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The masked torrent mite, *Torrenticola larvata* n. sp. (Acari: Hydrachnidiidae: 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; Hydrachnida; Hydrachnidiidae; 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
Torrenticolineae 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 larcuta 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)] 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 anterio-most 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 antero-medials [126 – 139 (127) long; 66 – 77 (66) wide]; two antero-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 (antero-lateral length/width = 2 – 2.25; antero-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-ocularia 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.
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itor morphology unknown.


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


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; antero-laterals 160 – 179 (160) long and 68 – 80 (80) wide. The anterior platelets are wider than many Torrenticola (antero-lateral length/width = 2 – 2.25; antero-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).


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 (OS-UAC), 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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