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The millipede family Striariidae Bollman, 1893. VIII. Three new genera and four new species of minute millipedes from Oregon and Washington, USA (Diplopoda, Chordeumatida, Striarioidea)

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Abstract

We describe three new genera and four new species of small, litter-dwelling millipedes from the states of Oregon and Washington, USA: *Miniaria ramifera,* **n. gen., n. sp.,** *Miniaria richarti,* **n. gen., n. sp.,** *Tigraria oregonensis***, n. gen., n. sp.,** and *Kingaria prattensis***, n. gen., n. sp.** Some of the unusual characters of these species are discussed, including a new type of sensory array on the third tarsus of males and a newly observed mandibular gland.

Key words: new taxa, Striariinae, northwestern North America, sense organs

Introduction

This is the eighth paper in a series on the endemic North American millipede family Striariidae Bollman, 1893 (for previous papers, see Shear 2020, 2021a, 2021b; Shear, Nosler & Marek 2022; Shear & Marek 2022a, 2022b; Shear *et al.,* 2022b). The extraordinary taxonomic diversity of this family, which prior to 2020 consisted of only two valid genera and 13 species [most of which were of dubious status (Hoffman 1999)], is concentrated in the northwestern part of North America, in northern California and in Oregon, Washington and Idaho. Thanks to the collecting efforts of Bill Leonard, Casey Richart, the late Ellen Benedict, Philip Nosler and a few others, and with the publication of this paper, the family now consists of 15 genera and 51 species. All but four of these species are to be found in the states just mentioned. We expect to publish one more paper in the series, describing a new genus from the San Francisco Bay area of California, related to *Amplaria* Chamberlin, 1941.

The three new genera described in this paper conform in their gonopod anatomy to members of the subfamily Striariinae Bollman, 1893, with large anterior angiocoxites, posterior angiocoxites that sheath at least one flagellocoxite or flagellum (see Discussion section, below), and membranous or fimbriate (albeit reduced) colpocoxites. Typical of the family, the modified and reduced ninth legpairs of males consist of coxae and single telopodite articles, usually fused, which in these genera bear single, curved coxal processes and obvious coxal gland pores. However, each of the new genera can be readily distinguished by the details of gonopod anatomy and unique combinations of secondary sexual characters in the males.

Methods

Specimens were field-preserved in various solutions and later transferred to 70% ethanol. Morphological studies were done using an Olympus SZH stereomicroscope and an Olympus BX50 compound microscope equipped with Nomarski optics. Gonopods were temporarily mounted on microscope slides in glycerine for study up to 400X

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magnification and drawings were made from these slides using a drawing tube on the BX50. For scanning electron microscopy (SEM), specimens were first cleaned in an ultrasonic cleaner, then mounted on 12.7 mm diameter aluminum stubs using double-sided adhesive carbon discs and allowed to air-dry. These were sputter coated with a 40 nm thick layer of platinum and palladium, using a Leica EM ACE600 high vacuum sputter coater. SEM micrographs were taken with a FEI Quanta 600 FEG environmental scanning electron microscope. Photographs were edited and refined using GIMP, and plates were composed in InkScape.

Dissection of these tiny animals with their brittle cuticle presents significant challenges, as does transferring the minute gonopods and ninth legs to microscope slides and SEM stubs. Details of the anatomy are difficult to impossible to see clearly under a dissecting microscope and necessitate the use of SEM pictures and drawings executed at 200–400X under the compound microscope.

All specimens and SEM stubs will be deposited in the California Academy of Sciences (CAS), San Francisco, California, USA.

Abbreviations used in the figures

aac	anterior angiocoxite
col	collum
cc	colpocoxite
cf	coxal flask of legpair 3
cx	coxa
cx (numeral)	coxa of numbered legpair
cxp	coxal process
f	flagellocoxite or flagellum
gl	glandular lobe of mandible
lab	labrum
L (numeral)	numbered leg
m	mandibular stipes
numerals	ring numbers
om	ommatidium
pac	posterior angiocoxite
pf (numeral)	prefemur of numbered legpair
s	sternum of gonopods
s (numeral)	sternum of numbered legpair
sp	spinneret
t	telopodite
t9	telopodite of leg 9
tel	telson
tp9	process of telopodite 9
vd	openings of vasa deferentia
w	accessory claw
x	comb seta
y	recessed pore plate
z	specialized sensory seta

Taxonomy

Family Striariidae Bollman, 1893

Subfamily Striariinae Bollman, 1893

Miniaria Shear & Marek, new genus

Type species: *Miniaria ramifera* Shear & Marek, **new species**

Diagnosis. A genus of Striariinae consisting of two species, distinct from other small striariids in the form of the male labrum, which is convex distally and with sharp lateral corners, but lacking curved processes (**lab**, Figs 1, 12). Additional distinguishing characters of the males: first legpair (Fig. 2) lacks needle setae; flasks of coxae 3 very short, with subterminal processes; fourth legpair largest but with short, wide podomeres (**L4,** Fig. 4); gonopod colpocoxites strongly reduced (Figs 9, 19); ninth legpair with coxal pores and curved coxal processes (**cxp,** Figs 10, 25).

Etymology. The genus name is feminine in gender and is an arbitrary combination of letters.

Description. Small species of Striariinae with 28 postcephalic rings. Length 3–4 mm, width about 0.25–0.30 mm. Color white, with single black ommatidium on each side of head. Antennae relatively short, robust, clavate. Head, except for labrum, covered with fine setae and small tubercles (Fig. 1). Collum ornamented by closely set small tubercles, coalescing into vague crests in posterior fifth of collum length. Metazonites with twelve subequal crests (Figs 13, 14); metazonital setae long, prominent, with longitudinal grooves and feathered tips (Figs 15). Telson with three lobes only shallowly separated, not prominent; spinnerets directed posteriad (**sp,** Fig. 16). Legs with specialized flattened setae with median ridges and long, filamentous extensions (Fig. 6).

The following secondary sexual characters occur in males. Head frontally flattened with slight swellings below antennal sockets. Labrum flat and smooth, slightly concave, distal corners distinctly angular, not rounded (**lab,** Fig. 1). Mandibular stipes with serrate anteriodistal margin, prominent distal tooth (**m,** Fig 1). First legpair (Fig. 2) enlarged, femora curved, lacking needle setae, distal podomeres with few long, flattened setae ventrally. Second legpair larger than first; openings of *vas deferentia* separate, subtended by long, flattened, ribbon-like setae (**vd,** Figs 3, 5). Third legpair robust, coxal flasks short, with subterminal process (Fig. 5); tarsi with special sensory array including comb setae and recessed pore plate (Fig. 6; see Discussion section below for further details). Fourth legpair the largest; prefemora and femora nearly as wide as long (**L4,** Figs 4, 8). Fifth, sixth and seventh legpairs enlarged; seventh coxae unmodified. Tenth coxae with glands, not modified or enlarged (**cx10,** Fig. 10).

Gonopods (Figs 9, 11, 19–24, 39–44, 46–53), separate from prominent, transverse sternum, coxae large, with two or three setae. Anterior angiocoxites curved, with fimbriate posterior margin distally. Posterior angiocoxites smaller than anterior ones, fimbriate, sheathing single flagellum or flagellocoxite. Colpocoxites membranous-fimbriate, much reduced. Ninth legs (Figs 10, 25, 45), variably free or partially fused to sternum; coxae and telopodites fused, coxae with prominent anterior lobe bearing gland pore, also with strongly curved single process; telopodites strongly flattened, setose, with ornament of pointed tubercles (as on other legs).

Included species.
Miniaria ramifera Shear & Marek, **n. sp.**,
M. richarti Shear & Marek, **n. sp.**

Distribution. Oregon and Washington, USA.

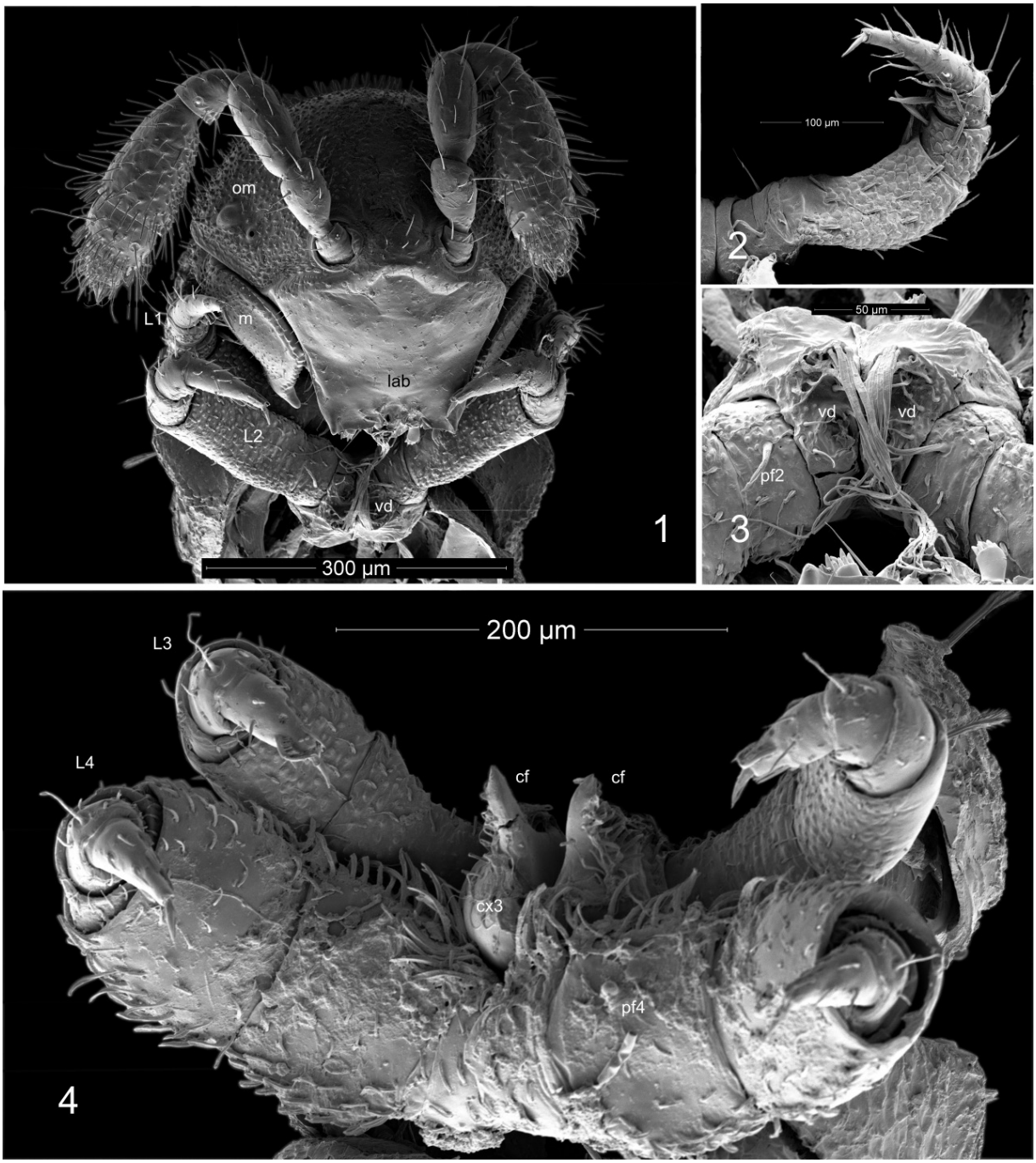
Notes. We have opted for broader species concepts for each of the two species of *Miniaria* due to what we see as subtle variation in the gonopods of males from the various collection localities. We are not sure if this variation is geographic in nature or simply due to seeing the gonopods at slightly different angles when, as is necessary with such small objects, they are mounted on microscope slides. We have provided drawings illustrating this "variation," if such it be. The result is that each of the species has a wider distribution than some other minute striariids we have described previously. Of course an alternative hypothesis is that each of these "variants" represents a distinct species population, but at present that could only be tested by recollecting at the several sites (and others) and obtaining genetic data.

Two interesting features of the species of *Miniaria* are the apparently unique sensory arrays on the third tarsi, covered more fully in the Discussion section, and the reduction of the colpocoxites of the gonopods. Colpocoxites were not seen at all in some of our light microscope preparations, or were visible only as small fimbriate branches. SEM pictures, however, revealed somewhat more structure.

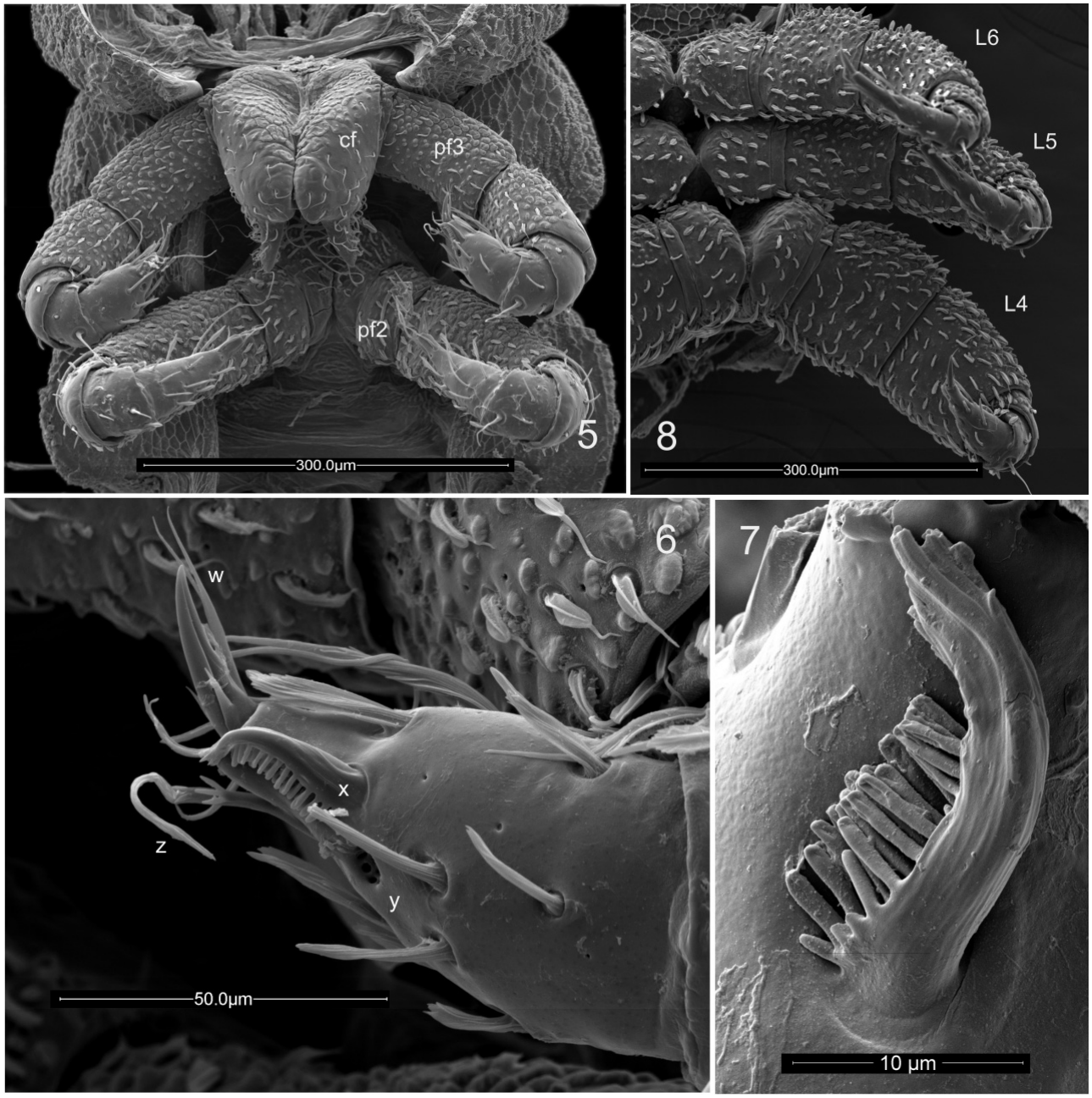
***Miniaria ramifera* Shear & Marek, n. sp.**
Figs 1–11, 39–45

Types: All specimens deposited in CAS. Male holotype, 6 male paratypes and 6 female paratypes from Mashel River at State Route 7, 46.86695°N, -122.33645°W, 600′asl, Pierce Co., Washington, collected 19 March 2004 by W. Leonard and C. Richart. Parts of the holotype are on SEM stub WS36-8.

Diagnosis. Distinct from *M. richarti* **n. sp.** in having the gonopod anterior angiocoxite with a prominent subterminal posterior branch (**aac,** Figs 9, 11, 39–44). The gonopods are widely separated mesally, while those of *M. richarti* **n. sp.** are appressed to each other in the midline. The anterior angiocoxites are evenly curved, not sharply elbowed as in *M. richarti* **n. sp.**.



FIGURES 1–4. *Miniaria ramifera* **n. gen.**, **n. sp.**, male holotype. **1.** Head and legpairs 1 and 2, anterioventral view. **2.** Left leg 1, posterior view. **3.** Coxae of legpair 2, ventral view. **4.** Legpairs 3 and 4, ventral view. **Abbreviations: cf**, coxal flask of coxa 3; **cx3**, body of coxa 3; **lab**, labrum; **L (numeral)**, numbered legpair; **m**, mandibular stipes; **om**, ommatidium; **pf (numeral)**, prefemur of numbered legpair; **vd**, opening of *vas deferens*.



FIGURES 5–8. *Miniaria ramifera* **n. gen.**, **n. sp.**, male holotype. **5**. Legpairs 2 and 3, ventral view. **6**. Tarsus of left leg 3, lateral view. **7**. Comb seta of tarsus 3. **8**. Legpairs 4–6, ventral view. **Abbreviations: cf**, coxal flask of leg 3; **L (numeral)**, numbered legpair; **pf (numeral)**, prefemur of numbered leg; **w**, accessory claw of tarsus 3, **x**, comb setae; **y**, recessed pore plate; **z**, sensory seta.

Etymology. The species name is a Latin adjective, meaning "branch-bearing," and refers to the subterminal posterior branch of the gonopod anterior angiocoxite.

Description. Male paratype from Mashel River. Length 3.5 mm, greatest width 0.31 mm. Nonsexual characters and secondary sexual modifications as described for genus. Gonopods (Figs 9, 11, 39–44) small; anterior angiocoxites (**aac**, Fig. 9) curved posteriad, slightly knobbed at tips, distally with prominent fringed margin, long, flattened subterminal process. Posterior angiocoxites (**pac**, Fig. 9) less than half length of anterior ones, fimbriate especially along posterior margin, sheathing single curved flagellocoxite or flagellum. Colpocoxite reduced to single branch with membranous base. (**cc,** Figs 39–44). Ninth legs (Fig. 10) as described for genus.

Females similar to males in all nonsexual respects.

Distribution. OREGON: Multnomah Co.: Ainsworth State Park, 45.596°N, -122.051°W, 210′ asl, 15 November 1967, E. M. Benedict, 2 mm. Gobbert Butte, Gresham, 45.4731°N, -122.4378°W, 30 October 2016, P.

Nosler, m. Washington Co.: 1.7 mi W of Timber, T3N, R5W, sec.?, 300′ asl, 27 November 1971, E. M. Benedict, m. WASHINGTON: Pierce Co.: Ohop Valley Road at State Route 7, 600′ asl, 46.86695°N, -122.33645°W, 12 January 2004, W. Leonard, m. Skamania Co.: Cook-Underwood Road, 1.4 mi NE of Cook, 450′ asl, 45.7239°N, -121.64765°W, 30 November 2003, W. Leonard, 4 mm.

Notes. Gonopod variation in this species focuses on the degree to which the anterior angiocoxite is terminally knobbed and the extensiveness of the fimbriated posterior distal margin. In the Ainsworth State Park male (Fig. 43), the fimbriate part appears as a coalesced process. In the Timber (Fig. 44) and Mashel River (Figs 39, 40) males, it is more extensive and does not protrude, and while in the male from Cook-Underwood Road (Figs 41, 42) there is a broad fimbriate region. We do not have enough localities to determine if this is geographic variation or simply due to positioning on a microscope slide.

Miniaria richarti Shear & Marek, n. sp.

Figs 12–25, 46–56

Types: All specimens deposited in CAS. Male holotype and female paratype from Rainier Road, 3.0 mi NW of Military Road, Fort Lewis Military Reservation, Thurston Co. Washington, collected 29 November 2003 by W. Leonard.

Diagnosis. Distinct from *M. ramifera* in lacking a posterior subterminal branch on the gonopod anterior angiocoxite, and in having the gonopods closely appressed in the midline. The anterior angiocoxite is sharply elbowed, not evenly curved as in *M. ramifera.*

Etymology. The species name honors Dr. Casey Richart, whose collecting has contributed much to our knowledge of the litter fauna of the Pacific Northwest and California.

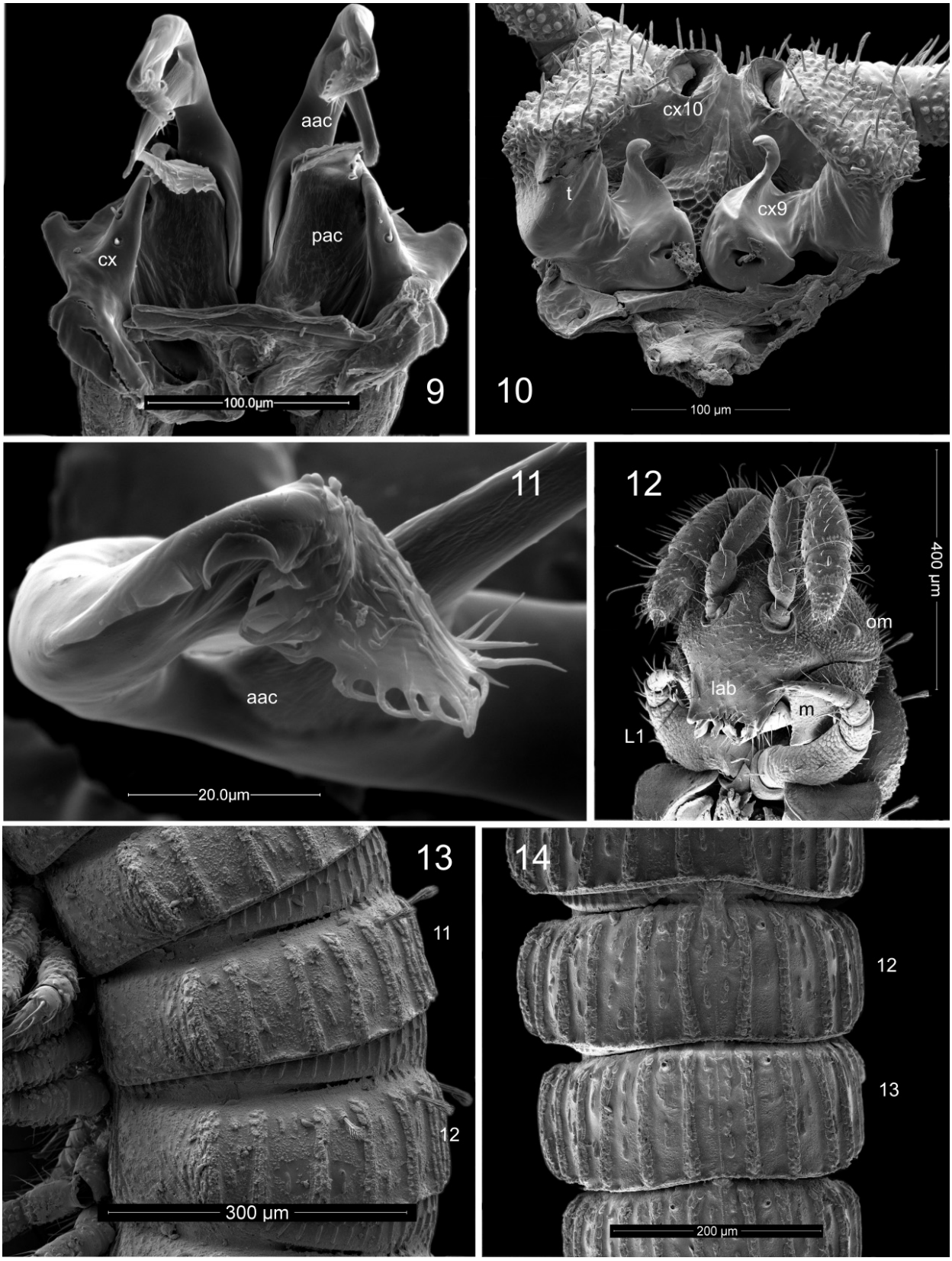
Description. Male from Germany Creek. Length 3.0 mm, greatest width 0.30 mm.

Nonsexual characters and secondary sexual modifications as described for genus. Gonopods (Figs 19–24, 46–53) small, anterior angiocoxites (**aac,** Fig. 19) distinctly elbowed at near right angle posteriorly, slightly knobbed at tips, distally with prominent fringed margin. Posterior angiocoxites (**pac,** Fig. 19) about two-thirds length of anterior ones, fimbriate along posterior margin, divided into medial fimbriate region and longer, thin apical branch, sheathing single curved flagellocoxite or flagellum. Colpocoxite much reduced. Ninth legs (Figs 25, 54, 55) as described for genus.

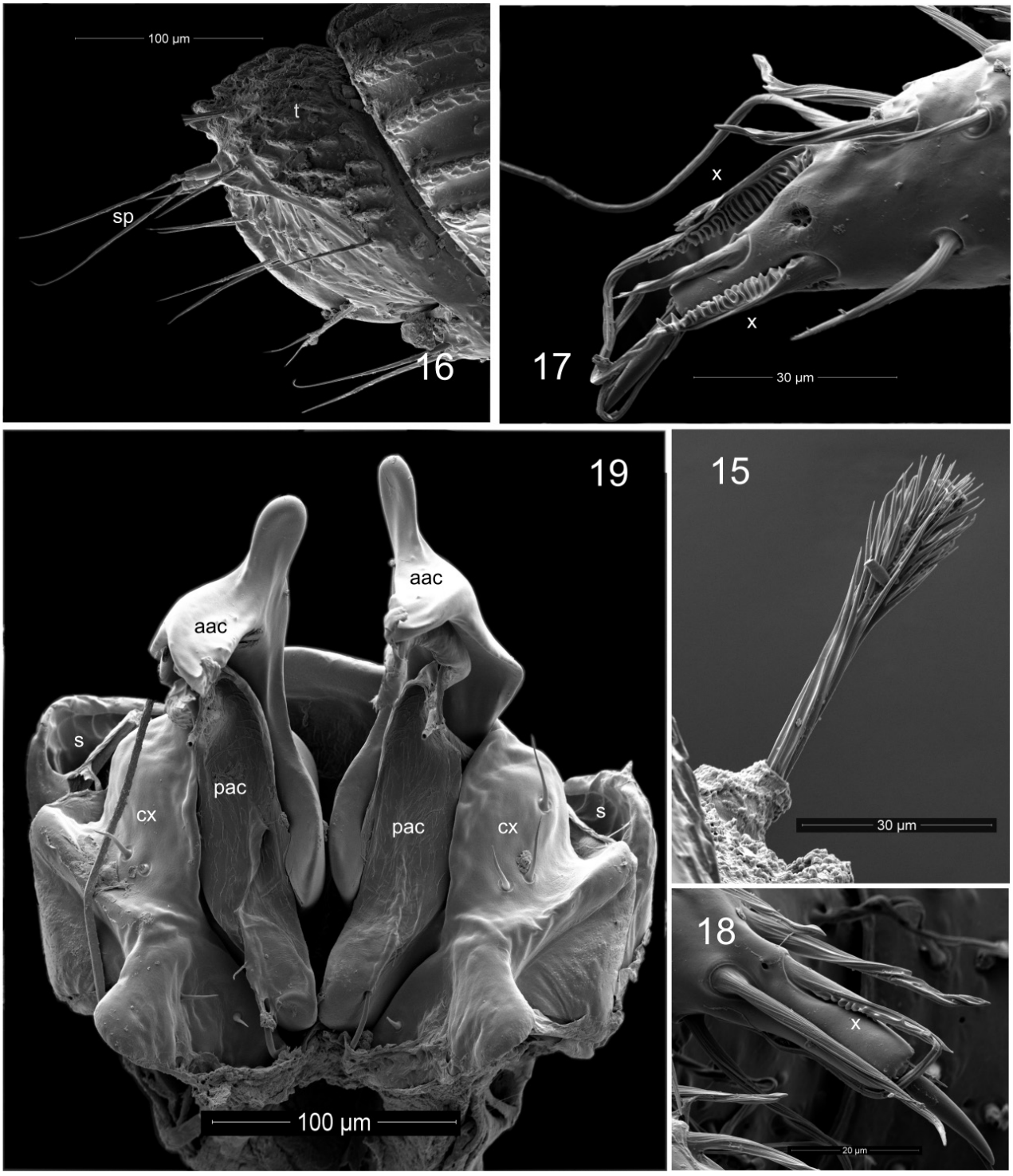
Females similar to males in all nonsexual respects.

Distribution. Oregon: Tillamook Co.: 1 mi W, 0.5 mi S of Lee's Camp, 45.587°N, -123.599°W, 700′ asl, 4 November 1972, E. M. Benedict, 2mm, 2ff. Washington: Cowlitz Co.: SR503, 11.4 mi E of I-5, 410′ asl, 45.968833°N, -122.549817°W, 7 March 2004, W. Leonard, m, f; Pin Creek, 0.5 mi E of Carrolls, 46.267°N, -122.853°W, 300′ asl. 7 March 2003. W. Leonard, m; Germany Creek, 5.3 mi N of SR4, 46.267°N, -123.132°W, 11 November 2004, W. Leonard, m. Grays Harbor Co.: Porter Creek Campground, 46.978167°N, -123.2565°W, 3 March 2005, W. Leonard, m. Lewis Co.:604 Roswell Road, Centralia, 280′ asl, 46.722317°N, -122.9444°W, 25 January 2004, C. Richart, W. Leonard, m. Mason Co.: Kennedy Creek, 47.0876°N, -123.0957°W, 30 March 2003, W. Leonard, 2 mm, f. Thurston Co.: Hospital Creek, above confluence with Skookumchuck River, 46.773267°N, -122.58555°W, 15 December 2003, W. Leonard, K. McAllister, 2 mm; Black Lake and Belmore Road at 66th Avenue, Tumwater, 46.989°N, -122.9665°W, 19 November 2004, W. P. Leonard, 2 mm, 5 ff; Summit Lake, 248′ asl, 47.002833°N, -123.130167°N, 18 December 2004, W. Leonard, m; Olympia, Watershed Park, 11 February 2003, W. Leonard, m, f. Wahakiakum Co.: 11.7 mi on Elochoman Valley Road from SR4, 450′ asl, 46.316783°N, -122.2617°W, 28 March 2004, C. Richart, m.

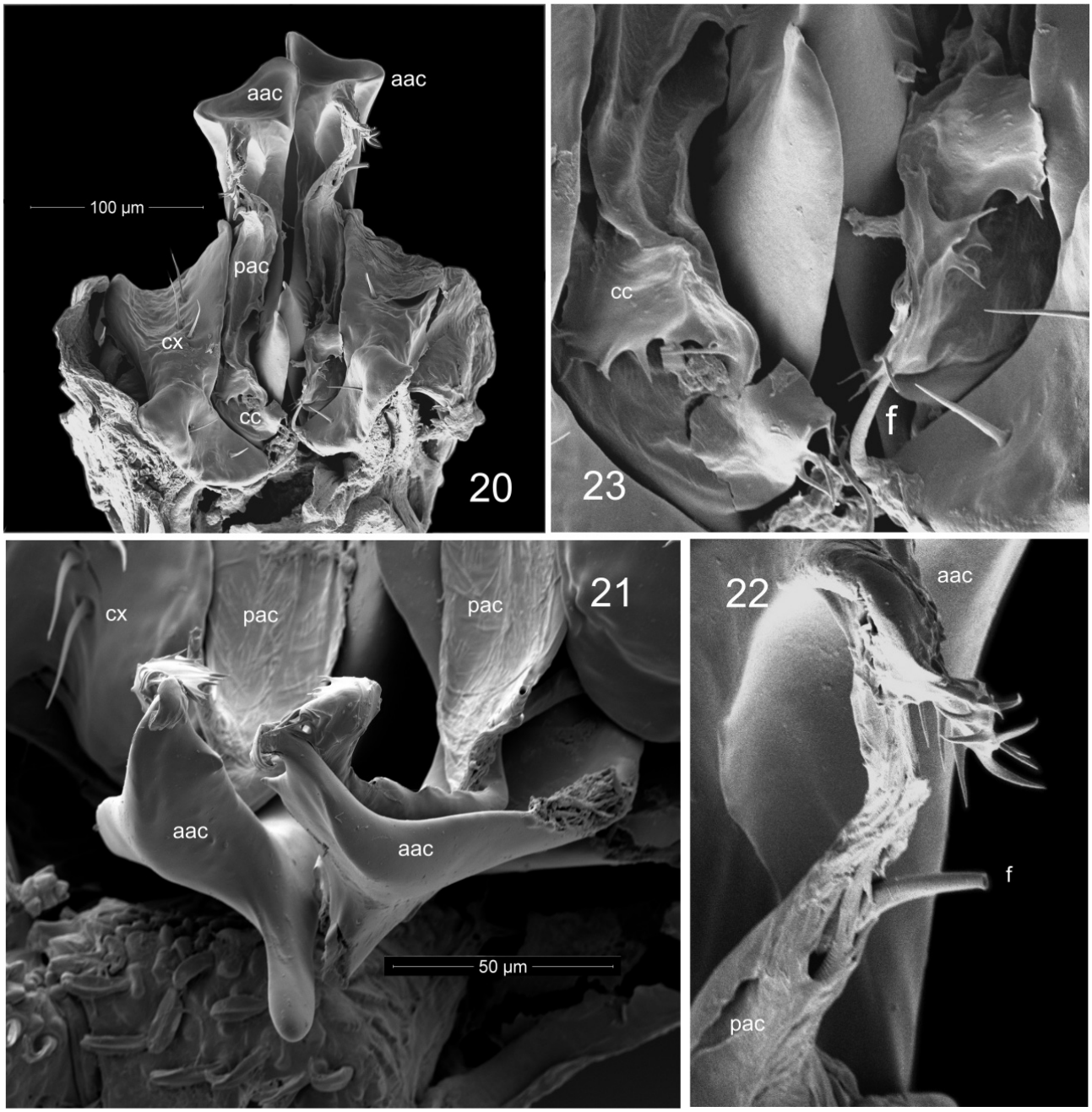
Notes. As with *M. ramifera,* variation is evident in the gonopod drawings, but it is not certain if this represents true geographic variation or is simply due to slightly different viewing angles. In the males from Hospital Creek (Fig. 47) and Centralia, the even curvature of the anterior angiocoxite of *M. ramifera* is approached, while in Lee's Camp (Figs 52, 53), Kennedy Creek (Fig. 51) and Toutle (Fig. 49) males, the anterior angiocoxite bends at almost a right angle—with the Lee's Camp (Figs 52, 53) and Kennedy Creek (Fig. 51) males having a distinct knob at the bend. A common feature appears to be the division of the fimbriate posterior angiocoxite into a thin distal branch and a broader, more proximal portion. Parts of specimens on SEM stubs: Hospital Creek, WS36-10; Kennedy Creek, WS36-3; Lee's Camp, WS36-4.



FIGURES 9–14. *Miniaria* **n. gen.** species. **9–11.** *Miniaria ramifera* **n. gen., n. sp.**, male holotype. **9**. Gonopods, posterior view. **10**. Legpair 9 and coxae of legpair 10, anterior view. **11**. Tip of gonopod anterior angiocoxite, ventral view. **12–14.** *Miniaria richarti* **n. gen., n. sp.,** male from Germany Creek. **12**. Head and legpair 1, ventrolateral view. **13**. Pleurotergites 11 and 12, lateral view. **14**. Pleurotergites 12 and 13, dorsal view. **Abbreviations: aac**, anterior angiocoxite; **cx**, gonopod coxa; **cx (numeral)**, coxa of numbered legpair; **lab**, labrum; **L1**, legpair 1; **m**, mandibular stipes; **numerals**, ring numbers; **om**, ommatidium.



FIGURES 15–19. *Miniaria richarti* **n. gen.**, **n. sp.,** male from Germany Creek. **15**. Segmental seta. **16**. Telson, lateral view. **17**. Tarsus 3, lateral view. **18**. Tip of tarsus 4, lateral view. **19**. Gonopods, posterior view. **Abbreviations:** aac, anterior angiocoxite; **cx**, coxae of gonopods; **pac**, posterior angiocoxite; **s**, sternum of gonopods; **sp**, spinnerets; **t**, telson; **x**, comb seta.



FIGURES 20–23. *Miniaria richarti* **n. gen.**, **n. sp.,** gonopods of specimen from Lee's Camp. **20**. Posterior view. **21.** Tips of anterior colpocoxites, ventral view. **22**. Posterior view showing sheathing of flagellocoxite by posterior angiocoxite. **23**. Posterior view showing colpocoxite and origin of flagellocoxite. **Abbreviations: aac**, anterior angiocoxite; **cc**, colpocoxite; **cx**, gonopod coxa; **f**, flagellocoxite; **pac**, posterior angiocoxite.

Tigraria Shear & Marek, new genus

Type species: *Tigraria oregonensis* Shear & Marek, **new species**

Diagnosis. Distinct from other small (<5 mm) striariid genera except *Petra* Shear *et al.,* 2022 in lacking flasks on the third coxae (Fig. 31) and having densely dentate processes on the fifth coxae (Fig. 32) of males. Distinct from *Petra sierwaldae* Shear *et al.*, 2022 in that the gonopod tips are not enveloped in the telopodites of the ninth legpair but instead the ninth legpair (Figs 34, 59) resembles that of species of *Miniaria* **n. gen.**

Etymology. The genus name refers to the type locality (Tiger Saddle) with the combining stem -*aria* commonly used in this family; gender is feminine.

Description. As for the only included species, see below.

Included species. Only *Tigraria oregonensis* Shear & Marek, **n. sp.**

Distribution. A single locality in Umatilla Co., Oregon, USA.

Tigraria oregonensis Shear & Marek, n. sp.

Figs 26–34, 57–59

Types: All specimens deposited in CAS. Male holotype, two male and four female paratypes from Umatilla National Forest, 0.2 mi E of Tiger Saddle, 45.944417°N, -118.009433°W, 4766′ asl, collected 24 October 2003 by W. Leonard.

Diagnosis. As for the genus, see above.

Etymology. The species name, an adjective, refers to the occurrence of the species in the state of Oregon.

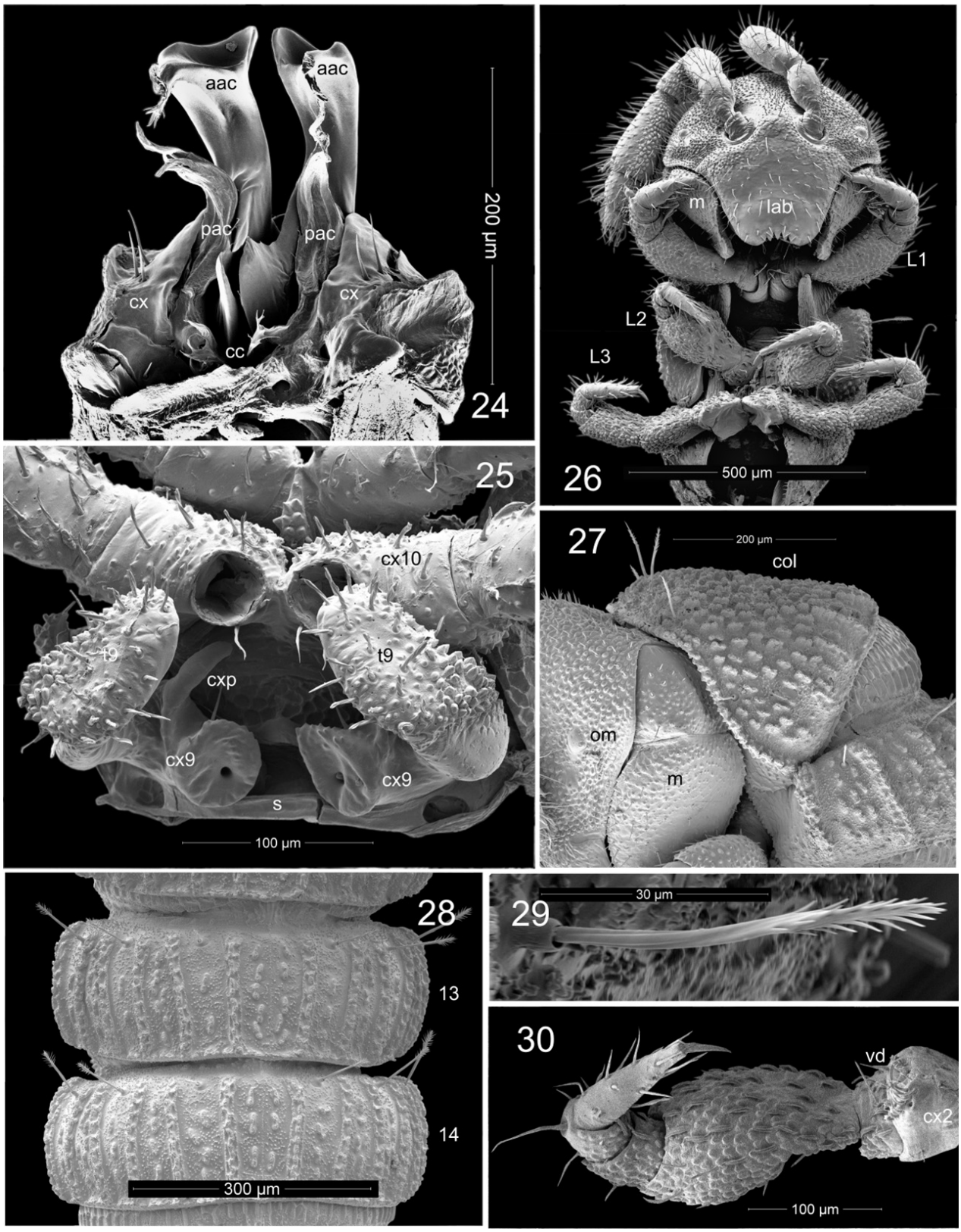
Description. Male paratype from Tiger Saddle. Length 4.3 mm, width 0.5mm. Twenty-eight postcephalic rings. Color white, with single black ommatidium on each side of head. Antennae robust, clavate; fifth antennomere longest, widest. Head (Fig. 26) except for labrum covered with fine setae and small tubercles. Labrum not flattened, tapering, corners rounded (**lab**, Fig. 26). Mandibular stipes (**m**, Fig. 26) with serrate edge suppressed, distally flattened and extended. Collum (**col**, Fig. 27) ornamented by closely set small tubercles, becoming indistinct crests only mesally on most posterior part. Metazonites with twelve subequal crests (Fig. 28); metazonital setae (Fig. 29) long, prominent, with longitudinal grooves and feathered tips occupying about 1/3 length of seta. Telson with lateral lobes practically obsolete, median lobe slightly projecting; spinnerets directed posteriorly. Legs with specialized flattened setae with median ridges and long, filamentous extensions.

The following secondary sexual characters occur in males. Head (Fig. 26) frontally flattened with slight swellings below antennal sockets; labrum with few setae, distal corners rounded. Mandibular stipes (Fig. 26) with weakly serrate anteriodistal margin, prominent blunt distal tooth. First legpair (**L1**, Fig. 26) enlarged, femora curved, lacking needle setae, distal podomeres with few long, flattened setae ventrally. Second legpair (**L2**, Fig. 26; Fig. 30) shorter than first, openings of vas deferentia separate (**vd**, Fig. 30), subtended by long, flattened, ribbon-like setae, femur distally swollen. Third legpair (**L3**, Fig. 26; Fig. 31) less robust than first two, coxal flasks absent but coxae complexly excavate; tarsi with special sensory array including comb setae and recessed pore plate. Fourth legpair the largest; prefemora and femora of usual proportions. Fifth coxae (**cx5**, Fig. 32) with prominent projecting knobs densely set with cuticular teeth, sixth and seventh legpairs enlarged; seventh coxae unmodified. Tenth coxae with glands, not modified or enlarged.

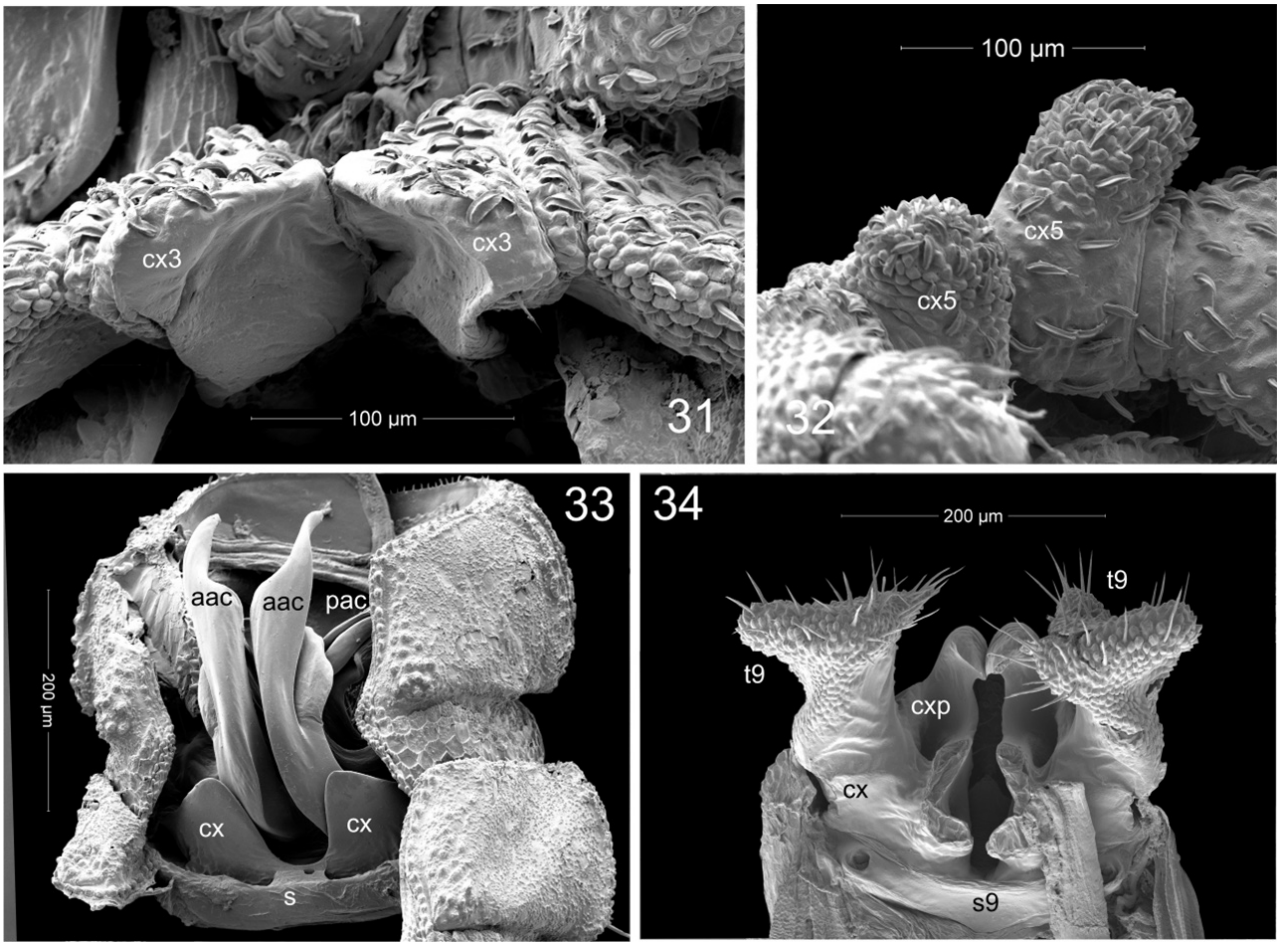
Gonopods (Figs 33, 57, 58) separate from prominent, transverse sternum (**s**, Fig. 33), coxae large (cx, Fig. 33), with five or six setae. Anterior angiocoxites curved, distally attenuated (**aac**, Figs 33, 57, 58), posterior margin not fimbriate, and with long, robust, curved branch arising near base and appearing almost to be articulated. Posterior angiocoxites (**pac**, Figs 33, 57, 58) smaller than anterior ones, fimbriate, divided into basal and distal parts, sheathing short, curved single flagellum or flagellocoxite (**f**, Figs 57, 58). Colpocoxites (**cc**, Figs 57, 58) membranous-fimbriate, not much reduced. Ninth legs (Fig. 34, 59) free from sternum, coxae and telopodites fused, coxae with prominent anterior poorly sclerotized lobe lacking obvious gland pore—also with strongly curved single process (**cxp**, Fig. 34) broad at base, distally hooked, with deep recess (pore?) at base; telopodites strongly flattened, setose, with ornament of pointed tubercles (as on other legs). Tenth coxae with pores, not modified.

Females similar in all nonsexual characters.

Notes. Despite the great distance separating their type localities, this species shares some significant characters with *Petra sierwaldae,* from Idaho, specifically the lack of flasks on the male third coxae and the modified coxae of legpair 5. The gonopods and second and ninth legpairs, however, are very different, justifying a new genus for this Oregon species. *Tigraria oregonensis* gonopods, however, are more conforming to the plan found in species of *Miniaria,* with a branched anterior angiocoxite and a two-part posterior angiocoxite. The male ninth legs also suggest a close relationship with *Miniaria.* The mandibular stipes is unique in that instead of a tooth-like process distally, the stipes is flattened into an extended lamella. Parts of a specimen from near Tiger Saddle are on SEM stub WS35-17.



FIGURES 24–30. Male striariid millipedes. **Figs. 24, 25.** *Miniaria richarti* **n. gen.**, **n. sp.,** male. **24**. Gonopods of specimen from Pin Creek, ventral view. **25.** Legpair 9 and coxae 10 of specimen from Kennedy Creek, ventral view. **Figs. 26–30.** *Tigraria oregonensis* **n. gen.**, **n. sp.** male. **26.** Head and first 3 legpairs, ventral view. **27.** Collum, lateral view. **28**. Pleurotergites 13, 14, dorsal view. **29**. Segmental seta. **30**. Left leg 2, ventral view. **Abbreviations: aac**, anterior angiocoxite; **cc**, colpocoxite; **col**, collum; **cx**, coxa of gonopods; **cx (numeral)**, coxa of numbered legpair; **L (numeral)**, numbered legpair; **lab**, labrum; **m**, mandibular stipes; **numeral**, ring numbers; **s**, sternite of gonopods; **vd**, opening of vas deferens.



FIGURES 31–34. *Tigraria oregonensis* **n. gen.**, **n. sp.** male paratype. **31**. Coxae of third legpair, ventral view. **32**. Coxae of fifth legpair, ventrolateral view. **33**. Gonopods, ventral view. **34**. Legpair 9, anterior view. **Abbreviations: aac**, anterior angiocoxite; **cx**, coxa; **cx (numeral)**, coxa of numbered legpair; **cxp**, coxal process; **pac**, posterior angiocoxite; **s**, sternum of gonopods; **s9**, sternum of legpair 9; **t9**, telopodite of leg 9.

Kingaria Shear & Marek, new genus

Type species: *Kingaria prattensis* Shear & Marek, **n. sp.**

Diagnosis. This is the only genus of Striariidae known to have an internal, glandular apophysis on the mandibular stipes of males.

Etymology. The name uses the county of the type locality (King Co., Washington) with the combining stem *-aria*, used in other striariid generic names. The gender is feminine.

Description. As for the only included species, *Kingaria prattensis* Shear & Marek, **n. sp.**

Distribution. Known only from the type locality of the single species in King Co., Washington.

Kingaria prattensis Shear & Marek, n. sp.

Figs 35–38, 60, 61.

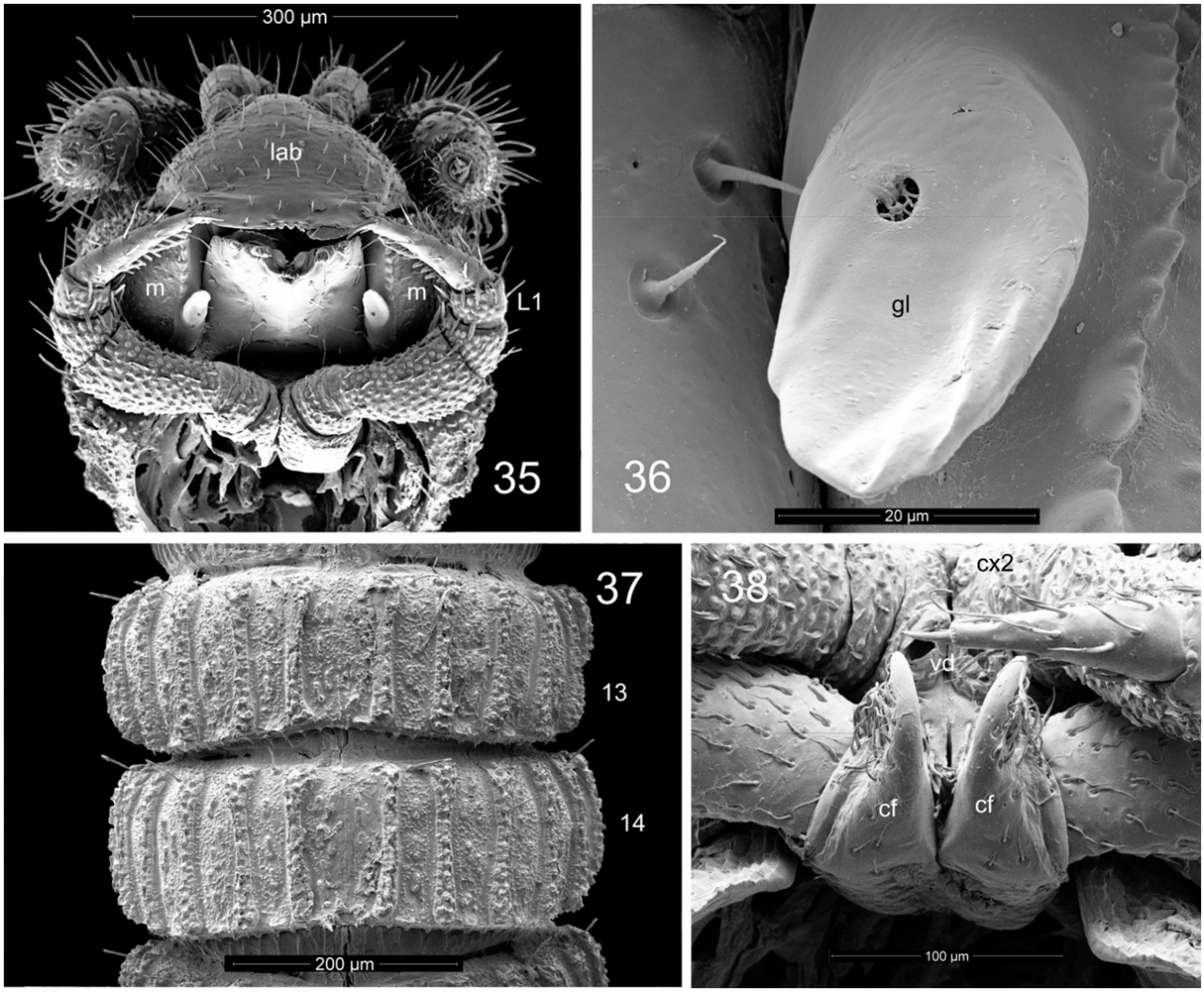
Types: Male holotype from Pratt Lake trailhead, north of I-90, 47.39715°N, -121.48515°W, collected 25 October 2003 by W. Leonard. The holotype is mounted on SEM stub WS36-6. Deposited in CAS.

Diagnosis. As for the genus, above.

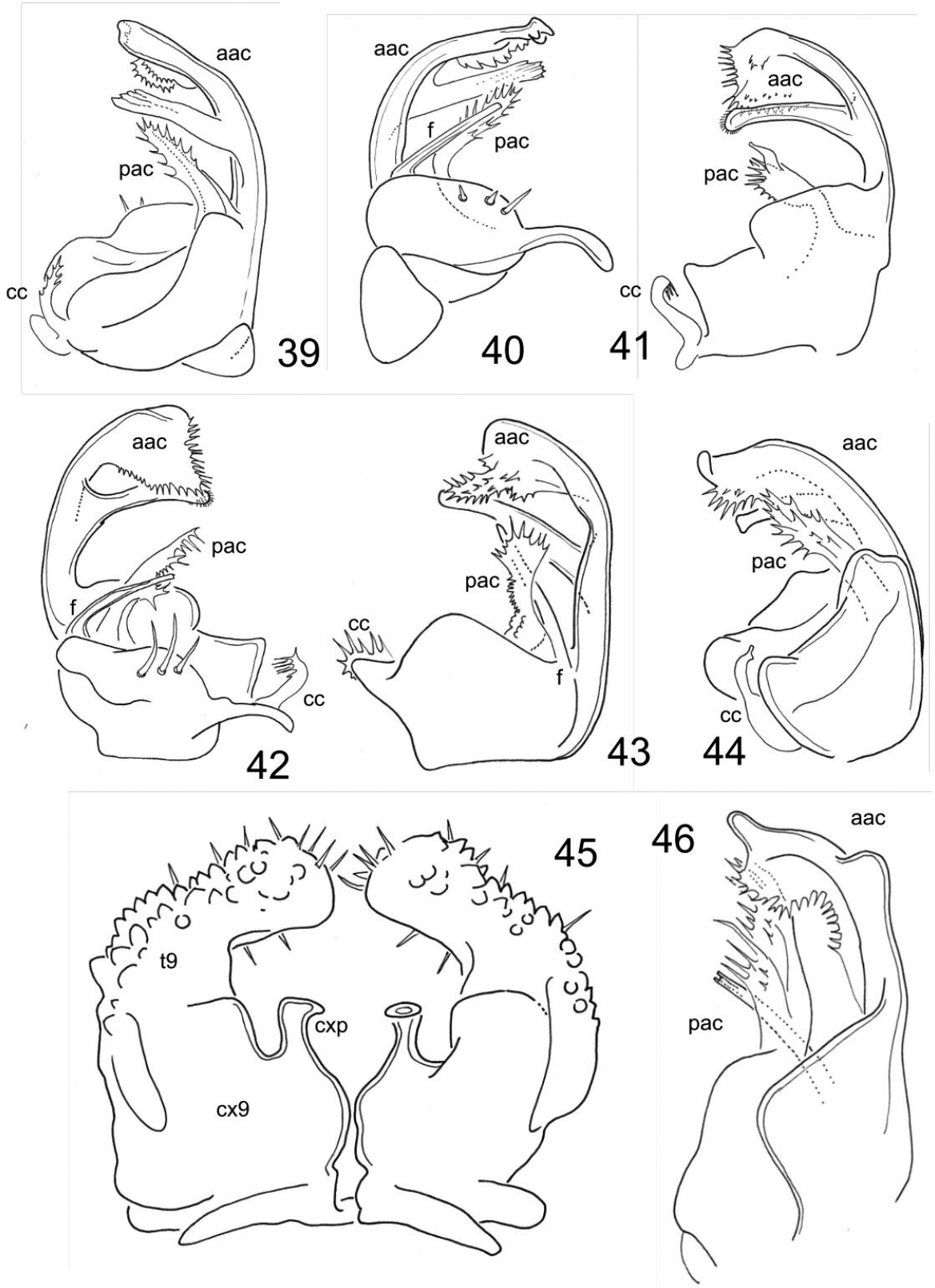
Etymology. The species name refers to the Pratt Lake Trail. This is not the same as "*pratensis,*" a Latin word meaning "of the meadow."

Description. Male holotype from Pratt Lake trailhead. Length 4.0 mm, width 0.45 mm. Twenty-eight postcephalic rings. Color white, with single black ommatidium on each side of head. Antennae robust, clavate; fifth antennomere longest, widest. Head (Fig. 35) except for labrum covered with fine setae and small tubercles. Labrum (**lab**, Fig. 35) not flattened, tapering, corners rounded. Collum ornamented by closely set small tubercles, becoming indistinct crests only mesally on most posterior part. Metazonites with twelve subequal crests (Fig. 37); metazonital setae long, prominent, with obscure longitudinal grooves and feathered tips occupying about 1/6 length of seta. Telson with indentations between lobes nearly obsolete, median lobe short; spinnerets directed posteriorly. Legs with specialized flattened setae with median ridges and long, filamentous extensions.

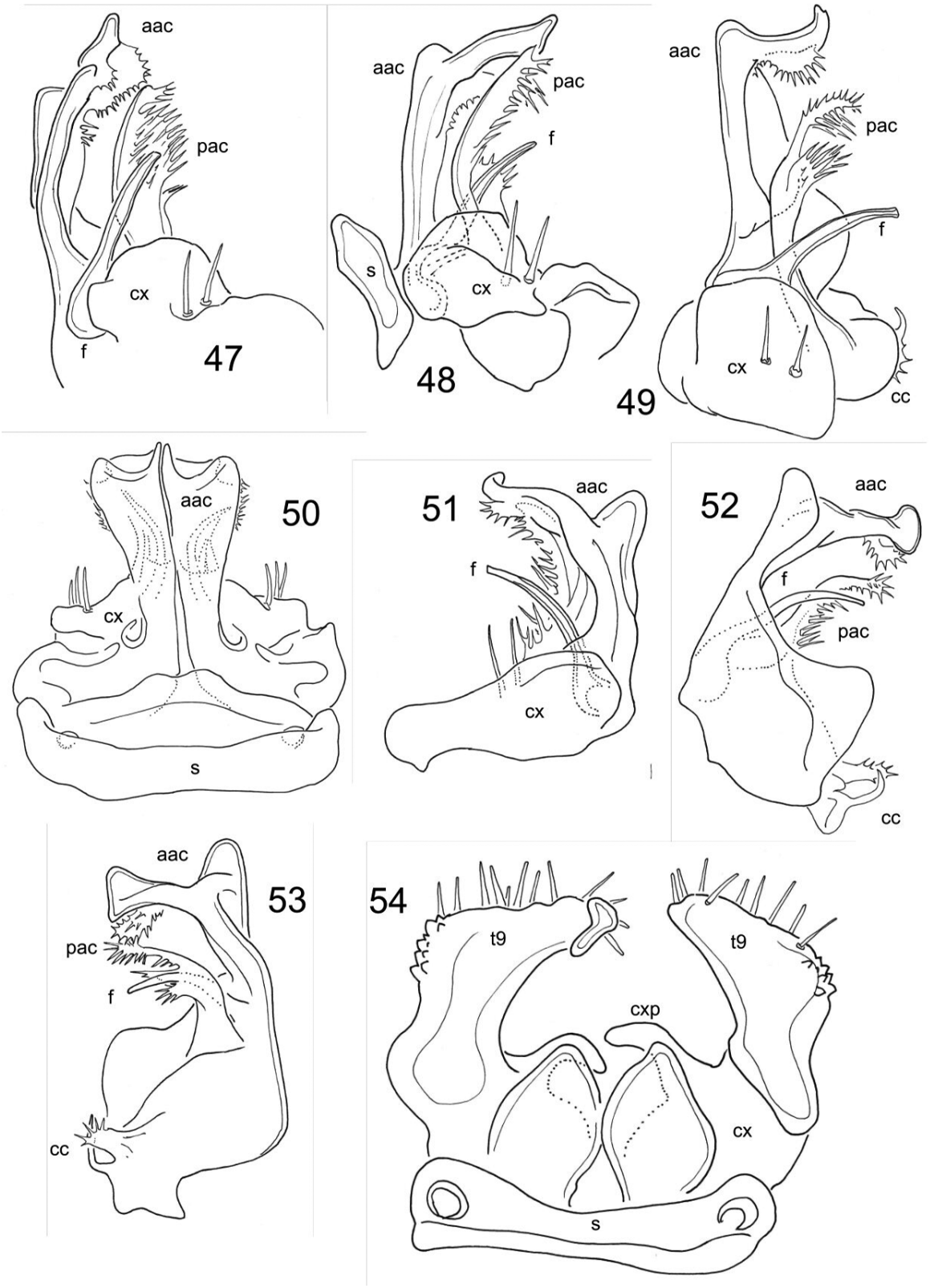
The following secondary sexual characters occur in males. Head evenly rounded; labrum (**lab**, Fig. 35) with few setae, distal corners rounded. Mandibular stipes (**m**, Fig. 35) with serrate anteriodistal margin, angular blunt distal tooth, inner suface of stipes with strongly projecting, rounded apophysis bearing on its posterior surface a small pore (Figs 35, 36). First legpair enlarged, femora curved, lacking needle setae, distal podomeres without flattened setae ventrally but with tarsal comb. Second legpair shorter than first, openings of vas deferentia separate, subtended by long, flattened, ribbon-like setae. Third legpair less robust than first two, coxal flasks short (**cf**, Fig. 38), without subapical branch, strongly procurved and densely set with curled setae. Fourth legpair the largest; prefemora and femora of usual proportions. Fifth, sixth and seventh legpairs enlarged; without modified coxae. Tenth coxae with glands, not modified or enlarged.



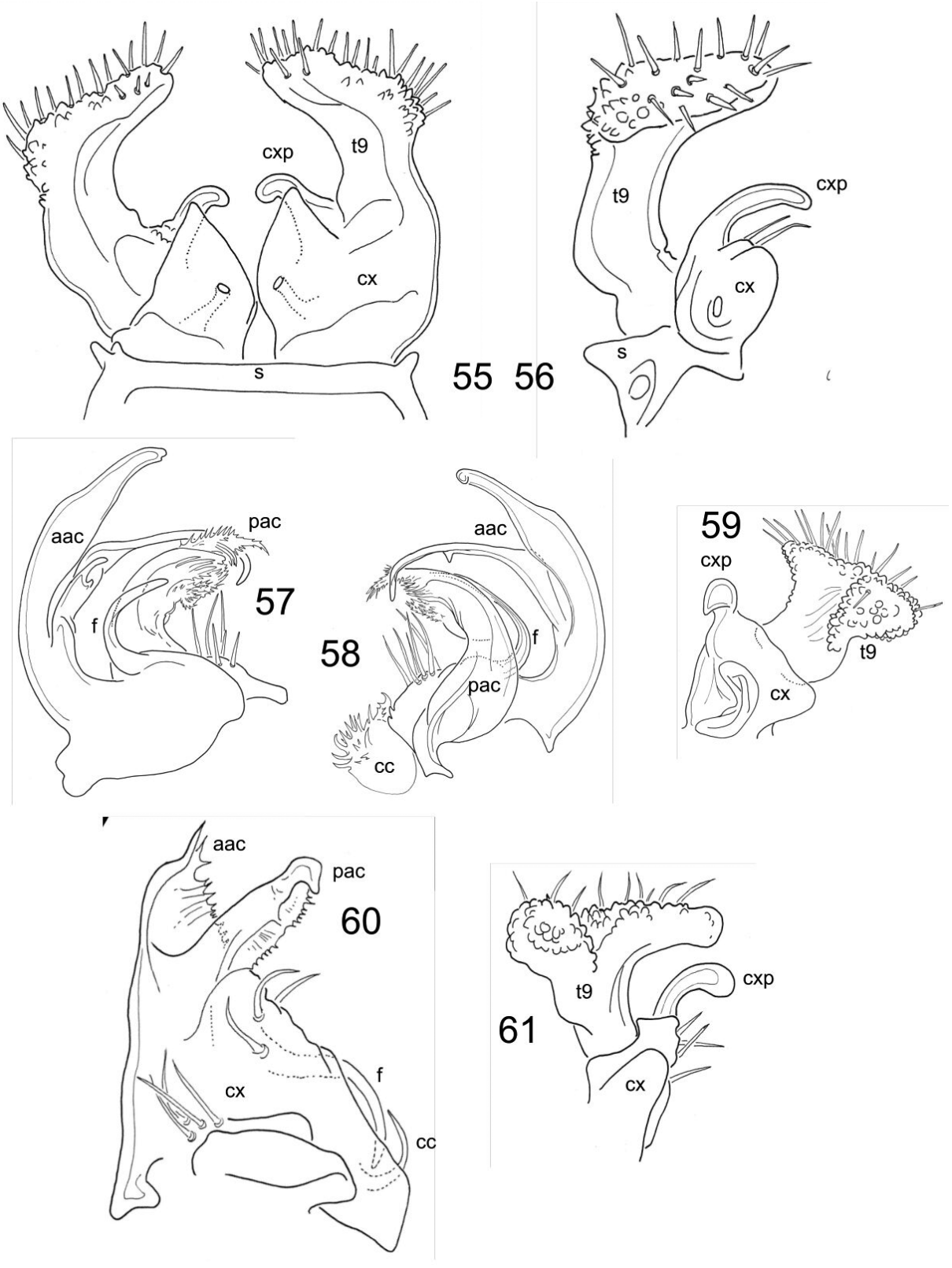
FIGURES 35–38. *Kingaria prattensis* **n. gen.**, **n. sp.**, male holotype. **35**. Head and legpair 1, ventral view. **36**. Glandular apophysis of mandibular stipes, ventral view. **37**. Pleurotergites 13, 14, dorsal view. **38**. Coxae of legpairs 2 and 3, ventral view. **Abbreviations: cf**, coxal flasks of legpair 3; **cx2**, coxa of leg 2; **gl**, glandular apophysis of mandibular stipes; **lab**, labrum; **m**, mandibular stipes; **numerals**, ring numbers; **vd**, opening of vas deferens.



FIGURES 39–46. Gonopods and ninth legs of male striariid millipedes. **Figs. 39–45.** *Miniaria ramifera* **n. gen.**, **n. sp. 39.** Right gonopod of specimen from Mashel River, mesal view. **40**. Same, lateral view. **41**. Right gonopod of specimen from Cook-Underwood Road, mesal view. **42**. Same, lateral view. **43**, Right gonopod of specimen from Ainsworth State Park, mesal view. **44**. Right gonopod of specimen from Timber, mesal view. **45**. Ninth legpair of specimen from Ainsworth State Park, posterior view. **46**. *Miniaria richarti* **n. gen.**, **n. sp.**, right gonopod of specimen from Hospital Creek, mesal view. **Abbreviations: aac**, anterior angiocoxite; **cc,** colpocoxite; **cx9**, ninth leg coxa; **cxp**, coxal process; **pac**, posterior angiocoxite; **t9**, telopodite of ninth leg.



FIGURES 47–54. *Miniaria richarti* **n. gen.**, **n. sp.**, male paratype. **47.** Right gonopod of specimen from Hospital Creek, lateral view. **48**. Right gonopod of specimen from Centralia, lateral view. **49**. Right gonopod of specimen from Toutle, lateral view. **50**. Gonopods of specimen from Elochoman River Road, anterior view. **51**. Right gonopod of specimen from Kennedy Creek, mesal view. **52**. Right gonopod of specimen from Lee's Camp, mesal view. **53**. Same, Lateral view. **54**. Ninth legpair of specimen from Lee's Camp, anterior view. **Abbreviations: aac**, anterior angiocoxite; **cc,** colpocoxite; **cx**, coxa; **cxp**, coxal process; **f,** flagellum; **pac**, posterior angiocoxite; **t9**, telopodite of ninth leg.



FIGURES 55–61. Gonopods and ninth legs of male striariid millipedes. **Figs. 55, 56.** *Miniaria richarti* **n. gen.**, **n. sp. 55**. Ninth legpair of specimen from Elochoman River Road, anterior view. **56.** Left ninth leg of specimen from Hospital Creek, anterior view. **Figs. 57–59**. *Tigraria oregonensis* **n. gen.**, **n. sp**., male paratype; **57**. Right gonopod, mesal view. **58**. Same, lateral view. **59**. Right ninth leg, anterior view. **Figs. 60, 61.** *Kingaria prattensis* **n. gen.**, **n. sp.**, male holotype. **60.** Right gonopod, lateral view. **61**. Left ninth leg, anterior view. **Abbreviations: aac**, anterior angiocoxite; **cc,** colpocoxite; **cx**, coxa; **cxp**, coxal process; **f,** flagellum; **pac**, posterior angiocoxite; **t9**, telopodite of ninth leg.

Gonopods (Fig. 60) separate from prominent, transverse sternum, coxae large, with two distinct groups of setae. Anterior angiocoxites (**aac**, Fig. 60) short, posterior margin membranous-fimbriate, without subdistal branch. Posterior angiocoxites (**pac**, Fig. 60) longer than anterior ones, posteriorly fimbriate, apparently not sheathing curved single flagellum or flagellocoxite (**f**, Fig. 60). Colpocoxites (**cc**, Fig. 60) as single, short, curved process. Ninth legs (Fig. 61) free from sternum, coxae and telopodites fused, coxae with strongly curved single process (**cxp,** Fig. 61) pore not observed; telopodites strongly flattened, setose, with ornament of pointed tubercles (as on other legs). Tenth coxae with pores, not modified.

Females not collected.

Distribution. Known only from the type locality.

Notes. The glandular apophysis on the mandibular stipes of the male (Figs 35, 36) is unique among chordeumatid millipedes, so far as we are aware. The gonopods of this species are difficult to interpret, not closely resembling those of any other striariids. What we are calling the posterior angiocoxite could well be the subapical branch of the anterior angiocoxite, but that would mean that the posterior angiocoxite is missing. The unusual position of the flagellocoxite (or flagellum) shown in Fig. 60 could be a result of mounting the gonopod on a microscope slide with the pressure of the coverglass. Unfortunately a lack of material prevented us from making further observations.

Discussion

All of the material reported here was collected from moist deciduous or coniferous forest litter, either by careful hand sorting with the use of a jeweler's magnification visor and a headlamp or by Berlese sampling. These tiny millipedes are very difficult to see, but fortunately their white color stands out against the usually darker litter.

The sensory array on the third tarsi of males of the species of *Miniaria* **n. gen.,** is worthy of a more detailed description. As depicted in Figs 6 and 17, the tarsus is short—shorter than the tarsi on legpairs 1 or 2 and on succeeding legpairs. Immediately above the tarsus can be seen a portion of the femur of the same leg with the typical modified setae found on all the legs (Fig. 6). These setae are flattened, recumbent, roughly triangular in outline with a median ridge and a long, thin filament projecting from beneath. As one examines the legs moving distally, the unusual appearance of these setae changes and they become more like "normal" setae, though some remain flattened. On the distodorsal surface of the tarsus occurs a deep pit (**y**, Fig. 6), within which are 5–7 distinct pores. Nearby is a strangely modified seta with minute, finger-like projections along one side (**x**, Figs 6, 7, 17). There may be as many as three of these setae near the tarsal tip, and the projections, seen from a different angle, look like deep corrugations. These setae may also have long, filamentous extensions perhaps homologous to the similar filaments on the femoral setae. In some specimens, similar, but not as strongly modified setae are also found on the fourth tarsi (Fig. 18). Another type of modified seta extends dorsally from the tarsus tip (**z**, Fig. 6). This seta is relatively stout and midway in its length has an array of short branches; the tip is curved in a sort of shepherd's hook, though this may be an artifact of SEM preparation. The claw differs from those on the other legs, with two lateral accessory claws, one of which is longer than the main claw and distally bifid (**w**, Fig. 6). We hypothesize that these special setae and the glandular pit serve some sensory function, and since they occur only in the males, that function has something to do with courtship and/or mating.

Similarly, the function of the third coxal flasks is not understood but postulated to have a role in mating, since they occur only in males. Similar third coxal structures are seen in other striarioid families, such as Caseyidae and Urochordeumatidae. However, in at least two striariid species, *Tigraria oregonensis* **n. gen., n. sp.,** and *Petra sierwaldae* Shear *et al*., 2022, the third coxae lack flasks. Some striariid secondary male sexual characters are unique to single species, like the mandibular glands in *Kingaria prattensis* **n. gen., n. sp.** and the inflated tarsi of *Amplaria oedipus* Shear, Nosler & Marek, 2022. Given the small size and relative rarity of these animals, it is unlikely the functions of these modifications will ever be understood.

When the gonopods were observed at 200–400X under a light microscope, we observed a single, curved branch which appeared to be the typical flagellocoxite of other striariine genera, partially sheathed by the posterior angiocoxite. In most cases this appeared to be movable, with a bulbous base and channel emerging at the tip. However in SEM observations we noted a much thinner structure entering the base of the posterior angiocoxite and emerging distally (**f**, Figs 22, 23). This structure appears hollow and has a pore at its tip. We cannot be sure at this time if these two structures are the same, or different, but we did not see a branch under SEM that appeared like

the supposed flagellocoxite in drawings made with the light microscope. Wojcieszek *et al.* (2012) used Micro-CT technology to study the gonopod functional morphology of an Australian paradoxosomatid milliped. Perhaps similar work on striariids can resolve some of the questions about the morphology and function of the complex gonopods.

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