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New Species of Cirratulidae (Annelida) from Continental Slope and Abyssal Depths off Eastern Australia

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Abstract. Seven new species of Cirratulidae are described from deep waters off the east coast of Australia. Samples were collected as part of the RV *Investigator* voyage IN2017_V03 in May/June 2017 using a Brenke sledge and 0.25 m^2 box core. Sample depths reported in the present study were from the lower continental slope of about 2100 m to abyssal depths up to 4170 m. These collections provide the first cirratulid polychaetes to be described from deep water off Australia. The new species of Cirratulidae are in the genera *Aphelochaeta* (2), *Chaetocirratulus* (2), *Chaetozone* (2), and *Kirkegaardia* (1). Each of the new species is compared and contrasted with their known congeners. The bitentaculate Cirratulidae known from abyssal depths of 3000 m and greater are reviewed and discussed.

Introduction

The present study is based on annelids of the family Cirratulidae collected as part of the RV *Investigator* cruise (IN2017_V03) along the eastern continental margin of Australia in May/June 2017 (Gunton *et al*., 2021) and represents the first report of deep-sea annelids of this family from Australian waters.

Cirratulid polychaetes are among the most commonly encountered polychaetes in benthic communities, including nearshore habitats as well as the deep sea (Blake & Magalhães 2019). Cirratulids are classified into bitentaculate and multitentaculate genera. The bitentaculate genera are widespread in all habitats including the deep sea, whereas the multitentaculates are more or less limited to nearshore habitats. With the advent of offshore surveys and monitoring programs, numerous species of bitentaculate cirratulids have been described globally as part of studies conducted over the past two decades (Blake, 1996, 2006, 2015, 2016, 2018, 2019, 2021, 2022; Blake & Dean, 2019; Chambers, 2000; Chambers & Woodham, 2003; Doner & Blake, 2009; Dean & Blake, 2007, 2009, 2016; Elías & Rivero, 2008, 2009, 2011; Elías *et al.,* 2017; Magalhães & Brock, 2013; Grosse *et al*., 2021). However, despite these studies and others, there have been few reports on bitentaculate cirratulids from Australia. Hutchings & Murray (1984) and Hutchings & Rainer (1979) described six new bitentaculate species from intertidal and nearshore habitats, but no bitentaculate cirratulid species have been described from deep water off Australia.

Annelids included in the present study include new species in the cirratulid bitentaculate genera *Aphelochaeta*, *Chaetocirratulus*, *Chaetozone* and *Kirkegaardia.*

Keywords: Annelida, polychaetes, Cirratulidae, benthos, deep sea, new species, *Aphelochaeta*, *Chaetocirratulus*, *Chaetozone*, *Kirkegaardia*, eastern Australia
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Materials and methods

Materials examined as part of this study. Biological samples were collected from along the east coast of Australia from Tasmania (42°S) to Southern Queensland (24°S) on the RV *Investigator* (voyage IN2017_V03), in May and June 2017 (Gunton *et al*., 2021). Benthic sampling was conducted at lower continental slope (c. 2500 m) and abyssal (c. 4000 m) depths, with a few comparative samples taken at shallower middle slope depths (c. 1000 m). Three types of sampling gear were used: (1) beam trawl, (2) Brenke sledge (Brenke 2005), and (3) 0.25 m^2 box core (Hessler & Jumars, 1974). For the identified samples in the present study, most are from the Brenke sledge; only one sample with cirratulids was from a box core. After collection, the contents of the Brenke sledge nets were emptied into seawater and visible animals were picked out. The remainder of the sample was elutriated with seawater and sieved with a 300-µm-mesh sieve. For box core samples, the top 2 cm of sediment was removed from the core, elutriated in seawater and sieved using a 300-µm-mesh sieve. Selected specimens were photographed by the field team. The majority of samples were preserved directly in 95% ethanol (ETOH), the remainder were preserved in 10% buffered formalin. Further details of the field methods are included in Gunton *et al*. (2021).

After the survey, annelid specimens were shipped to the Australian Museum, Sydney (AM), Museums Victoria, Melbourne (MV), and the Natural History Museum, London (NHMUK) where they were registered and sorted to the family level. For sorting, annelids fixed in formalin were soaked in water, transferred to 80% ETOH, and sorted in 80% ETOH; alcohol-fixed annelids were sorted in 95% ETOH. The specimens processed in this this study were provided by the AM.

Morphological observations. Specimens intended for morphological study were examined using a Wild M-5 stereomicroscope and a Zeiss RA research microscope equipped with phase contrast optics. Photomicrographs were taken with a Nikon D7100 camera mounted on both the stereo- and compound microscopes. For observation, specimens were first stained with an aqueous solution of Shirlastain A 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 identify staining patterns of subdermal glands evident on some species. 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. Photographs were edited in Photoshop.

Molecular data. Owing to the reduced number of cirratulid specimens collected and their overall poor condition, there were insufficient non-type materials available to sacrifice for molecular analysis. Most species were represented by only one or two specimens that could be confidently referred to any one species, and due to their small size were not appropriate for dissection of body parts. Furthermore, after staining with either Shirlastain A or Methyl Green, type specimens of each species were not suitable for molecular analysis.

Abbreviations used on figures. acSp, acicular spine(s); br, branchiae; car, caruncle; dCr, dorsal crest; dT, dorsal tentacle; mo, mouth; neS, neurosetae; noS, notosetae; nuO, nuchal organ; orL, oral lobe; per, peristomium; pr, prostomium; pyg, pygidium; vCr, ventral crest; vGr, ventral groove; vRdg, ventral ridge.

Taxonomic account

Family Cirratulidae Ryckholt, 1851

Type genus: *Cirratulus* Lamarck, 1818

Diagnosis. Body elongate with numerous short segments; not divided into distinct regions, but anterior and/or posterior segments sometimes expanded and crowded. Prostomium narrow and conical or broad and wedge shaped, without appendages; eyespots present or absent; paired dorsolateral nuchal organs present. Peristomium achaetous, smooth or with two or more distinct annuli. Grooved dorsal tentacles arise as a single pair or as multiple groups of filaments on posterior margin of peristomium or on one or more anterior setigerous segments. Branchiae long, filamentous, usually occurring over numerous segments. Parapodia biramous with rudimentary podial lobes. Setae simple, including capillaries, acicular spines or bidentate hooks. Pygidium a simple lobe sometimes with a sub-anal disk, or terminal cirri. Pharynx ventral, unarmed. Sexual and asexual reproduction may occur.

Remarks. The Cirratulidae currently include about 300 known species (Blake & Magalhães, 2019; Blake, 2019, 2021; Blake & Dean, 2019; Grosse *et al*., 2021) that are generally separated into genera and species having numerous tentacular filaments (multitentaculates, about 80 species) and species having two tentacular filaments or dorsal tentacles (bitentaculates, about 220 species). The multitentaculates are mostly found in nearshore habitats, rarely offshore, whereas the bitentaculates are found in all habitats including the deep sea. The discovery of new species in recent years has mostly involved bitentaculates due to emphasis on previously unexplored offshore and deep-water habitats. In the present study seven new species are described in four of the bitentaculate genera: *Aphelochaeta* (2), *Chaetocirratulus* (2), *Chaetozone* (2), and *Kirkegaardia* (1).

The following species are included in this article:

Aphelochaeta jubata sp. nov.
Aphelochaeta readi sp. nov.
Chaetocirratulus bathyalis sp. nov.
Chaetocirratulus glebalis sp. nov.
Chaetozone abyssalis sp. nov.
Chaetozone adusta sp. nov.
Kirkegaardia glabra sp. nov.

Genus *Aphelochaeta* Blake, 1991

Type species: *Tharyx monilaris* Hartman, 1960. Original designation by Blake (1991).

Diagnosis (after Blake, 2018). Prostomium conical to rounded; peristomium elongate with pair of grooved dorsal tentacles arising either on peristomium or anterior to setiger 1. Anterior segments often expanded, crowded or uncrowded; abdominal segments sometimes beaded or moniliform in appearance; setae simple capillaries lacking distinct serrations using light microscopy, but distinct fibrils may be visible using SEM; posterior end frequently expanded, tapering to a simple pygidial lobe.

Remarks. To date, only ten valid species *of Aphelochaeta* have been reported from abyssal depths of about 3000 m and greater (Blake, 2018, 2019). In the present study, two new species have been identified in the samples from off the Australian east coast. Others are most certainly present, but the available specimens are either too fragmented or damaged to characterize.

Aphelochaeta jubata sp. nov.

urn:lsid:zoobank.org:act:E7FF22A4-2129-488B-8015-DD316AF3B99F

Fig. 1

Holotype: Abyssal plain off eastern Australia, between Victoria and Tasmania, Flinders Marine Park, RV *Investigator*, Sta. 016, coll. 21 May 2017, Brenke sledge, 40.463°S 149.415°E to 40.461°S 149.364°E, 4131 m (Australian Museum W.52706). **Paratypes** (3): Bass Strait Marine Park, Sta. 031, coll. 23 May 2017, Brenke sledge, 39.422°S 149.604°E to 39.391°S 149.597°E, 4170 m (1, AM W.53523; 1, W.52716; 1, W.52328).

Description. All specimens incomplete: holotype (AM W.52706) with 61 setigers, 8.9 mm long, 0.61 mm wide across peristomium, 0.72 mm wide across setiger 8; paratype (AM W.52716) a mature female, with 39 setigers, 5.8 mm long, 0.3 mm wide across anterior setigers; with eggs measuring 120–200 µm in longest diameter. Ventral ridge present from setiger 1 (Fig. 1B), continuing along anterior and middle segments; in middle segments ridge becomes expanded medially at each segmental junction. Dorsal grooves and ridges absent. Colour in alcohol, light tan with no additional pigment.

Pre-setiger region elongate, thickened, about as long as first eight setigers (Fig. 1A–B). Prostomium triangular, tapering to narrow rounded tip (Fig. 1A–C); eyespots absent; nuchal organs narrow slits on posterior lateral margins (Fig. 1C). Peristomium elongate, with three annular rings interrupted dorsally by prominent dorsal crest (Fig. 1A); ventrally only first ring apparent, rest of venter relatively smooth, with a low ridge transitioning to a distinct ventral ridge from setiger 1 continuing along body (Fig 1B). Mouth with several rounded lobes inside posterior lip (Fig. 1B). Dorsal tentacles arise from posterior margin of third peristomial ring; first pair of branchiae lateral to dorsal tentacles (Fig. 1A, C); second pair of branchiae on setiger 1 dorsal to notosetae; subsequent branchiae in a similar position. Most branchiae missing or broken, represented by scars or stubs.

Parapodia of first 7–8 setigers slightly elevated producing shoulders; noto- and neuropodia rounded lateral lobes from which fascicles of capillary setae arise (Fig. 1C); thereafter podial lobes reduced, but still visible until about setiger 30 (Fig. 1D) after which setae appear to arise directly from body wall. Post- and pre-setal lobes or lamellae entirely absent. Setae all smooth capillaries, non-limbate or granulated; fimbriated borders not observed at 1000 ×. Anterior setigers with 6–9 capillaries in anterior notopodia and 5–6 in neuropodia; middle body setigers with about five notosetae and 3–4 neurosetae.

Nature of posterior end and pygidium unknown.

Methyl Green staining. Stain concentrates in the ventral intersegmental grooves on anterior and middle setigers producing a distinct band that extends from the base of each parapodium down and around each segment being interrupted mid-ventrally by the longitudinal groove. There are no other areas of the body that retain stain. The stain is very evident on the specimens from Sta. 016 (including holotype), but weaker on the specimens from Sta. 31.

Remarks. Among species of *Aphelochaeta* described from abyssal depths, *A. jubata* sp. nov. is most similar to *Aphelochaeta clarionensis* Blake, 2019 from the abyssal depths of the Clarion-Clipperton Fracture Zone in the Pacific Ocean, in having the peristomial rings interrupted by a dorsal crest. However, *A. clarionensis* has only two peristomial rings instead of three in *A. jubata* sp. nov. In addition, the MG staining patterns of the two species differ in that *A. clarionensis* has a distinct pattern on the pre-setiger region and no pattern on the body segments. In contrast, *A. jubata* sp. nov. has no pre-setiger staining pattern, but stain is retained as intersegmental bands on anterior and middle segments.

Another abyssal species *of Aphelochaeta* with a distinct dorsal peristomial crest is *Aphelochaeta brandtae* Blake, 2018 from the Southern Ocean and Weddell Sea, Antarctica. However, in contrast to *A. jubata* sp. nov., *A. brandtae* has two peristomial rings instead of three, and a prominent MG pattern on the pre-setiger region and broad bands across the venter of anterior segments instead of no pre-setiger pattern and the stain retained on anterior and middle segments is concentrated in the narrow intersegmental grooves.

Etymology. The epithet is from the Latin, *juba* for mane or crest, in reference to the distinctive dorsal crest found on the peristomium of this species.

Distribution. Abyssal plain between Victoria and Tasmania, eastern Australia, 4031–4170 m.

Aphelochaeta readi sp. nov.

urn:lsid:zoobank.org:act:8E09CD78-35D3-46EE-8BEB-5DE6E5C4F55E

Figs 2–3

Holotype: Abyssal plain off eastern Australia, off Byron Bay, New South Wales, RV *Investigator*, Sta. 098, coll. 8 June 2017, Brenke sledge, start 28.371°S 154.647°E, 3811 m to end 28.389°S 154.612°E, 3754 m (AM W.52714).

Description. A small species, holotype only specimen, complete with 28 setigers, 3.2 mm long and 0.47 mm wide across anterior setigers. Body expanded over first nine

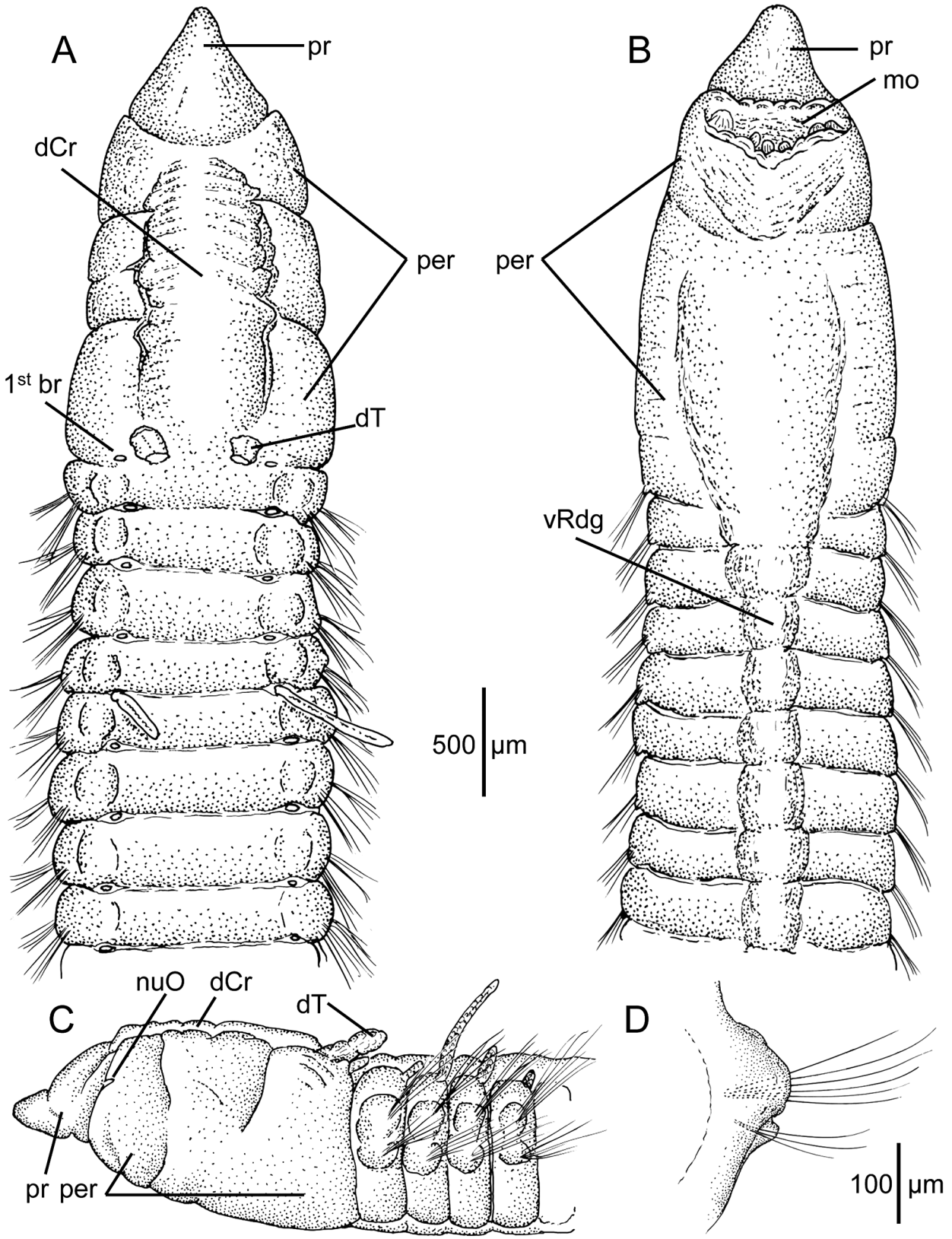

Figure 1. *Aphelochaeta jubata* sp. nov. (*A–B*) holotype (AM W.52706): (*A*) anterior end, dorsal view; (*B*) anterior end, ventral view. (*C–D*) paratype (AM W.53523): anterior end, left lateral view; (*D*) abdominal parapodium, anterior view.

setigers, then narrowing to consistent width along rest of body (Figs 2A, 3A). First 8–9 individual setigers short, each 11–12 times wider than long, following segments longer, about three times wider than long (Fig. 2A); far posterior segments becoming rounded, weakly moniliform (Fig. 2C). Each segment separated from following by relatively deep intersegmental grooves. Dorsal surface of all segments smooth without dorsal longitudinal grooves or ridges. Ventral surface of body with prominent mid-ventral ridge line composed of transverse raised ridges that together

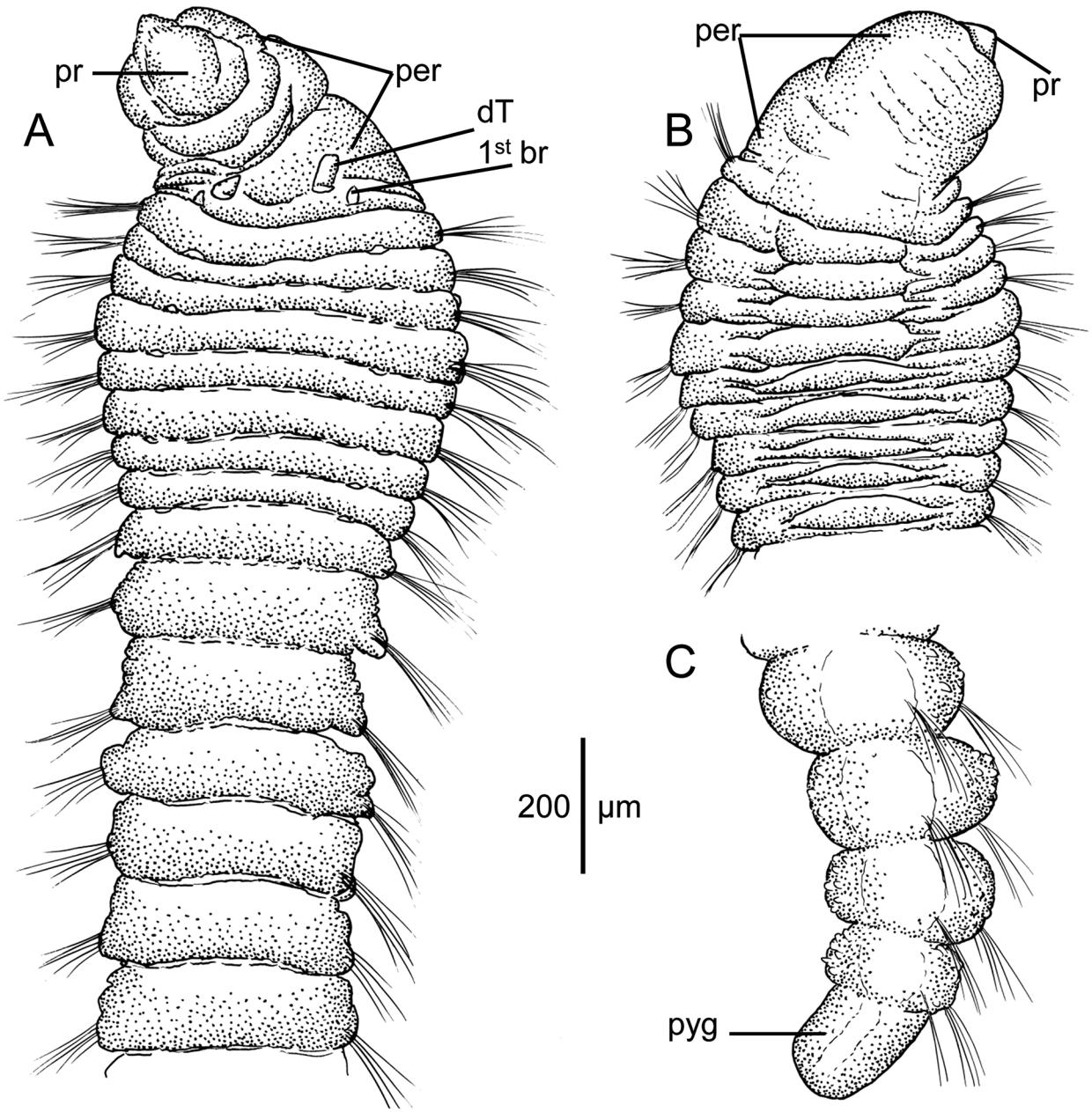

Figure 2. *Aphelochaeta readi* sp. nov. (*A–C*), holotype (AM W.52714): (*A*) anterior end, dorsal view; (*B*) anterior end, ventral view; (*C*) posterior end, left lateral view.

form a line of ridges along body (Fig. 2B); ventral ridges of anterior setigers about half as wide as ventral surface, narrowing to short ridge in posterior segments. Colour in alcohol light tan.

Pre-setiger region relatively short, thickened, about as long as first six setigers (Fig. 2A). Prostomium short, pear-shaped, tapering to narrow tip (Figs 2A–B, 3A–B); eyespots absent; nuchal organs not observed. Peristomium with three annular rings and one narrow achaetous segment, all complete dorsally (Fig. 2A); these all merged ventrally providing smooth ventral surface from anterior margin of peristomium to setiger 1 (Fig. 2B). Mouth of opening anteriorly, visible only in frontal view, a only visible ventrally as narrow slit between first peristomial ring and prostomium. Dorsal tentacles arise from middle of third peristomial ring (Fig. 2A); first pair of branchiae arises on achaetous segment anterior to setiger 1; subsequent branchiae arise on posterior margin of individual segments dorsal to notosetae (Fig. 2A). All branchiae missing or broken, represented only by scars or short stubs.

Parapodia relatively simple throughout, not producing prominent lobes or shoulders anywhere along body; setae arising directly from body wall (Figs 2A–B, 3A–B). Pre- and post-setal lobes or lamellae entirely absent. Setae all smooth capillaries, not limbate or granulated; fimbriated borders not present. Anterior and middle setigers with 8–9 capillaries in notopodia and 6–7 in neuropodia; posterior setigers with 3–4 notosetae and 4–5 neurosetae.

Pygidial segment elongate, with anal opening terminal; without anal lobes or cirri (Fig. 2C).

Methyl Green staining. Weak stain on prostomium and in intersegmental areas of anterior segments where subdermal glands occur; otherwise no pattern.

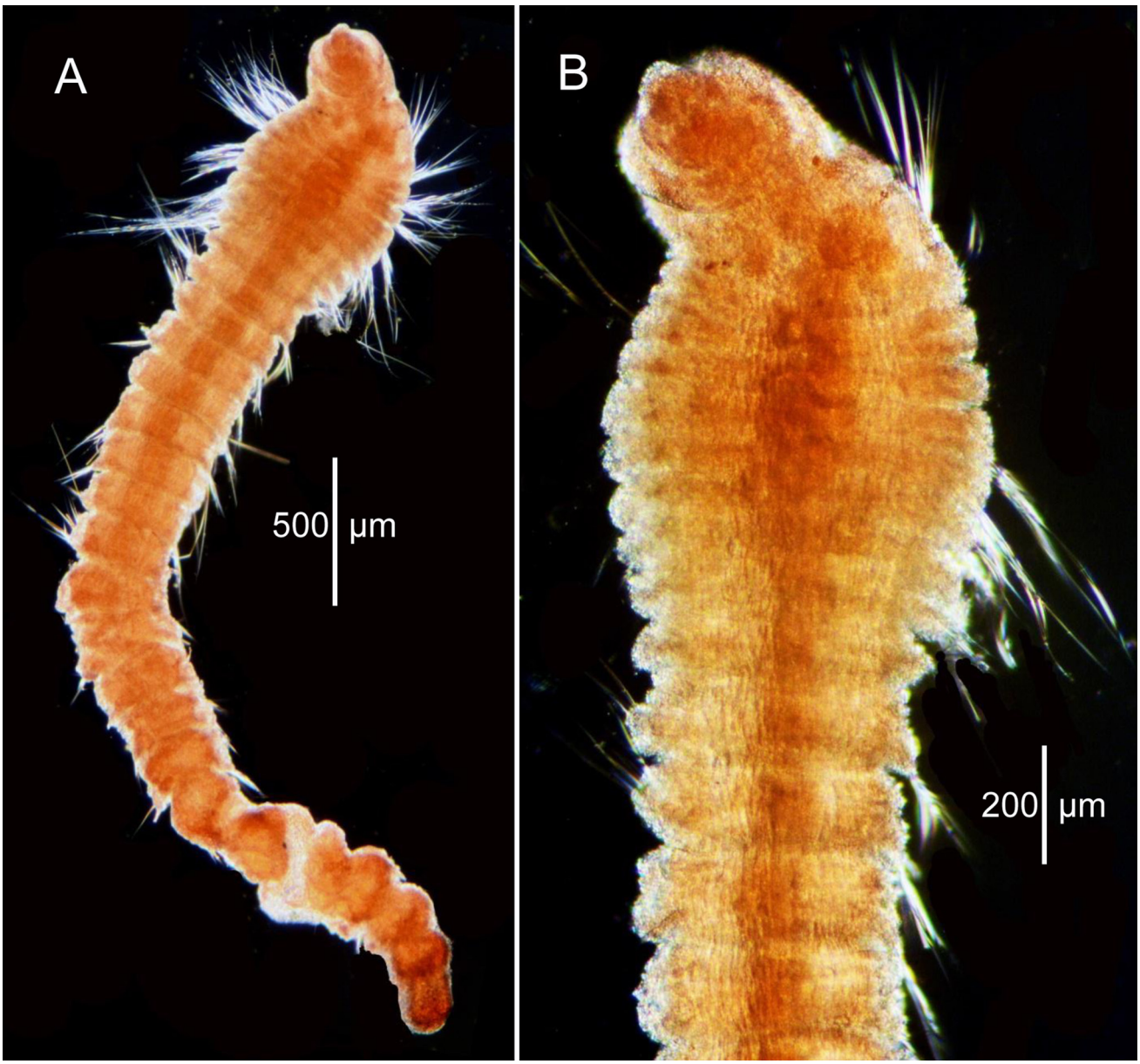

Figure 3. *Aphelochaeta readi* sp. nov. (*A–B*), photomicrographs of holotype (AM W.52714): (*A*) entire worm, dorsal view; (*B*) anterior end, dorsal view.

Remarks. To date, only 12 valid species of *Aphelochaeta* have been described from abyssal depths of about 3000 m or greater (Blake, 2018, 2019, this study). *Aphelochaeta readi* sp. nov. is the twelfth species in this group and the only one having multiple peristomial rings that cross the dorsal surface, yet do not cross the ventral surface leaving it smooth. In addition, the distinct widening of the first 8–9 setigers followed by a narrow middle and posterior body with a few far posterior moniliform segments terminating in a simple pygidial lobe is distinctive. Unlike other cirratulids encountered in this study and at other deep-water locations, *A. readi* sp. nov. is the only one to have the mouth opening directed frontally, not visible in ventral view.

Etymology. This species is named in honour of Dr Geoffrey Read, Marine Biologist with the National Institute of Water & Atmospheric Research Ltd (NIWA), Wellington, New Zealand in recognition of his long-time role as Chief Editor of annelids for the World Register of Marine Species (WoRMS). In addition, Dr Read has long maintained a website site dedicated to polychaetes and provides a wide range of assistance in addressing problems with zoological nomenclature and locating references, many of which are long out of print.

Distribution. Abyssal plain off Byron Bay, NSW, eastern Australia, 3754–3811 m.

Genus *Chaetocirratulus* Blake, 2018

Type species: *Heterocirrus andersenensis* Augener, 1932. Original designation by Blake (2018).

Diagnosis. (after Blake, 2018) Prostomium broadly rounded anteriorly or wedge-shaped; eyespots absent; with a pair of small nuchal slits or depressions at posterior edge. Peristomium with a single pair of grooved dorsal tentacles arising from posterior margin or interface with setiger 1. First pair of branchiae arising from posterior margin of peristomium, an achaetous segment, or setiger 1. Body typically thick and fusiform over many segments, rarely with middle or posterior body segments beaded or moniliform; individual segments short, numerous. Setae include capillaries on most setigers and thick, pointed acicular spines in neuropodia and a few in notopodia or spines in neuropodia only; spines few, often small and inconspicuous, not forming cinctures. Individual spines straight to weakly sigmoid. Pygidium with a simple ventral lobe.

Remarks. Species of *Chaetocirratulus* include a small group of bitentaculate cirratulids that share characteristics of both the multitentaculate genus *Cirratulus* Lamarck, 1818 and the bitentaculate genus *Chaetozone*. The genus was established by Blake (2018) to accommodate a group of large bodied *Chaetozone* species that had a short wedge-shaped prostomium and only a few acicular spines, not arranged in spreading fascicles or in the more typical cinctures. Blake (2018) reported on six species of this genus, three new to science, all from the southern hemisphere: four from Antarctica; two from off western South America. Blake (2022) reported on four additional species from the western North Atlantic Ocean, three of which were new to science. In the present study, two new species agreeing with the diagnosis of *Chaetocirratulus* have been encountered, bringing the total number of known *Chaetocirratulus* species to twelve.

Chaetocirratulus bathyalis sp. nov.

urn:lsid:zoobank.org:act:518D66CF-5EEA-4503-8069-A59E1D9BDC8B

Fig. 4

Holotype. Continental slope off eastern Australia, Central Eastern Marine Park, W of Coffs Harbor, NSW, RV *Investigator*, Sta. 087, coll. 06 June 2017, Brenke sledge, start 30.113°S 153.898°E, 2634 m to 30.116°S 153.867°E, 2324 m (AM W.52713).

Description. A small species, holotype complete, with about 65 setigers, 13.1 mm long, 1.1 mm wide across anterior setigers and about 1.2 mm wide across middle setigers, narrowing posteriorly. Body elongate, thick, grub-like, but not fusiform; segments short, wide, anterior segments about 4.5 times wider than long (Fig. 4A); posterior segments about six times wider than long (Fig. 4C). In cross section, body segments dorsoventrally flattened, but with dorsum and venter rounded; with ventral ridge extending from peristomium continuing along entire body; dorsal ridge or groove absent. Individual segments all uniannulate, but middle and posterior segments crossed with numerous thin wrinkles. Colour in alcohol: light tan.

Pre-setiger region about as wide as long, as long first five setigers (Fig. 4A). Prostomium wedge-shaped in dorsal and ventral view, narrowing to rounded tip (Fig. 4A–B); with rounded, bulbous shape in lateral view; eyespots absent; nuchal organs large, crescent-shaped grooves on posterior lateral margin. Peristomium with lateral and ventral grooves producing three rings (Fig. 4A), a narrow anterior ring followed by two more-or-less equal larger rings; surmounted by irregular shaped dorsal crest not crossed by peristomial grooves (Fig. 4A). Ventrally, peristomial rings only weakly apparent; mouth opening encompassed by first ring, with upper lip formed by about six lobes (Fig. 4B). Dorsal tentacles arise from a narrow groove between third peristomial ring and setiger 1, possibly an achaetous segment (Fig. 4A). First pair of branchiae lateral to dorsal tentacles in same groove. Subsequent branchiae arise dorsal to notosetae from setiger 1, continuing on subsequent setigers (Fig. 4B). Most branchiae missing or reduced to stubs or scars.

Parapodia reduced to ridge from which noto- and neurosetae arise (Fig. 4D); podial lobes entirely absent. Noto- and neurosetae include acicular spines and long, thin capillaries. Acicular spines arise from setiger 1 in both noto- and neuropodia. Notosetae include 3–4 acicular spines and at least one long capillary in anterior setigers (Fig. 4D), reduced to 1–2 spines and one long capillary in middle and posterior setigers. Neurosetae include 4–5 acicular spines and at least one long capillary in anterior setigers (Fig. 4D), reduced to 2–3 spines and one long capillary posteriorly. Notoacicular setae generally with weakly curved shafts narrowing to rounded tip (Fig. 4E); neuroacicular setae with slightly thicker, straight shaft and rounded tips (Fig. 4F). Capillaries of anterior setigers narrow, whip-like, becoming thicker and stiff posteriorly. Majority of setae broken off in holotype.

Posterior end narrowing to short pygidium with cap-like rounded lobe (Fig. 4C).

Methyl green staining. Individual gland cells staining all along body, producing bands of speckles over individual segments; dense concentrations of speckles on peristomium especially last ring and dorsal crest.

Remarks. *Chaetocirratulus bathyalis* sp. nov. is similar to *Chaetocirratulus pinguis* (Hartman, 1978) from Antarctica in having noto- and neuropodial spines from setiger 1. The two species differ in that *C. pinguis* has a distinctly fusiform body, three weakly developed peristomial rings with no dorsal crest, a shallow mid-dorsal groove along the body but no ventral ridge, and individual segments that are distinctly biannulate (Blake, 2018). In contrast, *C. bathyalis* sp. nov. has a thickened but not fusiform body, at least two well-developed peristomial rings and a prominent dorsal crest, no mid-dorsal groove but a distinct ventral ridge, and uniannulate segments with numerous transverse wrinkles. In addition, the MG staining pattern differs between the two species: in *C. pinguis* the retained stain is largely limited to the pre-setiger region where the prostomium stains lightly and the peristomium stains heavily, especially laterally. In contrast, *C. bathyalis* sp. nov. has stain concentrated in individual glands, producing bands of speckles all along the body and dense concentrations of speckles on the last peristomial ring and dorsal crest.

Etymology. The epithet is from the Greek, *bathys*, for deep, in reference to the deep-water habitat of this species.

Distribution. Australia, lower continental slope off New South Wales, 2324–2634 m.

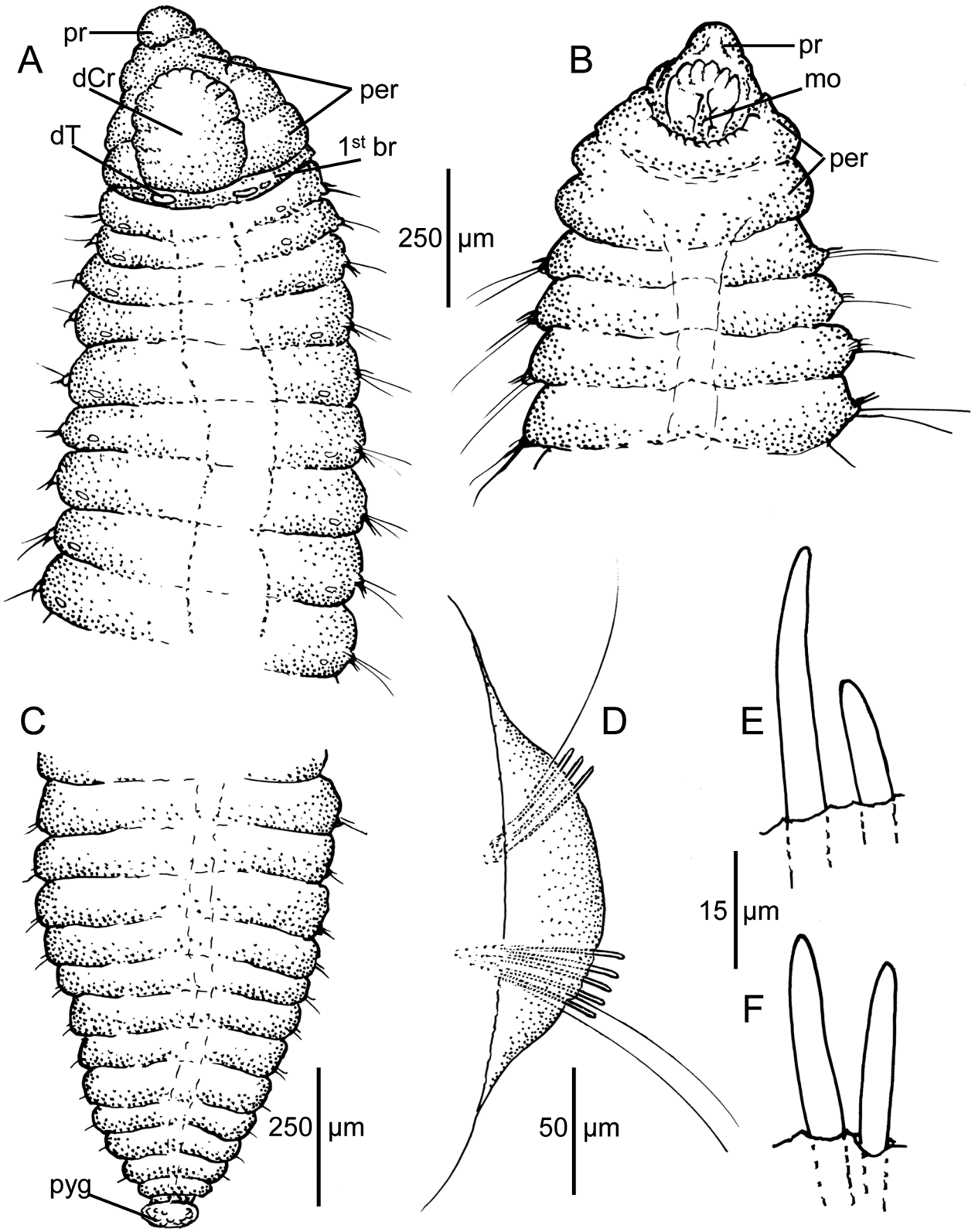

Figure 4. *Chaetocirratulus bathyalis* sp. nov. (*A–F*), holotype (AM W.52713): (*A*) anterior end, dorsal view; (*B*) anterior end ventral view; (*C*) posterior end, dorsal view; (*D*) parapodium from an anterior setiger, anterior view; (*E*) notoacicular spines; (*F*) neuroacicular spines.

Chaetocirratulus glebalis sp. nov.

urn:lsid:zoobank.org:act:62BD4E47-1F83-46C5-BAFD-6BCF6AC4C2F8

Figs 5–6

Holotype: Abyssal plain off eastern Australia, between Victoria and Tasmania, Bass Strait Marine Park, RV *Investigator*, Sta. 031, coll. 23 May 2017, Brenke sledge, 39.422°S 149.604°E to 39.391°S 149.597°E, 4170 m (AM W.53524). **Paratypes** (3): same data as holotype (3, AM W.53525).

Description. All specimens incomplete, including four anterior fragments and one posterior fragment. Holotype largest specimen, with 60 setigers, 10.6 mm long, 0.9 mm wide across anterior setigers; largest paratype with 25 setigers, 3.0 mm long, 1.0 wide. Body with thick, crowded segments along entire body (Figs 5A–B, 6C–E); individual segments up to ten times wider than long. Anterior segments with transverse lumpy dorsal ridge (Fig. 5A), but without longitudinal grooves or ridges; venter with prominent mid-ventral ridge along entire body composed of broad medial bulge on each segment (Figs 5B, 6B), connected mid-ventrally at intersegmental groove. One paratype a mature female with large eggs in two swollen posteriormost setigers of fragment (Fig. 6C–D). Eggs 160–200 μm in longest diameter. Colour in alcohol tan without any obvious pigment.

Pre-setiger region broad, thickened, with prostomium curved ventrally, not visible in dorsal view (Fig. 5A–B). Prostomium a short, pear-shaped lobe, broadly rounded across anterior margin (Figs 5B, 6B); eyespots absent; nuchal organs curved grooves on lateral margins (Fig. 5B). Peristomium with two irregularly-shaped rings, each with unique morphology: (1) anteriormost ring bulbous, encircling prostomium and mouth (Fig. 5B), bearing fan-shaped dorsal crest (Figs 5A, 6A, C); (2) second ring consisting of an irregular series of lobes that overall merge with setiger 1; mid-dorsal lobe swollen, with a pair of grooves on anterior margin with notch containing scar representing origin of dorsal tentacles (Fig. 5A); ventral side with broad semi-circular crest extending posteriorly over setigers 1–2 (Fig. 5B).

Parapodia of anterior setigers elongate rounded lateral lobes from which setae emerge; reduced to narrow ridge in middle and posterior setigers (Fig. 5C); pre- and post-setal lobes entirely absent. Branchiae from setiger 1, dorsal to notosetae, continuing to at least mid-body; branchiae mostly missing, but represented by scars and stubs. Noto- and neurosetae include long thin capillaries throughout, including a few long natatory-like setae (Fig. 6C) and few narrow acicular spines in far posterior setigers (Fig. 5C). Capillaries of anterior setigers numbering 6–8 in notopodia and 9–10 in neuropodia; middle setigers with 7–9 capillaries in notopodia and 8–10 in neuropodia. Acicular spines not present in short paratypes, but present from about setiger 55 in holotype, with 2–3 spines in neuropodia and 0–1 in notopodia. Posterior fragment with pre-pygidial segments with up to six spines in neuropodia and 2–3 in notopodia (Fig. 5C). Individual spines narrow, weakly curved, tapering to narrow rounded tip (Fig. 5D).

Posterior fragment narrowing to short conical pygidial lobe.

Methyl Green staining. No general pattern, however intersegmental grooves retain stain to varying degrees (Fig. 6D–E, arrows), with dorsal surface of some middle and posterior segments staining lightly.

Remarks. *Chaetocirratulus glebalis* sp. nov. is an entirely unique cirratulid in the nature of the numerous lobes and lumps on the pre-setiger region and on the body segments. The species is referred to *Chaetocirratulus* because of the relatively thickened body, short anteriorly rounded pre-setiger region and hidden nature of the prostomium. I know of no other cirratulids from deep water or shallower depths with a similar appearance. The morphology and arrangement of the acicular spines is, however, similar to some species of *Chaetozone*, except that posterior segments do not have cinctures and the spines are not large nor sigmoid in shape.

Biology. The large protruding eggs (160–200 μm) on the paratype suggest direct or lecithotrophic development, which would be expected for an abyssal species. However, long natatory-like capillaries might suggest a mechanism for movement at the sediment-water interface at the time of spawning. The short, blunted pre-setiger region suggests that the species burrows by pushing particles out the way and opening cracks in the sediment rather than moving between particles.

Etymology. The epithet is from the Latin, *gleba* for lump, in reference to the lumpy segmental appearance of the body of this species.

Distribution. Abyssal plain between Victoria and Tasmania, eastern Australia, 4170 m.

Genus *Chaetozone* Malmgren, 1867

Type species: *Chaetozone setosa* Malmgren, 1867, by monotypy.

Diagnosis. (Emended from Blake, 2018). Prostomium blunt to conical, elongate to short, usually lacking eyespots, with a pair of small nuchal slits or depressions at posterior edge. Peristomium with a single pair of grooved dorsal tentacles arising from posterior edge of peristomium, or sometimes more posterior on an asetigerous anterior segment, or rarely on an anterior setiger. First pair of branchiae arising from peristomium, an achaetous segment or first setiger; sometimes with first two pairs of branchiae on a single anterior segment. Body usually expanded anteriorly and narrowed posteriorly, rarely with middle or posterior body segments beaded or moniliform; posterior end often expanded. Setae include capillaries on most setigers and sigmoid acicular spines in neuropodia and notopodia, with spines typically concentrated in posterior segments forming distinct cinctures with spines carried on elevated membranes; cinctures with few to many spines sometimes encircling entire posterior end, accompanied with none to many alternating capillaries; bidentate spines sometimes present in juveniles or occasionally in ventral-most position of far posterior setigers of adults, accompanying unidentate spines in cinctures; some species with long, natatory-like capillary notosetae, sometimes limited to gravid individuals. Pygidium a simple lobe, disk-like, with long, terminal cirrus, or few short lobes.

Remarks. *Chaetozone* is the largest of the cirratulid genera with about 75 species (Blake, 2022). Species of *Chaetozone*

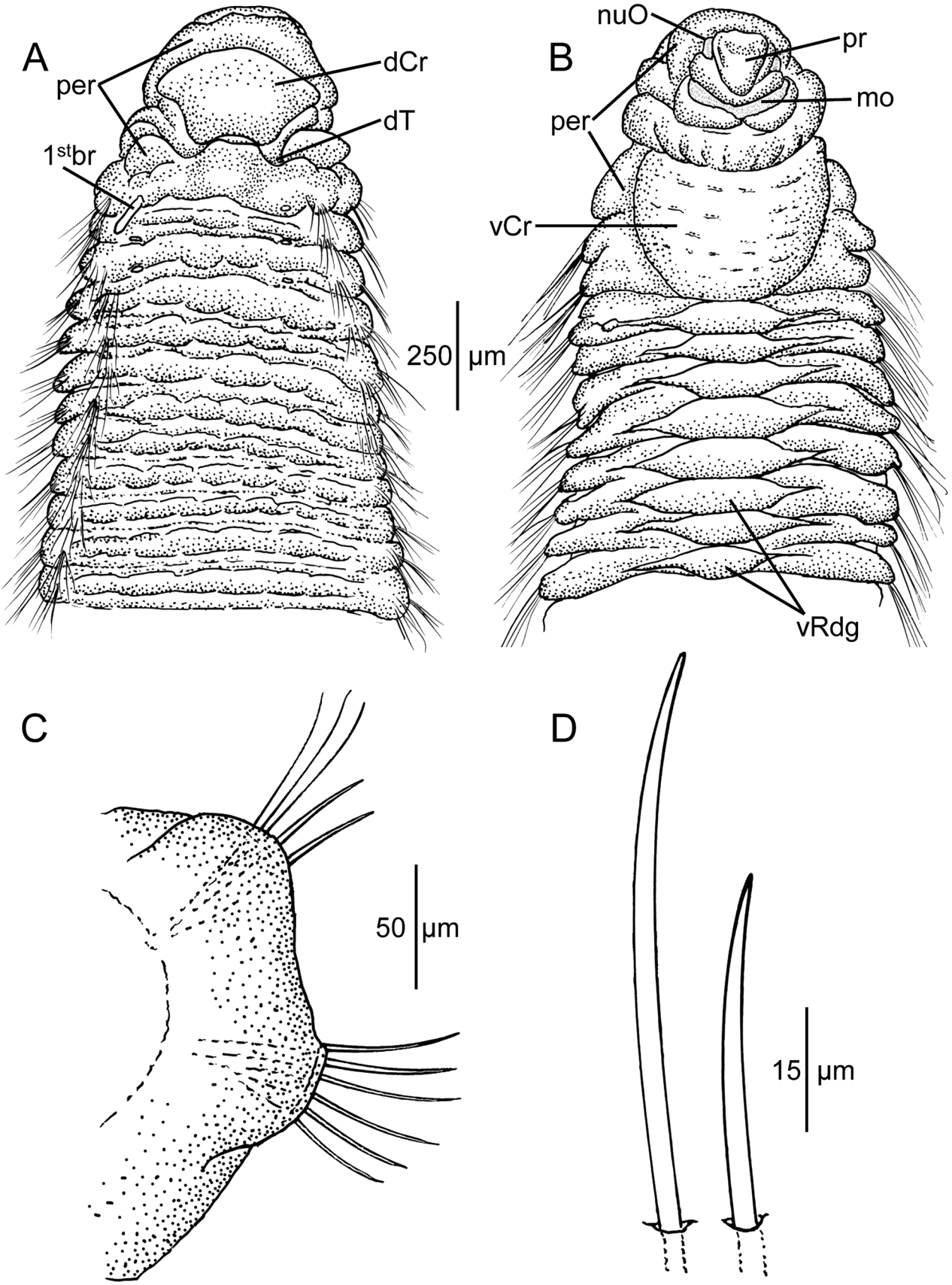

Figure 5. *Chaetocirratulus glebalis* sp. nov. (*A–B*) holotype (AM W.53524): (*A*) anterior end, dorsal view; (*B*) anterior end, ventral view. (*C–D*) paratype (AM W.53525): (*C*) posterior setiger, anterior view; (*D*) posterior neuroacicular spines.

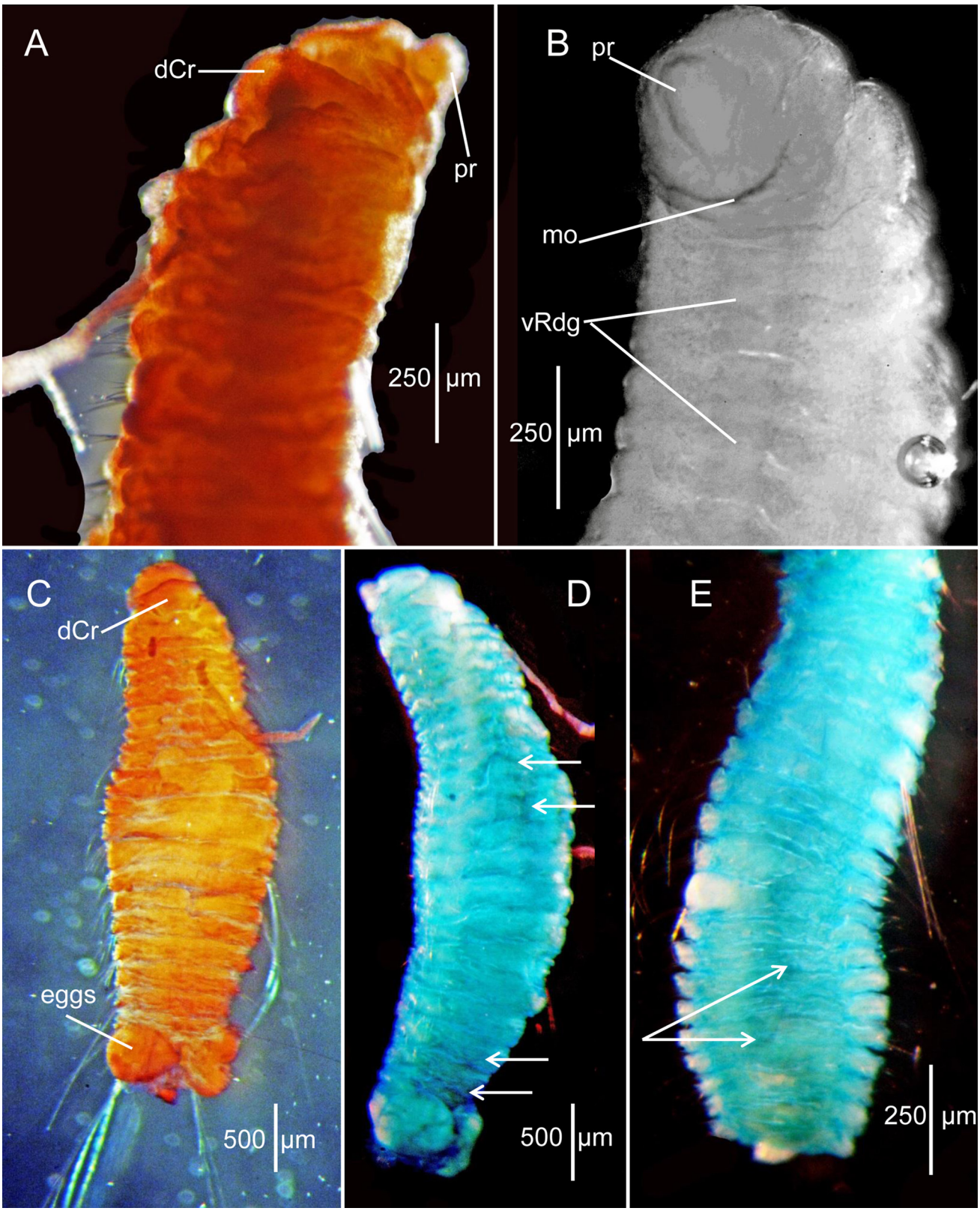

Figure 6. *Chaetocirratulus glebalis* sp. nov. Photomicrographs (*A*, *C–D*) paratype (AM W.53525); (*B*, *E*) holotype (AM W.53524). (*A*) anterior end, right lateral view; (*B*) anterior end, ventral view; (*C*) entire fragment, dorsal view; (*D*) same, left lateral view; (*E*) posterior segments, dorsal view. A–C, stained with Shirlastain A; D–E, stained with Methyl Green.

are typically recognized by having acicular spines in both noto- and neuropodia and with those of posterior segments frequently numerous and arranged in conspicuous spreading fascicles that often entirely encircle the body providing a characteristic armature. However, several species have a reduced number of acicular spines that are not superficially conspicuous and as such are peripheral to the above definition (Blake, 2022). In the present study, two species of *Chaetozone* were identified, but none of the specimens were complete precluding an exact determination of the number of

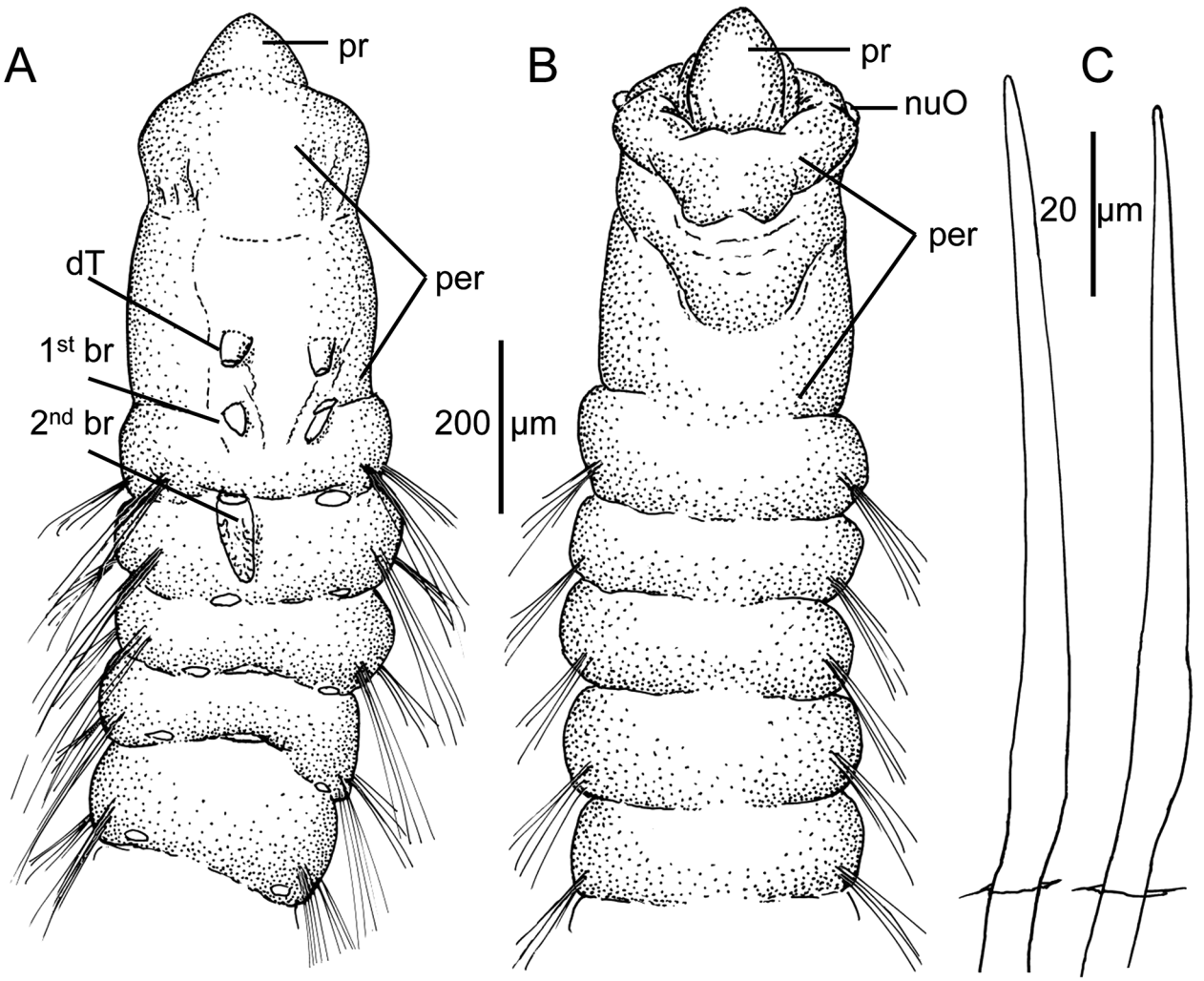

Figure 7. *Chaetozone abyssalis* sp. nov. (*A–C*) holotype (AM W.52712): (*A*) anterior end, dorsal view; (*B*) anterior end, ventral view; (*C*) neuroacicular spines.

acicular spines and their arrangement in posterior segments. However, the morphology of the pre-setiger region agrees well with other related species of *Chaetozone* and makes a comparison of soft morphology feasible.

Chaetozone abyssalis sp. nov.

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Figs 7–8

Holotype: Abyssal plain off New South Wales, eastern Australia, Hunter Marine Park, RV *Investigator*, Sta. 079, coll. 4 June 2017, Brenke sledge, 32.527°S 153.898°E to 30.163°S 153.524°E, 4031 m (AM W.52712). **Paratypes** (5): same data as holotype (1, W.53526);—Abyssal plain off eastern Australia, between Victoria and Tasmania, Bass Strait Marine Park, Sta. 031, coll. 23 May 2017, Brenke sledge, 39.422°S 149.604°E to 39.391°S 149.597°E, 4170 m (4, W.53528). All in Australian Museum.

Description. A small species, all specimens incomplete. Holotype a gravid female, with 24 setigers, 3.1 mm long and 0.22 mm wide across anterior setigers; paratype (AM W.53526) of a similar size, but coiled, lacking gametes (Fig. 8C), with 24 setigers. Body elongate, narrow, holotype with anterior 5–10 setigers narrow, c. 4.5 times wider than long (Fig. 7A), followed by swollen "stomach" area of about six setigers containing numerous eggs and an enlarged loop of the intestine filled with fine sediment (Fig. 8A–B); abdominal segments becoming moniliform, with partial cinctures developing on posterior segments of fragment. Paratype without enlarged "stomach" area but with some thickening of posterior thoracic segments filled with fine sediment particles. Dorsal and ventral crests and ridges absent. Eggs of holotype numerous, tightly packed, from about setiger 10 to 22, each egg 100–120 µm in longest diameter with conspicuous germinal vesicle. Colour in alcohol: opaque white, with no body pigment.

Pre-setiger region elongate, thick, about as long as first four setigers (Figs 7A–B, 8A); with expanded anterior peristomial ring surrounding narrow prostomium and mouth. Prostomium conical, tapering to rounded tip (Figs 7A, 8A); eyespots absent; nuchal organs present as rounded lobes on posterior lateral margins (Fig. 7B); ventrally prostomium forming anterior lip of mouth. Peristomium with two rings; anterior ring swollen, dorsally merging gradually with second peristomial ring (Fig. 7A); ventrally thickened forming posterior lip of mouth (Fig. 7B). Second peristomial ring relatively smooth dorsally, with low swelling mid-ventrally (Fig. 7A–B). Dorsal tentacles arising about

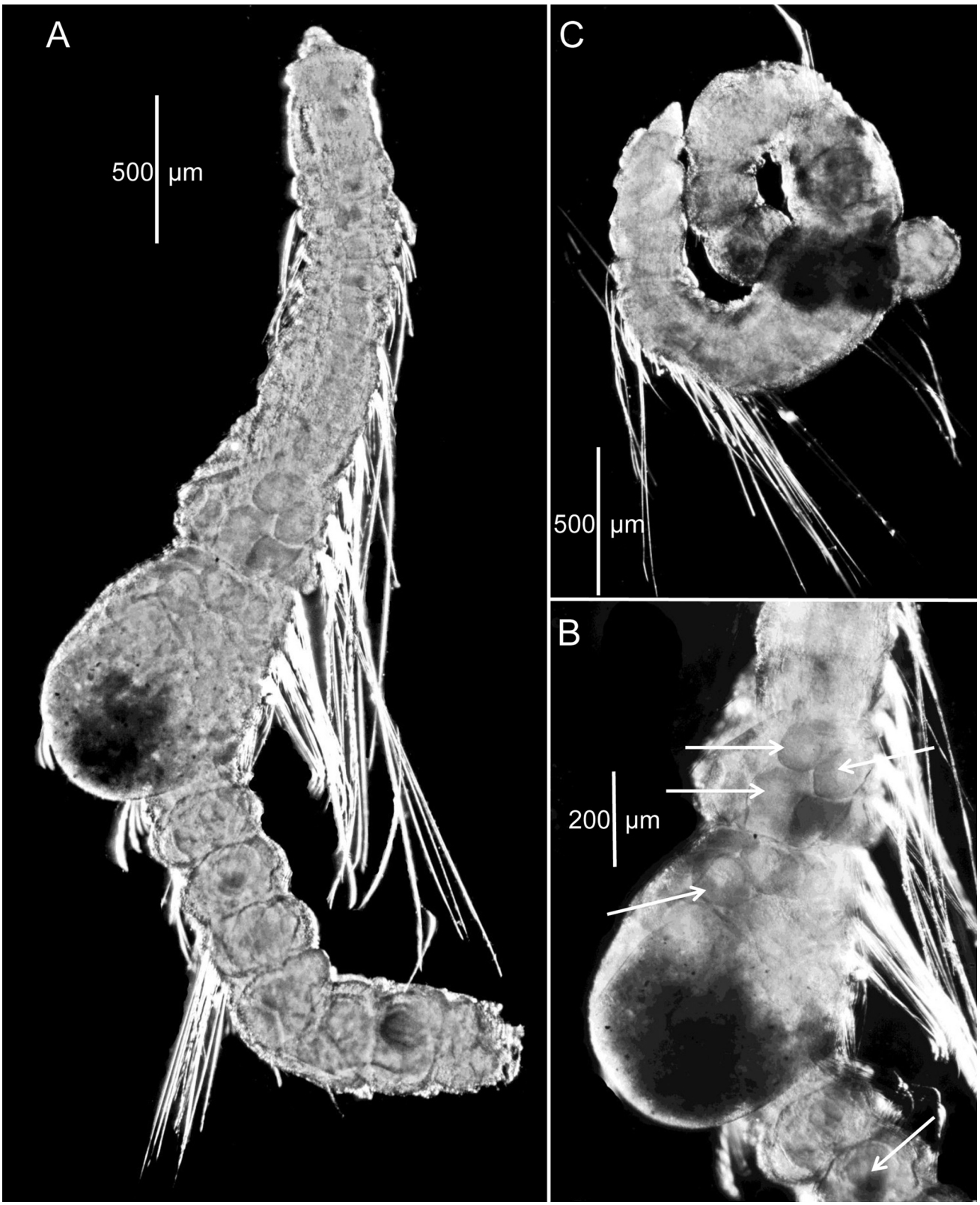

Figure 8. *Chaetozone abyssalis* sp. nov. Photomicrographs converted to grayscale. (*A–B*), holotype (AM W.52712): entire worm, dorsal view; (*B*) detail of enlarged "stomach" and eggs. (*C*) paratype (AM W.53526): entire worm, twisted in lateral view. All originally stained with Shirlastain A.

two-thirds along second peristomial ring with first branchiae arising directly posterior to tentacles on posterior border (Fig. 7A). Second pair of branchiae on posterior border of first setiger; subsequent branchiae in similar position; most branchiae missing, represented by scars or stubs.

Parapodia reduced to low ridges or mounds from which setae arise; posterior parapodia becoming moniliform with cinctured segments developing on posteriormost segments of both specimens. Anterior setae all long capillaries numbering about 10–12 per fascicle, including long natatory-like setae in

most notopodia of anterior and middle segments (Fig. 8A–C). Neuropodial acicular spines from setiger 22 and notopodial spines from setiger 24 on holotype. Spines numbering six in neuropodia and two in notopodia in setiger 24, or last setiger of incomplete holotype. Spines accompanied by 1–2 capillaries in neuropodia and 2–3 in notopodia. Individual spines with basal manubrium at emergence from podial lobes; spines only weakly curved, tapering to narrow pointed tip (Fig. 7C).

Pygidium unknown; specimens incomplete.

Methyl Green staining. Stain retained on lateral sides of peristomium, otherwise no pattern.

Remarks. *Chaetozone abyssalis* sp. nov. belongs to a group of deep-sea species that includes *Chaetozone australosetosa* Blake, 2018 and *Chaetozone biannulata* Blake, 2018, both from Antarctic seas, and *Chaetozone profunda* Blake, 2022 from deep water in the western North Atlantic. Each of these species has two peristomial rings with the large second ring bearing dorsal tentacles well anterior to the first pair of branchiae and setiger 1, suggesting that an achaetous segment is incorporated into the peristomium. *Chaetozone abyssalis* sp. nov. is most similar to *C. australosetosa* in having a relatively thick pre-setiger region instead of one that is long, narrow, and tapering anteriorly to a pointed prostomium.

Chaetozone abyssalis sp. nov. differs from *C. australosetosa* in having the first peristomial ring expanded and separated from the prostomium instead of narrow and conical tapering to a prostomium that is mostly merged with it. The number of posterior spines between the two species cannot be compared due to the absence of complete specimens of *C. abyssalis* sp. nov.

Etymology. The epithet is from *abyss*, Latin for a bottomless pit or the deep sea, in reference to this species being collected from abyssal depths.

Distribution. Abyssal plain off New South Wales, eastern Australia, 4031 m.

Chaetozone adusta sp. nov.

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Figs 9–10

Holotype: Abyssal plain off southeastern Victoria, eastern Australia, East Gippsland Marine Park, RV *Investigator*, Sta. 033, coll. 24 May 2017, Brenke sledge, 38.521°S 153.213°E to 38.498°S 150.207°E, 4107 m (AM W.52709).

Description. A moderately-sized species, holotype only specimen, incomplete, broken in two pieces, with 39 setigers, 8.4 mm long, 0.38 mm wide across setiger 1 and 0.80 mm across widest thoracic segments. Body with narrow pre-setiger region and about first eight setigers then expanding (Fig. 10A) and becoming widest over setigers 14–20, then narrowing posteriorly (Fig. 10A). All anterior and middle setigers short; anterior setigers about 4.5 times as wide as long; widest middle setigers about ten times wider than long; posterior setigers narrowing (Fig. 10A), becoming moniliform, about as wide as long (Fig. 10D). Simple ventral groove present from anterior border of setiger 1 (Fig. 9B); in middle setigers, groove joined by a conspicuous mid-ventral swelling at junction of each segment on venter. Colour in alcohol light tan; body with areas of dark pigment along most of body, mostly concentrated in intersegmental areas and as parapodial bands (Fig. 10A–C arrows); some branchiae pigmented.

Pre-setiger region about as long as first five setigers, consisting of a long, narrow prostomium, followed by a bulbous first peristomial ring and smooth second ring (Fig. 9A). Prostomium tapering anteriorly to a narrow tip (Figs 9A–B, 10A–B); eyespots absent; nuchal organs visible in a pit on dorsolateral margin (Fig. 10A). Peristomium with first bulbous ring merging with prostomium dorsally (Figs 9A, 10A–B) and forming anterior lip of mouth ventrally (Fig. 9B); second peristomial ring rectangular, merging seamlessly with setiger 1 dorsally (Fig. 9A), forming posterior lip of mouth ventrally, then merging with setiger 1 posteriorly (Fig. 9B). Three ciliated oral lobes observed within mouth opening (Fig. 9B). Dorsal tentacles arising from middle of second peristomial ring with first pair of branchiae arising posterior to tentacles on posterior margin (Fig. 9A). Second pair of branchiae on posterior border of setiger 1 dorsal to notosetae; subsequent branchiae in similar position; most branchiae missing with location observed as scars or stubs along most of body.

Parapodia of anterior setigers reduced to low mounds from which setae arise; middle expanded setigers with parapodia more prominent, narrow, forming lateral lobes; posterior segments again with parapodia reduced. Anterior setae all long capillaries numbering about 7–9 per fascicle, including long natatory-like setae in most notopodia of anterior and middle segments. Acicular spines from setiger 24 in neuropodia and setiger 31 in notopodia. Spines numbering five in neuropodia and three in notopodia in setiger 38 or with eight spines on a side, but not as cinctures; however, nature of far posterior segments and spines unknown. Spines accompanied by 1–2 capillaries in neuropodia and 3–4 in notopodia. Individual neuropodial spines with basal manubrium near emergence from podial lobes, thick, weakly curved, tapering to narrow pointed tip (Fig. 9D); notopodial spines longer and straighter than neuropodial spines (Fig. 9C).

Pygidium unknown.

Methyl Green staining. No pattern.

Remarks. *Chaetozone adusta* sp. nov. is easily recognized by the nature of the two peristomial rings of which the first is enlarged and bulbous and the second is smooth and merges with setiger 1 as well as the narrow anterior segments that transition to a distinctly enlarged middle section that then narrow to moniliform posterior segments. In addition, the body is distinctly pigmented with brown areas along most of its length, including distinct bands on the anterior borders of individual anterior and middle body segments.

Chaetozone adusta sp. nov. is most similar morphologically to two other deep-water species: *Chaetozone grasslei* Blake, 2019 from the abyssal Pacific Ocean and *Chaetozone lophia* Blake, 2022 from the U.S. Atlantic slope in bathyal depths. Both of these species also have two peristomial rings of which first is bulbous and the second is smooth. *Chaetozone grasslei* differs from *C. adusta* sp. nov. in having a long, narrow, threadlike body consisting of segments that are mostly rounded or moniliform instead of moniliform segments being limited to posterior setigers.

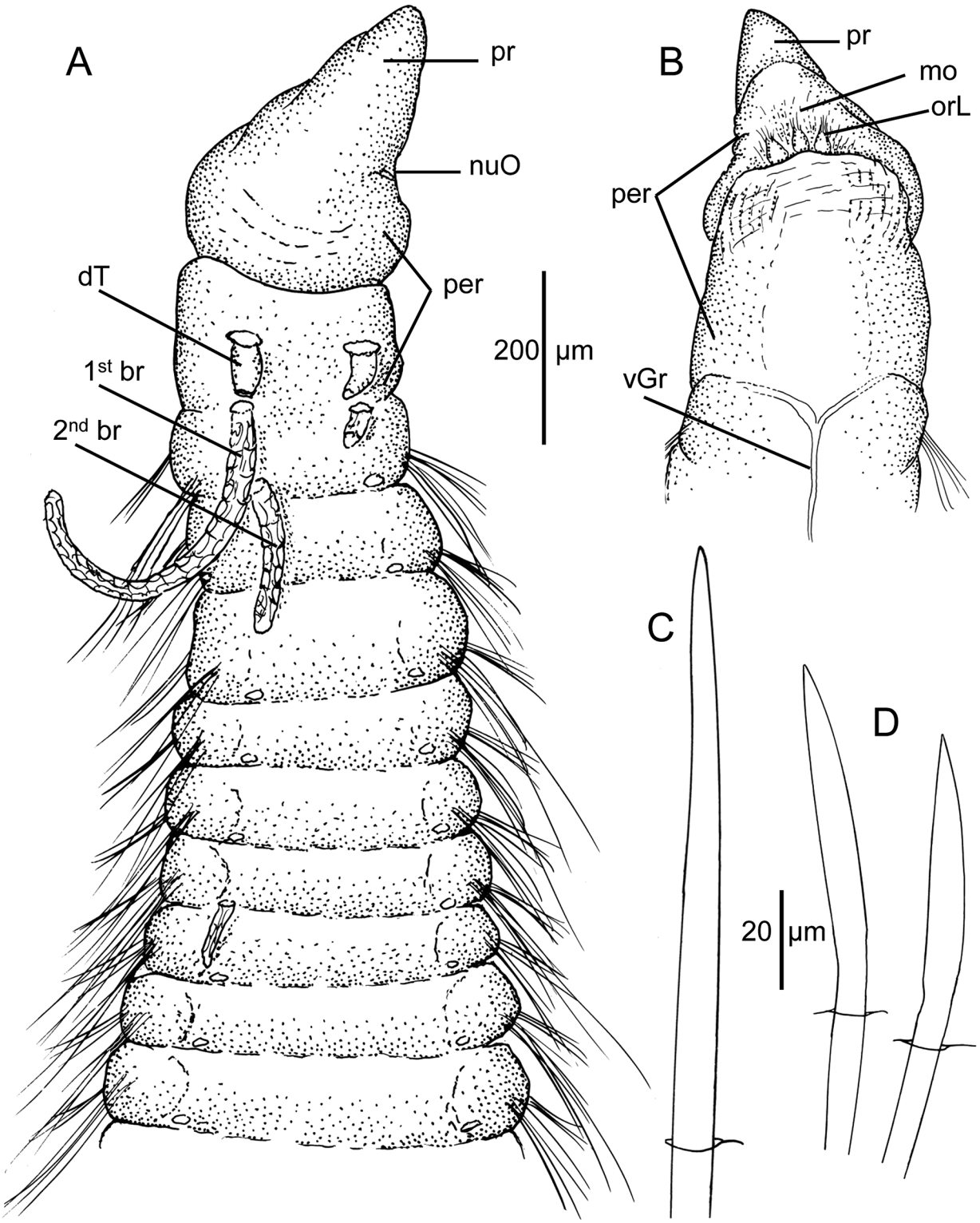

Figure 9. *Chaetozone adusta* sp. nov. (*A–D*) holotype (AM W.52709). (*A*) anterior end, dorsal view; (*B*) pre-setiger region, ventral view; (*C*) notoacicular spine; (*D*) neuroacicular spines.

Chaetozone lophia species differs from *C. adusta* sp. nov. by having instead of lacking a distinct dorsal crest on the bulbous first peristomial ring. In addition, while the new Atlantic species has an enlarged middle body region, this is the result of the intestine having intestinal loops that form a "stomach" packed with sediment.

The only other deep-water species with extensive body pigment is *Chaetozone brunnea* Blake, 2006 from the U.S. Pacific coast off northern California. The California species however is an entirely different kind of *Chaetozone*, in having two peristomial rings, but with the first tightly merged with the prostomium and the second likely being an achaetous segment where the dorsal tentacles arise anteriorly on that segment instead of at the posterior margin where the

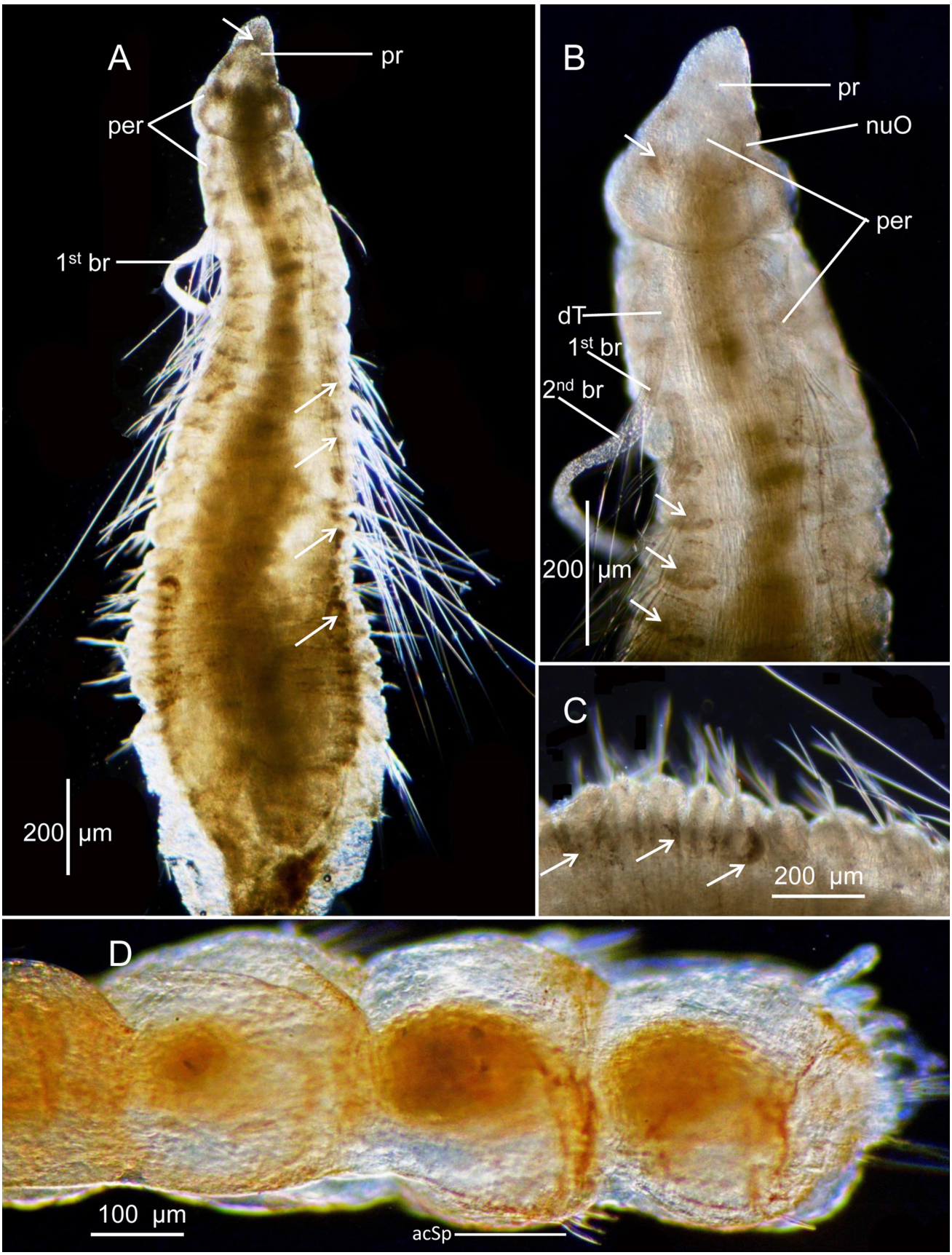

Figure 10. *Chaetozone adusta* sp. nov. Photomicrographs. (*A–D*) holotype (AM W.52709). (*A*) anterior and middle body segments, dorsal view, brown pigment emphasized; (*B*) anterior end, dorsal view, arrows denoting brown pigment; (*C*) middle body segments showing brown pigment; (*D*) posterior moniliform segments, lateral view. All stained with Shirlastain A; arrows indicate pigment.

branchiae occur. In addition, *C. brunnea* has full cinctures with an armature of up to 16 acicular spines on a side. Another unusual characteristic of *C. brunnea* is the presence of a prominently enlarged "stomach" at the juncture of the anterior and abdominal segments, which in some specimens results in a distinct twist to the body.

Etymology. The epithet is from the Latin, *adustus*, for brown or swarthy, in reference to the brown pigment that characterizes this species.

Distribution. Abyssal plain off southeastern Victoria, eastern Australia, 4107 m.

Genus *Kirkegaardia* Blake, 2016

Type species: *Monticellina heterochaeta* Laubier, 1961. Designated by Blake (2016). **Homonym**: *Monticellina* Laubier, 1961. Preoccupied by *Monticellina* Westblad, 1953

Diagnosis (after Blake, 2016): Bitentaculate cirratulids with distinct body regions and all setae distally pointed. Pre-setigerous region typically elongate, cylindrical, with short, blunt prostomium and long peristomium with none to many weakly developed annulations or peristomium short and thick; dorsal tentacles arising on posterior margin of peristomium, anterior to setiger 1. Thoracic notopodia often shifted dorsally, elevated, producing distinct dorsal groove along thoracic region; other species with thoracic parapodia more lateral, leaving broad elevated dorsum; parapodia of middle and posterior region lateral. Middle body segments longer than wide, frequently beadlike; posterior segments wider than long, somewhat crowded, with posterior most segments usually expanded or enlarged. Setae including simple capillaries with fibrils observed under SEM and denticulated capillaries with distinct denticles present along one edge of setae; denticles visible at 400–1,000×; blades usually basally expanded. Pygidium with simple ventral lobe.

Remarks. Species of *Kirkegaardia* are characterized by having capillary setae that have denticulated or serrated edges. Although the denticles are often difficult to see in light microscopy, they are highly diagnostic. In the present study, a single species, *Kirkegaardia glabra* sp. nov. has close relatives, also from deep water.

Kirkegaardia glabra sp. nov.

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Figs 11–12

Holotype: Abyssal plain off eastern Australia, between Victoria and Tasmania, Flinders Marine Park, RV *Investigator*, Sta. 016, coll. 21 May 2017, Brenke sledge, 40.463°S 149.415°E to 40.461°S 149.364°E, 4131 m (AM W.53527). **Paratype** (1): Bass Strait Marine Park, Sta. 028, coll. 22 May 2017, Box core, 39.500°S 149.535°E, 4147 m (1, AM W.52707).

Description. Holotype, incomplete, elongate, narrow-bodied; with 23 setigers, 6.15 mm long and 0.48 mm wide across setiger 5. First eight setigers short, about three times wider than long; following segments becoming longer, about as wide as long; no segments rounded or moniliform. Ventral grooves and ridges absent. Parapodia of anterior setigers elevated above dorsal midline producing shallow mid-dorsal channel or groove; this channel with narrow elevated medial ridge or keel continuing to end of setiger 12, thereafter dorsal surface of individual segments rounded, with no groove or ridge. Paratype incomplete, with body distorted, twisted and stretched resulting in middle and posterior segments becoming elongate; with about 30 setigers, 13.6 mm long and 0.36 mm wide across thorax. Colour in alcohol opaque white with no pigment markings.

Pre-setiger region about three times as long as wide (Figs 11A, 12A); prostomium and peristomium merging dorsally, separated by mouth ventrally (Fig. 11A). Prostomium conical, tapering to narrow rounded tip; eyes absent; oval-shaped nuchal organs present on posterior lateral margins (Fig. 11A). Peristomium elongate, smooth without annulations, dorsal surface with paired longitudinal grooves producing low mid-dorsal crest from prostomium to anterior margin of setiger 1 (Fig. 11A). Dorsal tentacles arising on posterior margin of peristomium, with first pair of branchiae posterolateral to tentacles (Fig. 11A); second pair of branchiae on posterior margin of setiger one dorsal to notosetae and on edge of mid-dorsal channel; subsequent thoracic branchiae in similar location. Branchiae mostly absent, reduced to scars or stubs.

Parapodia reduced, with podial lobes of short anterior setigers rounded, inconspicuous; segments of longer segments; with no obvious podial lobes. Intersegmental grooves with glandular tissue retaining MG when applied (see below). Setae all denticulated capillaries with about 6–9 capillaries in anterior noto- and neuropodia and 5–6 in more posterior setigers. Capillaries with minute denticles along one edge (Fig. 11B), with details best observed at 1000× in light microscope, but visible at 400×; notosetae long, thin; neurosetae shorter, becoming more spinous than notosetae. Notosetae with denticles directed ventrally and denticles of neurosetae directed dorsally, and *vis-à-vis*.

Nature of posterior end and pygidium unknown.

Methyl Green staining. Methyl Green imparts a diagnostic staining pattern to this species (Fig. 12A). The prostomium and peristomium are relatively unstained; the anterior setigers retain a light stain on the anterior half of individual segments, this becoming intense on setigers 9–12, then entirely absent on following segments. All segments retain stain in the intersegmental grooves which produces bands surrounding the body in posterior segments (Fig. 12A).

Remarks. *Kirkegaardia glabra* sp. nov. although poorly represented, can be easily recognized by the long, narrow smooth peristomium that lacks annular rings but has a low, indistinct dorsal crest along its entire length. Other species having an elongate narrow peristomium entirely lacking annular rings are *K. carinata* Blake, 2016 from lower slope and abyssal depths off northern California and *K. chilensis* Blake, 2016 from slope and bathyal depths off Chile. *Kirkegaardia glabra* sp. nov. differs from both of these species in having instead of lacking a low dorsal crest or ridge along the peristomium. Both *K. carinata* and *K. glabra* sp. nov. have distinctive MG staining patterns. In *K. carinata*, however, the staining pattern is intense, and extends over the entire body from the peristomium to posterior segments, whereas in *K. glabra* sp. nov. the stain is absent on the pre-

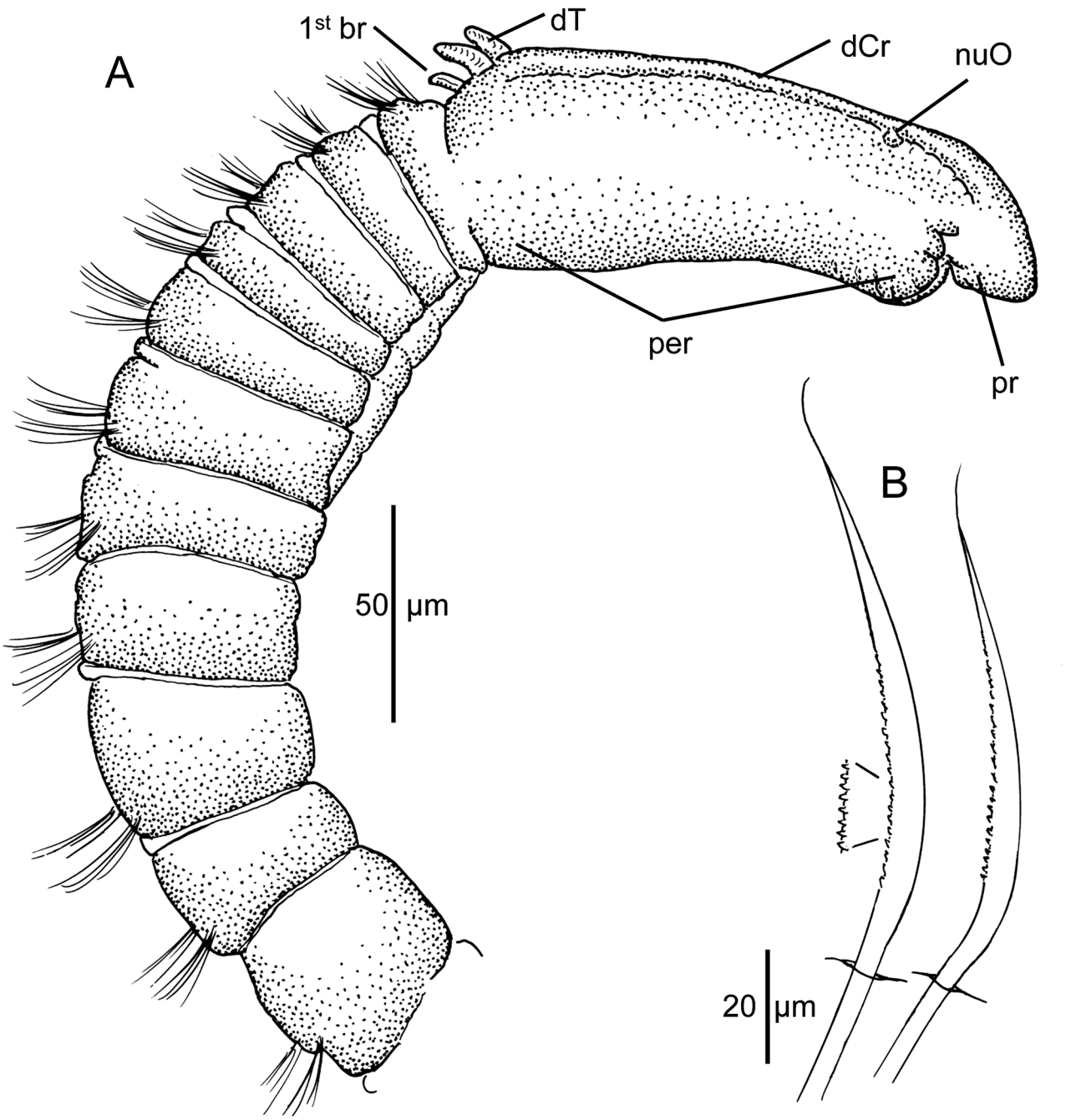

Figure 11. *Kiregaardia glabra* sp. nov. (*A–B*) holotype (AM W.53527). (*A*) anterior end, right lateral view; (*B*) denticulated capillary neurosetae from abdominal setiger, inset not to scale.

setiger region and weak or absent on anterior setigers, with only setigers 9–12 having an intense stain. In addition, while the intersegmental grooves retain stain along most of the body in *K. glabra* sp. nov., it is the parapodia themselves that retain the stain in *K. carinata*.

Etymology. The epithet is derived from the Latin, *glaber*, for smooth in reference to the smooth, uninterrupted pre-setiger region of this species.

Distribution. Abyssal plain between Tasmania and Victoria, eastern Australia, 4107–4147 m.

Discussion

Species of Cirratulidae from abyssal depths

In the present study "abyssal" depths are regarded as beginning at about 3000 m and continuing to the deepest parts of the abyssal plain. Historically, the deep-sea fauna was considered to be impoverished. This idea was largely based on the difficulty of obtaining samples and the paucity of most of the more typical benthic fauna known from studies of shallow-water habitats. Although the *Challenger* Expedition (1872–1876) and later *Galathea* Expedition (1950–1952)

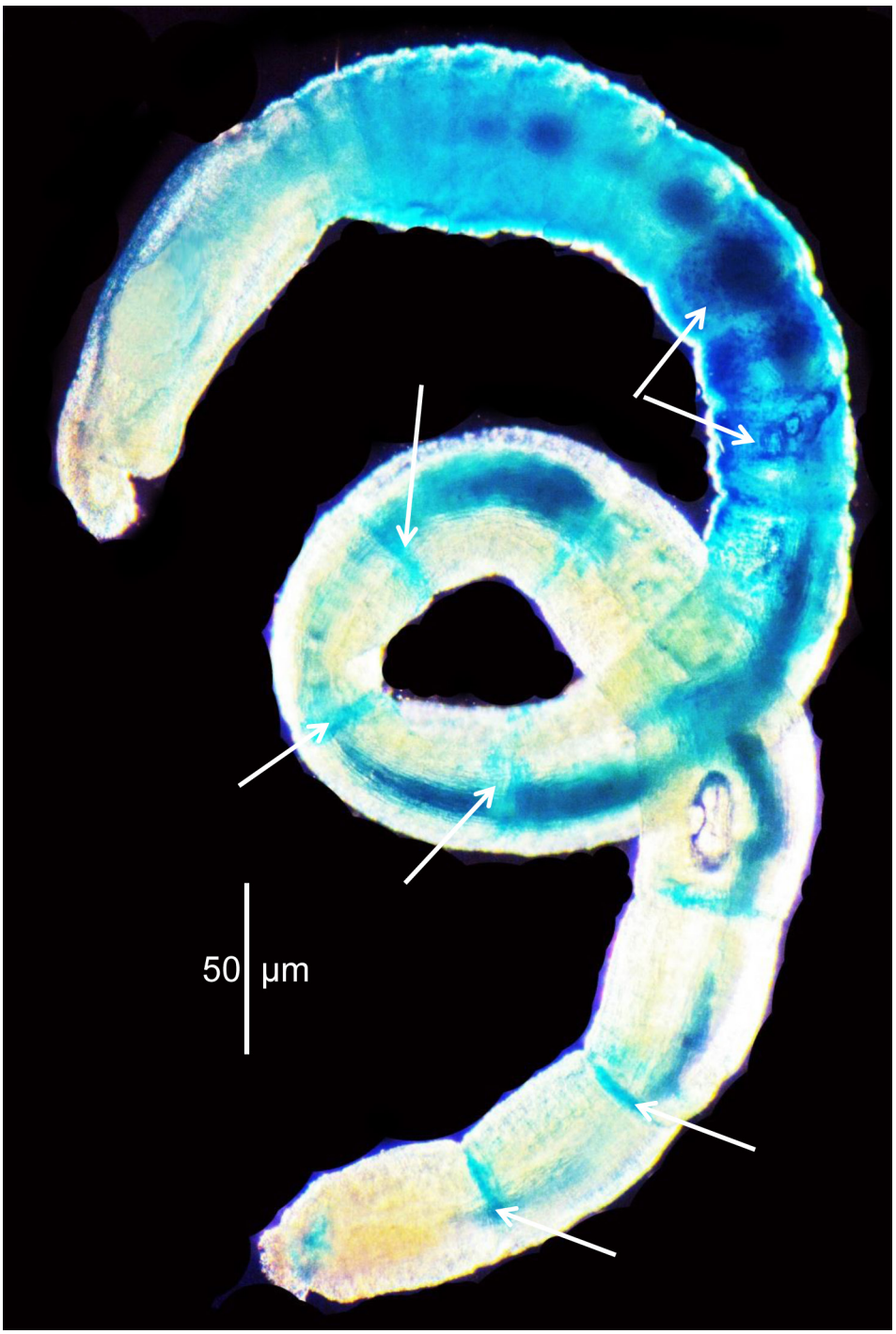

Figure 12. *Kiregaardia glabra* sp. nov. Photomicrograph of holotype (AM W.53527), anterior fragment, left lateral view showing distribution of MG stain after differentiation of stain. Arrows denote intersegmental concentrations of MG stain.

demonstrated that life was found in the deepest parts of the ocean, it was generally considered to be species-poor. The use of coarse mesh trawls and dredges used in those early expeditions were unable to adequately collect the more numerous smaller benthos known to occur in shallow waters.

Based largely on deep-water surveys during the 1960s, in which more quantitative samplers such as epibenthic sleds and fine-mesh sieves to separate the fauna from the sediments, benthic invertebrates from bathyal, slope, and abyssal depths in the North Atlantic Ocean were found to be far more diverse than previously believed (Sanders et al., 1965; Sanders & Hessler, 1969). Hartman (1965) and Hartman & Fauchald (1971) documented polychaetes from Sanders' North Atlantic surveys and collectively described more than 100 new species and several new genera. The introduction of quantitative box cores, multicores, and mega cores in subsequent years has yielded many more benthic invertebrate species and resulted in further estimates of high species richness in deep-sea sediments (e.g., Grassle & Maciolek, 1992).

The first compendium of abyssal polychaetes was by Hartman (1971) who listed 12 species of Cirratulidae in three genera. The majority of the cirratulid records she cited, however, were either not well documented or carried names that were derived from taxa, such as *Chaetozone setosa* Malmgren, 1867 that at the time were considered to be cosmopolitan in distribution. As a result, only two of the species listed by Hartman (1971) from 3000 m or greater are currently listed as valid in WoRMS. Recent studies of deep-water cirratulids by Blake (2006, 2016, 2018, 2019, 2022; this study; Doner & Blake, 2006) allow for a more comprehensive summary of cirratulids from 3000 m and greater.

Out of approximately 300 known species of Cirratulidae, about 220 belong to the bitentaculate genera and include an increasing number of deep-water taxa as materials from various expeditions and monitoring surveys are analyzed. Table 1 includes a list of 37 species of Cirratulidae recently described, or documented from depths of 3000 m or greater.

These 37 abyssal cirratulids are all from relatively few geographic areas: eastern Pacific off California (7), Peru-Chile Trench (3), Equatorial Pacific Ocean (12), eastern Australia (6), Antarctic seas (5), Western North Atlantic Ocean (3), and the Mozambique Channel, Indian Ocean (1). There are large areas in the Northern Pacific Ocean, northeast Atlantic Ocean, South Atlantic Oceans, and Indian Oceans where no abyssal cirratulids have been reported. In addition, despite the fact that 12 new cirratulid species were described from the abyssal plain of the Clarion-Clipperton zone in the Equatorial Pacific Ocean by Blake (2016, 2019); this area represents only a small fraction of the immense Pacific Basin. In keeping with the number of known species globally, the genera *Aphelochaeta* (12 species) and Chaetozone (15 species) are the best represented among the abyssal cirratulids that have been described to date. It is noteworthy that of the 37 species listed in Table 1, 34 have been described in the past 15 years, emphasizing the increasing interest in deep-sea exploration.

Table 1. Records of abyssal Cirratulidae (> 3000 m). Abbreviations: *E*, East; *N*, North; *NSW*, New South Wales; *Tas*, Tasmania; *US*, United States; *Vic*, Victoria.

species	depth (m)	species status	location	reference
Aphelochaeta abyssalis	4514–4861	valid	N Equatorial Pacific	Blake, 2019
Aphelochaeta brandtae	3957	valid	Drake Passage	Blake, 2016
Aphelochaeta bullata	2160–3775	valid	N California slope	Doner & Blake, 2009
Aphelochaeta clarionensis	4516–4518	valid	N Equatorial Pacific	Blake, 2019
Aphelochaeta clippertonensis	4506–4870	valid	N Equatorial Pacific	Blake, 2019
Aphelochaeta guttata	2420–3666	valid	N California slope	Doner & Blake, 2009
Aphelochaeta jubata sp. nov.	4031–4170	valid	E Australia, off Vic, Tas	This study
Aphelochaeta nigrorostrum	4825	species inquirendum	N Atlantic Ocean	Hartman & Fauchald, 1971; Blake, 2019
Aphelochaeta readi sp. nov.	3754–3811	valid	E Australia off NSW	This study
Aphelochaeta spargosis	4516	valid	N Equatorial Pacific	Blake, 2019
Aphelochaeta tanyperistomia	4006–4877	valid	N Equatorial Pacific	Blake, 2019
Aphelochaeta wilsoni	4500–4860	valid	N Equatorial Pacific	Blake, 2019
Caulleriella bathytata	4504–4877	valid	N Equatorial Pacific	Blake, 2019
Chaetocirratulus glebalis sp. nov.	4170	valid	E Australia, off Vic, Tas	This study
Chaetocirratulus neogracilis	4100	valid	Peru-Chile Trench	Blake, 2018
Chaetozone abyssalis sp. nov.	4131	valid	E Australia, off NSW	This study
Chaetozone adusta sp. nov.	4107	valid	E Australia, off Vic	This study
Chaetozone akaina	4480–4880	valid	N Equatorial Pacific	Blake, 2019
Chaetozone allanotai	1800–3200	valid	N California, slope	Blake, 2006
Chaetozone biannulata	6337	valid	South Sandwich Trench	Blake, 2018
Chaetozone brunnea	2000–3200	valid	N California slope	Blake, 2006
Chaetozone gracilis	4016	valid	S California abyssal plain	Moore, 1923; Blake, 1996, 2006
Chaetozone grasslei	4844–4880	valid	N Equatorial Pacific	Blake, 2019
Chaetozone palaea	1675–3130	valid	N California slope	Blake, 2006
Chaetozone paucispinosa	1200–3040	valid	US Atlantic slope and rise	Blake, 2022
Chaetozone profunda	1338–3494	valid	US Atlantic slope and rise	Blake, 2022
Chaetozone reticulata	3111	valid	Weddell Sea	Blake, 2018
Chaetozone spinosa	4100	valid	Peru-Chile Trench	Blake, 2018
Chaetozone truebloodi	4880	valid	N Equatorial Pacific	Blake, 2019
Chaetozone sp.	4866–5069	unknown	Mozambique Channel	Hartman, 1971
Kirkegaardia brigitteae	3864	valid	Bellinghausen Sea	Blake, 2016
Kirkegaardia carinata	2821–3864	valid	N California slope and rise	Blake, 2016
Kirkegaardia fragilis	4506–4880	valid	N Equatorial Pacific	Blake, 2016, 2019
Kirkegaardia glabra sp. nov.	4131–4147	valid	E Australia, off Vic, Tas	This study
Kirkegaardia jumarsi	5340	valid	Peru-Chile Trench	Blake, 2016
Tharyx hessleri	4506	valid	N Equatorial Pacific	Blake, 2019
Tharyx moniliformis	3935	valid	Weddell Sea	Blake, 2018

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