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New species and records of deep-water Orbiniidae (Annelida, Polychaeta) from the Eastern Pacific continental slope, abyssal Pacific Ocean, and the South China Sea

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Abstract

Eighteen species of Orbiniidae, 15 new to science, are reported from deep-sea habitats in the Pacific Ocean and the South China Sea. The collection includes specimens from continental slope and abyssal soft sediments as well as hydrothermal vent and methane seep sites. New collections of *Califia calida* Hartman, 1957, *Naineris uncinata* Hartman, 1957, and *Phylo nudus* (Moore, 1911) allow redescription and new distributional records of these species to be documented. Five species of *Leitoscoloplos*: *L., cliffordi* **n. sp.**, *L. gordaensis* **n sp.**, *L. lunulus* **n. sp.**, *L. sahlingi* **n. sp.**, and *L. williamsae* **n. sp.** are described together with a new species of *Berkeleyia*, *B. lelievre* **n. sp.**, two new species of *Scoloplos*: *S. californiensis* **n. sp.** and *S. sparsaciculus* **n. sp.**, and a new species of *Leodamas*, *L. bathyalis* **n. sp.** In addition, six new species of *Orbiniella* are described: *O. abyssalis* **n. sp.**, *O. eugeneruffi* **n. sp.**, *O. grasslei* **n. sp.**, *O. longilobata* **n. sp.**, *O. rugosa* **n. sp.**, and *O. tumida* **n. sp.**

Key words: Gorda Ridge, East Pacific Rise, Cascadia Subduction Zone, Clarion-Clipperton Fracture Zone, hydrothermal vents, methane seeps, *Berkeleyia*, *Califia*, *Leodamas*, *Leitoscoloplos*, *Naineris*, *Orbiniella*, *Phylo*, *Scoloplos*

Introduction

Polychaetes of the family Orbiniidae are often among the dominant species of benthic communities of nearshore and continental shelf habitats. However, in deep-sea habitats, orbiniids are rarely encountered and poorly known.

Blake (2017) reviewed most of the key literature on orbiniids, updated the definitions of ten genera, and reported on 44 species including 21 new species. Although several species reported by Blake (2017) were from deep-sea habitats, there have been few reports on lower slope and abyssal orbiniids. To date, out of more than 225 known species of Orbiniidae, only about 40 occur in depths greater than 500 m and only about 13 occur deeper than 3000 m.

In the present study, orbiniid collections from slope and abyssal habitats from the Pacific Ocean and South China Sea accumulated over many years are reported. Samples include specimens from hydrothermal vents on the East Pacific Rise at 21°N, the Gorda Ridge, Juan de Fuca Ridge, hydrate seeps off Oregon, continental slope and rise sites off northern California, abyssal sites off Costa Rica, the abyssal manganese nodule sites of the Clarion-Clipperton Fracture Zone in the equatorial North Pacific Ocean, and soft sediments off Brunei, in the South China Sea. Eighteen species from these collections are reported, 15 of which are new to science. The following species are included in this study:

Leitoscoloplos cliffordi **n. sp.** California continental slope, 2600–3136 m.
Leitoscoloplos gordaensis **n. sp.** Hydrothermal vents off California, Gorda Ridge, Escanaba Trough, 3271 m.
Leitoscoloplos lunulus **n. sp.** California continental slope, 1020–1760 m.
Leitoscoloplos sahlingi **n. sp.** Oregon, Cascadia Subduction Zone, 786 m.
Leitoscoloplos williamsae **n. sp.** California continental slope, 1760 m.
Berkeleyia lelievrei **n. sp.** British Columbia, Juan de Fuca Ridge, Endeavour Segment, 2196 m.
Califia calida Hartman, 1957. Eastern Pacific, Oregon to Mexico, continental slope, 430–2730 m; South China Sea, off Brunei, 1127–1487m.
Naineris uncinata Hartman, 1957. Alaska to California, continental slope, 500–800 m.
Phylo nudus (Moore, 1911). California to Costa Rica, continental slope, 400–3503 m.
Scoloplos californiensis **n. sp.** California continental slope, 1730–1880 m.
Scoloplos sparsaciculus **n. sp.** South China Sea, off Brunei, 1219–1955 m.
Leodamas bathyalis **n. sp.** South China Sea, off Brunei, 1260–1557 m.
Orbiniella abyssalis **n. sp.** Clarion-Clipperton Fracture Zone, equatorial North Pacific Ocean, 4844–4880 m.
Orbiniella eugeneruffi **n. sp.** South China Sea, off Brunei, 1199–1260 m.
Orbiniella grasslei **n. sp.** Hydrothermal vents, East Pacific Rise at 21°N, 1618–2616 m.
Orbiniella longilobata **n. sp.** South China Sea, off Brunei, 1199–2004 m.
Orbiniella rugosa **n. sp.** South China Sea, off Brunei, 1199–2194 m.
Orbiniella tumida **n. sp.** California continental slope, 1730–3221 m.

Materials and methods

Materials examined as part of this study. The materials on which this study is based come from a variety of sources: (1) benthic samples collected and analyzed as part of long-term monitoring at the San Francisco Deep-Ocean Disposal Site (SF-DODS) conducted from 1996–2017, and a few specimens from baseline surveys in the same general area conducted by the U.S. EPA (102 survey, 1991) and the U.S. Navy (103 surveys, 1990 and 1991); (2) hydrothermal vents on the East Pacific Rise at 21°N collected by the late Dr. J. F. Grassle in 1982 (WHOI); (3) Samples from the Escanaba Trough, Gorda Ridge, collected by Dr. Grassle in 1988; (4) benthic samples from hydrate seeps on the Cascadia Subduction Zone collected by the late Dr. Heiko Sahling (Geomar) in 1999 and by Dr. Greg Rouse (SIO) in 2010; (5) a few specimens from hydrothermal vents on the Juan de Fuca Ridge collected by Dr. Yann Lelièvre (Université de Montréal) in 2015, (6) collections by the R/V *Vema*, from off Costa Rica in 1958; (7) collections from manganese nodule sites at the Clarion-Clipperton Fracture Zone collected by Dr. Dwight D. Trueblood as part of the NOAA Benthic Impact Experiment (BIE) in 1993–1994; and (8) samples from deep-water off Brunei, Island of Borneo collected as part of surveys in 2011 managed by the author from sites intended for oil and gas exploration and development.

Specimens collected as part of these projects are deposited in the California Academy of Sciences, Department of Invertebrate Zoology, San Francisco, California (CASIZ), Los Angeles County Museum of Natural History, Los Angeles, California (LACM-AHF Poly), Museum of Comparative Zoology, Harvard University, Massachusetts (MCZ), Scripps Institution of Oceanography, San Diego, California (SIO-BIC) the National Museum of Natural

History, Smithsonian Institution, Washington, D.C. (USNM), and a few specimens retained by the author (JAB). A reference collection of polychaetes from off Brunei is also being prepared for the University of Brunei, Darussalam (UBD).

Most of the materials used in this study were originally fixed in 5–10% formalin and preserved in 70–80% ethyl alcohol (ETOH) for long-term storage. Parts of several specimens of *Naineris uncinata* collected by Dr. Greg Rouse were separately fixed in 95% ETOH at the time of collection and used for gene sequencing. GenBank accession numbers are provided for those samples.

Morphological observations. All specimens were examined using a Wild M-5 stereomicroscope and a Zeiss RA research microscope equipped with phase contrast and Nomarski differential interference optics. Photomicrographs were taken with a Nikon D7100 camera mounted on both the stereo- and compound microscopes. For observation, specimens were first stained with a solution of Shirlastain A in water to highlight difficult-to-see surficial morphology. Some specimens were stained with a saturated solution of Methyl Green (MG) in 70% ETOH in order to elucidate distinct staining patterns of subdermal glands evident on some species as well as highlighting surficial morphology. Line drawings were first sketched in pencil using a drawing tube or *camera lucida* on the Zeiss RA and later transferred to Dura-Lar® matte film and inked.

Abbreviations used on figures: ac, acicula; acSp, acicular spine; an, anus; anC, anal cirrus; br, branchia; bv, blood vessel; irP, interramal process; neL, neuropodial lamella; neP, neuropodium; noL, notopodial lamella; noP, notopodium; mo, mouth; nuO, nuchal organ; per, peristomium; pr, prostomium; pyg, pygidium; subPFla, subpodial flange; subPL, subpodial lamella; vC, ventral cirrus.

Systematic account

Family Orbiniidae Hartman, 1942

Type genus: *Orbinia* Quatrefages, 1866, designated by Hartman, 1942.

Remarks. The family as defined by Blake (2017) largely follows that of Hartman (1957). There are approximately 20 genera of Orbiniidae, some of which are rare or poorly known (Blake 2017; Bleidorn & Helm 2019). Of these, only seven genera contain species from depths exceeding 2000 m: *Berkeleyia*, *Califia*, *Leitoscoloplos*, *Microrbinia*, *Orbiniella*, *Phylo*, and *Scoloplos*. Most species of *Berkeleyia*, *Microrbinia*, and *Califia* are from deep-water habitats, whereas *Leitoscoloplos*, *Orbiniella, Phylo*, and *Scoloplos* contain species from all depths.

Subfamily Orbiniinae Hartman, 1957. Emended by Blake 2000.

Type genus. *Orbinia* Quatrefages, 1866, designated by Hartman 1957.

Diagnosis. (after Blake 2017). Body large, with distinct regions; parapodia lateral in thoracic region, typically shifted dorsally in abdominal region. Prostomium bluntly rounded to acutely pointed; nuchal organs present; eyespots present or absent. Peristomium with 1–2 achaetous rings, separated from prostomium. Noto- and neuropodial postsetal lamellae simple single lobes to multiple lobes, sometimes branched; subpodial lobes and stomach papillae present or absent; interramal cirri present or absent. Setae including aciculae, capillaries, furcate setae, spines, uncini, modified spear-like setae, and flail setae. Branchiae typically present, rarely absent; branchiae usually single, rarely branched; oval to flattened, with two longitudinal rows of cilia and two blood vessels connected by numerous capillaries; branchiae of abdominal region thinner, more elongate than on thorax. Pygidium with several long filamentous anal cirri, or cirri absent.

Inclusive genera. *Berkeleyia, Califia, Leitoscoloplos, Leodamas, Naineris, Orbinia, Phylo, Protoaricia, Schroederella, Scoloplella, Scoloplos*, and *Uncorbinia.*

Remarks. The subfamily Orbiniinae contains most of the commonly recognized genera and species of Orbiniidae.

Genus *Leitoscoloplos* Day, 1977

Type-species: *Haploscoloplos bifurcatus* Hartman, 1957, designated by Day 1977.

Diagnosis. (after Blake 2017) Prostomium pointed, conical; peristomium typically with one achaetous ring, but with additional superficial annulae on some species. Branchiae lacking, or present from posterior thoracic, transitional, or abdominal setiger. Posterior thoracic setigers with 0–2 postsetal lobes and 0–2 subpodial lobes; abdominal setigers with 0–4 subpodial papillae; stomach papillae rare, interramal cirri present or absent. Thoracic neurosetae only crenulated capillaries. Without abdominal neuropodial spines, with 2–3 imbedded aciculae present or absent. Notopodial furcate setae present or absent in abdominal segments.

Remarks. Blake (2017) referred 27 species to *Leitoscoloplos*. Five new species of *Leitoscoloplos*: *L., cliffordi* **n. sp.**, *L. gordaensis* **n. sp.**, *L. lunulus* **n. sp.**, *L. sahlingi* **n. sp.**, and *L. williamsae* **n. sp.** have been discovered from deep-water habitats in the northeastern Pacific and are here described. These five new species bring the total number of known species of *Leitoscoloplos* to 32. Four of the new species belong to the *L. kerguelensis* (McIntosh, 1885) group as defined by Blake (2017), in which the branchiae begin on an anterior abdominal segment. The fifth species, *L. sahlingi* **n. sp.**, is in a group that includes *L. pugettensis* (Pettibone, 1957), in which branchiae are first present from a posterior thoracic segment.

Seven species of *Leitoscoloplos* occur along the continental margin of the northeastern Pacific Ocean in depths of about 750 m or greater. In order to help readers separate these deep-water species, a key is presented here. Additional data on deep-water *Leitoscoloplos* from a global perspective is presented in the Discussion at the end of this paper.

Key to deep-water species of *Leitoscoloplos* from the Eastern Pacific

1A. Branchiae first present from a posterior thoracic setiger 2
1B. Branchiae first present from an anterior abdominal setiger 3
2A. With 12 thoracic setigers; branchiae from setiger 10; abdominal neuropodium with rounded tip and short ventral cirrus, subpodial flange absent; abdominal notopodia elongate, tapering to narrow tip; branchiae symmetrical, typically triangular, tapering to papillate tip . . . . . *Leitoscoloplos sahlingi* **n. sp.**
2B. With 14 thoracic setigers; branchiae from setigers 11–12; abdominal neuropodium with bi-lobed tip; subpodial flange present; abdominal notopodia elongate, with subdistal swelling; branchiae asymmetrical. . *Leitoscoloplos mexicanus* (Fauchald, 1972)
3A. Pre-setiger region long, narrow, triangular, longer than wide 4
3B. Pre-setiger region short, as wide as or wider than long 5
4A. Furcate setae present; branchiae from setiger 15–16; thoracic noto- and neuropodial postsetal lamellae short, triangular, tapering, arising from low base; abdominal neuropodia without subpodial flange . . . . . .*Leitoscoloplos cliffordi* **n. sp.**
4B Furcate setae absent; branchiae from setiger 17–18; thoracic noto- and neuropodial postsetal lamellae long, digitiform, arising from broadly rounded base; abdominal neuropodia with protruding subpodial flange . . . . . *Leitoscoloplos williamsae* **n. sp.**
5A. Prostomium distinctly separated from peristomium by groove; branchiae elongate, smooth, triangular, tapering to narrow tip 6
5B. Prostomium merging posteriorly with peristomium; branchiae short, thick, with glandular appearance . . . . . .*Leitoscoloplos pachybranchiatus* Blake & Hilbig, 1990
6A Thoracic notopodial postsetal lamellae triangular; abdominal neuropodia with blunt tip with two weakly developed lobes, ventral cirrus absent; subpodial flange absent . . . . . *Leitoscoloplos gordaensis* **n. sp.**
6B. Thoracic notopodial postsetal lamellae elongate, digitiform, arising from swollen base; abdominal neuropodia with rounded tip and subterminal ventral cirrus; subpodial flange present . . . . . *Leitoscoloplos lunulus* **n. sp.**

Leitoscoloplos cliffordi new species

Figures 1–2
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Leitoscoloplos sp. 1 and sp. 5: Blake *et al*. 2009: Table B1.

Material examined. Continental slope off northern California, **west of Farallon Islands, SF-DODS Benthic Monitoring Program**, Sta. 7, coll. 30 Oct 1997, 37°39.99′N,123°28.00′W, 2820 m, **holotype** (LACM-AHF Poly 11654); Sta. 2, 11 Dec 1996, 37°41.01′N, 123°29.90′W, 2600 m, **paratype** (LACM-AHF Poly 11655); Sta. 10, 26 Sep 2003, 37°40.00′N, 123°30.98′W. 2736 m, 1 **paratype** (CASIZ 234026); Sta. 16, 28 Aug 2016, 37°38.0111′N,

123°26.9950′W, 2753 m, 1 **paratype** (CASIZ 234034); Sta. 23, 10 Dec 1996, 37°37.13′N, 123°29.08′W, 2950 m, **paratype (**LACM-AHF Poly 11656); Sta. 27, 27 Jun 2015, 37°41.0072′N, 123°32.0183′W, 2750 m, 1 **paratype** (CASIZ 234035); Sta. 64, 25 Sep 2002, 37°36.01′N, 123°33.01′W, 3136 m, 2 **paratypes**.(CASIZ 234030); Sta. 116, 13 July 2007, 37°17.537′N, 124°09.192′W, 2908 m, 2 **paratypes (**LACM-AHF Poly 11657).

Non-type material. Sta. 2, 28 June 2015, 37°41.0060′N, 123°30.0152′W, 2560 1 specimen (CASIZ 234042); Sta. 6, 22 Sep 2002, 37°40.02′N, 123°27.00′W, 2697 m, 1 specimen (CASIZ 234053); Sta. 6, 15 Sep 2005, 37°40.004′N, 123°27.002′W, 2692 m, 1 specimen (CASIZ 234049); Sta. 9, 30 Oct 1997, 37°40.04′N, 123°29.98′W, 2927 m, 1 specimen (CASIZ 234043); Sta. 11, 28 Sep 2017, 37°38.9993′N, 123°30.9960′W, 3109m, 1 specimen (MCZ 153559); Sta. 17, 24 Sep 2003, 37°38.05′N, 123°27.94′W, 2750 m, 1 specimen (CASIZ 234050); Sta. 17, 27 Sep 2006, 37°37.960′N, 123°28.005′W, 2789 m, 1 specimen (MCZ 153560); Sta. 17, 27 Sep 2017, 37°38.009′N, 123°27.9995′W, 2827 m, 2 specimens (MCZ 153561); Sta. 23, 26 Sep 2002, 37°36.95′N, 123°29.02′W, 2954 m, 1 specimen (CASIZ 234045); Sta. 27, 16 Oct 2000, 37°40.97′N, 123°31.98′W, 2740 m, 1 specimen (CASIZ 234044); Sta. 57, 16 Oct 2000, 37°42.99′N, 123°32.99′W, 2650 m, 1 specimen (CASIZ 234051); Sta. 92, 14 Sep 2005, 37°44.943′N, 123°34.825′W, 2819 m, 1 specimen (MCZ 153562); Sta. 92, 21 Jun 2015, 37°45.0085′N, 123°35.0063′W, 2800 m, 1 specimen (MCZ 153563).—**US Navy 103 Site Selection survey**, R/V *Wecoma* Sta. B-5, 20 Jul 1991, 37°38.94′N, 123°28.81′W, 2925 m, 1 specimen (CASIZ 234047).

Description. A moderate-sized species, holotype complete, 20 mm long, 1.2 mm wide across thoracic segments and 0.75 mm across middle segments for about 90 setigers; paratypes all incomplete, up to 20 mm long and 1.7 mm wide across thoracic segments for approximately 90 setigers. Body elongate, with thoracic region widest, gradually narrowing posteriorly. Thoracic segments about twice as wide as long, each separated by distinct segmental groove dorsally elevated into an intersegmental transverse ridge producing a biannulate segmental pattern (Figs. 1A, 2A), best developed in large specimens, continuing on to anterior abdominal segments (Fig. 2B, arrows); intersegmental groove not as well developed ventrally (Fig. 2A). Laterally and ventrally, abdominal segments develop a narrow intersegmental annular ring anterior to larger segmental ring continuing ventrally between neuropodia (Fig. 2B–C, arrows). Middle and posterior segments about twice as wide as long. Shallow mid-ventral groove present from anterior segments to near posterior end (Fig. 2A). Color in alcohol: light tan; holotype and large paratypes with dorsal brown pigment across middle and posterior segments.

Pre-setiger region about as long as first two setigers, triangular in shape, narrowing anteriorly (Figs. 1A, 2A). Prostomium triangular, narrowing to pointed apex (Figs. 1A, 2A); nuchal organs short oval slits on posterior lateral margin, eyespots absent. Peristomium composed of one achaetous ring, but with weakly developed lateral grooves sometimes evident (Figs. 1A, 2A), none crossing dorsum; posterior margin weakly extending on to setiger 1 (Fig. 1A).

Thorax with nine setigers followed by 1–2 transitional setigers; boundary between last thoracic and first abdominal setiger demarcated by loss of most neurosetae and increase in size of neuropodial lobe on setigers 10–12. Thoracic notopodial and neuropodial lobes digitiform, relatively short, both similar in form (Fig. 1B); abdominal notopodia of anterior abdominal segments becoming narrower, elongate (Fig. 1C); posterior notopodia shorter, thicker, rounded apically (Fig. 1D). Abdominal neuropodia thickened, with rounded terminal lobe and short ventral cirrus (Fig. 1C–D); without subpodial flange or papillae.

Branchiae first present from setiger 15 (rarely 16) as rudiments; gradually increasing in size; branchiae of middle abdominal segments becoming broad and flattened, about one-third longer than notopodial lobe (Fig. 1C); branchiae of posterior segments where parapodia shifted dorsally, shorter, thicker, sometimes with expanded tip (Fig. 1D).

Notosetae include camerated capillaries and furcate setae (Fig. 1C–E); about 30 capillaries in two loose rows in thoracic notopodia reduced to 7–8 long, thin, weakly barbed capillaries in abdominal segments. Thoracic neurosetae all capillaries with up to 35 in four rows, some specimens with long silky capillaries in first 4–5 setigers; abdominal neurosetae include 1–4 capillaries and 1–2 short protruding aciculae, these minute, with rounded apex (Fig. 1D inset). Furcate setae of abdominal notopodia with unequal tynes, each tyne with a flattened rounded apex within which an opening and narrow channel can be observed with light microscope (Fig. 1E); narrow elongate fibrils present between tynes; flail setae absent.

Pygidium bluntly rounded, bearing two thin elongate cirri.

Variability. Most specimens were damaged to some extent and the most frequent problem was the lack of or damage to posterior segments and the loss or breakage of setae. Because of this, furcate setae were not observed

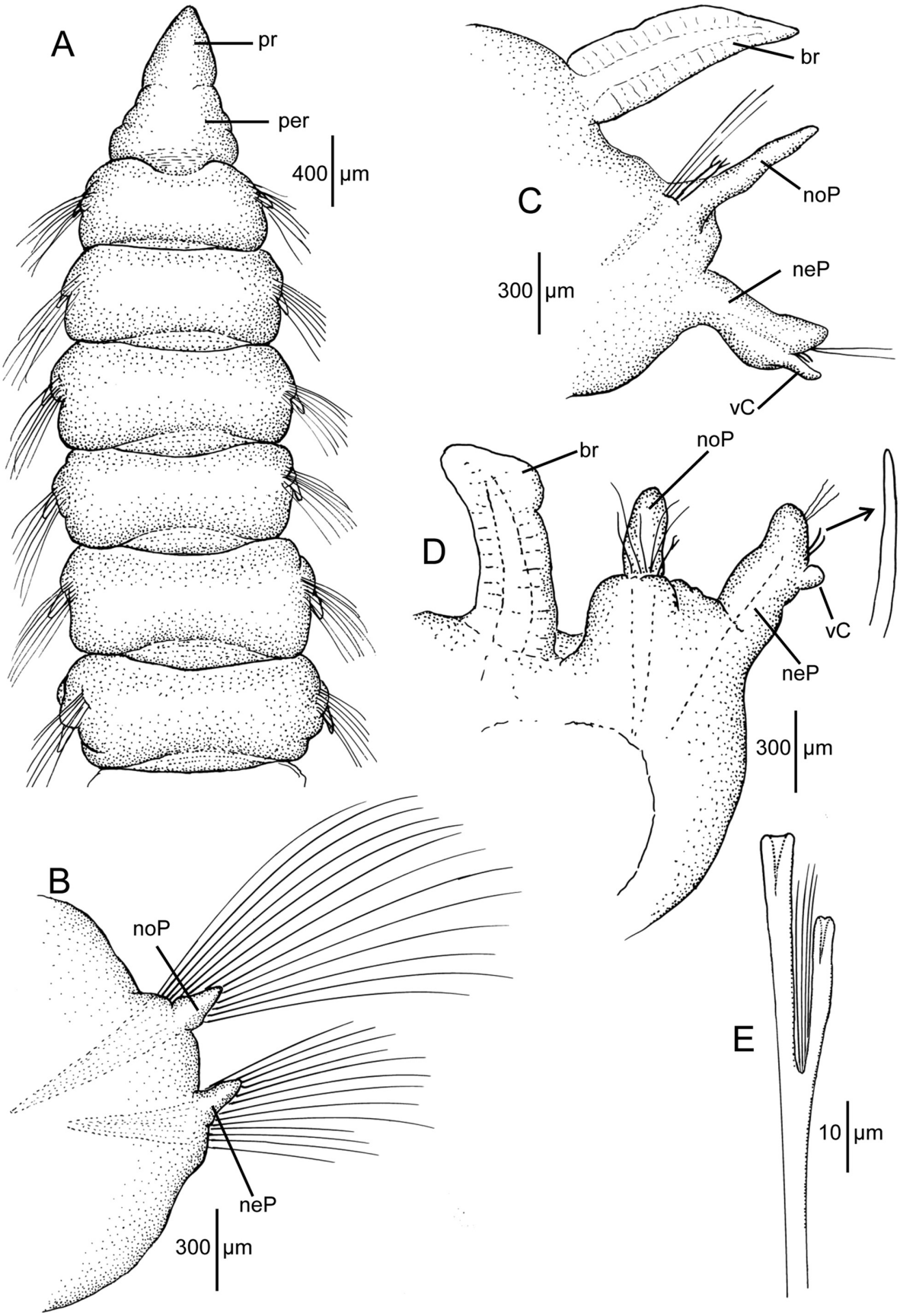

FIGURE 1. *Leitoscoloplos cliffordi* **n. sp.** Paratype (LACM-AHF Poly 11657): A, anterior end, dorsal view. Paratype (LACM-AHF Poly 11655): B, thoracic setiger, posterior view; C, anterior abdominal setiger, anterior view; D, far posterior abdominal setiger, anterior view; E, notopodial furcate seta.

on several specimens. However, the number of thoracic setigers was consistently nine and branchiae, when observed, generally began on setiger 15, sometimes 16. Later occurrences of branchiae were usually on damaged specimens. The prostomium was either narrower than figured (Fig. 1A) or wider and contracted. However, the general configuration was the same.

Methyl Green stain. Prostomium unstained, peristomium, light green; rest of body staining blue-green throughout, with no pattern, de-stains rapidly.

Remarks. *Leitoscoloplos cliffordi* **n. sp.** occurs throughout the SF-DODS sampling area, but is rare, with only 25–30 specimens identified from approximately 207 0.1-m^2 box core samples collected over 16 years of monitoring. It is likely that the preferred habitat or depth of this species has not been discovered.

Leitoscoloplos cliffordi **n. sp.** and four eastern Pacific deep-water congeners, *L. gordaensis* **n. sp.**, *L. lunulus* **n. sp.**, *L. pachybranchiatus*, and *L. williamsi* **n. sp**. belong to the *L. kerguelensis* group in having branchiae first present from an anterior abdominal setiger (Blake 2017). These species are separated from one another in the key and compared in Table 1. Although differing from all of these species in having instead of lacking furcate setae in abdominal notopodia, *L. cliffordi* **n. sp.** is most similar to *L. williamsi* **n. sp.** in having an elongate, narrow pre-setiger region. The two species further differ in that *L. cliffordi* **n. sp.** has short thoracic postsetal lamellae instead of lamellae that are long and digitiform.

Etymology. This species is named for Mr. Hovie Clifford, Woods Hole Oceanographic Institution (WHOI), who carefully prepared the box cores, pingers, and associated equipment used to collect benthic samples on the SF-DODS surveys.

Distribution. Off northern California in lower continental slope depths, 2600–3136 m.

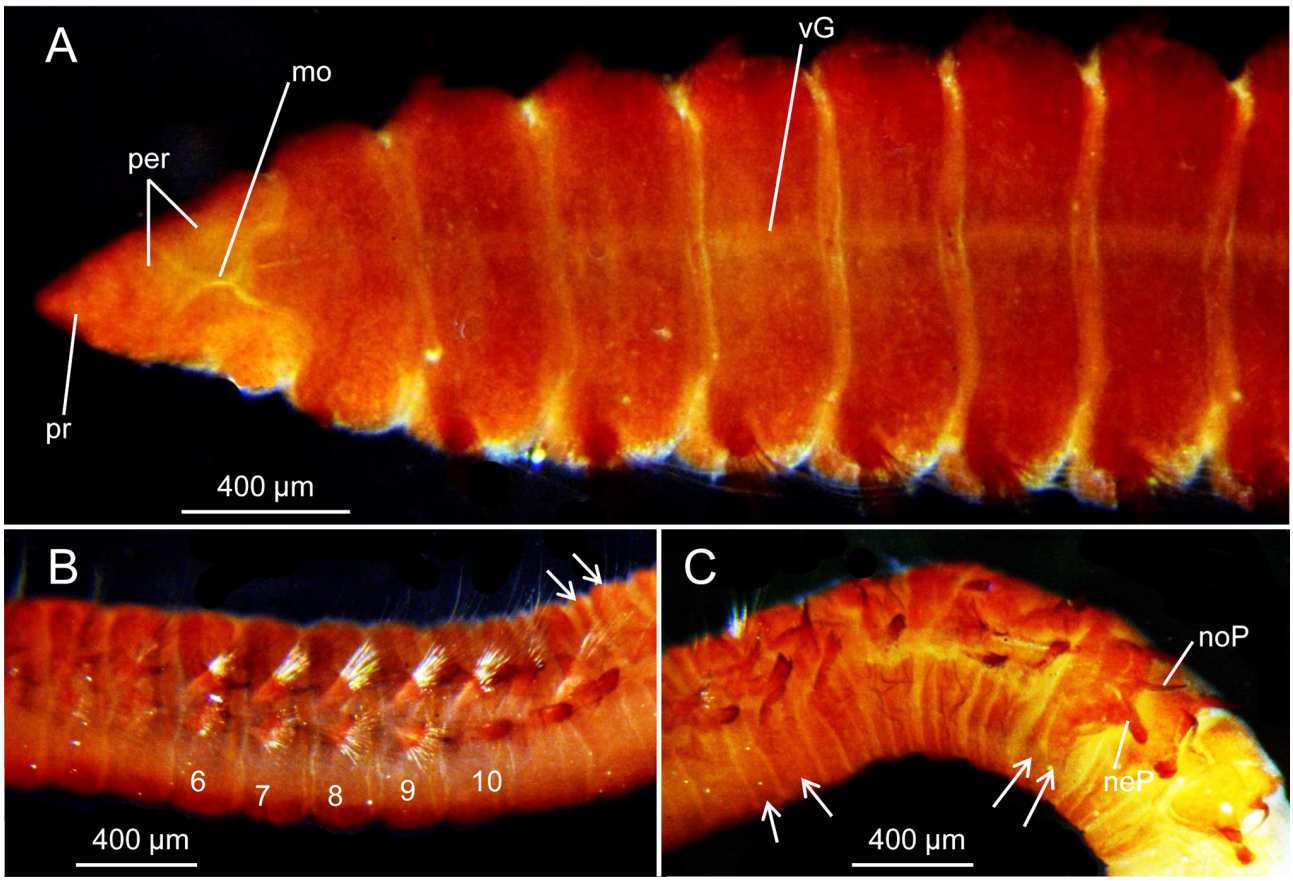

FIGURE 2. *Leitoscoloplos cliffordi* **n. sp.** Holotype (LACM AHF-Poly 11654): A, anterior end, ventral view; B, posterior thoracic and anterior abdominal segments, left lateral view, setigers numbered; C, mid-abdominal segments, left lateral view. B–C: Arrows denote annular rings. Stained with Shirlastain A.

***Leitoscoloplos gordaensis* new species**
Figures 3–4
urn:lsid:zoobank.org:act:03E8D6B6-DE48-42A5-9087-703A3E571C24

Material examined. **Gorda Ridge, off northern California, Escanaba Trough**, HOV *Alvin* Dive 2042, coll. J.F. Grassle, 12 May 1988, 41°00.4′N, 127°29.3′W, 3271 m, **holotype** (MCZ 153564) and 30 **paratypes** (MCZ 153565); same station, clam washings, 2 specimens (MCZ 153566).

Description. A moderate-sized species, holotype incomplete, 23 mm long and 1 mm wide for 63 setigers; some paratypes complete, up to 20 mm long and 1.7 mm wide for approximately 90 setigers. Body elongate, with narrow crowded segments throughout (Figs. 3A–B, 4A–C); thoracic and 1–2 transitional segments about six times wider than long; middle and posterior segments narrower, more crowded. Transition from thoracic to abdominal segments marked by development of three annular rings ventral to neuropodia, consisting initially of a broad medial ring joined on subsequent segments by two thin lateral intersegmental rings (Fig. 4B–C), thus providing ventral surface of each abdominal segment with three rings and an intersegmental groove between each segment. These rings most prominent in middle body segments (Fig. 4C), becoming shallower and less evident in posterior segments. Both dorsal and ventral surfaces smooth, lacking longitudinal grooves or ridges. Some paratypes mature females with large irregularly shaped eggs, ranging from 290–350 μm in diameter. Color in alcohol: opaque white.

Prostomium triangular, short (Figs 3A, 4A), with nuchal organs elongate slits on posterior lateral margin (Fig. 4A), eyespots absent. Peristomium with one or two annular rings, first longer and narrower than second when two present (Figs. 3A, 4A); presence of one or two peristomial rings not size related. Thorax with ten setigers followed by 1–2 transitional setigers (Fig. 4B); boundary between last thoracic setiger and first abdominal demarcated by loss of most neurosetae and increase in size of neuropodial lobe on setigers 11–12 (Fig. 4B).

Thoracic notopodial and neuropodial lobes elongate with triangular base, both similar in form (Fig. 3C); abdominal notopodia becoming narrower, more elongate, shifting dorsally in position (Figs. 3D–E, 4D); abdominal neuropodia thickened, with two terminal lobes (Figs. 3D–E, 4D); subpodial flanges and papillae absent. Branchiae first present from setiger 14–16 as rudiments; gradually increasing in size over middle abdominal segments, becoming broad and flattened, about one-third longer than notopodial lobe (Figs. 3D–E, 4D).

All notosetae camerated capillaries; thoracic notosetae arranged in a tight fascicle with capillaries appearing to arise from a spiral, numbering about 30–40 per fascicle; abdominal capillaries numbering 15–20 per notopodium in anterior and middle setigers, reduced to 10–18 in posterior setigers. Thoracic neurosetae all capillaries, with one prominent anterior row and 2–3 poorly organized secondary rows, numbering about 25–30 fascicle; abdominal neurosetae include 2–5 capillaries and 1–3 narrow aciculae with tips emergent, each short, smooth with rounded tip; furcate and flail setae absent.

Pygidium bluntly rounded, bearing two thin elongate cirri (Fig. 3B).

Variability. The separation of the two peristomial rings is sometimes apparent only laterally, with the groove not crossing the dorsum. The anal cirri are usually lost, best observed on smaller specimens.

Methyl Green stain. No pattern, body stains uniformly.

Remarks. *Leitoscoloplos gordaensis* **n. sp.** belongs to the *L. kerguelensis* group in having branchiae first present from anterior abdominal setigers (Blake 2017). The five species in this group from the eastern North Pacific are separated from the others in the key above and by additional characteristics in Table 1. Of the four species that lack furcate setae, *L. gordaensis* **n. sp.** and *L. lunulus* **n. sp.** each have a relatively short pre-setal region where the prostomium and peristomium are separated from one another by a distinct groove. The two species differ significantly from one another in that *L. lunulus* **n. sp.** has a ventral cirrus and subpodial flange on the abdominal neuropodia that are lacking in *L. gordaensis* **n. sp.**

Etymology. The species is named for its occurrence on the Gorda Ridge.

Distribution. Eastern Pacific, off northern California in the vicinity of hydrothermal vents on the Gorda Ridge, Escanaba Trough, 3271 m.

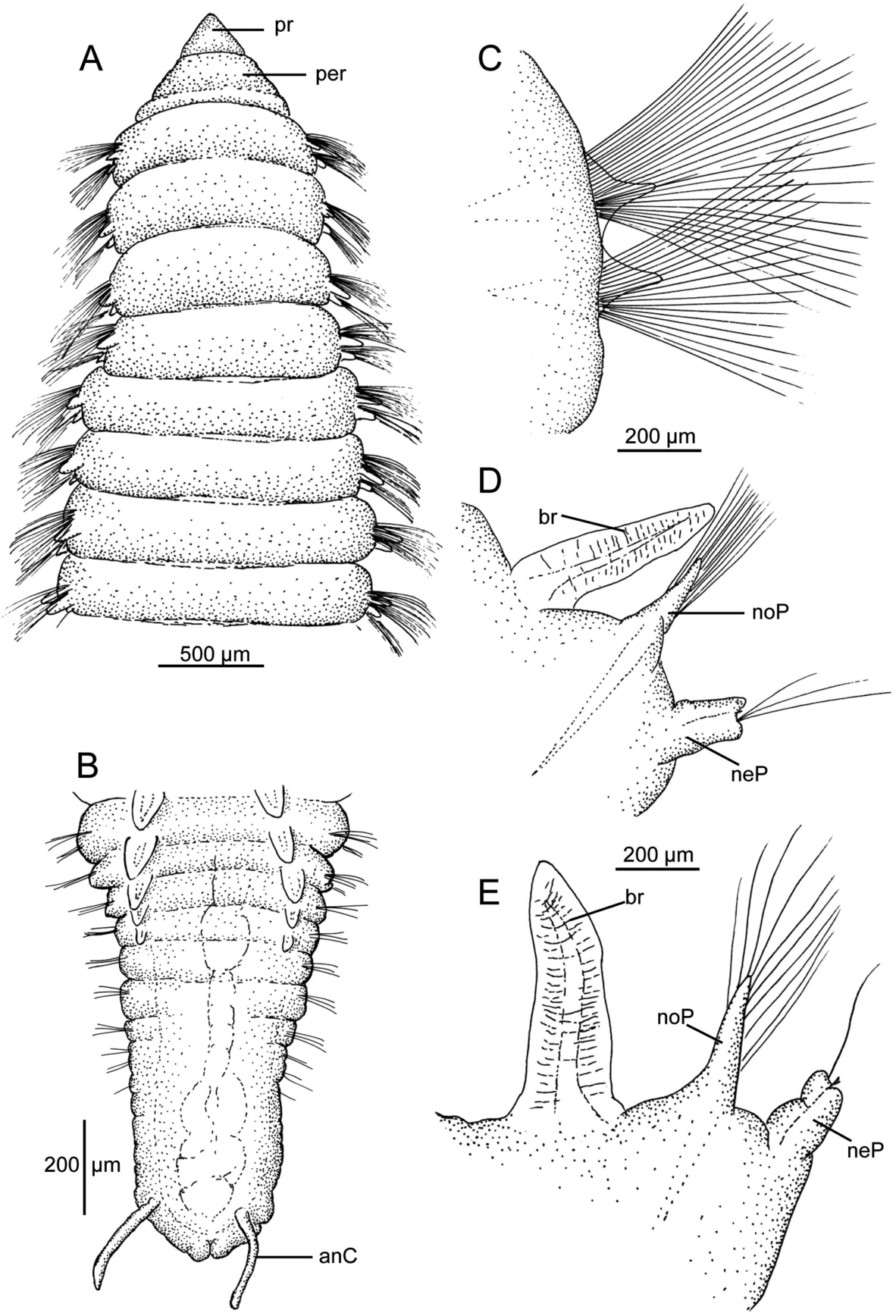

FIGURE 3. *Leitoscoloplos gordaensis* **n. sp.** Holotype (MCZ 153564): A, anterior end, dorsal view. Paratype (MCZ 153565): B, posterior end, dorsal view; C, thoracic setiger, anterior view; D, anterior abdominal setiger, posterior view; E, posterior abdominal setiger, posterior view.

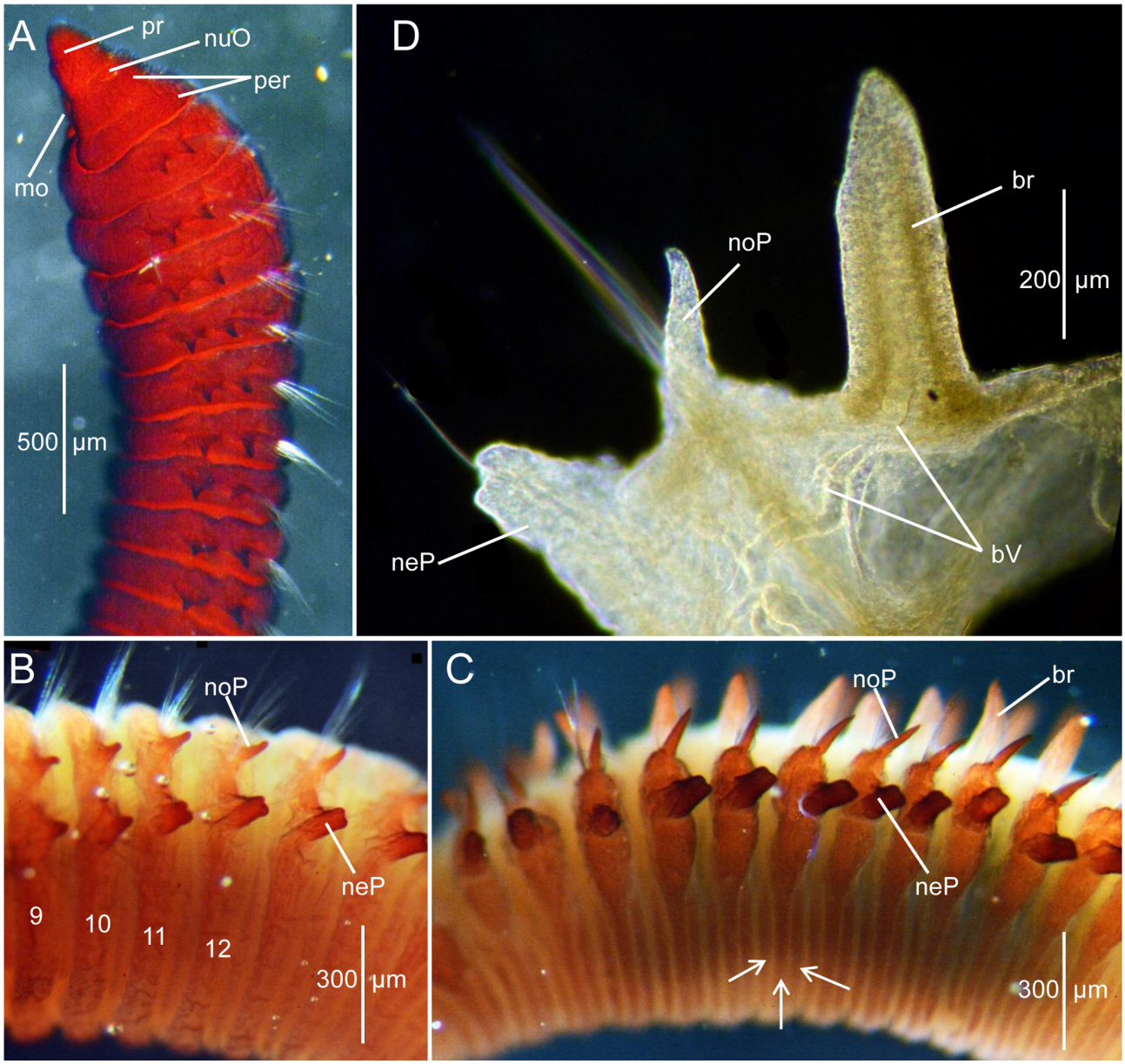

FIGURE 4. *Leitoscoloplos gordaensis* **n. sp.** Holotype (MCZ 153564): A, anterior end, left lateral view; B, posterior thoracic and anterior abdominal setigers, left lateral view, setigers numbered; C, middle abdominal setigers, left lateral view, arrows denote tri-annular rings on venter. Paratype (MCZ 153565): D, posterior abdominal setiger, anterior view. Stained with Shirlastain A.

Leitoscoloplos lunulus new species

Figures 5–6

urn:lsid:zoobank.org:act:9AC846BC-37A5-4B2A-98C7-3308A92D2EFA

Leitoscoloplos sp. 1: Hilbig & Blake 2006: 265.

Material examined. **Continental slope off northern California**, **off Half Moon Bay**, U.S EPA 102 Site selection Survey, R/V *Point Sur*, coll. J.A. Blake, **south of Pioneer Canyon**, Sta. 4-8. 18 Sep 1991, 37°13.85′N, 123°13.50′W, 1560 m, **holotype** (LACM-AHF Poly 11660); **north of Pioneer Canyon**, Sta. 3-4, 14 Sep 1991, 37°27.83′N, 123°11.60′W, 1030 m, 1 **paratype** in two pieces (LACM-AHF Poly 11661); Sta. 3-7, 14 Sep 1991, 37°27.44′N, 123°19.50′W, 1675 m, 1 **paratype** (CASIZ 234041); Sta. 3-16, 15 Sep 1991, 37°23.20′N, 123°14.44′W, 1220 m, 1 **paratype** (CASIZ 234048).

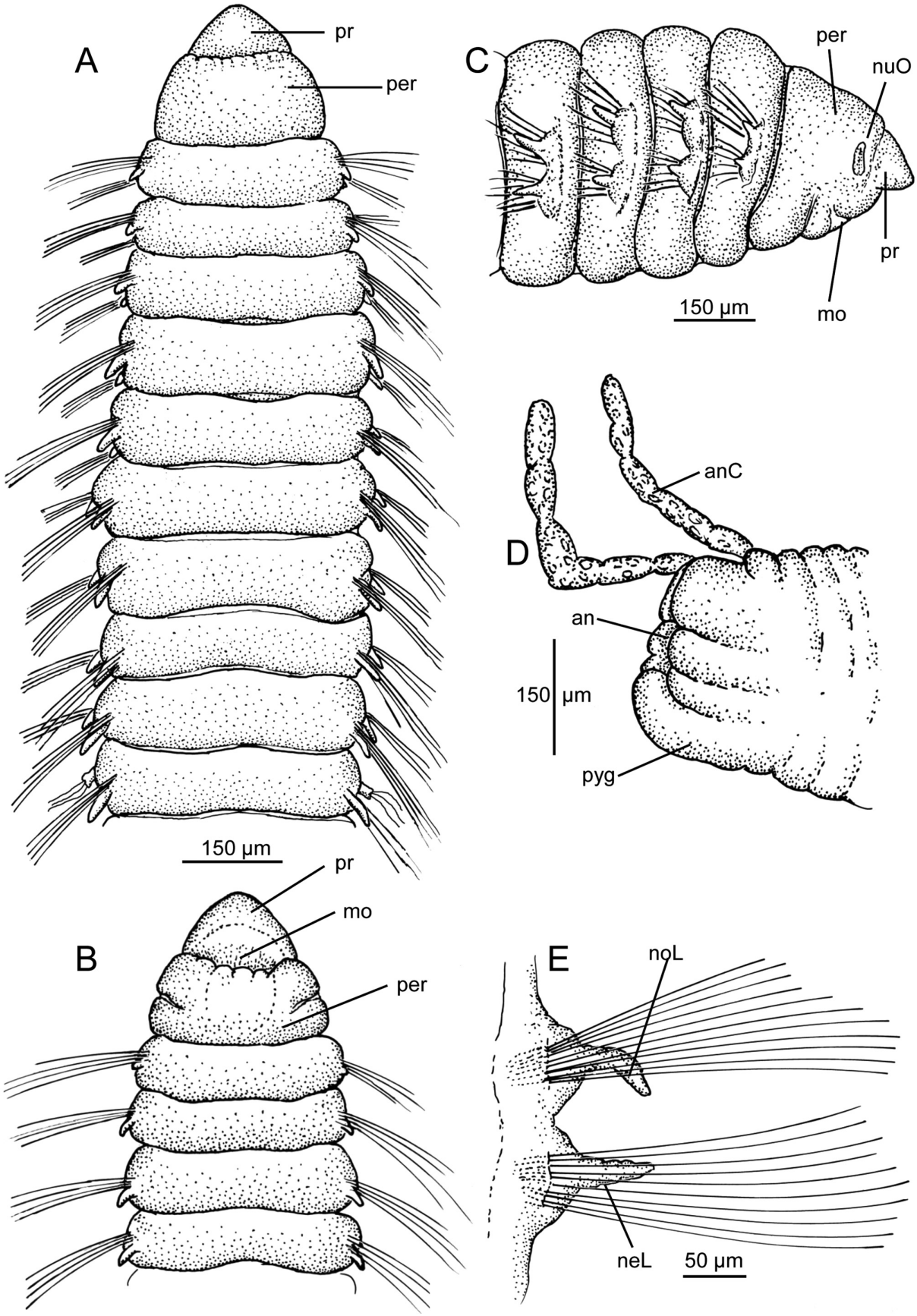

FIGURE 5. *Leitoscoloplos lunulus* **n. sp.** A, anterior end, dorsal view; B, anterior end, ventral view; C, anterior end, right lateral view; D, pygidium, right lateral view; E, thoracic setiger 7, right, posterior view. A–B, D holotype (LACM-AHF Poly 11660); C, E, paratype (CASIZ 234041).

Description. A small species, holotype (LACM-AHF Poly 11660) complete, with 50 setigers, 6.8 mm long, 0.45 mm wide across thoracic segments; paratype from Sta. 3-4 (LACM-AHF Poly 11661), smaller, mostly complete, with 34 setigers, 4.1 mm long. Body thickened in thoracic region with smooth rectangular-shaped segments about 4.6 times wider than long; abdominal segments becoming narrower and shorter. Thoracic segments uniannulate with narrow intersegmental groove (Fig. 5A); abdominal segments becoming biannulate due to narrow ring developing on posterior segmental margin. Dorsal and ventral longitudinal ridges or grooves absent. Color in alcohol: light tan.

Pre-setiger region short, compact, slightly wider than long, longer than first two setigers (Fig. 5A–B). Prostomium semi-circular in shape, narrowing to broadly rounded apex in dorsal and ventral views (Fig. 5A–B); narrower in lateral view (Fig. 5C); eyespots absent; nuchal organs elongate lateral opening on posterior margin (Fig. 5C). Peristomium appearing entire in dorsal view (Fig. 5A); with single ventrolateral groove (Fig. 5B–C). Anterior margin sculpted especially on lower lip of mouth (Fig. 5B)

Thorax with nine setigers, abruptly changing to abdominal segments with development of elongated neuropodium and loss of most neurosetae (Fig. 5A). Thoracic notopodial and neuropodial postsetal lamellae both elongate, digitiform, tapering to narrow apex; arising from broadly rounded base (Fig. 5E). Abdominal notopodia short, triangular, with long, thin, digitiform postsetal lamella (Fig. 6A–B). Abdominal neuropodia thickened lobes, short at first surrounded by thick basal flange (Fig. 6A); subsequent neuropodia long, narrow, with low subpodial flange on body wall below neuropodial base (Fig. 6B); subpodial papillae absent. Neuropodia with rounded apex and short, narrow ventral cirrus with rounded tip (Fig. 6A–B).

Branchiae from setiger 14 in holotype and setigers 14–15 in paratypes. Branchiae full size from initiation, weakly triangular at first, tapering to rounded tip (Fig. 6A); branchiae of middle and posterior setigers thicker, more fleshy in appearance with expansion, narrowing to papillate tip (Fig. 6B). Each branchia as long as or slightly longer than notopodial postsetal lamella.

All setae camerated capillaries except neuropodial aciculae; furcate and flail setae absent. Thoracic noto- and neurosetae long, crowded capillaries numbering about 14–16, arranged in two weakly defined rows. Abdominal notosetae include 7–8 capillaries, some long; abdominal neurosetae include 4–5 capillaries and 1–2 short, narrow protruding pointed aciculae.

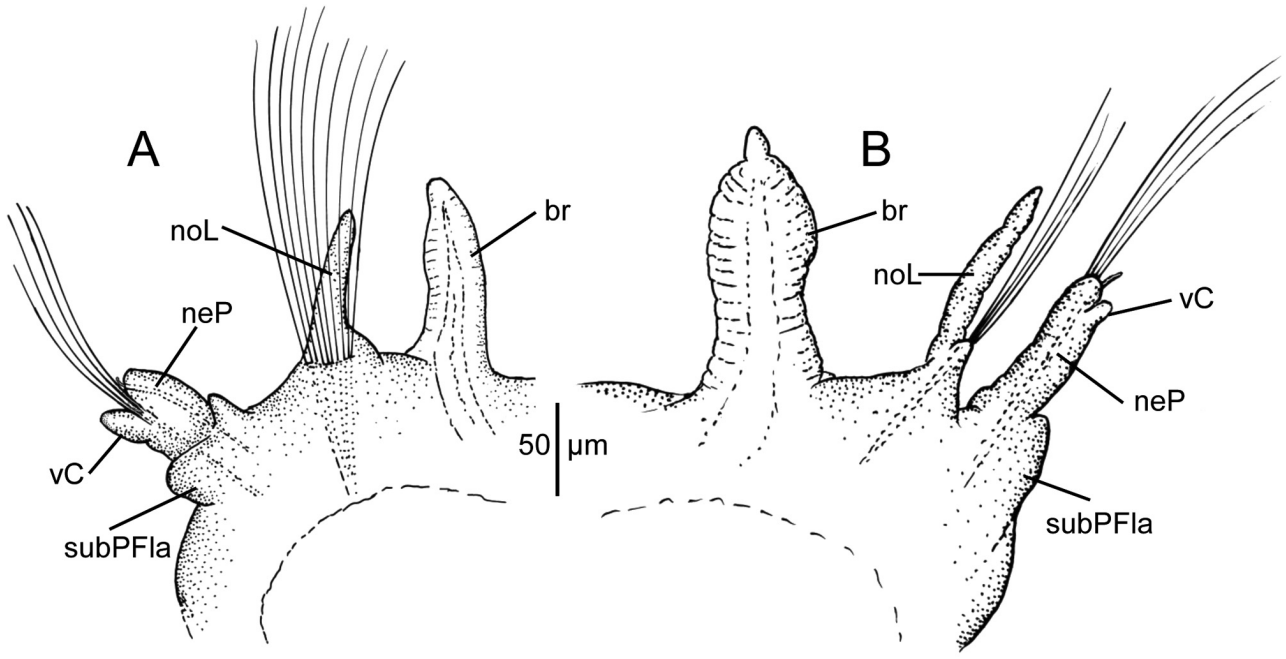

FIGURE 6. *Leitoscoloplos lunulus* **n. sp.** Holotype (LACM-AHH Poly 11660): A, anterior abdominal setiger 16, right, lateral anterior view; B, posterior abdominal setiger, left, lateral anterior view.

Pygidium with two dorsal, four lateral, and one large ventral lobe surrounding anal opening. Two thin, digitiform anal cirri arising from dorsal lobes (Fig. 5D).

Methyl Green stain. No pattern, body stains uniformly and de-stains rapidly.

Remarks. *Leitoscoloplos lunulus* **n. sp.** is another member of the *L. kerguelensis* group as defined by Blake (2017) in having branchiae first present from an anterior abdominal setiger. *L. lunulus* **n. sp.** is one of five species in the eastern Pacific belonging to this group and as noted in the previous account, is most closely related to *L. gordaensis* **n. sp.** by lacking furcate setae and having a short pre-setiger region where the prostomium is distinctly separated from the peristomium by a groove. In *L. lunulus* **n. sp.** the groove that separates the prostomium and peristomium is sculpted rather than smooth and the thorax has nine setigers instead of ten.

Etymology. The epithet is from the Latin, *lunula*, for moon, in relation to the survey location off Half Moon Bay, California.

Distribution. Off northern California, middle continental slope depths, 1020–1760 m.

Leitoscoloplos sahlingi new species

Figure 7

urn:lsid:zoobank.org:act:1ABF6485-9B70-43D1-A421-215DD4A2A35C

Material examined. **Continental margin off Oregon, Cascadia Subduction Zone, southern summit of Hydrate Ridge**, R/V *Sonne* Cruise 143, coll. H. Sahling, Sta. 179, 17 Aug 1999, 44°34.2′N, 125°08.8′W, 786 m, **holotype** (MCZ 153567) and 2 **paratypes** (MCZ 153568).

Description. A small species, all specimens incomplete. Holotype 6.8 mm long, 0.67 mm across thorax, with 37 setigers; large paratype 5.5 mm long, 0.87 mm wide across thorax, with 30 setigers. Bodies relatively thick, robust in thoracic region with smooth crowded segments, each about four times wider than long (Fig. 7A); abdominal segments becoming narrower and shorter. Dorsum of thorax rounded dorsally, venter flattened mid-ventrally; abdominal region flattened dorsally, rounded ventrally. Thoracic segments all uniannulate; abdominal segments becoming biannulate due to parapodial ridge elevated above rest of segment. Color in alcohol: light tan.

Pre-setiger region about as long as first two setigers. Prostomium triangular, narrowing to pointed apex (Fig. 7A–B); eyespots absent; nuchal organs prominent oval grooves on border with peristomium (Fig. 7B). Peristomium composed of one achaetous ring extending ventrally, surrounding mouth (Fig. 7A–B). Thorax with 12 setigers, abruptly separated from abdominal segments by loss of most neurosetae and increased size and shape of neuropodial lobe on setiger 13 (Fig. 7A).

Thoracic notopodial and neuropodial lamellae elongate, digitiform, arising from broad base (Fig. 7C), both similar in form; abdominal notopodia of anterior abdominal segments becoming long and narrow (Fig. 7D). Abdominal neuropodia thickened, divided into a rounded terminal lobe and short laterally directed ventral cirrus (Fig. 7D). Branchiae first present from setiger 10 (Fig. 7A), short at first then increasing in size; branchiae of middle abdominal segments long, triangular, and flattened, tapering to narrow papilla (Fig. 7D), each branchia about one-third longer than notopodial lamellae.

All setae camerated capillaries except neuropodial aciculae; furcate and flail setae absent. Thoracic noto- and neurosetae with numerous capillaries organized in separate rows: 2–4 rows of notosetae and 4–5 rows of neurosetae. Abdominal notosetae include 7–8 capillaries, some long; abdominal neurosetae include 4–5 capillaries and 1–2 short protruding pointed aciculae, these minute.

Pygidium not observed.

Methyl Green stain. No pattern, prostomium not staining, body staining uniformly, de-stains rapidly.

Remarks. *Leitoscoloplos sahlingi* **n. sp.** belongs to a group of species having branchiae first present from middle to posterior thoracic segments (Blake 2017). Four other species in this category occur in the eastern Pacific: *L. mexicanus*, *L. multipapillatus* Hernández-Alcántara & Solís-Weiss, 2014, *L. panamensis* (Monro, 1933), and *L. pugettensis*. Of these, *L. multipapillatus* and *L. panamensis* differ from *L. sahlingi* **n. sp.** in having instead of lacking subpodial lobes or stomach papillae across the venter of some thoracic segments. *Leitoscoloplos pugettensis* is the most common shallow-water orbiniid species in the eastern Pacific. This species differs from *L. sahlingi* **n. sp.** in having 14–20 thoracic setigers instead of 12, and branchiae from setigers 13–18, instead of 10. More importantly *L. pugettensis* has furcate setae in abdominal notopodia that are absent in *L. sahlingi* **n. sp.**

The remaining species, *L. mexicanus*, is the only deep-water species in the group and the most similar to *L. sahlingi* **n. sp.** Specimens reported by Fauchald (1972) from soft sediments in the Salsipuedes Basin, Gulf of California (Mexico) in 1377–1418 m are incomplete and similar in size (5.5 mm long, with 29 setigers) to those of *L. sahlingi* **n. sp.**, which are also incomplete (6.8 mm long, with 37 setigers). Both species lack furcate setae. However, *L. mexicanus* has 13–14 thoracic setigers instead of 12 and branchiae from setiger 11–13 instead of 10. The morphol-

ogy of the abdominal segments of *L. mexicanus* differs from that of *L. sahlingi* **n. sp.** as follows: (1) the branchiae are narrow along their length instead of triangular and tapering to a terminal papilla; (2) the notopodial lamella is inflated along its length instead of tapering to a pointed tip; and (3) the neuropodium bifurcates into two subequal lobes instead of a dorsal rounded lobe and a short ventral cirrus.

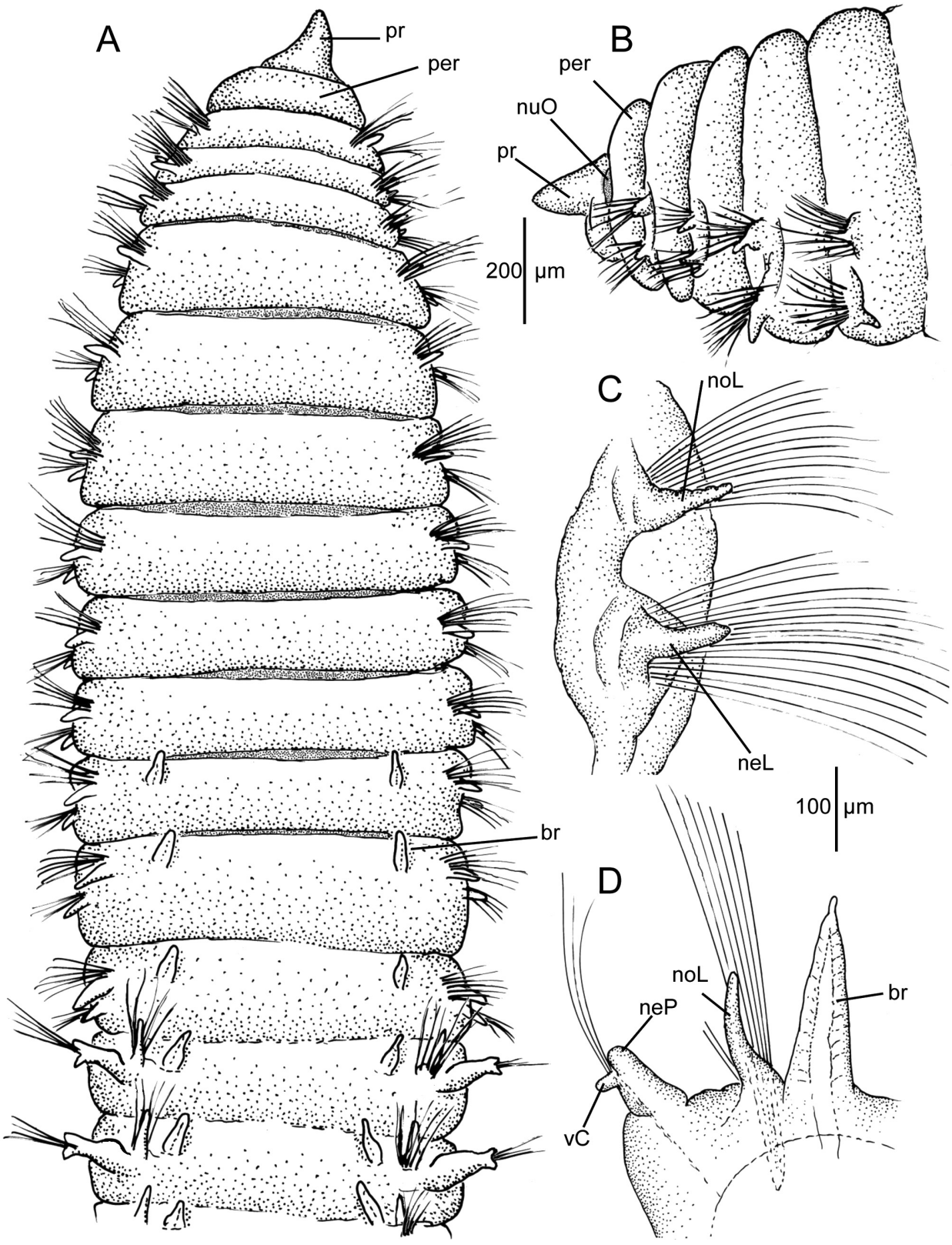

FIGURE 7. *Leitoscoloplos sahlingi* **n. sp.** Holotype (MCZ 153567): A, anterior end, dorsal view. Paratype (MCZ 1563568): B, anterior end, left lateral view; C, thoracic setiger, anterior view; D, middle abdominal setiger, posterior view.

Etymology. This species is named for the late Dr. Heiko Sahling (1969–2018), marine ecologist, who collected and provided these specimens of *Leitoscoloplos* and other polychaetes from the Cascadia Subduction Zone and authored an important paper on the macrofauna of the site (Sahling *et al*. 2002).

Distribution. Sediments with gas hydrates, off Oregon, Cascadia Subduction Zone, 786 m.

Leitoscoloplos williamsae **new species**

Figures 8–9

urn:lsid:zoobank.org:act:8CBB5BCD-91E0-4077-9803-095212E75A95

Leitoscoloplos sp. 3 and sp. 4: Hilbig & Blake 2006: 265.

Material examined. **Continental slope, off northern California**, **off Half Moon Bay,** U.S EPA Site selection Survey, R/V *Point Sur*, coll. J.A. Blake, **south of Pioneer Canyon**, Sta. 4-10, 17 Sep 1991, 37°11.26′N, 123°15.26′W, 1760 m, **holotype** (LACM-AHF Poly 11658); **North of Pioneer Canyon**, Sta. 3-19, 16 Sep 1991, 37°26.05′N, 123°19.99′W, 1760 m, 1 **paratype** (LACM-AHF Poly 11659).

Description. A moderate-sized species, holotype complete, 10.5 mm long, 0.6 mm across thoracic segments for 65 setigers; paratype mostly complete, 5.7 mm long, 0.25 mm across thorax for 40 setigers. Body elongate, more or less consistently same width throughout, tapering to narrow posterior end. Thoracic segments about 3.5 times as wide as long, each separated from one another by prominent intersegmental grooves, grooves with an elevated transverse dorsal ridge or hump (Fig. 8A–B) producing a biannulate appearance; lateral and ventral grooves not as conspicuous. Anterior abdominal segments narrow, becoming longer, about twice as wide as long in middle and posterior segments. Anterior and middle abdominal segments with intersegmental groove transformed into a flattened band producing a biannulate appearance, band obscured in posterior abdominal segments. Longitudinal grooves or ridges along body absent. Color in alcohol: light tan.

Pre-setiger region triangular, longer than wide, narrowing anteriorly (Fig. 8A–B). Prostomium conical, tapering to narrow apex (Fig. 8A); nuchal organs narrow, crescent-shaped on posterior lateral margin (Fig. 8B); eyespots absent. Peristomium composed of a single, smooth achaetous ring, ventrally surrounding mouth, inflated dorsally, with no transverse grooves (Fig. 8A–B).

Thorax with nine setigers on holotype, transitioning to abdominal segments over 1–2 segments; paratype with eight thoracic setigers. Boundary between last thoracic and first abdominal setiger demarcated by loss of most neurosetae and increase in size of neuropodial lobe. Thoracic notopodial and neuropodial lobes elongate, digitiform, both similar in form arising from broad rounded base (Fig. 8D); notopodia of anterior abdominal segments becoming thickened, elongate (Fig. 9A); posterior notopodia narrower, tapering to pointed tip (Fig. 9B). Anterior abdominal neuropodia thickened, with rounded terminal lobe and short ventral cirrus (Fig. 9A); middle and posterior abdominal neuropodia longer, narrow, with short ventral cirrus and bulbous subpodial flange (Fig. 9B).

Branchiae first present from setiger 17 in holotype and setiger 18 in paratype; branchiae moderately sized at first, triangular in shape (Fig. 9A), becoming longer and thicker in middle abdominal segments (Fig. 9B). Branchiae of some far posterior abdominal segments of holotype asymmetrical, with a lateral flaglike extension.

Notosetae include camerated capillaries throughout; furcate and flail setae absent. Thoracic notosetae numbering about 25 per fascicle, arranged in two or three rows. Abdominal notosetae narrow camerated capillaries numbering 8–12 in anterior abdominal segments, reduced to 5–10 posteriorly. Thoracic neurosetae all capillaries, numbering about 20–25 per fascicle in at least two rows. Abdominal neurosetae include 3–5 thin capillaries and 1–2 short protruding aciculae, these minute, with rounded apex (Fig. 9A).

Pygidium bluntly rounded, bearing two thin elongate cirri dorsal to the anal opening (Fig. 8C).

Methyl Green stain. No pattern; prostomium not staining, rest of body staining uniformly, de-stains rapidly.

Remarks. *Leitoscoloplos williamsae* **n. sp.** superficially resembles *L. cliffordi* **n. sp.** in having a narrow, elongate pre-setiger region and maximally nine thoracic setigers. However, there are several important differences between the two species: *L. cliffordi* **n. sp.** has lateral grooves on the peristomium; a longitudinal ventral groove along the body; thoracic parapodial postsetal lobes are short and digitiform; branchiae are first present from setigers 15–16; notopodial furcate setae with blunt, unequal tynes are present; abdominal neuropodia become short and thick in posterior segments and abdominal neuropodia lack a subpodial flange; *L. williamsae* **n. sp.** has a peristomium with no lateral grooves; longitudinal grooves along the body are absent; thoracic postsetal lobes are long and

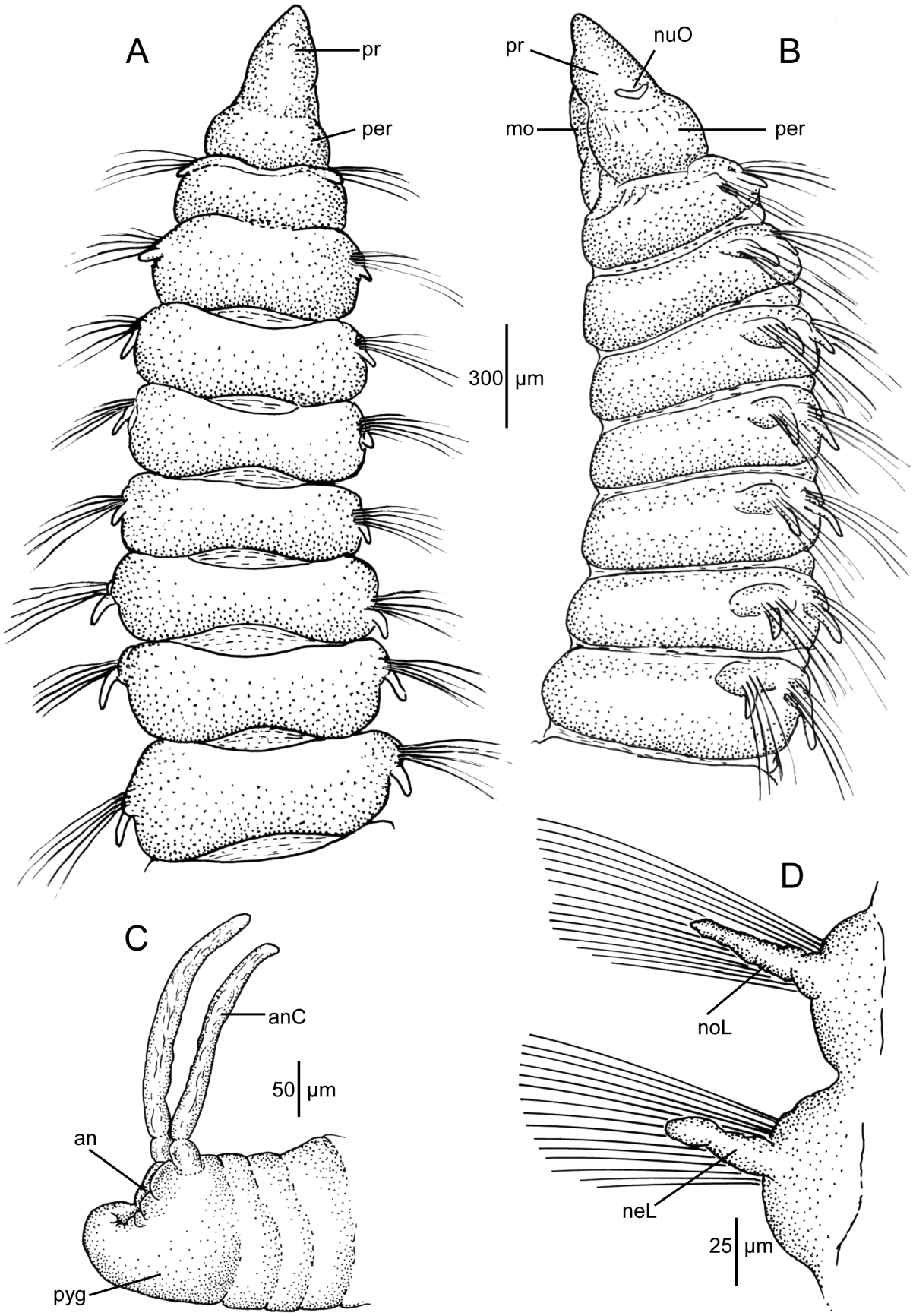

FIGURE 8. *Leitoscoloplos williamsae* **n. sp**. Holotype (LACM-AHF Poly 11658): A, anterior end, dorsal view; B, anterior end, left lateral view; C, posterior end, right lateral view; D, thoracic setiger 7, right posterior view.

digitiform; branchiae are first present from setigers 17–18; notopodial furcate setae are absent; abdominal neuropodia are long and digitate throughout; and abdominal neuropodia of middle and posterior segments have a bulbous subpodial flange.

Etymology. This species is named for my friend and long-time colleague, Isabelle P. (Izzie) Williams. Ms. Williams was part of the field team for the site-selection survey on which this species was collected and most of the following monitoring surveys at the SF-DODS site. Ms. Williams was also senior taxonomist on these projects, identifying the crustaceans and molluscs, and managed the benthic database.

Distribution. Off northern California in middle continental slope depths, 1760 m.

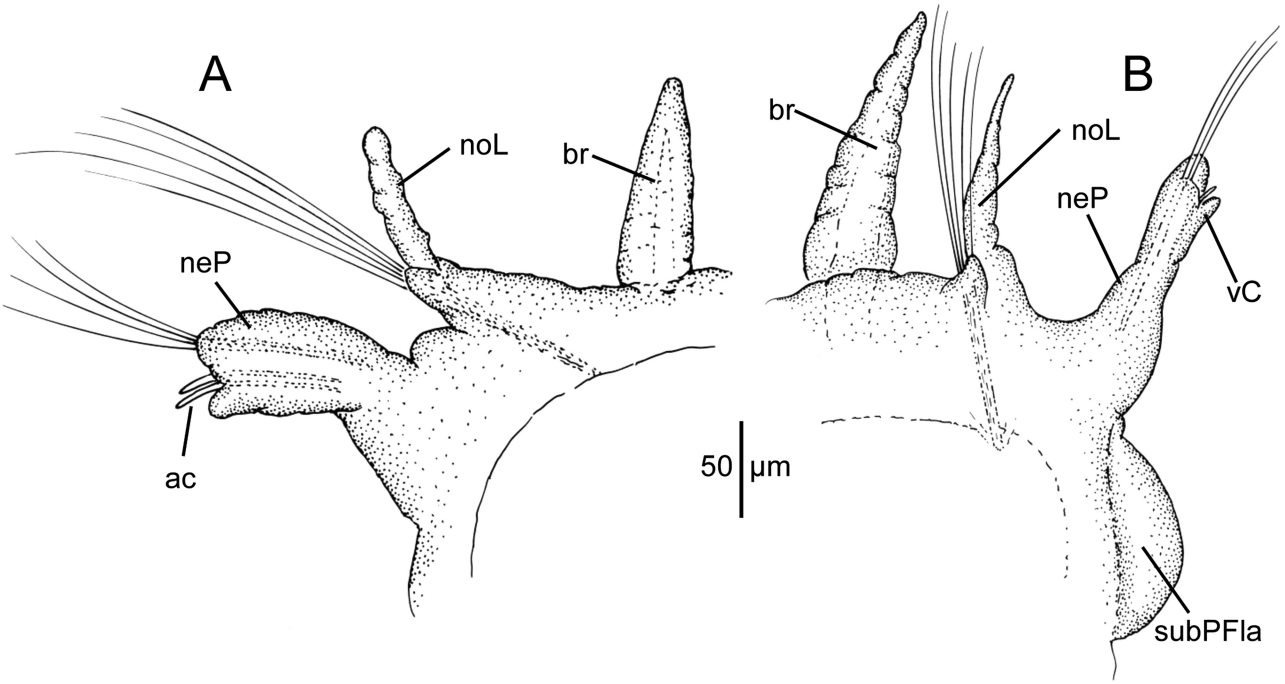

FIGURE 9. *Leitoscoloplos williamsae* **n. sp**. Holotype (LACM-AHF Poly 11658): A, abdominal setiger 20, left side, anterior view; B, abdominal setiger 32, right side, anterior view.

Genus *Berkeleyia* Hartman, 1971. Emended Blake 2017

Type-species: *Berkeleyia profunda* Hartman, 1971, Mozambique Basin, 4886–5069 m.

Diagnosis. (Emended) Prostomium pointed, conical; peristomium with one or two achaetous rings. Branchiae from posterior thoracic or abdominal segments. Thoracic noto- and neuropodia with one postsetal lobe, sometimes absent or inconspicuous on anteriormost setigers; subpodial lobes absent; abdominal setigers with simple noto- and neuropodia; neuropodia with or without ventral cirrus; interramal cirri absent. Thoracic noto- and neurosetae all capillaries. Abdominal notosetae include capillaries; pointed spines present or absent; furcate setae present or absent; neuropodia with capillaries and protruding acicular spines; or only spines.

Remarks. The genus *Berkeleyia* is similar to *Leitoscoloplos* in lacking spines or uncini in thoracic neuropodia. Species of *Berkeleyia*, however, have elongate neuropodial spines in abdominal setigers and sometimes abdominal notopodial spines.

Until recently, *Berkeleyia* was known for a single deep-water species, *B. profunda* Hartman, 1971, from the Indian Ocean. Blake (2017) described four additional species from off South America and Antarctica, three of which were from deep water, with *B. hadala* Blake, 2017 from the Peru-Chile trench in 6143 m representing the deepest known occurrence for an orbiniid polychaete. Another deep-water species has been discovered at the Juan de Fuca Ridge associated with hydrothermal vents and is described here.

***Berkeleyia lelievrei* new species**
Figure 10
urn:lsid:zoobank.org:act:D9A4ECEB-0440-422F-9EAF-323D6A79DFFA

Berkeleyia sp. nov. Lelièvre *et al*. 2018: 2633.

Material examined. **NE Pacific Ocean, off Washington, Juan de Fuca Ridge**, **Endeavour Segment**, R/V *T.G. Thompson* Cruise TN328, coll. Y. Lelièvre, Grotto Site, Sta. ROV *Jason* dive J2-831, 07 Sep 2015, 47°56.958′N, 129°5.899′W, 2196 m, **holotype** (MCZ 154094), 4 **paratypes** (MCZ 154095).

Description. A moderately sized species; all specimens incomplete, some damaged. Holotype 14.7 mm long, 1.6 mm wide across middle of thorax, 0.8 mm wide across abdominal segments, with 55 setigers. Paratypes 14–16 mm long with 38–50 setigers. Body with broad thoracic region more or less dorso-ventrally flattened, with 10–11 setigers, fusiform in shape (Fig. 10A); dorsum weakly rounded; venter flattened with mid-ventral groove. Individual thoracic segments narrow, middle segments about ten times wider than long (Fig. 10A). Abdominal segments narrow, about six times as wide as long. Eggs present in some specimens, up to 230 µm in diameter. Color in alcohol: tan with dark dusky pigment on prostomium and dorsum of thorax on some specimens.

Prostomium, conical, narrowing to rounded apex (Fig. 10A); nuchal organs lateral grooves on posterior margin; eyespots absent. Peristomium about twice as long as first setiger; composed of one or two rings; holotype with two distinct peristomial rings (Fig. 10A), paratypes with a single ring or with groove separating two rings weakly defined. Proboscis everted in two paratypes, composed of about seven thin lobes.

Thoracic parapodia with triangular postsetal lamellae, narrowing apically (Fig. 10B). Transition to abdominal segments abrupt, denoted by enlargement and elongation of neuropodium and reduced number of setae. Abdominal notopodia conical with narrow, elongate postsetal lamellae; neuropodia of anterior abdominal segments with rounded apex, becoming bi-lobed in middle and posterior segments (Fig. 10C). Branchiae from setiger 12, short at first, becoming longer, tapering in subsequent segments (Fig. 10C); individual branchiae ciliated, with lateral folds best seen in posterior segments.

All thoracic setae numerous camerated or bristled capillaries arranged in 3–4 rows; thoracic notosetae may include a superior tuft of thin capillaries (Fig. 10B); neurosetae may include an inferior tuft of thin capillaries (Fig. 10B). Abdominal notosetae initially include 4–5 thin capillaries, transitioning to long, brass-colored spinous setae continuing throughout. Abdominal neurosetae initially with 1–3 short, thin capillaries transitioning to 1–2 long brass-colored spines, continuing throughout. Spinous noto- and neurosetae of abdominal segments all smooth, not camerated or with any evidence of bristles or barbs, terminating in rounded tip (Fig. 10C inset). Furcate and flail setae entirely absent.

Pygidium not observed.

Methyl Green stain. No pattern, body stains uniformly green; de-stains rapidly.

Remarks. All five specimens are incomplete and exhibit evidence of poor preservation or handling, mainly in abdominal segments (Blake 2017). Setae of thoracic segments are generally intact, but many abdominal setae are broken or sheared off. Some middle abdominal segments are soft and fragile suggesting they were not preserved soon enough after collection. Nevertheless, there is sufficient intact morphology to define the specimens as a new species.

Berkeleyia lelievre **n. sp.** is the sixth species of the genus and is most similar to *B. hadala* Blake, 2017 from the Peru-Chile Trench in the transition of typical camerated or bristled capillaries in thoracic setigers to smooth, non-bristled brass-colored spinous setae in abdominal segments. The two species differ in that *B. hadala* has a triangular-shaped prostomium pointed on the tip, a peristomium that has a single ring merged with the prostomium, and branchiae from setiger 24. In contrast, *B. lelievre* **n. sp.** has a prostomium that is conical and rounded on the tip, a peristomium that has one or two rings that are distinctly separated from the prostomium, and branchiae from setiger 12.

Biology. The specimens of *Berkeleyia lelievre* **n. sp.** were collected from dense assemblages of *Ridgeia piscesae* Jones, 1985, a common siboglinid tubeworm at the Grotto hydrothermal site on the Endeavour Segment, Juan de Fuca Ridge. Associated organisms, including *B. lelievre* **n. sp.**, were collected with the tubeworms. A total of 35 macrofaunal taxa, including 19 polychaete species were removed from the tubeworm habitat. The dominant macrofaunal taxa were the gastropods *Lepetodrilus fucensis* McLean, 1988 and *Depressogyra globulus* Warén & Bouchet, 2001, and the ampharetid polychaete *Amphisamytha carldarei* Stiller *et al*., 2013.

Etymology. This species is named for Dr. Yann Lelièvre, Université de Montréal, benthic biologist who participated in the survey and published an important paper on the ecology and biodiversity of the site (Lelièvre *et al.* 2018).

Distribution. Eastern Pacific Ocean, hydrothermal vents, Juan de Fuca Ridge, 2196 m.

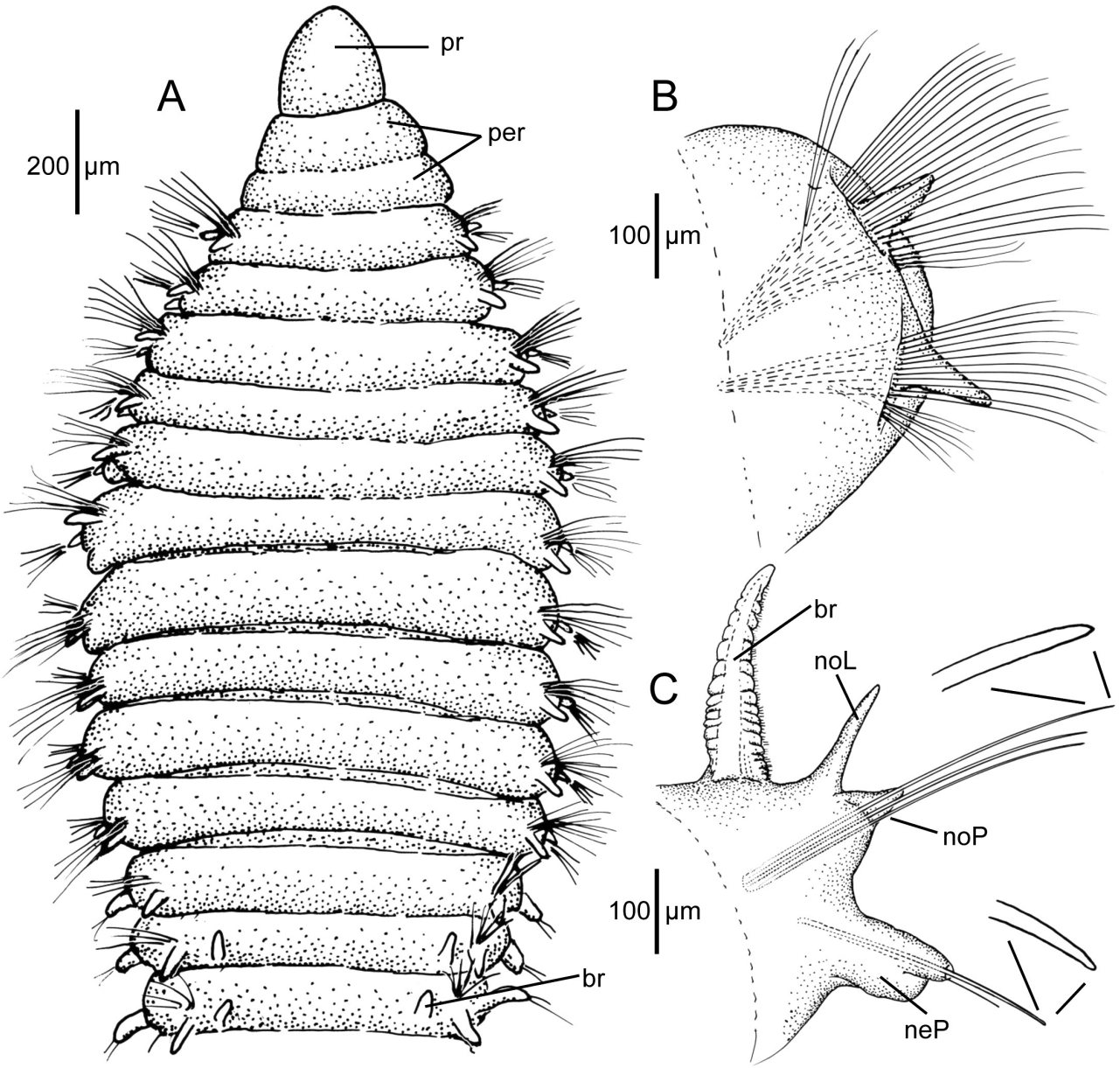

FIGURE 10. *Berkeleyia lelievre* **n. sp**. A, anterior end, dorsal view; B, thoracic setiger 7, anterior view; C, posterior abdominal setiger, anterior view, insets, detail of tips of spines, not to scale. A, C, holotype (MCZ 154094), B, paratype (MCZ 154095).

Genus *Califia* Hartman, 1957 Emended

Type-species: *Califia calida* Hartman, 1957, by original designation.

Diagnosis. Prostomium pointed. Peristomium consisting of a single achaetous ring. Transition from thorax to abdomen abrupt due to distinct change in neuropodia. Branchiae from thoracic setiger 8–10; each branchia simple, lanceolate, may be lacking in most of abdominal region. Neuropodia with or without postsetal lobe; subpodial lobes absent. Abdominal segments lacking interramal and ventral cirri. Thoracic setigers 1–3 with dense fascicles of thickened uncini in neuropodia and 0 to few capillaries; 0 to few similar spines or uncini present in subsequent thoracic neuropodia, but capillaries numerous; neuropodial uncini with shafts either smooth or with ribs; tip of shaft

with distinct sheath, often frayed, appearing bristled in light microscopy. Thoracic notosetae all capillaries. Abdominal notosetae including capillaries; furcate setae; flail setae present or absent; no uncini; abdominal neurosetae capillaries and imbedded uncini. Pygidium a rounded lobe with two long anal cirri.

Remarks. Specimens of a single species, *Califia calida* Hartman, 1967, were found in the present study. The genus is small, with only five known species (Blake 2017), all characterized by having heavy spines or uncini in the first three thoracic neuropodia, resulting in setigers 1–3 appearing superficially different from other thoracic segments. Pettibone (1957) noted that a few spines were sometimes present among the capillaries of the unmodified setiger 4 of *C. schmitti* (Pettibone, 1957) and Blake (2017) observed extra spines on setigers 4–5 of the holotype of *C. chilensis* Hartman, 1967. However, the presence and number of extra spines after setiger 3 is variable; only one specimen of *C. calida* in the present study exhibited an extra transitional spine on setiger 4.

Califia calida Hartman, 1957

Figures 11–12

Califia calida Hartman, 1957: 306–308, pl. 42, figs. 1–3; 1966: 109; 1969: 17–18, figs. 1–3; Fauchald 1972: 163–164; Blake 1996: 11–12, fig. 1.3; Imajima 1997: 191, fig. 12 a–h; 2009: 109.

Material examined. **Continental slope, off northern California**, **west of Farallon Islands**, **US Navy 103 Site Selection survey**, R/V *Wecoma*, coll. J.A. Blake, Sta. B-22, 25 July 1991, 37°31.75′N, 123°17.95′W, 2045 m, 1 specimen (CASIZ 234038).—**US EPA 102 Site Selection Survey**, **off Half Moon Bay,** R/V *Point Sur*, coll. J.A. Blake, **north of Pioneer Canyon**, Sta. 3-7, 14 Sep 1991, 37°27,44′N, 123°19.50′W, 1675 m, 1 specimen (CASIZ 234040); **south of Pioneer Canyon**, Sta. 4-6. 17 Sep 1991, 37°14.03′N, 123°16.84′W, 2010 m,1 specimen (CASIZ 234029); Sta. 4-15,19 Sep 1991, 37°12.42′N, 123°15.81′W, 1730 m, 1 specimen (CASIZ 234033).—**SF-DODS Benthic Monitoring Program**, **west of Farallon Islands**, R/V *Point Sur*, coll. J.A. Blake, Sta. 2, 11 Dec 1996, 37°41.00′N, 123°30.00′W, 2600 m, 1 specimen (CASIZ 234031); Sta. 16, 11 Jul 2007, 37°37.981′N, 123°26.957′, 2699 m, 1 specimen (CASIZ 234037); Sta. 114, 26 Sep 2003, 37°34.97′N, 123°26.98′′W, 2387 m, 1 specimen (CASIZ 234039); Sta. 116, 26 Sep 2003, 37°35.08′N, 123°29.06′W, 2730 m, 1 specimen (JAB).—**Continental margin off Oregon, Cascadia Subduction Zone, NW Knoll, seeps,** R/V *Sonne* Cruise 143, Sta. 68-2, TV-G, coll. H. Sahling, 27 Jul 1999, 44°43.686′N, 125°13.864′W, 946 m, 1 specimen (MCZ 153558).—**South China Sea, off Brunei, Island of Borneo**, Site CA1, R/V *Emma*, coll. J.A. Blake, box corer, Sta. 19, coll. 05 Jun 2011, 5°47.479′N, 114°9.317′E, 1487m, 1 specimen (UBD); Sta. 58, 01 Jun 2011, 5°44.766′N, 114°17.468′E, 1127 m, 1 specimen (MCZ 153580).

Description. A moderately sized species, largest specimen from off northern California nearly complete, 33 mm long and 2.2 mm wide for 114 setigers (Blake 1996); largest specimen in present study from off Oregon, 12.2 mm long, 2.0 mm wide for 35 setigers; larger incomplete specimens reported from original materials 80–100 mm long and 6.5 mm wide (Hartman 1957). Only complete specimen from US Navy Sta. B-22 (CASIZ 234038) small, 3.2 mm long, with 33 setigers. Color in alcohol: light tan; some specimens reported with variable amounts of dark pigment on dorsum from about setiger 9–10 and posteriorly (Blake 1996).

Prostomium conical, tapering to narrow rounded apex (Figs. 11A–B, 12A); eyespots absent; nuchal organs conspicuous elevated mounds, with apical cilia, arising at border with peristomium (Fig. 11B). Peristomium short, rectangular, about twice as wide as long with a single annular ring (Fig. 11A–B), extending ventrally and forming anterior and posterior lips of mouth (Fig. 11B).

Thorax with 9–14 setigers, with higher number on largest specimens. Branchiae from thoracic setigers 8–9 (Figs. 11A, 12A), short at first, becoming full size in abdominal segments, continuing posteriorly. Setigers 1–3 with short, digitate postsetal notopodial lamellae (Fig. 11A, C); neuropodia with short rounded or spherical postsetal lobes (Fig. 11C). Subsequent thoracic segments with elongate digitate noto- and neuropodial postsetal lamellae. Abdominal notopodia narrow, thin lobes (Fig. 11D). Abdominal neuropodia dorsally elevated, expanded apically, divided into two more or less equal lobes between which capillary setae arise (Fig. 11D). Thoracic segments uniannulate; abdominal segments bi-annulate, best developed on venter.

All thoracic notosetae dense fascicles of camerated capillaries (Fig. 11C, 12B-C, F). Setigers 1–3 with modified neurosetae (Figs. 11C, E–F; 12B, D–E), set off from setiger 4 and following segments (Figs. 11C, 12B). Thoracic neurosetae of setigers 1–3 of three types: (1) anterior row of 10 or more short, narrow ribbed uncini with adhering

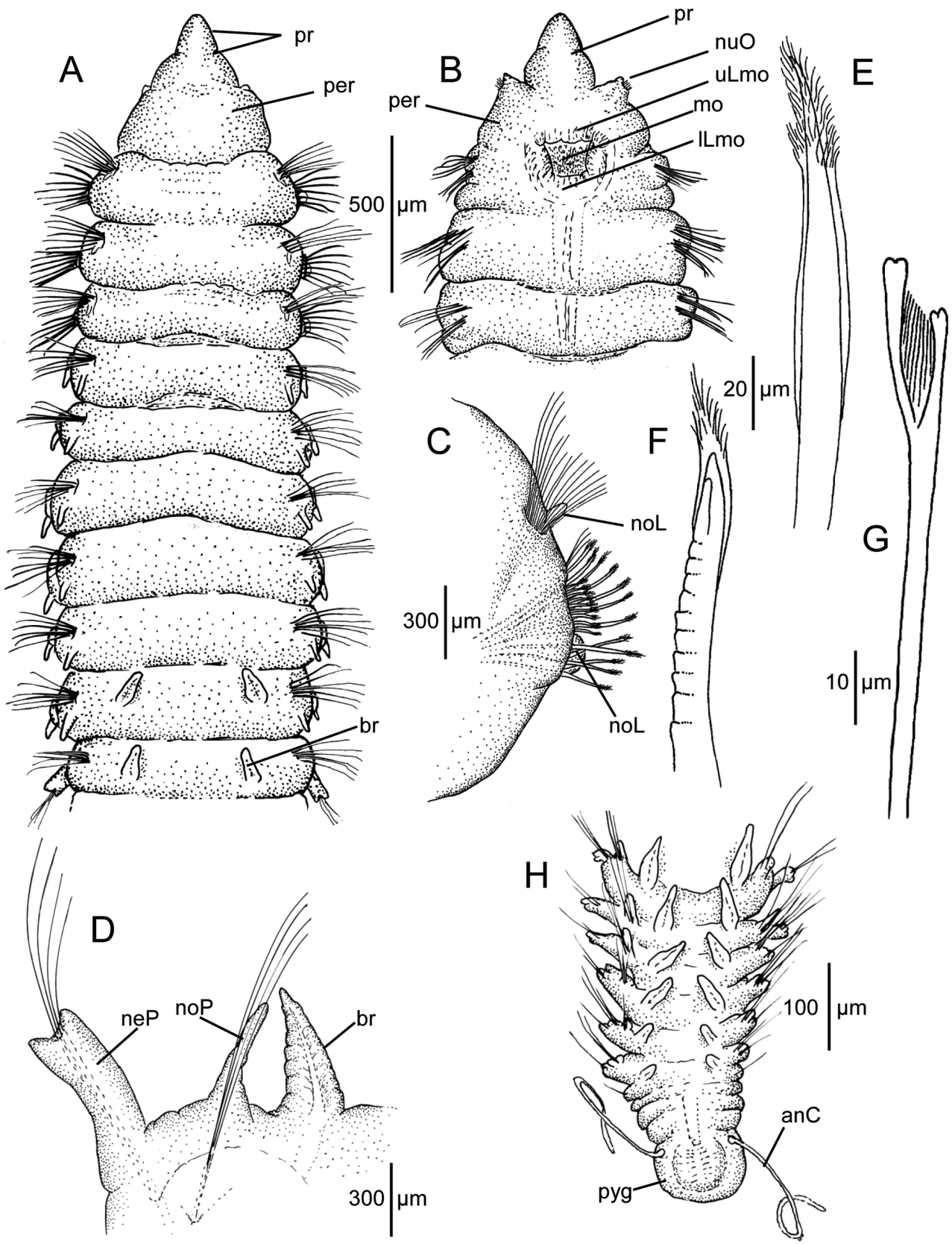

FIGURE 11. *Califia calida* Hartman, 1957. (CASIZ 234031): A, anterior end, dorsal view. (CASIZ 234031): B, anterior end, ventral view. (CASIZ 234040): C, setiger 2, anterior view; D, middle abdominal setiger, anterior view; E, long, smooth neuropodial spine from setiger 2; F, short, ribbed neuropodial spine, setiger 2; G, abdominal notopodial furcate seta; H, posterior end, dorsal view.

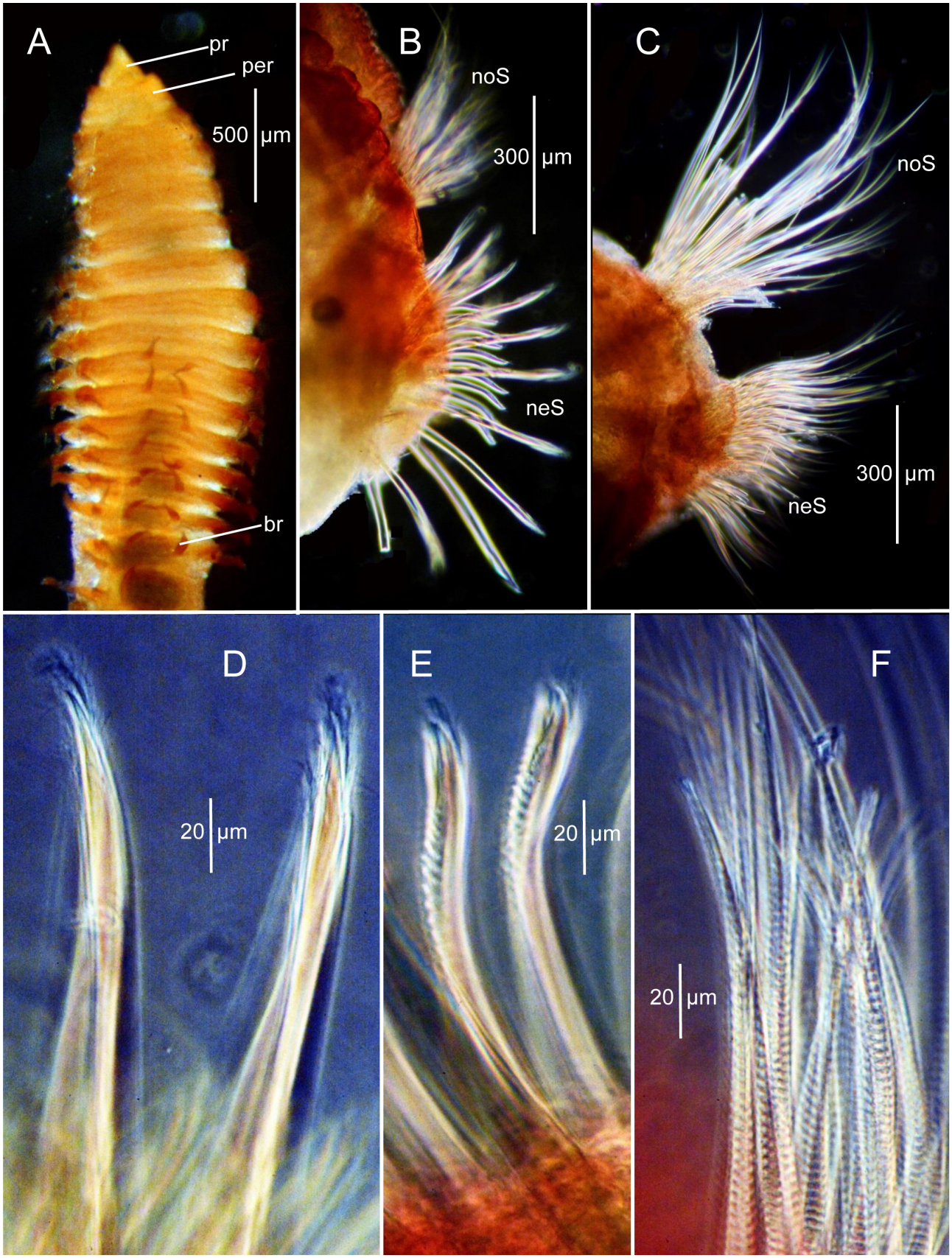

FIGURE 12. *Califia calida* Hartman, 1957. (CASIZ 234037): A, anterior end, dorsal view. (CASIZ 234040): B, setiger 2, anterior view; C, middle thoracic setiger, anterior view; D, long, smooth neuropodial spines from setiger 2; E, short, ribbed neuropodial spines from setiger 2; F, group of notopodial capillary setae from setiger 3. Stained with Shirlastain A.

sheath, fragmenting apically into tattered bristles (Figs. 11F, 12B,E), (2) 1–2 rows of long, heavy spines, mostly without ribs, bearing narrow adhering sheath dividing into apical bristles, sometimes extending beyond end of seta (Figs. 11E, 12D), and (3) superior fascicle of thin camerated capillaries; subsequent thoracic setigers with dense fascicles of short and long camerated capillaries (Fig. 12C, F). Abdominal notosetae include long, camerated capillaries and 2–3 delicate furcate setae (Fig. 11G). Abdominal neurosetae 5–10 thin capillaries.

Pygidium a rounded lobe with two long, thin anal cirri (Fig. 11H).

Variability. In larger specimens of *C. calida,* there are two rows of the long, smooth neuropodial spines on setigers 1–3; when present, the two rows are joined ventrally by 1–2 ventral-most spines forming a U-shape, similar to neuropodial uncini in some species of *Leodamas* (Blake 2017).

Methyl Green stain. No pattern, body stains uniformly and de-stains rapidly.

Remarks. *Califia calida* is similar to *C. mexicana* Fauchald, 1972 in parapodial and most setal morphology. The main differentiating character is the presence of an extra bundle of capillary neurosetae in setigers 1–3 of *C. calida* that is reported to be absent in *C. mexicana* by Fauchald (1972). However, Fauchald (1972) also reported *C. calida* in samples from off Mexico and a careful review of all of the Mexican specimens is needed to confirm the validity of *C. mexicana*.

Like most deep-water orbiniids reported in this study, *Califia calida* is relatively rare, with fewer than 10 specimens collected from the various site reconnaissance and monitoring programs off northern California since 1991. No specimens were collected in the most recent SF-DODS surveys of 31 samples (2015–2017). Hartman's (1957) original collection consisted of 20 specimens from upper slope depths of 430–764 m whereas most subsequent reports by Fauchald (1972), Blake (1996), and this study are from middle and lower slope depths greater than 1100 m. Imajima (1997), however, reported the species from Suruga Bay, Japan, in 180–740 m.

Blake (1996) noted that thoracic setiger 4 of *C. calida* sometimes exhibited a few acicular spines suggesting a transitional segment between the modified setigers 1–3 and the following thoracic setigers where all setae are camerated capillaries. One specimen (CASIZ 234029) did exhibit a single acicular spine in setiger 4; transitional spines were not observed in other specimens examined in this study.

Both specimens from the South China Sea have all of the main characters of *C. calida* including details of the neuropodial uncini of setigers 1–3. Furcate setae were not observed in abdominal notopodia, however, both specimens are incomplete and exhibit damage to the posterior parapodia.

The present description of the pygidial morphology (Fig. 11H) appears to be first record of this structure in any species *Califia*.

Distribution. Eastern Pacific Ocean, San Pedro Basin, California, 430–764 m (Hartman 1957); middle and lower slope depths from off Oregon to Mexico; 946–2730 m; western Pacific Ocean, Japan, 180–740 m; South China Sea off Brunei, 1127–1487m.

Genus *Naineris* Blainville, 1828

Naineris Blainville, 1828. **Type-species:** *N. quadricuspida* (Fabricius, 1780), by monotypy.
Synonyms:
Anthostoma Schmarda, 1861. Preoccupied. **Type-species**: *Anthostoma ramosum* Schmarda, 1861 (=*Naineris laevigata*), designated by Pettibone (1957).
Lacydes Kinberg, 1866. Preoccupied. Type-species: *Lacydes havaicus* Kinberg, 1866 (=*Naineris laevigata*), by monotypy.
Polynaineris Pettibone, 1957. **Type-species**: *Naineris laevigata* (Grube, 1855), by original designation.
Variant spellings. *Naidonereis* Malmgren, 1867; *Nainereis* Mesnil & Caullery, 1898; *Naidoneris* Webster & Benedict, 1887.

Diagnosis. Prostomium rounded or truncate on anterior margin. Peristomium with one or two achaetous rings. Thorax with 12–30 or more segments; branchiae first present from setiger 2–23. Thoracic neuropodia with 0–2 postsetal lobes; no subpodial lobes. Thoracic neurosetae include capillaries, or capillaries mixed with blunt-tipped uncini, sometimes hooded, or uncini and subuluncini. Abdominal setae include capillaries and sometimes furcate setae in notopodia and capillaries and imbedded or protruding aciculae in neuropodia. Paired dorsal sensory organs present in some species.

Remarks. There are few species of *Naineris* known from the eastern Pacific. The most common is *N. dendritica* (Kinberg, 1867), which ranges from Alaska to southern California and occurs in intertidal and shallow subtidal sedi-

ments (Hartman 1957; Blake 1996; Blake & Ruff 2007). *Naineris* cf. *grubei* (Gravier, 1908) was reported by Blake (1996) based on juveniles discovered in the Santa Maria Basin. However, it is likely that those specimens were actually juveniles of *Naineris uncinata* Hartman, 1957. In the present study, specimens of *N. uncinata* were identified from gas hydrate and seep sediments off Oregon at the Cascadia Subduction Zone.

Naineris uncinata Hartman, 1957

Figure 13

Naineris uncinata Hartman, 1957: 301–302, Pl. 38, figs. 1–8; 1960: 107; 1961: 26; 1969: 32–33, 4 figs.
Naineris (*Naineris*) *berkeleyorum* Pettibone, 1957: 165–167, Fig. 4 a–f.
Naineris cf. *grubei*: Blake 1996: 20–22, fig. 1.8. **Not** Gravier 1908.

Material examined. **Continental margin off Oregon, Cascadia Subduction Zone, Southern summit of Hydrate Ridge**, R/V *Sonne* Cruise 143, coll. H. Sahling, Sta. 179, TV-multicore, 17 Aug 1999, 44°34.2′N, 125°08.8′W, 786 m, 29 specimens (MCZ 153572); R/V *Atlantis,* coll. G. Rouse, HOV *Alvin* Dive 4629, 01 Aug 2010, 44º34.255′N, 125º09.289′W, 809 m, 1 specimen (SIO-BIC A2069); HOV *Alvin* Dive 4631, 03 Aug 2010, 44º40.173′N, 125º05.899′W, 618 m, 1 specimen (SIO-BIC A2082); HOV *Alvin* Dive 4633, 05 Aug 2010, 44º27.039′N,125º01.975′W, 643 m, 1 specimen (SIO-BIC A2102); HOV *Alvin* Dive 4634, 06 Aug 2010, 44º40.185′N, 125º05.974′W, 603 m, 2, specimens (SIO-BIC A2105); HOV *Alvin* Dive 4635, 07 Aug 2010, 44º34.118′N, 125º09.076′W, 795 m, 3 specimens (SIO-BIC A2113); ROV *Jason* II Dive 593, 02 Sep 2011, 44°40.17212′N, 122°5.88719′W, 795 m, 1 specimen (SIO-BIC A2659); ROV Jason II Dive 593, HR6, 06 Sep 2011, 44.67′N, 122.098′W, 795 m, 2 specimens (SIO-BIC A2660, A2661).—**Seeps at Northern Hydrate Ridge**, BSR-outcrop, R/V *Sonne* Cruise 143, coll. H. Sahling, Sta. 167, TV-Grab, 16 Aug 1999, 44°50.550′N, 125°55.827′W, 567 m, 1 specimen (MCZ 153573).

Description. A large species, recorded up to 180 mm long, 3 mm wide, with about 350 segments (Pettibone 1957); largest specimen in current collection incomplete (SIO-BIC A2113), 18.5 mm long, 1.8 mm wide, with 50 segments. Complete juvenile 3.05 mm long with 36 setigers; larger incomplete juvenile 5.2 mm long with 44 setigers. Body with laterally expanded thoracic segments, dorsoventrally flattened, with narrow crowded segments, about ten times wider than long (Fig. 13A); abdominal segments oval in cross section with venter rounded, individual segments shorter, narrower, less crowded, about three times wider than long. Parapodia continuing across abdominal venter as broad annular ring, with intersegmental areas subdivided into two narrow rings, producing triannulate segments. Some specimens with oval-shaped protozoans attached to thoracic parapodia. Color in alcohol white to light tan.

Prostomium short, thick, rounded to truncate on anterior margin (Fig. 13A); eyespots absent; nuchal organs transverse grooves on posterior lateral margin (Fig. 13B). Peristomium a single ring, narrower than, but about same length as, setiger 1 (Fig. 13A); extending ventrally to form ventral lip of mouth.

Thorax recorded with 17–26 setigers by Hartman (1957) and Pettibone (1957) and 13–14 setigers by Blake (1996); largest specimens in present collection with 14–15 thoracic setigers and 1–2 transitional setigers. Branchiae from setiger 4–6, short at first (Fig. 13A), becoming longer over thoracic segments and longest in middle and abdominal segments, continuing to posterior end; individual branchiae erect, tapering to narrow rounded apex, with dense lateral ciliation.

Thoracic notopodia with a narrow, tapering postsetal lamella and dense fascicles of long, camerated capillaries (Fig. 13D). Abdominal notopodia with a long, narrow postsetal lobe and a fascicle of long, thin camerated capillaries and 1–3 furcate setae with unequal, blunt-tipped tynes and a row of thin needles between tynes. Thoracic neuropodia thickened basally with an elongated postsetal lamella; a second lamella beginning ventral to the first at about setiger 10 (Fig. 13B–D), continuing on a few abdominal segments before disappearing. Juveniles of about 5 mm or less lacking second neuropodial postsetal lamella. Neurosetae of thoracic segments include 2–4 rows of thick uncini with transverse ribs along their length, terminating in a flattened, weakly notched tip surrounded by thin transparent hood (Fig. 13E–F). Uncini accompanied by long, thin camerated capillaries (Fig. 13E–F), both interspersed and as 1–2 separate posterior rows. Abdominal neuropodia narrow, ending in bilobed tip with short inner, rounded lobe and longer narrow outer lobe. Setae include a few thin, capillaries and 1–2 thicker, blunt-tipped projecting aciculae.

Pygidium with four lobes surrounding anus, each bearing a short cirrus.

Methyl Green stain. No pattern; prostomium not staining; body stains uniformly, de-stains rapidly.

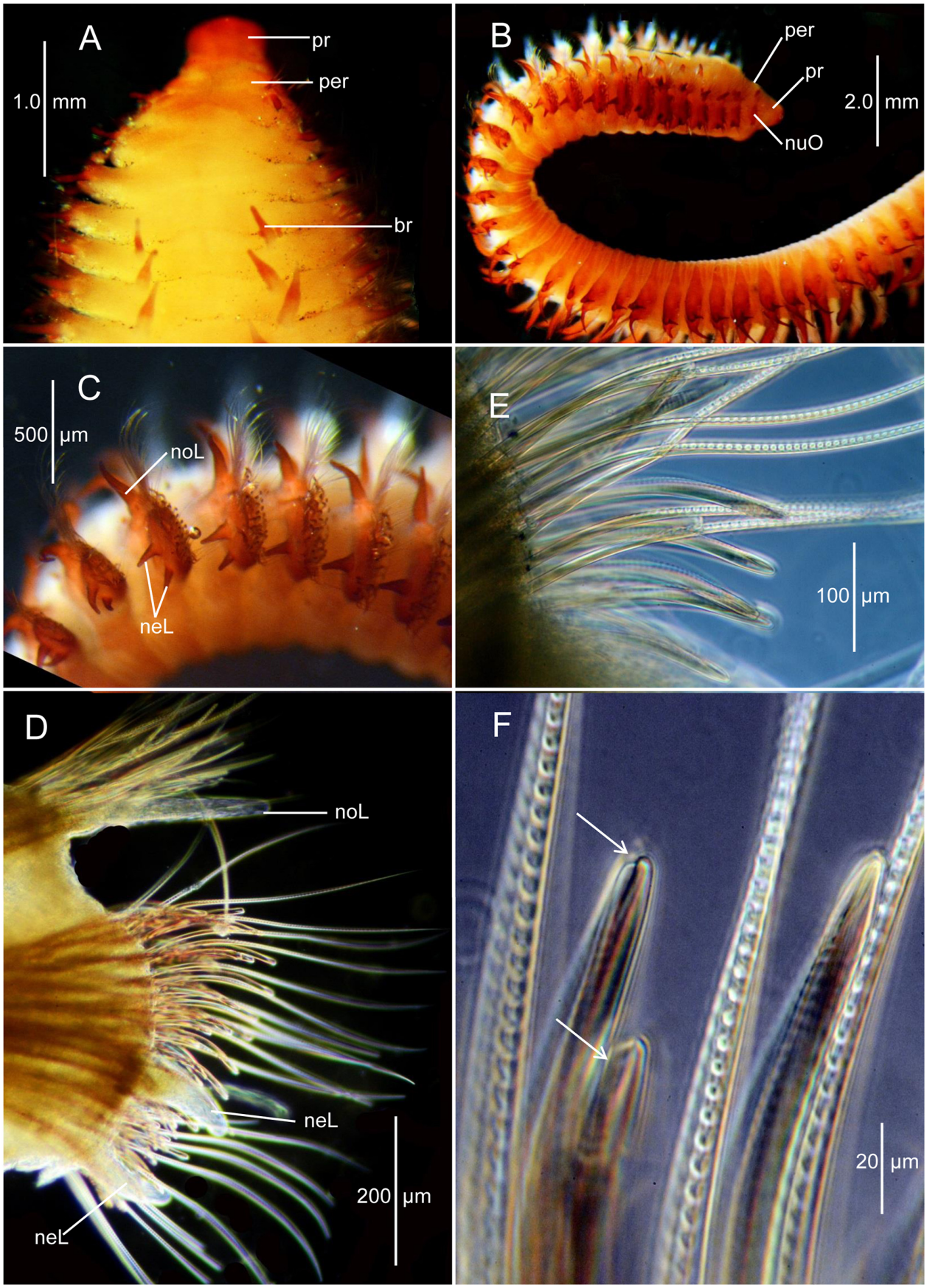

FIGURE 13. *Naineris uncinata* Hartman, 1957. (MCZ 153572): A, anterior end, dorsal view; B, anterior end, right lateral view; C, posterior thoracic segments, right lateral view; D, posterior thoracic parapodium, anterior view; E, fascicle of thoracic neurosetae; F, detail of thoracic neuropodial uncini and capillaries. Stained with Shirlastain A.

GenBank accession numbers: SIO-BIC A2069: **MN816166;** SIO-BIC A2659: **MN816167;** SIO-BIC A2660: **MN816168;** SIO-BIC A2661:**MN816169.**

Remarks. *Naineris uncinata* is characterized by having a short, blunt prostomium, a mixture of thoracic neuropodial capillaries and uncini with transverse ribs along the shaft and a notched tip, branchiae from setigers 4–6, and most importantly a second neuropodial postsetal lamella in posterior thoracic and some transitional segments. However, in the present study, juveniles ranging in size from 3–5 mm long and with 36–44 setigers that are clearly *Naineris uncinata* have all characteristics of the adults except for the second neuropodial lamella of posterior thoracic segments. Evidently, the extra cirrus does not develop until later in development. This discovery suggests that the small specimens identified as *N*. cf. *grubei* by Blake (1996) are in fact *N. uncinata*.

The range and depths recorded for *Naineris uncinata* are unusual, ranging from the intertidal and low water to middle slope depths down to about 600 m. However, the majority of historical records are from about 70–150 m with relatively few specimens recorded from any one location (Hartman 1957; Pettibone 1957). In the present study, larger numbers of specimens have been recorded from gas hydrate seeps off Oregon in 786 m suggesting that the preferred habitat for the species might be in such locations.

Distribution. Alaska to southern California, shallow subtidal to ca. 620 m (Hartman 1957; Pettibone 1957). Upper slope depths of 567–795 m off Oregon in gas hydrate and seep sediments on the Cascadia Subduction Zone (this study).

Genus *Phylo* Kinberg, 1866

Type-species: *Phylo felix* Kinberg, 1866, by monotypy.

Diagnosis. Prostomium pointed on anterior margin; peristomium with one achaetous ring. Branchiae first present from setiger 5–7. Posterior thoracic segments with several postsetal lobes and subpodial lobes (at least five of each type) together usually forming ventral fringe. Thoracic neurosetae include blunt uncini and crenulated capillaries; posterior thoracic segments with modified spear-like spines in neuropodia. Flail setae present or absent in posterior abdominal notopodia.

Remarks. Species of *Phylo* are characterized by having a posterior section of the thoracic region modified and bearing long, pointed spines in the neuropodia. These spines provide species of *Phylo* with an obvious and practical distinctness that makes them easy to identify. Twelve species of *Phylo* are considered valid (Read & Fauchald 2019). Specimens of *P. nudus* (Moore, 1911) were encountered in the present study and include the deepest known records for the species.

Phylo nudus (Moore, 1911)

Aricia nuda Moore, 1911: 311–315, pl. 21, figs 172–176.
Phylo nudus: Hartman, 1957: 268; 1969: 39–40, figs. 1–4; Blake 1996: 13, Fig. 1.4; Imajima 1997: 188–189, Fig. 11a–l; 2009: 113.

Material examined. **Continental slope off central California, Point Conception, US DOE, MMS Benthic Reconnaissance Survey**, Sta. 078 BSS-1, 09 Nov 1983, coll. SAIC, 34°18.775′N, 120°49.301′W, 774 m, 1 specimen (USNM 1594175).—**off northern California**, **US EPA 102 Site Selection Survey**, **off Half Moon Bay,** R/V *Point Sur*, coll. J.A. Blake: **north of Pioneer Canyon**, Sta. 3-17, 15 Sep 1991, 37°22.18′N, 123°16.76′W, 1457 m, 1 specimen (CASIZ 234028); **south of Pioneer Canyon**, Sta. 4-4, 18 Sep 1991, 37°16.13′N, 123°14.18′W, 1427 m, 1 specimen (CASIZ 234027); **Pioneer Canyon**, Sta. C-3, 19 Sep 1991, 37°20.21′N, 123°08.84′W, 1400 m, 1 specimen (CASIZ 234036).—**Eastern Pacific Ocean, west of Costa Rica**, R/V V*ema*, coll. Lamont-Doherty Geological Observatory, Sta. V-15-20, 22 Nov 1958, 09°18′N, 89°32′W, trawl, 3501–3503 m, 1 specimen (LACM-AHF Poly 5006); Sta. V-15-50, 22 Nov 1958, 09°18′N, 89°32′W, trawl, 3501–3503 m, 1 specimen (LACM-AHF Poly 5007); Sta. 15-52, 23 Nov 1958, 09°20.5′N, 89°39′W, trawl, 3475–3497 m, 1 specimen (LACM-AHF Poly 5004).

Remarks. *Phylo nudus* differs from other species of the genus in lacking a fringe of subpodial or stomach papillae extending across the venter of the thoracic region. In addition, the modified neuropodial spines of the posterior

thoracic region are relatively simple, differing from the spear-like spines of related species. The morphology of these specimens agrees well with the most recent description of the species by Blake (1996).

Although *P. nudus* is an offshore species known from shelf and slope depths, the present specimens from off Costa Rica in 3475–3503 m represent the deepest records for this species.

Distribution. Eastern Pacific Ocean, California to Costa Rica, 760–3503 m; western Pacific Ocean, off Japan, 230–510 m.

Genus *Scoloplos* de Blainville, 1828

Type species: *Lumbricus armiger* Müller, 1776, by monotypy.
Synonym: *Scolaricia* Eisig, 1914. Type-species: *Scolaricia typicus* Eisig, 1914, by monotypy. *Fide* Day 1973.

Diagnosis. (Emended). Prostomium pointed, usually prolonged; single achaetous peristomial ring. Branchiae first present from middle or posterior thoracic setigers or from abdominal setigers (8–26). Posterior thoracic setigers with 0–2 postsetal lobes and 0–2 subpodial lobes, never more than four lobes of both types combined; not forming ventral fringes. Thoracic neurosetae including blunt, inconspicuous uncini, few or many in distinct rows; accompanied by few to many crenulated capillaries; furcate setae usually present; heavy spear-like spines and bristle-topped setae absent. Abdominal neuropodia with embedded, non-projecting acicula. Abdominal noto- and or neuropodial flail setae present or absent.

Remarks. The type-species of *Scoloplos*, *S. armiger* has been reported globally despite there being no recent description of the species from the type-locality in Norway. Although most descriptions of *S. armiger* include the presence of subpodial papillae along the body, there have been two different patterns reported for the neuropodial spines or uncini that occur in thoracic neuropodia. One pattern is where there are numerous rows of uncini and fewer capillaries in thoracic neuropodia (Hartman 1957; Hartmann-Schröder 1996). A second pattern is where there are only a few uncini that typically occur in the ventral-most part of the fascicle and in the first or second setal row (McIntosh 1910; Pettibone 1963); capillaries are numerous in this second pattern and the uncini may not occur in all thoracic neuropodia. Both of these patterns have been reported widely and it is not apparent which of these actually refers to *S. armiger* from the type-locality in Norway. Recent ecological investigations and results of molecular sequence data in northern Europe suggest that at least three distinct populations or species of *Scoloplos* are present (Kruse & Reise 2003; Bleidorn *et al*. 2006).

Bleidorn *et al*. (2006, 2009) also provided molecular results on some orbiniids from the eastern Pacific that suggested that specimens identified as *S. armiger* from California are distinct from the European populations and represent additional undescribed species. To date, none of the various species suggested by these studies in Europe and California have been described or redescribed, including specimens from the type locality of *S. armiger*.

Among approximately 28 known species of *Scoloplos*, only three have been recorded from deep-sea habitats: *S. ehlersi* Blake, 1985 from the Galápagos Rift hydrothermal mounds, *S. bathytatus* Blake, 2017 from the Weddell Sea, Antarctica, and *S. intermedius* (Hartman, 1965) from the western North Atlantic. Two new species, *S. californiensis* **n. sp.** from off northern California and *S. sparsaciculus* **n. sp.** from off Brunei in the South China Sea have been discovered in the deep-water samples treated in the present study and are described. Both of these new deep-water species belong to the group having a reduced number of thoracic uncini in thoracic neuropodia.

Scoloplos californiensis new species

Figure 14
urn:lsid:zoobank.org:act:63650C44-3B94-4CD3-A541-E4A57F9B849F

Scoloplos armiger: Hilbig & Blake 2006: 265. **Not** Müller 1776.

Material examined. Continental slope, off northern California, **US EPA 102 Site Selection Survey**, **off Half Moon Bay,** R/V *Point Sur*, coll. J.A. Blake: **north of Pioneer Canyon**, Sta. 3-12, 15 Sep 1991, 37°25.03′N, 123°18.00′W, 1745 m, **holotype** (LACM-AHF Poly 11664); Sta. 3-14, 15 Sep 1991, 37°23.51′N, 123°12.16′W, 1880 m, **paratype** (LACM-AHF Poly 11665); **south of Pioneer Canyon**, Sta. 4-15, 19 Sep 1991, 37°12.42′N, 123°15.81′W, 1730 m, **paratype** (LACM-AHF Poly 11666).

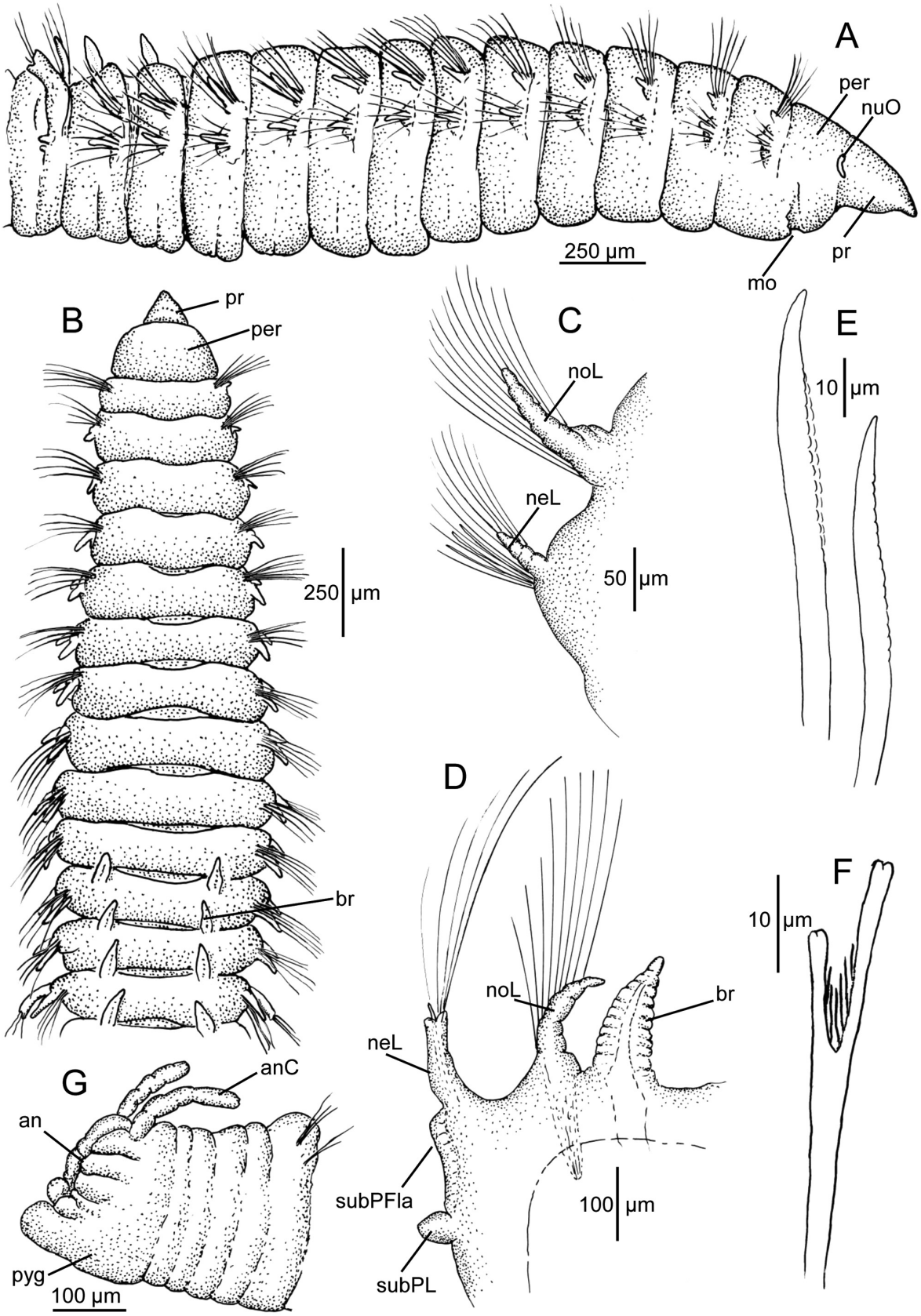

FIGURE 14. *Scoloplos californiensis* **n. sp**. A, anterior end, left lateral view; B, anterior end, dorsal view; C, thoracic setiger 7, left side, posterior view; D, abdominal setiger 16, left side, posterior view; E, thoracic neuropodial uncini; F, furcate seta from abdominal notopodium; G, posterior end, left lateral view. A, C–G holotype (LACM-AHF Poly 11664); B, paratype (LACM-AHF Poly 11665).

Description. An elongate, narrow-bodied species, cylindrical in cross section. Holotype complete, in three pieces, with about 120 setigers, 21.7 mm long, 0.51 mm wide across thorax; paratype from Sta. 4-10 incomplete, with 36 setigers, 6.5 mm long, 0.68 mm wide across thorax. Most segments intact, well-preserved. Thorax with 12 setigers on all specimens, last thoracic segment partially transitional on one paratype (LACM-AHF Poly 11665). Thoracic segments narrow, about 4.5 times as wide as long. Dorsal and ventral ridges and grooves absent. Color in alcohol: light tan.

Pre-setiger region relatively short, about as wide as long, triangular (Fig. 14A–B). Prostomium conical, tapering to pointed tip (Fig. 14A–B); nuchal organs vertical curved slits on posterior lateral margin (Fig. 14A); eyespots absent. Peristomium slightly longer than first setiger, with a single smooth annular ring dorsally (Fig. 14B), surrounding mouth ventrally, forming upper and lower lips (Fig. 14A).

Thoracic notopodia with a digitiform postsetal lobe, short at first, then becoming long, narrow in posterior thoracic segments (Fig. 14C); each notopodial lobe arises from a thick but narrow base. Thoracic neuropodia similar, with postsetal lobe shorter, thicker (Figs. 14A, C), arising from a broadly rounded base (Fig. 14C). Transition to abdominal segments abrupt, with fewer noto- and neurosetae; notopodial postsetal lobes continuing as narrow and elongate along rest of body (Fig. 14D); neuropodium becoming elongate, narrow with apex divided into two parts separated by notch (Fig. 14D); each abdominal neuropodium with narrow subpodial flange and 1–2 subpodial papillae on most abdominal segments (Fig. 14D).

Branchiae from a posterior thoracic setiger, 11 or 12 (Fig. 14B); branchiae full size at first, triangular and smooth, becoming wrinkled in middle segments, tapering to papillate tip (Fig. 14D). Branchiae of some middle and posterior setigers with flaglike swelling projecting laterally.

Thoracic notosetae numerous thick, long, camerated capillaries arranged in 4–5 rows. Thoracic neurosetae arranged in about four rows of numerous camerated capillaries and 3–5 uncini in third row. Individual uncini with shafts smooth on convex side, tapering to narrow, rounded tip; concave side of shaft flattened, bearing paired knobs along most of shaft (Fig. 14E). Abdominal notosetae thin, camerated capillaries and 1–2 furcate setae. Furcate setae with unequal tynes, each tyne with blunt tip and apical notch; row of thin needles between tynes (Fig. 14F). Abdominal neurosetae with up to 4–5 thin capillaries each with short barbs along one edge and a single curved aciculum, sometimes protruding, with rounded tip. Flail setae not observed.

Pygidium short, with a single large ventral lobe, about ten shorter lateral lobes surrounding anal opening, and two short dorsal anal cirri.

Methyl Green stain. No pattern.

Remarks. *Scoloplos californiensis* **n. sp.** from off northern California is similar to *S. sparsaciculus* **n. sp.** from off Brunei in the South China Sea (see below) in having thoracic neuropodia with relatively few uncini, a subpodial flange and subpodial lobe in abdominal neuropodia, and similar appearing thoracic neuropodial uncini. Both species also have a similar number of thoracic setigers and initiation of the branchiae. The two species differ most importantly in that *S. californiensis* **n. sp.** has furcate setae in abdominal notopodia that are absent in *S. sparsaciculus* **n. sp.** In addition, the pre-setiger region of *S. californiensis* **n. sp.** is about as wide as long instead of narrower and longer than wide and the thoracic segments are up to 4.5 times as wide as long instead of only about 2.5 times as wide as long. A low interramal process is present on a few anterior abdominal setigers of *S. sparsaciculus* **n. sp.**; this is absent on *S. californiensis* **n. sp.** Up to five uncini are present in thoracic neuropodia of *S. californiensis* **n. sp**. compared to up 1–3 in *S. sparsaciculus* **n. sp.**

Because one important difference separating *S. californiensis* **n. sp.** from *S. sparsaciculus* **n. sp.** appeared to be the presence of furcate setae in abdominal notopodia of the former and their absence in the latter, all 20 specimens of *S. sparsaciculus* **n. sp.** were re-examined and the absence of furcate setae was confirmed.

Etymology. The species is named for its location offshore California at continental slope depths.

Distribution. Off northern California in middle continental slope depths, 1730–1880 m.

Scoloplos sparsaciculus new species

Figures 15–16

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Material examined. South China Sea, off Brunei, Island of Borneo, Site CA1, R/V *Emma*, coll. J.A. Blake, box corer, Sta. 50, 2 Jun 2011, 5°42.932′N, 114°12.392′E, 1214 m, **holotype** (MCZ 153591); Sta. 41, 3 Jun 2011,

5°43.452′N, 114°11.302′E, 1268 m, 1 **paratype** (MCZ 153592); Sta. 11, 6 Jun 2011, 5°50.464′N, 114°10.949′E, 1405 m, 2 specimens (MCZ 153593); Sta. 36, 3 Jun 2011, 5°46.07′N, 114°12.158′E, 1313 m, 1 specimen (MCZ 153594); Sta. 39, 3 Jun 2011, 5°41.492′N, 114°07.681′E, 1443 m, 1 specimen (MCZ 153595); Sta. 44, 2 Jun 2011, 5°47.387′N, 114°15.605′E, 1294 m, 1 specimen (MCZ 153596); Sta. 48, 2 Jun 2011, 5°45.482′N, 114°15.391′E, 1219 m, 1 specimen (MCZ 153597); Sta. 61, 31 May 2011, 5°40.548′N, 114°13.261′E, 1050 m, 1 specimen (UBD).—Site CA2, R/V *Emma*, coll. P.A. Neubert, box corer, Sta. DA3, 3 Jul 2011, 5°25.251′N, 113°29.509′E, 1772 m, 3 **paratypes** (MCZ 153598); Sta. JA1, 30 Jun 2011, 5°28.376′N, 113°36.642′E, 1888 m, 1 specimen MCZ 153599); Sta. JA4, 30 Jun 2011, 5°30.906′N, 113°37.352′E, 1967 m, 1 **paratype** (MCZ 153600); Sta. JA6, 30 Jun 2011, 5°31.035′N, 113°36.46′E, 1999 m, 1 specimen (MCZ 153601); Sta. ME5, 25 Jun 2011, 5°18.475′N, 113°33.071′E, 1572 m, 1 specimen (MCZ 153602); Sta. SE2, 29 Jun 2011, 5°31.362′N, 113°42.309′E, 1955 m, 1 specimen (MCZ 153603); Sta. SE5, 28 Jun 2011, 5°35.739′N, 113°47.115′E, 1947 m, 1 specimen (MCZ 153604); Sta. TA4, 2 Jul 2011, 5°26.28′N, 113°26.45.6′E, 1954 m, 1 specimen (UBD).

Description. All specimens incomplete, most small, less than 3 mm long. Holotype with 56 setigers, 13.7 mm long, 0.4 mm wide across thoracic setigers; paratype from Sta. 41 (MCZ 153592), with 54 setigers, 7.85 mm long, 0.38 mm wide across thorax. All specimens with elongate, narrow bodies (Figs. 15A, 16A), cylindrical in cross section. Most with thoracic and anterior setigers well preserved and intact; posterior segments variable, often with podial lobes and setae damaged. With 9–12 thoracic segments, actual number size related. Thoracic segments narrow, but only about 2.5 times wider than long (Fig. 15A); abdominal segments longer, about twice as long as wide. Color in alcohol: light tan.

Pre-setiger region triangular (Figs. 15A, 16A–B). Prostomium conical, narrowing to rounded tip; nuchal organs oval openings on posterior lateral margin (Figs. 15A, 16B); eyespots absent. Peristomium about 1½ times longer than first setiger, with one smooth annular ring (Fig. 15A). Proboscis with 2–3 thin lobes when everted.

Thoracic notopodia swollen with a digitiform postsetal lamella (Fig. 15B), short at first, then becoming long, narrow in posterior thoracic segments (Fig. 15A). Thoracic neuropodia similar, with postsetal lamella shorter, thicker (Figs. 15B, 16C). Transition to abdominal segments abrupt, with fewer noto- and neurosetae. Thoracic notopodia transitioning in abdomen to short, triangular setal lobe with a long, narrow, finger-like postsetal lamella, often with a swollen or bulbous apex (Fig. 15C). A short interramal process present on a few anterior and middle abdominal setigers (Fig. 15C). Neuropodia elongate, thickened, rounded apically with short, narrow ventral cirrus (Figs. 15C, 16E); narrow subpodial flange present ventral to neuropodium followed by short subpodial papillate lobe (Fig. 15C), sometimes paired in a few transitional setigers. Subpodial papillae not observed on smallest specimens.

Branchiae from last thoracic setiger or an anterior abdominal setiger, usually from setiger 11–14, short at first (Fig. 15A), becoming longer, tapering, sometimes asymmetrical, with subapical enlargement (Fig. 15C).

Thoracic notosetae numerous thick, camerated or bristled capillaries arranged in 3–4 rows. Thoracic neurosetae with about 3–4 rows of similar camerated capillaries (Fig. 16C–D), with posterior row also containing 1–3, rarely 4, inconspicuous uncini (Figs. 15B, 16C–D). Individual uncini with smooth shafts and two rows of small barbs or camerations along one side (Figs. 15D, 16C–D), tapering to narrow pointed tip; camerations not visible in some views (Fig. 15E). Abdominal notosetae thin, camerated capillaries. Abdominal neurosetae with 2–3 thin capillaries and a single curved acicula, sometimes protruding, with rounded tip (Fig. 15C). Furcate and flail setae not observed.

Pygidium not observed.

Methyl Green stain. Prostomium not staining, rest of body stains uniformly with no pattern.

Remarks. Comparative comments for *S. sparsaciculus* **n. sp.** and the closely related *S. californiensis* **n. sp.** are discussed in the Remarks section for the latter species (above). *Scoloplos sparsaciculus* **n. sp.** and *S. californiensis* **n. sp.** both have only a few uncini in thoracic neuropodia. Most species of the genus recorded from the Pacific have two or more rows of uncini that are mixed with numerous longer capillaries (Hartman, 1957). In addition, both species have a subpodial flange and one or two subpodial lobes ventral to the neuropodium in anterior and some middle abdominal setigers.

Scoloplos sparsaciculus **n. sp.** is similar to *S. intermedius* (Hartman, 1965) from slope depths off New England in having 12 thoracic setigers, branchiae from setiger 11, and a subpodial flange and subpodial papillae in abdominal neuropodia. *S. intermedius*, however, has an interramal cirrus on anterior abdominal parapodia (Hartman, 1965; Mackie 1987); an interramal process is also present on a few anterior abdominal segments of *S. sparsaciculus* **n. sp.** but this is low, inconspicuous and not always observed. The two species differ most conspicuously in that the tip of the shaft of some thoracic neuropodial uncini of *S. intermedius* has an apical hood, and furcate setae are present

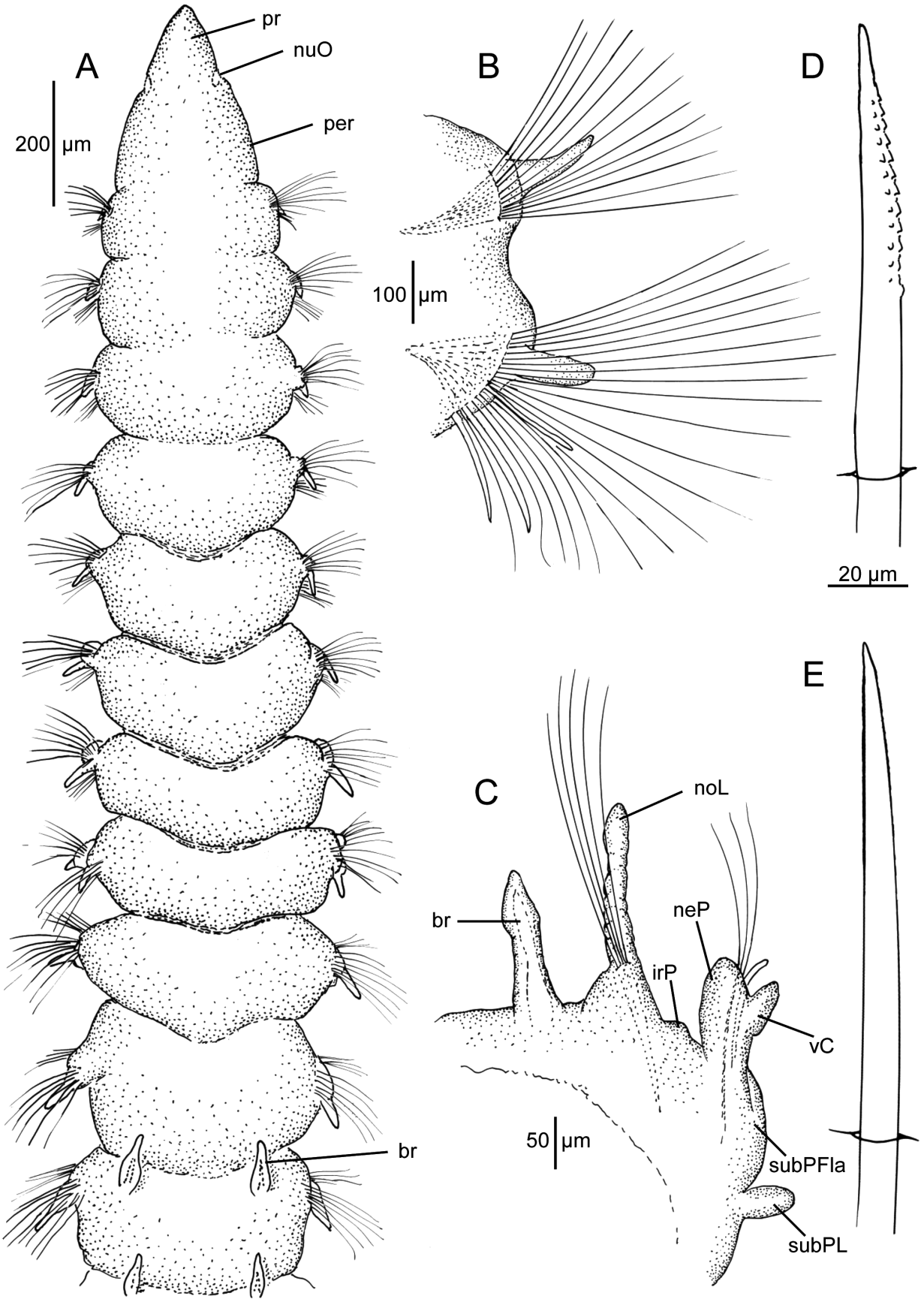

FIGURE 15. *Scoloplos sparsaciculus* **n. sp.** Holotype (MCZ 153591): A, anterior end, dorsal view; B, thoracic parapodium, anterior view; C, middle abdominal parapodium, anterior view; D, E, neuropodial uncini.

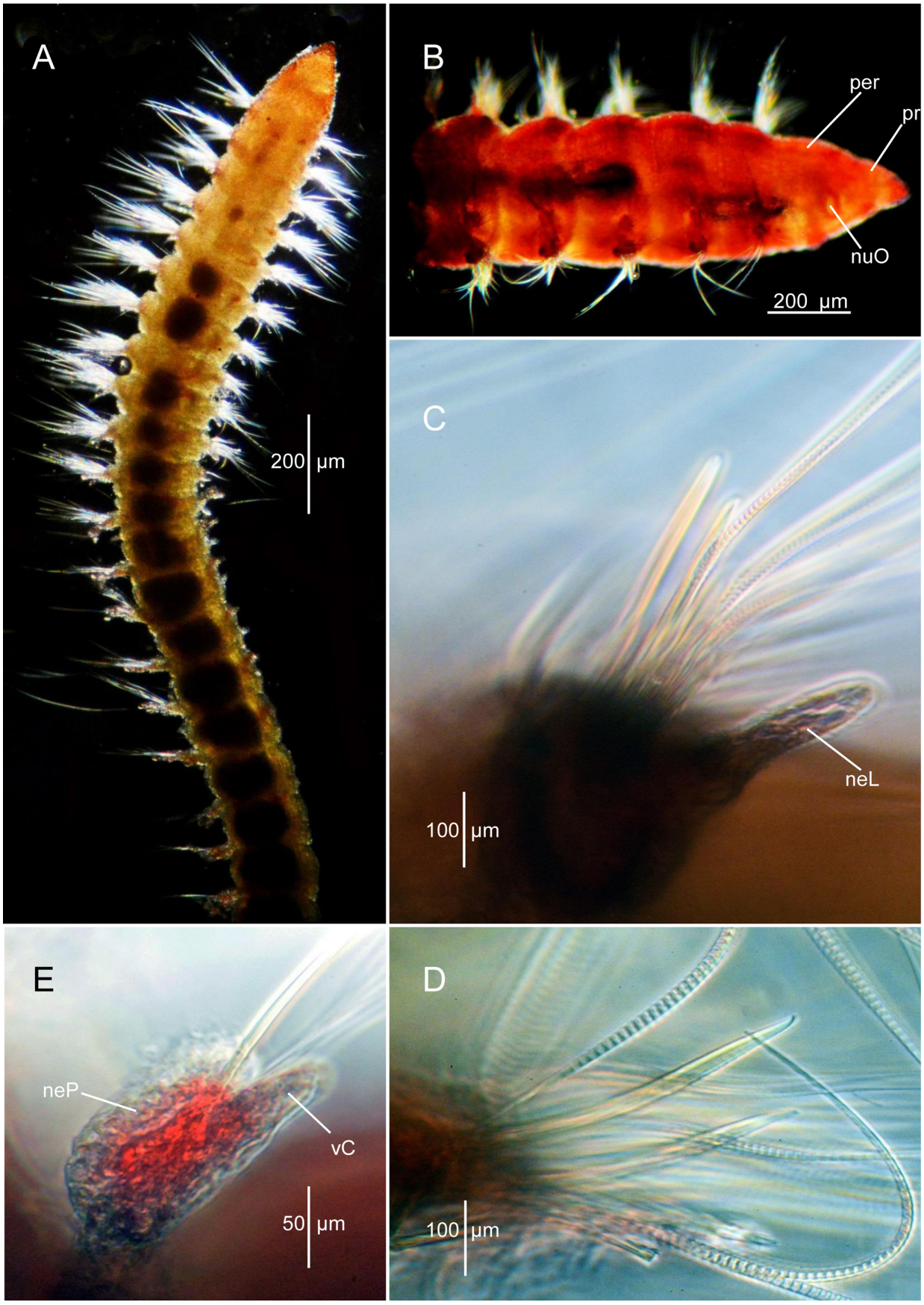

FIGURE 16. *Scoloplos sparsaciculus* **n. sp.** Paratype (MCZ 153600): A, anterior and middle body segments, dorsal view; B, anterior end, right lateral view; C, thoracic neuropodium with uncini and camerated capillaries; D, same, another segment; E, abdominal neuropodium. All stained with Shirlastain A.

in abdominal notopodia; in contrast, *S. sparsaciculus* **n. sp.** has no hood on the tip of thoracic neuropodial uncini and furcate setae are entirely absent. *Scoloplos intermedius* is being redescribed in another paper dealing with U.S. Atlantic deep-water orbiniids (Blake, in preparation).

Etymology. The epithet is from the Latin *sparsus* for few, and *acicula* for small pin or needle, referring to the reduced number of acicular spines or uncini found in thoracic neuropodia of this species.

Distribution. South China Sea, off Brunei, Island of Borneo, 1219–1955 m.

Genus *Leodamas* Kinberg, 1866

Type-species: *Leodamas verax* Kinberg, 1866, by monotypy.
Synonym: *Branchethus* Chamberlin, 1919. **Type-species:** *Branchethus latum* Chamberlin, 1919, by monotypy. *Fide* Hartman 1957.

Diagnosis. (after Blake 2017). Prostomium pointed on anterior margin, usually prolonged; most species with a single achaetous peristomial segment; immature adults of some species with two achaetous peristomial rings and adults of at least one species with vague indication of two achaetous segments. Branchiae single or with multiple branches, either from anterior thoracic setigers 4–7 or from posterior thoracic setigers or first abdominal setigers. Posterior thoracic setigers with 0–2 postsetal lobes and 0–2 subpodial lobes, never more than four lobes of both types combined; not forming ventral fringes. Thoracic neuropodial uncini large, conspicuous, arranged in one to many distinct vertical rows, with accompanying capillaries few or entirely lacking; heavy spear-like spines and bristle-topped setae absent. Abdominal neuropodia with projecting aciculae, either thin and inconspicuous or large and curved apically. Abdominal noto- or neuropodial flail setae present or absent.

Remarks. Blake (2017) redefined *Leodamas* and referred 29 species to the genus; an additional species was subsequently described by Sun *et al.* (2018) from the East China Sea. Blake (2017) divided the species into two groups: (A) species with branchiae from an anterior thoracic setiger (4–7) and thoracic neuropodial uncini typically in three or more rows and (B) species with branchiae from a posterior thoracic or anterior abdominal setiger (12–29) and thoracic neuropodial uncini typically in one or two rows. Based on Blake (2017) and Sun *et al*. (2018), 20 species of *Leodamas* are known from Group A, of which only three have been reported from depths greater than 500 m. An additional species belonging to Group A has been discovered among deep-water samples (>1500 m) from off Brunei in the South China Sea and is here described.

Leodamas bathyalis new species

Figure 17
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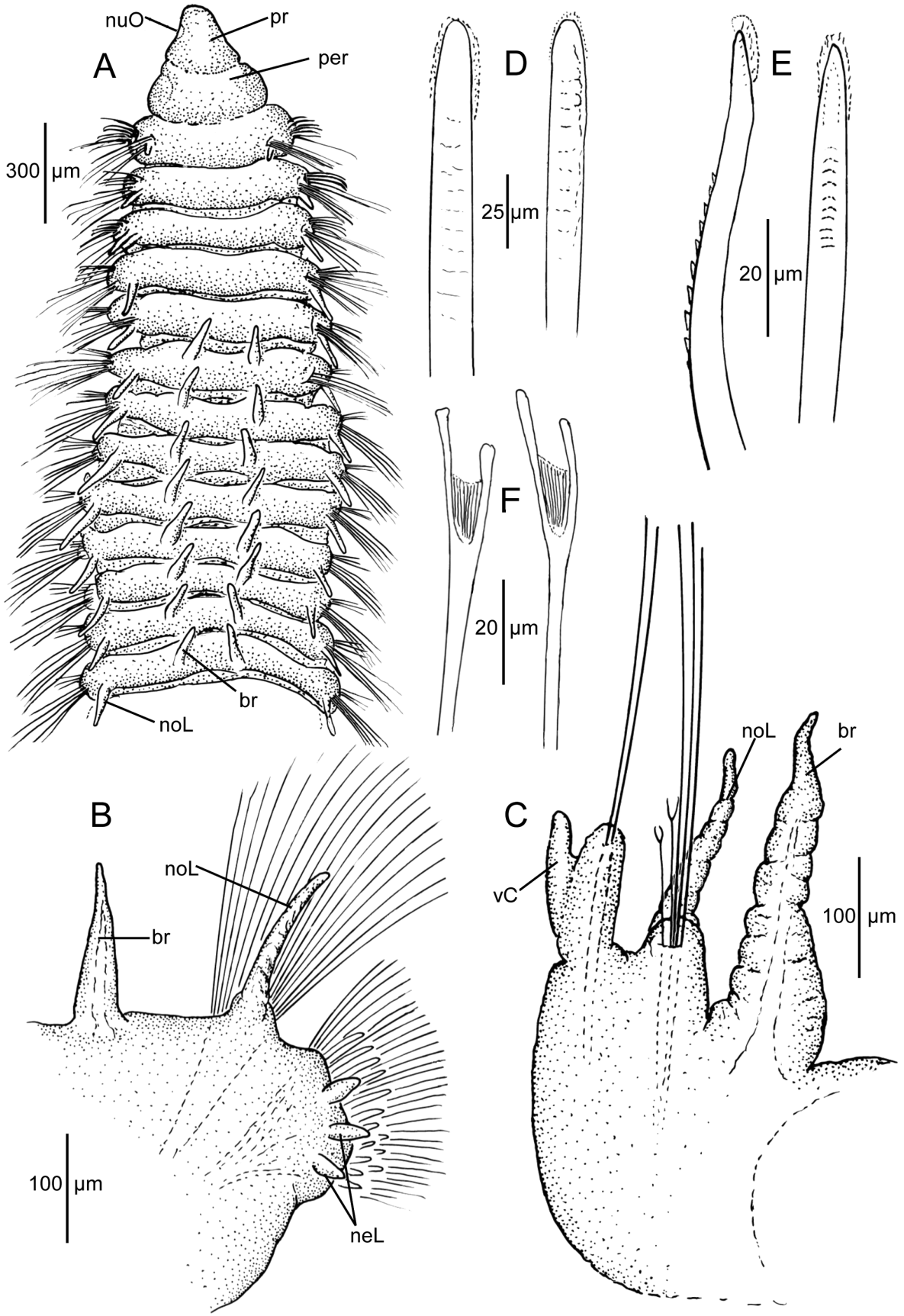
Material examined. **South China Sea, off Brunei, Island of Borneo**, Site CA1, R/V *Emma*, coll. J.A. Blake, box corer, Sta. 45, 2 Jun 2011, 5°48.965′N, 114°17.317′E, 1260 m, **holotype** (MCZ 153569); Sta. 38, 3 Jun 2011, 5°42.99′N, 114°09.269′E, 1353 m, **paratype** (MCZ 153570); Sta. 28, 4 Jun 2011, 5°44.496′N, 114°07.708′E, 1557 m, 1 juvenile specimen (MCZ 153571).

Description. A moderately sized species, all specimens incomplete. Holotype largest, 32 setigers, 6.7 mm long, 0.87 mm wide across thoracic segments; paratype 23 setigers, 2.3 mm long, 0.44 mm wide; juvenile, 13 setigers, 1.4 mm long, 0.3 mm wide. Body with narrow thoracic segments (Fig. 17A), flattened dorsally, rounded on venter, with lateral parapodia; thoracic segments about seven times wider than long, with prominent intersegmental furrow (Fig. 17A). abdominal segments narrower, with parapodia dorsally elevated. Number of thoracic segments size related: holotype with 13 thoracic setigers, smaller paratype with 10 thoracic setigers; juvenile with six thoracic setigers, all with branchiae from setiger 6. Color in alcohol: light tan.

Pre-setiger region triangular. Prostomium narrowing to rounded tip (Fig. 17A); nuchal organs distinct lateral grooves (Fig. 17A); eyespots absent. Peristomium longer, but narrower than first setiger, with a single annular ring (Fig. 17A) bearing dorsolateral grooves suggesting a simple dorsal crest. Proboscis everted on holotype, dendritic with numerous narrow lobes.

Thoracic notopodia low mounds, with long, narrow, digitiform postsetal lobe (Fig. 17A–B). Thoracic neuropodia broadly swollen, bearing up to three short postsetal lobes (Fig. 17B); initially a single lobe increasing to two,



FIGURES 17. *Leodamas bathyalis* **n. sp.** A, anterior end dorsal view; B, thoracic setiger 9, right, posterior view; C, middle abdominal setiger, anterior view; D, neuropodial uncini (holotype); E, neuropodial uncini (paratype); F, furcate setae. A–D, F, holotype (MCZ 153569); E, paratype (MCZ 153700).

and then three by setiger 7 in holotype; paratype with up to two thoracic postsetal lobes; juvenile with a single thoracic postsetal lobe. Transition to abdominal segments abrupt, with fewer noto- and neurosetae. Notopodium of abdominal segments similar to those of thoracic setigers with long, digitiform postsetal lobe (Fig. 17C); neuropodium becoming narrow, elongate, shifted dorsally; with narrow rounded setal lobe and a short lateral ventral cirrus (Fig. 17C).

Branchiae from sixth thoracic setiger (Fig. 17A), continuing along body through posterior setigers. Branchiae of thoracic setigers narrow, triangular in shape (Fig. 17B); abdominal branchiae becoming larger, thickened basally, tapering to narrow tip (Fig. 17C).

Thoracic notosetae numerous camerated capillaries arranged in 3–4 rows. Thoracic neurosetae include heavy spines or uncini among numerous camerated capillaries (Fig. 17B). Uncini in two rows, with first row curving ventrally and joining second row in a U-shaped pattern. Capillaries of first four segments reduced to a fascicle dorsal to uncini; subsequent setigers with multiple rows of numerous capillaries accompanying uncini through thoracic setigers. Uncini of larger holotype thick, with blunt tip covered with a thin cloak of fibrils, shaft with transverse rows of ribs worn down to low ridge (Fig. 17D); smaller paratype with uncini narrower with transverse rows of ribs more prominent, resembling low barbs (Fig. 17E). Abdominal notosetae 2–3 long, relatively smooth capillaries with short barbs along with one edge and 1–2 furcate setae; flail setae absent. Furcate setae with unequal, blunt-tipped tynes, connected by thin web of stiff fibrils (Fig. 17F). Abdominal neurosetae with 2–3 long, smooth capillaries; internal acicula present but not emergent in available specimens.

Pygidium not observed.

Variability. The three specimens available represent a size range with the most obvious difference being the number of thoracic setigers: 6 in the small juvenile, 10 in the paratype and 13 in the larger holotype. All three specimens, however, have branchiae first present from setiger 6. These results suggest that the number of thoracic setigers is size-related, but the first occurrence of branchiae is invariant.

The thoracic uncini of the paratype and juvenile exhibit distinct low barbs along the shaft; these are worn down and barely visible in the larger holotype.

Methyl Green stain. Prostomium not staining; rest of body stains uniformly; de-stains rapidly.

Remarks. *Leodamas bathyalis* **n. sp.** is a distinctive species in the nature of the thoracic neuropodial uncini and the presence of up to three short postsetal lobes in thoracic neuropodia. The reduced number of capillaries in the first 3–4 thoracic neuropodia accentuates the visibility of the uncini, which are more visible than in the following setigers where they are obscured by the numerous capillaries. Superficially the more obvious neuropodial uncini in a few anterior setigers are reminiscent of species of *Califia*, in which heavy uncini of the first three setigers provide a prominent armature. Unlike species of *Califia*, however, these same uncini continue through all thoracic setigers.

Etymology. The epithet is from the Greek, *bathys* for deep.

Distribution. South China Sea, off Brunei, Island of Borneo, 1260–1557 m.

Subfamily Microrbiniinae Blake, 2000

Type genus. *Microrbinia* Hartman, 1965. Designated by Blake, 2000.

Diagnosis. (after Blake 2017). Body small, lacking distinct regions; parapodia lateral throughout, none shifted dorsally. Prostomium broad, bluntly rounded or more elongate and conical; nuchal organs present. Peristomium with 1–3 achaetous rings, separated from prostomium. Noto- and neuropodial postsetal lamellae reduced to short lobes. Bases of podia separated throughout; setal tori simple. Setae consisting of capillaries, blunt-tipped spines or uncini and swan hooks present or absent; furcate setae typically absent. Branchiae typically absent, if present; simple throughout, oval to flattened with two longitudinal rows of cilia. Pygidium with few cirri or cirri absent.

Inclusive genera. *Microrbinia, Orbiniella, Proscoloplos,* and *Pettibonella*.

Remarks. Only species belonging to the genus *Orbiniella* were present in this study. Six new species were identified.

Genus *Orbiniella* Day, 1954

Type-species: *Orbiniella minuta* Day, 1954, by monotypy.
Synonym: *Falklandiella* Hartman, 1967. *Fide* Buzhinskaja 1992: 76. **Type species**: *Falklandiella annulata* Hartman, 1967, by monotypy.

Diagnosis: (after Blake 2017) Body elongate, with separation between thorax and abdomen indistinct, anterior segments may be shorter than more posterior segments, but size changing gradually over several segments, or no change in appearance between anterior and posterior segments; prostomium broad or elongate with paired nuchal organs usually present, these sometimes pigmented, eyespots present or absent; peristomium with 1–2 asetigerous rings. Noto- and neuropodia poorly developed, consisting of low tori from which setae emerge; with only simple post-setal lamellae, or these entirely absent; posterior parapodia not elevated and shifted dorsally as in genera of the Orbiniinae. Capillary noto- and neurosetae always crenulated or weakly camerated with pointed bristles apparent at relatively low magnification (100x); prominent acicular spines present or absent in noto- and neuropodia, or entirely absent; furcate setae absent. Branchiae absent.

Remarks. According to Blake (2017), there are 13 valid species of *Orbiniella*. Of these, only four are reported from deep-water habitats exceeding 1500 m. Six new deep-water species of *Orbiniella* have been discovered in the present study: *O. abyssalis* **n. sp.** from the abyssal Pacific Ocean at the Clarion-Clipperton Fracture Zone, *O. grasslei* **n. sp.** from hydrothermal vents on the East Pacific Rise at 21°N, *O. tumida* **n. sp.** from the continental slope off California, and three species, *O. eugeneruffi* **n. sp.**, *O. longilobata* **n. sp.**, and *O. rugosa* **n. sp.** from the South China Sea off Brunei. These new taxa bring the total number of known species of *Orbiniella* to 19, ten of which occur in deep-water.

Orbiniella abyssalis new species

Figures 18–19
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Material examined. **North Equatorial Pacific Ocean, abyssal plain, Clarion-Clipperton Fracture Zone**, **NOAA BIE Project site**, coll. D.T. Trueblood. Sta. DDT-05-93, veg. 20, 2–5 cm fraction, 13 Aug 1993, 12°56.566′N, 128°35.408′W, 4870 m, **holotype** (USNM 1594176); Sta. DDT-07-93, veg 24, 0–2 cm fraction, 02 Sep 1993, 12°56.303′N, 128°35.311′W, 4844 m, 1 specimen (USNM 1594177); Sta. DDT-11-93, veg. 22, 0–2 cm fraction, 04 Sep 1993, 12°56.055′N, 128°35.695′W, 4859 m, **paratype** (USNM 1594178); Sta. DDT-12-93, veg. 6, 0–2 cm fraction, 04 Sep 1993, 12°56.329′N, 128°35.698′W, 4851 m, **paratype** (USNM 1594179); Sta. DDT-08-94, 29 Jul 1994, 12°55.020′N, 128°35.400′W, 4880 m, 1 specimen (USNM 1594180).

Description. Holotype elongate, of moderate size, mostly complete in two parts, 8.0 mm long, 0.7 mm wide for 65 setigers. Paratype (USNM 1594178) incomplete, 17 setigers, 1.35 mm long, 0.275 mm wide. All segments short, crowded, about eight times wider than long (Fig. 18A). Body with similar segments throughout, lacking a separate thorax and abdomen. Body dorsoventrally compressed, without dorsal or ventral longitudinal grooves. Parapodia all lateral, not shifted dorsally in posterior segments. Each segment separated from following by an intersegmental area formed of 2–3 narrow raised annulae. Color in alcohol: light tan.

Pre-setiger region short, narrower than anterior setigers, merging with setiger 1 (Fig. 18A). Prostomium short, broadly rounded anteriorly (Fig. 18A); eyespots absent; nuchal organs low mounds on sides of posterior prostomium (Fig. 18A). Peristomium a single large ring, longer than setiger 1, with one weakly defined lateral groove, not crossing dorsum or producing separate rings (Fig. 18A).

Setiger 1 and following segments separated from one another by intersegmental groove with narrow annular rings. Branchiae entirely absent. Noto- and neuropodia formed as elongate lobes, tapering to rounded apex (Fig. 18B). Notopodia with short, clavate postsetal lamellae (Figs. 18B, 19A); neuropodial postsetal lamellae absent. Notopodia with numerous long capillaries and 1–2 large, elongate acicular spines projecting well beyond parapodia (Figs. 18C, 19A–B); neuropodia with one large elongate acicular spine and numerous long capillaries; furcate setae absent. Spines thick, smooth, narrowing to pointed tip, some spines with slight curvature where narrowing begins (Figs. 18C, 19B). Capillaries not camerated, with minute bristles or barbs poorly developed; setae appearing smooth at 400x; bristles observed only at 1000x.

Pygidium not observed.

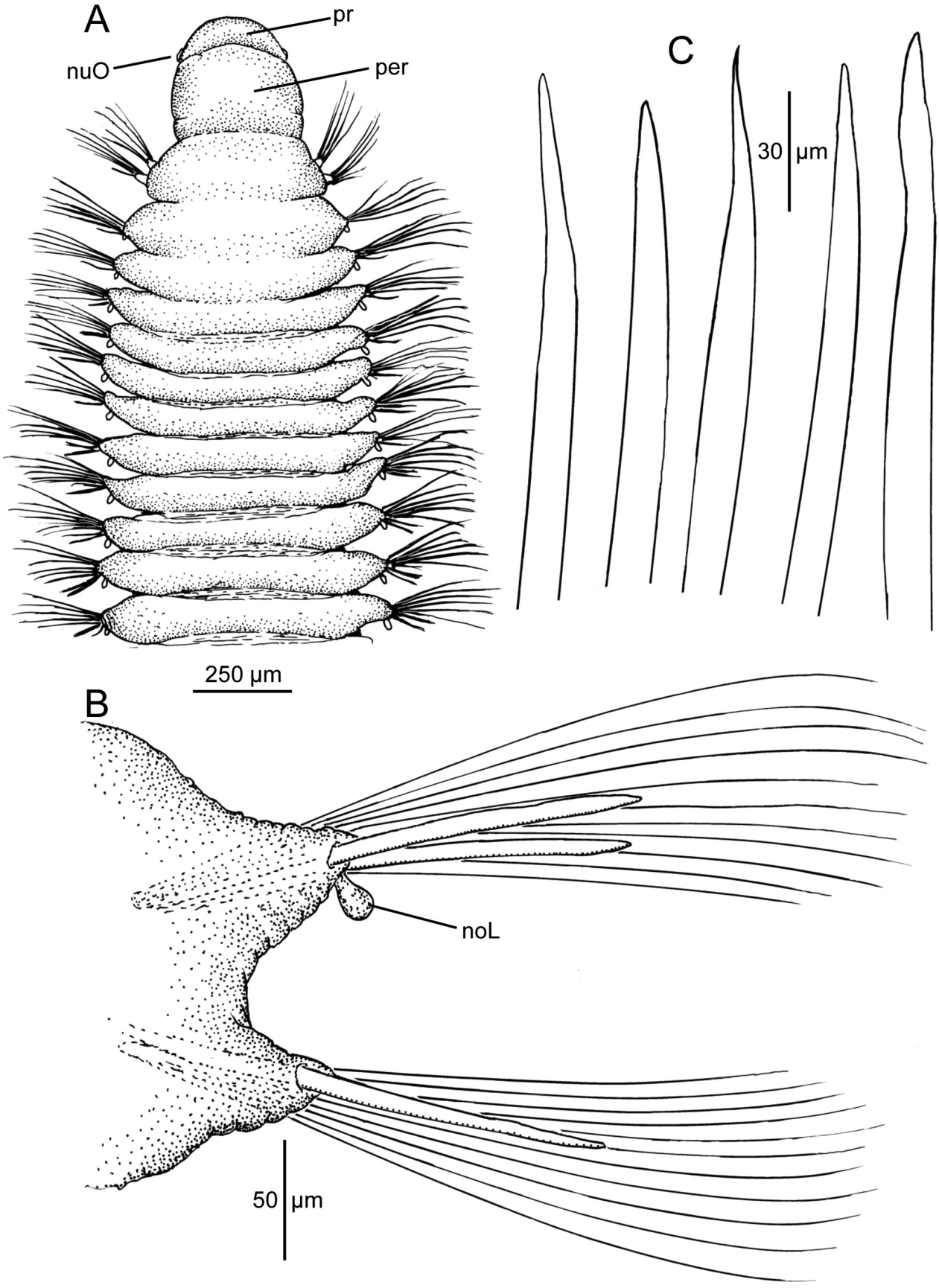

FIGURE 18. *Orbiniella abyssalis* **n. sp.** Holotype (USNM 1594176): A, anterior end dorsal view, B, parapodium from an anterior setiger, anterior view; C, acicular spines.

Methyl Green stain. No pattern, body stains uniformly, de-stains rapidly.

Remarks. *Orbiniella abyssalis* **n. sp.** is similar to three other deep-sea congeners: *O. andeepia* Narayanaswamy & Blake, 2005, from Antarctica, *O. petersenae* Parapar, Moreira & Helgason, 2015 from the NE Atlantic, and *O. tumida* **n. sp.** from the California continental slope, in having a notopodial postsetal lamella and acicular spines in both noto- and neuropodia. *Orbiniella abyssalis* **n. sp.** differs from the other three species in having an unusually short and broad prostomium followed by a long, thick peristomium composed of a single ring, but with a weak lateral groove that does not cross the dorsum; the other species have two distinct peristomial rings. In addition, the noto- and neuropodial spines of *O. abyssalis* **n. sp.** are unusually long, about half as long as the capillaries. The spines of the other species are considerably shorter than the capillaries. The notopodial postsetal lamella is short and clavate in both *O. abyssalis* **n. sp.** and *O. tumida* **n. sp.** and longer and digitate in *O. andeepia* and *O. petersenae*. More details of these species and others are presented in Table 2 in the Discussion.

Etymology. The epithet is derived from the Latin *abyssus*, in reference to the deep-sea habitat of the species.

Distribution. Abyssal Pacific Ocean, 4844–4880 m.

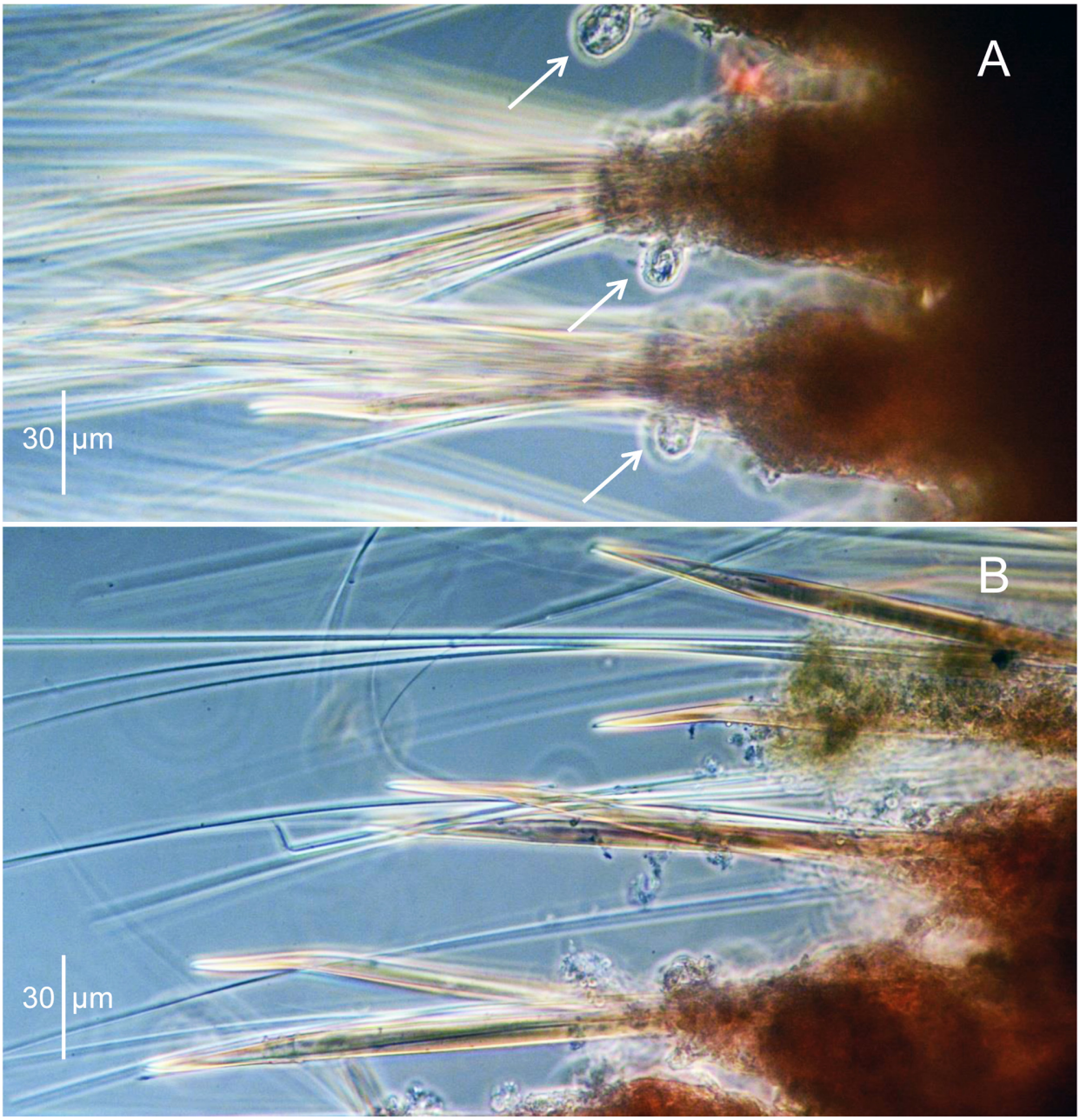

FIGURE 19. *Orbiniella abyssalis* **n. sp.** Holotype (USNM 1594176): A, anterior setigers, in dorsal view showing notopodia with numerous capillaries and spines, and clavate notopodial lamella; B, posterior setigers in dorsal view showing notopodia with few capillaries and long spines.

***Orbiniella eugeneruffi* new species**

Figure 20

urn:lsid:zoobank.org:act:52A90D09-F6F2-4C99-B141-BB75003ACC0D

Material examined. South China Sea, off Brunei, Island of Borneo, Site CA1, R/V *Emma*, coll. J.A. Blake, box corer, Sta. 45, 2 Jun 2011, 5°48.965′N, 114°17.317′E, 1260 m, **holotype** (MCZ 153578); Sta. 49, 2 Jun 2011, 5°44.405′N, 114°13.993′E, 1199 m, 1 **paratype** (MCZ 153579).

Description. A small species, holotype complete with 18 setigers, 4.0 mm long and 0.6 mm wide across mid-body; paratype complete with 21 setigers, 6.1 mm long, 0.5 mm wide. Body more or less oval in cross section; segments short, about five times wider than long. All parapodia lateral; posterior segments not elevated or modified. Dorsal and ventral grooves absent; venter with mid-ventral ridge formed of lobes along the ventral mid-line of each segment (Fig. 20B). Individual segments with narrow transverse intersegmental groove (Fig. 20A–B); groove of middle segments weakly expanded into 1–2 transverse annuli, best observed dorsally (Fig. 20A). Color in alcohol: white.

Pre-setiger region about as long as first two setigers, but about one-third narrower. Prostomium broadly rounded on anterior margin, about as long as wide (Fig 20A); eyespots absent; nuchal organs not observed. Peristomium with two annular rings, separated from one another, first ring shorter than second (Fig. 20A–B), forming posterior lip of mouth (Fig. 20B). Both rings with a few lobes on anterior margin.

Branchiae entirely absent. Noto- and neuropodia conical, setae emerge from distal tip; postsetal lobes or lamellae entirely absent (Fig. 20D). Setae include capillaries and acicular spines; furcate setae absent. Capillaries from setigers of first half of body numbering 5–7 per fascicle; all long with a distinct row of barbs or camerations along one edge (Fig. 20D); capillaries of posterior segments reduced to 3–4 per fascicle; all long, but relatively smooth, with barbs either absent or only irregularly present. Acicular spines include one in notopodia and 1–2 in neuropodia; each spine smooth, thick, narrowing to pointed tip (Fig. 20D).

Pygidium narrow, with four short anal cirri (Fig. 20C).

Methyl green stain. No pattern, de-stains rapidly.

Remarks. By lacking postsetal lobes or lamellae and having smooth instead of serrated acicular spines, *Orbiniella eugeneruffi* **n. sp.** is most closely related to *O. aciculata* Blake, 1985 from near hydrothermal vents at the Galápagos Rift. Both species also have the first of two peristomial rings shorter than the second. The two species differ in that *O. aciculata* has 1–4 acicular spines in the noto- and neuropodia and two anal cirri, whereas *O. eugeneruffi* **n. sp.** has only one spine in the notopodia and 1–2 in the neuropodia and four anal cirri.

Etymology. This species is named for the late Mr. Robert Eugene Ruff, polychaete systematist and long-time friend and colleague. Eugene was part of a select taxonomic team that was developed by the author to identify polychaetes from offshore and deep-sea surveys, including those from off Brunei.

Distribution. South China Sea, off Brunei, Island of Borneo, 1199–1260 m.

***Orbiniella grasslei* new species**

Figure 21

urn:lsid:zoobank.org:act:C1344615-DC39-4782-89FB-F7DBBAB3ECA1

Material examined. **East Pacific Rise**, hydrothermal vent area at 21°N: HOV *Alvin* Dive 1221-15, 20°50′N; 109°06′W, 4 May 1982, 1618 m, washings of *Riftia pachyptila* tubes and *Calyptogena magnifica* shells, **holotype** (MCZ 153574) and 3 **paratypes** (MCZ 153575); HOV *Alvin* Dive 1223-17, 20°50′N; 109°06′W, 7 May 1982, 2616 m, rubble, 4 **paratypes** (MCZ 153576); HOV *Alvin* Dive 1223-11, 7 20°50′N; 109°06′W, 7 May 1982, 2616 m, fine fraction from washings, 3 specimens (MCZ 153577).

Description. Holotype largest specimen, complete, 5.44 mm long and 0.22 mm wide for 26 setigers. Body not divided into distinct thoracic and abdominal regions; body segments all similar. Parapodia reduced, lamellae lacking.

Pre-setiger region thick, with prostomium and peristomium lacking obvious separation dorsally and laterally (Fig. 21A). Prostomium broadly rounded anteriorly; eyespots absent, nuchal organs not visible. Peristomium entirely merged with prostomium dorsally; ventrally with a large ventral lip below mouth; two partial annular rings weakly developed, only apparent ventrally (Fig. 21A).

Setiger 1 and following segments separated from one another by swollen intersegmental annular rings produc-

ing biannulate segments (Fig. 21A). Notopodia bearing 2–3 camerated capillaries and three serrated spines from setiger 1; spines reduced to two by setiger 5, continuing to posterior setigers where only a single spine and two capillaries persist (Fig. 21B–C). Neuropodia bearing two spines and three capillaries from setiger 1, increasing to three spines and five capillaries by setiger 5, reduced to two spines and 0–2 capillaries in posterior setigers (Fig. 21B–C). Spines with distinct serrations along shaft (Fig. 21C).

Pygidial segment simple, lacking cirri.

Methyl Green stain. No pattern.

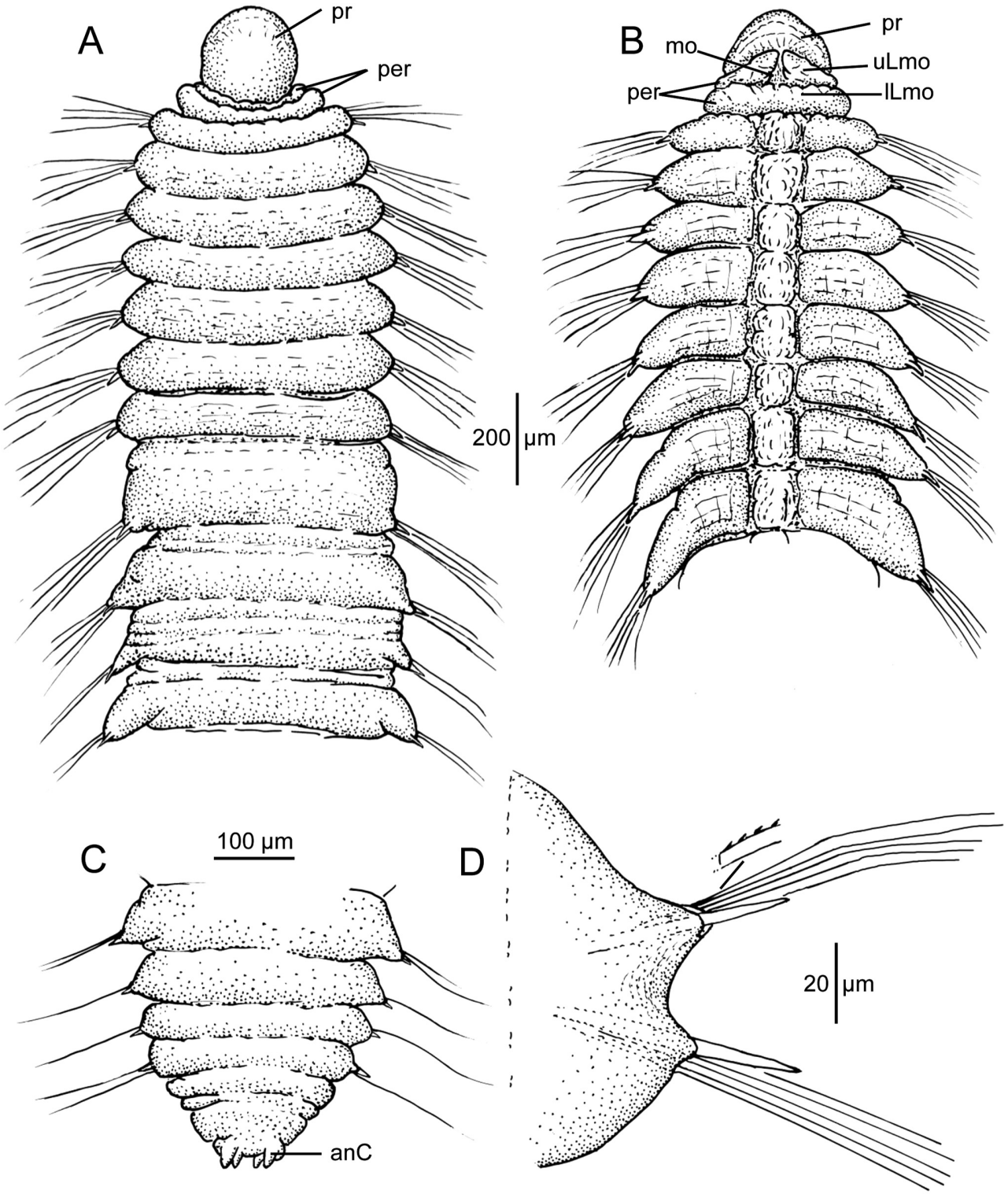

FIGURE 20. *Orbiniella eugeneruffi* **n. sp.** Holotype MCZ 153578): A, anterior end, dorsal view; B, anterior end, ventral view; C, posterior end, dorsal view. Paratype (MCZ 153579): D, mid-body setiger, anterior view (inset not to scale).

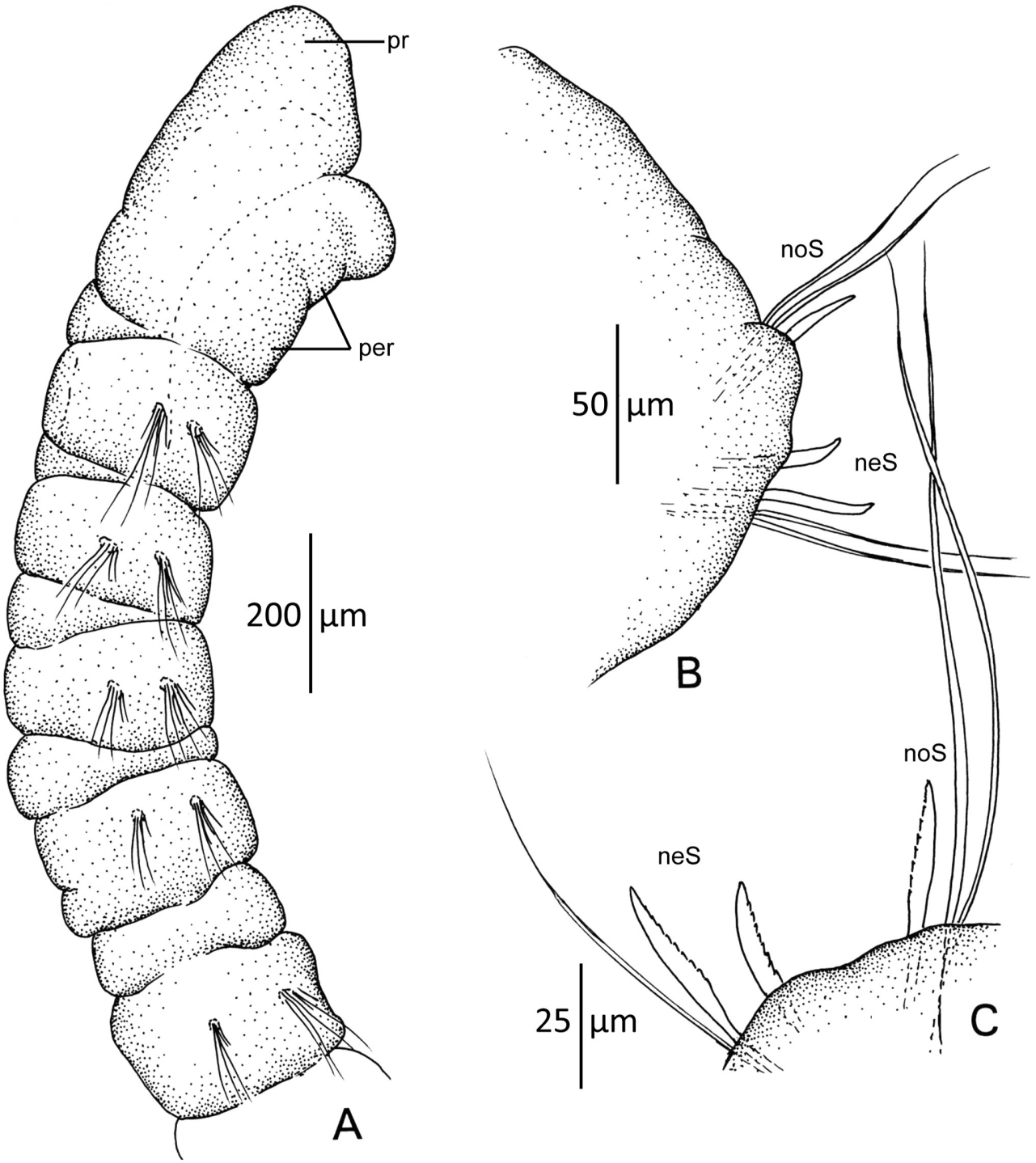

FIGURE 21. *Orbiniella grasslei* **n. sp.** Holotype (MCZ 153574): A, anterior end, right lateral view; B, anterior parapodium, anterior view; C, another parapodium showing details of serrated spines.

Remarks. *Orbiniella grasslei* **n. sp.** is most similar to *O. hobsonae* Blake & Hilbig, 1990 from hydrothermal vents on the Juan de Fuca Ridge. Both species have long, thin bodies and acicular spines with a row of barbs or serrations along the shaft. *Orbiniella grasslei* **n. sp.** differs from *O. hobsonae* in having a peristomium on which the annular rings are indistinct instead of being present as two distinct rings; in addition, nuchal organs are not visible instead of being prominent laterally on the prostomium. The most conspicuous difference between *O. grasslei* **n. sp.** and *O. hobson*ae, however, is the segmentation. In *O. grasslei* **n. sp.**, the intersegmental groove is expanded

into a large swelling that provides a prominent biannulate appearance to segments along the body. In contrast, the segments of *O. hobsonae* are entirely uniannulate. There are additional differences in the fine details of the structure of the spines and capillary setae. Another species of *Orbiniella*, *O. aciculata* Blake, 1985, from the vicinity of the Galápagos Rift hydrothermal vents has spines that are smooth instead of serrated, and the body is short and compact instead of long and thin.

Etymology. This species is named for the late Dr. J. Frederick Grassle, prominent deep-sea benthic ecologist of the Woods Hole Oceanographic Institution and the Rutgers University Institute of Marine and Coastal Sciences. As part of his numerous expeditions to deep-sea locations, Dr. Grassle provided this author and other investigators with numerous polychaetes from vents and other habitats that have resulted in a rich harvest of new species.

Distribution. Hydrothermal vents on the East Pacific Rise at 21°N, 1618–2616 m.

***Orbiniella longilobata* new species**

Figure 22

urn:lsid:zoobank.org:act:02448FFD-904C-4659-BE6C-B73F1A376216

Material examined. South China Sea, off Brunei, Island of Borneo, Site CA2, R/V *Emma*, coll. P.A. Neubert, box corer, Sta. TA7, 2 Jul 2011, 5°25.805′N, 113°22.188′E, 2004 m, **holotype** (MCZ 153588); Sta. SE5, 28 Jun 2011, 5°35.739′N, 113°47.115′E, 1947 m, 1 **paratype** (MCZ 153589); Sta. TA5, 2 Jul 2011 5°27.844′N, 113°26.572′E 2008 m, 1 specimen (UBD).—Site CA1, R/V *Emma*, coll. J.A. Blake, box corer, Sta. 49, 2 Jun 2011, 5°44.405′N, 114°13.993′E, 1199 m, 1 **paratype** (MCZ 153590).

Description. A small species, all specimens incomplete. Holotype with 18 setigers, 2.14 mm long, 0.18 mm across pre-setiger region, 0.43 mm across setiger 6; paratype (MCZ 153590) with 17 setigers, 2.01 mm long, 0.4 mm across anterior setigers. Body dorsoventrally flattened, with narrow segments, up to eight times wider than long (Fig. 22A–B); without dorsal or ventral longitudinal grooves. All parapodia lateral, not shifted dorsally. Anteriormost setigers with narrow intersegmental groove, best developed ventrally (Fig. 22A–B). Color in alcohol: light tan.

Pre-setiger region about 2.5 times narrower than following segments, about as long as first three setigers (Fig. 22A). Prostomium conical, rounded on anterior margin; eyespots absent; nuchal organs prominent lateral ciliated lobes (Fig. 22A). Peristomium with two narrow annular rings distinctly separated from one another dorsally and ventrally by inter-annular grooves; when swollen, grooves providing a superficial appearance of four annular rings (Fig. 22A–B). First annular ring forming posterior lip of mouth; anterior lip of mouth with three lobes (Fig. 22B).

Setiger 1 and 2–3 following segments separated from one another by swollen intersegmental grooves (Fig. 22A–B). Branchiae entirely absent. Noto- and neuropodia weakly developed, elongate, more or less conical. Notopodia with long, digitate postsetal lamella (Fig. 22C), narrowest and longest in posterior setigers. Setae include capillaries and 1–2 acicular spines in both noto- and neuropodia (Fig. 22C); furcate setae absent. Capillaries with a row of barbs along one edge. Spines thick, smooth, tapering to narrow tip (Fig. 22D–E); some posterior spines long, extending well beyond parapodia.

Pygidium not observed.

Methyl Green stain. No pattern, body stains uniformly.

Remarks. *Orbiniella longilobata* **n. sp.** belongs to a group of species having a notopodial postsetal lobe instead of lacking one. In *O. longilobata* **n. sp.**, the notopodial postsetal lobe is long, narrow and digitiform instead of short and thick as in most species. This species is also characterized by having a narrow pre-setiger region with two peristomial rings and two wide inter-annular rings that superficially provide the peristomium with the appearance of four annular rings. The long acicular spines that occur in some posterior parapodia of *O. longilobata* **n. sp.** are similar to those of *O. abyssalis* **n. sp.** However, in the latter species, the peristomium consists of a single large ring with weakly developed lateral grooves instead of two prominent peristomial rings as in *O. longilobata* **n. sp**.

Etymology. The epithet, *longilobata* is from the Latin, *longus*, for long and *lobus* for lobe in reference to the elongate, dorsal postsetal lobes that are characteristic for this species.

Distribution. South China Sea, off Brunei, Island of Borneo, 1199–2008 m.

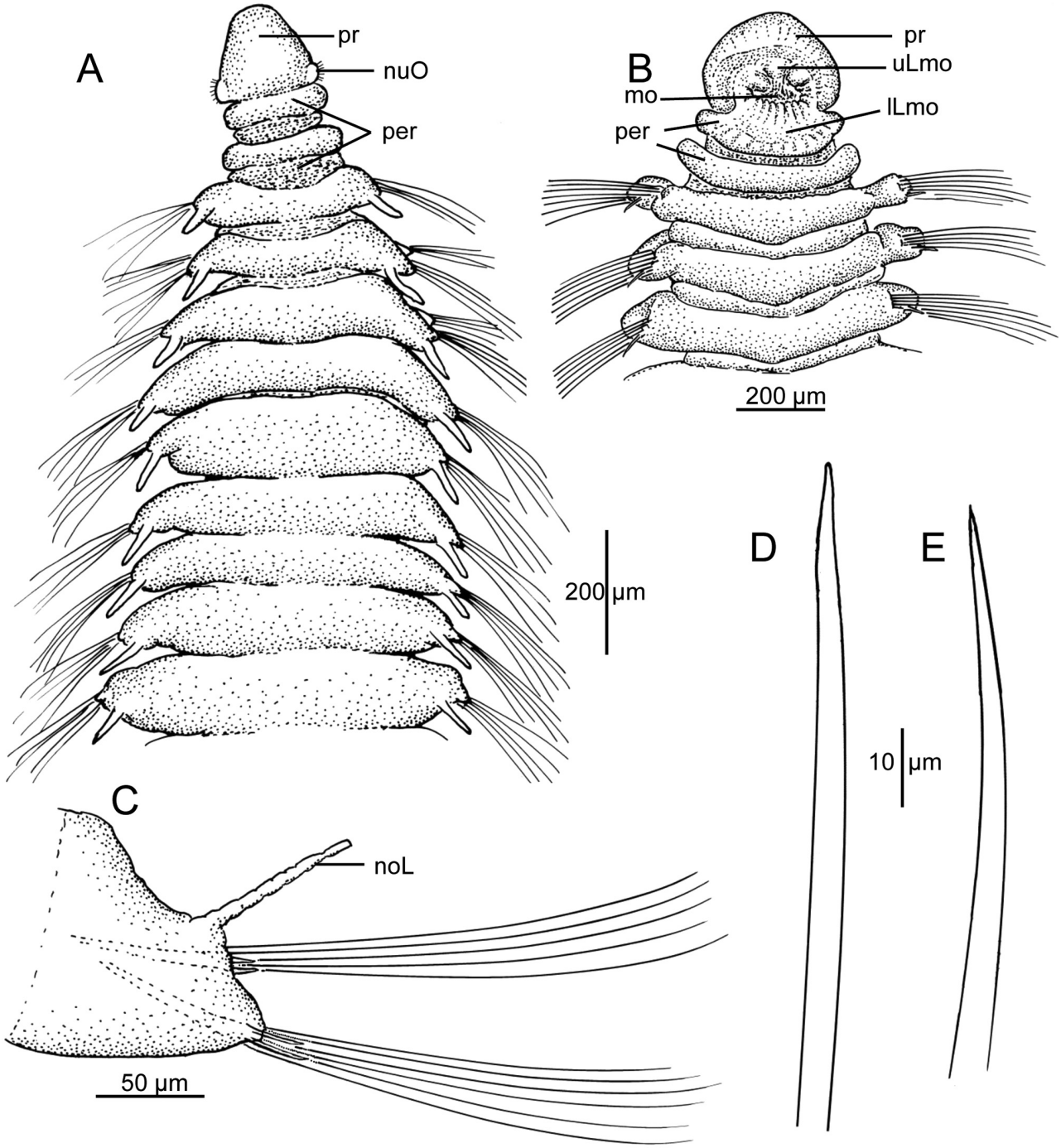

FIGURE 22. *Orbiniella longilobata* **n. sp.** A, anterior end, dorsal view; B, anterior end, ventral view; C, middle body setiger, anterior view; D–E, notopodial spines. A, C–E, holotype (MCZ 153588); B, paratype (MCZ 153590).

***Orbiniella rugosa* new species**

Figure 23

urn:lsid:zoobank.org:act:B4156792-6AC0-4B23-A766-AF2DA124F512

Material examined. South China Sea, off Brunei, Island of Borneo, Site CA2, R/V *Emma*, coll. P.A. Neubert, box corer, Sta. SA6, 29 Jun 2011, 5°36.318′N, 113°37.76′E, 2178 m, **holotype** (MCZ 153582); Sta. SA1, 29 Jun 2011, 5°34.093′N, 113°39.735′E, 2075 m, **paratype** (MCZ 153583); Sta. SA5, 29 Jun 2011, 5°36.943′N, 113°41.123′E, 2162 m, 1 specimen (UBD); Sta. SE3, 29 Jun 2011, 5°32.454′N, 113°43.246′E, 2008 m, 1 specimen (MCZ 153584); Sta. TA5, 2 Jul 2011 5°27.844′N, 113°26.572′E 2008 m, 1 **paratype** (MCZ 153585).—Site CA1, R/V *Emma*, coll.

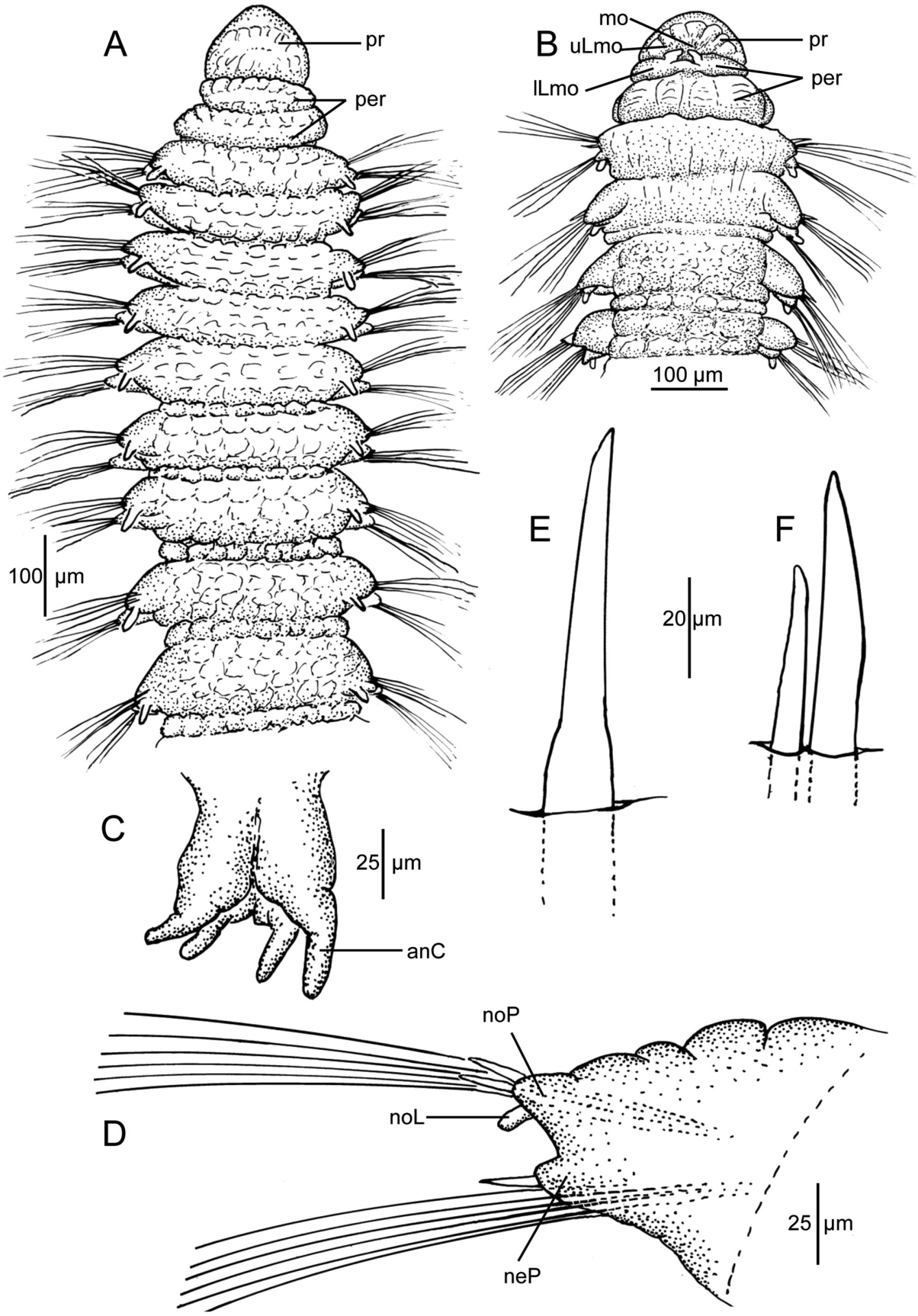

FIGURE 23. *Orbiniella rugosa* **n. sp**. A, anterior end, dorsal view; B, anterior end, ventral view; C, posterior end, dorsal view; D, middle body parapodium, anterior view; E, notopodial acicular spine; F, neuropodia acicular spine. A, paratype (MCZ 153583); B, C, E–F, holotype (MCZ 153582); D, paratype (MCZ 153586).

J.A. Blake, box corer, Sta. 47, 2 Jun 2011, 5°47.364′N, 114°17.179′E, 1242 m, 1 specimen (MCZ 153587); Sta. 49, 2 Jun 2011, 5°44.405′N, 114°13.993′E, 1199 m, 1 **paratype** (MCZ 153586).

Description. A small species, holotype complete, with 32 setigers, 5.0 mm long and 0.22 mm wide across anterior setigers. Other specimens incomplete. Body more or less cylindrical in cross section; segments generally short, about three times wider than long (Fig. 23A); dorsal and ventral grooves absent. All parapodia lateral, posterior parapodia not shifted dorsally. Anterior segments with narrow intersegmental groove (Fig. 23A–B); most segments with 2–3 transverse rows of reticulated wrinkles producing rough appearance across dorsum with a similar pattern on the venter (Fig. 23A–B). Color in alcohol: white to tan.

Pre-setiger region about as long as first three setigers; about half as wide as anterior setigers (Fig. 23A). Prostomium broadly rounded anteriorly, wider than long; eyespots absent, nuchal organs on lateral margins as low ciliated mounds. Peristomium with two annular rings, distinctly separated from one another, first generally narrower than second (Fig. 23A–B); both rings with 2–3 rows of reticulated raised mounds visible dorsally; ventrally, first ring incorporating posterior lip of mouth (Fig. 23B).

Branchiae entirely absent. Noto- and neuropodia with elongate podial lobes rounded apically, setae emerge from distal tip (Fig. 23D). Noto- and neurosetae consisting of 5–8 long, camerated capillaries and 1–3 notoacicular and 1–2 neuroacicular spines; spines from setiger 1 to end of body (Fig. 23D). Capillaries with a row of barbs or camerations along margin, similar throughout. Acicular spines thick, pointed, tapering apically to narrow tip (Fig. 23D–F). Furcate and flail setae absent.

Pygidium narrow, with four anal cirri of moderate length (Fig. 23C).

Methyl Green stain. No pattern, body stains uniformly.

Remarks. *Orbiniella rugosa* **n. sp.** belongs to a group of *Orbiniella* species having a notopodial lobe together with acicular spines in the noto- and neuropodia. In contrast to other species, the entire surface of the body of *O. rugosa* **n. sp.** has a lumpy appearance consisting of numerous folds and wrinkles. Superficially the lumpy integument is reminiscent of the annular rows of pads found on species of the Scalibregmatidae.

Etymology. The epithet is from the Latin, *ruga* for folds or wrinkles, referring to the rugose or rough reticulated appearance of the epithelium caused by numerous folds.

Distribution. South China Sea, off Brunei, Island of Borneo, 1199–2178 m.

Orbiniella tumida new species

Figure 24

urn:lsid:zoobank.org:act:98DC0D6D-13A8-43B5-9F57-ACB41CE5C9A3

Orbiniella sp. 1: Blake *et al*. 2009: 1797.

Material examined. Continental slope, off northern California, **west of Farallon Islands, SF-DODS Benthic Monitoring Program,** Sta. 23. 28 Sep 2017, 37°37.0012′N, 123°28.9813′ W, 2934 m, **holotype** (LACM-AHF Poly 11662), 2 **paratypes** (LACM-AHF Poly 11663); Sta. 10, 22 Sep 2002, 37°40.00′N, 123°31.00′, 2739 m, 1 **paratype** (CASIZ 234025); Sta. 64, 26 Sep 2003, 37°35.98′N, 123°32.96′, 3130 m, 2 **paratypes** (CASIZ 234032); Sta. 64, 29 Aug 2016, 3221 m, 37°36.0068′N, 123°32.9960′W, 3221 m, 1 **paratype** (MCZ 153581).—**Northern California off Half Moon Bay, US EPA 102 Site Selection Survey**, R/V *Point Sur*, coll. J.A. Blake, **south of Pioneer Canyon**, Sta. 4-15. 9 Sep 1991, 37°12.42′N, 123°15.81′W, 1730 m, 1 specimen (CASIZ 234046); **Pioneer Canon**, Sta. C-7,19 Sep 1991, 37°17.57′N, 123°13.50′W, 1840 m, 1 specimen (CASIZ 234052).—**Off Central California, abyssal Plain**, Sta. M, coll. 15 Aug 2006, HOV *Alvin* Dive 4227, B. Strickrott (Pilot), 34°39.105′N, 123°05.116′W, 4119 m (1, JAB)

Description. A small species, holotype mostly complete but with damaged posterior end, 2.5 mm long, 0.8 mm wide with 21setigers; complete paratype (CASIZ 234032) 2.7 mm long, 0.36 mm wide, with 37 setigers; larger paratype (CZSIZ 234032) incomplete, 3.1 mm long, 0.25 mm wide, with 32 setigers. Body thick throughout, with no separate thorax and abdomen; all parapodia lateral, not shifted dorsally in posterior segments; individual segments crowded, about seven times wider than long (Fig. 24A). Each segment with narrow intersegmental swelling along most of body producing superficial bi-annulate appearance (Fig. 24A). Body with numerous subdermal glands appearing brown with Shirlastain A. Body somewhat dorsoventrally compressed, without dorsal or ventral

longitudinal grooves. Holotype with eggs in setigers 7–11, each about 120–125 μm in diameter; individual eggs in notopodia forming large lobe, a possible brooding or discharge chamber. Color in alcohol: light tan.

Pre-setiger region short, narrower than following setigerous segments (Fig. 24A). Prostomium broadly rounded anteriorly; eyespots absent; nuchal organs prominent lateral lobes, with numerous long cilia (Fig. 24A). Peristomium with two narrow annular rings distinctly separated from one another dorsally and ventrally (Fig. 24A–B). First annular ring forming ventral lip of mouth; dorsal lip with broad opening or vestibule (Fig. 24B).

Branchiae entirely absent. Noto- and neuropodia formed as elongate lobes, more or less conical. Notopodia with short, clavate postsetal lamella (Fig. 24D). Notopodia with 1–2 large, acicular spines and 3–5 long camerated capillaries; neuropodia with one large acicular spine and 5–6 long capillaries; (Fig. 24D); furcate setae absent. Spines thick, smooth, tapering to narrow tip (Fig. 24E–H), some with a distinct notch where spine narrows abruptly (Fig. 24G–H). Capillaries all camerated with row of barbs along one edge.

Pygidium with four short anal cirri (Fig. 24C).

Methyl Green stain. Prostomium not staining; rest of body staining uniformly green, de-staining rapidly.

Remarks. Among deep-sea species of *Orbiniella*, *O. tumida* **n. sp.** is most similar to *O. abyssalis* **n. sp.** from the abyssal Pacific Ocean, *O. andeepia* from Antarctica, and *O. petersenae* from the NE Atlantic Ocean in having smooth acicular spines in noto- and neuropodia and a notopodial postsetal lamella (see previous Remarks for *O. abyssalis* **n. sp.**). In having a short, clavate notopodial postsetal lamella *O. tumida* **n. sp.** is most similar to *O. abyssalis* **n. sp.**, but differs in having two distinct peristomial rings instead of one. Another distinguishing feature of *O. tumida* **n. sp.** is the presence of a notch on some acicular spines that has not been observed previously on orbiniids. Spines with notches occur in both noto- and neuropodia and occur randomly with spines lacking this feature.

Etymology. The epithet is from the Latin, *tumidus* for swollen, in reference to short, thickened body of this species.

Distribution. Off northern California, lower continental slope and abyssal plain, 1730–4119 m.

Discussion

This study deals with deep-water species of Orbiniidae from the eastern Pacific continental margin and the abyssal Pacific Ocean as well as species from the South China Sea. A companion study will deal with deep-water species of the western North Atlantic (Blake, in preparation).

Out of more than 225 species of Orbiniidae few have been described from depths greater than 500 m. Based on published records and the present study, there are about 44 known species of Orbiniidae from deep-sea habitats: *Berkeleyia* (5), *Califia* (4), *Leitoscoloplos* (13), *Leodamas* (4), *Microrbinia* (1), *Naineris* (1), *Orbiniella* (10), *Phylo* (1), and *Scoloplos* (5). It is noteworthy that *Berkeleyia*, *Califia*, *Microrbinia*, and *Orbiniella* are mainly composed of deep-water species.

Deep-Sea Orbiniidae. One characteristic of deep-sea orbiniids is that they are relatively rare in most collections. In the present study, only two species, *Leitoscoloplos gordaensis* **n. sp.** with 31 specimens in a single HOV *Alvin* core from the Gorda Ridge, Escanaba Trough (3271 m) and *Naineris uncinata* with 30 specimens from a multicore deployment at a gas hydrate site on the Cascadia Subduction Zone off Oregon (786 m), have what might be considered dense populations. Indeed, the local abundance and dominance of the new species of orbiniid polychaete on the Escanaba Trough, here described as *L. gordaensis* **n. sp.**, was noted by Petrecca & Grassle (1990) and Van Dover *et al.* (1990). Similarly, orbiniids, here described as *L. sahlingi* **n. sp.**, were noted by Sahling *et al*. (2002) in gas hydrate deposits on the Cascadia margin off Oregon. These results suggest that apparently rare species of Orbiniidae likely have higher densities in defined habitats or depth intervals from which recruits are distributed to more distant locations where they are not abundant. Out of 207 0.1-m^2 box cores collected over 16 years of monitoring at the SF-DODS site off San Francisco in depths from 2200–3200 m and processed at sea with a 300-μm-mesh sieve, only 24 specimens of *Leitoscoloplos cliffordi* **n. sp.** and seven specimens of *Orbiniella tumida* **n. sp.** were collected. It would appear that the preferred habitat or depth for these two species has not yet been sampled.

In contrast to these results, Blake (1993) provided life history data for *Microrbinia linea* Hartman, 1965, a small orbiniid that was a dominant species in sediments on the 2000 m isobath off North Carolina in the western North Atlantic sampled as part of the Atlantic Continental Slope and Rise (ACSAR) Program conducted from 1983 to 1987. Unlike the SF-DODS monitoring program, ACSAR sampling was conducted three times per year along defined transects and with three replicate 0.09-m^2 box core samples taken at each station. Transects were typically along

depth gradients of 500, 1000, 1500, 2000, 2500, and 3000 m. Over two years of sampling at the 2000 m station, 577 specimens of *M. linea* were available for the life history analysis. With this pattern and regularity of sampling over a greater depth range, it is more likely that habitats preferred by apparently rare species will be encountered.

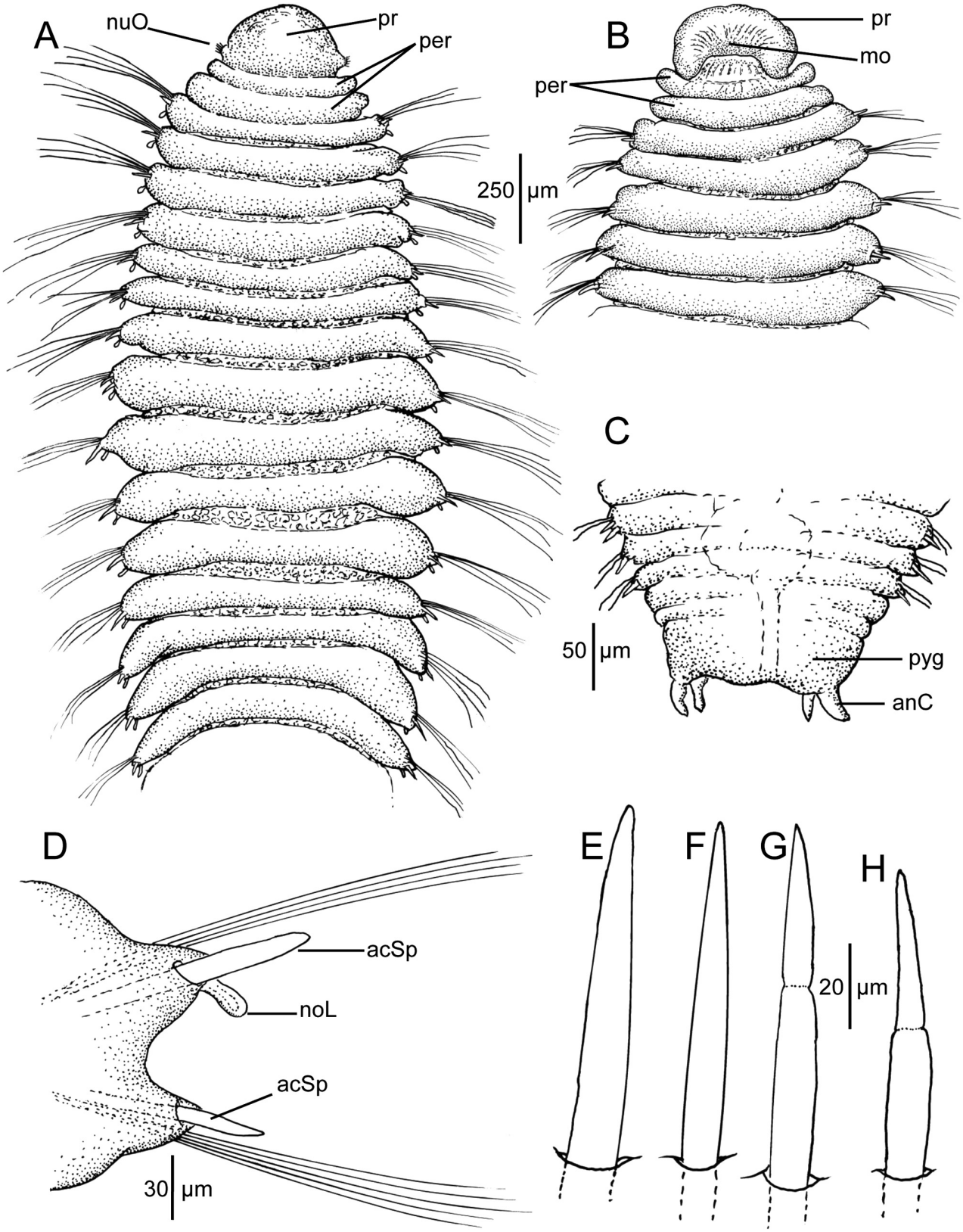

FIGURE 24. *Orbiniella tumida* **n. sp.** A, anterior end, dorsal view; B, anterior end, ventral view; C, posterior end, dorsal view; D, parapodium from mid-body setiger, anterior view; E–H, acicular spines. A–B, D–F, holotype (LACM-AHF Poly 11662); C, paratype (CASIZ 234032).

Genus *Leitoscoloplos* (Table 1). Out of approximately 27 known species of *Leitoscoloplos* reported by Blake (2017), only eight occur in water depths greater than 1000 m. The five new species described in the present study bring the overall total number of *Leitoscoloplos* species to 32, 13 of which occur in deep-water. Blake (2017) divided the genus into five groups based on the distribution of branchiae (new species included here):

(A) Branchiae absent (2 species);
(B) Branchiae from middle to posterior thoracic segments (12 species);
(C) Branchiae from transitional segments between thorax and abdomen (3 species);
(D) Branchiae from anterior abdominal segments (14 species);
(E) Branchiae from posterior abdominal segments (1 species).

The 13 species that occur in deep-water habitats are listed in Table 1. These include all three of the species in groups A and E, two species in group B, no species in group C, and eight species in group D. Thus, apart from two species in Group B, the majority of deep-water species of *Leitoscoloplos* either have no branchiae or branchiae are present only in abdominal setigers.

The characters that separate the 13 deep-water species are noted in Table 1. Apart from the two species in group B with branchiae from thoracic setigers that have 12–14 thoracic setigers, the other ten deep-water species of *Leitoscoloplos* have 8–10 (11) thoracic setigers. Eight of the 13 species in Table 1 also lack furcate setae, with species not restricted to any one group. When present, the furcate setae always have blunt-tipped tynes, which exhibit an external opening or hole in the tip on species that have been scanned by SEM (Blake 2017). Furcate setae with tynes having thin pointed tips have not been reported for the deep-sea taxa of *Leitoscoloplos*. The shape and size of the thoracic and abdominal noto- and neuropodial lobes and postsetal lamellae where they occur are important species-level characters. Some species have a simple rounded apex on the abdominal neuropodia, while on others it is divided into two lobes or there is a short ventral cirrus below the rounded tip. Unfortunately, the presence or absence of anal cirri is unknown for six of the 13 species. For the seven species where this character is known, a pair of thin anal cirri has been observed.

The species composition and distribution of *Leitoscoloplos* off northern California in soft sediments now includes four species along a depth gradient: *L. pugettensis* (intertidal to ca. 200 m); *L. lunulus* **n. sp.** (1020–1760 m); *L. williamsae* **n. sp.** (1760 m); and *L. cliffordi* **n. sp.** (2600–3136). It is likely that when other areas are as well explored, similar depth-related patterns will be encountered from shelf, slope, and abyssal depths.

Remarks on the syntypes of *Leitoscoloplos kerguelensis* (McIntosh, 1885). As part of a visit to the Natural History Museum, London, in 2007 during a deep-sea polychaete workshop, the opportunity was taken to examine the type specimens of several species of polychaetes that were of interest, including syntypes of *Leitoscoloplos kerguelensis* from the subantarctic Kerguelen Islands. Unfortunately, the notes taken on those specimens were unavailable while completing the recent paper on Antarctic orbiniids (Blake 2017) and thought to be lost. The notes were recently recovered and a few comments are warranted.

The syntypes of *Scoloplos kerguelensis* McIntosh, 1885 (BMNH ZK 1885.12.1.252) together with additional specimens identified as *Haploscoloplos kerguelensis* from Kerguelen reported by Monro (1939) were examined and redescribed by Mackie (1987) and transferred by him to *Leitoscoloplos*. Mackie's redescription is excellent and his observations are largely confirmed. Unfortunately, the syntypes are short anterior fragments of 14 and 34 setigers, respectively, and most of the thoracic setae were broken or sheared off. Nine thoracic setigers were present on the two syntypes and branchiae were present on setigers 13 and 14 on the 34- and 14-setiger syntypes, respectively. The noto- and neuropodial postsetal lobes were illustrated by Mackie (1987) as digitate lobes arising directly from the body wall. In my observations, the notopodial lobes were as Mackie described. However, the neuropodial lobes appeared to arise from a low mound or swelling. The latter observation is in line with my observations of Antarctic specimens having the thoracic neuropodial lobe arising from a basal cushion (Blake 2017). Mackie (1987) reported furcate setae (as forked setae) present, apparently on the Monro specimens, but did not describe their morphology. Furcate setae were not on the anterior fragments of the syntypes; the three posterior fragments available in the McIntosh materials were not examined. In my own observations of Antarctic materials, the furcate setae were of the blunt-tipped form typically found in species of *Leitoscoloplos* (Blake 2017: Fig. 8D–F). However, it would be of interest to confirm that the furcate setae of the Kerguelen specimens have the same morphology.

The morphology of the syntypes of *Leitoscoloplos kerguelensis* agrees with the observations of Mackie (1987).

However, additional observations from a much larger collection (ca. 130 specimens) from numerous subantarctic and Antarctic locations (Blake 2017) revealed that the number of thoracic setigers ranged from 8–10 rather than being limited to nine, and that branchiae began on setigers 13–17 instead of 13–15. These differences, while relatively minor, are likely due to a greater range of sizes available, with smaller specimens having fewer thoracic setigers than larger specimens. The larger collection examined by Blake (2017) included specimens up to a length of 30 mm and with 100 setigers versus one non-type specimen of 12 mm and 80 setigers examined by Mackie (1987). Out of 13 deep-sea species listed in Table 1, seven species exhibit a range on the number of thoracic setigers. For those with a fixed number of thoracic setigers, the materials examined included only a few specimens. The first setiger on which the branchiae began was also variable throughout.

Since the number of thoracic setigers in *Leitoscoloplos kerguelensis* ranges from 8–10 instead of 9 and branchiae from setigers 13–17, it follows that *L. banzareae* Mackie, 1987 with 10 thoracic setigers and branchiae from setigers 14–15, together with an overlapping distribution in Antarctica, and no other differences is a junior synonym of *L. kerguelensis* as suggested by Blake (2017: 23–26).

Deep-water species of *Scoloplos* (Table 2). Species of *Scoloplos* are among the most familiar orbiniids in near coastal habitats and have been reported globally. Many species, however, are poorly known and often have not been reported or redescribed since their original account. The most recent paper on *Scoloplos* is by Oliveira *et al*. (2019), who described a new species, *S. maranhensis* Oliveira *et al*., 2019, from shallow-water mangrove habitats in Brazil and provided a comparative table listing characters of the known species of the genus. Unfortunately, their new species should be referred to the genus *Leodamas* as redefined by Blake (2017), not *Scoloplos* and is similar to *Leodamas texana* (Maciolek & Holland, 1978) from the Gulf of Mexico. The table in Oliveira *et al.* (2019) listing 30 species of *Scoloplos*, therefore, includes several species that do not belong in the genus *Scoloplos* and should be used with caution. With the removal of those four species and the description of two new species in the present study, the total number of known *Scoloplos* species is 28, of which only the following five occur in depths exceeding 1000 m:

S. bathytatus Blake, 2017. Southern Ocean (Antarctica), Drake Passage to South Georgia; 2800–3463; Weddell Sea, 650–3111 m.
S. californiensis **n. sp.** Northern California continental slope, 1730–1880 m.
S. ehlersi Blake, 1985. SW Pacific Ocean, Galápagos Rift hydrothermal mounds, 2730 m.
S. intermedius (Hartman, 1965). Off New England, continental slope, 1330–1500 m.
S. sparsaciculus **n. sp.** South China Sea, off Brunei, Island of Borneo, 1219–1955 m.

An examination of the morphology that characterizes these five deep-sea species of *Scoloplos* suggests that *S. ehlersi* from the vicinity of the Galápagos Rift hydrothermal vents is unique in that it lacks furcate setae but has flail setae in abdominal notopodia and branchiae are first present from setiger 21, or from middle abdominal setigers. Flail setae are rare in orbiniids (Blake 2017). The other four species have branchiae from a posterior thoracic setiger or an anterior abdominal setiger.

Scoloplos californiensis **n. sp.**, *S. intermedius*, and *S. sparsaciculus* **n. sp.** form a group that have a subpodial neuropodial flange, subpodial neuropodial papillae, and a reduced number of thoracic neuropodial uncini. Of these three species, furcate setae are absent only in *S. sparsaciculus* **n. sp.** A low abdominal interramal process is present in anterior parapodia in both *S. intermedius* and *S. sparsaciculus* **n. sp.**

Scoloplos bathytatus has a ventral cirrus on the abdominal neuropodia but lacks subpodial flanges and papillae.

Genus *Orbiniella* (Table 3). Blake (2017) recorded 13 known species of *Orbiniella.* The six new species in this study increase that total to 19 of which ten occur in deep water (Table 3). Among the ten deep-sea species, five occur in the Pacific Ocean, three occur in the South China Sea, one in the Southern Ocean (Antarctica), and one in the NE Atlantic. However, additional deep-water species have been collected from the western North Atlantic and will be treated in a subsequent paper (Blake, in preparation).

All of the ten known deep-water species of *Orbiniella* have acicular spines in both noto- and neuropodia; of these, six species have notopodial postsetal lamellae and four have no postsetal lamellae. Key characters required to separate the deep-water species of *Orbiniella* include:

TABLE 1. Comparison of 13 Species of *Leitoscoloplos* from deep-sea habitats greater than 750 m.

Species/Character	Prostomium	Peristomium	Segmental annulation	No. thoracic setigers	Branchiae: A: begin on setiger B: shape
L. abranchiatus (Hartman, 1967)	Short, conical, pointed apex	With 2–3 annuli	Uniannulate	9–13	Absent
L. cliffordi **n. sp.**	Long, narrow, triangular	One long ring, with lateral grooves; post margin extending on to setiger 1	Biannulate abd segments	9, 1–2 transitional setigers	A: 15–16 B: anterior abd broad, tapering; post abd short with blunt tip
L. drakei (Hartman, 1967)	Broadly triangular, tapering to narrow tip	With 2 weak annuli; partially fused with setiger 1	Biannulate posterior setigers	8–9	A: 18–20 B: digitiform
L. eltaninae Blake, 2017	Conical, pointed apex	Single tapering ring	Uniannulate	10	A: 20 to end B: short, stubby, slightly longer than notopodia
L. gordaensis **n. sp.**	Short, triangular	1–2 annular rings; 2nd narrow when present	3 annular rings abd segments	10, 1–2 transitional setigers	A: 14–16 B: broad, tapering
L. kerguelensis (McIntosh, 1885)	Short, narrow, conical	Single tapering ring	Uniannulate anteriorly; 2–3 annuli posteriorly	8–10	A: 13–17 B: short, tapering, curving toward mid-line
L. lunulus **n. sp.**	Semi-circular, broadly rounded on anterior margin	Single ring, cut by a ventrolateral groove	Uniannulate anteriorly; 2 annulae in abd segments	9	A: 14–15 B: broad, tapering to rounded tip; post abd with expanded apex
L. mexicanus (Fauchald, 1972)	Short, sharply conical	Single ring	Uniannulate	14	A: 11–12 B: slender, strap-like, sub-distally swollen
L. pachybranchiatus Blake & Hilbig, 1990	Broadly conical, rounded anterior margin	With 1–2 annular rings, 2nd best seen in juveniles	Uniannulate	9	A:13–15 B: short, thick, glandular
L. rankini Blake, 2017	Short, conical, narrow rounded tip	Single ring	Biannulate	9–11	A: 18–21 B: elongate, narrow
L. sahlingi **n. sp.**	Triangular with narrow apex	Single thick ring	Thoracic segments uniannulate; abd segments biannulate	12, abrupt change to abd setigers	A: 10 B: becoming long, triangular, tapering to papillate tip
L. simplex Blake, 2017	Short, triangular, narrow rounded apex	Single bulbous ring	Uniannulate	8	Absent
L. williamsae **n. sp.**	Long, narrow, triangular	Single ring, dorsally inflated	Thoracic segments uniannulate; abd segments biannulate	8–9	A: 17–18 B: triangular, longer posteriorly

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TABLE 1. (Continued)

Species/Character	**Thoracic parapodia** **A: notopodia** **B: neuropodia**	**Abdominal neuropodia**	**Furcate Setae**	**Pygidium**	**Distribution/Depth/ References**
L. abranchiatus (Hartman, 1967)	A, B: both with short conical lobes	Elongated, rectangular, entire apex	Present, blunt-tipped tynes	Not observed	Antarctic and sub-Antarctic seas, 1400–5338 m. Blake 2017
L. cliffordi **n. sp.**	A, B: short, digitiform, tapering to narrow tip	Thick, tapering to blunt tip; with short, rounded ventral cirrus	Present, notched, blunt-tipped tynes	Bluntly rounded with 2 thin anal cirri	Off northern California, 2600–3136 m. This study
L. drakei (Hartman, 1967)	A, B: short, stubby	Elongate, thickened	Absent	Rounded lobe with 2 thin anal cirri	Drake Passage & Weddell Sea, 3312–4547 m. Hartman 1967; Blake 2017
L. eltaninae Blake, 2017	A: short, triangular B: longer, digitiform	Short, with thickened apex [abd notopodia bilobed]	Present, blunt-tipped tynes	Not observed	South Atlantic Ocean, 3742–3806 m. Blake 2017
L. gordaensis **n. sp.**	A, B: broad triangular base tapering to blunt tip	Thick, elongate, with bifid tip	Absent	Bluntly rounded with 2 thin anal cirri	Gorda Ridge, Escanaba trough, 3271 m. This study
L. kerguelensis (McIntosh, 1885)	A: short, triangular B: papillate from broad basal cushion	Elongate, with apical notch; subpodial flange present	Present, blunt-tipped tynes	Simple rounded lobe	Antarctic and sub-Antarctic seas, low water to 1400 m. Mackie 1987; Blake 2017
L. lunulus **n. sp.**	A, B: Long, digitate; both arising from rounded base	Elongate, with rounded tip and narrow ventral cirrus; short subpodial flange present	Absent	Six lobes surrounding anus; with 2 thin anal cirri	Off northern California, 1020–1760 m. This study
L. mexicanus (Fauchald, 1972)	A: elongate, triangular, with narrow tip; ?narrow base B: same, with broad base	Thickened, with bilobed tip. subpodial flange present	Absent	Not observed	Gulf of California, 1378–1421 m. Fauchald 1972; Mackie 1987
L. pachybranchiatus Blake & Hilbig, 1990	A: elongate, narrow, digitate; B: short, triangular	Thick, elongate, apex with 2 lobes	Absent	Broadly rounded lobe with 2 anal cirri	Off British Columbia, Juan de Fuca Ridge, Endeavor Segment, 2216 m. Blake & Hilbig 1990
L. rankini Blake, 2017	A, B: both narrow, tapering lobes; neuropodial from broad base	Elongate, apex with 2 lobes	Present, blunt-tipped tynes with apical notch	Rounded lobe with 2 thin anal cirri	Drake Passage & Weddell Sea, 1622–3959 m. Blake 2017
L. sahlingi **n. sp.**	A, B: elongate, digitiform, arising from broad base	Thick, elongate, with rounded tip; with short ventral cirrus	Absent	Not observed	Off Oregon, Cascadia Subduction Zone, 786 m; This study
L. simplex Blake, 2017	A: broad base bearing elongate, digitate lobe B: short digitate lobe	Short, thick, with rounded apex bearing ventral cirrus	Absent	Not observed	Abyssal Pacific Ocean, Clarion-Clipperton Fracture Zone, 4843 m. Blake 2017
L. williamsae **n. sp.**	A, B: elongate, digitiform; arising from broadly rounded base	Thick, tapering to blunt tip; with short, rounded ventral cirrus; subpodial flange present	Absent	With 2 long anal cirri	Off northern California, 1760 m. This study

Abbreviation: abd, abdominal; post, posterior.

TABLE 2. Comparison of five deep-water species of *Scoloplos*.

Species/ Character	Prostomium	Peristomium	No. thoracic setigers	Branchiae: A: begin on setiger B: shape	Thoracic neuropodial uncini	A: furcate Setae B: flail setae
S. bathytatus Blake, 2017	Elongated, pointed	Long narrow, a single ring	11–12	A: 9–10 B: broad basally, tapering	2 rows; each curved, with blunt tip and shaft with ribs along one edge of shaft	A: present, with blunt tynes connected with webbing B: absent
S. californiensis **n. sp.**	Conical, narrowing to pointed tip	Short, broad, a single ring	12	A:11–12 B:triangular, wrinkled posteriorly	3–5 uncini, each with shaft narrowing to rounded tip; paired ribs along one edge of shaft	A: present B: absent
S. ehlersi Blake, 1985	Conical, pointed on anterior margin	Triangular, a single ring	11	A: 21 B: subapical swelling	Long, narrow, tapering to narrow tip; ribs along one edge of shaft	A: absent B: present, 1–2 in abd notopodia
S. intermedius (Hartman, 1965)	Short, conical, pointed	Broad, a single ring	12–13	A: 10–12 B: broad, triangular at first, then swollen subapically	Few, long, narrow, with narrow tip and distal hood; ribs along one edge of shaft	A: present, morphology not reported B: absent
S. sparsaciculus **n. sp.**	Short, conical, narrow rounded tip	Triangular, a single ring	9–12	A: 11–14 B: broad, tapering, with subapical swelling	1–4 uncini; in a poster row in fascicle; each with shaft narrowing to pointed tip; paired ribs along one edge of shaft	A: absent B: absent

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TABLE 2. (Continued)

Species/ Character	Thoracic segmental annulation	Abdominal neuropodia: A: ventral cirrus B: subpodial flange C: subpodial papillae D: interramal cirrus	Pygidium	Distribution/Depth/ References
S. bathytatus Blake, 2017	With broad dorsal intersegmental swelling	A: short B: absent C: absent D. absent	Not observed	Antarctic Seas, 650–3463 m. Blake 2017
S. californiensis **n. sp.**	With narrow dorsal intersegmental swelling	A: absent B: present, narrow C: present, 1–2 D: absent	With 2 dorsal cirri	Northern California slope, 1730–1880 m. This study
S. ehlersi Blake, 1985	With narrow intersegmental groove	A: short B: absent C: absent D: absent	Not observed	SW Pacific, Galápagos Rift, 2730 m. Blake 1985
S. intermedius (Hartman, 1965)	With broad dorsal intersegmental swelling	A: absent B: present, short C: present (1–2) D: present, triangular process, few ant setigers	Not observed	Off New England, 1330–1500 m. Hartman 1865; Mackie 1987
S. sparsaciculus **n. sp.**	With inconspicuous intersegmental groove	A: present, short B: present, long C: present, 1, rarely 2 D: present, low process, not a lobe; few ant setigers.	Not observed	South China Sea off Brunei, 1219–1955 m. This study

Abbreviations: abd, abdominal; ant, anterior.

TABLE 3. Comparison of ten deep-water species of *Orbiniella*.

Species	Body shape	Prostomium	Peristomial rings	Segmental annulations	Noto/Neuro post setal lobes or lamellae
O. abyssalis **n. sp.**	Elongate, 8 mm long & 65 setigers	Narrow, broadly rounded ant margin	1 large ring; with lateral groove not crossing dorsum	Uniannulate; with 2–3 narrow annuli in intersegmental grooves	Present (notopodia only); minute, clavate-shaped
O. aciculata Blake, 1985	Short, thick, 3.2 mm long & 22 setigers	Broadly rounded ant margin	2 complete, one or both narrow	Uni- & biannulate if large intersegmental swellings present	Absent
O. andeepia Narayanaswamy & Blake, 2005	Elongate, up to 120 mm long & 68 setigers	Broadly rounded ant margin	2 complete, both narrow	Uni- & biannulate; all segments short	Present (notopodia only)
O. eugeneruffi **n. sp.**	Short, thick, up to 6.1 mm long & 21 setigers	Broadly rounded ant margin	2 complete, first narrow	Uniannulate; intersegmental area with 1–2 rings	Absent
O. grasslei **n. sp.**	Elongate, up to 5.44 mm long & 26 setigers	Broadly rounded ant margin	Single, merged with prostomium	Biannulate, prominent	Absent
O. hobsonae Blake & Hilbig, 1990	Elongate, thread-like, 4.5 mm long & 25 setigers	Round on ant margin	2, 1st narrow; 2nd large; both complete	Uniannulate	Absent
O. longilobata **n. sp.**	Short, dorso-ventrally flattened, 2.1 mm long & 17 setigers	Conical, rounded on ant margin	2 complete, separated by deep grooves	Uniannulate, but with a few anterior segments with deep intersegmental grooves	Present (notopodia only); long, digitiform
O. petersenae Parapar *et al*. 2015	Elongate, narrow; up to 6 mm long & 25 setigers	Broadly rounded ant margin	2 complete, both narrow	Bi- & triannulate; post segments elongate	Present (notopodia only); small, digitiform
O. rugosa **n. sp.**	Elongate, up to 5 mm long & 32 setigers	Broadly rounded ant margin	2 complete, equivalent size	Uniannulate with swollen intersegmental groove	Present (notopodia only); short, digitiform
O. tumida **n. sp.**	Short, thick, up to 3.1 mm long & 37 setigers	Broadly rounded ant margin	2 complete, both narrow	Uni- and weakly biannulate; all segments short	Present (notopodia only); clavate

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TABLE 3. (Continued)

Species	Capillary setae	Noto/neuro acicular spines	Pygidium	Unique characters	Distribution/Depth/ References
O. abyssalis **n. sp.**	Minute bristles along one edge; best seen at 1000x	1–2 unusually long smooth spines in notopodia; 1 in neuropodia	Not observed	Peristomium with a single ring; long ac spines	Abyssal Equatorial Pacific, Clarion-Clipperton Fracture Zone, 4844–4880 m. This study
O. aciculata Blake, 1985	Crenulated	1–4 large, conspicuous, ac spines in both noto- & neuropodia	With 2 short anal cirri	No postsetal lobes; smooth ac spines; 2 anal cirri	Galápagos Rift, from sediments near but not at hydrothermal vents, 2730 m. Blake 1985
O. andeepia Narayanaswamy & Blake, 2005	Crenulated	Notopodia with 1 spine; neuropodia with 2 spines	Bilobed, with 2 short anal cirri	Short, oval postsetal lobe; long smooth spines, MG stains pr and raised segmental ridges; 2 anal cirri	Antarctica: Drake Passage, Weddell Sea, South Sandwich Slope, 2257–5338 m. Narayanaswamy & Blake 2005; Blake 2017
O. eugeneruffi **n. sp.**	Caps of ant setigers with row of barbs; post caps smooth	Notopodia with 1 spine; neuropodia with 1–2 spines	With 4 short anal cirri	No postsetal lobes; smooth ac spines; 4 anal cirri	South China Sea, off Brunei, 1199–1260 m. This study
O. grasslei **n. sp.**	Crenulated	Notopodia with 1–3 spines; neuropodia with 1–2 spines; spines serrated	Not observed	Single per ring merged with pr; serrated ac spines	East Pacific Rise, 21°N; hydrothermal vents, 1618–2616 m. This study
O. hobsonae Blake & Hilbig, 1990	Crenulated throughout	1–2 crenulated ac spines in both noto- & neuropodia	Simple, without lobes or cirri	2 per rings, 1st narrow, 2nd large; serrated ac spines; no anal cirri	NE Pacific, Juan de Fuca Ridge, Endeavour Seamount, vent site, 2216 m. Blake & Hilbig 1990
O. longilobata **n. sp.**	Barbs along one edge	Noto- and neuropodia with 1–2 long smooth spines	Not observed	Long, digitiform, noto post setal lobe; 2 per rings and 2 wide intersegmental grooves	South China Sea, off Brunei, 1199–2004 m. This study
O. petersenae Parapar *et al*. 2015	Crenulated	1–3 smooth noto- & neuropodial ac spines	With 4 short lobes	2 per rings, both large; short, digitiform noto post setal lobe; triannulate post segments; 4 short anal cirri;	NE Atlantic, 133–197 m (1) and 1490–1915 m. Parapar *et al*. 2015
O. rugosa **n. sp.**	Barbs along one edge	Notopodia with 1–3 spines; neuropodia with 1–2 spines; all spines smooth	With 4 long anal cirri	Body surface with rows of folds and wrinkles	South China Sea, off Brunei, 1199–2194 m. This study
O. tumida **n. sp.**	Barbs along one edge	1–2 notopodia, 1 neuropodia; smooth, some with "joint" along shaft	Simple, with 4 short cirri	Short clavate postsetal lobe; ac spines with notch	NE Pacific, northern California, off Farallon Islands, 2739–3221 m; abyssal plain off central California, 4119 m. This study

Abbreviations: ac, acicular; ant, anterior; caps, capillaries; MG, Methyl Green stain; noto, notopodia; per, peristomium; pr, prostomium.
(1) Two distinct depth ranges, shallow and deep, suggest that two species are present rather than one.

(1) differences in the form and size of the acicular spines
(2) shape and length of the postsetal lamellae
(3) length and width or shape of the body segments
(4) number and degree of development of segmental annular rings
(5) number, shape, and length of anal cirri on the pygidium
(6) details on the form of the prostomium
(7) development of the peristomial rings.

Some details of these and other characters are in Table 3.

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