairs of setae 54–84 (72) μm long; suranal setae flagellate, each about 44 μm long. Anal tube without sclerotization.

Venter with a flagellate seta singly on margin of each abdominal segment from segment VII to thorax; marginal flagellate setae on segment II 3–7 (6) μm long; transverse rows of 1–3 pairs (submarginal, sublateral, submedial pairs) across each segment. A single pair of enlarged setae present on head, aligned with rows on margin/dorsum of head's apex between antennal bases. Microtubular ducts absent. Macrotubular ducts slightly smaller than those on dorsum (each about 15 μm long, with orifice about 5 μm wide) and less abundant, numbering 4 or 6 (4) across each entire segment on segments II–VII and forming longitudinal lines (marginal and mediolateral). Multilocular pores mostly 5-locular, with 2–8 across each abdominal segment, progressively increasing in numbers anteriorly. Single cruciform pores present submarginally on each segment from segment VI to thorax, and with 1 or 2 medially on head; occasionally present also in medial areas of abdomen and thorax. Spiracles with variable associated pores, normally 5-locular but occasionally 3-locular; with 4–6 multilocular pores associated with each spiracle. Legs without translucent pores; each tibia with 4 setae on distal end, lacking seta in middle of tibia length; length of hind tibia/length of hind tarsus 0.64–0.79 (0.71); claw with small denticle near tip; tarsus with digitules capitate, extending beyond claw. Antennae each 7-segmented, 128–149 (142) μm long, with segments all of about same size, apical segment slightly longer and third segment. Frontal lobes absent; preantennal pore present on each side. Microtrichia present on all body segments.

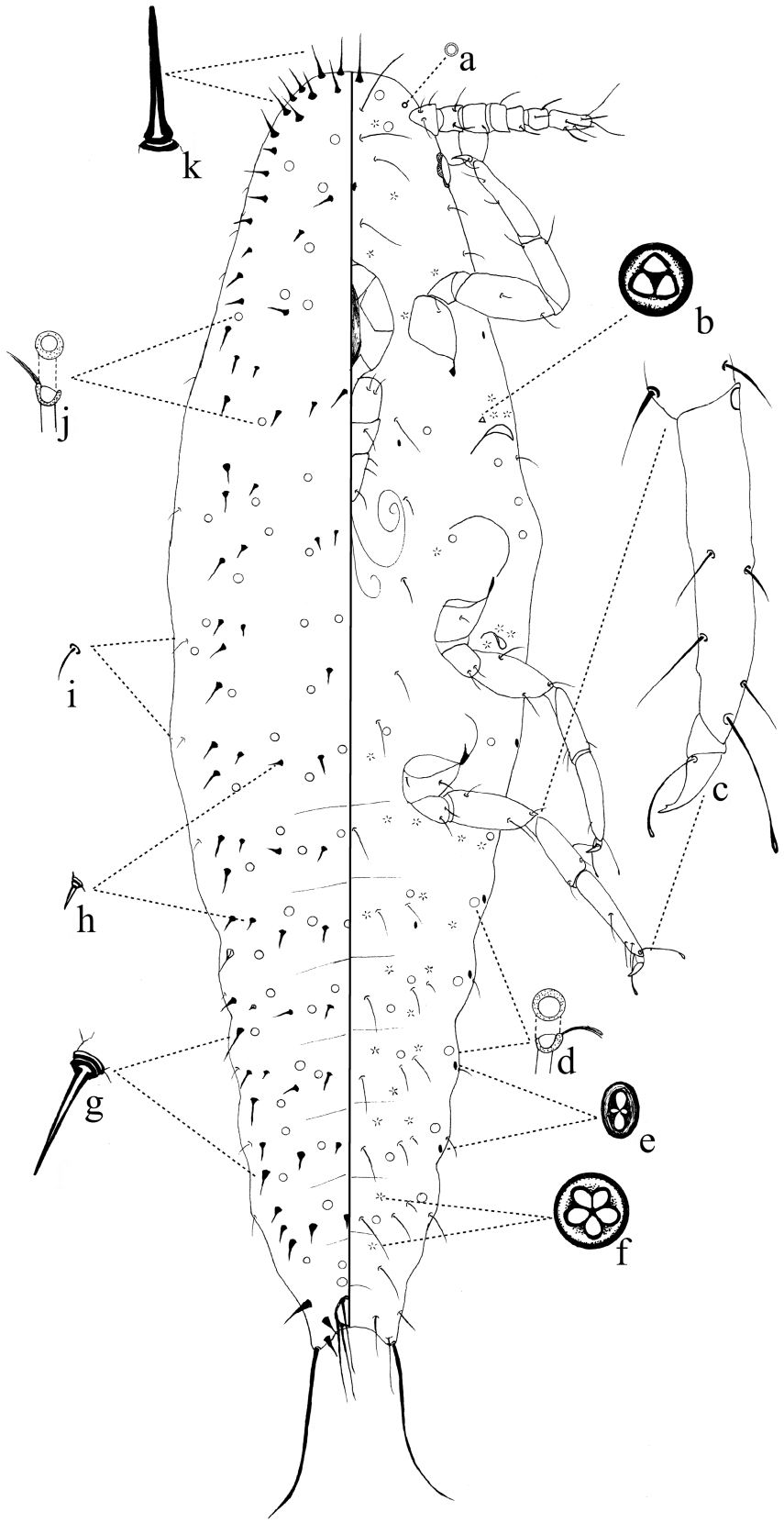

FIGURE 10. *Acanthococcus orzo* Deeter, Miller & Powell, **sp. nov.**, second-instar male. FLORIDA: Gainesville, Doyle Conner Building, 1911 SW 34th St, 21.V.2024, on *Muhlenbergia capillaris* (Poaceae), coll. L. Deeter, E-2024-05582-1, FSCA_00073800. **a**=preantennal pore; **b**=3-locular pore; **c**=dorsal surface of hind tibia, tarsus, and claw; **d**=macrotubular duct; **e**=cruciform pore; **f**=5-locular pore; **g**=marginal large-sized enlarged seta; **h**=small-sized enlarged seta; **i**=flagellate seta; **j**=macrotubular duct; **k**=apical large-sized enlarged seta.

Variation: As in the adult and second-instar females, the submarginal pair of dorsal enlarged setae on segment VII are variable and can be either large-sized (seen in one out of 10 specimens) or the typical small-size. In three instances, there is one large-sized enlarged seta on only one side of segment VII, with a small-sized seta on the opposite side. When the submarginal setae on segment VII are large, the rest of the small-sized enlarged setae are larger on average, particularly on the head.

Notes. This description is based on 10 specimens from four localities. Only a few second-instar males from *Acanthococcus* and similar genera have been described, including those of *Ac. droserae* Miller, Liu & Howell, 1992, *Ac. eriogoni* (Ehrhorn, 1911), *Ac. pennyae* (Miller & Stocks 2022), and *Ac. hoyi* Miller & Miller, 1992 (Miller & Stocks 2022). The second-instar males of *Ac. orzo* differ from other described second-instar males of *Acanthococcus* by their elliptical body shape and by having enlarged setae on the margin conspicuously larger than other dorsal setae.

FIGURE 11. *Acanthococcus orzo* Deeter, Miller & Powell, **sp. nov.**, slide-mounted adult females with hymenopteran parasitoids. **(a)** FLORIDA: Gainesville, Depot Park, (29.64489, -82.32273), 29.IV.2024, on *Muhlenbergia capillaris* (Poaceae), coll. L. Deeter, E-2024-04442-1, FSCA_00073824. **(b)** FLORIDA: Gainesville, Depot Park, (29.64494, -82.32276), 29.III.2024, on *M. capillaris* (Poaceae), coll. L. Deeter, E-2024-03057-1, FSCA_00073823.

Ecological associations

No significant damage caused by *Ac. orzo* was observed in any of the four localities, three of which were monitored from March 2024 through to March 2025. Seemingly healthy plants hosted plenty of specimens for sampling. Infestations were often limited to a few individual plants near each other within large landscape plantings of up to about 50 plants. Anecdotally, *Ac. orzo* host plants tended to harbor mixed infestations of various sap-sucking insect species. Visible insect damage was observed only on host plants that harbored heavy infestations of other pests, especially armored scales. *Acanthococcus orzo* was found in mixed infestations with *Duplachionaspis uniolae* (Takagi) (Coccomorpha: Diaspididae) (2024-02816), *Stemmatomerinx acircula* Howell & Miller (Coccomorpha: Pseudococcidae) (2024-06221-2, 2021-4233-2), and *Aleurocybotus* sp. Quaintance & Baker (Hemiptera: Aleyrodomorpha: Aleyrodidae) (2024-04442-2). Three specimens (FCSA_00073750, FSCA_00073823–FSCA_00073824) were found to contain larval hymenopteran parasitoids after being slide-mounted (Fig. 11).

Key to adult female species of *Acanthococcus* of Florida, based on Miller & Miller (1993).

1(0) With 5 setae on each hind tibia (1 seta in middle of tibia) . . . 2
- With 4 setae on each hind tibia (without seta in middle of tibia) . . . 8
2(1) Anal lobes each with 3 enlarged setae . . . 3
- Anal lobes each with 4 setae . . . ***Ac. howelli* Miller & Miller**
3(2) Dorsal large-sized enlarged setae present in medial and/or mediolateral areas of abdomen . . . 5
- Dorsal large-sized enlarged setae absent from medial and/or mediolateral areas of abdomen . . . 4
4(3) Tibia + tarsus less than 225 µm long . . . ***Ac. coccineus* (Cockerell)**
- Tibia + tarsus more than 275 µm long . . . ***Ac. megaporus* Miller & Miller**
5(3) Hind tarsus equal to or slightly longer than hind tibia . . . 6
- Hind tarsus about half length of hind tibia . . . ***Ac. quercus* (Comstock)**
6(5) Abdominal segment V with less than 26 enlarged setae . . . 7
- Abdominal segment V with more than 26 enlarged setae . . . ***Ac. eriogoni* (Ehrhorn)**
7(6) Dorsal enlarged medial setae conical, with rounded or acute apices . . . ***Ac. mesotrichus* Miller & Miller**
- Dorsal enlarged medial setae dome shaped with blunt apices . . . ***Ac. droserae* Miller, Liu & Howell**
8(1) Front tibiae each with 5 setae (with seta in middle) . . . 10
- Front tibiae each with 4 setae (without seta in middle) . . . 9
9(8) Microtubular ducts absent; multilocular pores absent from dorsum . . . ***Ac. orzo* Deeter, Miller & Powell, sp. nov.**
- Microtubular ducts present; multilocular pores present on dorsum . . . ***Ac. dennoi* Miller & Miller**
10(8) Large-sized setae absent from medial and mediolateral areas of abdominal segments III to VII . . . 12
- Large-sized setae present in medial and mediolateral areas of abdominal segments III to VII . . . 11
11(10) Sensory seta on 5th antennal segment short and thick with rounded apex not extending beyond base of sensory seta on 6th antennal segment; longest enlarged setae 30–40 µm long, not overlapping in pre-gravid specimens; common on *Lagerstroemia* L. and other Lythraceae . . . ***Ac. lagerstroemiae* (Kuwana)**
- Sensory seta on 5th antennal segment long and slender with pointed apex extending beyond base of sensory seta on 6th antennal segment; longest enlarged setae 45–55 µm long, overlapping in pre-gravid specimens; common on *Rhododendron* L. and other Ericaceae. . . . ***Ac. azaleae* (Comstock)**
12(10) Large-sized marginal setae straight on abdominal segment VII . . . 13
- Large-sized marginal setae conspicuously curved on abdominal segment VII . . . ***Ac. beshearae* Miller & Miller**
13(12) Multilocular pores near vulva predominantly with 5 loculi . . . 15
- Multilocular pores near vulva predominantly with more than 5 loculi . . . 14
14(13) Dorsal multilocular pores present. . . . ***Ac. davidsoni* Miller & Miller**
- Dorsal multilocular pores absent . . . ***Ac. smithi* (Lobdell)**
15(13) With more than 1 large-sized enlarged seta on each margin of abdominal segment VII . . . 17
- With 1 large-sized enlarged seta on each margin of abdominal segment VII . . . 16
16(15) Large-sized enlarged setae present around entire body margin . . . ***Ac. monotrichus* Miller & Miller**
- Large-sized enlarged setae present on body margin on posterior abdomen and head only . . . ***Ac. ophius* Miller & Miller** (in part)
17(15) Large-sized enlarged setae present around entire body margin . . . ***Ac. actius* Miller & Miller**
- Large-sized enlarged setae present on body margin on posterior abdomen and head only . . . ***Ac. ophius* Miller & Miller** (in part)

Discussion

It is worth noting that *Ac. orzo* is similar to the morphological description of *Anophococcus* Balachowsky, an Old-World genus grouped by being mostly grass-infesting and having large-sized enlarged setae only on the margins or the dorsum of the anal lobe (Balachowsky 1954; Kozár *et al*. 2013; Kosztarab & Kozár 1988). These features are likely convergent, resulting from the shared environmental pressure of feeding inside the tight spaces of grasses, such as sheaths and culms. Kozár *et al*. (2013) also presented a phylogenetic tree based on COI and 28S, displaying *Anophococcus* as a polyphyletic group. More molecular data are needed to support generic groupings in the family, especially in grass-infesting species with convergent morphologies, including elongate bodies and the lack of large-sized enlarged dorsal setae. The generic limits of the *Anophococcus* are not stable, and the particular condition of their enlarged setae is unlikely to be a significant character for taxonomic grouping. In conclusion, we chose to place this new species in *Acanthococcus* based on having the following features: (i) sclerotized, protruding anal lobes; (ii) developed anal ring with pores; and (iii) enlarged setae present across entire dorsum (Kozár *et al*. 2013, Miller & Miller 1993).

As mentioned, molecular data for the Eriococcidae are woefully underdeveloped. The Eriococcidae as a whole has been considered to be a paraphyletic group containing the Dactylopiidae Signoret, based on morphological and molecular data (Miller & Gimpel 2000; Gullan & Cook 2007; Vea & Grimaldi 2016). In addition, no character states have been found to consistently characterize all taxa in the Eriococcidae (Miller & Gimpel 2000). At this time, there are 681 described species of Eriococcidae reported by ScaleNet, but only 40 species with COI sequence data in the Barcode of Life Data System (Ratnasingham & Hebert 2007; García Morales *et al.* 2016). Full genome data exists for only one species, *Ac. lagerstroemiae*. Thus, the DNA sequence data presented in this paper do not directly support the morphological identity of this species as new to science. Far more data will be needed family-wide to make such an assessment. However, the data generated here were simple to gather and should be standard for new eriococcid descriptions and revisionary works moving forward.

It is currently unclear whether *Ac. orzo* is native or introduced to Florida, and evidence suggesting its origin is inconclusive. The collection records presented in this paper are the first records of this species in the FSCA, which contains over 90,000 scale insect slides, some dating back as early as the 1910s. This suggests the species could have been introduced recently. However, its cryptic habit is the most likely contributor to its late discovery, which occurred during an intentional survey for grass scales. Even mature specimens are entirely hidden within the tightly-involute leaf blades or near the ligules, deep in the clustered base of the grass host.

Though specimens were observed anywhere within the length of the blade of grass, immatures were more often found at the distal end whereas adults and ovisacs were often found closer to the proximal end near the ligule. This is where the blade has a small opening before becoming involute. Perhaps this area is where mating occurs, as the opening near the ligule would allow for males to easily find mature females.

Its only known host, *Muhlenbergia capillaris*, is understood to be native to Florida with a distribution from Texas to New York (Kirk & Belt 2010). The shape of the scale insect's venter fits snugly to the grooves within its host's leaf-blades (Fig 2). Ornamental grasses with similar involute morphology were inspected, including *Sporobolus bakeri* (Merr.) P.M.Peterson & Saarela (Poales: Poaceae), but *Ac. orzo* was never detected. Although this anecdotal evidence does not prove that *Ac. orzo* only feeds on *M. capillaris*, it suggests the species is potentially host specific.

Muhlenberghia capillaris is widely used as an ornamental plant in Florida landscapes for its striking inflorescences, hardiness, and drought tolerance. However, it is also classed as endangered in Connecticut, Indiana, Maryland, and New Jersey, and considered extirpated in Pennsylvania and Ohio (Kirk & Belt 2010). It is therefore worth gathering more data on the distribution of *Ac. orzo* to understand its distribution and pest potential on *M. capillaris.*

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References

Ahmed, M.Z., Ray, C.H., Moore, M.R. & Miller, D.R. (2020) The *Matsucoccus* Cockerell, 1909 of Florida (Hemiptera: Coccomorpha: Matsucoccidae): potential pests of Florida pines. *Insecta Mundi*, 810, 1–31.

Afifi, S.A. (1968) Morphology and taxonomy of the adult males of the families Pseudococcidae and Eriococcidae (Homoptera: Coccoidea). *British Museum (Natural History), Second Report on Economic Zoology*, 13, 3–210. https://doi.org/10.5962/p.313991

Altschul, S.F., Gish, W., Miller, W., Myers, E.W. & Lipman, D.J. (1990) Basic local alignment search tool. *Journal of Molecular Biology*, 215, 403–410. https://doi.org/10.1016/S0022-2836(05)80360-2

Balachowsky, A.S. (1954) Sur une nouvelle espèce d'Eriococcini de la forêt de Fontainebleau avec création d'un genre nouveau. [Hom. Coccoidea]. *Bulletin de la Société entomologique de France*, 59, 61–64. [in French] https://doi.org/10.3406/bsef.1954.18703

Boratyński, K.L. (1962) A new species of *Acanthococcus* Signoret, 1875 (Eriococcidae, Coccoidea, Homoptera) from Britain. *Proceedings of the Royal Entomological Society of London*, Series B: Taxonomy, 31, 55–60. https://doi.org/10.1111/j.1365-3113.1962.tb01183.x

Borchsenius, N.S. (1949) [Insects Homoptera. suborders mealybugs and scales (Coccoidea). Family mealybugs (Pseudococcidae). Vol. VII]. *Fauna SSSR. Zoologicheskii Institut Akademii Nauk SSSR*, New Series, 38, 1–382. [in Russian]

Cockerell, T.D.A. (1894) Descriptions of new Coccidae. *Entomological News*, 5, 203–204.

Comstock, J.H. (1881) Report of the Entomologist. *Report of the Commissioner of Agriculture, United States Department of Agriculture*, 1880/1881, 276–349.

Danzig, E.M. (1962) Revision of the genus *Rhizococcus* Signoret (Homoptera, Coccoidea) of the SSR fauna. *Entomologicheskoe Obozrenye*, 41, 839–860.

Douglas, J.W. (1888) Notes on some British and exotic Coccidae (No. 12). *Entomologist's Monthly Magazine*, 25, 150–153.

Edgar, R.C. (2004) MUSCLE: multiple sequence alignment with high accuracy and high throughput. *Nucleic Acids Research*, 32, 1792–1797. https://doi.org/10.1093/nar/gkh340

Ehrhorn, E.M. (1911) New Coccidae with notes on other species. *Canadian Entomologist*, 43, 275–280. https://doi.org/10.4039/Ent43275-8

Ferris, G.F. (1955) *Atlas of the Scale Insects of North America. Vol. 7. The Families Aclerdidae, Asterolecaniidae, Conchaspididae Dactylopiidae and Lacciferidae. III.* Stanford University Press, Palo Alto, California, 233 pp.

García Morales, M., Denno, B.D., Miller, D.R., Miller, G.L., Ben-Dov, Y. & Hardy, N.B. (2016) ScaleNet: a literature-based model of scale insect biology and systematics. Database. Available from: http//scalenet.info (accessed 27 March 2025) https://doi.org/10.1093/database/bav118

Gill, R.J. (1993) *The Scale Insects of California: Part 2. The Minor Families (Homoptera: Coccoidea).* California Department of Food & Agriculture, Sacramento, California, 241 pp.

Green, E.E. (1921) Observations on British Coccidae: with descriptions of new species. VI. *Entomologist's Monthly Magazine*, 57, 146–152. https://doi.org/10.5962/bhl.part.22330

Green, E.E. (1922) *The Coccidae of Ceylon, Part V.* Dulau & Co., London, 345–472.

Gu, M., Merchant, M., Robbins, J. & Hopkins, J. (2014) *Crape Myrtle Bark Scale: a new exotic pest*. *EHT 49*. Texas A&M AgriLife Extension Service, College Station, Texas. Available from: https://agrilife.org/extensionento/files/2017/10/Crape-mrytle-bark-scale-EHT-049.pdf (accessed 27 March 2025)

Gullan, P.J. & Cook, L.G. (2007) Phylogeny and higher classification of the scale insects (Hemiptera: Sternorrhyncha: Coccoidea). *Zootaxa*, 1668 (1), 413–425.

https://doi.org/10.11646/zootaxa.1668.1.22
Hodgson, C.J. (2005) The adult males of Coccoidea (Hemiptera: Sternorrhyncha) known from Greenland. *Zootaxa*, 907, 1–48. https://doi.org/10.11646/zootaxa.907.1.1
Hodgson, C.J. (2020) A review of neococcid scale insects (Hemiptera: Sternorrhyncha: Coccomorpha) based on the morphology of the adult males. *Zootaxa*, 4765 (1), 1–264. https://doi.org/10.11646/zootaxa.4765.1.1
Hodgson, C.J. & Trencheva, K.G. (2008) A new species of *Eriococcus* (Hemiptera: Sternorrhyncha: Coccoidea: Eriococcidae) and redescriptions of *Eriococcus roboris* Goux and *E. thymelaeae* Newstead, with a key to the *Eriococcus* species on *Quercus* in the western Palaearctic. *Zootaxa*, 1959 (1), 1–38. https://doi.org/10.11646/zootaxa.1959.1.1
Hodgson, C.J., Gonçalves, S.J.M.R., Miller, D.R. & Isaias, R.M.S. (2004) A key to genera of Eriococcidae (Hemiptera: Coccoidea) from the Neotropical region and a revision of *Pseudotectococcus* Hempel (Eriococcidae), a gall inducing scale insect genus from Brazil, with a description of a new species. *Lundiana*, 5 (1), 51–72. https://doi.org/10.35699/2675-5327.2004.21902
Hoy, J.M. (1962) Eriococcidae (Homoptera: Coccoidea) of New Zealand. *New Zealand Department of Scientific and Industrial Research Bulletin*, 146, 1–219.
Hoy, J.M. (1963) A catalogue of the Eriococcidae (Homoptera: Coccoidea) of the world. *New Zealand Department of Scientific and Industrial Research Bulletin*, 150, 1–260.
Hua, L.Z. (2000) *List of Chinese Insects. Vol. 1*. Zhongshan University Press, Guangzhou, 448 pp.
Jancke, G.D. (1955) Zur Morphologie der männlichen Cocciden. *Zeitschrift für Angewandte Entomologie*, 37, 265–314. https://doi.org/10.1111/j.1439-0418.1955.tb00790.x
Kirk, S. & Belt, S. (2010) Plant Fact Sheet for Hairawn Muhly (Muhlenbergia capillaris) USDA-Natural Resources Conservation Service, Norman A. Berg National Plant Materials Center, Beltsville, Maryland. Available from: https://plants.usda.gov/DocumentLibrary/factsheet/pdf/fs_muca2.pdf (accessed 27 March 2025)
Kozár, F., Kaydan, M.B., Konczné Benedicty, Z. & Szita, É. (2013) *Acanthococcidae and Related Families of the Palaearctic Region.* Hungarian Academy of Sciences, Budapest, 679 pp.
Kosztarab, M.P. (1996) *Scale insects of Northeastern North America. Identification, biology, and distribution.* Virginia Museum of Natural History, Martinsburg, Virginia, 650 pp.
Kosztarab, M.P. & Kozár, F. (1988) *Scale Insects of Central Europe*. Akademiai Kiado, Budapest, 456 pp. https://doi.org/10.1007/978-94-009-4045-1
Kumar, S., Stecher, G. & Tamura, K. (2016) MEGA7: molecular evolutionary genetics analysis version 7.0 for bigger datasets. *Molecular Biology and Evolution*, 33, 1870–1874. https://doi.org/10.1093/molbev/msw054
Kuwana, S.I. (1907) Coccidae of Japan, (I). A synoptical list of Coccidae of Japan with descriptions of thirteen new species. *Bulletin of the Imperial Central Agricultural Experiment Station, Tokyo, Japan*, 1, 1–31.
Maskell, W.M. (1891) Further coccid notes: with descriptions of new species from New Zealand, Australia, and Fiji. *Transactions and Proceedings of the New Zealand Institute*, 23 (1890), 1–36.
Miller, D.R. & Gimpel, M.E. (2000) *A Systematic Catalogue of the Eriococcidae (Felt Scales) (Hemiptera: Coccoidea) of the World.* Intercept Ltd, Andover, 589 pp.
Miller, D.R. & McKenzie, H.L. (1967) A systematic study of *Ovaticoccus* Kloet and its relatives, with a key to North American genera of Eriococcidae (Homoptera: Coccoidea: Eriococcidae). *Hilgardia*, 38, 471–539.
Miller, D.R. & Miller, G.L. (1992) Systematic analysis of *Acanthococcus* (Homoptera: Coccoidea: Eriococcidae) in the western United States. *Transactions of the American Entomological Society*, 118 (1), 1–106.
Miller, D.R. & Miller, G.L. (1993) Eriococcidae of the Eastern United States (Homoptera). *Contributions of the American Entomological Institute*, 27 (4), 1–91.
Miller, D.R. & Stocks, I.C. (2022) New genera and species of felt scales (Hemiptera: Coccomorpha: Eriococcidae), with descriptions of new species and immature instars of described species. *Zootaxa*, 5221 (1), 1–213. https://doi.org/10.11646/zootaxa.5221.1.1
Miller, D.R., Liu, T. & Howell, J.O. (1992) A new species of *Acanthococcus* (Homoptera; Coccoidea; Eriococcidae) from sundew (*Drosera*) with a key to the instars of *Acanthococcus*. *Proceedings of the Entomological Society of Washington*, 94 (4), 512–523.
Modéer, A. (1778) Om fastflyet. *Coccus*. *Handlingar Gotheborgska Wetenskaps och Witterhets Samhallets. Wetenskaps Afdelingen, Gotheborg*, Series 1, 1, 11–50. [in Swedish]
Newstead, R. (1891) On some new or little known Coccidae found in England. *Entomologist's Monthly Magazine*, 26, 164–166.
Ratnasingham, S. & Hebert, P.D.N. (2007) BOLD: The Barcode of Life Data System (http://www.barcodinglife.org). *Molecular Ecology Notes*, 7, 355–364. https://doi.org/10.1111/j.1471-8286.2007.01678.x
Signoret, V. (1875) Essai sur les cochenilles ou gallinsectes (Homoptères—Coccides), 14ème partie [Essay on the gall forming insects (Homoptera—Coccidae)—14th Part]. *Annales de la Société entomologique de France*, 5, 15–40. [in French]
Tang, F.T. & Hao, J.J. (1995) [*The Margarodidae and others of China*]. Chinese Agricultural Science Technology Press, Beijing,

738 pp. [in Chinese]
Vea, M. & Grimaldi, D.A. (2016) Putting scales into evolutionary time: the divergence of major scale insect lineages (Hemiptera) predates the radiation of modern angiosperm hosts. *Scientific Reports*, 6, 23487. https://doi.org/10.1038/srep23487
Wilkey, R.F. (1962) A simplified technique for clearing, staining, and permanently mounting small arthropods. *Annals of the Entomological Society of America*, 55 (5), 606. https://doi.org/10.1093/aesa/55.5.606