

**Primnoidae (Cnidaria: Octocorallia: Calcaxonia) of the *Okeanos Explorer* expeditions (CAPSTONE) to the central Pacific**

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Abstract

This paper discusses and illustrates the 23 primnoid species collected by the R/V *Okeanos Explorer* in the US marine protected areas in the central and western Pacific, ranging from the Musician Seamounts in the north to American Samoa to the south, and the northern Mariana Islands to the west (CAPSTONE expeditions, 2015-2017). *In situ* photographs are provided for most species. Thirteen of the 23 species are described as new, as well as two new genera. One new genus, *Macroprimnoa*, possesses some of the largest polyps in the family. A dichotomous key is provided to facilitate comparisons among the 27 species of *Calyptrophora*. An update of the abyssal octocorallian species occurring deeper than 3000 m is provided, increasing that number from 39 to 49 species. The character of the articulating ridge, found on the distal edge of the basal body wall scales, is re-evaluated, resulting in four genera having this character state, and requiring the description of the new genus *Pseudonarella*.

Key words: Primnoidae, Octocorallia, Calcaxonia, central Pacific, Musicians Seamounts, Northwest Hawaiian Islands, Johnston Atoll, Wake Island, Northern Mariana Islands, Phoenix Islands, American Samoa, CAPSTONE, *Okeanos Explorer*, articulating ridge

Introduction

Except for the Hawaiian Islands, Emperor Seamounts (Cairns *et al.* 2018), and the Clarion-Clipperton Fracture Zone (Cairns 2016a), most of our knowledge of Pacific primnoids comes from specimens collected off large islands (e.g., New Zealand, Japan, New Caledonia) or continents. The CAPSTONE cruises emphasized collection from insular environments, mostly from seamounts in the mid-Pacific far from large land masses. This may explain why such a relatively high percentage, *i.e.*, 58%, of the reported species are new, as this represents a heretofore under-collected environment and region. Nonetheless, some species have broader distributions and thus knowledge of the entire Pacific primnoid fauna is essential. Although not exhaustive, significant revisions of the Pacific primnoid fauna, listed from north to south, include: off Alaska (Nutting 1912, Bayer 1952, Cairns & Baco 2007, Cairns, 2011, Baco & Cairns 2012), Japan (Kinoshita 1908, Nutting 1912, Aurivillius 1931), the Emperor Seamounts (Cairns *et al.* 2018), Hawaiian Islands (Nutting 1908, Bayer & Stefani 1989, Cairns & Bayer 2007, Cairns 2009, 2010), Marcus-Necker Ridge (Pasternak 1981), east Pacific seamounts (Nutting 1909, Cairns 2007b), Clarion-Clipperton Fracture Zone (Cairns 2016a), Galápagos and Cocos Islands (Studer 1894, Cairns 2018), New Caledonia (Bayer & Stefani 1989), off New South Wales, Australia (Thomson & Mackinnon 1911), New Zealand (Bayer 1996, Cairns 2012, 2016b), off Chile (Ofwegen *et al.* 2009), and other general localities (Studer 1878, Wright & Studer 1889, Versluys 1906, Kükenthal 1919, Cairns & Bayer 2009).

Material and methods

As mentioned in the Introduction, most of the specimens studied in this report were collected by the R/V *Okeanos Explorer* during the CAPSTONE expeditions, all of which are deposited at the NMNH. “CAPSTONE is a multi-year foundational initiative to collect deepwater baseline information in and around US marine protected areas in the central and western Pacific” (Bell *et al.* 2017: 53). Starting in July 2015 and concluding in September 2017, CAPSTONE cruises operated in the Musicians Seamounts, the Papahânaumokuâkea Marine National Park of the Northwest Hawaiian Islands, Johnston Atoll, Wake Island, the Marianas Marine National Monument, Kingman Reef and Palmyra Atoll, Jarvis Island, Howland and Baker Islands of the Phoenix Island Group, and Rose Atoll Marine National Monument/National Marine Sanctuary of American Samoa. Several additional specimens collected in the Hawaiian Islands by HURL’s research vessel *Pisces-4* are also included when they supplement types series of new species. And several additional specimens were also included from the Phoenix Islands, collected by the R/V *Falkor*. Those specimens, at the publication of this paper, are deposited at Temple University, but will eventually be moved to the NMNH.

Morphological terminology used herein can be found in Bayer *et al.* (1983) as updated by Cairns (2012, 2016b). The methodology concerning sclerite preparation for SEM can also be found in Cairns (2016b). Photomicrographs were taken by the author on a Zeiss EVO MA15 scanning electron microscope.

In some cases, specimens were reported on the basis of images only. This was done only when the morphology of the species in question was unequivocal based on the high quality images taken by the *Okeanos Explorer*.

Abbreviations used in this paper include:

BM	British Museum (Natural History), London
CAPSTONE	Campaign to Address Pacific Monument Science, Technology, and Ocean NEeds
EX	<i>Okeanos Explorer</i>
FK	<i>Falkor</i>
HURL	Hawai'i Undersea Research Laboratory
L:W	Ratio of the length to width of a scale
NOAA	National Oceanic and Atmospheric Administration
NMNH	National Museum of Natural History, Smithsonian Institution, Washington DC
SEM	Scanning Electron Microscope (used in conjunction with SEM stub numbers)
USNM	United States National Museum (used to preface catalog numbers of the NMNH)
ZMA	Zöologisch Museum, Amsterdam

Systematic Account

Class Anthozoa

Subclass Octocorallia

Order Alcyonacea Lamouroux, 1812

Suborder Calcaxonia Grasshoff, 1999

Family Primnoidae Milne Edwards, 1857

Genus *Callogorgia* Gray, 1858

Callogorgia Gray, 1858: 286.—Bayer, 1982: 119–123 (key to Indo-Pacific species).—Cairns & Bayer, 2002: 841–845; 2009: 40.—Cairns, 2010: 425 (Hawaiian species); 2016b: 58 (New Zealand species); 2018: 6 (key to Indo-Pacific species).—Cairns & Wirshing, 2018: 8, 18, fig. 4o.

Fanellia Gray, 1870: 46.—Bayer, 1982: 134–135 (key to species).—Bayer & Stefani, 1989: 470–471 (key to genus and all species).—Cairns & Bayer, 2009: 40–41.—Cairns & Wirshing, 2018: 8, 18.

Type Species. *Gorgonia verticillata* Pallas, 1766, by monotypy.

Diagnosis. Colonies uniplanar, pinnately or dichotomously branched. Polyps arranged in pairs or whorls of up to 16, all polyps facing upward. Polyps covered by eight longitudinal rows of body wall scales, the number of scales per row decreasing from ab- to adaxial polyp side. Body wall scales granular, smooth, pitted, tuberculate, or covered with tall ridges (crystate) for all or part of polyp. Inner side of opercular scales convex, covered with a multiply serrate keel.

Discussion. With the recent synonymy of *Fanellia* with *Callogorgia*, the genus now contains 38 species (Cairns & Wirshing 2018, Cairns 2018). A key to the 22 Indo-Pacific species was recently published by Cairns (2018). Discussions of the genus are included in Cairns & Bayer (2009) and Cairns (2018).

Distribution. Indo-Pacific, Atlantic, 37–2472 m.

Callogorgia cracentis, n. sp.

Figs. 1A, 2A–G

Etymology. Named *cracentis* (Latin for neat or graceful), an allusion to the uniform length of the branchlets of the colony.

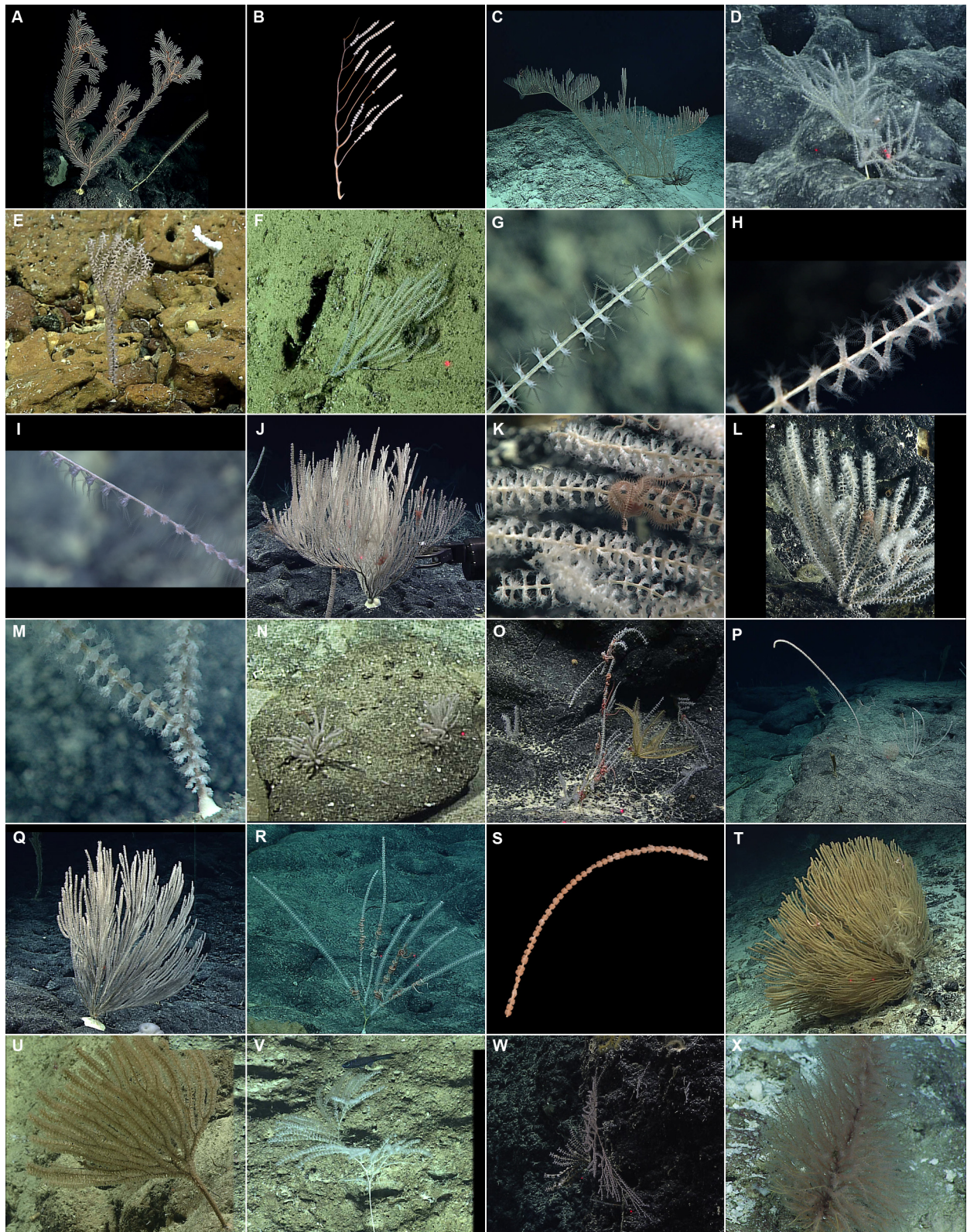


FIGURE 1. *In situ* images of various species: **A**, *Callogorgia cracentis*, holotype. **B**, *Calyptrophora lyra*, holotype (not *in situ*). **C**, *C. diaphana*, EX1606-9-1. **D**, *C. carinata*, holotype. **E**, *C. clarki*, EX1605-L3-6. **F**, *C. pourtalesi*, holotype. **G**, *C. distolos*, holotype. **H**, *Candidella gigantea*, EX1606-6. **I**, *Macroprimnoa ornata*, holotype. **J**, *Narella virgosa*, holotype. **K-L**, *N. aurantiaca*, holotype. **M**, *N. merga*, holotype. **N**, *N. horrida*, EX1703-2-3. **O**, *N. fordii*, holotype. **P**, *N. calamus*, holotype. **Q**, *N. virgosa*, paratype, EX1504-L4-9-4. **R**, *N. macrocalyx*, EX1606-7. **S**, *N. hawaiiensis*, EX1504-9-2. **T**, *Paracalyptrophora hawaiiensis*, EX1703-2-1. **U**, *P. echinata*, EX1703-10-1. **V**, *P. spiralis*, holotype. **W**, *Plumarella circumoperculum*, EX1603-2-3. **X**, *Thouarella hilgendorfi*, EX1605-L1-17.

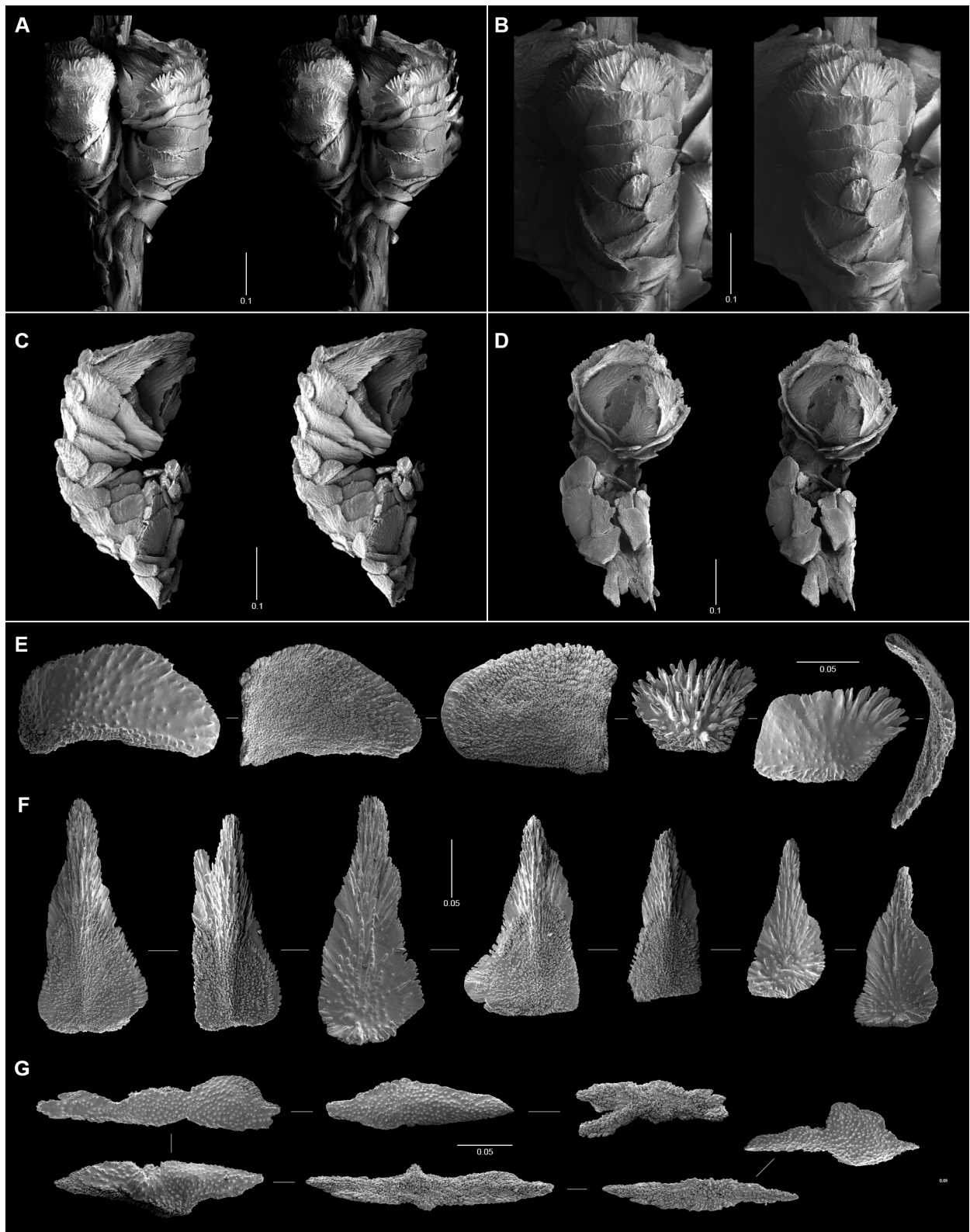


FIGURE 2. *Callogorgia cracentis*, holotype: **A**, stereo view of a polyp whorl. **B–D**, stereo views of abaxial, lateral and adaxial side of a polyp. **E**, body wall scales. **F**, opercular scales. **G**, coenenchymal scales. Scale bars in mm.

Type and Type Locality. Holotype: partial colony, SEM stubs 2499-2501, USNM 1453718. Type Locality: EX1703-7-01, 0.39°S, 176.2°W (Titov Seamount, south of Baker Island, Phoenix Island Group), 1760 m.

Material Examined. Holotype.

Description. The holotype is a tall, uniplanar colony about 1 m in height, consisting of a basal main stem about 15 cm in length, which supports three large branches from which smaller branchlets originate in an alternate pinnate manner (Fig. 1A). The branchlets are uniformly 7–8 mm in length. Polyps are arranged in whorls of three or four, the whorl diameter being 2.4–2.8 mm; polyps are 1.7–2.2 mm in horizontal length.

The body wall scales are arranged in eight longitudinal rows, with progressively fewer scales per row from ab- to adaxial side, the adaxial side being largely bare. The body wall sclerite formula is: 8-10: 2-3+3-4:1-2:1-2, the abaxials being closely spaced and thus heavily shingled (Fig. 2A). The plus mark in the formula for the outer lateral body wall scales indicates that this is a discontinuous row of scales, occurring distally and proximally, but missing at mid-polyp, this space being occupied by overly broad abaxial scales (Fig. 2C). The distal edges of the abaxial and outer lateral marginals and submarginals bear tall ridges, and thus qualify as cristate scales (Figs. 2A, E), but the remaining body wall scales are flat and have a serrate distal edge. The distal-most cristate abaxial body wall scales are relatively narrow (0.45–0.50 mm wide), becoming broader (up to 0.8 mm wide) and curved toward the base of the polyp, where they almost encircle the polyp and occupy the space normally occupied by the outer lateral scales. The inner lateral scales are also quite broad (0.6–0.7 mm).

The operculum is prominent, composed of symmetrical, triangular, pointed scales, all having a relatively high L:W ratio; occasionally the lateral operculars bear two points (Fig. 2F). The abaxials are 0.9–1.0 mm in length, with an L:W of 2.1–2.6. The lateral operculars are 0.7–0.9 mm in length, with an L:W of 2.2–2.3. The adaxial operculars are 0.65–0.70 mm in length, with an L:W of about 2.1. The distal inner and outer faces of the operculars are covered with multiple serrate ridges, and the tip is sometimes somewhat cylindrical in cross section.

The coenenchymal scales (Fig. 2G) are elongate (up to 1.1 mm in length, with an L:W of 4–7.5), pointed, and uniformly covered with low granules.

Comparisons. Using the key to the Indo-Pacific *Callogorgia* species recently published by Cairns (2018), *Callogorgia cracentis* keys closest to *C. gilberti* (Nutting, 1908) and *C. flabellum* (Ehrenberg, 1834). *Callogorgia gilberti* (re-described by Cairns 2010), and known from the Hawaiian Islands at 326–965 m, differs in having more abaxial body wall scales (11–13 per row), more polyps per whorl (3–7), cristate body wall scales extending up to five scales from the polyp margin, and smaller polyps (1.2–1.5 mm). *Callogorgia flabellum* (re-described by Bayer 1982), known from throughout the Indo-Pacific at 540–1250 m, differs in having all its abaxial and outer lateral body wall scales cristate, blunt opercular scales, and many fewer outer lateral scales. *C. cracentis* is distinctive in having a discontinuous row of outer lateral body wall scales and branchlets that are uniform in length. *Callogorgia cracentis* is also quite similar to *C. ramosa* (Kükenthal & Gorzawsky, 1908)(Japan, 600 m), especially in having cylindrical opercular tips, but that species lacks inner lateral and adaxial body wall scales.

Remarks. At least a dozen ophiuroids were attached to the holotype colony (Fig. 1A).

Distribution. Known only from the type locality.

Genus *Calyptrophora* Gray, 1866

Calyptrophora Gray, 1866: 25, fig. 1.—Bayer, 2001: 367–368.—Cairns & Bayer, 2009: 44–45.—Cairns, 2009: 420–426 (key to species); 2012: 42–43.

Type Species. *Calyptrophora japonica* Gray, 1866, by monotypy.

Diagnosis. Colonies uniplanar to slightly bushy (lyrate, dichotomous, polychotomous) or unbranched (flagelliform). Polyps arranged in whorls or pairs, in most species directed upward (*japonica*-complex) or less commonly downward (*wyvillei*-complex). Polyps consist of two annular sclerite rings, the basal and buccal scales, each composed of two inseparably fused components; basal and buccal scales hinge on a straight articular ridge. Distal margins of body wall scales usually spinose, toothed or lobate. Coenenchymal scales elongate and flat, usually with a granular and sometimes ridged outer surface. Curved tentacular platelets usually present.

Discussion. The genus currently consists of 27 species: 19 in the *japonica*-complex, which have upward-directed polyps; seven in the *wyvillei*-complex, which have downward-directed polyps; and one indeterminate. This

morphological division, while helpful in identifying species, is not supported by phylogenetic analysis, either using morphology (Cairns 2009) or molecular sequencing (Cairns & Wirshing 2018). Furthermore, two species are known to have polyps that are oriented in both directions. This character may be due to a simple point mutation, and thus have less value in the classification of these species. The genus is more fully discussed by Cairns (2012).

A key to all 16 species known at that time was given by Cairns (2009), but because 11 additional species are now known, including four herein, a revised key is provided below. The order of the species below are initially grouped by their polyp orientation.

Distribution. Tropical and temperate latitudes in Atlantic, Pacific and Indian Oceans, 227–3737 m.

Key to the 27 species of *Calyptrophora* (bold face = species included herein)

1. Polyps arranged in pairs (orientation of polyps uncertain) ***C. distolos***, n. sp.
- 1'. Polyps arranged in whorls that are directed downward toward base of main stem (*wyvillei*-complex) 2
- 1''. Polyps arranged in whorls that are directed upward toward branch tips (*japonica*-complex) 8
2. Colony unbranched. *C. clinata* Cairns, 2007
- 2'. Colony branched. 3
3. Branching bushy (tetrachotomous or polychotomous); spines on basal scales broad-based (spatulate) 4
- 3'. Branching uniplanar, equal-dichotomous, and usually delicate; spines on basal scales slender (round in cross-section). 5
4. Three to five polyps per whorl; body wall and opercular scales not ridged; branching initially tetrachotomous followed by lyrate *C. wyvillei* Wright, 1885
- 4'. Two to three polyps per whorl; body wall and opercular scales ridged; branching polychotomous followed by equal dichotomous ***C. carinata***, n. sp.
5. Distal margin of basal scale straight, lacking marginal spines, teeth and lobes *C. inornata* Cairns, 2012 (in part)
- 5'. Distal margin of basal scale bears long spines, teeth, or lobes. 6
6. Distal edge of basal scale bears two broad triangular teeth ***C. lyra***, n. sp.
- 6'. Distal edge of basal scale lobate, forming a cowl ***C. diaphana*** Cairns, 2012
- 6''. Distal edge of basal scale with two elongate, slender ridged spines 7
7. Basal spines blunt, 0.45–0.55 mm in length. *C. reedi* Cairns, 2018
- 7'. Basal spines attenuate (pointed), 0.9–1.1 mm in length. *C. agassizii* Studer, 1894
8. Spines on basal scale absent or quite short (less than 0.3 mm in height). 9
- 8'. Spines on basal scale taller (0.4–2.2 mm in height) 13
9. Colony biplanar; basal spines circular in cross-section *C. japonica* Gray, 1866
- 9'. Colony uniplanar (dichotomous or lyrate branching); basal spines absent or flat 10
10. Branching equal-dichotomous; 2–5 polyps/ whorl. 11
- 10'. Branching lyrate; over 5 polyps/whorl. 12
11. Four to five polyps per whorl; polyp length 2.0–2.4 mm. ***C. pourtalesi***, n. sp.
- 11'. Two to four polyps per whorl; polyp length 1.3–1.6 mm. *C. trilepis* (Pourtales, 1868)
12. Distal margin of buccal scale smooth; polyp length 2.5–2.8 mm *C. inornata* Cairns, 2012 (in part)
- 12'. Distal margin of buccal scale undulates, sometimes with short flat teeth; polyp length 1.9–2.2 mm *C. angularis* (Nutting, 1908)
13. Colony unbranched. 14
- 13'. Colony branched. 15
14. Spines on basal scale massive, up to 1.5 mm long; coenenchymal scales granular *C. juliae* Bayer, 1952
- 14'. Spines on basal scale elongate and thin, less than 0.6 mm in length; coenenchymal scales ridged *C. persephone* Cairns, 2016
15. Margin of buccal scale bears several broad-based, triangular, flat teeth 16
- 15'. Margin of buccal scale bears two or more elongate cylindrical spines 22
16. Colony biplanar; body wall scales longitudinally ridged. *C. cristata* Cairns, 2012
- 16'. Colony uniplanar; body wall scales granular (not ridged) 17
17. Colony initially lyrate, but may be secondarily dichotomously branched 18
- 17'. Colony dichotomously branching. 20
18. Coenenchymal scales thick and granular; polyp length less than 1.6 mm *C. pileata* Cairns, 2009
- 18'. Coenenchymal scales thin, granular or ridged; polyp length more than 1.9 mm 19
19. Translucent buccal cowl prominent; coenenchymal scales ridged *C. cucullata* Cairns, 2012
- 19'. Opaque buccal cowl short; coenenchymal scales granular *C. spinosa* Pasternak, 1984
20. Marginal teeth on buccal scales small, less than 0.2 mm in height *C. bayeri* Cairns, 2007
- 20'. Marginal teeth on buccal scales taller. Only 0.3–0.6 mm in height 21
21. Branching unequal-dichotomous; polyps 2.2–2.4 mm in length; spines on basal scale up to 1.3 mm in length and tend to curve forward *C. alpha* Cairns, 2009
- 21'. Branching equal-dichotomous; polyps less than 1.5 mm in length; spines on basal scale less than 0.65 mm in length and are straight *C. gerdae* Bayer, 2001

22.	Spines on basal scale smooth or sparsely granular (not ridged or serrate)	23
22'	Spines on basal scale bear serrate longitudinal ridges	24
23.	Colony quasi-pinnate in branching, in multiple fronds; spines on buccal scale up to 0.6 mm long, often with a smaller shoulder spine on abaxial side.	<i>C. laevispinosa</i> Cairns, 2007
23'	Colony equal-dichotomous in branching; spines on buccal scales 0.2–0.4 mm long, lacking a shoulder spine	<i>C. microdentata</i> Pasternak, 1985
24.	Colony initially lyrate in branching, but may become secondarily dichotomous; base of basal spines circular in cross section	<i>C. antilla</i> Bayer, 2001
24'	Colony equal-dichotomous in branching; base of basal spines flattened.	25
25.	Buccal spines (2–6) up to 1.1 mm in length and ridged to tip; spines on basal scale slender, up to 1.5 mm in length	<i>C. clarki</i> Bayer, 1951
25'	Buccal spines (6) less than 0.6 mm in length and smooth at tip; spines on basal scale robust and less than 1.0 mm in length	<i>C. niwa</i> Cairns, 2012

***Calyptrophora lyra*, n. sp.**

Figs. 1B, 3A–L

Etymology. Named *lyra* (Greek for lyre) in allusion to the lyrate colony shape.

Type and Type Locality. Holotype: colony and SEM stubs 2389-2392, USNM 1424218. Type Locality: EX1606-10-02, 18.4705°N, 166.680°E (guyot 50 km south of Wake Island), 1409 m.

Material Examined. Type.

Description. The holotype is uniplanar and distinctly lyrate in branching, although only a part of the colony (Fig. 1B) was collected and *in situ* photographs do not show the entire colony; the holotypic colony fragment measures 22 cm in length. Long (up to 12 cm in length) unbranched branchlets originate on the main branch at intervals of 14–19 mm, these branchlets growing parallel to one another in a plane. Polyps are directed downward and are arranged in whorls of four, being fairly closely spaced (3.5–4 whorls/cm), the whorl diameter being 3.5–4.3 mm. Individual polyps are 2.3–2.8 mm in horizontal length, the contracted opercular scales pointing downward toward the branch. The polyps are orange; the axis is bronze.

The fused basal scale is 1.6–1.9 mm in length, including its two broad, flat, blunt distal teeth (Figs. 3B, D–F), which constitute 0.45–0.55 mm of its length. The inner surface of the distal teeth is covered with several longitudinal, serrate to spinose ridges; the outer surface is uniformly covered with low spines, as is the outer surface of all the sclerites of this species. The articulating ridge is pronounced (Figs. 3D, E), and up to 0.95 mm in length. The fused buccal scale (Fig. 3G) is slightly longer (1.9–2.1 mm), terminating in a rounded (not lobate or toothed), finely serrate (serration about 8 µm in height, Fig. 3H) margin that is produced into a very short cowl encircling the bases of the opercular scales (Fig. 3C). Both basal and buccal scales have an indication of a sagittal suture. There is one pair of prominent (up to 0.45 mm in maximum height), curved infrabasal scales (Figs. 3A–B, I–J), which meet on the abaxial side of the polyp.

The operculum (Fig. 3C) is relatively low, the opercular scales being thin, flat, and triangular in shape. The symmetrical abaxial operculars measure 1.08–1.15 mm in length and have an L:W of 1.4–1.5. The slightly asymmetrical lateral operculars measure 0.9–1.0 mm in length and have an L:W of 1.5–1.65. The symmetrical adaxial operculars measure about 0.75 mm in length, with an L:W of 1.15–1.35. All operculars (Fig. 3K) have a low longitudinal ridge on their distal inner face.

The coenenchymal scales (Fig. 3L) are flat and irregular in shape, up to 1.5 mm in greater length. As with all the other scales of this species, they bear a uniform coverage of small spines that are not arranged in lines or ridges.

Comparisons. *Calyptrophora lyra* belongs to the *wyvillei* species complex (*sensu* Bayer 2001), including eight to nine species that have their polyps oriented as facing downward (see key, couplet 1'): *C. wyvillei* Wright, 1885 (New Zealand, Hawaii), *C. agassizii* Studer, 1894 (Galápagos), *C. reedi* Cairns, 2018 (Galápagos), *C. clinata* Cairns, 2007a (New England Seamounts), *C. diaphana* Cairns, 2012 (New Zealand, 680–1113 m), *C. distolos*, n. sp. (American Samoa and Guam), *C. carinata*, n. sp. (Musicians Seamounts), *C. lyra*, and some specimens of *C. inornata* Cairns, 2012 (New Zealand, some of which are keyed in Cairns 2009). The new species is most similar to *C. diaphana*, both being lyrate in growth form and having very similar buccal scales, but *C. diaphana* differs in

having: larger polyps; a much larger buccal cowl; basal scales that project well beyond the attachment to the buccals as a continuous only slightly indented single lobe, not as two broad teeth; only one (not a pair) abaxial opercular scale that is almost circular in shape (L:W less than 1); in general, stouter opercular scales; more elongate, almost rectangular, coenenchymal scales; and, in general, two pairs of infrabasal scales.

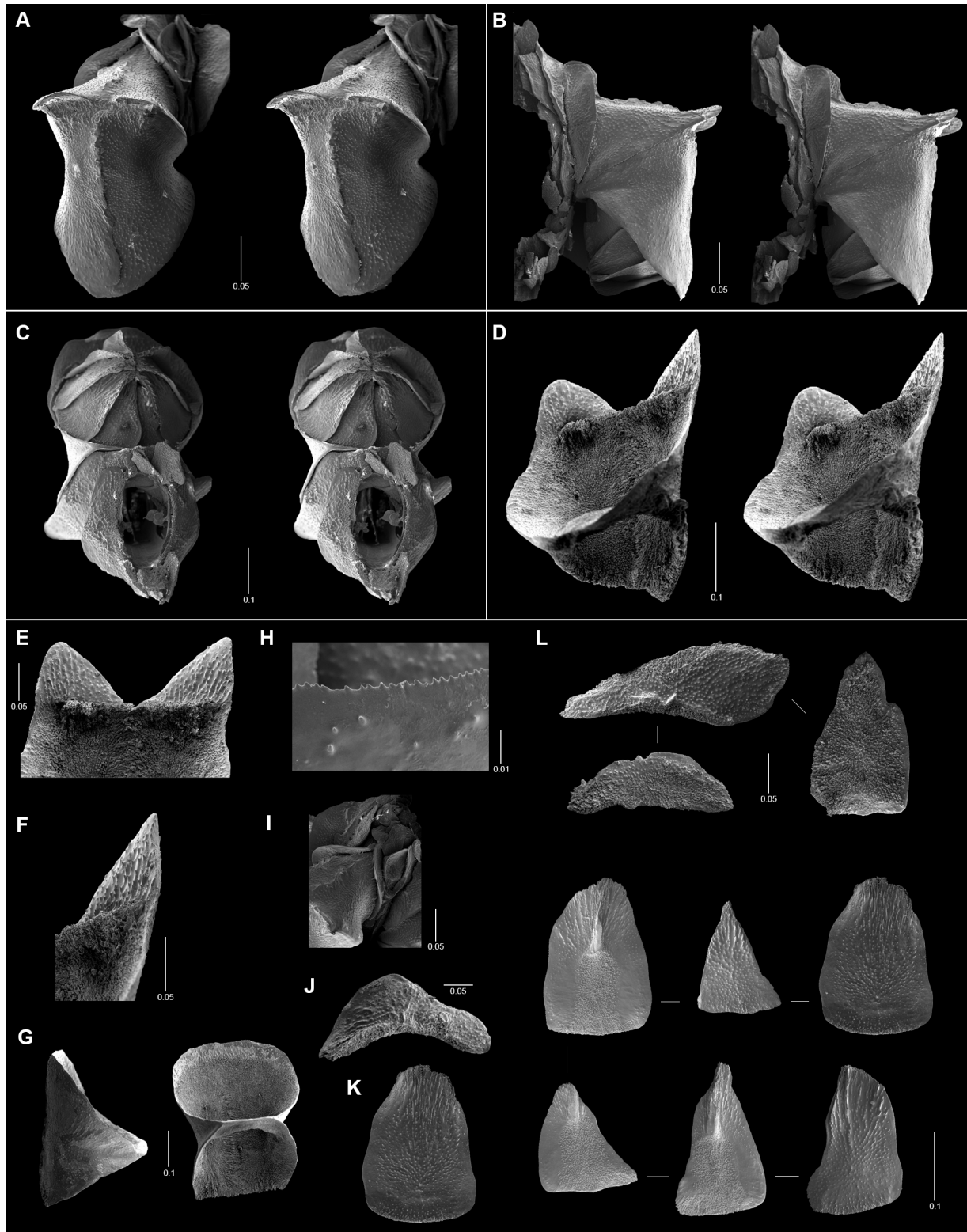


FIGURE 3. *Calyptrophora lyra*, holotype: **A–C**, stereo views of abaxial, lateral, and adaxial sides of a polyp. **D**, stereo view of inner face of a basal scale showing the articular ridge. **E–F**, spines of basal scales. **G**, lateral and adaxial views of a buccal scale. **H**, serrate margin of a buccal scale. **I**, infrabasal scale *in situ*. **J**, an infrabasal scale. **K**, opercular scales. **L**, coenenchymal scales. Scale bars in mm.

Remarks. During collection, the polyps of the colony were being grazed by a large orange seastar.

Distribution. Known only from the type locality.

***Calyptrophora diaphana* Cairns, 2012**

Figs. 1C, 4A–H

Calyptrophora diaphana Cairns, 2012: 56–57, figs. 3, 9A, 40, 41; 2016b: 119.

Types and Type Locality. The holotype (NIWA 11307) and paratype are deposited at NIWA, with some reference material also at the NMNH. Type Locality: 36.5045°S, 176.5075°E (off Coromandel Peninsula, North Island, New Zealand), 990 m.

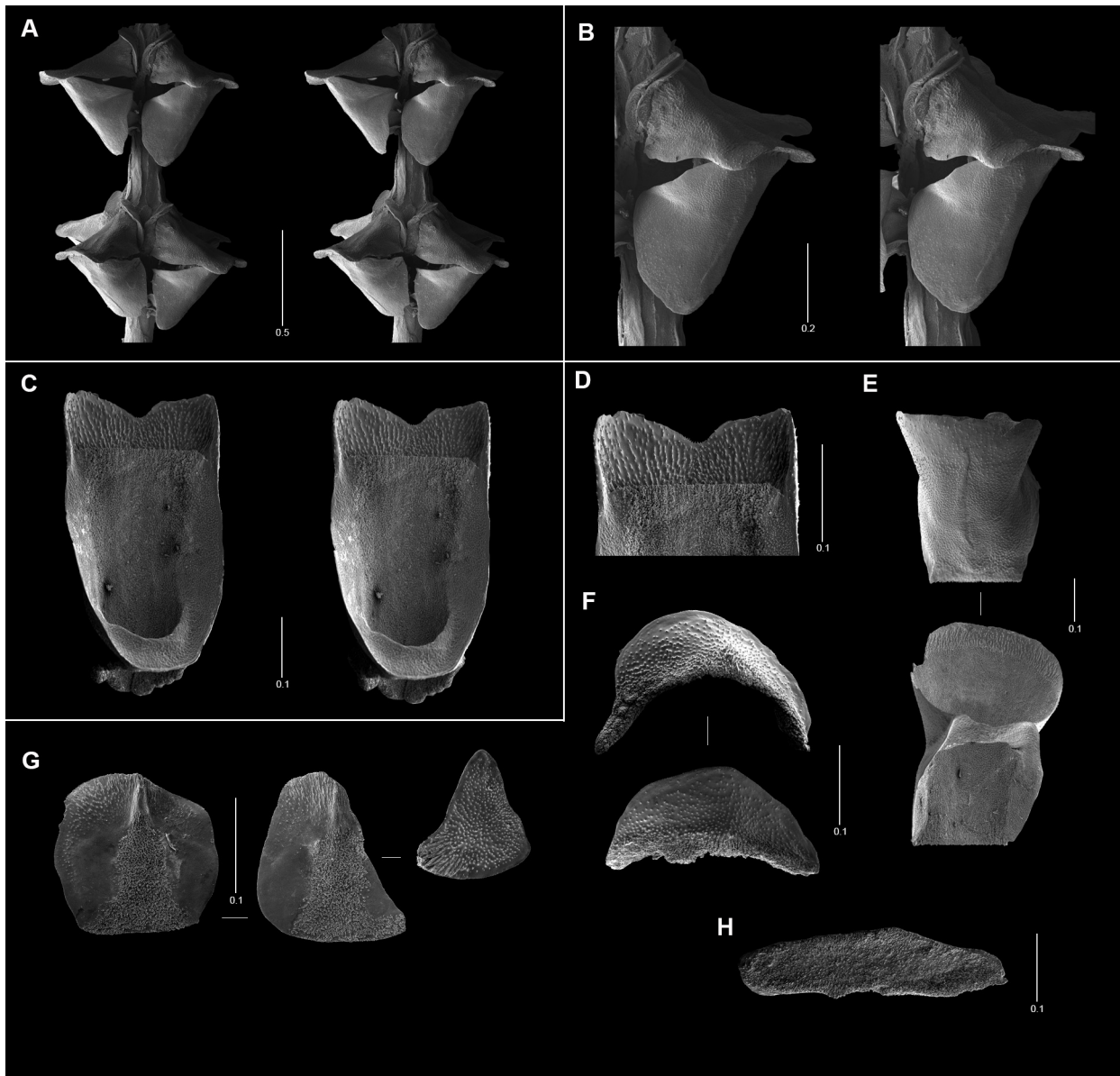


FIGURE 4. *Calyptrophora diaphana*, USNM 1424217; **A**, stereo view of two polyp whorls. **B**, stereo lateral view of a polyp. **C**, stereo view of inner face of a basal scale showing articular ridge. **D**, articular ridge of basal scale. **E**, outer and inner surfaces of a buccal scale. **F**, infrabasal scales. **G**, opercular scales. **H**, a coenenchymal scale. Scale bars in mm.

Material Examined. EX1606-9-01, 19.2543°N, 166.635°E (south of Wake Island), 1105 m, part of a large colony, SEM stubs 2393-2396, USNM 1424217; FK17-157, 4°30.827'S, 172°16.088'W (off Orona Atoll, Phoenix Islands), 1225 m, 19 October 2017, 1 colony, Temple University.

Remarks. This species was adequately described and figured by Cairns (2012) and thus will not be fully re-described or figured herein. The Wake Island specimen is quite similar to those collected from off New Zealand except that its polyp buccal cowl is not quite as pronounced. This specimen allows for the added observation of the colony form, which in this case is 0.5 m tall and 1.1 m in width, composed of a complicated series of lyrate-branching regions (Fig. 1C). Also, there are about a dozen hypertrophied regions on this colony measuring about 9 x 9 mm that consist of a dense concentration of about 100 closely-spaced polyps that are not arranged in well define whorls. They do not appear to be galls produced by another organism. The specimen from the *Falkor* station had its polyps directed upward, contrary to all previously reported specimens, but is otherwise identical.

Comparisons. See *C. lyra*.

Distribution. Northern New Zealand region, off Wake Island, Phoenix Islands, 680–1225 m.

Calyptraphora carinata, n. sp.

Figs. 1D, 5A–H

Etymology. Named *carinata* (Latin for carinate or ridged), in allusion to the ridged nature of the body wall, opercular, and coenenchymal scales.

Type and Type Locality. Holotype: colony fragments and SEM stubs 2532-2535, USNM 1467625. Type Locality: EX1708-15-5, 28.69°N, 161.67°W (Mozart Seamount, Musicians Seamounts), 3659 m, 22 Sept 2017.

Material Examined. Type.

Description. The holotype, which now constitutes seven colony fragments, the largest of which is 20 cm in length, and a number of smaller branches, represents about one-third of the entire colony (Fig. 1D). Based on the *in situ* image, it is estimated that the intact holotype was about 31 cm wide. Branching is roughly uniplanar and dichotomous, although several branching nodes produce three to five branches at the same level (polychotomous), resulting in a slightly bushy aspect; distal branches are up to 11 cm long. The polyps are widely spaced (three whorls/cm), directed downward, and consist of pairs or whorls of three. Individual polyps are 2.3–2.6 mm in horizontal length; the whorl diameter is about 2.9 mm.

The basal scale is 1.0–1.25 mm in height (including distal teeth) and bears two broad, flat teeth on its distal margin (Fig. 5D–E), the teeth being up to 0.45 mm in length and ridged on their inner surface. The basal scale bears multiple prominent dorsolateral ridges (Figs. 5C–D) as well as a basolateral ridge, the former continuing along the outer face of the basal teeth. The buccal scale is slightly shorter (0.95–1.1 mm in length) but is also strongly ridged, the ridges radiating from a dorsolateral mound on either side of the sagittal plane (Figs. 5A, F). The distal edge of the buccal scale is slightly serrate. No infrabasal scales are present.

The operculum is long (Fig. 5B), all the opercular scales (Fig. 5G) being quite elongate with a high L:W ratio. The abaxial operculars are 1.3–1.5 mm in length, with an L:W of about 3.1, and have multiple ridges on both their inner and outer surfaces, and a coarsely serrate margin. The lateral operculars are 1.1–1.2 mm in length with an L:W of 2.3–2.4. The adaxial operculars are 1.0–1.1 mm in length and are quite slender (L:W = 3.2–4.5).

The coenenchymal scales (Fig. 5H) are elongate (up to 1.2 mm in length) and slender (L:W = 3.3–7.8). They bear coarse granules as well as a prominent (up to 0.15 mm in height) longitudinal ridge (i.e., a sail scale).

Comparisons. Having downward directed polyps (*wyvillei* species complex) and multiple branching nodes (polychotomous), *Calyptraphora carinata* keys closest to *C. wyvillei* Wright & Studer, 1889 in the key, a widespread species known from New Zealand to the Hawaiian Islands at 784–1278 m (Cairns 2012). However, *C. wyvillei* differs in many ways including having three to five polyps per whorl; non-ridged basal, buccal, and opercular scales; a lyrate branching mode; and a shallower distribution.

Remarks. A white anemone was attached to the colony nears its main stem.

Distribution. Known only from the type locality.

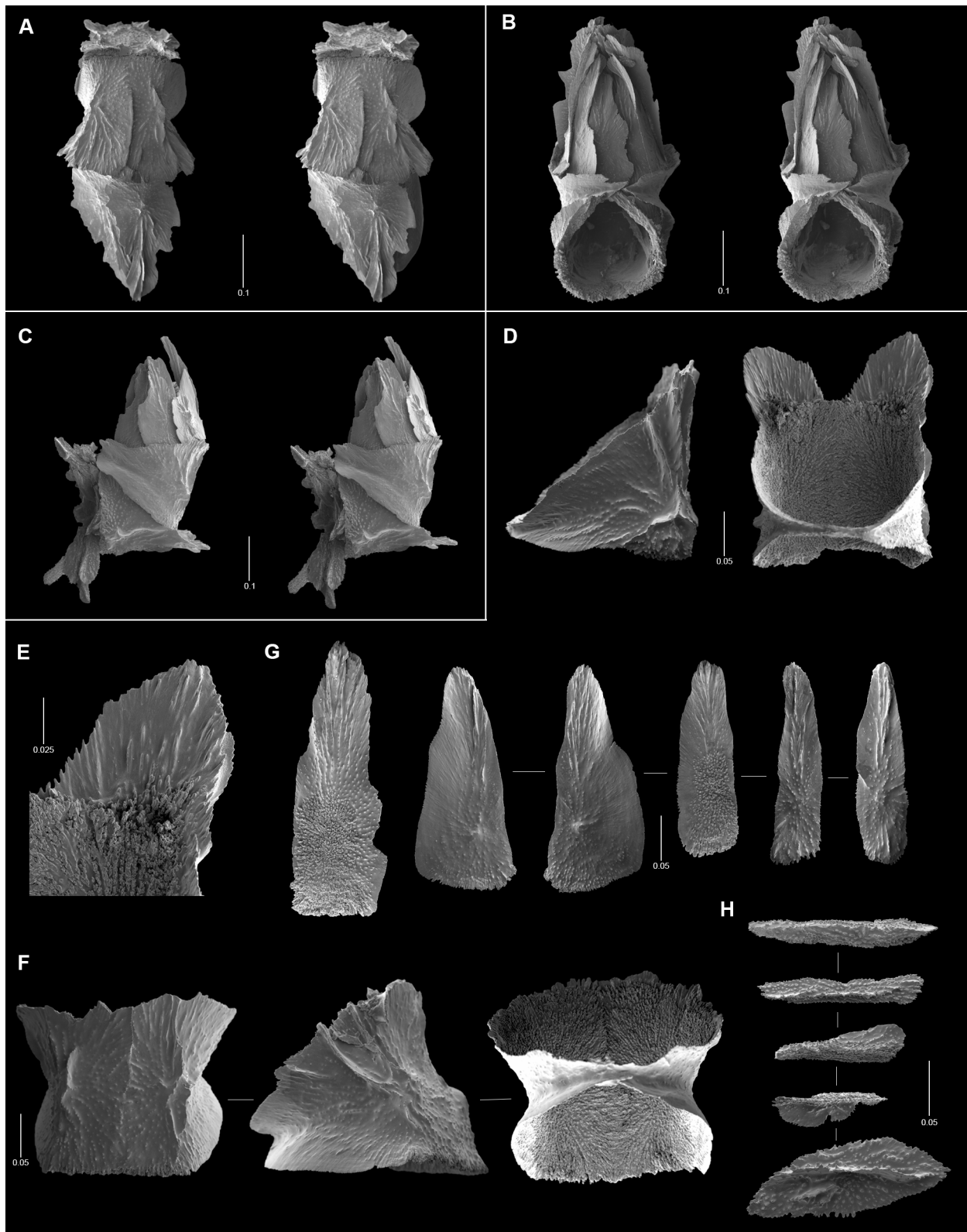


FIGURE 5. *Calyptrophora carinata*, holotype: **A–C**, stereo views of abaxial, adaxial, and lateral sides of a polyp. **D**, lateral and inner view of a basal scale, showing outer ridges and inner articular ridge. **E**, articular ridge of basal scale. **F**, outer, lateral and inner views of buccal scale. **G**, opercular scales. **H**, coenenchymal scales. Scale bars in mm.

Calyptrophora clarki Bayer, 1951

Figs. 1E, 6A–H

Calyptrophora clarki Bayer, 1951: 40–41, figs. 1A–F.—Cairns, 2009: 432–435, figs. 1G, 13–14 (complete synonymy).

Calyptrophora japonica: Nutting, 1908: 578 (in part: *Alb*-4007, 4108).

Types and Type Locality. The holotype (USNM 25370) and paratype are deposited at the NMNH (Cairns 2009). Type Locality: 21°50'20"N, 159°31'40"W (south of Kauai, Hawaiian Islands), 929–1018 m.

Material Examined. *EX*1605-L3-6-05 and 02, 20.15°N, 145.11°E (Supply Reef, Northern Mariana Islands), 286 m, 1 colony and SEM stubs 2400-2401, USNM 1424146; *FK*17-093, 3°44.012'S, 170°43.109'W (off Rawaki Island, Phoenix islands), 562 m, 17 October 2017, 1 colony, Temple University; *FK*17-167, 4°30.846'S, 172°15.967'W (Orona Atoll, Phoenix Islands), 928 m, 19 October 2017, 1 colony, Temple University.

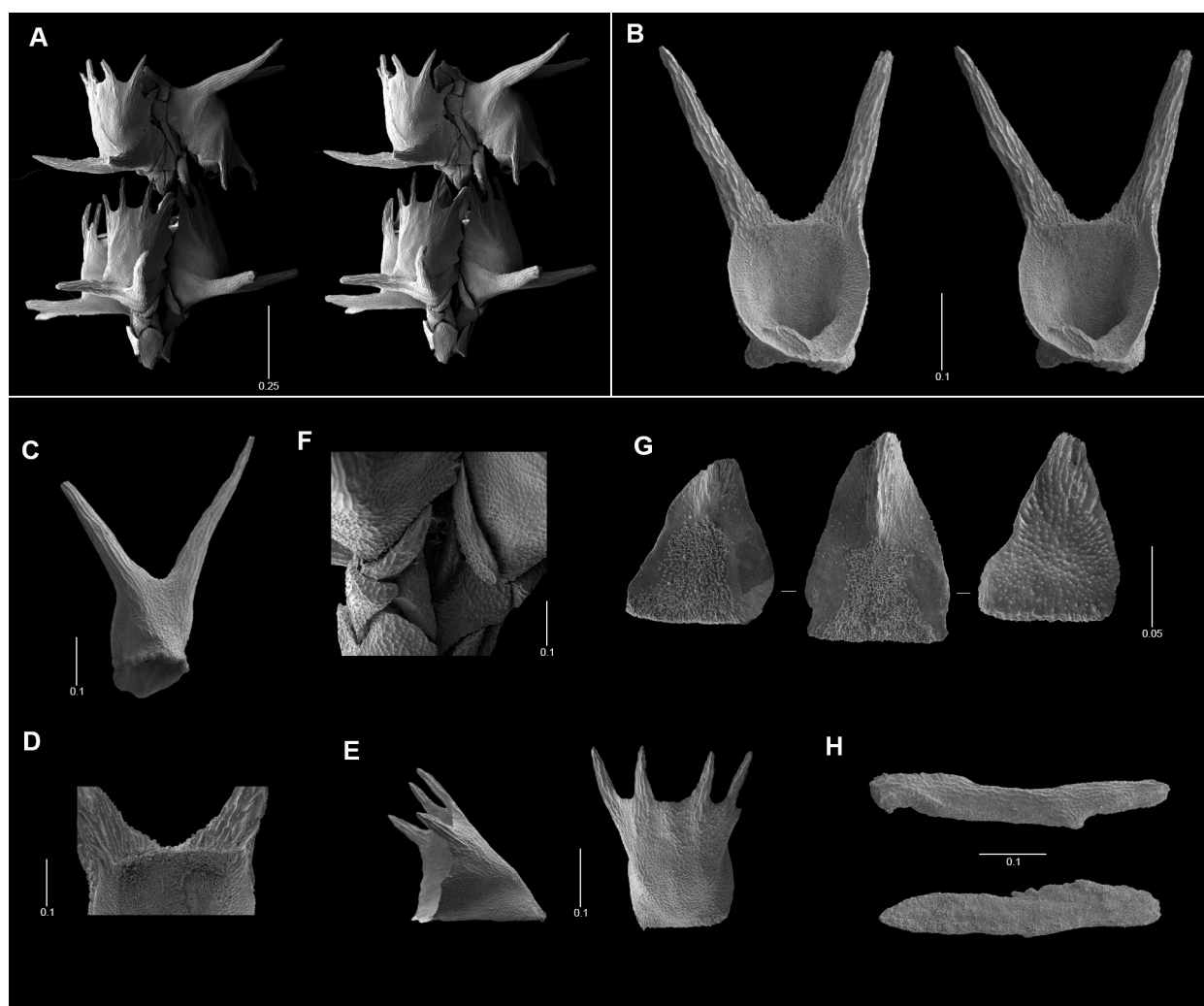


FIGURE 6. *Calyptrophora clarki*, USNM 1424146: **A**, stereo view of two polyp whorls, one showing polyps oriented in conflicting directions. **B**, stereo view of inner face of a basal scale. **C**, outer surface of a basal scale. **D**, articular ridge of a basal scale. **E**, lateral and outer views of a buccal scale. **F**, infrabasal scales *in situ*. **G**, opercular scales. **H**, coenenchymal scales. Scale bars in mm.

Remarks and Comparisons. This species was adequately described and figured by Cairns (2009) and thus will not be fully redescribed or figured herein. The specimen figured herein is a small colony only 10 cm in height when alive (Fig. 1E) and ambiguously between lyrate and equal-dichotomous in branching, having only seven distal branches. It may be the juvenile lyrate shape. It allows the observation that the polyps in the whorls on the main stem are directed downward, but those on the branches are directed upward, and those near the first point of bifurcation are mixed even within the same whorl (Fig. 6A). Thus, this specimen does not fit conveniently into either of the two species complexes of this genus. Also, its coenenchymal scales are quite long (up to 2.1 mm), thick, and have blunt ends.

Within the genus, *C. clarki* is distinctive in having extremely long basal spines (up to 1.7 mm in length and constituting $\frac{3}{4}$ of the height of the basal scales, Figs. 6A–D) and in having four to six prominent buccal spines (Figs. 6A, E). It is quite similar to *C. antilla* Bayer, 2001, the basic difference being that *C. antilla* has lyrate branching, *C. clarki*, equal-dichotomous branching. If that distinction is subsequently found to be trivial, then those records will have to be added to those of *C. clarki*.

Cairns (2007b, 2009) suggested that specimens from the eastern Pacific were similar to the western Atlantic *C. antilla*, but differed in having longer basal scale spines. This was based on an incorrect interpretation of a misleading scale given for the figures of *C. antilla* in Bayer's (2001) original description. The magnification as printed on his figures are incorrect, as the original SEM had been reduced in size, the correct magnification having to be determined by reference to the scale bar. Using the scale bar, not the number, the spines on the basal scales of both the Atlantic and Pacific populations are about the same, suggesting that this is a truly a widespread species.

Distribution. Off Hawaii (Cairns 2009), northern Mariana Islands, Phoenix Islands, 286–1105 m.

Calyptraphora pourtalesi, n. sp.

Figs. 1F, 7A–L

Etymology. Named in honor of Count Louis François Pourtalès (1824–1880), early contributor to our knowledge of deep-sea Scleractinia, Stylasteridae, and Octocorallia (Agassiz 1905), and author of the closely related species *C. trilepis*.

Type and Type Locality. Holotype: colony and SEM stubs 2505-2508, USNM 1453726. Type Locality: EX1703-8-01, 0.210°N, 176.48°W (off Baker Island, Phoenix Islands), 437 m, 16 March 2017.

Material Examined. Type.

Description. The holotype (Fig. 1F) now consists of two branch fragments, each about 23 cm in height, which display equal, dichotomous branching, the distance between each bifurcation about 3–4 cm. Polyps are directed upward (Fig. 7B–C) and are arranged in whorls of four or five (seven or more on larger-diameter branches), 4–4.5 whorls occurring per cm branch length; the whorl diameter is about 3.5 mm. Individual polyps are 2.0–2.4 mm in horizontal length.

The fused basal scale (Figs. 7D, G) is 1.3–1.4 mm in height, projecting only slightly (0.06–0.10 mm) beyond the articular ridge as a thin shelf (Fig. 7G), but not expressed as a spine or tooth. The articulating ridge is distinct and because of the short basal shelf, can be seen even from the outer surface of a bent polyp (Fig. 7F). The fused buccal scale (Fig. 7D) is larger (1.7–1.8 mm in length), having a rounded, finely serrate distal edge, the serrations being equilateral triangles about 8 μ m in height (Fig. 7H); there is essentially no cowl. The outer surface of both types of body wall scales is uniformly covered with low granules. There is one pair of prominent, crescent-shaped infrabasal scales (Figs. 7C, I), which may be up to 1.3 mm in length and 0.45 mm in maximum height; often each bears one or more vertical radiating low ridges.

The operculum is quite low (Fig. 7J), almost flat in the contracted condition, the opercular scales (Figs. 7K) being relatively similar in shape and size; they have a concave outer surface and a keeled inner surface. The adaxial operculars are symmetrical, 0.72–0.89 mm in length, and have an L:W of 1.25–1.40; the lateral, slightly asymmetrical operculars are 0.65–0.80 mm in length, with an L:W of 1.15–1.30; and the adaxial operculars are also asymmetrical, 0.50–0.60 mm in length, with a very broad base resulting in a low L:W of 0.85–1.00.

The coenenchymal scales (Fig. 7L) are elongate (L:W = 3.5–7.5), slightly irregular in shape, flat, and bear low granules (no ridging) like the body wall scales.

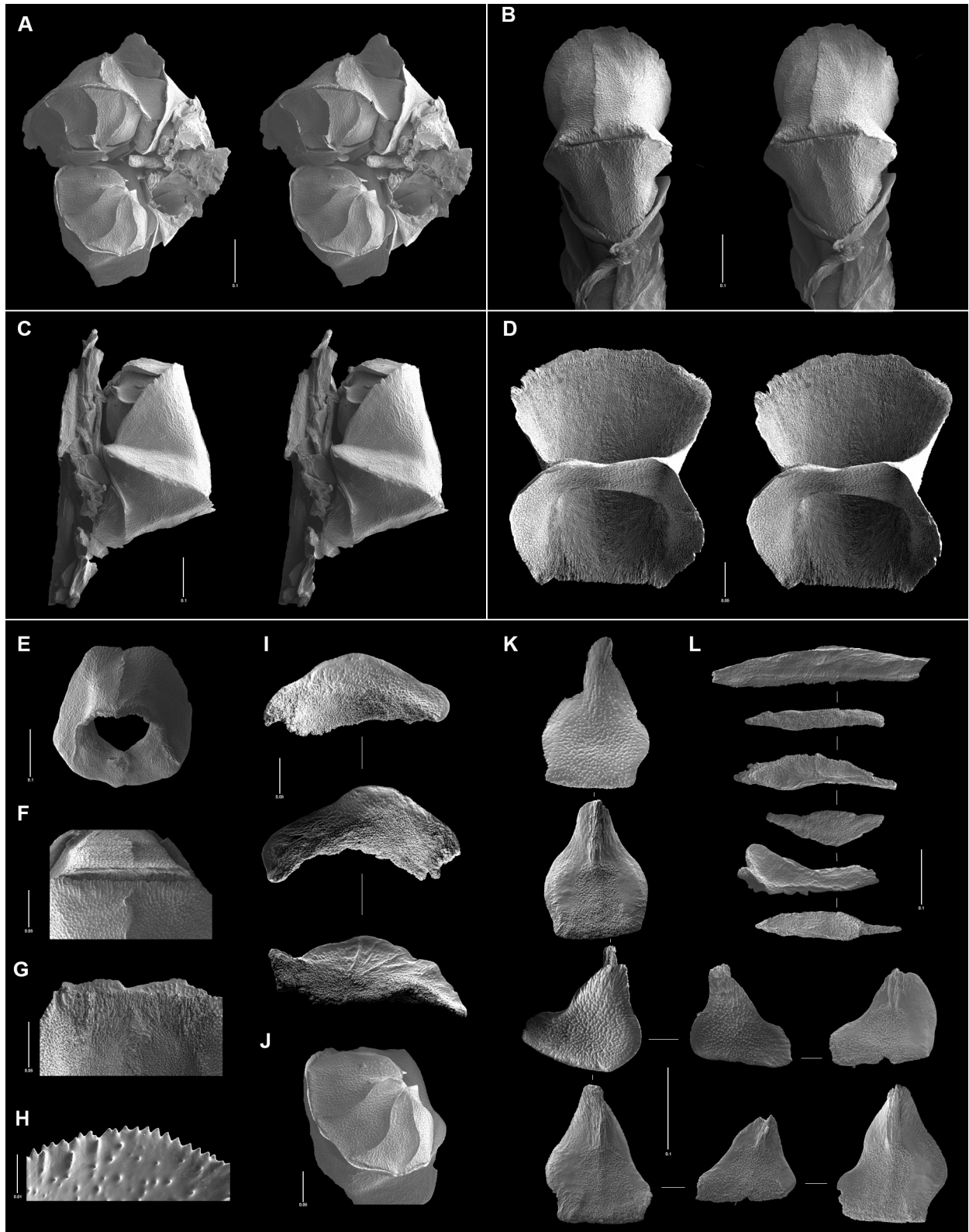


FIGURE 7. *Calyptrophora pourtalesi*, holotype: **A**, stereo opercular view of two polyps. **B–C**, stereo views of abaxial and lateral sides of a polyp. **D**, stereo view of inner side of buccal scale. **E**, basal scale. **F**, articulation of basal to buccal scale. **G**, distal margin of a basal scale. **H**, distal edge of a buccal scale. **I**, infrabasal scales. **J**, polyp operculum. **K**, opercular scales. **L**, coenenchymal scales. Scale bars in mm.

Comparisons. *Calyptrophora pourtalesi*, a member of the *japonica* species complex, is remarkably similar to *C. trilepis* (Pourtales, 1868), a species known only from the tropical western Atlantic from 593–911 m, and might even be considered as a sister species. *C. trilepis* differs only in having smaller polyps (1.3–1.6 mm in length, and thus a smaller whorl diameter) and fewer polyps per whorl (2–4). Although redescribed by Bayer (2001), both species are known from very few specimens and thus comparisons are tentative. Within the Pacific *C. pourtalesi* is most similar to *C. japonica* Gray, 1866, but that species has a biplanar, bipectinate colony.

Distribution. Known only from the type locality.

Calyptrophora distolos, n. sp.

Figs. 1G, 8A–H

Etymology. Named *distolos* (Greek for “in pairs”), in allusion to the paired nature of the polyps.

Types and Type Locality. Holotype: colony fragment and SEM stubs 2398–2399, USNM 1424085. Paratypes: EX1702-11-02, 15.73°S, 167.26°W (American Samoa), 2994 m, branch fragments, USNM 1453657. Type Locality: EX1605-L1-4-03, 11.41°N, 144.78°E (Enigma Seamount, south of Guam), 3737 m.

Material Examined. Types.

Description. The holotype is flagelliform (unbranched), about 21 cm in length, although only the distal half was collected (Fig. 1G). The paratype is extremely sparsely branched. When alive the polyps project perpendicular to the branch and when dead they fold in a 90° angle (i.e., buccal scales parallel to the branch), typical of the genus, but because the entire colony was not collected, the direction that the polyps face was indeterminate. The polyps are arranged in widely spaced (about 2 per cm) pairs (Fig. 1G), not arranged in whorls, approximately 40 pairs occurring on the holotype. Individual polyps are 2.9–3.2 mm in horizontal length, the opercular scales adding significantly to this length.

The basal scale (Fig. 8E) is 1.4–1.5 mm in height, usually including a short (about 0.2 mm tall) inconspicuous blunt lobe on either side of the straight articular ridge. The basal scale usually bears a dorsolateral ridge as well as several more ridges on its lateral face (Fig. 8A), but sometimes these ridges are inconspicuous or lacking altogether. The buccal scale is slightly longer (1.4–1.6 mm in length) and usually bears a similar longitudinal ridging (Figs. 8C–D); its distal edge is finely serrate. No infrabasal scales were noted.

The operculum is quite long (Figs. 8A–B), in fact longer than either of the body wall scales. The opercular scales (Fig. 8H) are all rather similar in shape (elongate and triangular with a high L:W ratio). The abaxial operculars are up to 1.8 mm in length with an L:W of 2.5–3.0, and sometimes bear a low longitudinal ridge on their outer surface. The lateral operculars are 1.0–1.35 mm in length, with an L:W of 2.5–3.1, and often terminate in two tips. The small adaxial operculars are 0.9–1.0 mm in length with an L:W of 2.8–3.3. In addition to the typical eight opercular scales, there are sometimes additional smaller accessory scales at the base of some of the opercular scales (Fig. 8F), these being circular to elliptical, 0.45–0.50 mm in diameter, and highly concave.

The coenenchymal scales (Fig. 8H) are quite long and narrow, up to 2 mm in length, and with an L:W ranging from 4.4–9.0. Each coenenchymal scale bears a single, tall (up to 0.3 mm, thus a sail scale) ridge, which meanders down the center of the scale.

Comparisons. *Calyptrophora distolos* is unique among the 27 species in the genus in having paired polyps (not arranged in whorls of three or more) and in having auxiliary opercular scales. It is one of four species having a predominantly unbranched mode of growth, the other three being: *P. juliae* Bayer, 1952; *C. clinata* Cairns, 2007a; and *C. persephone* Cairns, 2016a (Clarion-Clipperton Fracture Zone, 4123–4244 m). It is most similar to *C. persephone* in morphology, geography and depth range, but that species differs in having whorls of three or four smaller polyps, basals with two prominent pointed distal spines, lobate buccal scales, and in lacking accessory opercular scales. Because the orientation of the polyps is indeterminate, the species cannot at this time be assigned to the *wyvillei* or *japonica* species complex.

Distribution. American Samoa and Guam, 2994–3737 m.

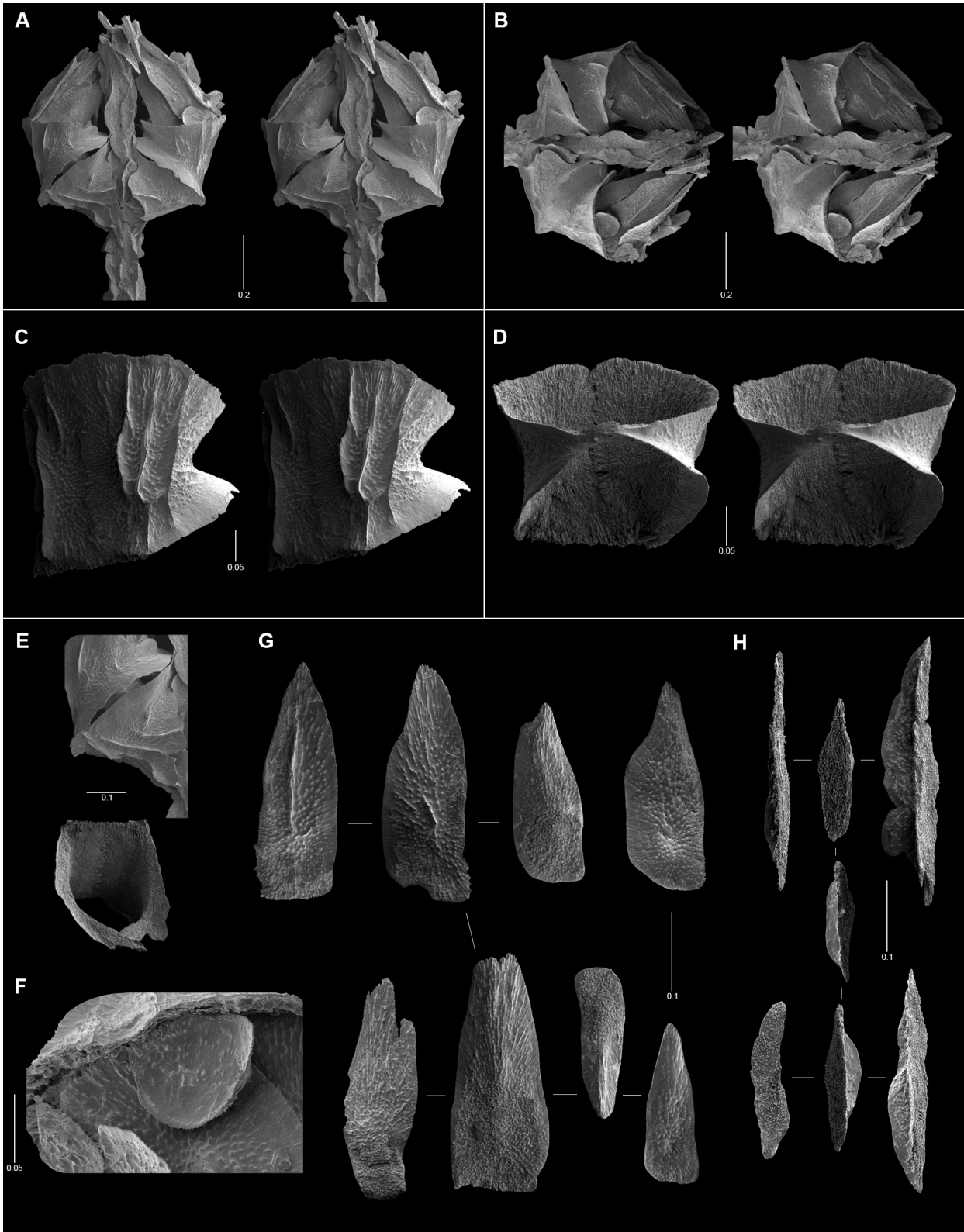


FIGURE 8. *Calyptrophora distolos*, holotype: **A–B**, lateral stereo views of paired polyps. **C**, stereo view of ridged buccal scale. **D**, stereo view of inner face of a buccal scale. **E**, two views of a basal scale. **F**, an accessory buccal scale. **G**, opercular scales. **H**, coenenchymal scales. Scale bars in mm.

Genus *Candidella* Bayer, 1954

Stenella Gray, 1870: 48 (junior homonym).

Candidella Bayer, 1954: 296.—Cairns & Bayer 2004b: 476–477; 2009: 46, fig. 16H–N.—Cairns, 2009: 440; 2012: 37; 2016b: 102.

Type Species. *Primnoa imbricata* Johnson, 1862, by monotypy.

Diagnosis. Colonies dichotomously branching or unbranched (flagelliform). Polyps arranged in whorls, individual polyps standing perpendicular to branch. Each polyp with four large marginal scales, forming a distinct cowl around operculum. Other body wall scales much smaller, occurring in 2–4 sub-terminal transverse tiers. Opercular scales have a prominent keel. Coenenchymal scales elliptical, with concave outer surface.

Discussion. Four species are known in this deep-water genus, which has been reviewed by Cairns (2009) and Cairns & Bayer (2009).

Distribution. Amphi-Atlantic, central Pacific from Hawaii to New Zealand, 1115–2211 m.

Candidella gigantea (Wright & Studer, 1889)

Fig. 1H

Stenella gigantea Wright & Studer, 1889: 57.

Candidella gigantea: Cairns & Bayer, 2004b:477.—Cairns, 2009: 443–445, figs. 1B, 21–22 (complete synonymy).

Types and Type Locality. The holotype is deposited at the BM (1889.5.27.36). Type Locality: 19°10'S, 178°10'E (Fiji Plateau), 384–1115 m.

Material Examined. EX1603-7, 26.431°N, 177.806°W (south of Midway Island), 1837 m, 11 March 2016, image only; EX1605-L3-19, 19.804°N, 148.444°E (northern Mariana Islands), 1943 m, 5 July 2016, image only; EX1606-1, 16.853°N, 154.06°E (northern Mariana Islands), 2205 m, 30 July 2016, image only; EX1606-6, 19.447°N, 165.80°E (south of Wake Island), 2211–2157 m, 6 August 2016, image only; EX1606-7, 17.3097°N, 165.9601°E (Unnamed Seamount, northwest of Wake Island), 2087 m, 8 August 2016, image only.

Remarks. This species was adequately described and figured by Cairns (2009) and is known only from images (no collected specimens) in this report, and thus will not be fully redescribed or figured herein.

Distribution. Northwest Hawaiian Islands, south of Wake Island, northern Mariana Islands, Fiji Plateau, 1115–2211 m. Previously reported depth ranges that included 384 m were based on the depth range of the type locality, which cannot be used for a definitive depth range. If a more conservative “confirmed” depth range is used (*i.e.*, the shallowest deep to the deepest shallow component of a trawl having a range) then the depth range for the species results in 1115–2211 m.

Genus *Macroprimnoa*, gen. nov.

Type Species. *Macroprimnoa ornata*, here designated.

Etymology. From the Greek *makros* (meaning long) and *primnoa* (a common primnoid suffix), meaning a primnoid with long (and large) polyps. Gender: feminine.

Diagnosis. Colonies unbranched (flagelliform). Polyps uniseriably arranged, oriented perpendicular to branch, and well spaced. Body wall scales in eight longitudinal rows of only two or three scales each. Opercular scales keeled. Coenenchymal scales elongate and prominently ridged.

Discussion. *Macroprimnoa* is unique among the 48 other primnoid genera (Cairns & Wirshing 2018) in having unilinearly arranged (uniserial) polyps. It is also distinctive, although not unique, in having very large and widely-spaced polyps, and in having very few body wall scales. Superficially it resembles *Abyssoprino* in polyp shape, coenenchymal ornamentation, and extreme depth of capture, but *Abyssoprino* differs in being dichotomously branched, having paired polyps, and in having only four (marginal) body wall scales. In the key to the genera pub-

lished by Cairns & Wirshing (2018), *Macroprimnoa* keys close to *Helicoprinnia* and *Callozostron*, but is easily distinguished from those genera by numerous characters.

Distribution. Central Pacific (see below), 3066–3676 m.

***Macroprimnoa ornata*, n. sp.**

Figs. 1I, 9A–H

Etymology. Named *ornata* (Latin for decorated or adorned), an allusion to the somewhat ornate ridging on the body wall scales.

Types and Type Locality. Holotype: a complete colony, USNM 1463530. Paratypes: *EX1708-2-1*, 25.553°N, 158.214°W (topotypic), 3282 m, colony fragment, USNM 1467528; *EX1605-L1-4-05*, 11.41°N, 144.78°E (Enigma Seamount, south of Guam, Northern Mariana Islands), 3643 m, colony fragment, USNM 1424086; *EX1606-13-03*, 16.581°N, 166.472°E (Batfish Seamount, south of Wake Island), 3066 m, colony fragment, SEM stubs 2386–2388, USNM 1424231. Type Locality: *EX1708-2-GEO2-A2*, 25.553°N, 158.215°W (Beach Ridge, Musicians Seamounts), 3207 m.

Material Examined. Types; *EX1605-L1-13*, 16.027°N, 147.113°E (off Saipan, northern Mariana Islands), 3676 m, image only.

Description. Colonies are unbranched (flagelliform), the holotype (Fig. 1I) an intact stem 8.7 cm in height supporting 12 polyps. A larger colony (USNM 1424086, paratype) was estimated to have been 27 cm in height at the time of collection). The polyps are uniseriably arranged on one side of the stem and very widely spaced (1 polyp/cm), about 6–7 mm of branch coenenchyme between each polyp (Fig. 1I). The polyps stand perpendicular to the branch, are 3.5–3.7 mm in height, and are shaped as a squat cylinders topped with a conical operculum, which accounts for well over half of the height.

The body wall scales consist of eight longitudinal rows or two or three roughly rectangular (1.8–2.5 mm in width) scales, resulting in only 16–24 body wall scales (Fig. 9A–B). The body wall scales have a sinuous upper margin, sometimes similar to a *Parastenella*-like flute (Fig. 9F), and those nearest the branch often bear several vertical ridges on their outer surface (Fig. 9H). The proximal margin of the body wall scales bear a series of irregular digitiform processes.

The operculum is prominent (Fig. 9A–B), composing over half the height of the polyp. The symmetrical abaxial operculars are up to 3.1 mm in length, have an L:W of 2.6–3.1, and have a pointed tip and irregular lateral edges. The asymmetrical lateral operculars are only slightly shorter (2.5–2.7 mm) and have an L:W of about 1.6. The symmetrical adaxials are about 2.5 mm in length, with an L:W of about 1.9. All operculars (Fig. 9G) have a highly concave outer surface, a keeled inner surface, and a digitiform base, like the body wall scales, and are fragile.

The coenenchymal scales (Fig. 9H) are elongate (up to 3.3 mm in length with an L:W = 2.6–5.6), and usually pointed on both ends. Each coenenchymal bears tall (up to 0.5 mm, sail scales) ridges that sometimes coalesce into a network of interconnecting ridges.

Comparisons. Monotypic.

Remarks. The length of each pinnate tentacle is approximately 6.5 mm, with 16–18 pinnules on either side of each tentacle. This might explain why the polyps are so widely spaced and the opercular scales so long, but even so, tentacles from contiguous polyps overlap.

Distribution. Musicians Seamounts, northern Mariana Islands, and south of Wake Island, 3066–3676 m.

Genus *Narella* Gray, 1870

Narella Gray, 1870: 49.—Cairns & Bayer, 2009: 43 (synonymy and discussion).—Cairns, 2012: 14.—Taylor & Rogers, 2017: 4.—Cairns, 2018: 20–21.

Stachyodes Wright & Studer in Studer, 1887: 49.—Versluys, 1906: 86–88.

Calypternius Wright & Studer in Studer, 1887: 49–50.

Type Species. *Primnoa regularis* Duchassaing & Michelotti, 1860, by monotypy.

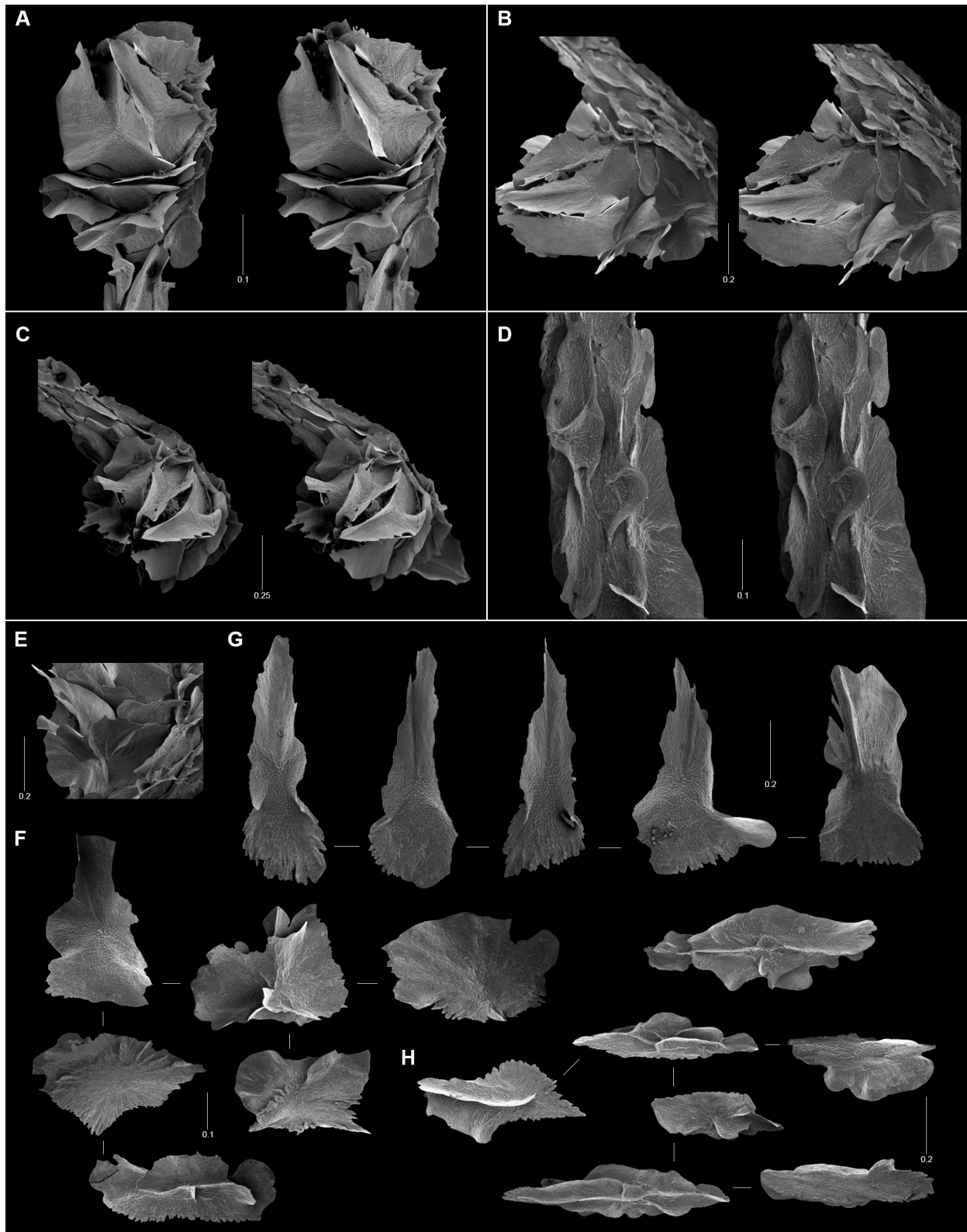


FIGURE 9. *Macroprimnoa ornata*, paratype from USNM 142423: **A–C**, stereo views of lateral and opercular sides of a polyp. **D**, stereo view of coenenchymal scales, *in situ*. **E**, body wall scales, *in situ*. **F**, highly ridged body wall scales. **G**, opercular scales. **H**, ridged coenenchymal scales. Scale bars in mm.

Diagnosis. Colonies branched dichotomously (laterally or equal), pinnately, in a lyrate fashion, or unbranched. Polyps arranged in whorls, all polyps facing downward in contracted condition. Each polyp covered with three (rarely four) pairs of abaxial body wall scales (one pair of basals, one or two pairs of medials, and one pair of buccals) and a variable number of pairs of smaller adaxial scales, nonetheless leaving the adaxial face largely naked. Articular

ridge not present on basal scales. Paired infrabasal scales usually present. Opercular scales keeled on inner surface. Coenenchymal scales thin and slightly imbricate or thick and mosaic in placement, and sometimes prominently ridged.

Discussion. Although keys exist to the *Narella* species from various geographic regions (see Cairns 2018 for a summary), a comprehensive key, preferably a tabular key, is sorely needed for the 50 species in the world, and is currently being constructed by Cairns and Taylor (in prep.). The last comprehensive key to the species was that of Kükenthal (1919, 1924), which included only 18 species. Most of the currently recognized species are listed by Taylor & Rogers (2017).

The order in which species are treated below are grouped by presence or absence of a ridge on the dorsolateral basal edge, followed by the colony form, simplest to most complex.

Distribution. All ocean basins except for Arctic, 128–4594 m.

Narella ferula, n. sp.

Fig. 10A–I

Etymology. Named *ferula* (Latin for whip), in allusion to the flexible unbranched shape of the colony.

Type and Type Locality. Holotype, colony and SEM stubs 2502-2504, USNM 1453829. Type Locality: EX1705-11-Geo 01, 6.370°N, 162.31°W (Kingman Cone, off Palmyra Atoll), 1023 m, 12 May 2017.

Material Examined. Type.

Description. The holotype is 22 mm long and consists of six whorls, but is lacking its holdfast. Judging from *in situ* images, the colony was unbranched (see Remarks). The whorls are evenly spaced, about 2.5–2.7 occurring every cm, each whorl having only two or three polyps; the whorl diameter is 3.6 mm. The horizontal length of the contracted polyp is 2.3–2.5 mm. Polychaete commensalism was not noted.

The basal body wall scales are relatively tall, up to 2.0 mm, the distalmost 0.7 mm projecting beyond their attachment with the medial scales as a prominent serrated cowl (Fig. 10A–B). The proximal edge of the dorsolateral edge of the basal scales bears several low ridges and one or two taller spurs (Fig. 10C). The medial body wall scales (Fig. 10D) are much shorter, only 0.9–1.1 mm in length, and have a toothed distal margin. The buccal scales (Fig. 10E) are 0.9–1.3 mm in length, quite wide, and have a slightly undulating distal edge. One pair of adaxial buccals are present, each about 0.65 mm in width (Fig. 10F). The ratio of the lengths of the major body wall scales is thus about: 1: 0.47: 0.66.

The abaxial opercular scales (Fig. 10G, rightmost) are tall (up to 1.5 mm) and wide (L:W = 1.7), often being multi-tipped. The lateral operculars are 0.7–1.4 mm in length and have a L:W of about 1.8–2.2. The adaxial operculars are small (0.8–1.05 mm) with an L:W of about 2.1–3.1.

The coenenchymal scales (Fig. 10I) are elongate (L:W = 3.25–6.6), thin, and imbricate, measuring 0.65–2.1 mm in length. Each usually bears a tall medial ridge, sometimes as high as 0.4 mm.

Comparisons. Among the approximately 23 species of *Narella* having basal scales with dorsolateral ridges, *Narella ferula* is most similar to *N. hawaiiensis* Cairns & Bayer, 2007 (Hawaiian Islands, 1492–1944 m), a species that is also unbranched and has similarly shaped coenenchymal scales. *Narella ferula*, however, differs in having a multi-ridged dorsolateral edge of its basal scales (vs an inconspicuous single ridge), smaller polyps and thus a smaller whorl diameter, a cowl formed by the basal scales, and serrate or toothed body wall scales. Also, the two spurs (Fig. 10C) at the base of the basal scales may be unique for this species.

Remarks. This specimen was incidentally collected attached to a 31 cm diameter rock that was collected for geological reasons, and thus *in situ* photographs were not very detailed, however it can be seen from the image of the rock that the holotype colony was not a short distal branch of an otherwise branching colony but an unbranched colony about 3 cm long.

Distribution. Known only from type locality.

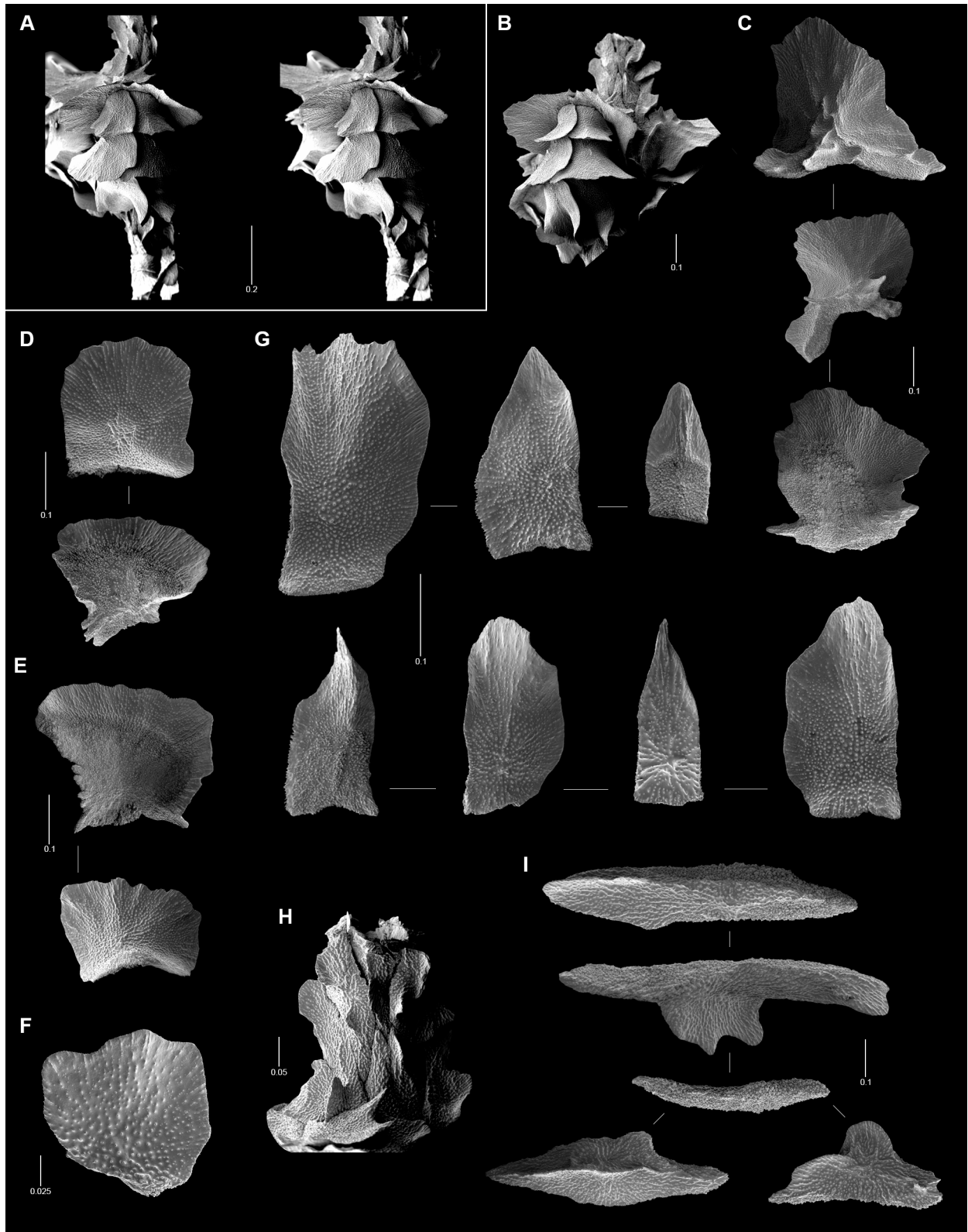


FIGURE 10. *Narella ferula*, holotype: **A**, stereo view of polyp whorl. **B**, abaxial view of polyp. **C**, basal scales. **D**, medial scales. **E**, buccal scales. **F**, adaxial buccal scale. **G**, opercular scales. **H**, coenenchymal scales *in situ*. **I**, coenenchymal scales. Scale bars in mm.

***Narella hawaiiensis* Cairns & Bayer, 2007, nom. correct.**

Fig. 1S

Narella hawaiiensis Cairns & Bayer, 2007: 108–112, figs. 1B, 16A–E, 17A–F.

Types and Type Locality. The holotype (USNM 79396) and paratypes are deposited at the NMNH. Type Locality: Bushnell Seamount, 1921 m.

Material Examined. EX1504-9-2: 16.14°N, 167.85°W (South Karen Ridge, southeast of Johnston Atoll), 1944 m, USNM 1297746.

Remarks. This species was adequately described and figured by Cairns & Bayer (2007) and thus will not be redescribed herein. In the original description the colony form was assumed to be unbranched. The *in situ* image of the *Okeanos* specimen also clearly shows an unbranched colony approximately 66 cm in length (Fig. 1S).

This additional specimen also extends the known distribution to a seamount southeast of Johnston Atoll and slightly extends the known bathymetric range from 1921 m to 1944 m.

The original intention of the authors was to name the species after the Hawaiian Islands, and thus the name is corrected to *hawaiiensis*.

Comparisons. The most similar species to *N. hawaiiensis* is *N. ferula*, which are compared in the description of the latter.

Distribution. Known from Pioneer Bank to Bushnell Seamount, Hawaiian Islands (Cairns & Bayer 2007); South Karen Ridge (southeast of Johnston Atoll), 1492–1944 m.

***Narella macrocalyx* Cairns & Bayer, 2007**

Fig. 1R

Narella macrocalyx Cairns & Bayer, 2007: 99–103, figs. 1C, 10A–D, 11A–H.

Types and Type Locality. The holotype (USNM 1072133) and paratypes are deposited at the NMNH. Type Locality: seamount east of Necker Island (Hawaiian Islands), 1443 m.

Material Examined. EX1504-L2-14-2, 26.2010°N, 173°3255'W (North Pioneer Ridge, Hawaiian Islands), 1587 m, 15 August 2015, USNM 1294081; EX1606-3, 20.443°N, 163.714° E (west of Wake Island), 1983 m, image only; EX1606-7, 17.309°N, 165.961°E, (southwest of Wake Island), 2033 m, image only; EX1606-12, 18.320°N, 165.98°E (southwest of Wake Island), 1258 m, image only.

Remarks. This species was adequately described and figured by Cairns & Bayer (2007) and thus will not be redescribed herein. The additional collected specimen and *in situ* images of three additional colonies allow the observation that it is a very sparsely branched colony, most of its three to seven long distal branches originating from the main stem within 5 cm of the base of the colony (Fig. 1R). Collection of a partial colony could easily be confused for an unbranched species. It would appear that most of the basal scales have a dorsolateral ridge, and that the whorl diameter may be as small as 7 mm.

The specimens reported herein extend the geographic to off Wake Island, and the known bathymetric range from 1807 to 1983 m.

Comparisons. Among the 23 species of *Narella* having a dorsolateral ridge on their basal scales, only one other is commensal with a polychaete worm, *N. gilchristi* (Thomson, 1911). *Narella macrocalyx* differs from that species, as well as all the other species in that group by having the largest polyps and whorl diameter of any species and by having two or three pairs of adaxial buccal scales.

Distribution. Hawaiian Islands from Pioneer Bank to Molokai (Cairns & Bayer 2007), off Wake Island, 1206–2033 m.

***Narella merga*, n. sp.**

Figs. 1M, 11A–J

Etymology. Named *merga* (Latin for a two-pronged pitchfork), in allusion to the growth form of the colony. The name is considered as a noun in apposition.

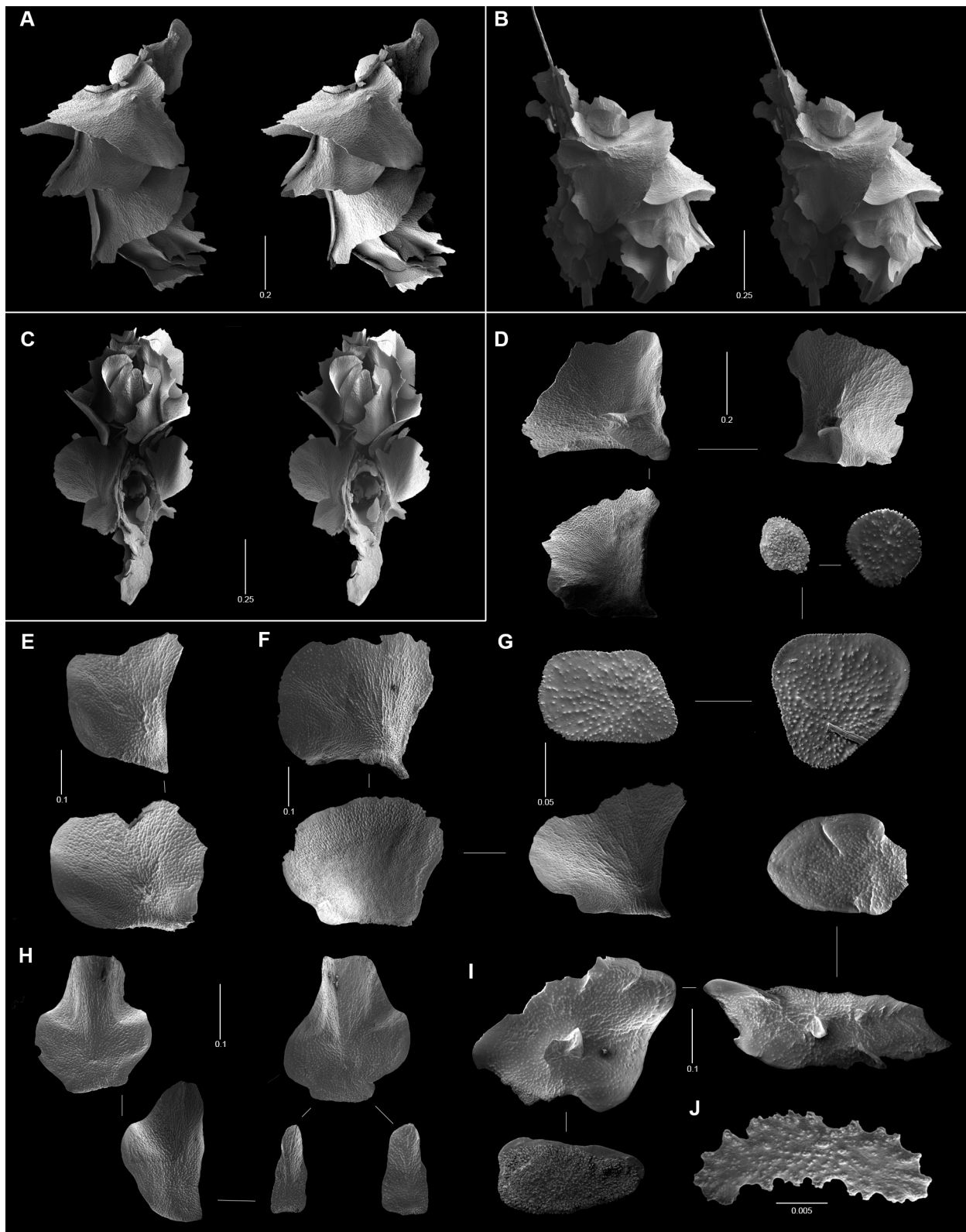


FIGURE 11. *Narella merga*, holotype: **A–C**, Stereo views of lateral and adaxial sides of a polyp. **D**, basal scales. **E**, outer surface of medial scales. **F**, buccal scales. **G**, adaxial buccal scales. **H**, opercular scales. **I**, coenenchymal scales. **J**, pinnular scale. Scale bars in mm.

Type and Type Locality. Holotype and SEM stubs 2436–2440, USNM 1424202. Type Locality: EX1606-502, 19.15048°N, 164.5587° E (McDonald Guyot, Mid-Pacific Mountains Range west of Wake Island), 2575 m.

Material Examined. The holotype.

Description. Only the distal 9.5 cm (19 whorls) of the holotype was collected, representing just part of one of the two branches, but *in situ* photographs (Fig. 1M) show the colony to have a short, stout stem about 2 cm in height that bifurcates into two long branches, each about 20 cm long. The color of the colony is white. The whorls are relatively closely spaced (about 2 whorls/cm), each whorl having three polyps; the whorl diameter is about 4.4 mm. The horizontal length of a contracted polyp is about 4.0 mm. Polychaete commensalism was not noted.

The basal body wall scales (Fig. 11D) are 1.8–2.2 mm in height, their distal margin rounded (not spinose, serrate or undulate), forming a short cowl around the medial scales. The dorsolateral edge of the basal scale is rounded but on its lower half bears one or two short but tall (up to 0.5 mm) thin ridges. The basal scales are open on the adaxial side. The medials (Fig. 11E) are short (1.3–1.5 mm), narrow, and upturned at their distal edge. The buccal scales (Fig. 11F) range from 1.6–2.2 mm in length and are quite wide, also having a rounded distal edge. All body wall scales bear a low granulation and are not ridged except for the dorsolateral edge of the basals. The ratio of the lengths of the major body wall scales is: 1: 0.7: 0.95. There is one pair of flat adaxial buccal scales, shaped as rectangles or ellipses, measuring 0.6–0.7 mm in greater diameter. The adaxial polyp side is also covered with numerous smaller elliptical scales (Fig. 11G) measuring 0.25–0.35 in diameter.

The abaxial opercular scales (Fig. 11, top) are symmetrical, each bearing broad lateral lobes and measuring 1.8–1.9 mm in length (L:W = 1.2). The lateral opercular scales are asymmetrical, having only one lateral lobe, and measure 1.8–1.9 mm in length (L:W = 1.5–2.0). The symmetrical (no lateral lobes) adaxial opercular scales are the smallest (Fig. 11H, lower), measuring 1.2–1.4 mm in length (L:W = 1.9–2.0). The adaxial operculars are flat, whereas the other operculars have highly concave outer surfaces. The pinnular scales are about 0.11 mm in length, flat, and slightly curved (Fig. 11J).

The coenenchymal scales (Fig. 11I) are a mixture of elongate (L:W = 3.1) to elliptical (L:W = 1.4) in shape and up to 2.2 mm in length. They are thin and imbricate, most bearing a short and relatively low ridge on their outer surface.

Comparisons. The single bifurcation growth mode of *N. merga* appears to be unique within the genus. Among those species that have sparse dichotomous branching and a basal scale dorsolateral ridge, *N. merga* is most similar to *N. alaskensis* Cairns & Baco, 2007 (Gulf of Alaska, 2377–3075 m) and even shares an overlapping depth range. But, *N. alaskensis* differs in having more polyps per whorl (4–9), smaller polyps, and much longer medial body wall scales that sometimes bear a longitudinal ridge.

Distribution. Known only from the type locality.

***Narella fordii*, n. sp.**

Figs. 1O, 12A–J

Etymology. Named in honor of Robert H. Ford, terrestrial plant ecologist, teacher, and colleague.

Type and Type Locality. Holotype: Six branches of the same colony, SEM stubs 2494–2497, USNM 1453764. Type Locality: EX1703-18-02, 6.4916°S, 173.581°W (Te Kaitira, seamount south of Phoenix Islands), 1899 m, 25 March 2017.

Material Examined. Holotype.

Description. Judging from *in situ* images of the holotype prior to collection (Fig. 1O), only the distal third of the colony was collected, consisting now of six branch fragments, the largest only 8 cm in length. The intact colony was about 30 cm in height and had very sparse, equal dichotomous branching. The color of the colony is white. The whorls are evenly spaced at 2.5–3.0 per cm, each whorl having three polyps; the whorl diameter is 3.4–3.5 mm. The horizontal length of a contracted polyp is 2.1–2.6 mm. Polychaete commensalism was not noted.

The basal body wall scales are relatively short, only 0.8–1.1 mm in length, having a rounded distal margin. The dorsolateral edge of the basal scale is also rounded but bears a series of low ridges on its proximal surface (Fig. 12D). The basal scales are open on the adaxial side, separated by a pair of rectangular ridged adaxial buccal scales (Figs. 12C, G), each measuring 0.29–0.40 mm in greater width. The medial body wall scales (Fig. 12E) are also relatively short (0.8–0.9 mm), each bearing a low continuous dorsolateral ridge. The buccal body wall scales (Fig. 12F) are the largest of the scales, up to 1.2 mm in length, and have a rounded dorsolateral edge devoid of ridges. The ratio of the lengths of the major body wall scales is thus about: 1: 0.85: 1.2, all scales being almost the same length.

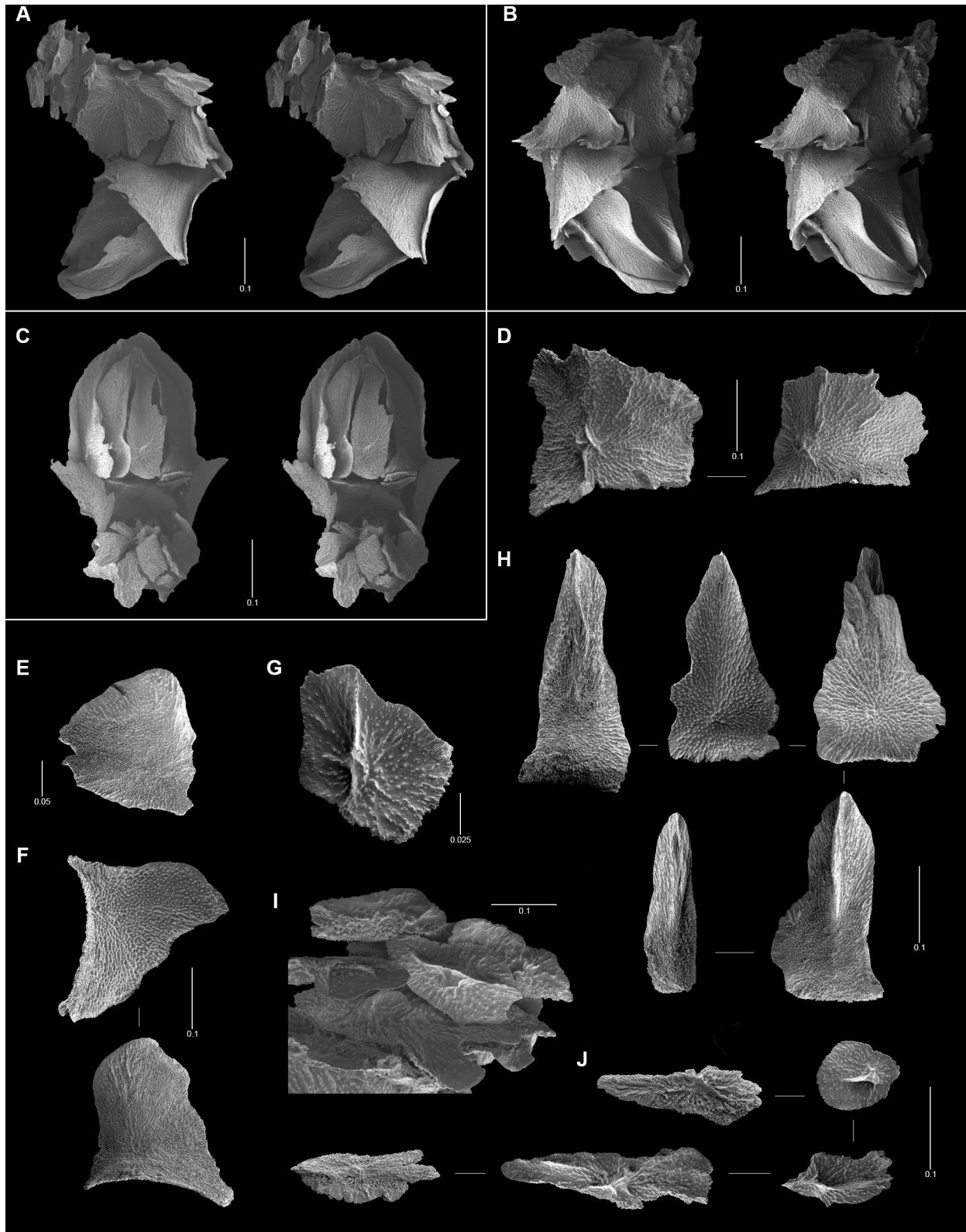


FIGURE 12. *Narella fordi*, holotype: **A–C**, stereo views of lateral and adaxial sides of a polyp. **D**, outer surface of basal scales. **E**, medial scale. **F**, buccal scales. **G**, adaxial buccal scale. **H**, opercular scales. **I**, coenenchymal scales *in situ*. **J**, coenenchymal scales. Scale bars in mm.

The abaxial opercular scales are symmetrical, with small lobes on each lateral side, and measure up to 1.3 mm in length (L:W = 1.6). The lateral opercular scales are asymmetric, each having only one lateral lobe on its adaxial side, and measure 1.2–1.3 mm in length (L:W = 2.0–2.3). The adaxial operculars are quite slender (Fig. 12H, lower left), symmetrical, lack lateral lobes, and measure 1.0–1.1 mm in length (L:W = 3.4).

The coenenchymal scales (Fig. 12J) vary from square to elongate (L:W = 1.1–4.0), thin, imbricate, and measure up to 1.2 mm in length. They usually bear tall, complex ridges on their outer surface.

Comparisons. *Narella fordi* is most similar to *N. cristata* Cairns & Baco, 2007, a species found in much deeper water (i.e., 3385 m) in the Gulf of Alaska. It differs in having a series of ridges on the dorsolateral edge of its basal scales (*N. cristata* has only one), lacking a ridge on the dorsolateral edge of the buccal scales and in having more complex coenenchymal ridging.

Remarks. A large orange ophiuroid was attached to the holotype colony (Fig. 1O).

Distribution. Known only from the type locality.

Narella virgosa, n. sp.

Figs. 1J, Q, 13A–J

Etymology. Named *virgosa* (Latin for bushy), in allusion to the bushy nature of the large colony.

Type and Type Locality. Holotype: over a dozen branches and many detached polyps from the same colony, the largest branch 18 cm in length, and SEM stubs 2406-2408, USNM 1424064. Paratypes: EX1504-L4-9-04, 16.14°N, 167.85°W (South Karin Ridge, southeast of Johnston Atoll), 1931 m, a colony, now in eight branch fragments, and SEM stubs 2522-2526, 2528-2529. USNM 1297747; EX1708-17-05, 26.6°N, 160.67°W (Rapano Seamount, Musicians Seamounts), 1901 m, distal branches of a colony, USNM 1467640. Type Locality: EX1603-7-02: 26.43°N, 177.80°W (Castellano Seamount, approximately 370 km south of Midway Islands, Hawaiian Islands), 1985 m, 10 March 2016.

Material Examined. Holotype.

Description. The holotype colony is roughly uniplanar but also slightly bushy, abundantly branched and thus having many distal branches. Only a small portion of the holotype was collected, but photographs of the living colony (Fig. 1J) show it to be about 70 cm in height and 85 cm in width. Branching is initially lyrate, followed by equal dichotomous branching, resulting in long unbranched terminal branches up to 60 cm in length. The color of the colony is a very pale orange. The polyps are arranged in moderately closely spaced whorls (about 3/cm) of three or four polyps; the whorl diameter ranges from 3.3–4.5 mm. The horizontal length of the polyps is 2.6–3.6 mm in their contacted position, although the living polyps appear to be straight and stand perpendicular to the branch and are thus taller. Polychaete commensalism was not noted.

The basal scales (Figs. 13 B, E) stand perpendicular to the branch and extend up to 1.65 mm in height, their distal edges smooth (not serrate or spinose), forming a relative short cowl (0.3 mm) around the proximal portion of the medial scales. The dorsolateral edge of the basal scale is rounded but bears multiple thin longitudinal ridges, some as tall as 0.1 mm. Otherwise, the outer face is covered with small granules. The adaxial edges of the basal scales do not meet (open position, Fig. 13C). The medial scales (Fig. 13F) are much shorter (1.10–1.15 mm in length), and do not wrap around the polyp as the basal and buccal scales do. Each medial scales usually bears a single longitudinal ridge. It is not unusual for there to be two pairs of medial body wall scales. The buccal scales (Figs. 13B, G) are 1.1–1.35 mm in length and quite broad, wrapping around most of the polyp; they also bear a series of low radiating longitudinal ridges, and their distal edge is rounded, forming a short cowl of about 0.4 mm over the opercular crown. The ratio of the major body wall scales is thus: 1: 0.7: 0.85. There is one pair of large (each up to 0.7 mm in width), roughly rectangular adaxial buccal scales (Fig. 13H), below which the polyp is naked, probably to facilitate bending of the polyp toward the branch.

The abaxial opercular scales are symmetrical, 1.2–1.35 mm in length, and have an L:W of about 1.4. The outer and inner lateral operculars are similar in size and shape, 1.2–1.3 mm in length, slightly asymmetrical (having a small adaxial lateral lobe), and an L:W of about 1.7. The adaxial operculars are small (0.8–1.0 mm in length), symmetrical, and have an L:W of about 2.0. All opercular scales (Fig. 13I) bear a short longitudinal keel on the distal third of their inner surface; their outer surface is granular.

The coenenchymal scales (Fig. 13J) are flat and elongate (up to 1.8 mm in length, with an L:W = 3–6), each usually bearing one of more longitudinal ridges, these ridges sometimes up to 0.15 mm in height and thus resembling sail scales.

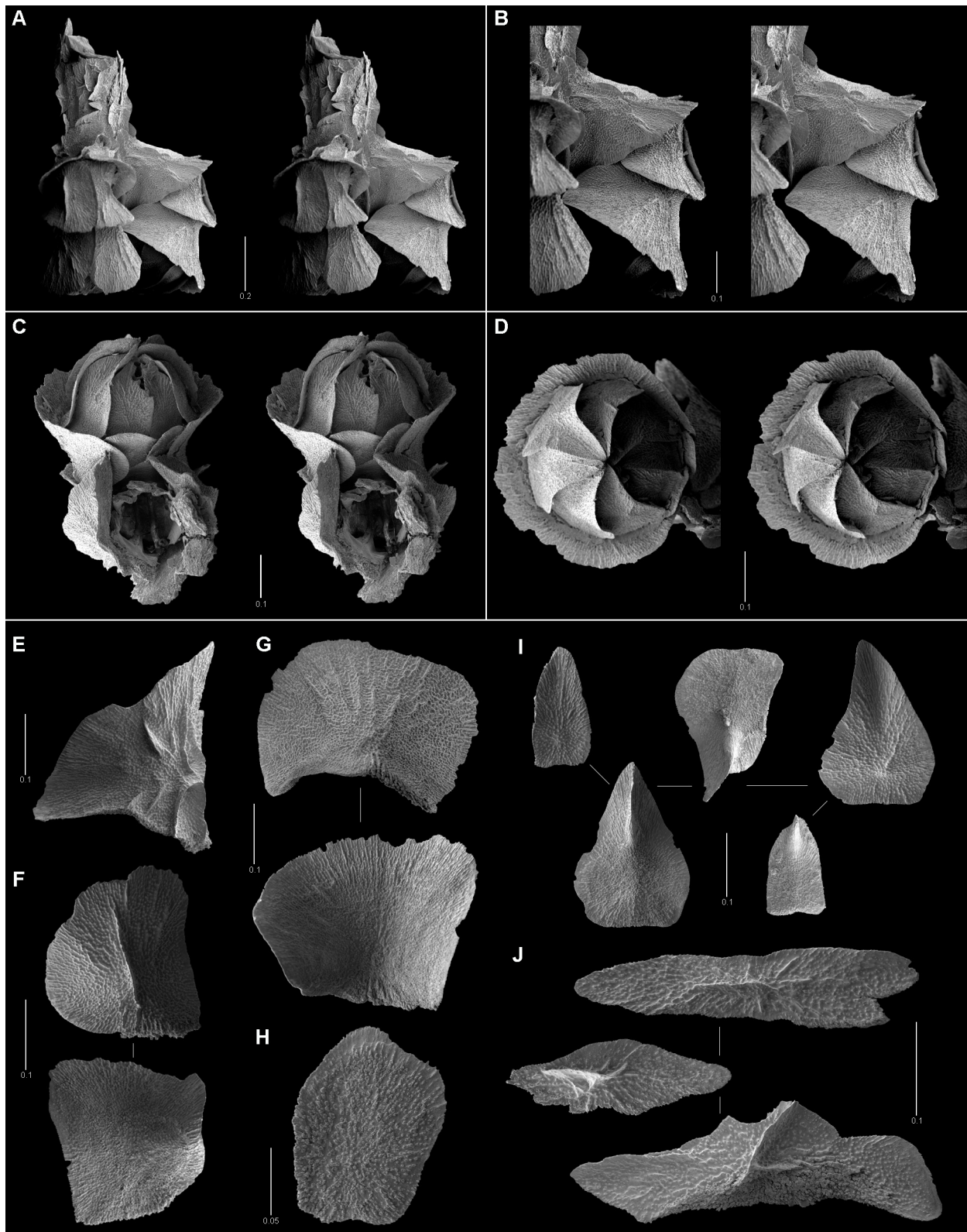


FIGURE 13. *Narella virgosa*, holotype: **A**, stereo view of a whorl. **B–D**, stereo views of lateral, adaxial, and opercular aspects of a polyp. **E**, outer surface of basal scale. **F**, medial scales. **G**, buccal scales. **H**, adaxial buccal scale. **I**, opercular scales. **J**, coenenchymal scales. Scale bars in mm.

Comparisons. When compared to other *Narella* found in the closely adjacent Hawaiian Islands (see Cairns & Bayer 2007), *Narella virgosa* most closely resembles *N. muzikae* Cairns & Bayer, 2007, particularly in the ridging of the basal and coenenchymal scales. However, *N. virgosa* differs from that species in having non-ridged adaxial

buccal scales, fewer polyps per whorl, non-ridged outer surface of opercular scales, larger polyps, and by occurring in much deeper water. Within the larger Indo-Pacific region, *N. virgosa* is most similar to *N. parva* (Versluys, 1906), known from Indonesia and New Zealand at 920–2400 m (see Cairns 2012), but differs in having lyrate branching, fewer polyps per whorl, and small polyps. The lyrate nature of the branching of *Narella virgosa* is shared with only four other species in the genus (Taylor & Rogers 2017), but that of *Narella virgosa* is so profusely branched as to be considered bushy, and may be unique for the genus.

Remarks. The holotype was host to several large, orange-red ophiocanthid ophiuroids (Fig. 1J).

Distribution. Midway Island, off Johnston Atoll and Musician Seamounts north of Hawaiian Islands, 1901–1985 m.

Narella calamus, n. sp.

Figs. 1P, 14A–H

Etymology. Named *calamus* (Greek for a fishing rod), in that the unbranched colony of this species resembles a small fishing rod and is used for the purpose of catching prey.

Types and Type Locality. Holotype, and SEM stubs 2419-2422, 2479-2481, USNM 1424208. Paratypes: EX1706-10-04, 15.04°N, 170.87°W (Wetmore Seamount, off Johnston Atoll), 1994 m, one colony, USNM 1457388, 25 July 2017; Pisces 4-2672, 21°30'51"N, 167°56'22" W (Necker Ridge), 1793 m, 15 October 2011, 1 colony, USNM 1170790; Pisces 4-2638, 21°37'52"N, 167°49'02"W (Necker Ridge), 1746 m, 14 October 2011, 1 branch, USNM 1171059. Type Locality: EX1606-6-03: 19.4447°N, 165.79899°E (Unnamed Seamount, northwest of Wake Island), 2073 m, 6 August 2016.

Material Examined. Types.

Description. Only the distal 14.5 cm (27 whorls) of the holotype colony was collected, but *in situ* photographs of the type show it to be an unbranched colony approximately 77 cm in length (Fig. 1P). The color of the colony is white. The whorls are arranged in relatively closely spaced (1.8–2.0 polyps/cm) whorls of four polyps each; the whorl diameter is about 5 mm. The horizontal length of contracted polyps is 4.4–5.0 mm. Polychaete commensalism was not noted.

The basal body wall scales are 1.8–1.9 mm in height, the distal margin serrate (but with rounded apices) and extend only slightly past the proximal portion of the medial scales (Figs. 14A, C). The dorsolateral edge of the basal scales are rounded; none of the body wall scales are ridged, all having a smooth to slightly granular outer face. The adaxial edges of the basal scales do not meet (open position, Fig. 14B). The medial body wall scales (Fig. 14D) are much smaller, only 1.1–1.3 mm in length. The buccal scales (Fig. 14E) are the largest of the body wall scales, up to 2.4 mm in length and also having a slightly wavy distal edge. The ratio of major body wall scales is: 1: 0.65: 1.2, the buccal scales being larger than the basals. There is one pair of square adaxial body wall scales (Fig. 14F), each measuring about 0.5 mm to a side, below which the polyp is naked. All body wall scales are quite thin and thus fragile and often were often broken in collection.

The abaxial opercular scales are symmetrical, up to 2.0 mm in length, with an L:W of about 1.4, often having a bifid tip. The lateral opercular scales are asymmetrical, 1.5–2.3 mm in length, having an L:W of 2.1–2.3; some of the lateral operculars also have a bifid tip. The adaxial operculars are the smallest and most slender, being symmetrical, only 1.5–1.8 mm in length, and having an L:W of 2.5–3.5. All opercular scales (Fig. 14G) have a highly concave outer surface.

The coenenchymal scales (Fig. 14H) are elongate (up to 1.5 mm in length, with an L:W ranging from 3.5–6.0), thin and imbricate. Most coenenchymals bear one tall longitudinal ridge on their outer surface.

Comparisons. Only two of the 27 known species of *Narella* that lack a dorsolateral ridge have unbranched colonies, the other species being *N. versluysi* (Hickson, 1909) (Amphi-Atlantic, 550–3100 m). *Narella calamus* differs from *N. versluysi* in having a serrate edge to their basal scales and much longer polyps. *Narella calamus* and *N. macrocalyx* have the longest polyps in the genus.

Remarks. The fragility of the corallum may be associated with the depth of capture, deep-living primnoid taxa often having thin scales and thus brittle polyps, which are prone to damage when collected.

Distribution. Off Wake Island, Johnston Atoll, and Necker Ridge, 1746–2073 m.

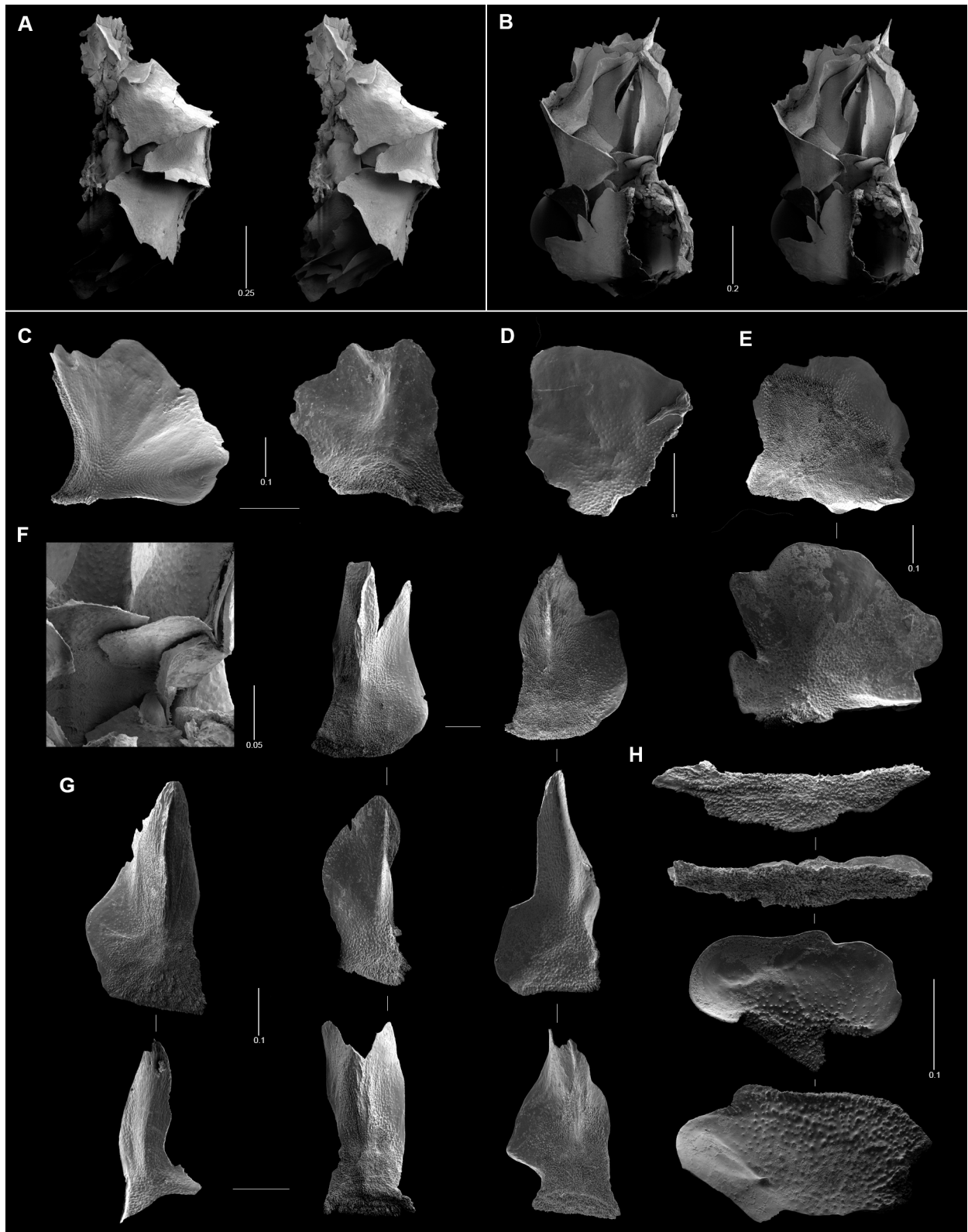


FIGURE 14. *Narella calamus*, holotype: **A–B**, stereo views of lateral and adaxial sides of polyp. **C**, basal scales. **D**, medial scale. **E**, buccal scales. **F**, adaxial buccal scales, *in situ*. **G**, opercular scales. **H**, coenenchymal scales. Scale bars in mm.

Narella horrida (Versluys, 1906)

Figs. 1N, 15A–L

Stachyodes horrida Versluys, 1906: 101–103, pl. 8, fig. 24, figs. 129–133.—Kükenthal, 1919: 465; 1924: 315.

Narella irregularis Kinoshita, 1907: 233; 1908: 49–51, pl. 3, figs. 23–24, pl. 6, fig. 52.

Narella horrida: Cairns & Bayer, 2007: 86; 2009: 30.

Types and Type Locality. The holotype of *S. horrida* consists of a small colony and several branch fragments, deposited at Naturalis (ex ZMA Coel. 3423), and a fragment is also deposited at NMNH (USNM 1097264). Type Locality: *Siboga* 252, 5°28.4'S, 132°0.2'E (off Kei Island, Banda Sea, Indonesia), 204 m.

The type of *S. irregularis* is untraced. Type Locality: west of Satsuma, Japan, depth unknown.

Material Examined. Holotype: a single colony now in six pieces, and SEM stubs 2487-2492, 2530-2531, EX1703-2-03, 7.1926°S, 173.6361°W (off Pao Pao, Tokelau Islands), 327 m, USNM 1453686.

Description. The figured specimens (Fig. 1N) consist of about a dozen (entire colony not collected) unbranched branches, all but one of which originate from a common basal calcareous encrustation about 3 mm in thickness; one bifurcates a branch 1 cm above the encrustation. The longest of the individual branches are about 10 cm in length, altogether producing a small bushy colony. The polyps are evenly spaced at about 3 per cm, each whorl having five or six polyps, space on one side of each branch occupied by a rather large (up to 2.5 mm in diameter) polychaete worm tube produced by the lateral extensions of contiguous basal scales. The whorl diameter is 7–9 mm. The horizontal length of a contracted polyp is 3.0–3.4 mm.

The basal body wall scales are quite tall (up to 4.3 mm in height) and thick (massive), the distal third to half of the scale constituting a flattened spine (Fig. 15B–D, E). The dorsolateral edge of the basal scales are rounded (not ridged) and it, as well as all other body wall and coenenchymal scales, is uniformly granulated. The basal scales are closed in the adaxial position, but the medial and buccals are open. The medial body wall scales are narrower (Fig. 15F), also massive, but rarely more than 2 mm in length, and also bear one or two elongate distal spines, these spines circular in cross section. The buccal scales are not massive (Fig. 15G), 1.5–1.7 mm in length, and have a rounded distal edge that forms a cowl (Fig. 15J) around the opercular crown. The ratio of the length of the body wall scales is thus approximately: 1:0.54: 0.46. The adaxial side of the polyp is mostly covered with three or four pairs of thin, flat, elliptical scales, the greater axes ranging from 0.24–0.41 mm.

The abaxial opercular scales are symmetrical, measuring up to 1.3 mm in length (L:W = about 1.9). The asymmetrical laterals are 0.85–1.1 mm in length (L:W = 1.8–2.2). The small adaxial operculars are about 0.9 mm in length and have an L:W of about 2.6.

The coenenchymal scales (Figs. 15K–L) are irregular to elongate in shape, massive (thick, up to 0.08 mm), and non-imbricate. Most are about 0.6–0.7 mm in greater length, but some are as long as 1.1 mm.

Comparisons. *Narella horrida* is easily distinguished from the other 26 species of *Narella* having rounded dorsolateral edge of the basal scales, by having prominently spinose basal and medial body wall scales. It belongs to a group of species having massive basal body wall scales and mosaic, non-imbricate coenenchymal scales.

Remarks. The *Okeanos* specimen differs from the type in having slightly larger polyps (3.0–3.4 mm vs 2.0 mm) and thus a larger whorl diameter, and in having a primarily unbranched colony, that of the type of *N. horrida* being sparsely branched. Since all other characters are similar and at least one of the branches of the *Okeanos* specimen is branched, it is likely that they are conspecific. This would appear to be the first report of this species subsequent to its description in 1906.

Distribution. Banda Sea, Indonesia; Tokelau Islands; off Japan, 204–327 m.

Narella aurantiaca, n. sp.

Figs. 1K–L, 16A–K

Etymology. Named *aurantiaca* (Latin for orange colored), in allusion to the orange color of the colony and its commensal ophiuroids.

Types and Type Locality. The holotype, now in three parts, and SEM stubs 2411-2415, USNM 1424215. Paratype: EX1708-12-05, 30.440°N, 164.01°W (Mussorgsky Seamount, Musicians Seamounts), 1983 m, fragments of a colony, USNM 1467597; FK17-358, 3°35.702'S, 174°9.265'W (off Nikumaroro, Phoenix Islands), 1112 m, 27

October 2017, 1 colony, Temple University. Type Locality: EX1606-8-01: 19.3304°N, 166.6038°E (northwest of Wake Island), 745 m, 10 August 2016.

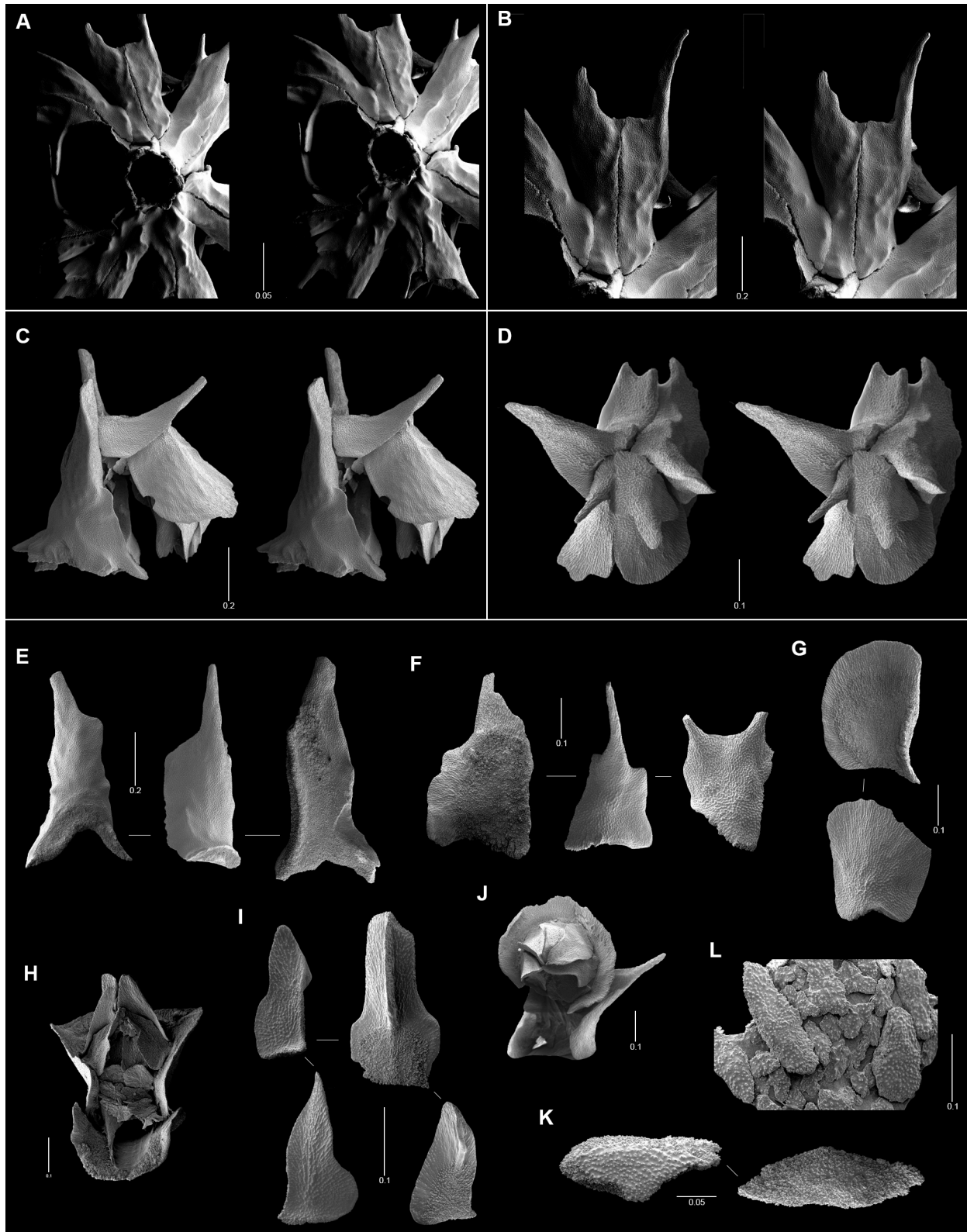


FIGURE 15. *Narella horrida*, USNM 1453686: **A**, adaxial stereo view of polyp whorl and worm tube. **B**, stereo view of basal scales. **C–D**, stereo views of lateral and abaxial sides of a polyp. **E**, basal scales. **F**, medial scales. **G**, buccal scales. **H**, adaxial buccal scales *in situ*. **I**, opercular scales. **J**, operculum surrounded by buccal cowl. **K**, coenenchymal scales. **L**, coenenchymal scales, *in situ*. Scale bars in mm.

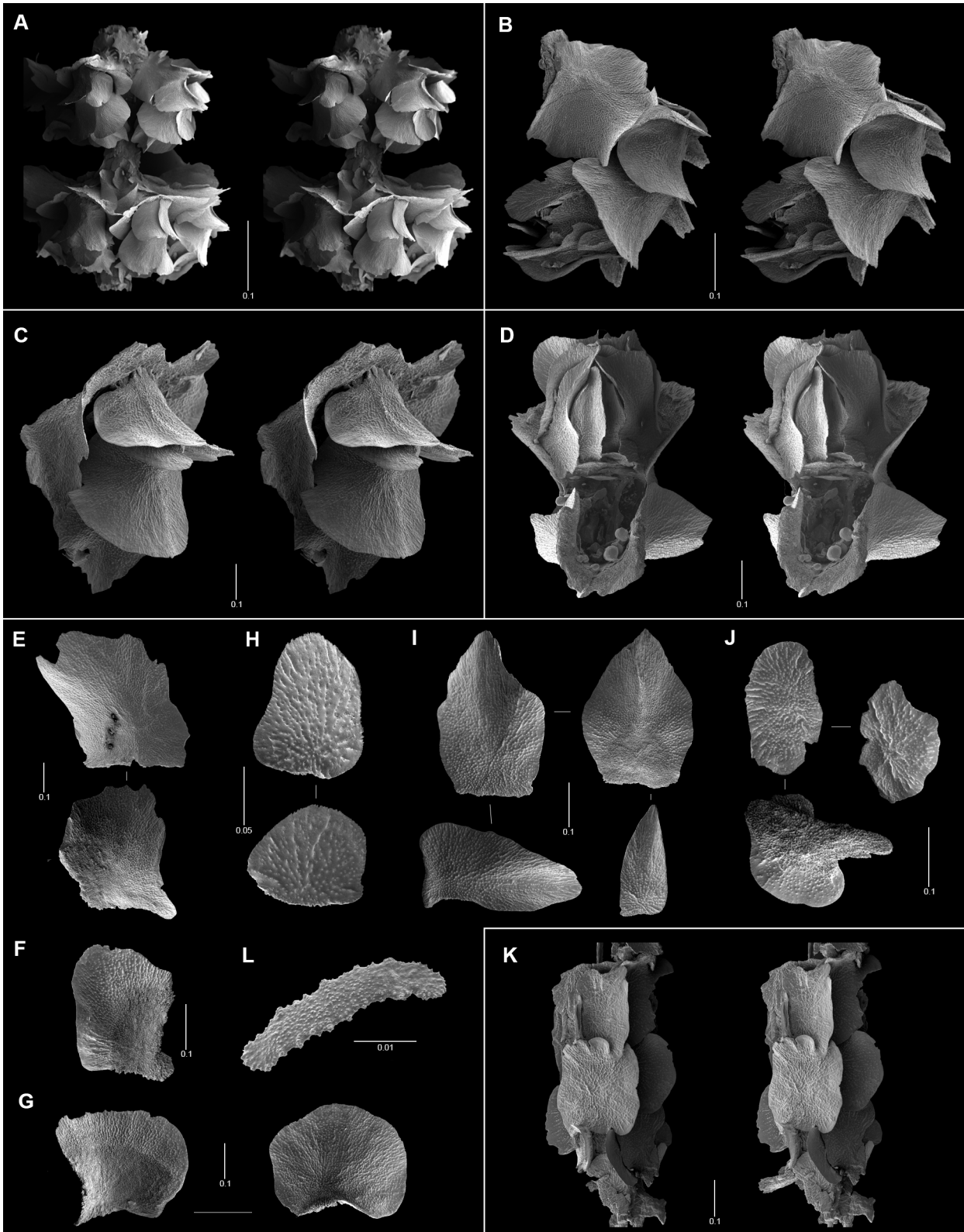


FIGURE 16. *Narella aurantiaca*, holotype: **A**, stereo view of two polyp whorls. **B–D**, stereo views of lateral, oblique abaxial, and adaxial sides of a polyp. **E**, basal scales. **F**, medial scale. **G**, buccal scales. **H**, adaxial buccal scales. **I**, opercular scales. **J**, coenenchymal scales. **K**, stereo view of interlocking coenenchymal scales. Scale bars in mm.

Material Examined. Types.

Description. The holotype was collected intact, measuring 21 cm in height and 11 cm in width, with a calcified basal stem 3.9 mm in diameter; the colony is uniplanar. Branching is sparse and equal-dichotomous, with quite long terminal branches up to 18 cm in length; most branching occurs near the base of the colony (Fig. 11L). The color of the colony is white to pale orange. The polyps are arranged in moderately closely spaced (3–3.5/cm) whorls of four to six polyps; the whorl diameter ranges from 6.5–7.0 mm. The horizontal length of mature polyps is 2.8–3.2 mm in their contracted position.

The basal scales (Fig. 16B, E) stand perpendicular to the branch and are up to 2.9 mm in height, the distalmost 0.65–0.70 mm projecting as a cowl encircling its attachment to the proximal edge of the medial scales (Fig. 16C), their edge being smooth (i.e., not serrate or spinose). The dorsolateral edge of the basal scale is rounded and does not bear ridges; none of the body wall scales are ridged, but all are covered with a low granulation. The adaxial edges of the basal scales do not meet (open position, Fig. 16D). When a polychaete commensal is present (usually only near the base of the colony), the basolateral edges of adjacent buccal scales are modified (reflected) to form a circular worm tube about 1.1 mm in diameter. The medial scales are much shorter (1.2–1.3 mm in length) and narrower, having a highly concave outer surface. The broad buccal scales are up to 1.9 mm in length, forming a cowl around the opercular scales. The distal edges of all body wall scales are rounded (not serrate or spinose). The ratio of the major body wall scales is approximately: 1: 0.44: 0.65. There is one pair of elliptical adaxial buccal scales (Figs. 16D, H), measuring 0.4–0.6 mm in greater diameter, the lower adaxial portion of the polyp being naked.

The abaxial opercular scales are symmetrical, 1.6–1.8 mm in length, and have an L:W of about 1.4. The outer and inner lateral operculars are similar in size and shape, 1.3–1.7 mm in length, slightly asymmetrical, and have an L:W of about 2.1. The adaxial operculars are the smallest, only 1.1–1.3 mm in length, symmetrical, and have an L:W of about 2.3.

There are two types of coenenchymal scales. Some are roughly rectangular, up to 1.5 mm in greater width, thin, and flat (unridged), having several thin, shallow notches or indentations on their edges, which gives them an irregular outline (Fig. 16J). The second type is roughly the same size and shape but bears tall vertical ridges that fit into the peripheral notches of the other type of scale (Fig. 16K) thus forming an interlocking structure that inhibits lateral movement of the scales.

Pinnular scales are about 0.17 mm in length and 0.03 mm in width, flat, and slightly curved (Fig. 16L).

Comparisons. Among the 27 species of *Narella* that lack dorsolateral ridges on the basal scale, *N. aurantiaca* is morphologically most similar to *N. ambigua* (Studer, 1894), a species known only from the Galápagos and off Panama at 702–1463 m (Cairns 2018). It differs in having only one pair (not four) of adaxial body wall scales, and in having ridged interlocking coenenchymal scales, the latter character unique to this species. *Narella aurantiaca* is also similar to *N. leilae* Bayer, 1951, known from Indonesia at 740 m, but differs by having larger polyps, rounded (not serrate) buccal and basal scales, and in having interlocking coenenchymal scales.

Remarks. Two orange ophiuroids were attached to the holotype.

Distribution. Off Wake Island, Phoenix Islands, and Mussorgsky Seamount, 745–1983 m.

Genus *Paracalyptrophora* Kinoshita, 1908

Calyptrophora (*Paracalyptrophora*) Kinoshita, 1908: 58.

Paracalyptrophora: Bayer, 1981: 937, 946.—Cairns & Bayer, 2004a: 115 (key to species); 2009: 44 (more complete synonymy).—Cairns, 2016b: 91.

Type Species. *Calyptrophora kerberti* Versluys, 1906, by subsequent designation (Cairns & Bayer 2004a)

Diagnosis. Colonies uniplanar, biplanar, or bushy, usually dichotomously branched or lyrate. Polyps arranged in whorls, the polyps directed downward. Body wall covered with two pairs of discrete (unfused) scales (the basals and buccals) that encircle the polyp, one or two pairs of infrabasals, and sometimes large adaxial buccal scales. Inner surface of basal scales attach to buccal scales by a discontinuous articulating ridge. Inner surface of opercular scales keeled. Coenenchymal scales irregular in shape, usually elongate, and often granular and/or ridged.

Remarks. Because the basal scales are paired (not fused), the articular ridge occurs on the inner subdistal side of each basal scale just beneath the basal spine or tooth, and thus the ridge is discontinuous, unlike in the genus

Calyptrophora where the basal scale is a single scale and thus the articular ridge is continuous across the sagittal plane.

Discussion. Including the new species described herein, there are nine species in the genus, most of which are keyed by Cairns & Bayer (2004a).

In the course of scoring the various species for a tabular key to the species of *Narella* (Cairns & Taylor in prep.), it was noted that the distal edges of the basal scales of *N. mesolepis* Cairns, 2012 have a distinct discontinuous articulating ridge. This character is used herein to help distinguish the genera *Calyptrophora* and *Paracalyptrophora*, both of which have an articulating ridge, from *Narella*, which does not. *Narella mesolepis* differs from both *Calyptrophora* and *Paracalyptrophora* in having three tiers (pairs) of body wall scales (the other two genera having only two scales or two pairs or scales). Furthermore, *N. mesolepis* differs from those two genera in having one or two unpaired medial infrabasal scales and lacks ridges on the inner surface of its opercular scales. It differs from *Narelloides* Cairns, 2012), another genus with a basal articular ridge and unpaired infrabasal scales, in having downward projecting polyps, only one pair of medial body wall scales, unkeeled opercular scales, and only four (not six) marginal scales. Finally, it differs from *Narella*, as stated previously in having an articulating ridge, one or two unpaired medial infrabasal scales, and unkeeled opercular scales. These genera were compared by Cairns (2012: Table 2). It is thus suggested that *N. mesolepis* represents a heretofore undescribed genus for which the name *Pseudonarella* is proposed. It may be diagnosed as a primnoid having unbranched colonies, polyps arranged in whorls, and polyps that face downward. Each polyp is covered with three pairs of abaxial body wall scales (one pair of basals, one pair of medials, and one pair of buccals) and one pair of adaxial scales. The distal edge of the basal scales bears a discontinuous articular ridge. One or two large unpaired medial infrabasal scales are present. Its opercular scales not keeled on their inner surface. Coenenchymal scales thin, imbricate and ameoboid in shape, the outer surface being unridged. The type species is *Narella mesolepis* Cairns, 2012, a species known from off northern New Zealand at 157–1246 m.

Distribution. Southwestern Pacific (Lord Howe Island, Phoenix Islands, American Samoa), Japan, Hawaiian Islands, North Atlantic, 150–1480 m.

***Paracalyptrophora hawaiiensis* Cairns, 2009**

Figs. 1T, 17A–E

Paracalyptrophora hawaiiensis Cairns, 2009: 416–420, figs. 1J, 4–5.

Paracalyptrophora hawaiiensis: Cairns, 2016b: 94, figs. 46D, 54–55.

Types and Type Locality. The holotype (USNM 1071425) and paratypes are deposited at the NMNH. Type Locality: 18°42'35"N, 158°15'19"W (near Cross Seamount, Hawaii), 367 m.

Material Examined. EX1703-2-1, 7.19°S, 173.64°W (Pao Pao, Tokelau Islands), 464 m, 9 unbranched distal branch fragments from same colony, and SEM stubs 2510-2514, USNM 1453680; EX1702-2-2, 14.29°S, 169.5°W (off American Samoa), 448 m, 10 unbranched branch fragments from same colony, USNM 1453585; FK17-90, 3°44.030'S, 170°43.131'W (off Rawaki Island, Phoenix Islands), 601 m, 17 October 2017, 1 colony, Temple University.

Remarks and Comparisons. This species was adequately described and figured by Cairns (2009) and thus will not be redescribed or fully figured herein. As noted by Cairns (2009), *P. hawaiiensis* is similar to *P. echinata* Cairns, 2009, a species also known from the Hawaiian Islands but generally found in deeper water. Although the specimens reported herein are slightly different from the type series (i.e., their polyps are slightly larger and their coenenchymal scales bear low ridges), they are otherwise consistent with *P. hawaiiensis*, and differ from *P. echinata* in usually having a pair of prominent adaxial buccal scales (each up to 0.6 mm in diameter), smaller basal spines, a bushy colony (not uniplanar), and in having long distal branches (up to 13 cm). Although the types were described as being uniplanar, it is clear even from the holotype that additional flabellate branches overlapped the primary, and the specimens collected herein show that as the colony grows larger (e.g., USNM 1453680, 60 cm tall and 88 cm in width) it becomes bushy (Fig. 1T) and has long distal end branches. That colony was also host to several crinoids and an orange-striped galatheid crab, matching the color of the colony (Fig. 1T).

These records partially fill a void between the two previously known occurrences of the species from Hawaii and Lord Howe Rise, indicating that it may be a widespread species in the southwest Pacific.

Distribution. Southeast Hawaiian Islands (Cairns 2009), southern Lord Howe Rise (Cairns 2016b), Tokelau Islands, Phoenix Islands, American Samoa, 320–970 m.

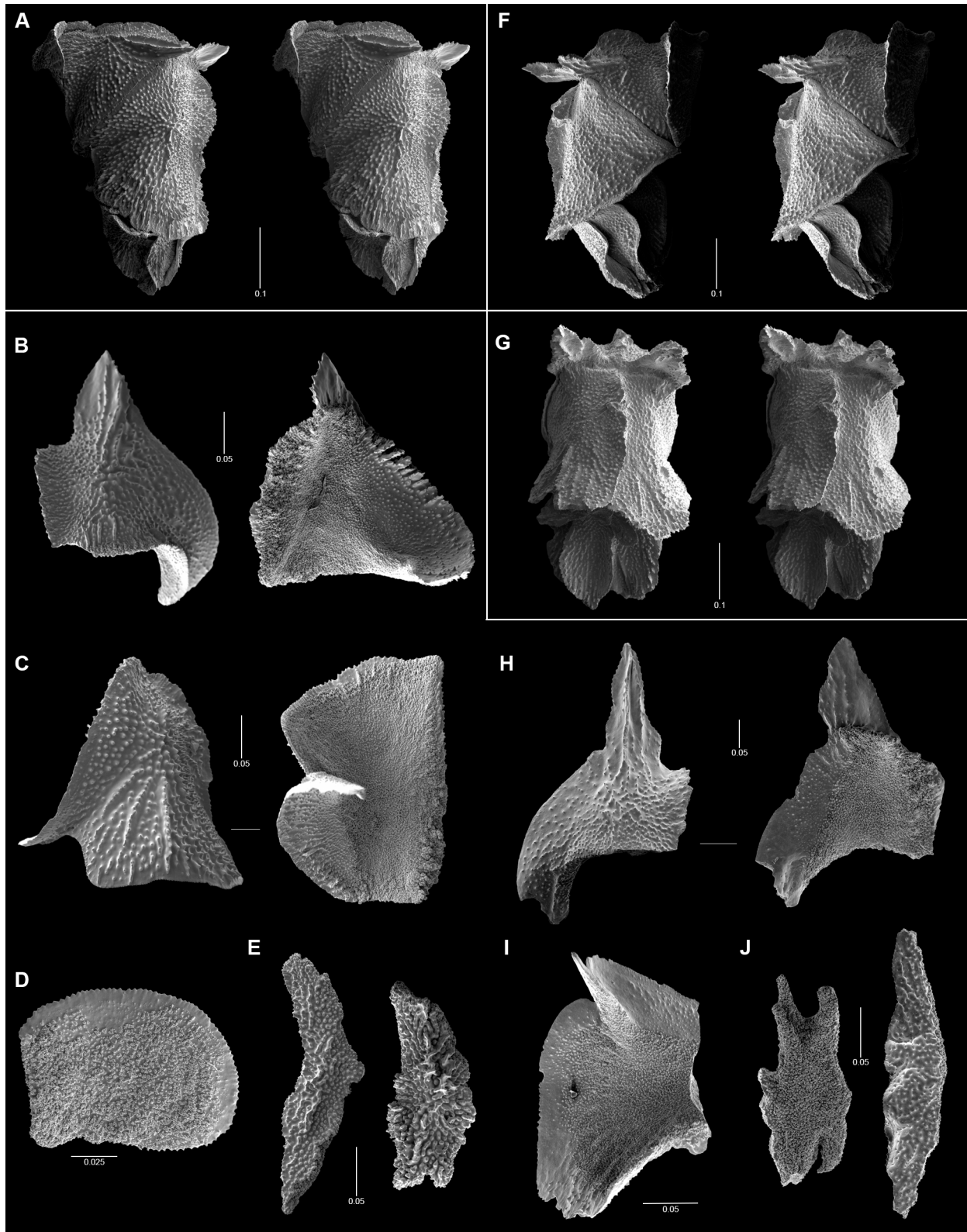


FIGURE 17. A–E (*Paracalyptophora hawaiiensis* from USNM 1453680): A, lateral stereo view of polyp. B, basal scales. C, buccal scales. D, adaxial buccal scale. E, coenenchymal scales. F–J (*P. echinata* from USNM 1453739). F–G, stereo views of lateral and abaxial sides of a polyp. H, basal scales. I, buccal scale. J, coenenchymal scales. Scale bars in mm.

Paracalyptrophora echinata Cairns, 2009

Figs. 1U, 17F–J

Paracalyptrophora echinata Cairns, 2009: 414–416, figs. 1C, 2–3.

Types and Type Locality. The holotype (USNM 1115283) and paratypes are deposited at the NMNH. Type Locality: 24°16.369'N, 166°2.132'W (Brooks Bank, Northwest Hawaiian Islands), 708 m.

Material Examined. EX1703-10-1, 0.835°N, 176.63°W (near Howland Island), 545 m, 1 colony and SEM stubs 2515-2518, USNM 1453739.

Remarks and Comparisons. This species was adequately described and figured by Cairns (2009) and thus will not be redescribed or fully figured herein. *Paracalyptrophora echinata* is similar to *P. hawaiiensis*, as discussed in the previous account of that species, but differs primarily in lacking adaxial buccal scales. That region is instead covered by an adaxial process of the large abaxial buccal scales. Furthermore, *P. echinata* differs in having a uniplanar colony (Fig. 1U) (not bushy), shorter distal branches, and taller basal spines (Figs. 17F–H).

This is the first record subsequent to its original description, and extends its known distribution from Hawaii to Howland Island, and its depth range from a minimum of 708 to 545 m.

Distribution. Northwest Hawaiian Islands from Brooks Bank to Nihoa (Cairns 2009), Howland Island, 545–1475 m.

Paracalyptrophora spiralis, n. sp.

Figs. 1V, 18A–K

Etymology. Named *spiralis* (Latin for coiled, spiral or twisted) in allusion to the spirally coiled nature of the secondary branches of the colony.

Type and Type Locality. Holotype: colony and SEM stubs 2519-2521, 2527, USNM 1453670. Type Locality: EX1702-13-01: 14.32°S, 170.65°W (off Tutuila, American Samoa), 345 m.

Material Examined. Types.

Description. The holotype, now in four pieces, consists of an elongate basal stem about 20 cm in length, which bifurcates, each secondary branch giving rise to a series of branchlets on one side of the secondary; the two secondary branches ascend in a loose spiral. The branchlets are up to 9 cm in length and often bifurcate once. Thus, the branching can be described as lyrate, followed by dichotomous terminal branchlets; colony flaccid (not stiff). Most of the holotype was collected (Fig. 1V), the entire colony measuring about 40 cm in height. The whorls are widely spaced (four whorls per cm), each whorl having three (sometimes two) polyps (Fig. 18A), all of which point downward; the whorl diameter is 2.2–2.3 mm. The horizontal length of a contracted polyp is 1.6–2.0 mm.

The basal body wall scales are 0.9–1.1 mm in height and terminate in a straight-edged (about 0.20–0.25 mm in width), short (about 0.07 mm in height) extension, the inner face constituting the articular ridge (Figs. 18D–E). The outer surface of the basals, and all other body wall and coenenchymal scales, bear low granules (not ridged). The buccal body wall scales (Fig. 18F) are slightly longer (1.1–1.3 mm), terminating in a rounded to slightly undulating distal margin. The adaxial side of both the basal and buccals are quite open. Most polyps have one pair of curved infrabasal scales (Figs. 18G–H), 0.25–0.30 mm in height, but polyps often lack these scales. Four large (greater axis 0.3–0.45 mm) elliptical adaxial buccals occur below the two adaxial and outer lateral opercular scales and another pair occur below these (Figs. 18C, I).

All of the opercular scales (Fig. 18J) are isosceles triangles and quite elongate, having a high L:W ratio. The abaxial operculars are up to 1.1 mm in length, having an L:W of 2.5–2.6. The lateral operculars measure 0.85–0.95 mm in length, with an L:W of 2.6–2.7. The adaxial operculars are only 0.65–0.75 mm in length, with an L:W of 2.8–2.9.

The coenenchymal scales (Fig. 18K) are elongate (L:W = 3.3–4.6), thin, slightly imbricate, and flat, their distal ends rounded.

Comparisons. *Paracalyptrophora spiralis* is unique among the nine known species in the genus in its branching form (uniplanar/spiral: lyrate followed by dichotomous). It is also distinctive in having so few polyps per whorl (usually three), most other species having four or more. It also has a very open adaxial polyp side, allowing at least six large adaxial body wall scales to cover this region, and it has very small distal extensions on its basal scales.

Distribution. Known only from type locality.

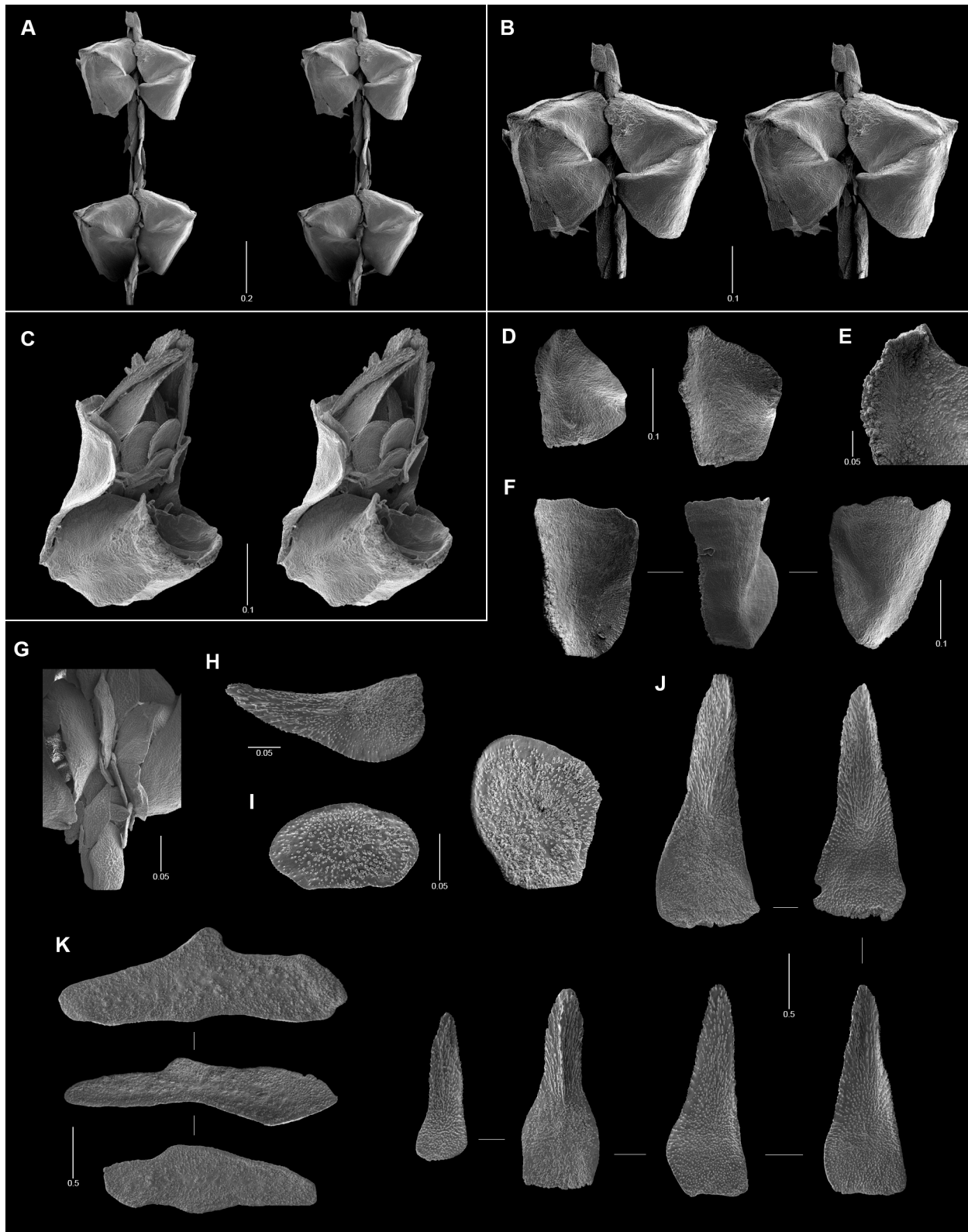


FIGURE 18. *Paracalyptophora spiralis*, holotype. **A**, stereo view of two polyp whorls. **B**, stereo view of one polyp whorl. **C**, stereo view of adaxial side of polyp showing adaxial buccal scales. **D–E**, basal scales. **F**, buccal scales. **G**, infrabasal scales, *in situ*. **H**, infrabasal scale. **I**, adaxial buccal scales. **J**, opercular scales. **K**, coenenchymal scales. Scale bars in mm.

Genus *Plumarella* Gray, 1870

Plumarella Gray, 1870: 36.—Kükenthal, 1919: 144–145 (key to species).—Bayer & Stefani, 1898: 454 (key to genus).—Cairns & Bayer, 2009: 3940, figs. 11K–S.—Cairns, 2011: 7–9; 2016b: 51–52.—Cairns & Wirshing, 2018:1, 11.

Type Species. *Gorgonia penna* Lamarck, 1815, by subsequent designation (Wright & Studer 1889: 73).

Diagnosis. Colonies uniplanar, usually pinnately branched, but may be dichotomous. Polyps usually arranged in alternating biserial fashion or isolated (random order). Polyps covered with eight longitudinal rows of body wall scales, those on the adaxial side sometimes smaller and fewer in number. The eight marginal scales do not fold over the operculum and thus usually do not have a keel on inner surface. Distal margin of marginal scales straight, pointed, serrate, or spinose. Inner face of opercular scales usually smooth (not keeled).

Discussion. Based on molecular evidence, Cairns & Wirshing (2018) recently elevated to genus level two of the four subgenera in *Plumarella* and collapsed the other two into one genus, *Plumarella* ss, which now has no subgenera and consists of 33 species.

Distribution. Central, north, and western Pacific, Patagonia, New Zealand, northwestern Atlantic, 10–3182 m.

Plumarella circumoperculum Cairns, 2010

Fig. 1W

Plumarella circumoperculum Cairns, 2010: 422–425, figs. 1C, 6–7 (synonymy).

Types and Type Locality. The holotype (USNM 1072129) and paratypes are deposited at the NMNH. Type Locality: 23°14'24"N, 163°31'21"W (Blank Bank, Northwest Hawaiian Islands), 1373 m.

Material Examined. EX1603-2-03, 23°56'45"N, 166°02'W (French Frigate Shoal, Northwest Hawaiian Islands), 1221 m, colony fragment, USNM 1424051.

Remarks. This species was adequately described and figured in the original description (Cairns 2009) and thus will not be redescribed, discussed, or fully figured herein. The *Okeanos* site of collection is also just kilometers from previously collected specimens. The only addition to the knowledge of this species is by providing an *in situ* photograph of the living colony, which measures about 25 cm in width (Fig. 1W).

Distribution. Northwest Hawaiian Islands between Brooks Bank and Blank Bank, 432–1373 m.

Genus *Thouarella* Gray, 1870

Thouarella Gray, 170: 45.—Wright & Studer, 1889: 59–61.—Cairns, 2010: 415.—Taylor, *et al.*, 2013: 20–21 (monograph of genus, including key to all species).—Cairns & Wirshing, 2018: 11.

Thouarella (*Thouarella*) Cairns & Bayer, 2009: 33.

Type Species. *Primnoa antarctica* Valenciennes, 1846, by monotypy.

Diagnosis. Colonies bottlebrush in shape or uniplanar, the latter branched dichotomously or pinnately. Polyps isolated on branches (nominated subgenus) or arranged in pairs or whorls (subgenus *Euthouarella*). Polyps protected by 6–8 rows of body wall scales, the 2 adaxial rows having smaller and fewer scales, especially near base of polyp. Marginal scales capable of folding over operculum, arranged in two circles of four scales. Marginals have a prominently keeled inner surface.

Discussion. The genus was monographed by Taylor *et al.* (2013), in which all species were described, illustrated and keyed. They divided the genus into two groups: group 1 having isolated polyps, group 2 having polyps arranged in pairs or whorls. Cairns & Wirshing (2018) resurrected subgeneric names for these two group names. The genus currently consists of 32 species, and, although worldwide in distribution, is concentrated in the Subantarctic and Antarctic regions.

Distribution. Worldwide, 11–6400 m.

***Thouarella (Euthouarella) hilgendorfi* (Studer, 1878)**

Fig. 1X

Plumarella hilgendorfi Studer, 1878: 648–649, pl. 2, figs. 15a–e.

Thouarella hilgendorfi: Versluys, 1906: 24–29, pl. 2, fig. 7.—Taylor, *et al.*, 2013: 76–77 (synonymy, but no illustrations, Group 2).—Taylor & Roger, 2015: 193.

Thouarella (Euthouarella) hilgendorfi: Cairns & Bayer, 2009: 28.—Cairns, 2010: 417–422, pl. 2, figs. 1D, 4–5 (complete synonymy and description).

Type and Type Locality. The holotype is deposited in the Zoologisches Museum, Berlin (2070). Type Locality: Tokyo Bay, 548 m.

Material Examined. EX1605-L1-17, 16.134°N, 146.082°E (northern Mariana Islands), 284 m, 8 May 2016, image only.

Remarks. This species was adequately described and figured by Cairns (2010) and is only known from images (no collected specimens) in this report, and thus will not be fully redescribed or figured herein. Cairns & Wirshing (2018) recently resurrected the subgenus *Euthouarella* for those species having their polyps arranged in pairs or whorls.

Distribution. A widespread species, occurring throughout the Indo-West Pacific and central Pacific, 164–750 m.

TABLE 1. Central Pacific (CAPSTONE) *Okeanos Explorer* primnoids. (*species not described herein because well described previously; ** species not described because only images are available)

Callogorgia cracentis, n. sp.

Calyptrophora lyra, n. sp.

**Calyptrophora diaphana* Cairns, 2012

Calyptrophora carinata, n. sp.

**Calyptrophora clarki* Bayer, 1951

Calyptrophora pourtalesi, n. sp.

Calyptrophora distolos n. sp.

***Candidella gigantea* (Wright & Studer, 1889)

Macroprimnoa ornata, n. gen., n. sp.

Narella ferula, n. sp.

**Narella hawaiiensis* Cairns & Bayer, 2007

**Narella macrocalyx* Cairns & Bayer, 2007

Narella merga, n. sp.

Narella fordi, n. sp.

Narella virgosa, n. sp.

Narella calamus, n. sp.

Narella horrida (Versluys, 1906)

Narella aurantiaca, n. sp.

**Paracalyptrophora hawaiiensis* Cairns, 2009

**Paracalyptrophora echinata* Cairns, 2009

Paracalyptrophora spiralis, n. sp.

**Plumarella circumoperculum* Cairns, 2010

***Thouarella hilgendorfi* (Studer, 1878)

Deep-water (abyssal) Octocorallia

Cairns (2016) listed the 39 species of Octocorallia that had been collected deeper than 3000 m. The *Okeanos* collected three more species below that depth, and seven more have been discerned since 2016. Thus an updated table is provided below (Table 2), showing the additional ten octocorallian taxa that are known to occur deeper than 3000 m. Primnoid species are still the largest component, accounting for 55% of the total, followed by the Isididae, Chrysogorgiidae, and pennatulaceans, each with 14%, and one species is in Clavulariidae, for 2%.

TABLE 2. Additional (updated from Cairns 2016) octocorallian species known from deeper than 3000 m. Species treated herein in bold face.

Species Name	Family	Greatest Depth (m)
<i>Bathygorgia abyssicola</i> Lapointe & Watling, 2015	Isididae	3950
<i>Calyptrophora distolos</i> , n. sp.	Primnoidae	3737
<i>Macroprimnoa ornata</i> , n. sp.	Primnoidae	3676
<i>Calyptrophora carinata</i> , n.sp.	Primnoidae	3659
<i>Radicipes stonei</i> Cordeiro, Cairns & Perez, 2017	Chrysogorgiidae	3580
<i>Radicipes verrilli</i> (Wright & Studer, 1889)	Chrysogorgiidae	3429
<i>Callozostrom carlottae</i> Kükenthal, 1909	Primnoidae	3397
<i>Narella alaskensis</i> Cairns & Baco, 2007	Primnoidae	3075
<i>Bathygorgia tasmaniensis</i> Lapointe & Watling, 2015	Isididae	3065
<i>Telesto rigida</i> Wright & Studer, 1889	Clavulariidae	3065

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