

The millipede family Striariidae Bollman, 1893: III. Four new species of *Striaria* Bollman, 1888 (Diplopoda, Chordeumatida, Striariidae) from Idaho, USA

WILLIAM A. SHEAR¹

¹Professor Emeritus, Department of Biology, Hampden-Sydney College, Hampden-Sydney VA 23943 USA; current address: 1950 Price Drive, Farmville VA 23901 USA. wshear@hsc.edu; <https://orcid.org/0000-0002-5887-7003>

Abstract

The millipede genus *Striaria* Bollman, 1888 heretofore had been thought to be confined to the Appalachian region of eastern North America, is replaced in western North America by species of the genus *Amplaria* Chamberlin, 1941. Collections from northern Idaho show that this is not the case, and that at least four species of *Striaria* occur in the west. These species are described herein as *Striaria aculeata* n. sp., *S. bombillus* n. sp., *S. vagabundus* n. sp. and *S. orator* n. sp.

Key words: new species, western millipedes, Appalachia

Introduction

The millipede genus *Striaria* Bollman, 1888 was for many years considered to be the only genus in the family Striariidae Bollman, 1893. Eight species were described in *Striaria* from the western states (California, Oregon; Cook 1899; Loomis 1936; Chamberlin 1910, 1941, 1947; Causey 1958) but later research showed that these species did not belong in *Striaria*, but instead to the genus *Amplaria* Chamberlin, 1941 and conversely, eastern North American species ascribed to *Amplaria* were shown to be in fact members of *Striaria* (Shear & Krejca 2007; Shear 2020a, 2021; Shear *et al.* 2017). Only the genus *Striaria* Bollman, 1888, occurs in the eastern United States, in the Appalachian Mountains and foothills from southern Ohio and northern Virginia south to Alabama and Georgia, and west to Indiana.

However, collecting in northern Idaho has shown that at least four species in five populations referable to *Striaria* occur there.

Methods

Specimens were field-preserved in 70–85% ethanol. Morphological studies were done using an Olympus SZH stereomicroscope and an Olympus BX50 compound microscope equipped with Nomarski optics. Gonopods, ninth legs, pregonopodal legs and other body parts were temporarily mounted on microscope slides in glycerine for study up to 400X magnification. Drawings were made from these slides using a drawing tube fitted to the BX50. Specimens were mounted and air-dried on 12.7-mm diameter aluminum scanning electron microscopy (SEM) stubs affixed with double-sided carbon conductive tape. These were sputter-coated with a 40 nm thickness layer of platinum and palladium metals using a Leica EM ACE600 high vacuum sputter coater. Scanning electron micrographs were taken with a FEI Quanta 600 FEG environmental SEM. Measurements were transferred from scale lines on scanning electron micrographs. Photographs and drawings were edited and refined using GIMP and plates were composed in InkScape.

All specimens, including types, used in this study will be deposited in the collection of the California Academy of Sciences, San Francisco, California, USA. Scanning Electron Microscopy stubs with parts of types and other specimens will be deposited later in the same repository.

Taxonomy

Family Striariidae Bollman, 1893

The taxonomic characters useful in distinguishing species of Striariidae were discussed by Shear (2020), with reference to *Striaria columbiana* Cook, 1899 (Virginia, USA). The members of the family may be easily recognized in the field by the broad, hooded collum (**col**, Figs 1, 14) and the crested pleurotergites (Fig. 15). All presently known striariids have 30 pleurotergites.

Subfamily Striariinae Bollman, 1893

Included genera: *Striaria* Bollman, 1888, *Amplaria* Chamberlin, 1941. The genera *Vaferaria* Causey, 1958, and *Speostriaria* Causey, 1960 have been synonymized with *Amplaria* (Shear 2020a, 2021)

Distribution: As for *Striaria*, below. *Amplaria* is distributed along the west coast of North America from southern California to southern British Columbia, with a single species in northern Idaho (Shear 2021).

Diagnosis: Distinct from the subfamily Trisariinae Shear, 2020 in the form of the gonopods, which in species of Trisariinae are compact and with all elements rotated laterally, while in species of Striariinae the same elements are aligned to the body axis. In addition, the ninth legs of trisariines have the sternum, coxae and telopodites fused, while these elements are separate in striariines (Shear 2020).

Genus *Striaria* Bollman, 1888

Type species: *Striaria granulosa* Bollman, 1888. The exact identity of the type species has yet to be established, as the type specimens are lost and there are no known collections from the type locality (Beaver Creek, Jefferson Co., Tennessee), or nearby. According to Hoffman (1999, p. 209) the types were originally deposited in the United States National Museum of Natural History (Smithsonian Institution), but by 2012 they could no longer be found there.

Included species:

Striaria granulosa Bollman, 1888,
Striaria columbiana Cook, 1899,
Striaria causeyae Chamberlin, 1941,
Striaria zygoleuca Hoffman, 1950,
Striaria antica Causey, 1952,
Striaria aculeata n. sp.,
Striaria bombillus n. sp.,
Striaria vagabundus n. sp.,
Striaria orator n. sp.

Hoffman (1999) includes six additional species, but these have all been transferred to *Amplaria* (Shear 2021). There are numerous undescribed species.

Distribution: From northern Virginia west to Indiana, south to Alabama and Georgia (includes unpublished records).

Diagnosis: *Striaria* and *Amplaria* are obviously closely related (Shear 2020) but clearly distinct in the configuration of the gonopods. In species of *Striaria*, the anterior angiocoxites have a distinct angular “kink”, a sharp posterior flexure marked by an anterior ridge (Fig. 9) half to three-fourths in their length, and proximal to the “kink” are several transverse rugae. Further, the anterior angiocoxites are usually tipped by a complicated array of spinules (Fig. 12). All the eastern species I have seen have the crown of spinules on the anterior angiocoxites also characteristic of two of the four of the species from Idaho described here, and all species without exception have the “kink” and rugae of the anterior angiocoxites. The complex array of spinules may not be a very good source of species characters, however, since the arrangement can vary even between the right and left gonopods of the same male

(Shear 2020: 280, fig. 7). It seems better to rely on the overall configuration of the gonopods, or on characters of the anterior legs of the males that may vary between species. The posterior angiocoxites of the Appalachian species bear a distal structure that appears to be a weakly sclerotized fimbriate pad (Shear 2020: 280, fig. 6), but this is absent in the Idaho species described below.

These distinguishing gonopod features are not found in *Amplaria* species; the anterior angiocoxites are not bent posteriad, lack anterior rugae and a crown of spinules. While the differences in the gonopods allow the two genera to be readily separated, the other secondary sexual characters of the males are much the same: modifications of the first seven legpairs as well as extensions of the third pleurotergite that extend between the third and fourth pairs of legs. The modifications (reduction to a single article) of the telopodites of the ninth legpair are virtually identical in the two genera (Fig. 18), though in species of the Nazinta Group of *Amplaria* the single article has a long, finger-like extension (Shear 2021). A sinuous spine extends from each lateral angle of the labrum of males (**lh**, Fig. 1) and the stipes of the mandible may be distally angular (**man**, Fig. 1), but both of these characters may be absent in some *Amplaria* species.

Notes: A character not mentioned previously for *Striaria* species is the sexual dimorphism of the telson, which in the Idaho species is longer and narrower in males and with deeper divisions between the lobes than in females (Figs 16, 17). A few species of *Amplaria* show this modification, but it is present in both sexes (Shear 2021). It is not found in the eastern species of *Striaria* that I have examined.

Striariids have poorly developed eyes (**e**, Fig. 2). The ommatidia are relatively few in number, often unpigmented and often varied in shape and size within the same ocularium. All of the Idaho species described below have four or five pigmented ommatidia arranged in a single row (**e**, Fig. 2) and are pale brown in color, without markings. The Tömösváry Organ (**to**, Fig. 2) is a small pore near the ocularium. As with all striariids so far studied, the true surface of the cuticle (**cs**, Fig. 2) is mostly covered with a secreted cerotegument (**ct**, Figs 2, 14), which flakes and peels as specimens are handled.

Making decisions about the number of species in the available Idaho collections was difficult; two competing hypotheses were that four species were present, or only two, with variation in the gonopods (such that *aculeata* and *bombillus* represented three populations of the same species, and *orator* and *vagabundus* two populations of the same species). Finally I came to the conclusion that the best solution for the time being was to describe each of the populations, except for the two that are clearly conspecific as *S. aculeata*, as species, given the general overall differences in gonopod configuration. This hypothesis can be tested by further collecting in northern Idaho, as well as by genetic data if and when that becomes available.

The four species described below fall into two groups, based on gonopod morphology. In *S. aculeata* and *S. bombillus*, the subterminal spine of the anterior angiocoxite has moved from a true lateral position to the posterior surface of the coxite, and the coxite is tipped with a crown of spinules. The spinules are not present in *S. vagabundus* and *S. orator* and the subterminal spine remains in its lateral position.

***Striaria aculeata*, n. sp.**

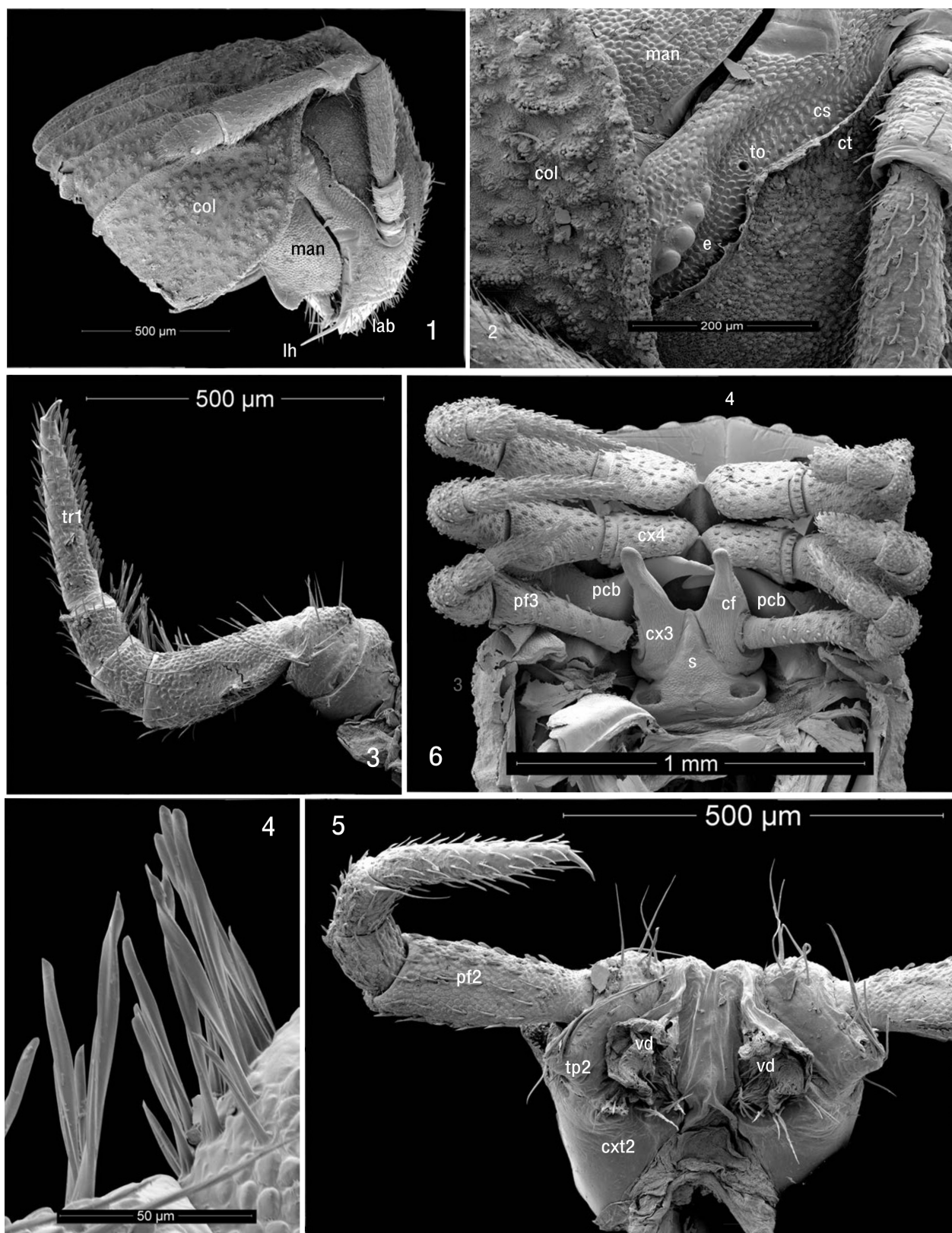
Figs 1–13, 22–24

Types: Male holotype, 6 male and 5 female paratypes from Meadow Creek, 46.0426°, -115.2952°, 1800' (550 m) asl, Idaho Co., Idaho, collected 17 April 2004 by W. Leonard and C. Richart; 1 male and 1 female paratypes from the same locality, but 46.0426°, -115.2973°, collected 12 April 2003 by W. Leonard; 1 male paratype from State Route 5 at Benewah/Latah County boundary, 15 mi (24 km) south of State Route 3, St. Joe National Forest, 47.0337°, -116.6735°, 900 m asl, collected 13 May 2006 by C. Richart. Types deposited in the California Academy of Sciences, San Francisco, California. Parts of a male and a female paratype are mounted on SEM stub WS34-4, which will be deposited along with the specimens.

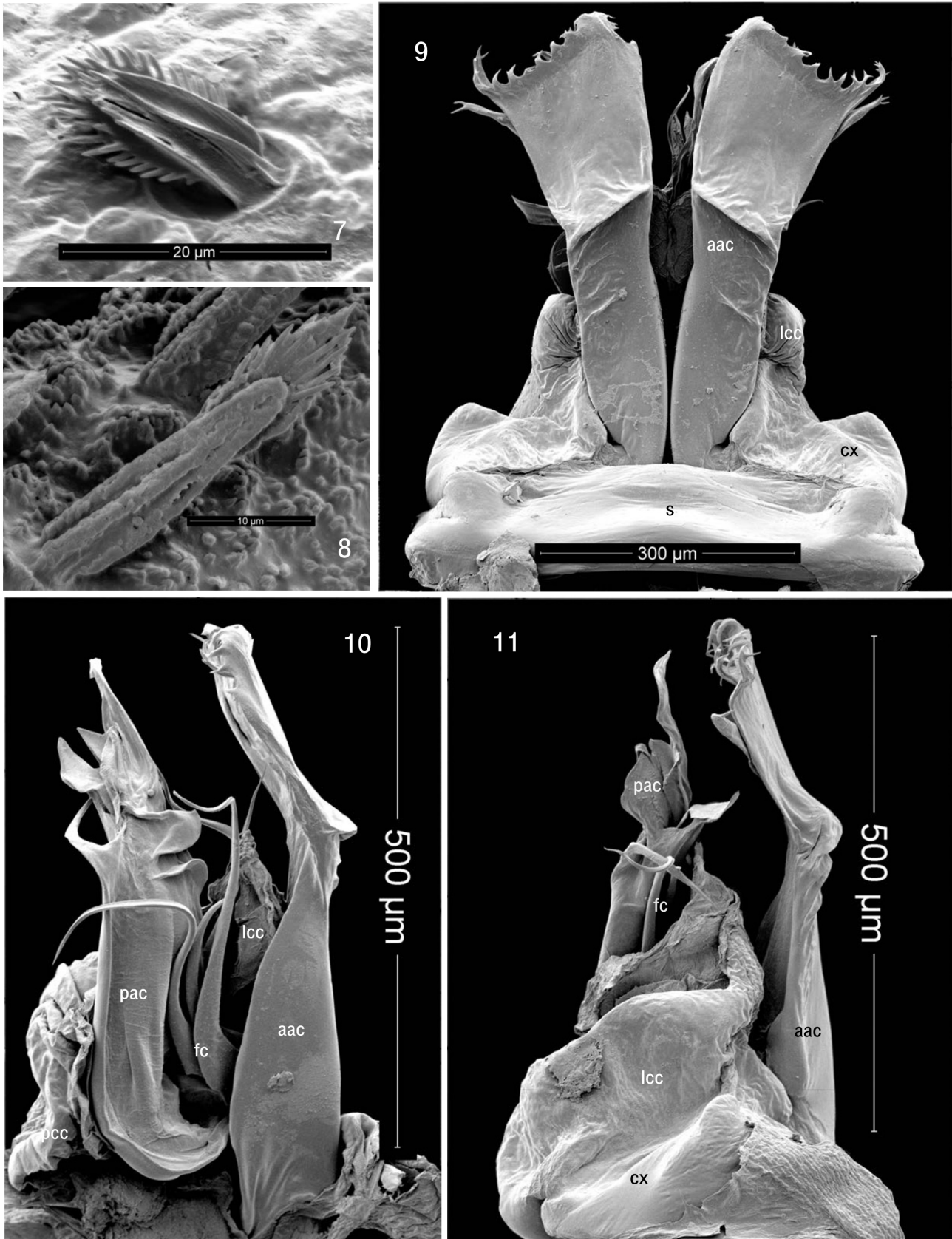
Etymology: The species epithet is a Latin adjective, “prickly” or “thorny” and refers to the tips of anterior angiocoxites of the gonopods.

Diagnosis: Distinct from the other species found in Idaho in the broad tips of the anterior angiocoxites, divided into many small spinules.

Description: Male paratype from Meadow Creek. Length, about 11 mm, width about 1.0 mm. Body form and secondary sexual modifications typical of the genus: labrum (**lab**, Fig. 1) with long, lateral spines (**lh**, Fig. 1).



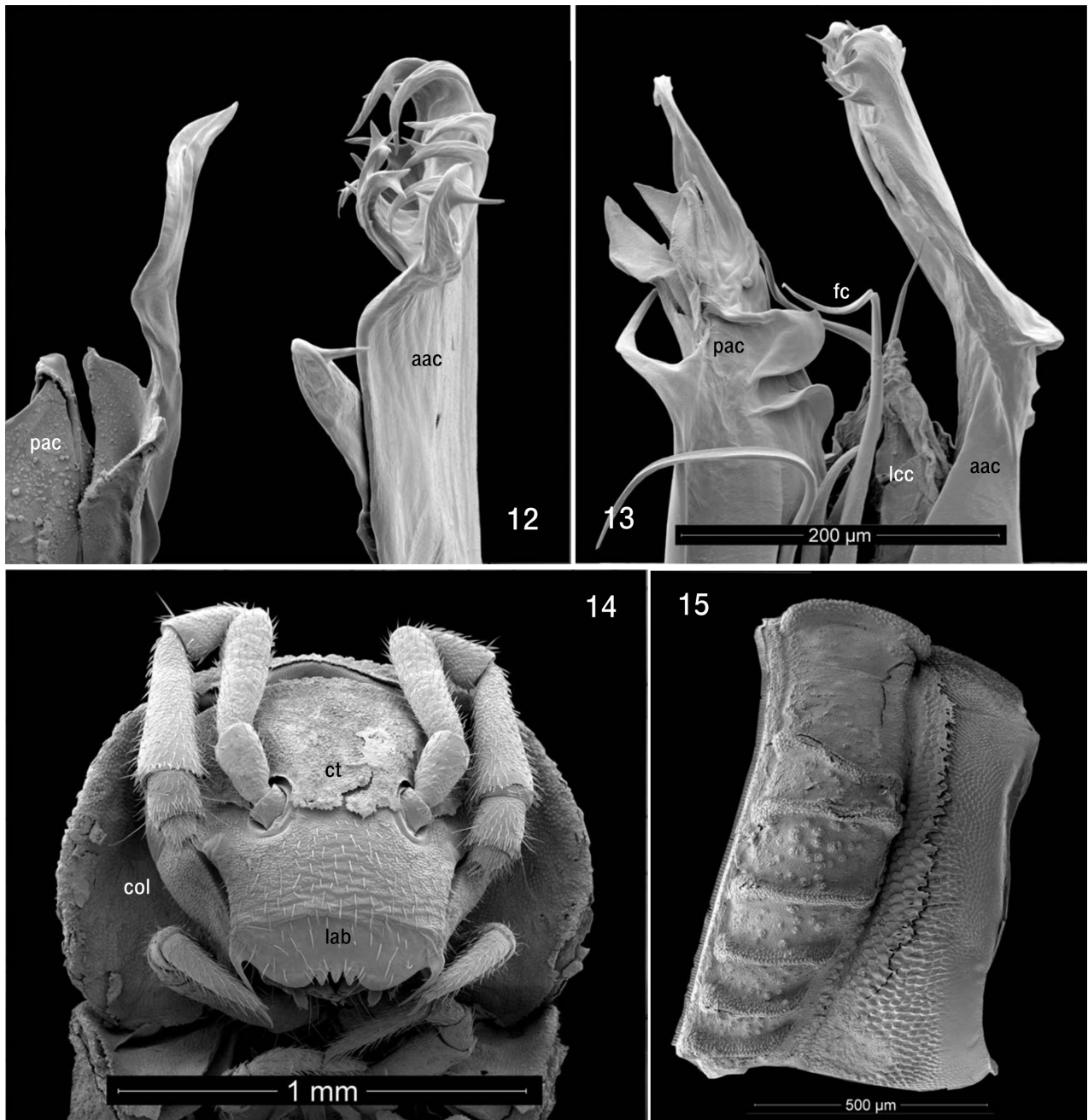
FIGURES 1–6. Male *Striaria aculeata*, n. sp. **1.** Head and collum, lateral view; **2.** Lateral view of head, showing ommatidia (e) and Tömösváry organ (to); **3.** Right leg 1, posterior view. **4.** Specialized setae of femur and tibia of leg 1. **5.** Legpair 2, posterior view. **6.** Legpairs 3–5, anteroventral view. **Abbreviations:** cf, coxal flask; col, collum; cs, cuticle surface; ct, cerotegument; cx3, coxa of leg 3; cxt2, coxotrochanter of leg 2; e, ocularium; lab, labrum; lh, labral hook; man, mandible; pcb, postcoxal bar; pf2, prefemur of leg 2; pf3, prefemur of leg 3; s, sternum to, Tömösváry Organ; tr1, tarsus of leg 1; tp2, trochanteral process of leg 2; vd, openings of vasa deferentia.



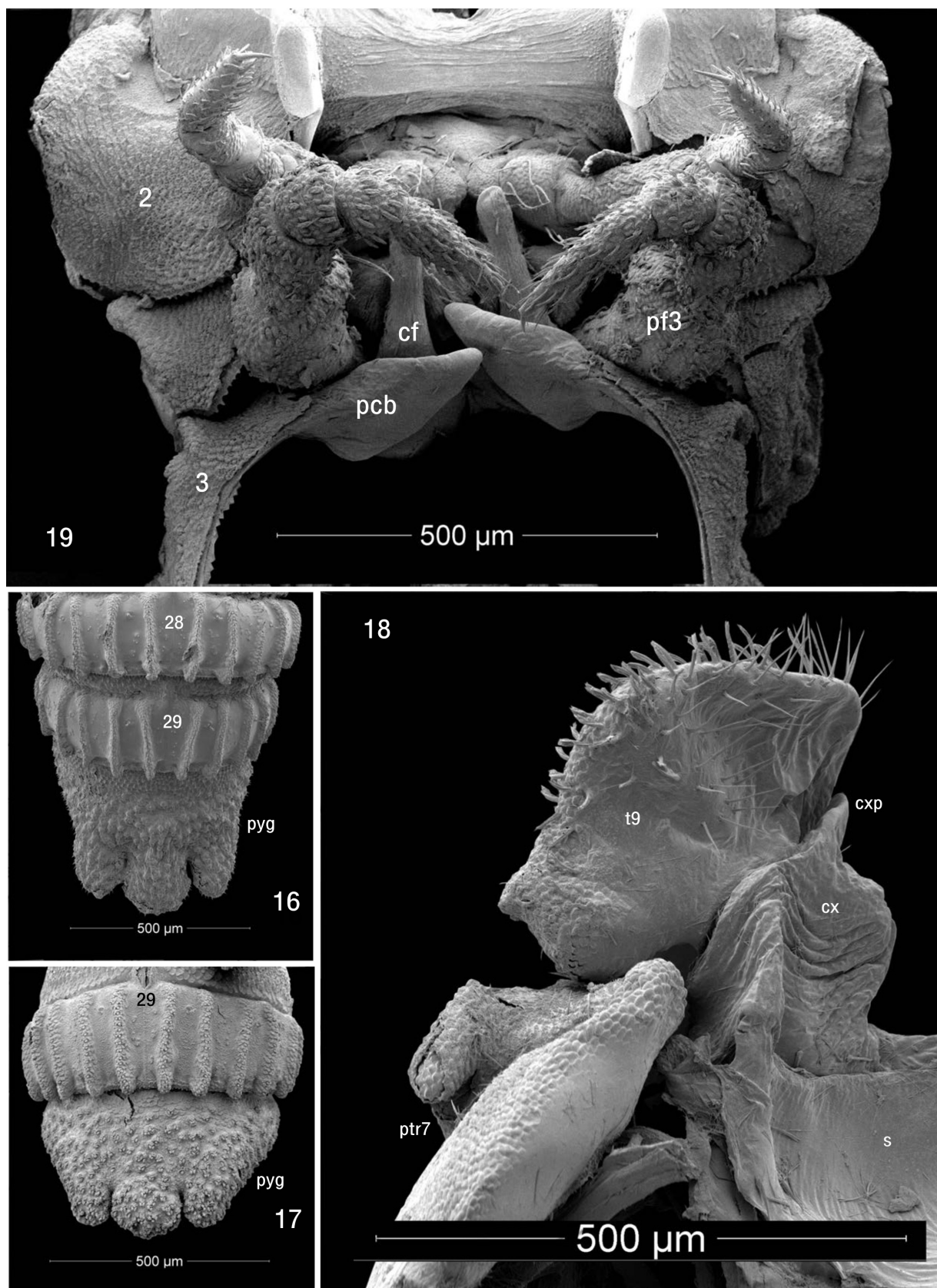
FIGURES 7–11. Male *Striaria aculeata*, n. sp. 7. Specialized seta of prefemur of legpair 3. 8. Specialized seta of distal tibia of legpair 3. 9. Gonopods, anterior view. 10. Right gonopod, mesal view. 11. Left gonopod, lateral view. **Abbreviations:** aac, anterior angiocoxite; cx, coxa; fc, flagellocoxite; lcc, lateral lobe of colpocoxite; pac, posterior angiocoxite; s, sternum. Mandibular stipes distally strongly angular (**man**, Fig. 1). First legpair (Fig. 3) larger than second legpair (Fig. 5),

long acute macrosetae distal on prefemur, on ventral surface of femur and tibia (Fig. 4), spatulate macrosetae on ventral surface of tarsus. Second legpair with fused coxae, seminal openings extended as short, membranous tubes, enlarged trochanters with groups of long, fine setae (Fig. 5). Third legpair coxae (**cx3**, Fig. 6) extended ventrally as flask-shaped processes (**cf**, Fig. 6), prefemur narrow, slightly enlarged distally (**pf3**, Fig. 6). Legpairs 4–7 incrassate, prefemora distally swollen (Fig. 6), with characteristic setae (Figs 7, 8). Pygidium elongate, narrowed.

Gonopods (Figs 9–13, 22–24) in anterior view (Fig. 9) with flattened, plate-like anterior angiocoxites, sharply bent posteriad at a transverse ridge about midway in angiocoxite length, proximal to ridge are a few low rugae. In lateral view (Fig. 11), tip of anterior angiocoxite (Figs 12, 13, 23, 24) with complex array of sharply curved, acute spinules, subterminal spine sharply bent at tip, abruptly becoming acute. Posterior angiocoxites sheathing three or four flagellocoxites (Fig. 10), with subterminal hook-like process, three terminal divisions. Ninth legs typical, median coxal process small, weak.



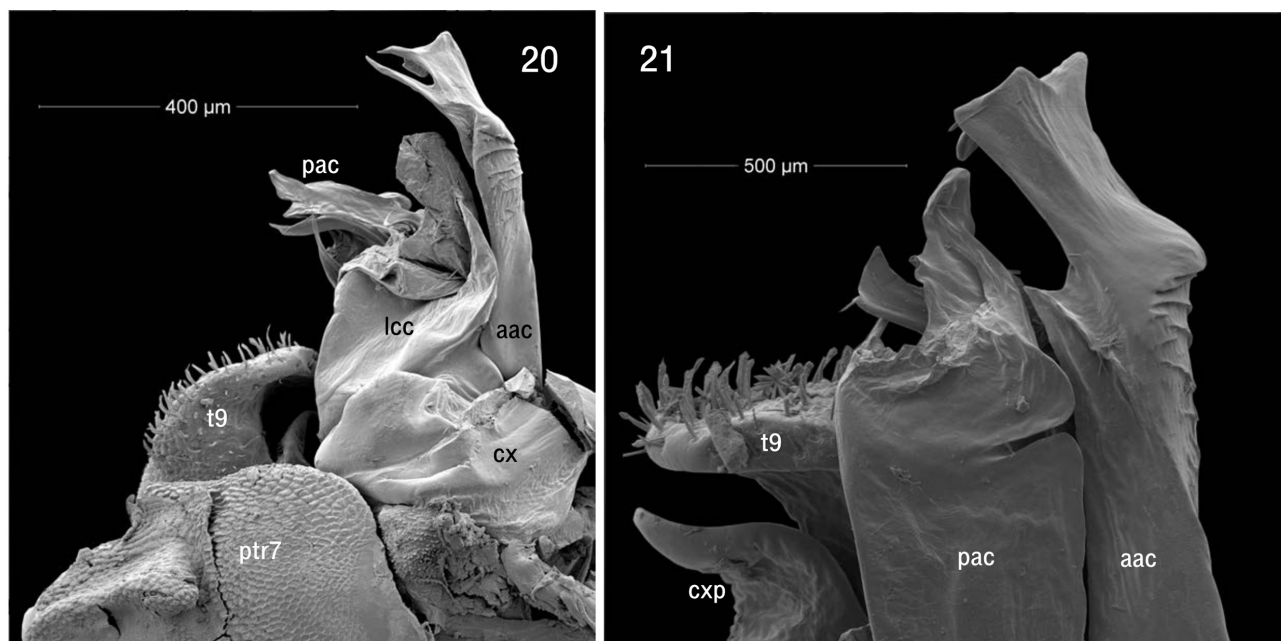
FIGURES 12–15. Males of new species of *Striaria*. **12, 13.** *S. aculeata*, **n. sp.** **12.** Tips of left gonopod, lateral view. **13.** Tips of right gonopod mesal view. **14, 15.** *S. bombillus*, **n. sp.** **14.** Head and collum, frontal view. **15.** Pleurotergite 8, lateral view, anterior to the right. **Abbreviations:** **col**, collum; **ct**, cerotegument; **aac**, anterior angiocoxite; **fc**, flagellocoxite; **lab**, labrum; **lcc**, lateral lobe of colpocoxite; **pac**, posterior angiocoxite.



FIGURES 16–19. New species of *Striaria*. **16, 17.** *S. bombillus*, **n. sp.** **16.** Pygidium of male, dorsal view. **17.** Pygidium of female, dorsal view. **18.** Right ninth leg of *S. vagabundus*, **n. sp.**, anterior view. **19.** Second and third legpairs of *S. orator*, **n. sp.**, ventroposterior view. **Abbreviations:** cf, coxal flask; cx, coxa; cxp, coxal process; **numerals**, pleurotergite numbers; pcb, post-coxal bar; **pf3**, prefemur of leg 3, **ptr7**, modified margin of pleurotergite 7; **pyg**, pygidium; s, sternum; **t9**, telopodite of leg 9.

Female paratype: Similar to male but without secondary sexual modifications. Female pygidium short.

Distribution: Known only from the vicinity of Meadow Creek.



FIGURES 20, 21. *Striaria orator*, n. sp. **20.** Left gonopod complex, lateral view. **21.** Gonopod tips of right side, mesal view. **Abbreviations:** aac, anterior angiocoxite; cx, coxa; cxp, coxal process; lcc, lateral lobe of colpocoxite; pac, posterior angiocoxite; ptr7, modified margin of pleurotergite 7; t9, telopodite of leg 9.

Striaria bombillus, n. sp.

Figs 14–17, 25–28

Types: Male holotype and two female paratypes from Little Bumblebee Creek, 47.6238°, -116.2972°, Shoshone Co., Idaho, collected 11 April 2003 by W. Leonard, deposited in the California Academy of Sciences. Parts of the holotype are mounted on SEM stub WS34-5, deposited with the specimens.

Etymology: The species epithet is a Latin noun in apposition, diminutive of *bombus*, a bumblebee, and refers to Little Bumblebee Creek, the type locality.

Diagnosis: Similar to the preceding species, but differing in the fewer, shorter, less curved spinules and in lacking a lateral process of the anterior angiocoxites; possibly the lateral process has shifted somewhat to the mesal side of the anterior angiocoxites.

Description: Male holotype. Length, about 11 mm, width about 1.0 mm. Body form and secondary sexual characters as for the genus and *Striaria aculeata*, see above.

Gonopod anterior angiocoxites (Figs 25, 26) sharply bent posteriorad about two thirds their length at pronounced transverse ridge, proximal to ridge are 2 or 3 distinct rugae; tip (Figs 27, 28) with a few long spinules mesal, more laterally are more numerous but lower spinules in single row. Posterior angiocoxites robust, sheathing three or four flagellocoxites, lacking hook-like process seen in *S. aculeata*. Ninth legs as in *S. aculeata*.

Female paratype: Similar to male but without secondary sexual modifications; pygidium short, broad (Fig. 17).

Distribution: Known only from the type locality.

Striaria vagabundus, n. sp.

Figs 18, 29–32

Types: Male holotype and paratype and two female paratypes from Hobo Cedar Grove Botanical Area, St. Joe National Forest, 47.0879°, -116.1128°, 4400' (1340 m) asl, Shoshone Co., Idaho, collected 8 June 2004 by W. Leonard,

deposited in the California Academy of Sciences. Parts of the holotype are mounted on SEM stub WS34-7, deposited with the specimens.

Etymology: The species epithet, *vagabundus*, is a Latin noun in apposition, meaning “a wanderer” and refers to the type locality, Hobo Cedar Grove.

Diagnosis: Distinct from other Idaho species of *Striaria* in having no spinules tipping the anterior angiocoxites of the gonopods, but instead three low, triangular teeth presumably homologous to the spinules.

Description: Male holotype. Length, about 9.0 mm, width about 0.85 mm. Body form and secondary sexual modifications typical of genus, as described above for *S. aculeata*.

Gonopod anterior angiocoxites (Figs 29–32) only slightly bent at “kink,” with about five distinct rugae proximal to the transverse ridge, long lateral subterminal spine, mesal tip projecting posteriorly. Posterior angiocoxites robust, with three terminal process, subterminal posterior hook, sheathing three or four flagellocoxites. Ninth legs typical, telopodite broadly flattened, coxa with small mesal process, loosely articulating with modified margin of seventh pleurotergite (Fig. 18)

Female paratype: Similar to male but without secondary sexual modifications.

Distribution: Known only from the type locality. Hobo Cedar Grove is an area of primary forest, with huge western red cedar trees (*Thuja plicata*) estimated to be as much as 500 years old. Many rare plants are known from this locality.

Striaria orator, n. sp.

Figs 19–21, 33–36

Types: Male holotype and female paratype from Banks Gulch, 4 mi north, 8 mi east of Harvard, 46.9818°, -116.5607°, 2905' (890 m) asl, Latah Co., Idaho, collected 10 September 1978 by A. K. Johnson, deposited in the California Academy of Sciences. Parts of the holotype are mounted on SEM stub WS34-6, deposited with the specimens.

Etymology: The species epithet, a noun in apposition, honors Orator F. Cook (1867–1949), a botanist specializing in cotton, rubber trees and palms who also laid a sound foundation for the study of North American millipedes, establishing many families and genera still valid today.

Diagnosis: Distinct from the foregoing species from Idaho in lacking any spinules or teeth on the apex of the anterior angiocoxite of the gonopod.

Description: Male holotype. Length, about 10 mm, width about 1.0 mm. Body form and secondary sexual modifications typical of genus, as described above for *S. aculeata*. Third legpair coxae with long flasks (**cf**, Fig. 19), postcoxal bars of pleurotergite 3 overlapping, broad (**pcb**, Fig. 19). legpair 3 telopodites robust, prefemora thickly swollen (**pf3**, Fig. 19).

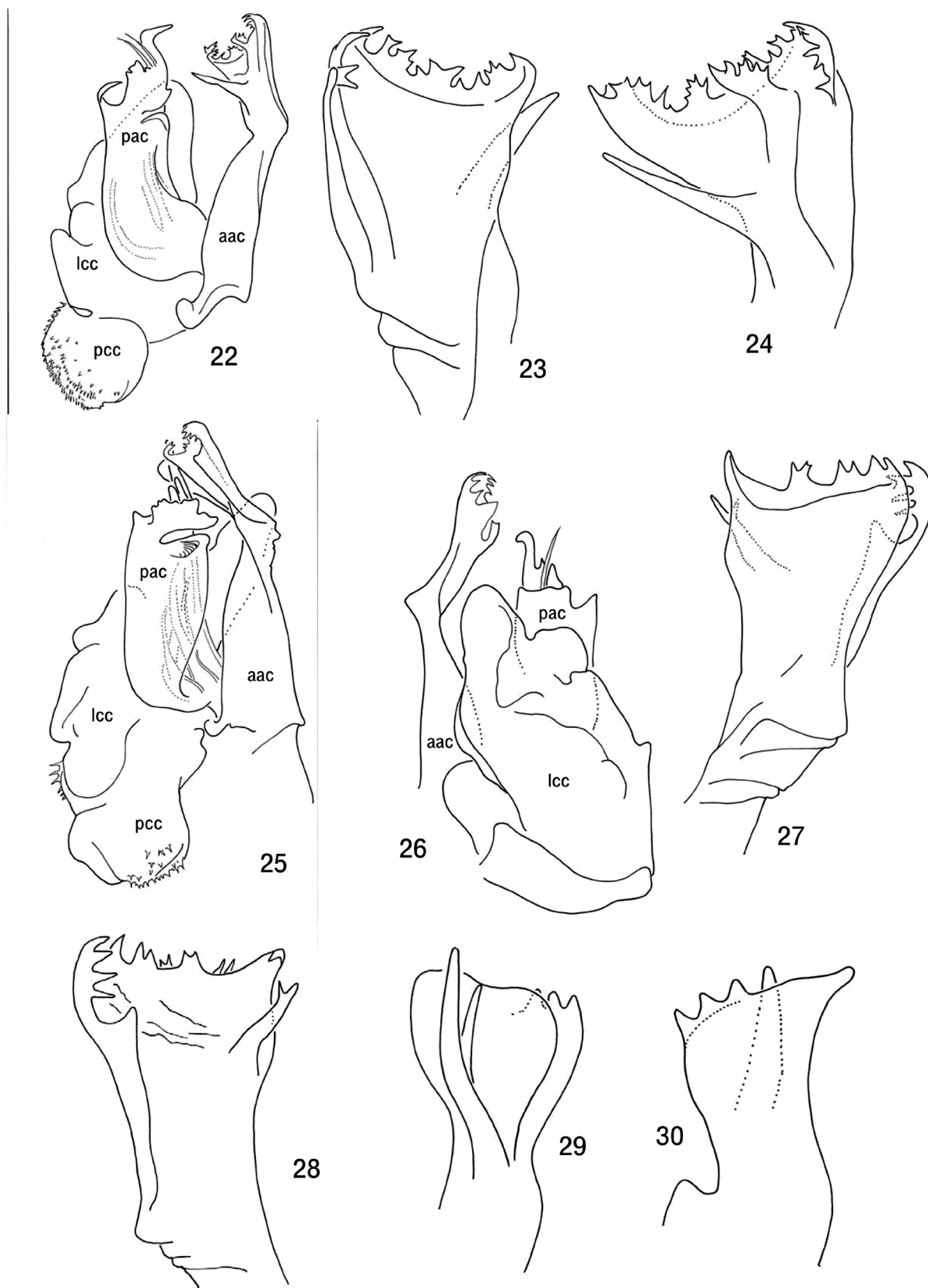
Gonopod (Figs 20, 21, 33–36) anterior angiocoxites hardly bent at all at “kink” but with very prominent transverse ridge, at least five distinct rugae, lateral subterminal spine shorter than in *S. vagabundus*, mesal tip of anterior angiocoxite not projecting but laterally hammer-shaped. Posterior angiocoxites with two blunt terminal processes, three or four narrower processes, short posterior hook, sheathing four flagellocoxites.

Female paratype: Similar to male but without secondary sexual modifications.

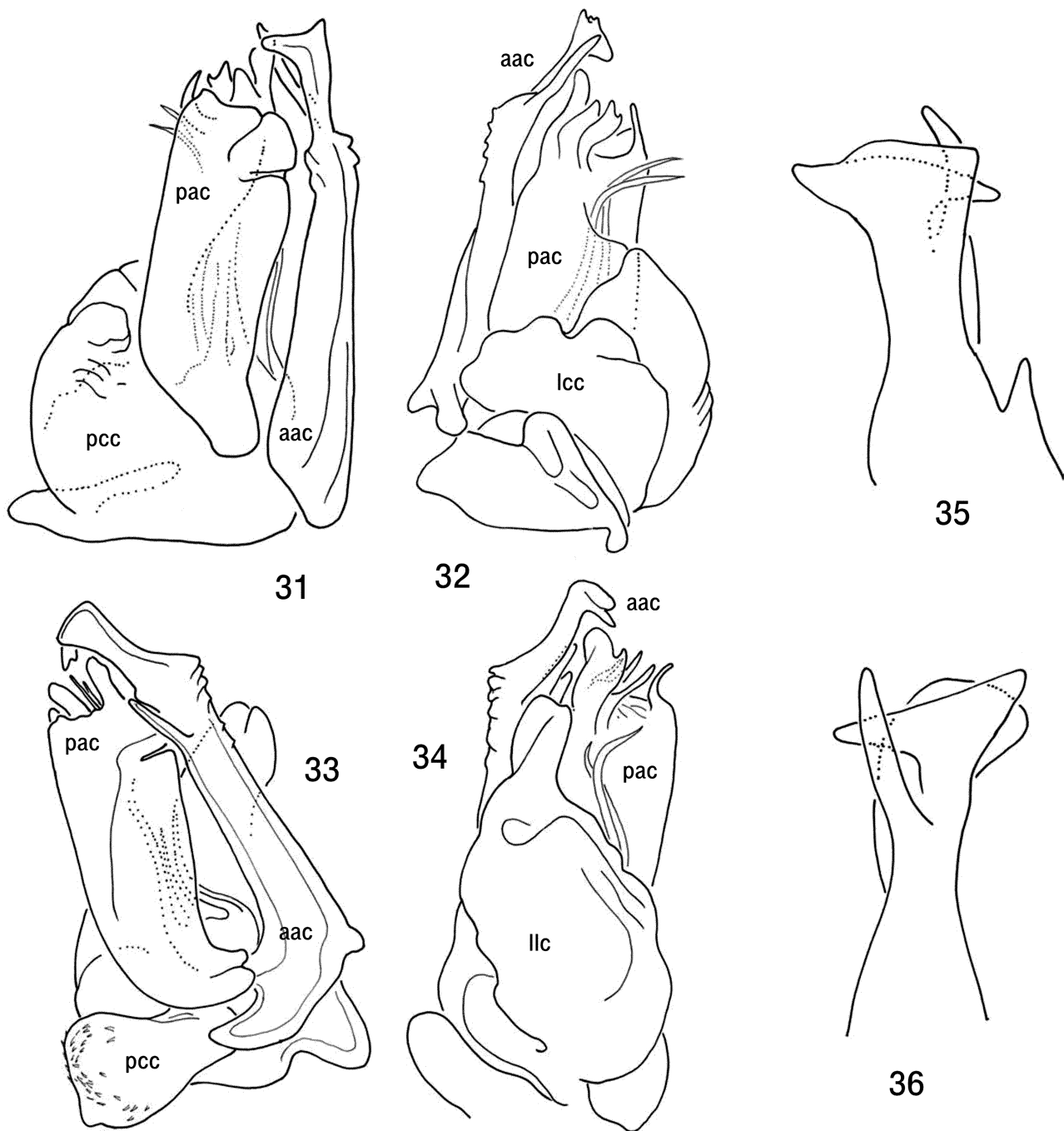
Distribution: Known only from the type locality.

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FIGURES 22–30. Gonopods of new species of *Striaria*. **22–24.** *S. aculeata*., **n. sp.** **22.** Right gonopod, mesal view. **23.** Tip of anterior angiocoxite, lateral view. **24.** Same, mesal view. **25–28.** *S. bombillus*, **n. sp.** **25.** Right gonopod, mesal view. **26.** Right gonopod, lateral view. **27.** Tip of anterior angiocoxite, lateral view. **28.** Same, mesal view. **29, 30.** *S. vagabundus*, **n. sp.** **29.** Tip of anterior angiocoxite, lateral view. **30.** Same, mesal view. **Abbreviations:** **aac**, anterior angiocoxite; **lcc**, lateral lobe of colpocoxite; **pac**, posterior angiocoxite; **pcc**, posterior lobe of colpocoxite.



FIGURES 31–36. Gonopods of new species of *Striaria*. **31, 32.** *S. vagabundus*, **n. sp.** **31.** Right gonopod, mesal view. **32.** Right gonopod, lateral view. **33–36.** *S. orator*, **n. sp.** **33.** Right gonopod, mesal view. **34.** Right gonopod, lateral view. **35.** Tip of anterior angiocoxite, mesal view. **36.** Same, lateral view. **Abbreviations:** **aac**, anterior angiocoxite; **llc**, lateral lobe of colpocoxite; **pac**, posterior angiocoxite; **pcc**, posterior lobe of colpocoxite.

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