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Lepidodermella weissi, new species (Gastrotricha: Chaetonotida: Chaetonotidae) from northwestern Oregon, U.S.A.

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Abstract.—A new species of *Lepidodermella* (Gastrotricha: Chaetonotida: Chaetonotidae) is described from two streams in northwestern Oregon, U.S.A. This is the fourth species of freshwater gastrotrich reported from the Pacific Northwest region of the United States. The dearth of reports appears to be due more to a lack of study rather than a lack of gastrotrichs. *Lepidodermella squamata* is one of the species already reported from the Pacific Northwest, and occurs sympatrically with the new species described here. No other members of the genus have been reported from the Pacific Northwest. Three species of *Lepidodermella* have been reported previously from North America. The genus includes one marine species and 14 freshwater species. *Lepidodermella weissi*, new species, brings the number of freshwater species to 15 and can be distinguished from other freshwater members of the genus by the following characters: absence of parafurcal spines, absence of transverse anterior ventral plates, head width of less than 40 µm, head with five lobes, pharynx length 44 µm or less, adhesive tube length of 5 µm or more, more than 35 scales per middorsal column, presence of seven or fewer posterior midventral columns of scales, presence of a pair of posterior ventral plates, and the presence of several columns of spined scales between the ventral ciliary bands and the smooth scales of dorsum and sides.

Keywords: freshwater streams, morphology, Pacific Northwest, speciation

Gastrotrichs are small (60–3500 µm), vermiform or tenpin-shaped, acoelomate animals common in most aquatic environments. The Phylum Gastrotricha includes nearly 900 species divided into two orders: Chaetonotida and Macrodasyida. The Order Chaetonotida includes 38 genera and over 470 species, of which just over three-quarters occur in freshwater; the remainder occur in marine or brackish water. For an expanded introduction to the phylum, see Kånneby (2016), Kieneke & Schmidt-Rhaesa (2014), Todaro et al. (2019), and WoRMS (2019).

Some 59 freshwater species have been reported from the United States (Kånneby & Weiss 2016, Kånneby & Kirk 2017), but only three species have been reported from the west coast states of Washington, Oregon, and California: *Redudasys neotemperatus* Kånneby & Kirk, 2017 was reported from the Little Nestucca River in western Oregon, and *Chaetonotus chuni* Voigt, 1901 and *Lepidodermella squamata* Dujardin, 1841 were reported from a pond on the University of Washington campus in Seattle, Washington (Hatch 1939).

Materials and Methods

Sediment and occasional limited samples of aquatic moss were collected more or less throughout the year, depending in

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part on weather and stream flow (high water limits collecting), during 2015 through 2016. Eighteen collecting trips were made, eight of which (May through October) yielded the new species. Samples were collected by hand, by use of a mosquito larva dipper (350 ml capacity) on an aluminum handle extensible to 1.6 m, by use of a manual, piston-type aquatic sediment sampler with a tube length of 1 m and a bore diameter of 5.6 cm (manufacturer unknown), or by use of a smaller, manual, piston-type aquatic sediment sampler with a tube length of 42 cm, a bore diameter of 4.6 cm, and a plastic sediment collection jar (220 ml capacity) near the lower end of the tube. Sediment or moss samples were placed with water in 1.1 L self-sealing plastic bags in the field, and transferred to 250 ml or 550 ml plastic deli cups in the lab. Subsamples of sediment or mosses with water were drawn from deli cups with a spoon or a disposable plastic syringe with no needle and placed in 100 × 15 mm plastic Petri dishes. Petri dishes were monitored at irregular intervals for up to 8 wk using a Wild M8 stereo microscope. Single specimens usually were anesthetized with 0.5% or 1% magnesium chloride for examination, but occasionally were examined without anesthesia. Specimens were examined using a Leitz Orthoplan, Nikon Optiphot, or Nikon Microphot FXA microscope, all equipped with differential interference contrast optics. Specimens were photographed using a PAXcam5+ or PAXcam2+ dedicated microscope camera and PAX-it! Imaging Software (©2020). Measurements were made on captured images using PAX-it! software. Drawings were made using Inkscape software. The positions of selected morphological features along the longitudinal axis are reported as percentage units ("U") of the total body length following the convention of Hummon (1974).

This work has been registered in ZooBank with registration number urn:lsid:zoobank.org:act:3AD4AF44-93A4-4784-BAED-FF7ABE2F4144.

Results

Systematic Account

Phylum Gastrotricha Metschnikoff, 1865

Order Chaetonotida Remane, 1925

Suborder Paucitubulatina d'Hondt, 1971

Family Chaetonotidae Gosse, 1864 (sensu Garraffoni et al. 2016)

Subfamily Chaetonotinae Gosse, 1864

Genus *Lepidodermella* Blake, 1933

Lepidodermella weissi, new species

Figs. 1–4, Table 1

Type locality.—Sand pockets among boulders in rapids on the Little Nestucca River, near Pacific City, Tillamook County, State of Oregon, United States; (45°06′59″N; 123°51′23″W). The site is shown in Kånneby & Kirk (2017, Fig. 1).

Other localities.—Sand pockets among boulders in rapids on the Little Nestucca River, near Pacific City, Tillamook County, Oregon, U.S.A. (45°07′02″N, 123°51′52″W); sand pockets in the Little Nestucca River below the mouth of Hiack Creek, Tillamook County, Oregon, U.S.A. (45°05′13″N, 123°47′27″W); and coarse sand behind a small log jam, Nestucca River, Tillamook County, Oregon, U.S.A. (45°17′19″N, 123°30′13″W).

Type material.—Pursuant to Articles 72.5.6 and 73.1.4 of the International Code of Zoological Nomenclature (ICZN), the specimen shown in Figs. 1 and 3 is hereby designated as the holotype of *Lepidodermella weissi*. Other specimens illustrated or described are designated as paratypes. No attempt was made to preserve a specimen as the name-bearing type in part because specimens may be destroyed in the course of examination (e.g., Schwank 1990:22–23), "permanent" microscope slide preparations of freshwater gastrotrichs tend to

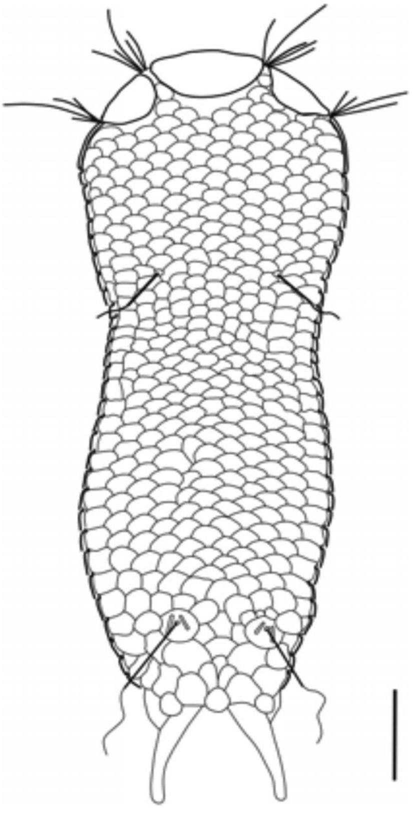

Fig. 1. Drawing of dorsal aspect of *Lepidodermella weissi* holotype. Scale bar = 12 μm.

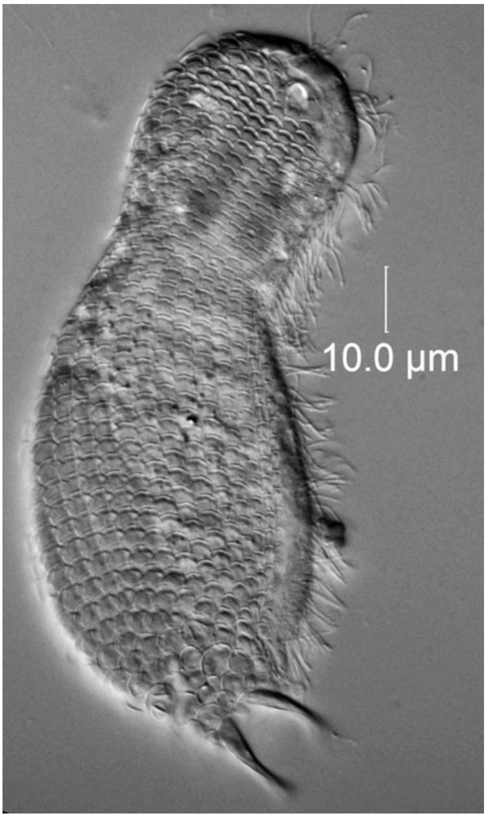

Fig. 2. Photomicrograph of dorsal aspect of *Lepidodermella weissi* paratype showing dorsal scalation typical of the genus *Lepidodermella*.

deteriorate over relatively short periods of time, and modern photomicrography provides high quality images that persist much longer (see Kånneby et al. 2014, Garraffoni et al. 2019, Todaro et al. 2019). In the author's own limited experience, gastrotrichs shipped in ethanol sometimes "disappear" in transit.

Etymology.—Named in honor of Dr. Mitchell J. Weiss, longtime student of gastrotrichs, especially *Lepidodermella*, and mentor to the author upon the latter's entry into the world of gastrotrichs.

Diagnosis.—A small *Lepidodermella* (mean total length = 108 μm; range = 77–143) with a with large head and a stocky body (maximum body width ÷ total length = 0.31). Ventral motor ciliary bands merge anteriorly. Small, keeled, midventral scales in 3–7 longitudinal columns, extending from the pharyngeal area to the posterior ventral plates. Middorsal longitudinal column with 34–42 scales. With 15–24 dorsal plus ventrolateral longitudinal columns of scales. Small, keeled, usually spine-bearing scales in 1–3 ventral longitudinal columns on the trunk, immediately lateral to the ventral motor ciliary bands. Usually with a single pharyngeal tooth. With a single pair of broad, overlapping, posterior ventral plates with offset keels. Without parafurcal spines.

Differential diagnosis.—*Lepidodermella weissi* differs from *Lepidodermella acantholepida* Suzuki, Maeda & Furuya, 2013 in having: (1) a shorter pharynx (22–33 μm versus 37 μm), (2) no anterior transverse ventral plates, (3) more scales per midven-

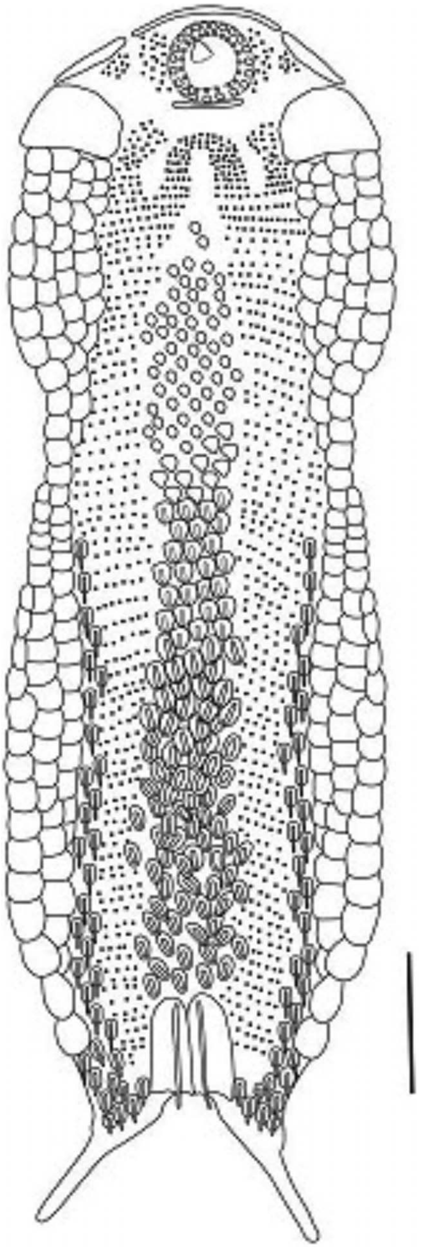

Fig. 3. Drawing of ventral aspect of *Lepidodermella weissi* holotype. Scale bar = 12 μm. The mouth is the round feature at the anterior end; a pharyngeal "tooth" is visible within the mouth. The cephalion is visible just anterior to the mouth. Epipleuria are lateral to the cephalion. The hypopleuria are the largest plates visible on the head. The hypostomion is a narrow, transverse element in contact with the posterior edge of the mouth. Patches of motor cilia (denoted as dots) are visible on either side of the mouth (longer sensory cilia are not shown but can be

tral column (22–28 versus 18), and (4) more columns of dorsal trunk scales (9–15 versus 5–7).

Lepidodermella weissi differs from *Lepidodermella amazonica* Kisielewski, 1991 in having: (1) a shorter total length (77–143 μm versus 199–200 μm), (2) a shorter pharynx (22–33 μm versus 61–65 μm), (3) no anterior transverse ventral plates, (4) more columns of dorsal trunk scales (9–15 versus 5, (5) more dorsal and lateral columns of trunk scales (15–24 versus 17–19), and (6) shorter adhesive tube length (6–13 μm versus 17–19 μm).

Lepidodermella weissi differs from *Lepidodermella aspidioformis* Sudzuki, 1971 in having: (1) fewer columns of dorsal trunk scales (9–15 versus 16), (2) keeled scales between ventral ciliary bands versus none, and (3) a pair of posterior ventral plates versus no such plates.

Lepidodermella weissi differs from *Lepidodermella broa* Kisielewski, 1991 in having: (1) more scales per middorsal column (34–42 versus 18–19, (2) shorter adhesive tubes (6–13 μm versus 13–15 μm), (3) a narrower cephalion (9–14 μm versus 16–18 μm, (4) midventral scales (absent in *L. broa*), and (5) more dorsal and lateral columns of trunk scales (15–24 versus 10–12).

Lepidodermella weissi differs from *Lepidodermella forficulata* Schwank, 1990 in having: (1) more dorsal trunk scale columns (9–15 versus 5–7), (2) more dorsal and lateral scale columns (15–24 versus 9–13), (3) shorter adhesive tubes (6–13 μm versus 20–22 μm), (4) shorter furca (11–18

←

seen in Fig. 1). The motor cilia bands divide into two "fingers" at their anterior ends; the medial "fingers" merge medially; the lateral fingers end opposite the hypopleura. Midventral, keeled scales occupy the interciliary field, with keels posteriorly and no or small keels anteriorly. Large keeled terminal plates overlap at the posterior end. One or more narrow columns of keeled, spined scales occur lateral to the motor cilia, and extend from the furcal base to about halfway to the head.

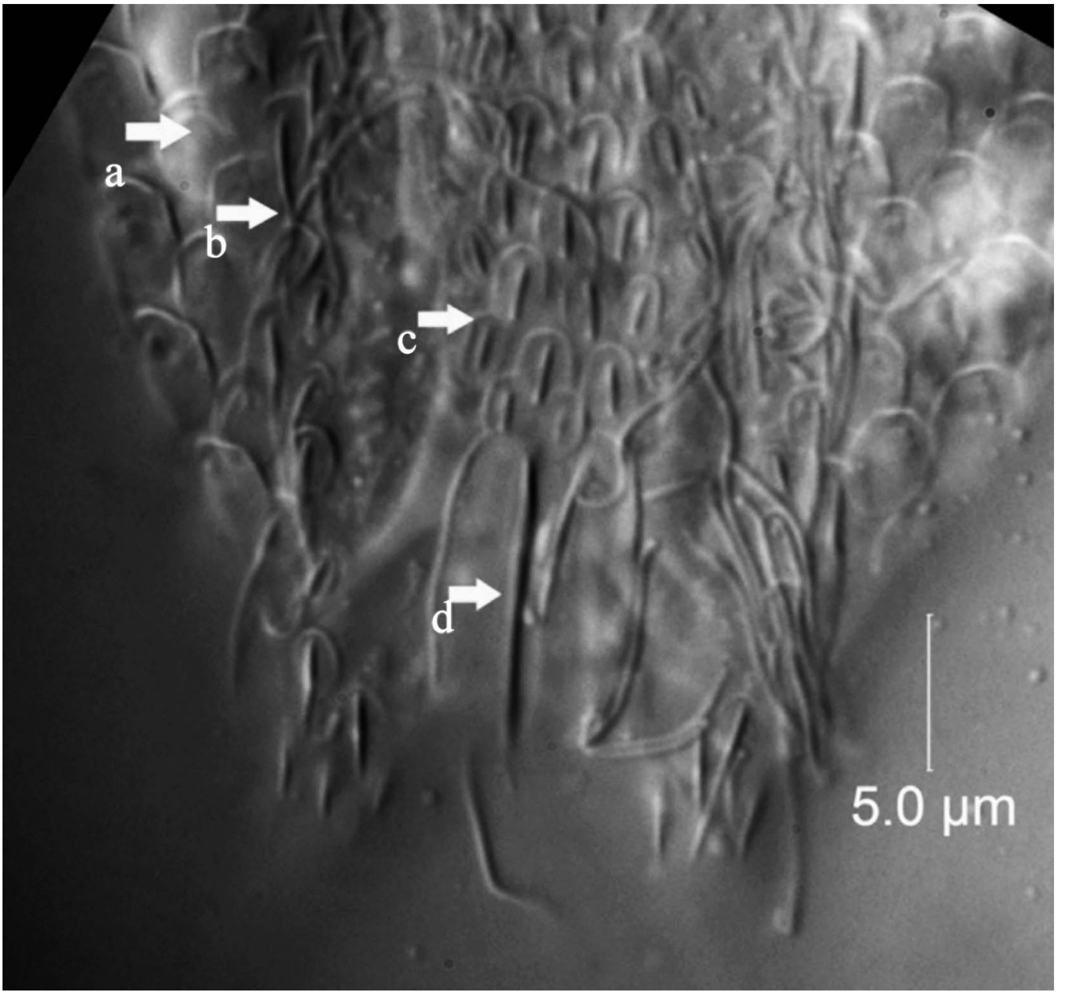

Fig. 4. Photomicrograph (DIC) of posterior ventral aspect of *Lepidodermella weissi* paratype: (a) ventrolateral trunk scales, (b) spined, keeled scales medial to ventrolateral trunk scales, (c) keeled midventral scales, and (d) a pair of large, posterioventral plates. Note motor cilia insertion points on the left (specimen's right) side between the spined scales and the keeled, midventral scales.

µm versus 30 µm), and (5) parafurcal spines absent versus present.

Lepidodermella weissi differs from *Lepidodermella intermedia* Kånneby, Todaro & Jondelius, 2011 in having: (1) parafurcal spine absent versus present, and (2) interciliary area with elliptical, keeled scales versus round smooth scales.

Lepidodermella weissi differs from *Lepidodermella limogenum* Schrom, 1972 in inhabiting freshwater versus salt water and in having: (1) parafurcal spine absent versus present, and (2) interciliary area covered with elliptical, keeled scales versus round, smooth scales.

Lepidodermella weissi differs from *Lepidodermella macrocephala* d'Hondt, 1971 in having: (1) a pharynx length of 22–36 µm versus 45 µm, (2) a maximum head width of 22–36 µm versus 45 µm, (3) 9–15 dorsal trunk scale columns versus 8, (4) a furca length of 11–18 µm versus 24 µm, and (5) an adhesive tube length of 6–13 µm versus 18 µm.

Table 1.—Morphometrics of *Lepidodermella weissi*. Measurements in micrometers.

Character	$\bar{X}$	Range	*n*
Total length	108.1	77.2–142.5	22
Maximum head width	29.3	22.5–35.3	21
Minimum neck width	23.7	16.9–31.2	21
Maximum trunk width	33.6	22.3–49.0	22
Prefurcal width	15.8	12.9–18.4	19
Pharynx length	26.7	22.3–32.3	21
Anterior maximum pharynx width	10.9	8.3–14.1	21
Middle minimum pharynx width	9.9	6.6–12.7	21
Posterior maximum pharynx width	12.7	9.0–16.5	21
Location of pharynx-intestine junction	U28	U22–U35	20
Location of anterior sensory cilia	U28	U24–U31	9
Location of posterior sensory cilia	U80	U75–85	18
Location of anus	U83	U79–U86	13
Furca length	14.1	11.2–17.7	17
Adhesive tube length	9.4	6.3–12.1	19
Outside mouth diameter	6.5	3.1–13.8	16
Mouth opening diameter	4.2	2.2–8.4	16
Number of mouth folds	21	20–21	15
Scales per longitudinal middorsal column	37	34–42	18
Scales per transverse dorsal head row	13	9–17	18
Scales per transverse dorsal trunk row	11	9–15	16
Total scales per transverse trunk row	18	15–24	18
Scales per longitudinal midventral column	25	22–28	5
Maximum scales per transverse midventral row	5	3–7	13
Cephalion width	11.1	9.0–13.4	13
Epipleurion width, dorsal view	8.0	5.9–9.4	11
Hypopleurion width, dorsal view	8.5	5.7–12.2	6
Hypostomion transverse member length	3.9		1
Hypostomion longitudinal member length	2.7		1
Posterior ventral plate length	9.6	8.0–11.6	14
Posterior ventral plate width	4.2	3.0–5.6	12

Lepidodermella weissi differs from *Lepidodermella minor chaetifer* Kisielewski, 1991 in having: (1) 34–42 scales per middorsal column versus 30–31, (2) 15–24 dorsal and ventrolateral longitudinal columns versus 13–15, (3) 34–42 scales per middorsal column versus 30–31, and (4) parafurcal spine absent versus present.

Lepidodermella weissi differs from *Lepidodermella minor minor* (Remane, 1936) in having: (1) midventral scales with keels versus without keels, and (2) Kisielewski's (1991) "ratio of scale distribution" of 49% versus 50–63% (number of columns of scales, counted from one ciliary band around the dorsum to the other ciliary band, divided by the number of scales in the median dorsal column, and expressed as a percentage).

Lepidodermella weissi differs from *Lepidodermella polaris* Kolicka, Kotwicki, & Dabert, 2018 in having: (1) no transverse plates posteriolateral to the hypostomion versus having those plates, (2) a single pair of posterior ventral plates versus two pair, and (3) no transverse ventral plates versus transverse ventral plates in the pharyngeal area.

Lepidodermella weissi differs from *Lepidodermella serratum* Sudzuki, 1971 in having keeled midventral scales versus none.

Lepidodermella weissi differs from *Lepidodermella spinifera* Tretjakova, 1991 in having: (1) 3–7 midventral columns of scales versus 8–16, (2) 22–28 scales per midventral column versus 60, (3) adhesive tube length 6–13 μm versus 20–23 μm, (4) furca length 11–18 versus 27, (5) dorsal trunk scales with smooth edges versus jagged lateral edges, (6) parafurcal spines absent versus present, and (7) ventral base of each caudal appendage without a large lamella versus the ventral base of each caudal appendage covered by a large lamella.

Lepidodermella weissi differs from *Lepidodermella squamata* (Dujardin, 1841) in having: (1) 34–42 scales per middorsal column versus 25–30, (2) anterior ventral plates absent versus present, (3) adhesive tube length 6–13 μm versus 13–19 μm, (4) hypostomion not visible or a single transverse bar versus a pair of bumps, (5) furca length 11–18 μm versus 18–27 μm, and (6) 9–15 scales per transverse dorsal trunk row versus 7–9.

Lepidodermella weissi differs from *Lepidodermella tabulata* Preobrajenskaja, 1926 in having: (1) adhesive tube length of 6–13 μm versus 3 μm, (2) 34–42 scales per longitudinal middorsal column versus 50, and (3) furcal scales extending to the base of adhesive tubes versus not extending to the base of adhesive tubes.

Lepidodermella weissi differs from *Lepidodermella trilobum* (Brunson, 1950) in having: (1) pharynx length of 22–33 μm versus 50 μm, (2) head five-lobed with two pairs of anterior sensory cilia tufts versus a three-lobed head with a single pair of anterior sensory cilia tufts, (3) total length 77–143 μm versus 177 μm, (4) prefurcal width of 11–19 μm versus 19 μm, and (5) furca length 11–18 μm versus 20 μm.

Lepidodermella weissi differs from *Lepidodermella zelinkai* (Konsuloff, 1913) in having: (1) visible midventral scales and keels versus only keels visible, (2) 3–7 midventral scale columns versus 20 midventral keel columns, (3) furcal notch broad, shallow, and not sharp anteriorly versus furcal notch deep, narrow, and with a sharp anterior end; (4) spined trunk scales between the ventral cilia bands and ventrolateral smooth scales versus no such spined scales, and (5) posterior ventral plates wide and overlapping versus narrow and not touching.

Description.—Morphometrics are described below, and most are summarized in Table 1.

I. Head: The maximum head width exceeds the maximum trunk width in some specimens. The head is rounded (virtually a partial circle in a compressed specimen). The hypopleuria (see Figs. 1 and 3) are sometimes difficult to see from above. When measured from above or below, the epipleuria average 8 μm in length (5–10 μm, $n = 11$), and the hypopleuria also average 8 μm in length (5–13 μm, $n = 6$). When measured from the side ($n = 2$), the epipleuria average 8 μm in length (7–10 μm), 9 μm in height (7–11), and 51 μm^2 in area (38–64); the hypopleuria average 9 μm in length (6–12), 8 μm in height (5–11), and 58 μm^2 in area (27–89). The width of the cephalion and the lengths of the pleuria viewed from above or below vary with the position of the focal plane along the z-axis. Tufts of at least four sensory cilia (see Fig. 1) arise from between the cephalion and each epipleurion, and from between each epipleurion and its associated hypopleurion. Each tuft includes approximately equal numbers of cilia in two size classes: short, averaging 5 μm (4–7), and long, averaging 13 μm (11–15). In a living animal, the long cilia arising between the cephalion and each epipleurion are typically carried extended in a sagittal plane and directed forward at an angle of 5–65° from the animal's extended midline, and those arising between each epipleurion and hypopleurion are typically carried extended slightly forward in the same plane and at an angle of 60–90° from the animal's extended midline.

II. Hypostomion: The hypostomion, without stain, appears as a narrow, transverse structure immediately posterior to the mouth. Stained with 2% aceto-

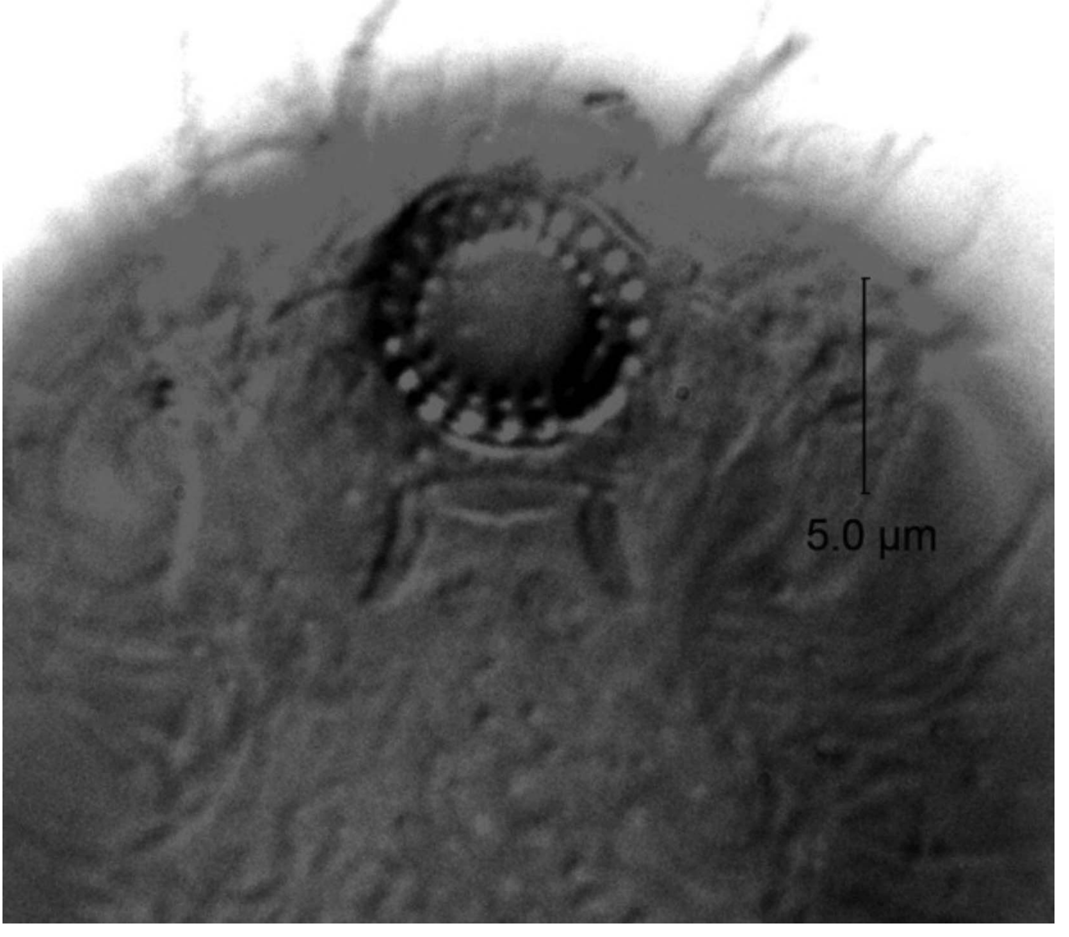

Fig. 5. Photomicrograph (DIC) of ventral aspect of *Lepidodermella weissi* paratype showing the hypostomion with an anterior transverse element and a pair of lateral longitudinal elements. Specimen stained with 2% aceto-orcein. Without staining, the horizontal element generally appears narrower and the longitudinal elements generally are invisible or barely visible.

orcein (Weiss 2001), the hypostomion is seen to consist of an anterior transverse element, with a longitudinal element extending posteriorly from each end of the transverse element (Fig. 5). In some cases evidence of the longitudinal elements is visible without staining, but the elements are clear only when properly stained (obscured if over-stained). The transverse element is fusiform, straight, and measures about 1.1 × 3.9 µm. The anterior end of each longitudinal element touches a lateral end of the transverse element; each lateral element is fusiform and slightly curved (describing an arc of a circle with its center lateral to the element and a radius of 2–5 µm), and measures about 0.7 × 2.7 µm.

III. Dorsal Scales: Dorsal scales (see Figs. 1 and 2) average 13 longitudinal columns on the head (9–17, $n = 18$), and 11 longitudinal columns on the trunk (9–15, $n = 16$). Dorsal plus ventrolateral trunk scales average 18 longitudinal columns (15–24, $n = 18$). The number of scales per middorsal longitudinal column, counting posteriorly to the furcal notch, averages 37 µm (34–42, $n = 18$). Dorsal scale width generally increases from 3–4 µm anteriorly to 4–5 μm posteriorly. Dorsal scale width also increases from 2–3 μm ventrolaterally to 4–5 μm dorsally. Lateral scale length generally increases from 1–3 μm anteriorly to 1–5 μm posteriorly. Measurement of middorsal scale lengths with the scales in place is difficult because the scales overlap and their posterior margins tend to be obscured. However, one image allowed some measurements, which showed that middorsal, midtrunk scales averaged 5.4 μm long (5.0–5.8, $n = 6$ scales) and 5.0 μm wide (4.8–5.2, $n = 6$ scales). Dorsal scales are wider than long on the head, but longer than wide on the posterior trunk. The dorsal scales posterior to the transverse row immediately anterior to the double-keeled scales ("posterior dorsal scales") are arranged in a pattern that differs from the more anterior dorsal scales (Fig. 1) but which is consistent among all individuals in which the posterior dorsal scales could be studied. Whether that scale pattern is unique to this species remains to be seen.

IV. Spined Scales: On the trunk, immediately lateral to each ventral band of cilia, is a band of one to three, but usually two, narrow longitudinal columns of small scales that bear keels and spines (Figs. 3, 4). Each band appears to continue posteriorly onto the ventral surface of the base of the furcal branch, which bears two transverse rows of small, keeled and spined scales. In one specimen the scales appeared to be keeled with very short or no spines. The spined scales tend to be larger posteriorly with longer spines, are reduced to a single column on the anterior trunk, and do not extend into the neck constriction. The spined scales in the marginal column tend to be smaller and more rounded than those of the other column(s); the latter resemble smaller, narrower versions of the spineless ventrolateral scales.

V. Sensory Cilia: A pair of anterior sensory cilia are located at U28 (U24–U31, $n = 9$), and a pair of posterior sensory cilia are located on double-keeled scales at U80 (U75–U85, $n = 18$). The anterior sensory cilia average 10.2 μm in length (4.8–21.1, $n = 13$); the thicker proximal section averages 6.2 μm in length (5.4–7.6, $n = 3$). The posterior sensory cilia average 12.7 μm in length (8.2–22.0, $n = 14$); the thicker proximal section averages 8.0 μm in length (6.0–10.1, $n = 2$).

VI. Pharynx: Pharynx length averages 27 μm (22–33, $n = 21$). The maximum anterior pharynx width averages 11 μm (8–15, $n = 21$). The minimum mid-pharynx width averages 10 μm (6–13, $n = 21$). The maximum posterior pharynx width averages 13 μm (9–17, $n = 21$). The slight anterior widening and greater posterior widening of the pharynx are consistently present. When stained with 2% aceto-orcein, longitudinal bands are visible in both the posterior and anterior pharyngeal swellings; band length in one specimen averaged 4.1 μm (4.0–4.4) and width averaged 0.6 μm (0.4–0.7). These bands are sometimes faintly visible without staining.

VII. Ventral Plates and Scales: A single pair of posterior ventral plates (see Figs. 3 and 4) average 10 μm in length (8–12, $n = 14$) and 4 μm in width (3–6, $n = 12$). The plates bear keels and short spines. The plates almost always overlap medially, and the keels are offset so that the distance from keel to margin is greater on the lateral side than on the medial side of each plate. Anterior to the plates are keeled midventral scales which consistently extend anteriorly to the pharyngeal area, and in some specimens can be seen as far forward as just posterior to the hypostomion. The midventral scales are sometimes rounded anteriorly, but are always ellipsoidal on the mid- and posterior trunk. The more anterior midventral scales often lack the distinct keels visible in the more posterior scales. The number of scales in a midventral longitudinal column averages 25 (22–28, $n = 5$), and the number of columns averages 5 (3–7, $n = 13$).

VIII. Digestive Tract: The pharynx-intestine junction is located at U28 (U22–

U35, $n = 20$). The ventral anus is located at U83 (U79–U86, $n = 13$). The outside diameter of the subterminal mouth averages 6 μm (3–14, $n = 16$), and the diameter of the mouth opening averages 4 μm (2–9, $n = 16$). The average number of folds around the mouth periphery is 21 (20–21, $n = 15$). A single pharyngeal tooth (Kisielewski 1991) projects from the mouth opening in most individuals.

IX. Ventral Cilia: A band of ventral motor cilia originates on each side in the area lateral to the anterior half of the posterior ventral plates, and extends anteriorly into the pharyngeal area, where the band divides into two fingers which extend anteriorly to U9 (U8–U10, $n = 5$). The medial finger of each band arches mediad and merges with the opposite medial finger at the centerline (see Fig. 3). Cilia from the posterior ends of the cilia bands may extend posteriorly and give the appearance of a more posterior origin, but the cilia insertion points are located opposite the anterior half of the posterior ventral plates. In addition to the ventral bands of cilia, patches of cilia are located on either side of the mouth.

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