



## On some mites (Acari: Prostigmata) from the Interior Highlands: descriptions of the male, immature stages, and female reproductive system of *Pseudocheylus americanus* (Ewing, 1909) and some new state records for Arkansas

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### Abstract

The male and immature stages of *Pseudocheylus americanus* (Ewing, 1909) (Pseudocheylidae) are described and illustrated for the first time and the female is re-illustrated. The description of *Pseudobonzia reticulata* (Heryford, 1965) (Cunaxidae) is modified to include the presence of dorsal setae  $f_2$ , which were not reported in the original description. In addition, *Bonzia yunkeri* Smiley, 1992 and *Parabonzia bdelliformis* (Atyeo, 1958) (Cunaxidae) are reported from the Ozark Mountains, *Caeculus cremnicolus* Enns, 1958 (Caeculidae) is reported from the Ozark and Ouachita Mountains, and *Dasythyreus hirsutus* Atyeo, 1961 (Dasythyreidae) is reported from Missouri and the Ouachita Mountains in Arkansas.

**Key words:** taxonomy, Interior Highlands, Ozark Mountains

### Introduction

The Ozark Highlands comprise some of the oldest continuously exposed land worldwide and may have served as refugia during glaciation and flooding events throughout biological history (The Nature Conservancy, Ozarks Ecoregional Assessment Team, 2003). While many taxa are characteristic of Eastern and Midwestern North America, others are known from similar refugia, such as the Southern Appalachians and Sierra Madre in Mexico, but are absent from intervening areas. The Ozark Highlands, with more than 200 known endemic organisms, have thus been proposed as an area of hyperdiversity (Allen 1990; Redfearn 1986). In comparison to other areas of known or suspected hyperdiversity the Ozarks have received relatively little study (though see Robinson & Allen 1995). This trend is especially true for arthropods, for which species composition and biogeographic studies are virtually non-existent (but see Moulton & Steward 1996 and Poulton & Stewart 1991).

This study, which represents the latest in a recent effort (Fisher *et al.* 2011; Skvarla *et al.* 2011; Skvarla & Dowling 2012) to remedy this problem with prostigmatid mites, focuses on four families: Pseudocheylidae, Caeculidae, Cunaxidae, and Dasythyreidae. Below are brief introductions to each of these families.

Pseudocheylidae includes 14 species in three genera—*Anoplocheylus*, *Neocheylus*, and *Pseudocheylus*. All are predatory mites usually found under the bark of trees or in leaf litter and moss, though a few have been found in soil (Van Dis 1991). Van Dis (1991) provides the most up-to-date keys to genera and species. Except for the genital developmental sequence illustrated by Van Dis (1991) no pseudocheylid immatures have been described or illustrated to date. *Pseudocheylus* contains two species, *P. americanus* (Ewing, 1909) and *P. biscutatus* (Berlese, 1888), which have been found under tree bark in North and South America, respectively.

Caeculidae, commonly known as the rake-legged mites, are large (1,000–3,000  $\mu\text{m}$ ), slow-moving, heavily armored mites that are commonly dark in color. They are generally thought to be ambush predators, although a few

species have been shown to feed on fungus (Crossley & Merchant 1971; McDaniel & Boe 1990; Walter & Proctor 1998). They typically inhabit dry habitats, such as beaches, tree bark, deserts, rock outcrops, and leaf litter (Krantz & Walter 2009). In North America, most species are known from the desert southwest (Mulaik 1946; Mulaik & Allred 1954), although representatives of the genus can be found from California to Georgia and north through South Dakota (Banks 1899; Hagan 1985; McDaniel & Boe 1990).

Cunaxidae are small (300–1000  $\mu\text{m}$ ), predaceous mites found in a variety of habitats including leaf litter and soil, tree holes, agricultural fields, moss, rock outcrops, and stored products (Den Heyer 1977a; Sepasgosarian 1984; Smiley 1992; Skvarla & Dowling 2012). They are easily recognized by their spined, raptorial palpi (except Bonzinae) and diamond-shaped bodies (Krantz & Walter 2009). They feed on a variety of microarthropods including Collembola, nematodes, scales, mites, and small insects (Castro & Moraes 2010; Chaudhri *et al.* 1979; Ewing & Webster 1912; Walter & Kaplin 1991). More than 330 species in 27 genera are described, eight of which have been previously reported from Arkansas (Skvarla & Dowling 2012; Skvarla *et al.* 2011).

Dasythyreidae includes two species, *Dasythyreus hirsutus*, which is known from Arkansas, and *Xanthodasythyreus toohey*, which is known from Queensland, Australia; an undescribed species of *Dasythyreus* has been reported from New Jersey, USA (Walter & Gerson 1998). Walter and Gerson (1998) described the family best when referring to *X. toohey* as “ambulatory pincushions.” It appears that dasythyreids are arboreal, but not much else is known.

## Material and methods

Leaf litter was collected at multiple locations throughout the Ozark Highlands; some samples were concentrated with a litter reducer in the field. Samples were processed with modified Berlese-Tullgren funnels for three to seven days. All specimens are mounted in Hoyer’s Medium.

In accordance with recent taxonomic efforts, all species dealt with herein have been registered with ZooBank (Table 1); in addition all known species of *Pseudocheylus*, *Bonzia*, *Parabonzia*, *Pseudobonzia*, and *Dasythyreus*, and all known North American species of *Caeculus* have also been registered with ZooBank. The illustration methods outlined by Fisher and Dowling (2010) were followed and all illustrations have been submitted to MorphBank. Solenidia are indicated by having open shaft bases. Normal setae are indicated by having closed shaft bases. On illustrations of legs lateral and ventral setae are drawn to the side. Unstriated membrane, including arthrodistal membrane, is denoted with large stippling.

All measurements are in micrometers ( $\mu\text{m}$ ). For measurements of multiple specimens, ranges are reported first, followed parenthetically by the mean and number of specimens examined.

Setal notation follows Grandjean (1939, 1944) as implemented by Kethley (1990) for dorsal setae and Norton (1977) for leg setae. Leg solenidia counts are indicated parenthetically within setal counts. As suggested by Fisher *et al.* (2011), the term subcapitulum is used in place of hypostome.

All specimens are deposited in the Acarology Collection at the University of Arkansas (ACUA).

## Pseudocheylidae

### *Pseudocheylus americanus* (Ewing, 1909)

(Figs. 1–9)

*Cheyletiella americana* Ewing 1909: 429, fig. 15.

*Pseudocheylus americanus* (Ewing) Baker & Wharton 1952: 226; Baker 1958: 136; Baker & Atyeo 1964: 259, figs. 6–8; Van Dis & Ueckermann 1991: 105.

**Diagnosis.** *Pseudocheylus americanus* can be differentiated from *P. biscutatus* (Berlese, 1888), the only other *Pseudocheylus*, by the lack of tarsal claws on leg I.

**TABLE 1.** Known species of *Paracaropsis*, *Pseudocheylus*, *Bonzia*, *Parabonzia*, and North American species of *Caeculus*, associated descriptions, and ZooBank LSID numbers.

<i>Pseudocheylus</i>	Bertelse, 1888		urn:lsid:zooBank.org:act:E0ADCCD5-95A8-4EB0-A1C0-D3ABA7955D57
<i>Pseudocheylus americanus</i>	(Ewing, 1909)		urn:lsid:zooBank.org:act:1007BD99-C36B-4ED3-9448-EEA82EB6631E
<i>Pseudocheylus biscalatus</i>	Bertelse, 1888		urn:lsid:zooBank.org:act:04902763-B80B-42BE-8609-63E587312FCE
<i>Caeculus</i>	Dufour, 1832		urn:lsid:zooBank.org:act:77B6F848-CFDC-4A75-8BA9-0527CEFA5E9
<i>Caeculus americanus</i>	Banks, 1899		urn:lsid:zooBank.org:pub:65EB15A7-28B0-429F-94C8-68DB88794C1E
<i>Caeculus archeri</i>	Mulaik, 1945		urn:lsid:zooBank.org:act:B4429C5D-1074-4965-8624-26AC8B6BB977
<i>Caeculus brevis</i>	Mulaik, 1945		urn:lsid:zooBank.org:act:7993034C-CEB3-4543-A8EE-FC0AAB01E4DD
<i>Caeculus calechius</i>	Mulaik, 1945		urn:lsid:zooBank.org:act:4E458B12-AF77-4115-BB5F-A9B5381E976F
<i>Caeculus clavatus</i>	Banks, 1905		urn:lsid:zooBank.org:act:444AC2CD-877E-45DC-8BD4-D691757F6EAA
<i>Caeculus cremnicolus</i>	Enns, 1958		urn:lsid:zooBank.org:pub:7DFB6855-FEBE-4F06-89A1-059EC8EDD4B7
<i>Caeculus crossleyi</i>	Hagan, 1985		urn:lsid:zooBank.org:act:22A95079-27FF-4986-8D46-3AE1FD564E18
<i>Caeculus dortheae</i>	Mulaik, 1945		urn:lsid:zooBank.org:act:9D3209F0-133F-43F5-BBD2-7C3129C3870A
<i>Caeculus gretschii</i>	Mulaik, 1945		urn:lsid:zooBank.org:act:3BECE009-7EB4-4AB3-8E41-64D1CAF616EA
<i>Caeculus hardyi</i>	Mulaik & Allred, 1961		urn:lsid:zooBank.org:act:B983B7F8-1A10-4BBB-8465-73E1259F466
<i>Caeculus hypopachus</i>	Mulaik, 1945		urn:lsid:zooBank.org:act:6CE4261D-8CEF-4B6C-919B-0DB167DDAC7B
<i>Caeculus janetae</i>	Higgins & Muliak, 1957		urn:lsid:zooBank.org:pub:56B56276-7779-4B15-97A7-DFA84328B3FC
<i>Caeculus kerrulius</i>	Mulaik, 1945		urn:lsid:zooBank.org:act:E3324A3E-F7EF-490D-B62A-C40DF1260B3B
<i>Caeculus lewisi</i>	McDaniel & Boe, 1990		urn:lsid:zooBank.org:act:76812787-3858-4CA7-A736-B498D7B2CDC2
<i>Caeculus mexicanus</i>	Mulaik & Allred, 1961		urn:lsid:zooBank.org:act:2C05362F-8FD3-437A-9B89-75AC01801288
<i>Caeculus orchidicolis</i>	Mulaik & Allred, 1961		urn:lsid:zooBank.org:act:64F4E18B-C9FB-4720-AF0E-141CE0998893
<i>Caeculus oregonus</i>	Mulaik & Allred, 1961		urn:lsid:zooBank.org:act:8E64C734-E836-4F37-92CD-0C796C567A8C
<i>Caeculus puertoricus</i>	Mulaik, 1945		urn:lsid:zooBank.org:act:FA17BDE0-F4EF-4FE6-887B-7F460BD7BB5F

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TABLE 1. (Continued)

<i>Caeculus</i>	<i>pettiti</i>	Nevin, 1943	urn:lsid:zoobank.org:act:FCEFD8A2-A6AE-42AC-B485-03E00D308A72
<i>Caeculus</i>	<i>potosi</i>	Mulaik & Allred, 1961	urn:lsid:zoobank.org:act:737F6CC8-F9D2-4CF9-AA45-4197B4FB947D
<i>Caeculus</i>	<i>tipus</i>	Mulaik, 1945	urn:lsid:zoobank.org:act:38E020D6-E987-4964-B333-51B9E2B9D820
<i>Caeculus</i>	<i>valverditus</i>	Mulaik, 1945	urn:lsid:zoobank.org:act:1BB9BA83-F91D-42A7-BC24-3B8C62F64B53
<i>Bonzia</i>		Oudemans, 1927	urn:lsid:zoobank.org:act:87380A29-8567-4C9B-82DA-097170151335
<i>Bonzia</i>	<i>halacaroides</i>	Oudemans, 1927	urn:lsid:zoobank.org:act:C2E06987-2C21-4161-85C7-4235BC99D772
<i>Bonzia</i>	<i>sphagnicola</i>	Willmann, 1939	urn:lsid:zoobank.org:act:60AA7096-B326-402D-BE0C-538FF8B7588C
<i>Bonzia</i>	<i>woodi</i>	Smiley, 1992	urn:lsid:zoobank.org:act:4FC21133-74C0-4C4A-A21C-EF5FF7466C0C
<i>Bonzia</i>	<i>yunkeri</i>	Smiley, 1992	urn:lsid:zoobank.org:act:01591516-0AEE-4DAB-AC7B-05EC3D41F0D6
<i>Parabonzia</i>		Smiley, 1975	urn:lsid:zoobank.org:act:68635467-1FFF-4871-B86A-2FE8677236F2
<i>Parabonzia</i>	<i>athiasae</i>	Den Heyer, 1978	urn:lsid:zoobank.org:act:B44B490C-E7A5-4DAA-A72D-4EDED962BC9F
<i>Parabonzia</i>	<i>bdelliformis</i>	(Atyeo, 1958)	urn:lsid:zoobank.org:act:1D6D7840-2911-4BDC-86ED-C14A572C132E
<i>Parabonzia</i>	<i>marthae</i>	Den Heyer, 1975	urn:lsid:zoobank.org:act:EEBA0D8A-73BE-4030-B14F-8DC77AD28E1A
<i>Parabonzia</i>	<i>mumai</i>	Smiley, 1992	urn:lsid:zoobank.org:act:F89139B2-2896-48BD-88E7-E0996160C280
<i>Pseudobonzia</i>		Smiley, 1975	urn:lsid:zoobank.org:act:6A96E3E0-E2F1-4E05-A98D-CF8A747A69F8
<i>Pseudobonzia</i>	<i>clathralthus</i>	(Shiba, 1978)	urn:lsid:zoobank.org:act:94C7A151-317C-4F07-AEFD-27773DA85958
<i>Pseudobonzia</i>	<i>delfinadobakerae</i>	Smiley, 1992	urn:lsid:zoobank.org:act:EFB11A46-0E85-490D-8BCB-07D63713680B
<i>Pseudobonzia</i>	<i>neoreticulata</i>	Den Heyer, 1977	urn:lsid:zoobank.org:act:AE8E5AB5-6E28-47E0-950E-FFF565CC7270
<i>Pseudobonzia</i>	<i>reticulata</i>	(Heryford, 1965)	urn:lsid:zoobank.org:act:E7BA836B-5F12-449C-B0A2-3EAD672FAB40
<i>Pseudobonzia</i>	<i>tanganasingae</i>	Fuangarworm & Lekprayoon, 2004	urn:lsid:zoobank.org:act:0FC68F11-B37D-4579-9F63-038129A1E5CC
<i>Dasythyreidae</i>		Atyeo, 1961	urn:lsid:zoobank.org:act:5EFFD322-8CFE-4A6E-BDB4-8E9833AC4DA1
<i>Dasythyreus</i>	<i>hirsutus</i>	Atyeo, 1961	urn:lsid:zoobank.org:act:B53EE7C4-E9C1-403F-B300-D67E0C1B0BF3

**Imago description.** Females and males similar, except for genital and chaetotaxic differences noted below. In life, integument clear to slightly opaque white, with red internal coloration in body that extends into basal leg segments (fig. 1). Most setae slightly to densely barbulate (for example, see fig. 9), though they have been illustrated as smooth to retain clarity in figures.



**FIGURE 1.** *Pseudocheylus americanus* (Ewing, 1909). Stereomicrographs of specimens in ethanol.

**Female** (n=5). 720–1080 (914) long, 420–770 (574) wide.

**Gnathosoma. Subcapitulum** less than half the length of the idiosoma, 248–303 (265). Two pairs of adoral setae and two pairs of subcapitular setae present. **Palp** 213–288 (246) long, 88–110 (97) wide. Setal count: trochanter—0; femur—14; genua—2; tibiae—3, 2 spine-like setae, 1 claw-like setae; tarsus—7. **Chelicera** 240–250 (244) long, 70–88 (77) wide, tapering anteriorly. Two setae present, one at apex and one on anterior half.

**Dorsum** (fig. 2). Two pairs of eyes present; anterior pair with lenses, posterior pair without lenses or other external marks (see remarks). Proterosomal shield present, unsclerotized; differentiated by weaker, self enclosing striations. One pair of setose trichobothria, 65–78 (73) long, and 15–16 pairs of setae present. Hysterosoma with approximately 50 pairs of setae; setal rows difficult to differentiate. Two anal setae present dorsally. Integument striated.

**Venter.** Coxal plates I and II closely approximated; coxal plates III and IV also closely approximated, fused toward midline. Coxae I–IV setal formula 3-3-3-2. Three genital setae present (Figs. 7f, 8). 65–70 pairs of setae present, including 4 pairs of apparently pseudanal setae.

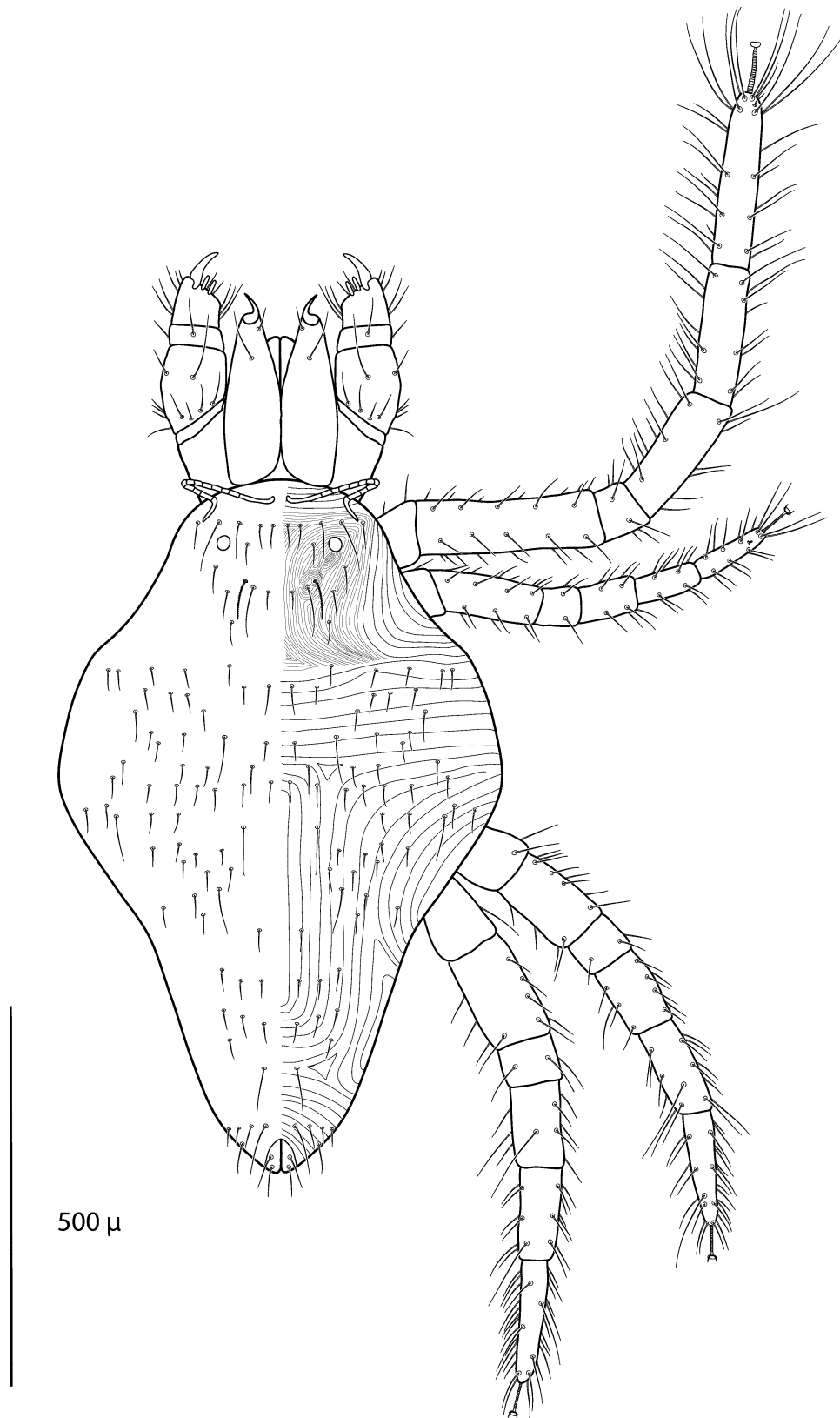
**Legs.** Leg I longer than body, legs II–IV shorter than body. Leg I 950–1110 (1028), leg II 300–600 (494), leg III 530–690 (616), leg IV 610–790 (730). Setal formula: trochanters I–IV, 2-1-2-1; basifemora I–IV, 23-17-12-8 to 11; telofemora I–IV, 6-3-4-3; genua I–IV, 17-8-7 to 9-7 to 8; tibiae I–IV, 15 to 17-10-14-15 to 16; tarsi I–IV, 30 (1)-17 (1)-35 to 38-44 to 46.

**Male** (n=3). Same as female, except as follows. 780–950 (870) long, 410–590 (517) wide.

**Gnathosoma. Subcapitulum** 225. **Palp** 200–213 (208) long, 83–98 (88) wide. **Chelicera** 200–213 (206) long, 65–70 (67) wide.

**Venter.** Eight genital and 7–10 paragenital setae present. Large, internal genital structure (Fig. 7e) visible through integument.

**Legs.** Leg I 890–1050 (953), leg II 400–450 (423), leg III 500–590 (550), leg IV 580–680 (637). Setal formula: basifemora I–IV, 27-17 to 18-12-9 to 10; telofemora I–IV, 6 to 7-3-4-4; genua I–IV, 17-9-8-9 to 10; tibia I–IV, 17-10-13 to 14-14; tarsi I–IV, 32 (1)-17 (1)-46 to 48-44 to 48.

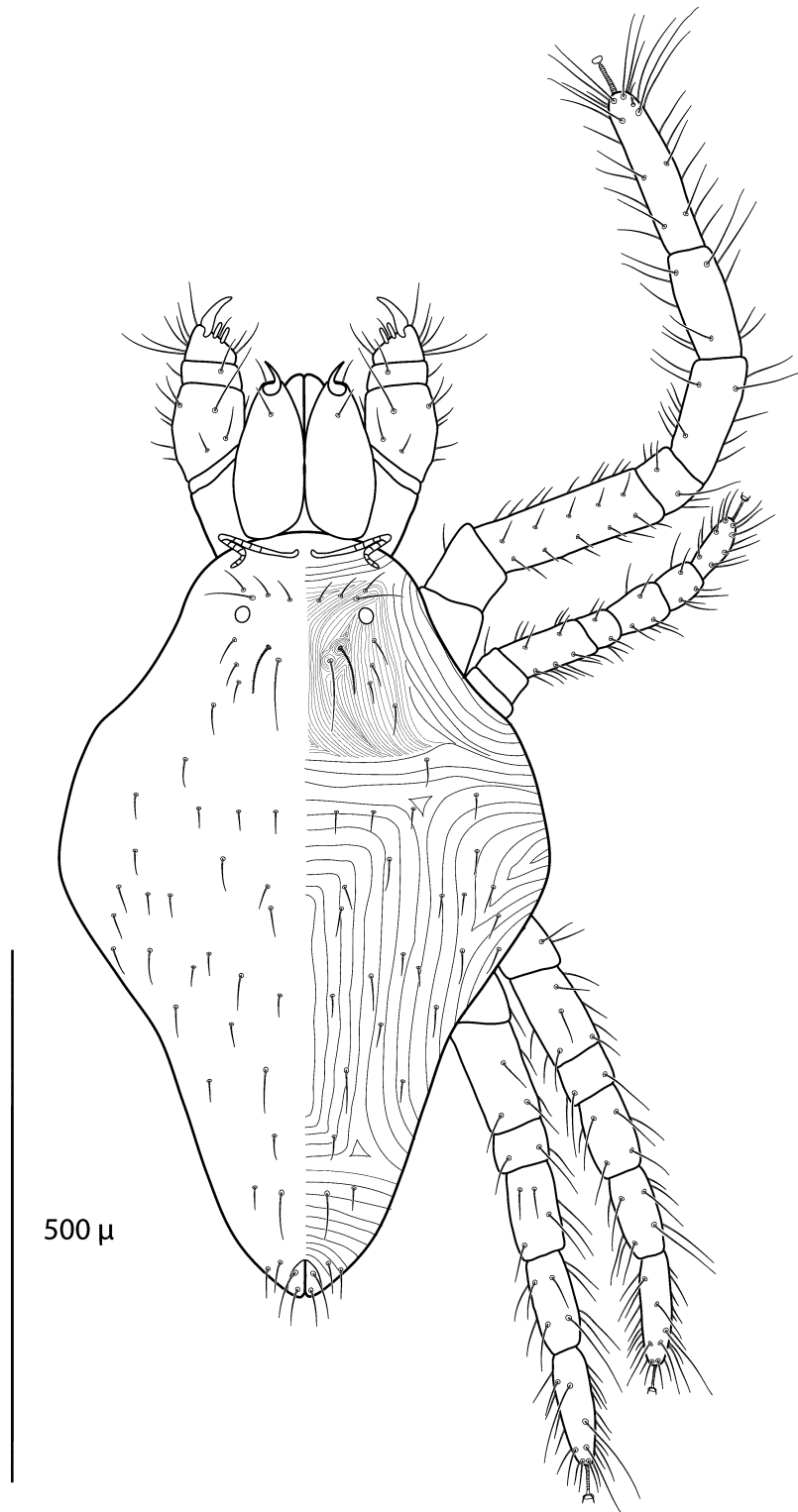


**FIGURE 2.** *Pseudocheylus americanus* (Ewing, 1909), adult, dorsum.

**Immatures description.** Immature *Pseudocheylus americanus* superficially resemble adults. They can be differentiated by the number of legs (larvae have six legs), generally smaller size, genital development, and chaetotaxy. Most setae are slightly to densely barbulate.

**Tritonymph** (n=2). 650–780 (715) long, 450–550 (500) wide.

**Gnathosoma. Subcapitulum** less than half the length of the idiosoma, 163–175 (169). Two pairs of adoral setae and two pairs of subcapitular setae present. **Palp** 163–200 (181 long, 70–75 (73) wide. Setal count: trochanter—0; femur—11; genua—2; tibiae—3, 2 spine-like setae, 1 claw-like setae; tarsus—7. **Chelicera** 163–178 (170) long, 58–63 (60) wide, tapering anteriorly. Two setae present, one at apex and one on anterior half.



**FIGURE 3.** *Pseudocheylus americanus* (Ewing, 1909), tritonymph, dorsum.

**Dorsum** (fig. 3). Proterosomal shield present, unsclerotized; differentiated by weaker, self enclosing striations. One pair of setose trichobothria, 55–68 (61) long, and 7–9 pairs of setae present. Hysterosoma with 26–29 pairs of setae. Two anal setae present dorsally. Integument striated.

**Venter.** Coxal plates I and II closely approximated; coxal plates III and IV also closely approximated, fused toward midline. Coxae I–IV setal formula 3-3-3-1. Three genital setae present (fig. 7d). 32–36 pairs of setae present, including 2 pairs of apparently pseudanal setae.

**Legs.** Leg I longer than body, legs II–IV shorter than body. Leg I 640–680 (660), leg II 330–350 (340), leg III 450–540 (495), leg IV 450–500 (475). Setal formula: trochanters I–IV, 1-1-2-1; basifemora I–IV, 21-13-9-6; telofemora I–IV, 6-3-3-3; genua I–IV, 12-6-6-3; tibiae I–IV, 12-5-10-10; tarsi I–IV, 25 to 27 (1)-13 (1)-25-24 to 25.

**Deutonymph** (n=4) 470–630 (558) long, 290–400 (336) wide.

**Gnathosoma. Subcapitulum** less than ½ the length of the idiosoma, 100–155 (131). Two pairs of adoral setae and two pairs of subcapitular setae present. **Palp** 125–163 (148) long, 55–68 (62) wide. Setal count: trochanter—0; femur—5; genua—2; tibiae—3, 2 spine-like setae, 1 claw-like setae; tarsus—7. **Chelicera** 128–145 (138) long, 45–63 (54) wide, tapering anteriorly. Two setae present, one at apex and one on anterior half.

**Dorsum.** (fig. 4). Proterosomal shield present, unsclerotized; differentiated by weaker, self enclosing striations. One pair of setose trichobothria, 53–68 (62) long, and 6 pairs of setae present. Hysterosoma with 18 pairs of setae. Two anal setae present dorsally. Integument striated.

**Venter.** Coxal plates I and II closely approximated; coxal plates III and IV also closely approximated, fused toward midline. Coxae I–IV setal formula 3-3-3-0. Genital setae absent (fig. 7c). Fourteen pairs of setae present, including 2 pairs of apparently pseudanal setae.

**Legs.** Leg I longer than body, legs I–IV shorter than body. Leg I 490–620 (534), leg II 248–413 (324), leg III 310–430(384), leg IV 360–430 (402). Setal formula: trochanters I–IV, 1-1-2-1; basifemora I–IV, 10-6-5-1; telofemora I–IV, 6-3 to 4-3-3; genua I–IV, 8-4-4-4; tibiae I–IV, 6-5-5-5; tarsi I–IV, 22 (1)-9 (1)-14-12.

**Protonymph** (n=1) 510 long, 313 wide.

**Gnathosoma. Subcapitulum** less than ½ the length of the idiosoma, 128. Two pairs of adoral setae and two pairs of subcapitular setae present. **Palp** 123 long, 50 wide. Setal count: trochanter—0; femur—2; genua—1; tibiae—3, 2 spine-like setae, 1 claw-like setae; tarsus—7. **Chelicera** 113 long, 50 wide, tapering anteriorly. Two setae present, one at apex and one on anterior half.

**Dorsum** (fig. 5). Proterosomal shield present, unsclerotized; differentiated by weaker, self enclosing striations. One pair of setose trichobothria, 58 long, and 4 pairs of setae present. Hysterosoma with 9 pairs of setae. Two anal setae present dorsally. Integument striated.

**Venter.** Coxal plates I and II closely approximated; coxal plates III and IV also closely approximated, fused toward midline. Coxae I–IV setal formula 3-3-1-0. Genital setae absent (fig. 7b). Twelve pairs of setae present, including 1 pair of apparently pseudanal setae.

**Legs.** Leg I longer than body, legs II–IV shorter than body; femora IV completely fused. Leg I 400, leg II 233, leg III 350, leg IV 333. Setal formula: trochanters I–IV, 1-1-2-0; basifemora I–III, 3 to 4-5-0; telofemora I–III, 4-4-3; femora IV, 0; genua I–IV, 5-4-4-1; tibiae I–IV, 5-5-5-1; tarsi I–IV, 21 (1)-9 (1)-13-8.

**Larva** (n=1) 390 long, 250 wide.

**Gnathosoma. Subcapitulum** less than 1/3 the length of the idiosoma, 110. Two pairs of adoral setae and two pairs of subcapitular setae present. **Palp** 100 long, 48 wide. Setal count: trochanter—0; femur—2; genua—1; tibiae—3, 2 spine-like setae, 1 claw-like setae; tarsus—6. **Chelicera** 95 long, 40 wide, tapering anteriorly. Two setae present, one at apex and one on anterior half.

**Dorsum** (fig. 6). Proterosomal shield present, unsclerotized; differentiated by weaker, self enclosing striations. One pair of setose trichobothria, 53 long, and 3 pairs of setae present. Hysterosoma with 6 pairs of setae. Two anal setae present dorsally. Integument striated.

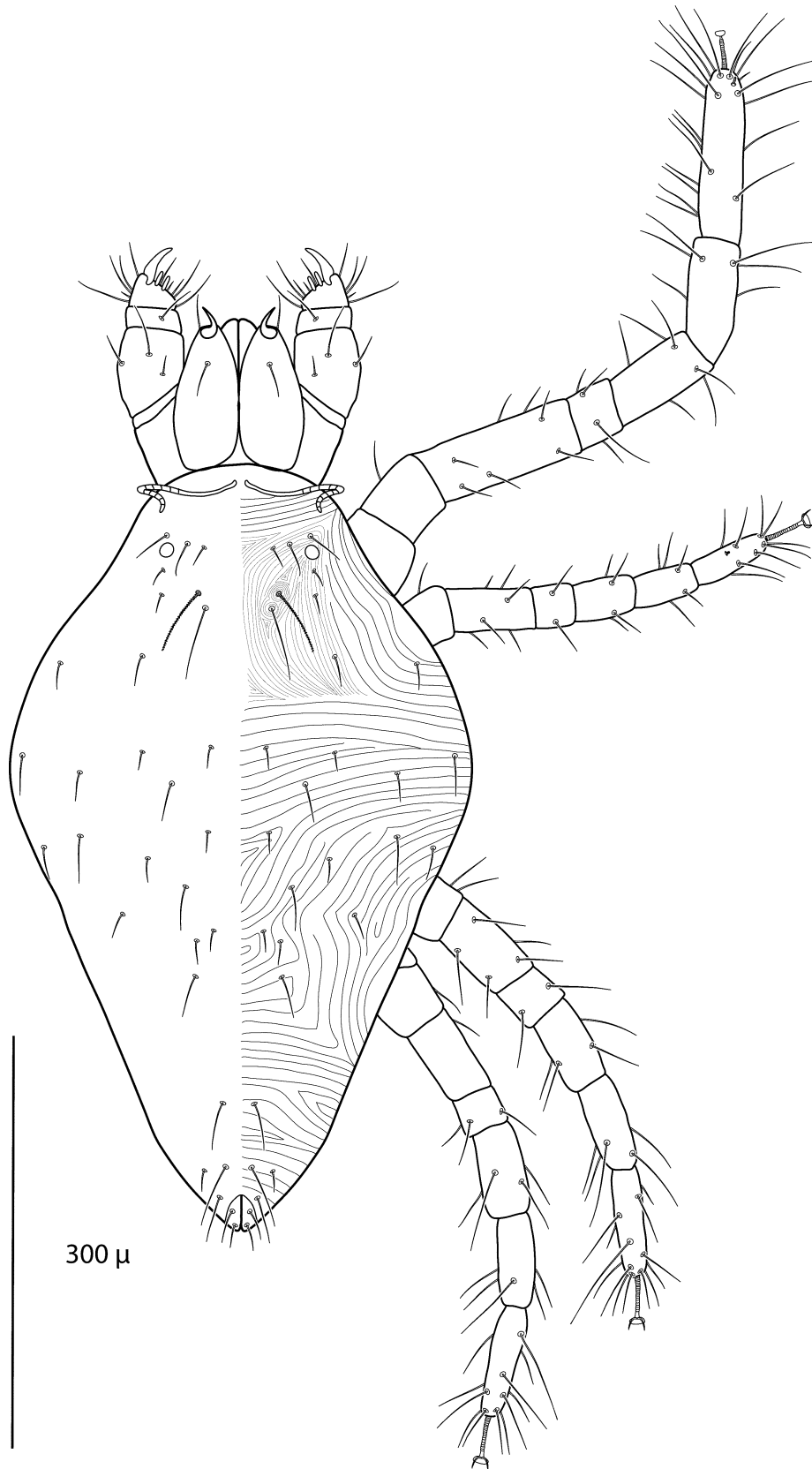
**Venter.** Coxal plates I and II closely approximated. Coxae I–III setal formula 2-1-1. Genital setae absent (fig. 7a). Two pairs of setae present.

**Legs.** Leg I longer than body, legs II and III shorter than body. Femora I–III completely fused. Leg I 310, leg II 178, leg III 220,. Setal formula: trochanters I–III, 1-0-1; femora I–III, 5-4-3; genua I–III, 4-4-4; tibiae I–II, 5-5-5; tarsi I–III, 11 (1)-9 (1)-9.

**Remarks.** Ewing (1909) provided a small illustration of the dorsal habitus of the adult female which, while useful for gestalt, lacks the detail to be used diagnostically. He stated that the species has “on each side of the base



of the mandibles and not far from the same is a prominent, curved horn about as long as the width of the mandibles” and the “mandibles each [have] three bristles; a long, straight bristle at about one-third the distance from the anterior end, a similar bristle at about the middle of the mandibles, and a much shorter one situated just about the piercing organ”.



**FIGURE 4.** *Pseudocheylus americanus* (Ewing, 1909), deutenymph, dorsum.

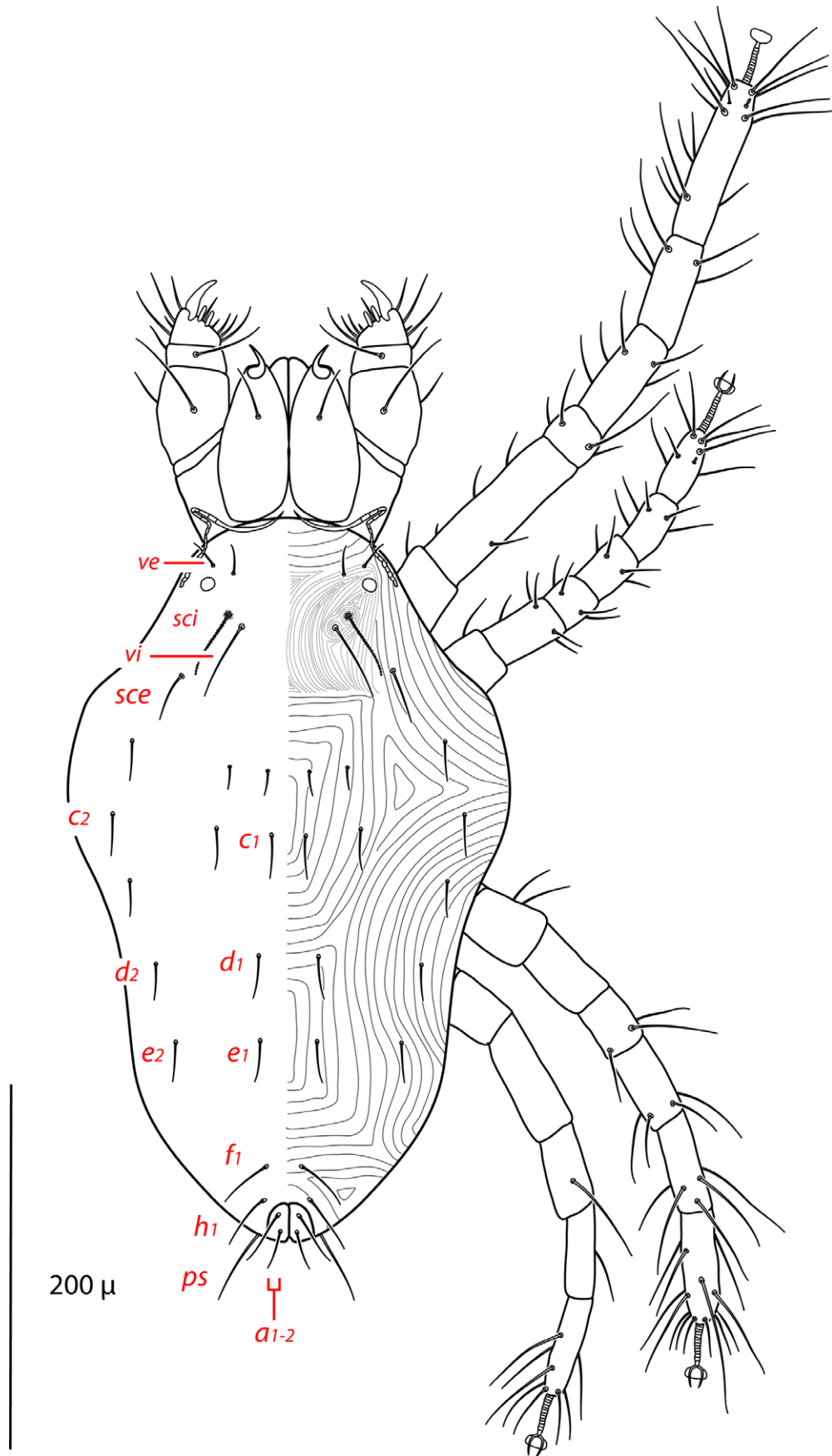


FIGURE 5. *Pseudocheylus americanus* (Ewing, 1909), protonymph, dorsum.

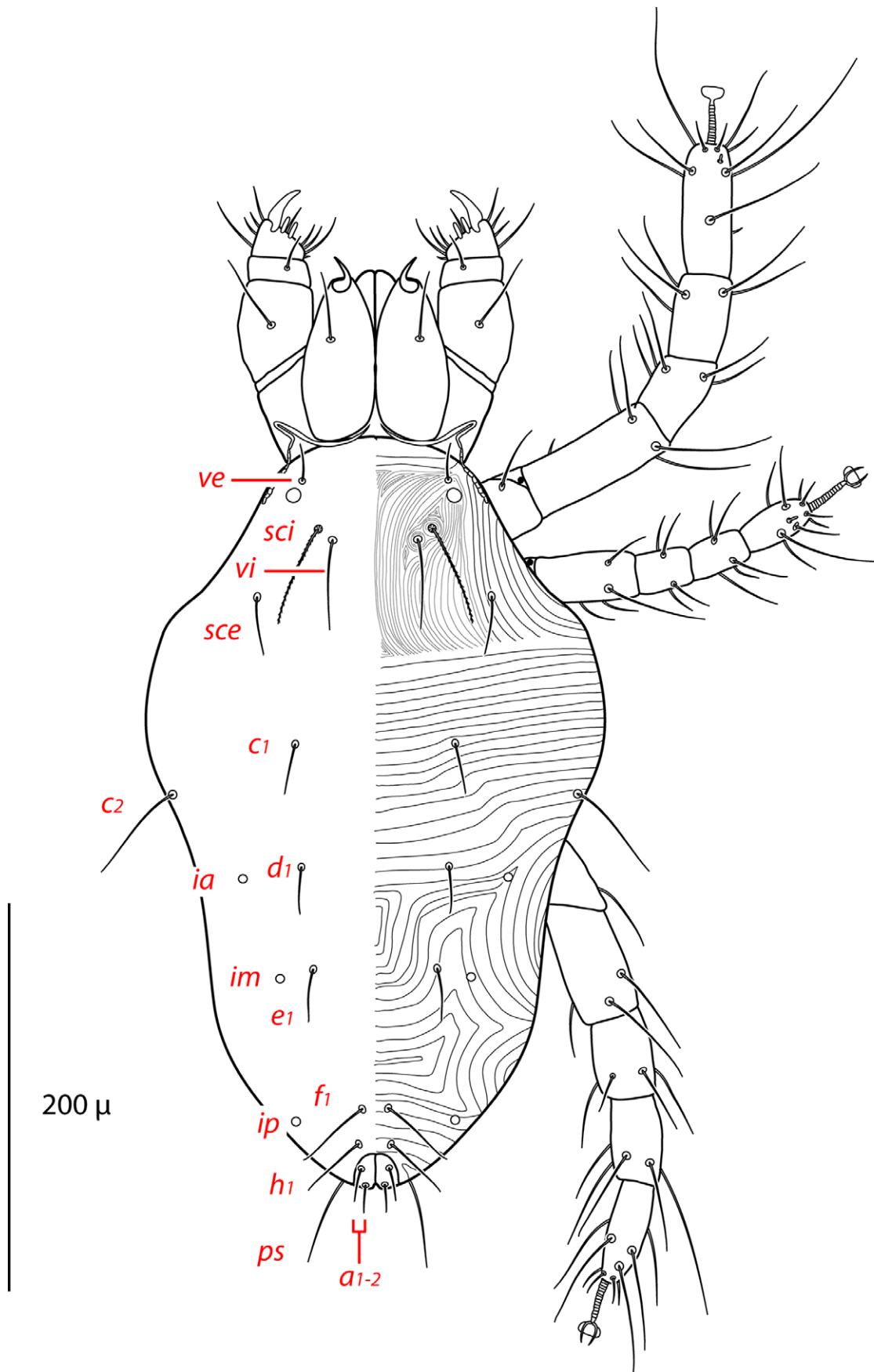
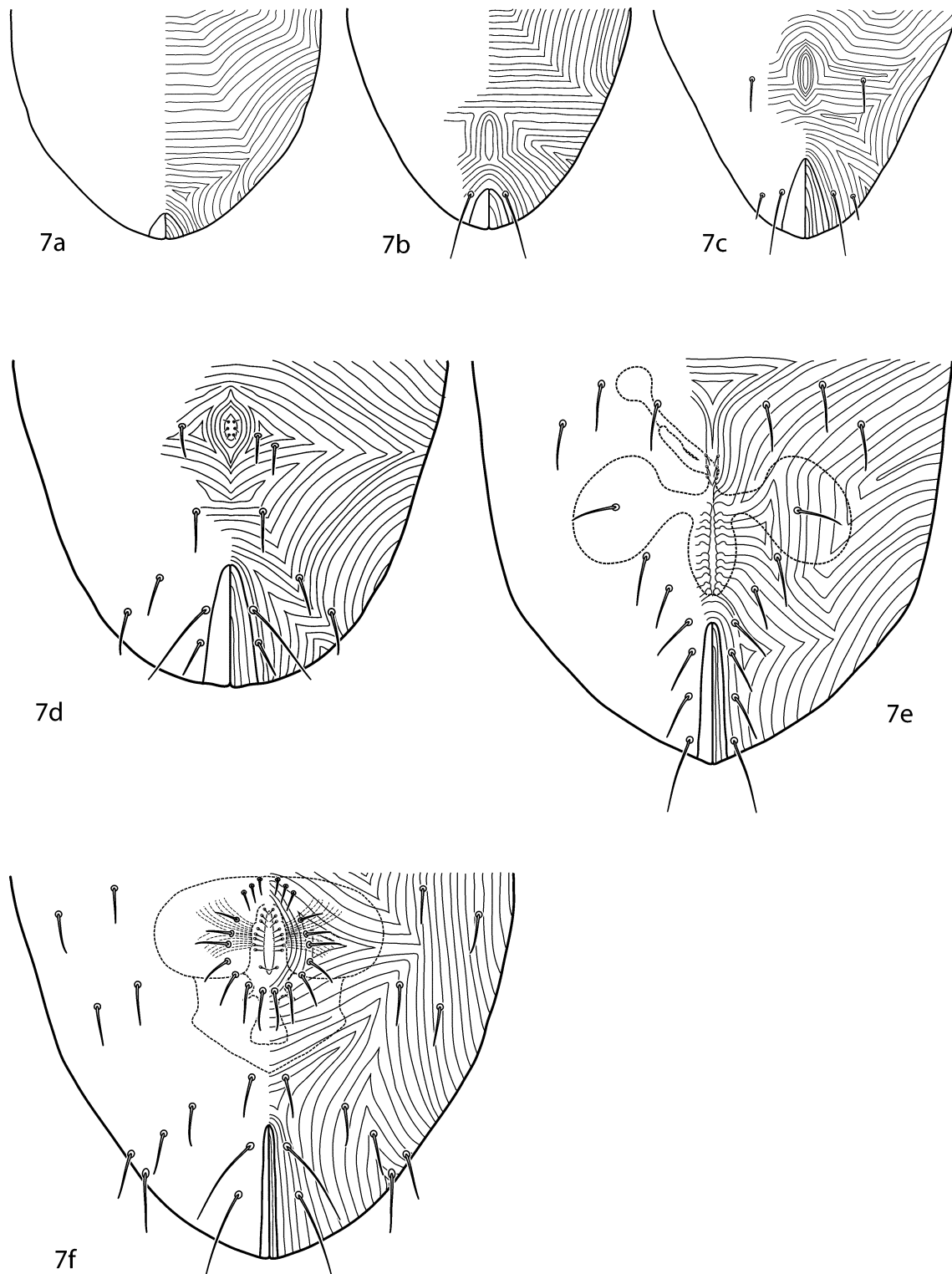


FIGURE 6. *Pseudocheylus americanus* (Ewing, 1909), larva, dorsum.



**FIGURE 7.** *Pseudocheylus americanus* (Ewing, 1909). Anogenital developmental sequence. Internal structures represented by dotted lines. **a**—larva. **b**—protonymph. **c**—deutonymph. **d**—trity nymph. **e**—adult female. **f**—adult male.

Baker (1958) presented detailed drawings of the dorsal habitus, tibiae I and tarsi I, the tip of tarsi I, and the dorsal gnathosoma of a mite only identified as “*Pseudocheylidae*”. These illustrations were reproduced by Baker and Atyeo (1964), who reported them to be drawings of *Pseudocheylus americanus*. In these drawings the peritremes are depicted as terminating on the gnathosoma and not looping back towards the body. The horns described by Ewing are lacking. Baker and Atyeo also depicted two setae on the chelicerae instead of the three described by Ewing. Vin Dis and Ueckermann (1991) wrote that Baker and Atyeo (1964) reported the shape of the

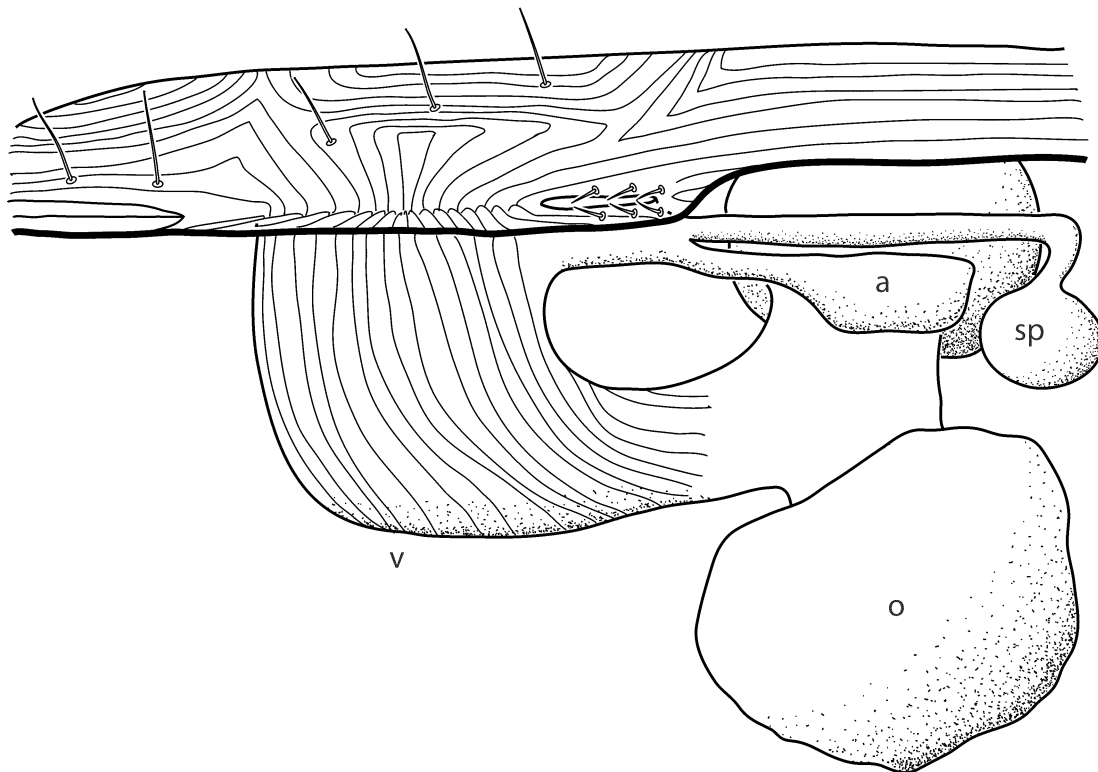
peritreme can be used to differentiate *P. americanus* and *P. biscalatus*, the only other described species. The authors could not find such a direct statement, however Baker and Atyeo (1964) state that “Berlese (1888) [referring to *P. biscalatus*] defined the genus, in part, as having peritremes appearing as little horns...The genus must be redefined to include species with distally free peritremes.” This suggests they considered *P. americanus* to have distally free peritremes.

To resolve these issues the authors wished to view the type material. Ewing did not say where he deposited the two slides of *P. americanus* he examined, however Baker and Atyeo (1964) reported them to be in the United States National Museum collection. A search was made by Debra Creel but the slides were not found. Dr. Barry OConnor was kind enough to examine the slide material Dr. Atyeo donated to the University of Michigan, but the types were not present there either. We suggest the types are probably lost.

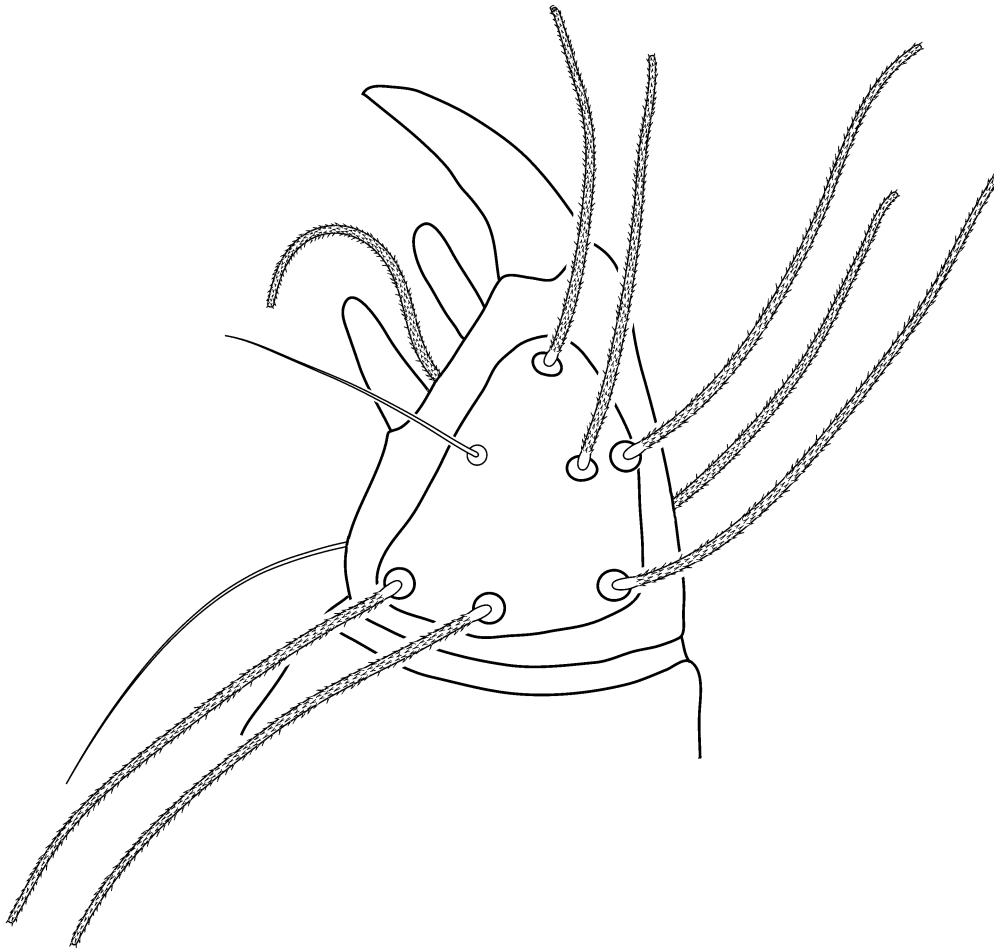
When the freshly collected specimens reported here were examined under low power, the peritremes, which form a loop that is free of the body, look like the “horn” Ewing illustrated and Berlese used to define the genus. We therefore suggest that our specimens are *P. americanus* and that either the illustrations by Baker (1958) and Baker and Atyeo (1964) depict another genus of Pseudocheylidae or do not accurately depict the peritremes of *P. americanus*.

The chelicerae of the newly collected specimens possess two setae, one distally near the movable digit and one approximately one-third the distance from the tip. There is, however, a pair of setae on the subcapitulum that might appear to be on the chelicerae if the chelicerae are not forced into an unnatural position during mounting. We suggest this is the third seta reported by Ewing that was subsequently not included in the illustration by Baker and Atyeo.

Two pairs of eyes are readily apparent in unmounted specimens (see for example fig. 1). The anterior pair is designated by having a lens, while the posterior pair lacks such a lens. When cleared or slide mounted in Hoyer’s medium the posterior pair of eyes are obliterated and no external indication of them on the cuticle is present. Ewing (1909) and subsequent authors do not mention this second pair of eyes, possibly because they only examined slide mounted specimens in which the eyes would not be apparent.



**FIGURE 8.** *Pseudocheylus americanus* (Ewing, 1909). Schematic reconstruction of female reproductive system.



**FIGURE 9.** *Pseudocheylus americanus* (Ewing, 1909). Ventrodistal adult palp, showing the tarsus appearing as a flat disc.

The trichobothria in Anystoidea have historically been considered to be homologous to setae *sci* of other mites (Kethley 1990; Krantz & Walter 2009). In *Pseudocheylus americanus* the trichobothria of the larvae are posterior to a second pair of internal setae. Two hypotheses might account for this: the trichobothria are setae *vi* and not homologous to the trichobothria of other Anystoidea or the trichobothria are *sci* and have migrated anteriorly while *vi* have migrated posteriorly. The authors have labeled the figures as per historical conventions (e.g., the trichobothria are *sci*), though this needs further study.

The palp tibiae and tarsi have historically been illustrated as being completely fused without any indication of the suture lines (see for example Van Dis & Ueckermann 1991). Upon close examination it is possible to discern the outline of the tarsi and therefore assign setal counts to the individual segments (fig. 9).

Stephen and Kinn (1980) collected two unidentified *Pseudocheylus* specimens near Ashdown, Arkansas on *Dendroctonus frontalis* (Curculionidae: Scolytinae), upon which they were apparently phoretic. While *P. americanus* is the only *Pseudocheylus* known from North America, the authors cannot confirm the identity of the specimens as the slides have apparently been lost. These new specimens therefore represent the first record of *Pseudocheylus americanus* from Arkansas.

**Material examined.** 5 females, 3 males, 1 tritonymph, 4 deutonymphs, 1 protonymph, 1 larva (APGD 11-0712-001) (all slide mounted), under bark of dead tree, USA, Arkansas, Washington Co., Fayetteville, Lake Sequoia, 12 July 2011, coll. A. Lynn-Miller.

## Caeculidae

### *Caeculus cremnicolus* Enns, 1958

*Caeculus cremnicolus* Enns 1958: 107, figs. 1–6; Dunn 1976: 2, figs. 1, 2; Hagan 1985: 245; McDaniel & Boe 1990: 723.

**Diagnosis.** *Caeculus cremnicolus* is differentiated from other North American *Caeculus* by the median dorsal hysterosomal plate possessing more than 3 pairs of setae, the propodosomal plate projecting anteriorly over the gnathosoma, and opisthosomal transverse plates I and II not fused along midline, instead forming two pairs of small oval plates.

**Remarks.** This species has previously only been documented from the type location in Boone Co., Missouri. Dunn (1976) used *C. cremnicolus* as a model organism in cluster and principal component analyses, but obtained the specimens from Dr. W. R. Enns and did not report the location they were collected. These new specimens increase the range of the species by approximately 400 km and suggest it may be found throughout the Interior Highlands.

**Material examined.** 1 larva (APGD 08-0509-003), ex litter, USA, Arkansas, Buffalo National River, Steel Creek (36°01'55.2"N, 93°20'02.4"W), 9 May 2008, coll. A. P. G. Dowling • 1 individual (APGD 10-0730-004), ex semidry mixed cedar and deciduous litter, same locality (36°01.924'N, 93°20.040'W), 30 July 2010, coll. M. J. Skvarla • 2 individuals (APGD 10-0730-006), ex moist litter drifts against hillside in creek bottom, same locality (36°02.213'N, 93°20.137'W), 30 July 2010, coll. M. J. Skvarla • 1 individual (APGD 10-0314-013), ex litter, USA, Arkansas, Newton Co, Buffalo National River, Boen Gulf (35°52.010'N, 93°24.060'W), 14 March 2010, coll. M. J. Skvarla • 1 individual (APGD 10-0314-017), same habitat and locality (35°52.040'N, 93°24.081'W), 14 March 2010, coll. M. J. Skvarla • 1 individual (APGD 10-0417-001), same habitat and locality (35°51.992'N, 93°24.046'W), 17 April 2010, coll. M. J. Skvarla • 1 individual (APGD 10-0518-017), same habitat and locality (35°52.010'N, 93°24.060'W), 18 May 2010, coll. M. J. Skvarla • 1 individual (APGD 10-0919-003), ex mixed cedar and deciduous litter in deep crevice between rocks, same locality (36°02.381 N, 93°20.394 W), coll. M. J. Skvarla • 1 individual (APGD 10-0919-006), ex mixed cedar and deciduous litter in drifts against logs and rocks, same locality, 19 Sept. 2010, coll. M. J. Skvarla • 2 individuals (APGD 10-0919-007), same habitat and locality, 19 Sept 2010, coll. M. J. Skvarla • 4 individuals (JRF 12-1029-002), ex leaf litter, USA, Arkansas, Conway Co., Petit Jean State Park (35°6'58"N, 92°56'31"W), 28 October 2012, coll. J. R. Fisher.

## Cunaxidae

### *Bonzia yunkerii* Smiley, 1992

*Bonzia yunkerii* Smiley 1992: 50, fig. 19.

**Diagnosis.** *Bonzia yunkerii* can be distinguished from the three other described *Bonzia* by possessing a smooth (instead of setose) trichobothrium on tibiae IV and smooth (instead of spiculate) dorsal setae.

**Remarks.** This species was previously known only from the holotype, which was collected under a log in "Passalaus beetle habitat" in Virginia, USA (the authors assume *Passalaus* in this case refers to *Odontotaenius disjunctus*, the only passalid beetle that occurs in Virginia). These specimens extend the species' range considerably.

**Material examined.** 2 females (APGD 10-0424-007), ex. deciduous leaf litter, USA, Arkansas, Washington Co., Devil's Den State Park (35°46.817 N, 94°14.750 W), 24 April 2010, coll. M. J. Skvarla • 1 female (APGD 10-0518-004), ex. deciduous leaf litter, USA, Arkansas, Newton Co., Buffalo National River, Boen Gulf (35°52.073 N, 93°24.099 W), 18 May 2010, coll. J. R. Fisher & M. J. Skvarla.

### *Parabonzia bdelliformis* (Atyeo, 1958)

*Bonzia bdelliformis* Atyeo 1958: 173, fig. 1–3; Den Heyer 1975: 665; Sepsagosarian 1984: 140.

*Cunabdella bdelliformis* (Atyeo), Den Heyer 1975: 665; Kuznetsov and Livshitz 1979: 1233; Sepsagosarian 1984: 140.

*Parabonzia bdelliformis* (Atyeo) Smiley 1975: 228, fig. 3; Den Heyer 1977b: 601; Kuznetsov and Livshitz 1979: 1233; Sepsagosarian 1984: 140; Smiley 1992: 68, fig. 30; Lin & Zhang 1998: 29.

**Diagnosis.** *Parabonzia bdelliformis* may be distinguished from other *Parabonzia* by possessing the following characteristics: 6 or 7 genital setae, 4 setae ( $c_1$ – $e_1$ ,  $c_2$ ) on the hysterosomal shield, and basifemora I–II with 5–8 setae.

**Remarks.** This species is widespread, having been reported from South Africa, Russia, and Ohio, Tennessee, Georgia, Oklahoma, and Texas in the United States. These are the first records of the species from Arkansas. Most specimens examined were collected from material in tree holes and, when present in such environments, were extremely abundant (i.e., hundreds of specimens collected per tree hole).

**Material examined.** 7 females (APGD 10-0919-001), ex wet organic material in hole at base of tree, USA, Arkansas, Newton Co, Buffalo National River, Steel Creek (36°02.016 N, 93°20.137 W), 19 Sept. 2010, coll. M. J. Skvarla • 7 females (APGD 10-1008-004), ex tree hole at base of tree, same locality (36°02.259 N, 93°20.880 W), 8 Oct. 2010, coll. M. J. Skvarla • 2 females (APGD 11-1004-004), ex oak and hickory litter on talus slope, USA, Arkansas, Washington Co., Devil's Den State Park (35°46.817 N, 94°14.750 W), 4 Oct. 2011, coll. M. J. Skvarla • 1 female (APGD 11-1004-002) ex wet tree hole detritus & dry material in rotten log, same locality (35°46.875 N, 94°14.743 W), 4 Oct. 2011, coll. M. J. Skvarla

### *Pseudobonzia reticulata* (Heryford, 1965)

*Cunaxa reticulata* Heryford 1965: 310, fig. 1–3; Corpuz-Raros & Garcia 1996: 15; Den Heyer & Castro 2008: 42.

*Pseudobonzia reticulata* (Heryford) Smiley 1975: 242, fig. 15; Den Heyer 1977c: 193; 1980: 121; Sepsagosarian 1984: 143; Smiley 1992: 112, fig. 54; Corpuz-Raros & Garcia 1996: 16; Fuangarworn & Lekprayoon 2004: 45; Den Heyer & Castro 2008: 42.

**Diagnosis.** *Pseudobonzia reticulata* can be distinguished from other *Pseudobonzia* by the following characteristics: palp basi- and telofemoral setae simple (not spine-like), setae  $f_2$  present, and the proximal leg podomeres (excluding coxae) lack reticulations.

**Remarks.** After examining two paratypes and the newly collected specimens, a discrepancy between the original description and the specimens was found. Heryford (1965) did not report setae  $f_2$  being present, either in the description or illustration. However, we found it to be present in all six specimens and suggest it is always present.

This species was apparently known only from the type series, which was collected from “humus litter from an abandoned ground silo” in Johnson Co., Kansas. These specimens expand the range of this species by approximately 725 km across the Ozark Highlands.

**Material examined.** 1 female (APGD 10-0726-005), ex litter among grass along ridge top, USA, Arkansas, Washington Co., Ozark National Forest, Weddington (36°06.312 N, 93°23.390 W), 26 July 2010, coll. M. J. Skvarla • 1 female (APGD 10-0915-001), ex grass mixed deciduous litter in grass, same locality, (36°06.322 N, 93°23.390 W), 15 September 2010, coll. M. J. Skvarla • 2 females (APGD 11-1007-007), ex moist pine litter & humus under log and at base of tree, same locality (36°07.534 N, 94°23.916 W), 7 October 2011, coll. M. J. Skvarla.

## Dasythyreidae

### *Dasythyreus hirsutus* Atyeo, 1961

*Dasythyreus hirsutus* Atyeo 1961: 11, figs. 1–4; Walter & Gerson 1998: 189.

**Diagnosis.** *Dasythyreus hirsutus* can be differentiated from *Xanthodasythyreus toohey*, the only other described dasythyreid, by locality (*D. hirsutus* is known only from North America while *X. toohey* is known only from Australia), having pretarsi that are longer than the tarsi, and lack of anastomosing peritremes.



**Remarks.** Three of the specimens examined were all collected in malaise traps and one was extracted from bark using Berlese funnels. This is not surprising as *Dasythyreus hirsutus* appears to inhabit the bark of trees. Walter and Gerson (1998) suggested *Dasythyreus* forage on tree bark, citing that Atyeo (1961) collected *D. hirsutus* under the bark of a tree and Dr. Evert Lindquist collected an undescribed species from eyed-click beetles (*Alaus myops* (F.)), which are predatory under the bark of pine trees.

These new records expand the range of *Dasythyreus hirsutus* by approximately 150 km south and 150 km northeast of the original collection site. This suggests that the species is found throughout the Interior Highlands.

**Material examined.** 1 adult (APGD 10-0608-001), ex malaise trap in grass in open glade, USA, Missouri, Taney Co., Mark Twain National Forest, Hercules Glades (36°41.183 N, 98°58.25 W), 8 June 2010, coll. J. R. Fisher and M. J. Skvarla • 3 adults (APGD 10-0609-006), ex malaise trap in grass in opening of oak/hickory forest, same locality (36°41.01 N, 94°53.36 W), 9 June 2010, coll. J. R. Fisher and M. J. Skvarla • 1 adult (APGD 12-0706-004), ex bark & wood of standing dead oak, USA, Arkansas, Polk Co., Ouachita National Forest, Black Fork Mountain Wilderness, Black Fork Trail (34°41.277' N, 94°18.856' W).

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