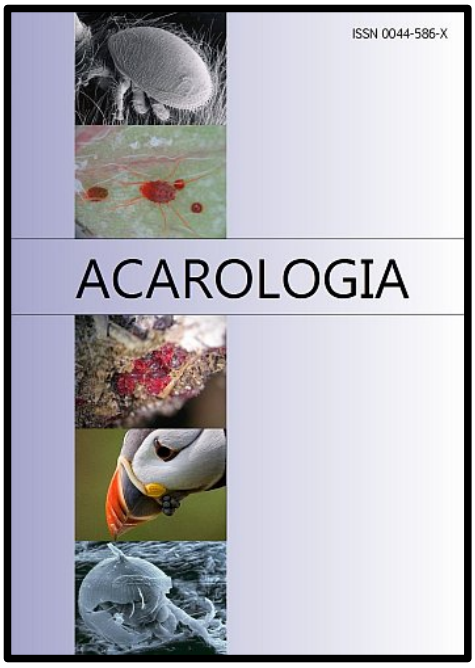

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The masked torrent mite, *Torrenticola larvata* n. sp. (Acari: Hydrachnidiae: Torrenticolidae): a water mite endemic to the Ouachita Mountains of North America

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ABSTRACT — *Torrenticola larvata* **n. sp.** is described from the Interior Highlands of North America. Given the absence of this species from surrounding collecting events, this species is proposed to be endemic to the Ouachita Mountains of Arkansas, USA. The present study reveals significant morphological features in *T. larvata* that distinguish it from similar species (e.g., *T. trimaculata* Fisher, 2015). Adult *T. larvata* are most easily differentiated from other *Torrenticola* by their unique color pattern, with dorsal pigmentation restricted to the anterio-medial platelets and adjacent areas and occasionally with pigmentation posteriorly. Further, *T. larvata*, particularly the males, are more rectangular than other species found in eastern North America.

KEYWORDS — Trombidiformes; Prostigmata; Hydrachnidia; Hydrachnidiae; endemism

INTRODUCTION

The present study is the third in a series of descriptions from an ongoing taxonomic project on North American Torrenticolidae Piersig, 1902 (Fisher *et al.* 2015; O'Neill *et al.* 2016). *Torrenticola* Piersig, 1896 are diverse and abundant, yet largely unknown in North America, with 77 described (23 north of Mexico) and approximately 50 more undescribed in our collections (Fisher *et al.* 2015). Herein, we describe *Torrenticola larvata* **n. sp.**, a distinct species inhabiting streams in the Ouachita Mountains, USA.

Torrenticola are diverse water mites that prey on chironomid larvae as adults and parasitize chironomid adults as larvae (Smith 2010). Although it has not been investigated for *Torrenticola* specifically, water mites in general have been shown to control host populations (Smith 1988, Smith 2010).

The Interior Highlands of eastern North America comprise two primary features, the Ozark and Ouachita Mountains. These reliefs are biogeographically relevant because they have been continuously exposed through historical events (e.g., flooding, glaciation) and over 100 Arkansas endemics inhabit the region (Robison and Allen 1995). The Ouachita Mountains are a region of endemism to several species of plants and animals (e.g., Pringle and Witsall 2005; Radwell *et al.* 2011) that have important taxonomic relevance to similar species existing far outside of the Interior Highlands (for a more complete overview see Skvarla *et al.* 2015).

Water mites are present worldwide, but many genera in North America north of Mexico exhibit relict distributions in areas that served as unglaciated refugia during the Paleogene and Neogene periods (Smith *et al.* 2010). Areas such as the Appalachian Mountains and the Interior Highlands are well known refugia during climatic upheaval during these periods (Robison and Allen 1995). Several genera of Arrenuroidea in North America contain species with distributions in and adjacent to these known refugia (Smith 1989, 1991, 1992a,b, 2009). Furthermore, while water mites of the Interior Highlands have yet to be rigorously studied, Radwell *et al.* (2011) described an endemic, *Kongsbergia robisoni* Radwell & Smith, 2011, and identified a similar, but genetically distinct species restricted to Ouachita Mountain streams. Later, Radwell & Smith (2012) described another Highlands endemic, *K. crumpae*. *Torrenticola larvata* **n. sp.** have been found exclusively in Ouachita streams, and represents the latest endemic to the region.

MATERIALS AND METHODS

Mites were collected using protocols detailed in Smith *et al.* (2010, p.516-518). In brief, mites were collected in the riffles and pools of streams using fine-mesh (250 μm) nets. In cobblestone riffles, shovels were used to dig up substrate and detritus and cause fine particulate matter to flow downstream into the nets. In pools, nets were swayed through the bottom of the water column after stirring up detritus with boots and/or shovels. Collected material was passed through a set of sieves to remove larger particulates. This residue was transferred to white trays filled with 4 cm of water and mites were pipetted as they moved from the residue.

Mites were stored in either 95 % EtOH or GAW (mixture of glycerol, acetic acid, and water), the latter not being suitable for DNA preservation. Specimens were cleared in 10 % KOH, dissected, and mounted in either glycerin jelly or Hoyer's medium. Pictures were taken by positioning the camera of a cell phone (iPhone 5) over the eyepiece of a Leica DM2500 microscope. Illustrations were created in Adobe Illustrator CS6 and a Wacom Cintiq 21UX tablet using methods outlined in Fisher and Dowling (2010). All measurements were taken digitally from the images using ImageJ (Schneider *et al.* 2012) and are recorded in micrometers (μm). Ranges are presented for each character measured, when appropriate, and the measurements for the female holotype and male allotype are shown in parentheses, when available. Selected measurements follow those outlined in Goldschmidt (2007) and Fisher *et al.* (2015). Terminology follows Goldschmidt (2007) as modified by Fisher *et al.* (2015) and abbreviations for structures are defined in the text upon first usage. *Torrenticola larvata* **n. sp.** has been registered in ZooBank and images have been deposited in Morphbank.

TAXONOMY

Torrenticolidae Piersig, 1902
Torrenticolinae Piersig, 1902
***Torrenticola* Piersig, 1896**

***Torrenticola larvata* n. sp.**
Cheri, Fisher, & Dowling

LSID: urn:lsid:zoobank.org:act:F41E803A-0032-462D-B77E-4B0DC5E0DD83

Diagnosis — Among North American *Torrenticola* of eastern North America, *T. larvata* **n. sp.** is most similar to *T. tricolor* Habeeb, 1957 and *T. trimaculata* Fisher, 2015 in sharing the following combination of characters:
1) anterio-lateral platelets free from dorsal plate;
2) rostrum short and conical;
3) long pedipalpal tibiae, conical pedipalpal projections on genua & femora;
and 4) a distinct and prominent dark pigmentation pattern on the dorsum. *Testudacarus larvata* **n. sp.** can be immediately differentiated from both of these species by the distinctive dorsal pattern (Fig.1-3), which is unique among North American *Torrenticola*, and by a more elongate body (dorsum length/width = 1.41 – 1.57 in *T. larvata*; and 1.20 – 1.38 in *T. trimaculata* and *T. tricolor*).

FIGURE 1: *Torrenticola larvata* **n. sp.** female: dorsal habitus.

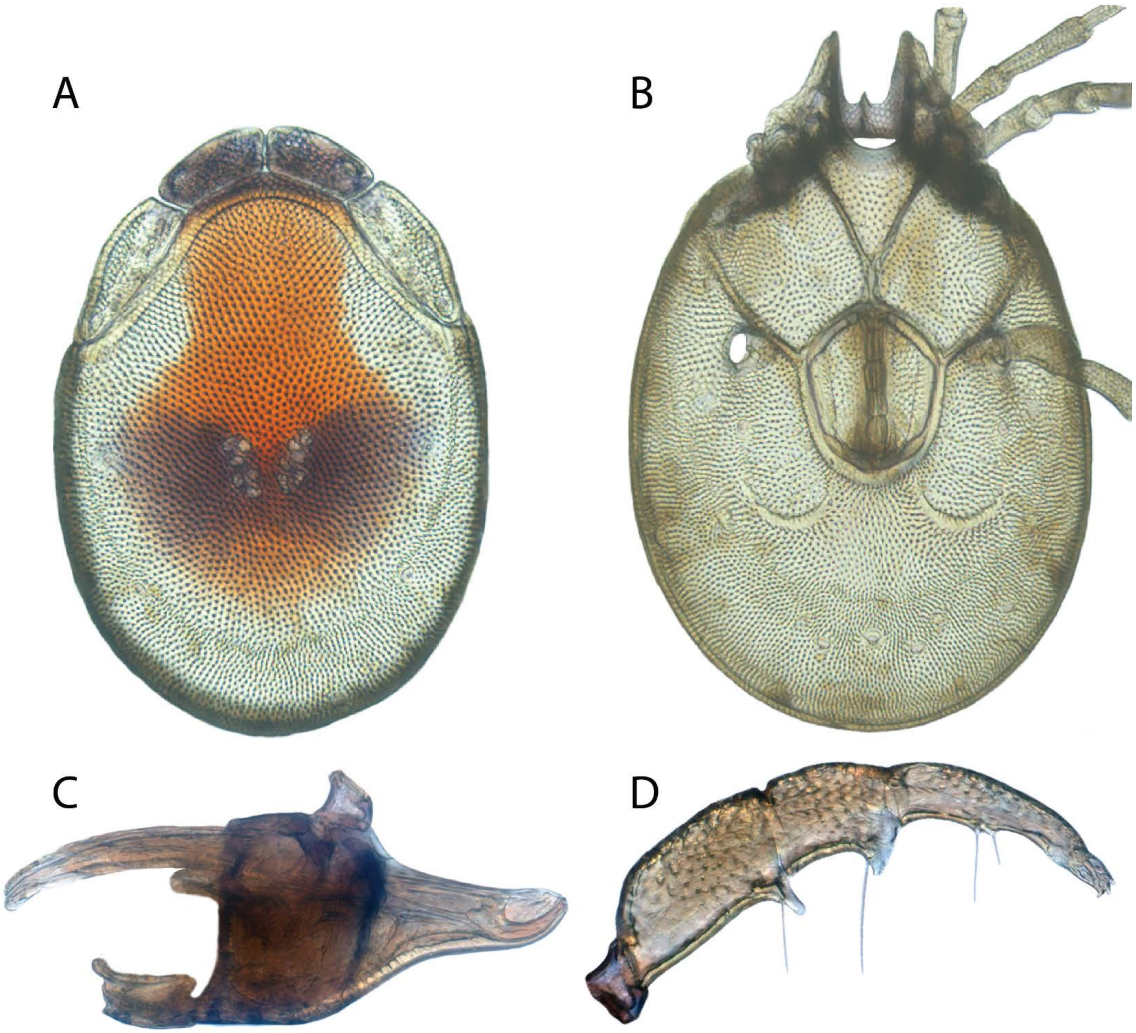

FIGURE 2: *Torrenticola larvata* **n. sp.** female: A – dorsal plates; B – ventral plates; C – subcapitulum and chelicerae; D – pedipalp (dorsal setae removed).

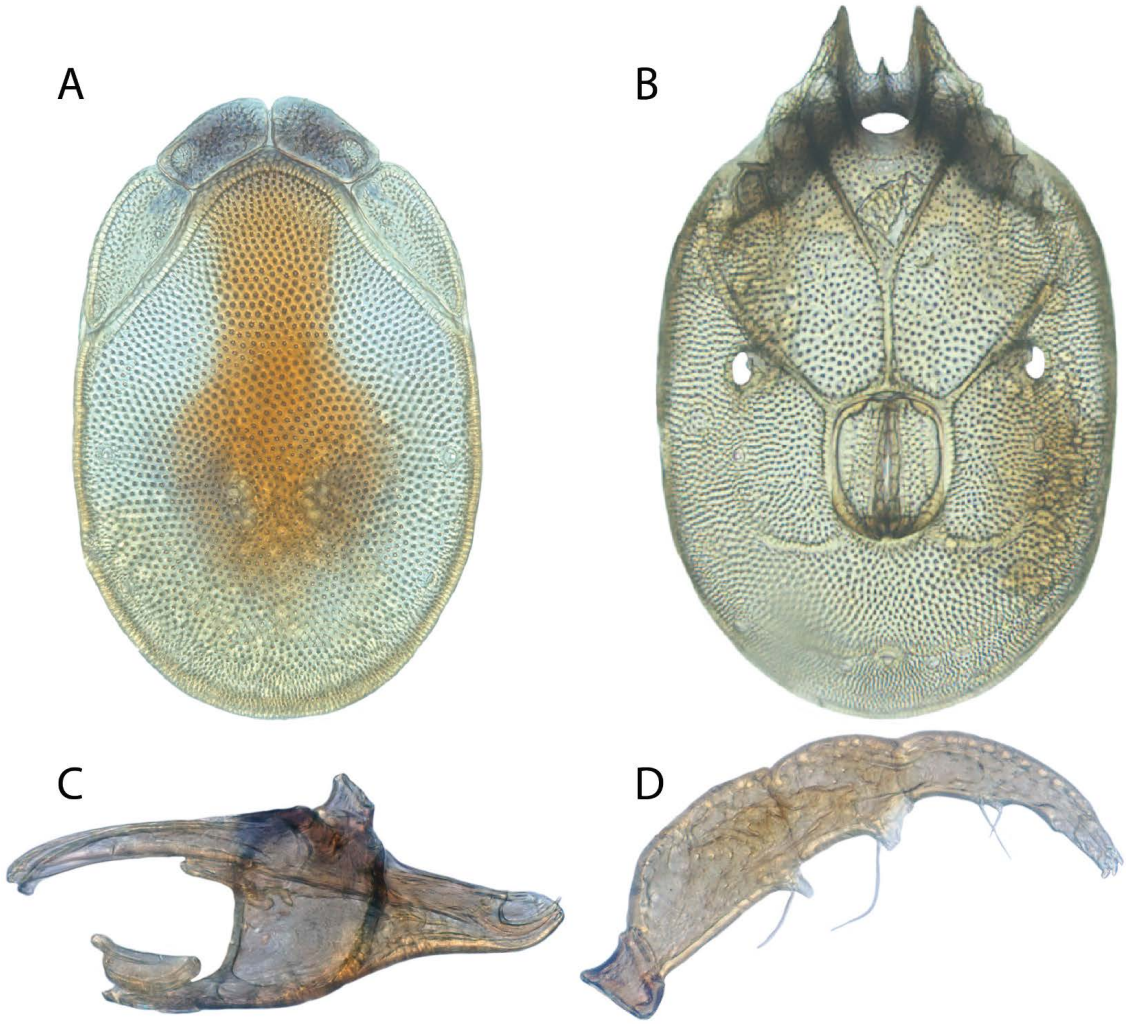

FIGURE 3: *Torrenticola larvata* **n. sp.** male: A – dorsal plates; B – ventral plates; C – subcapitulum and chelicerae; D – pedipalp (dorsal setae removed).

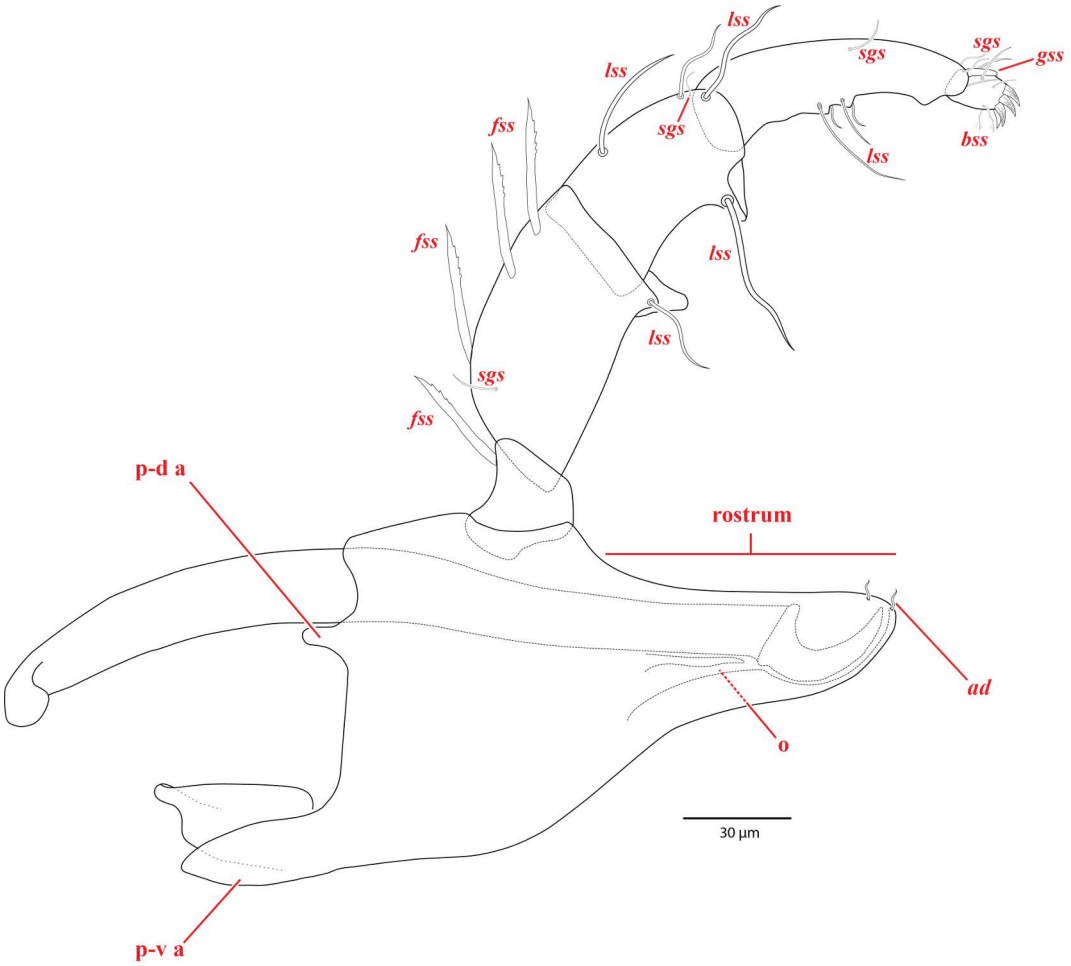

FIGURE 4: *Torrenticola larvata* **n. sp.** female gnathosoma: adoral setae (ad); bifurcating short setae (bss), fringed spatulate setae (fss), long simple setae (lss), oral opening (o), posterio-dorsal apodeme (p-d a), posterio-ventral apodeme (p-v a), simple grooved setae (sgs).

FEMALE (n=6) with characters as described for genus (Fisher *et al.* 2015), with following specifications.

Gnathosoma (Fig. 4) — Often colorless, but subcapitulum occasionally with dark purple pigment throughout (Fig. 2C). Subcapitulum [273 – 285 (273) ventral length; 198 – 210 (204) dorsal length; 121 – 128 (121) tall] posterior edge nearly vertical, ventral bend depth slight [10 – 15 (15)], and with short, conical rostrum [103 – 113 (103) long] that is directed forwards. Two pairs of adoral setae rim the rostral opening (Fig. 4). Chelicerae [258 – 280 (260) long; 21 – 30 (30) high] unmodified with strongly curved fangs [56 – 73 (62) long]. Pedipalps [261 – 290 (278) long] with P-2 and P-3 bearing ventro distal projections, denticulate at the tip (Fig. 4). Trochanters [34 – 37 (34) long; 32 – 36 (34) wide] with one dorso-distal fringed spatulate seta (*fss*). Femora [106 – 110 (106) long; 49 – 54 (49) wide] with one long simple seta (*lss*) associated with the ventral projection and four dorsal setae as follows: proximally one short simple grooved seta (*sgs*); one central *fss*, and two distal *fss*. Genua [62 – 76 (63) long; 42 – 47 (43) wide] shorter than femora, but comparable in length (Femur/Genu = 1.4 – 1.8); with one *lss* associated with the ventral projection, one short *sgs* laterally, and four dorsal setae (one central *lss*, and three setae distally as follows: one *sgs* medially, one *lss* medially, and one *lss* laterally). Tibiae [89 – 108 (98) long; 26 – 31 (27) wide] subequal in length to femora (Tibia/Femur = 0.8 – 1.15), with two short, spiny tubercles mid-ventrally that are edentate and associated with 3-4 *lss* (Fig. 4). Mid-dorsally, there are two *sgs* (one proximo-lateral; one disto-medial). Distally, there is one *lss* dorso-centrally; two *lss* dorso-medially; two *lss* dorso-laterally; one *lss* laterally; and one large, grooved, spine-like seta (gss) dorso-medially (Fig. 4). Tarsi [19-28 (28) long; 12-15 (14) wide] are accompanied by four tarsal claws, with the bottom two paired (Fig. 4), thus appearing as three claws in most slide preparations. Ventrally, there are 2-3 short bifurcating setae (*sbs*) and dorsally there are three *lss* (Fig. 4).

Dorsum (Fig. 5) — [650 – 720 (660) long; 437 – 476 (468) wide] ovoid (length/width = 1.4 – 1.52); armored with a central dorsal plate that is divided into an area of primary sclerotization [515 – 574 (515) long; 388 – 419 (405) wide] and an area of secondary sclerotization posteriorly [extends dorsal plate length by 82 – 85 for a total dorsal plate length of 597 – 659 (609)]. Dark purple pigmentation is restricted to the anterio-medial platelets and anteriormost portion of anterio-lateral platelets (rarely continuing to anterior border of the dorsal plate) and to the posterior dorsal plate within the area of primary sclerotization (Fig. 1-2), although this posterior pigmentation is absent in some samples. Reddish central coloration is usually broad and bold. The dorsal plate is bordered by ten platelets: two anterio-medials [126 – 139 (127) long; 66 – 77 (66) wide]; two anterio-laterals [166 – 187 (179) long; 81 – 89 (81) wide]; and a posterior ring of six smaller platelets in a striated membranous fold. The anterior platelets are wide (anterio-lateral length/width = 2 – 2.25; anterio-medial length/width = 1.7 – 2). Dorsal glandularia-4 (Dgl-4) slightly lateral to Dgl-5 and usually in the area of secondary sclerotization, but occasionally near edge of primary sclerotization. Eyes are apparently paired and located within sclerotized capsules on the margin of the anterio-medial platelets and dorsal covering of the gnathosoma.

Venter (Fig. 6) — [740 – 850 (805) long; 515 – 604 (536) wide] round, fully sclerotized, and divided into primary and secondary areas of sclerotization; generally colorless, but with purple pigment obvious anterio-dorsally near the legs and eyes (*i.e.* "face"; visible in Fig. 1). Gnathosomal bay [118 – 179 (136) long; 78 – 84 (78) wide] not narrow (length/width < 3; 1.9 average). Coxae-1 (Cx-1) narrowed to blunt tip, bearing coxal glandularia-4 (Cxgl-4) ventro-apically (Fig. 6). Medial length of Cx-II + Cx-III short, barely longer than wide [35 – 52 (42)]. Genital plates large [179 – 216 (179) long; 153 – 171 (153) wide] and trapezoidal, extending anteriorly beyond level of Leg IV. Each genital plate rimmed in small setae ranging from simple to slightly barbulate (Fig. 6). Additional measurements as follows: Cx-I total length 275 – 358 (281); Cx-III width 308 – 355 (308); Cx-I medial length 149 – 182 (152); genital field to excretory pore 177 – 221 (211); genital field to cauda 249 – 320 (320). Ovipos-

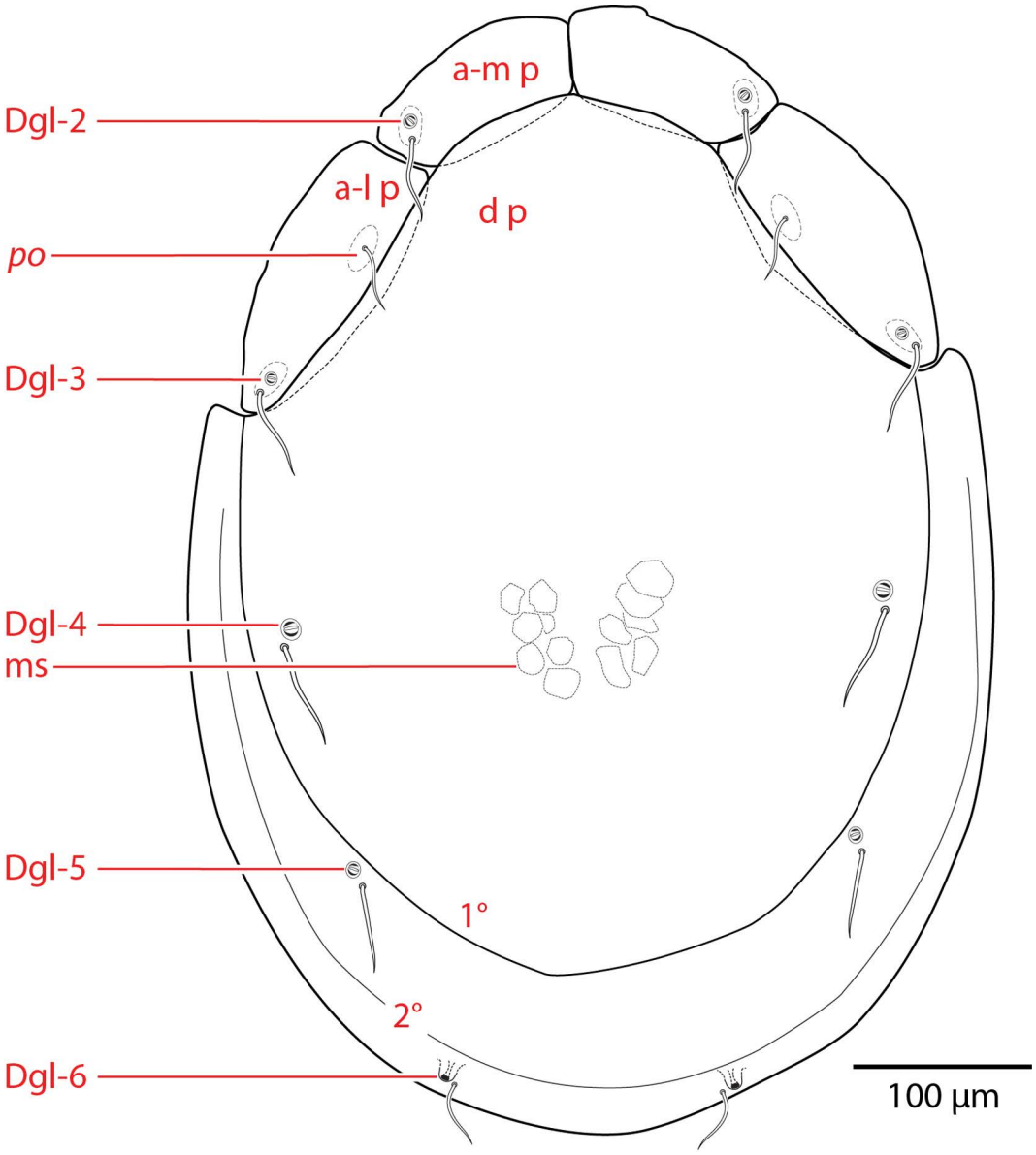

FIGURE 5: *Torrenticola larvata* **n. sp.** female dorsal plates: anterio-lateral platelet (a-l p); anterio-medial platelet (a-m p); dorsal glandularia (Dgl); dorsal plate (dp); muscle scars (ms); post-ocularial setae (po); and area of primary (1°) and secondary (2°) sclerotization.

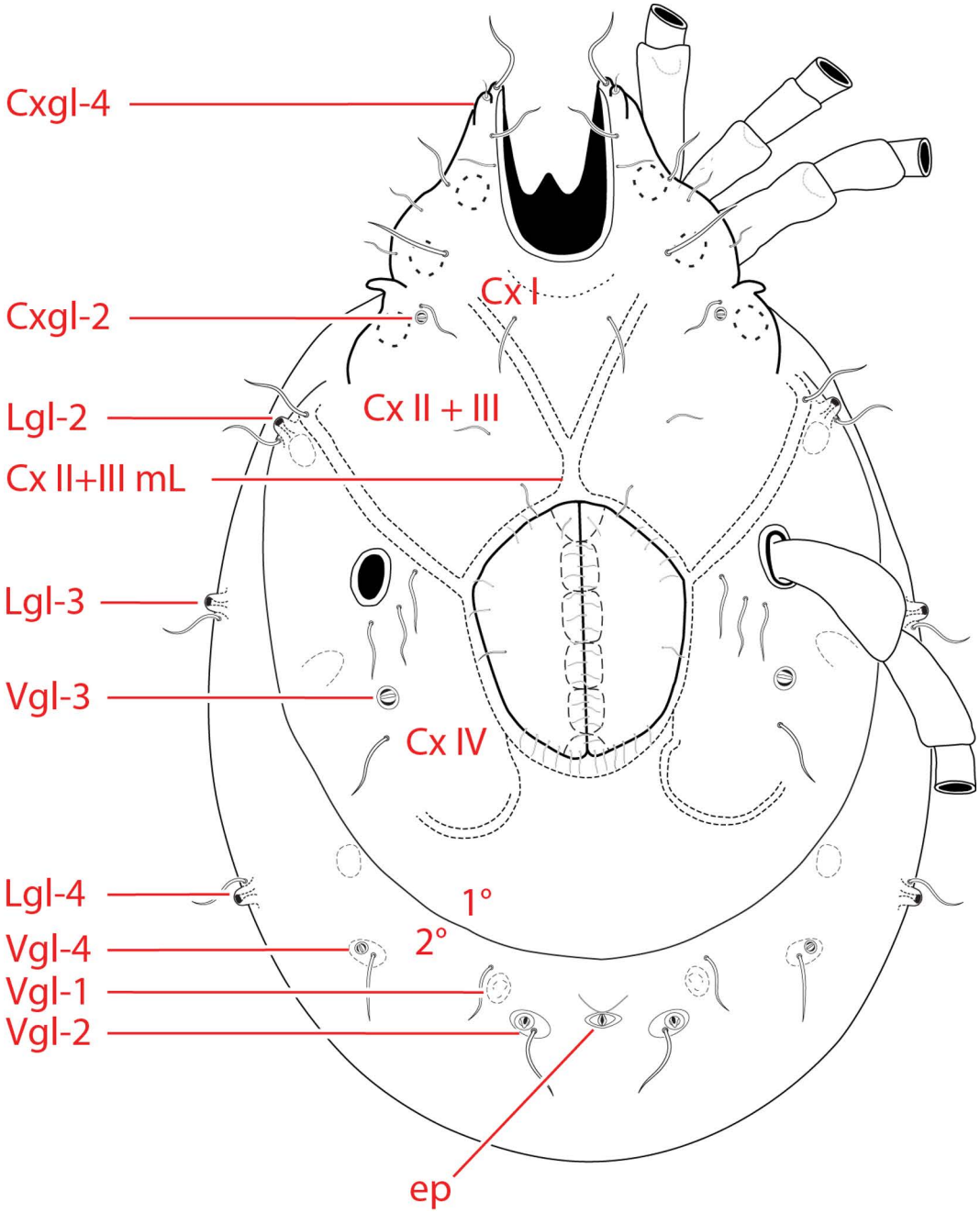

FIGURE 6: *Torrenticola larvata* **n. sp.** female venter (right legs removed; leg setae omitted; female depicted): coxae (Cx); coxal glandularia (Cxgl); excretory pore (ep); latero-glandularia (Lgl); medial length of suture between Cx II+III (Cx II+III mL); ventral glandularia (Vgl); and area of primary (1°) and secondary (2°) sclerotization.

itor morphology unknown.

Legs — Colorless. Podomere measurements as follows. Leg I [497-528 total length (519)]: trochanter 53 – 60 (60), basifemur 96 – 105 (105), telofemur 87 – 111 (87), genu 101 – 115 (101), tibia 118 – 140 (118), tarsus 108 – 138 (111). Leg II [495 – 528 total length (497)]: trochanter 48 – 62 (48), basifemur 88 – 105 (94), telofemur 74 – 89 (78), genu 99 – 115 (101), tibia 120 – 138 (120), tarsus 123 – 134 (125). Leg III [570 – 593 total length (570)]: trochanter 58 – 64 (62), basifemur 97 – 105 (98), telofemur 80 – 99 (80), genu 111 – 128 (111), tibia 135 – 152 (135), tarsus 148 – 167 (148). Leg IV [773 – 875 total length (829)]: trochanter 100 – 131 (116), basifemur 129 – 155 (147), telofemur 124 – 134 (124), genu 163 – 179 (163), tibia 178 – 197 (183), tarsus 176 – 201 (176).

MALE (n=9) similar to female, but with sexually dimorphic characters outlined in Fisher *et al.* (2015) and following specifications.

Gnathosoma — Subcapitulum [225 – 250 (245) ventral length; 168 – 183 (180) dorsal length; 95 – 107 (99) tall] posterior edge nearly vertical, ventral bend depth slight [11 – 13 (13)], and with short, conical rostrum [92 – 104 (103) long] that is not directed downwards. Chelicerae [222 – 241 (223) long; 17 – 22 (19) high] unmodified with strongly curved fangs [46 – 54 (53) long]. Pedipalps [212 – 251 long] with ventral projections and chaetotaxy as in female. Podomere measurements as follows: trochanters 22 – 31 long and 24 – 27 wide; femora 76 – 88 (78) long and 42 – 47 (46) wide; genua 49 – 65 (65) long and 37 – 42 (42) wide; tibiae 77 – 90 (90) long and 23 – 27 (27) wide; tarsi 22 – 27 (24) long and 12 – 15 (13) wide. Genua shorter with respect to the femur than many *Torrenticola* (Femur/Genu = 1.6 – 1.2). Tibia subequal to the length of the femur (Tibia/Femur = 0.95 – 1.16).

Dorsum — [550 – 615 (581) long; 351 – 399 (371) wide] ovoid to rectangular (length/width = 1 – 1.5). Dorsal plate with area of primary sclerotization [469 – 527 (500) long; 332 – 376 (346) wide] and an area of secondary sclerotization posteriorly [extends dorsal plate length by 33 – 40 (35) for a total dorsal plate length of 502 – 567 (542)]. Anterior platelets as follows: anteriomedials 112 – 130 (120) long and 60 – 73 (63) wide; anterio-laterals 160 – 179 (160) long and 68 – 80 (80) wide. The anterior platelets are wider than many *Torrenticola* (anterio-lateral length/width = 2 – 2.25; anterio-medial length/width = 1.7 – 2).

Venter — [660 – 720 (713) long; 415 – 476 (435) wide] ovoid to narrow. Gnathosomal bay [116 – 126 (124) long; 61 – 72 (61) wide] not narrow (length/width < 3; 1.6 average). Medial length of Cx-II + Cx-III long [89 – 115 (92)]. Genital plates small [140 – 151 (146) long; 102 – 115 (113) wide] and rectangular, not extending anteriorly beyond level of Leg IV. Additional measurements as follows: Cx-I total length 245 – 271 (270); Cx-III width 281 – 316 (304); Cx-I medial length 136 – 149 (143); genital field to excretory pore 105 – 130 (111); genital field to cauda 158 – 184 (178).

Legs — Colorless. Podomere measurements as follows. Leg I [389 – 488 total length (469)]: trochanter 38 – 63 (58), basifemur 74 – 102 (91), telofemur 67 – 94 (94), genu 83 – 108 (108), tibia 107 – 122 (122), tarsus 91 – 124 (112). Leg II [397 – 476 total length (446)]: trochanter 52 – 61 (61), basifemur 60 – 93 (86), telofemur 71 – 88 (77), genu 85 – 106 (94), tibia 96 – 126 (111), tarsus 105 – 135 (119). Leg III [437 – 495 total length (485)]: trochanter 48 – 60 (52), basifemur 83 – 95 (89), telofemur 72 – 86 (74), genu 97 – 115 (103), tibia 113 – 133 (126), tarsus 109 – 138 (132). Leg IV [688 – 799 total length (727)]: trochanter 93 – 112 (106), basifemur 121 – 133 (133), telofemur 111 – 126 (125), genu 145 – 162 (154), tibia 155 – 171 (170), tarsus 165 – 175 (173).

IMMATURES: Unknown.

Etymology — Named for the unique anterior pigmentation of the anterio-medial platelets, dorsal coxal region, and often gnathosoma, giving the appearance that the "face" is masked (*larvata*, L. masked). There is disagreement as to whether *Torrenticola* should be considered masculine or feminine, which concerns our proposed specific epithet (masculine: *larvatus*; feminine: *larvata*). We take the view that *Torrenticola* should be considered feminine to be consistent with most other species described for the genus.

Common name — Masked torrent mite

Habitat — Riffles of clean streams with medium cobble to small gravel.

Distribution — Ouachita Mountains, Arkansas, USA. Given extensive collection events from surrounding areas, *T. larvata* is likely endemic to the Ouachita Mountains. Unlike many other *Torrenticola*, *T. larvata* is uncommon even locally, as is evidenced by the collection of only 15 specimens from 5 localities, despite heavy sampling in the area.

Remarks — *T. larvata* is proposed as endemic to the Ouachita Mountains of Arkansas. The hypothesis of endemism is supported by the examination of 331 collections from across Arkansas and more than 12,000 collections from across the continental United States and Canada, from which, *T. larvata* was only found in five localities within the Ouachita Mountains.

Type series — Holotype (♀): USA, Arkansas, Polk Co., Bard Springs, Ouachita National Forest, Blaylock Creek (34°23'28.3"N, 94°00'31.8" W), 11 Aug 2009, by AJ Radwell and BG Crump, AJR090307B. Paratypes (5♀; 8♂): Allotype (♂): USA, Arkansas, Polk Co., Bard Springs, Ouachita National Forest, Blaylock Creek (34°23'28.3"N, 94°00'31.8" W), 11 Aug 2009, by AJ Radwell and BG Crump, AJR090307B. Other Paratypes: **Arkansas, USA**: 3♀ Polk Co., beside FR38, North of Shady Lake Rec Area, East Saline Creek (34°22'53.4"N, 94°01'51.2" W), 30 Jul 2011, by IM Smith, IMS110041 • 1♀ and 6♂ Montgomery Co., Ouachita National Forest, Ouachita River at Mcguire (34°22'53.4"N, 94°1'51.2" W), 27 Aug 2011, by AJ Radwell, AJR110307 • 1♀ and 1♂ Garland Co., beside Rt. 7, 3 miles south of Mountain Valley, South Fork of Saline River (34°35'43.3"N, 93°00'45.3" W), 11 May 1977, by DR Cook, DRC770002 • 1♂ Montgomery Co., Ouachita National Forest, Ouachita River at Pine Ridge (34°34'53.5"N, 93°53'00.9" W), 5 Oct 2007, by AJ Radwell and HW Robison, AJR070300A

Type Deposition — Holotype (♀), allotype (♂), and 7 (2♀; 5♂) paratypes deposited at the Canadian National Collection of Insects, Arachnids, and Nematodes (CNC), Ottawa, Canada. Additional paratypes (3♀ and 3♂) deposited in the Acari Collection of the University of Arkansas (ACUA), Fayetteville, Arkansas and (1♀ and 1♂) deposited at the Ohio State University Acarology Collection (OSUAC), Columbus, Ohio. The holotype and allotype are slide mounted in glycerin jelly and paratypes are a mixture of Hoyer's and glycerin jelly slide mounts.

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