

# ZOOTAXA

3823

## Taxonomic review of Hadromerida (Porifera, Demospongiae) from British Columbia, Canada, and adjacent waters, with the description of nine new species

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Magnolia Press  
Auckland, New Zealand

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(*Zootaxa* 3823)

84 pp.; 30 cm.

26 Jun. 2014

ISBN 978-1-77557-429-3 (paperback)

ISBN 978-1-77557-430-9 (Online edition)

FIRST PUBLISHED IN 2014 BY

Magnolia Press

P.O. Box 41-383

Auckland 1346

New Zealand

e-mail: [zootaxa@mapress.com](mailto:zootaxa@mapress.com)

<http://www.mapress.com/zootaxa/>

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ISSN 1175-5326 (Print edition)

ISSN 1175-5334 (Online edition)

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## Abstract

The history of sponge collecting and systematics in British Columbia is reviewed over the period 1878 to 1966. Recent additions and changes are provided in an on-line species list: [www.mareco.org/kml/projects/NEsponges.asp](http://www.mareco.org/kml/projects/NEsponges.asp). Hadromerids are the focus of this paper as eight of 19 species in British Columbia are considered new. An additional new species is described from southern California to clarify the status of *Tethya californiana* in BC. An update is timely for hadromerids in BC as there is new material and renewed interest, while existing descriptions are often inadequate. We describe new species and provide additions to previous descriptions for sponges of the order Hadromerida (Porifera: Demospongiae) in the cold temperate NE Pacific off British Columbia and adjacent waters. We propose one range extension and one new species in Clionaidae; two range extensions and five new species in Polymastiidae; one range extension, two name changes and two new species in Suberitidae; and one new species in Tethyidae. New species include *Pione giblaltarensis* n.sp., *Polymastia piscesae* n. sp., *Radiella endeavourensis* n. sp., *Sphaerotylus raphidophora* n. sp., *Sphaerotylus verenae* n. sp., *Weberella perlucida* n. sp., *Prosüberites saanichensis* n. sp., *Suberites lambei* n. sp., and *Tethya vacua* n. sp..

**Key words:** taxonomy, NE Pacific, Clionaidae, Polymastiidae, Suberitidae, Tethyidae

## Introduction

George M. Dawson, working for the Geological Survey of Canada, was the first naturalist to make significant collections of sponges in British Columbia. He surveyed the coastline and shallow waters of Haida Gwaii (Queen Charlotte Islands) in 1878 and the Strait of Georgia and outer coast of Vancouver Island in 1885 (Whiteaves 1886, Bernard *et al.* 1967). Lawrence Lambe (1893a, 1893b, 1895), also with the Geological Survey of Canada, described 24 new species and an additional eight records from Dawson's collections.

The U.S. Fish Commission Steamer *Albatross* dredged along the coasts of South, Central and North America, from the Galapagos Islands to the Bering Sea over the period 1888 to 1914. However, within British Columbia and adjacent waters, the only demosponges described from *Albatross* stations were members of the Geodiidae (Lendenfeld 1910).

Several other expeditions brought marine biologists to the west coast. Columbia University mounted an expedition expressly to examine the Puget Sound area. Bristol & Dean (1897) commented that 12 to 14 species of sponges were collected by Calkins. Calkins (1897) commented that he reported these at a meeting of the New York Academy of Science. However, the results were apparently not published, and the collections have been lost (Bakus 1966). The Harriman Alaska Expedition (1899) took a number of specialists on a two month trip from Prince Rupert (BC) to Nome (Alaska), but did not produce a publication on the sponges. More than a half century later, a short paper published posthumously briefly described 15 species of demosponges, two of which were regarded as new, from a 1931 collection in Puget Sound (de Laubenfels 1961). In the same region Bakus (1966) published more detailed descriptions of 23 species of poeciloscleridans including seven new species, all of which remain valid.

While publications on demosponges in British Columbia and adjacent waters have been very limited, publications on species recorded elsewhere, particularly in central California (e.g., de Laubenfels 1932, Ristau 1978), include many species also recorded in the British Columbia region.

The "Sponges of the cold temperate NE Pacific" on the Khojatan Marine Lab website (Austin *et al.* 2012) includes 237 demosponge species ranging from central California to Kodiak (Alaska) of which 194 species are recorded from British Columbia and adjacent waters. About 90 of these appear to be undescribed, or unknown from the NE Pacific.

The Hadromerida were selected for this paper for several reasons: 1) we had abundant material; 2) nine species appeared to be new; 3) some common species needed to be more clearly defined; 4) descriptions of all but five species predate the application of SEMs; 5) many hadromerids are misidentified by divers; and 6) there is a resurgence of interest in viewing deep water habitats where hadromerid sponges are often conspicuous. It is our hope that the descriptions together with field characters will improve recognition, but at the same time reveal where field characters are insufficient for identification at the species level.

Lambe (1893a, 1893b, 1895) discussed eight species of hadromerids, and his papers are frequently cited. We take this opportunity to note some problems in the publication dates of Lambe's papers. He published in three volumes of the Transactions of the Royal Society of Canada which were dated 1892 (vol. X), 1893 (vol. XI) and 1894 (vol. XII). However, as pointed out by Frank *et al.* (1985) these transactions were not published as volumes until the year following the stated date (which may have been the year that they were read to the Royal Society). To further complicate matters, separate copies of Lambe's paper in volume XI included the printed statement "Distributed November, 1893" with a handwritten notation below "Rec. 28-12-93", although the full volume was not published until 1894. According to the International Code of Zoological Nomenclature (1999) 21.8; "Before 2000, an author who distributed separates in advance of the specified date of publication of the work in which the material is published thereby advanced the date of publication". There is no printed indication that separates for vol. X and XII were similarly published in any particular year. We, therefore, cite Lambe's three papers in the Transactions dated 1892, 1893 and 1894, as Lambe 1893a, 1893b and 1895. Changes in publication dates for Lambe as author of new species are changed accordingly.

The order Hadromerida (Porifera: Demospongiae), including updates in this paper, is represented by four families and 20 species in British Columbia and adjacent waters. We discuss new species and range extensions in this region on the west coast of Canada.

## Material and methods

Specimens housed in the Khoyatan Marine Laboratory museum (KML) were largely preserved and maintained in 70% isopropyl alcohol. Some are dried. KML specimens were collected by hand in the intertidal, by SCUBA in the shallow subtidal, and by dredge, submersible (*PISCES IV, DELTA*) and ROV (*ROPOS*) in deeper water.

Specimens at KML from the Pacific Biological Station (PBS) were dredged. Hadromerids from the NE Pacific were also examined at Bamfield Marine Sciences Centre, Royal BC Museum, California Academy of Sciences, Allan Hancock Foundation, U.S. National Museum, Museum of Comparative Zoology, and the Canadian Museum of Nature. In some cases material was brought back to KML for more detailed study and to obtain SEM images.

Under material examined, for each lot we report: museum accession number, station number, location, latitude and longitude, depth, date of collection, collector, and number of specimens. Where geographic location was given but not latitude and longitude, we include them with the note “approximate”. We endeavoured to track down missing data but were not always successful. Sources for obtaining the coordinates include: Google Earth, Sailing directions BC Coast (North & South Portion), United States Coast Pilots (Pacific Coast #8, southern Alaska, and #7, California to Washington and Hawaii), BCGNIS (BC Geographical Names Information System), and CHS hydrographic charts.

For most species, colour photographs were taken in situ. In these cases scale bars are approximate. Photos taken together with specimens are assigned the same station number and accession number as those specimens. Photos without specimens are listed under Field Images as a third category in the material examined sections.

Thick sections of specimens with and without a dense cortex were made by excising approx. one cm<sup>3</sup> surface blocks and embedding these in 55–57°C melting point histological paraffin. After cooling to room temperature, the blocks were trimmed to either vertical or tangential orientation and re-warmed to 40°C for one hour to prevent cracking during sectioning. Warmed tissue blocks were set into a guiding jig and sectioned by hand with a straight razor at varied, but only marginally controllable thicknesses of between 0.1 and 1.0 mm. The best sections were deparaffinized in xylene and, of those, the best sections were mounted on microscope slides in Canada balsam for photography.

Thin sections and spicule preparations were made for taxonomic observations. Specimens with a dense cortex were embedded in paraffin, sectioned by hand with a razor blade, deparaffinized in xylene and mounted on microscope slides in Canada balsam. Tissue-free spicule preparations were made by dissolving small pieces of sponge in sodium hypochlorite. Using a compound microscope, we measured the diameter or length and width of 20 to 25 spicules (unless noted otherwise by N=) for each spicule type. We scanned microscope fields for spicules of variable sizes, but ignored obviously ontogenetically young spicules in determining size ranges. We list spicule dimensions as three numbers, the minimum, mean and maximum, e.g., 200–(250)–300. All measurements are in micrometers (μm). For one species, *Cliona californiana*, spicule dimensions in our material were compared to those in the literature using box and whisker plots. In box and whisker plots the bottom and top of the box are always the 25th and 75th percentile (the lower and upper quartiles, respectively), and the band near the middle of the box is always the 50th percentile (the median). The ends of the whiskers represent the maximum and minimum values. In another species, *Polymastia pachymastia*, we determined relative % of spicules by counting spicules in six 10X microscope fields.

For scanning electron microscopy (SEM), cleaned spicules were either deposited onto membrane filters that were then taped to stubs, or deposited directly on double-sided tape attached to stubs. Preparations were coated with gold-palladium and viewed either in a Hitachi S-3500N SEM at the University of Victoria, or in a few cases, an ETEC Biosem at Simon Fraser University.

Holotypes and some paratypes have been deposited in the Royal British Columbia Museum (Victoria, BC, Canada), with the exception of *Sphaerotylus raphidophora* n. sp. where the holotype is deposited in the United States National Museum (Washington D.C., U.S.A.) and the holotype of *Tethya vacua* n. sp. deposited at the California Academy of Sciences. Some paratypes have also been deposited in the Canadian Museum of Nature (Ottawa, Ontario).

Taxa including families, genera and species are arranged alphabetically. Abbreviations used in the text are: AHF=Allan Hancock Foundation (Los Angeles, California, USA); BC=British Columbia; BMSC=Bamfield Marine Sciences Centre (Bamfield, BC, Canada); CA=California; CASIZ=California Academy of Sciences, Invertebrate Zoology (San Francisco, California, USA); Cat.=catalogue; CBoL=Canadian Barcode of Life

Network; CMN=Canadian Museum of Nature (Ottawa, Ontario, Canada); coll.=collector; FRB=Fisheries Research Board of Canada (Ottawa, Ontario, Canada); h=high; Hbr.=harbour; I.=island; ID=identified; KML=Khoyatan Marine Laboratory (North Saanich, BC, Canada); mi.=mile (1.6 km); MCZ=Museum of Comparative Zoology, Harvard (Cambridge, Massachusetts, USA); No.=number; NOAA=National Oceanic and Atmospheric Administration (Washington, DC, USA); observ.=observer; nt=nucleotide; PBS=Pacific Biological Station (Nanaimo, BC, Canada); PEI=Pacific Environment Institute, Fisheries and Oceans Canada (West Vancouver, BC, Canada); Pt.=point; RBCM=Royal British Columbia Museum (Victoria, BC, Canada); RRMU=Redpath Museum, McGill University (Montreal, Quebec, Canada); Sd.=sound; Sta.=station; Str.=strait; USNM=United States National Museum (Washington, DC, USA); w=wide.

## Species descriptions

### Family Clionaidae d'Orbigny, 1851

#### Genus *Cliona* Grant, 1826

##### *Cliona californiana* de Laubenfels, 1932

Figs. 1A–F; 2

*Cliona celata* var. *californiana* de Laubenfels, 1932; *Pseudosuberites pseudos* Dickinson, 1945

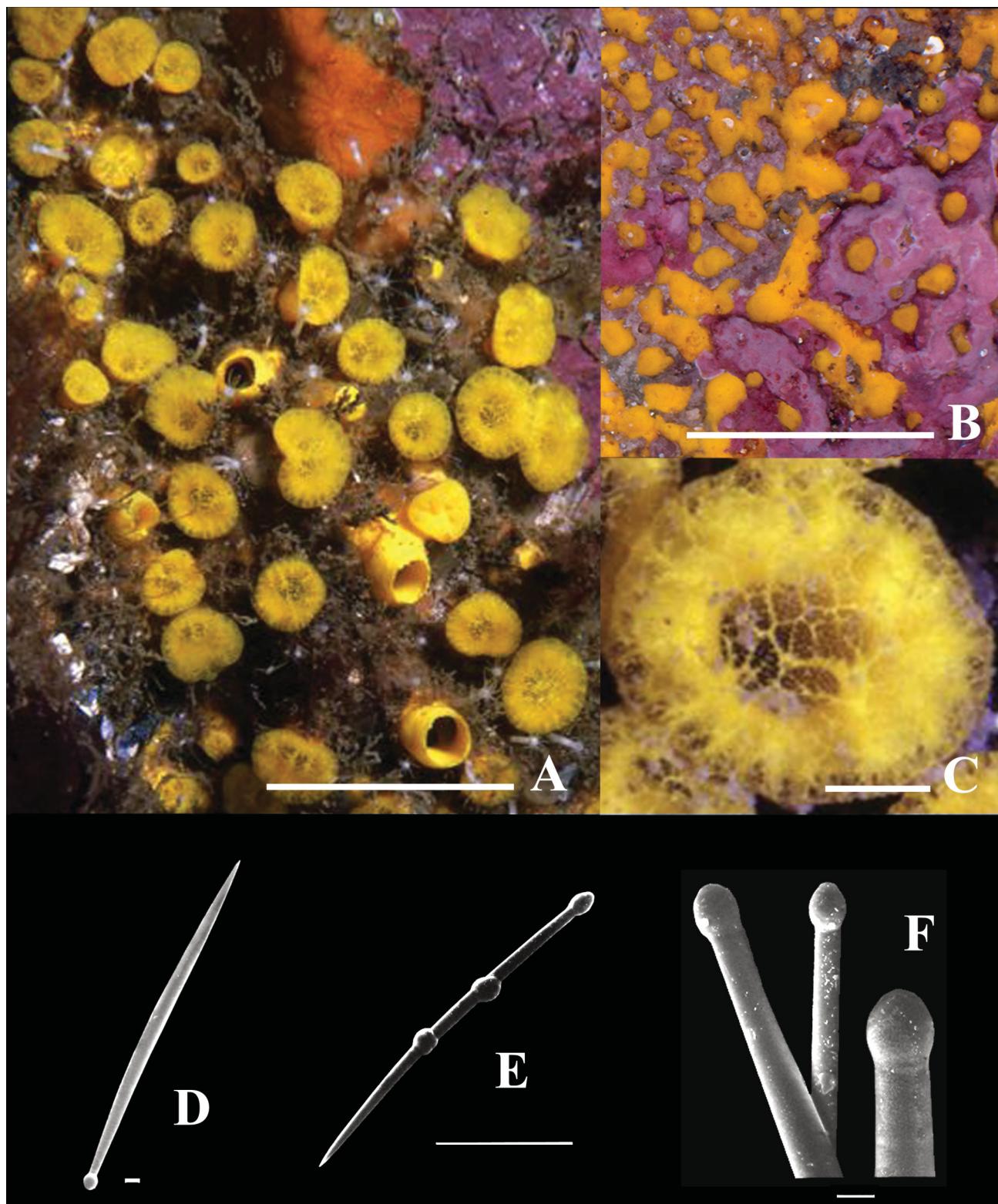
**Material examined.** KML 1002, KML sta. 61/69, Wharf, Bamfield E, BC, (48° 50.1'N, 125° 08.1'W), 5 m depth, Jun. 2, 1969, coll. W.C. Austin; KML 1003, PBS sta. 63-35, Porlier Pass, BC, (49° 11.0'N, 123° 41.0'W), 36 m depth, coll. D.B. Quayle (PBS); KML 1004, 10 km off Copper Bay, Haida Gwaii, BC, (approximately 53° 09' N, 131° 36'W), no depth given, Aug. 29, 1960, coll. D.B. Quayle (PBS); KML 1005, KML sta. 16/80, Wizard Island Pass, BC, (48° 51.6'N, 125° 10.4'W), 15 m depth, Mar. 22, 1980, coll. W.C. Austin; KML 1006, Exeter Shoal, BC, (49° 39'N, 124° 39'W), 22 m depth, Jun. 28, 1962, coll. D.B. Quayle (PBS); KML 1008, Effingham Island, BC, (approximately 48° 52'N, 125° 18'W), no depth given, Jun. 6, 1961, coll. D.B. Quayle (FRB); KML 1009, KML sta. 100/75, E. of Diana Island, BC, (48° 50'N, 123° 11'W), coll. W.C. Austin; KML 1010, KML sta. 50/77, Thieves Bay, BC, (48° 46.2'N, 123° 19.8'W), 20 m depth, Mar. 20, 1977, coll. W.C. Austin; KML 1017, KML sta. 160/75, W side of Satellite Passage, Barkley Sound, BC, (48° 51.1'N, 125° 10.6'W), 65 m depth, Oct. 6, 1975, coll. W.C. Austin; KML 1011, KML 85/73, Whittlestone Point, Barkley Sound, BC, (48° 48.5'N, 125° 11.1'W), 9–12 m, May 5, 1973, coll. W.C. Austin; KML 1189, Christie Islet, Howe Sound, BC, (49° 29.919 N, 123° 17.985W), 15 m depth, May 19, 2012, coll. & photo N. McDaniel.

Field images (not accompanied by voucher): Howe Sd., BC, (approx. 49° 28'N, 123° 20'W), photos, N. McDaniel; Flat Top Islands, BC (49° 9'N, 123° 41'W), photo, N. McDaniel.

**Description.** *Macroscopic features.* The basic growth form was determined for specimens from ten localities: nine were  $\alpha$  stage, one was  $\gamma$  stage (KML 1017). Colour alive bright yellow, in alcohol dark brown. Colour photos show dramatic differences between expanded and contracted sponges (Fig. 1A–C).

**Spicules.** Spicules exclusively tylostyles (Fig. 1D–F), often subterminal (Fig. 1F), some polytylote (Fig. 1E). The range and mean tylostyle dimensions ( $\mu\text{m}$ ) in specimens of *Cliona californiana* from various sites in BC are given below.

Accession Numbers	Location in BC	Length	Width
KML 1002	Bamfield Wharf	240–(310)–410	10.0–(11.5)–15.0
KML 1003	Porlier Pass	240–(288)–316	7.5–(10.8)–12.5
KML 1004	Copper Bay	220–(280)–336	7.5–(10.3)–12.5
KML 1011	Whittlestone Pt.	259–(310)–374	7.5–(11.4)–15.0
KML 1006	Exeter Shoal	220–(272)–310	10.0–(11.4)–15.0
KML 1008	Effingham I.	240–(280)–310	10.0–(11.3)–12.5
KML 1005	Wizard I. Pass	240–(268)–300	7.5–(10.1)–15.0



**FIGURE 1.** *Cliona californiana* de Laubenfels, 1932. A, expanded specimen, scale bar approx. 4 cm; B, contracted specimen, scale bar approx. 1 cm; C, expanded papilla and ostia, scale bar approx. 5 mm; D, tylostyle, scale bar 100 µm; E, polytylote tylostyle, scale bar 100 µm; F, heads of tylostyles, scale bar 10 µm.

We compared tylostyle dimensions using box and whisker plots (Fig. 2) of BC specimens (our data) and of east Atlantic/ Mediterranean and Mexican Pacific specimens (data from Carballo *et al.* 2004).

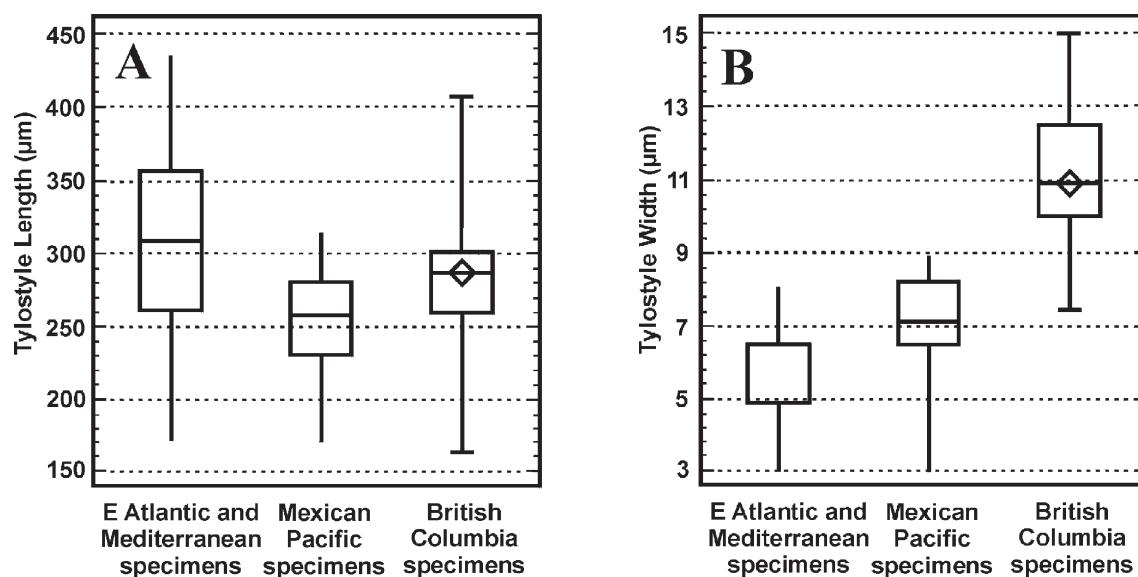
**Remarks.** Carballo *et al.* (2004) found that *Cliona celata* var. *californiana* from the Mexican Pacific coast had tylostyles which were significantly shorter and wider than specimens of *Cliona celata* from the Mediterranean.

Their measure of significance was  $P<0.0001$ . F-ratio 30.04 for length and  $P<0.0001$  F-ratio 66.98. They also noted that tylostyle heads of Mexican material had better formed tylostyles with fewer style/subtylostyle modifications than the Mediterranean specimens. They proposed that *C. celata* var. *californiana* be considered as a valid species, *C. californiana*, and distinct from *C. celata*.

When we compared our BC specimens with the box and whisker plots of Caraballo *et al.* 2004, we found that tylostyle lengths did not significantly vary from the Atlantic/Mediterranean or from the Mexican Pacific specimens (Fig. 2A). However, tylostyles were wider in the BC specimens than in the Mexican Pacific specimens and much wider than in the Mediterranean specimens (Fig. 2B). This may reflect a genetic difference sufficient to support full species status for *C. californiana*. However, it has also been demonstrated that in some sponges the width but not necessarily the length is directly correlated with ambient silica concentration (e.g. Stone 1970, Mercurio *et al.* 2000). British Columbia has one of the highest levels of silica in the world in shallow water (Austin 2012). By contrast Mediterranean waters have low silica concentrations relative to the Atlantic (e.g., Uriz *et al.* 2003) and the North Atlantic has low concentrations compared to the NE Pacific (e.g., Schlitzer 2000). The spicule width of *Cliona celata* populations could, therefore, be a reflection of differences in silica concentration.

Rosell & Uriz (2002) provided a table listing 11 populations of *C. celata* reported in the literature from various localities in the North Atlantic. We compared the maximum lengths and widths for each population with those for the Mexican and BC specimens. Minimums were not used as it was unclear whether or not juvenile spicules were included. Mean values were not available for most populations.

Range in maximum lengths Atlantic specimens	300–450 µm
Range in maximum lengths Mexican specimens	287–412 µm
Range in maximum lengths BC specimens	300–410 µm
Range in maximum widths Atlantic specimens	7.0–17 µm
Range in maximum widths Mexican specimens	7.5–13.8 µm
Range in maximum widths BC specimens	12.5–15 µm



**FIGURE 2.** *Cliona californiana* de Laubenfels, 1932. ‘Box and whisker’ comparisons of tylostyles length A and width B from Mexican Pacific with East Atlantic and Mediterranean specimens (redrawn from Caraballo *et al.* 2004), and from both regions with British Columbia specimens (our data, right). The bottom of the box represents the 25th percentile, the top the 75th percentile, and the line bisecting the box the 50th percentile (the median), the bottom and top of the whisker are the minimum and maximum values.

For both lengths and widths the ranges in sizes for the largest spicules of Mexican and BC specimens fit within the ranges for the Atlantic specimens except for a slightly smaller maximum size of 287 µm compared to 300 µm in the Atlantic populations. We also compared the ratios of length to width for the specimens. These ratios were 31 for

Atlantic, 33 for Mexico, and 26 for BC. The lower ratio for the BC specimens could be an ecophenotypic response to higher levels of silica in BC (discussed above). Carballo *et al.* (2004) suggested that the more regular production of tylostyles with few styles or subtylostyles in the Mexican specimens compared to the Atlantic specimens supports elevation of *Cliona celata* var. *californiana* to species status. However, these differences may also be ecophenotypic rather than genetic. Uriz *et al.* (2003) commented that the transformation of styles to tylostyles or subtylostyles may depend on silica concentration.

**Conclusions.** We have reservations about accepting *C. celata* var. *californiana* as a distinct species given the possibility that apparent differences in size and form of the tylostyles in Mexican specimens compared to Atlantic and Mediterranean specimens could well be ecophenotypic expressions in response to silica concentrations. Also the range in upper size limits of tylostyles for a broader selection of N. Atlantic localities (Rosell & Uriz 2002) encompasses the range for the Mexican and BC samples. However, until more detailed data suggest otherwise, we follow Carballo *et al.* (2004) in considering *C. californiana* as a distinct species. We agree with one of the reviewers that the *Cliona celata* /*Cliona californiana* complex is a good candidate for barcoding. We extend the species range further north to British Columbia. Populations from southern Alaska are also likely to be this species. Given that we suggest barcoding and Carballo *et al.* (2004) have compared the Mexican specimens with those from the Atlantic, we hesitate to compound the confusion by comparing classical characters for Indo-Pacific species.

**Bathymetric range.** Low intertidal to 46 m depth.

**Geographic distribution.** British Columbia (Canada), Washington, California (USA), Baja California, Sonora, Sinaloa, Nayurit, Jalisco, Guerrero, Gulf of Tehuantepec (W. Mexico).

#### *Cliona lobata* Hancock, 1849

Figs. 3A–E; 4A–G

*Cliona howsei* Hancock, 1849; Topsent 1891.

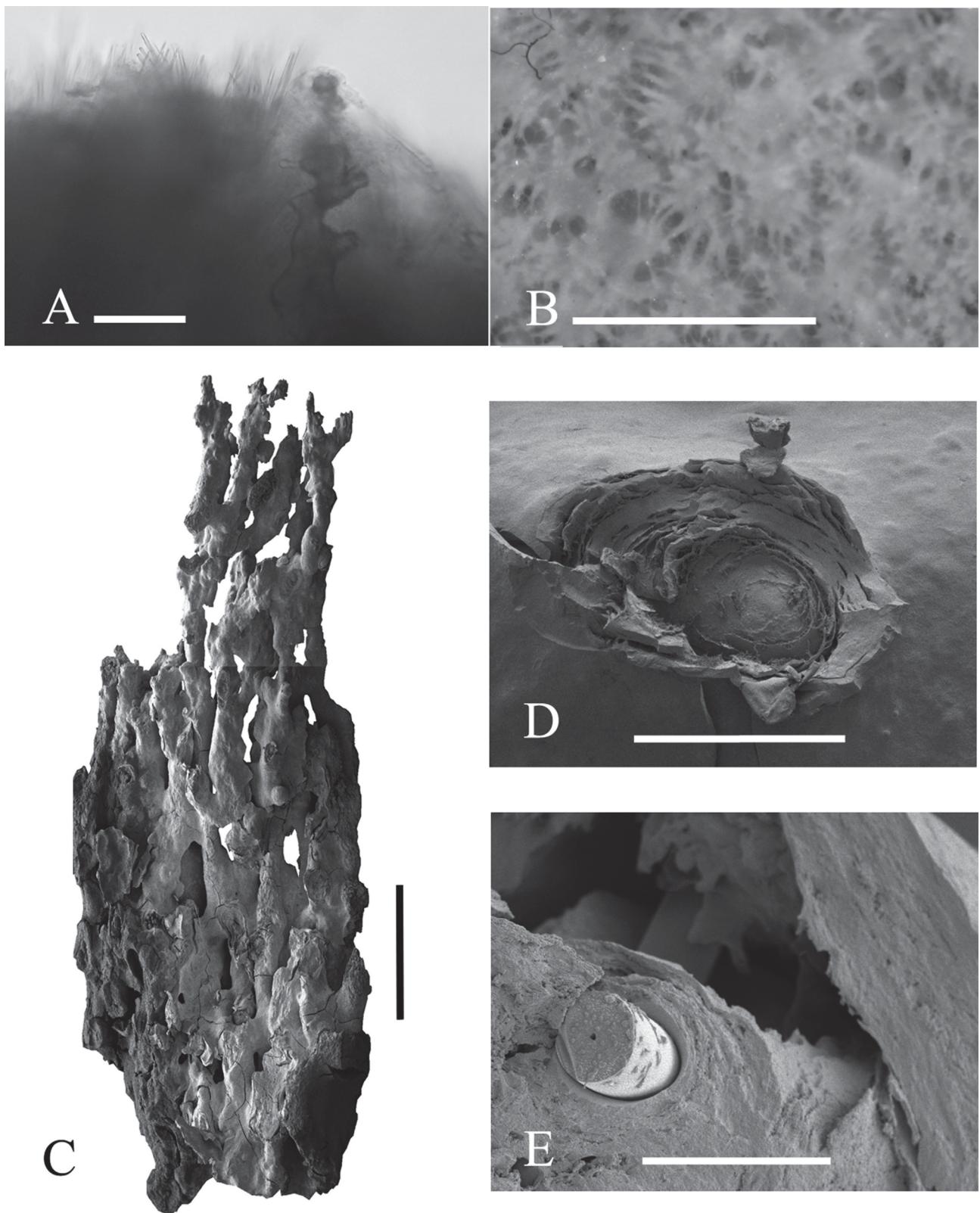
**Material examined.** KML 1012, sta. 07-11-15.1 212, Rapid Assessment Inventory of Species, Point Grenville, WA, ( $47^{\circ} 18.3'N$ ,  $124^{\circ} 16.6'W$ ), low intertidal, Aug. 10, 2002, coll. J. Goddard, 1 specimen in skeleton of a dictyoceratid sponge; RBCM 981-144-6, sta. PBS No. 2242-2S, shore of Nootka I., BC, (approx.  $49^{\circ} 40'N$ ,  $126^{\circ} 30'W$ ), intertidal, Jul./Aug. 1934, coll. W.A. Clemens, 1 specimen on barnacle; KML 1016, sta. 46-97, Razor Bank Point, Hollister Ranch, Santa Barbara, CA, ( $34^{\circ} 26.0'N$ ,  $119^{\circ} 52.2'W$ ), depth unknown, Nov. 18, 1975, coll. F. Hochberg, 1 specimen.

**Description.** *Macroscopic features.* KML 1012; specimen up to 2 cm high extending over several  $\text{cm}^2$  as a mat in the field, beta stage. In a 1 cm x 2 cm portion the surface is penetrated by four holes into which the oscula have retracted. One hole is 1.1 mm in diameter, the other three are 0.35 mm in diameter; oscula closed. Much of the surface covered by pore sieves which in the preserved material are flush with the surface (Fig. 3B); sieve formed by a series of arched fingerlike structures connected by fine filaments; spaces between the intersections represent the pores averaging about 22  $\mu\text{m}$  in diameter; 10–20 pores together form the sieve covering 1 to 2 ostia each 55–92  $\mu\text{m}$  in diameter, and spaced at intervals of 185–440  $\mu\text{m}$ . Ectosome 0.2–0.5 mm thick; where thin, forms dimples over tips of fibres spaced at 90 to 100  $\mu\text{m}$  intervals (Fig. 3A). Ectosome with tylostyles aligned with points extending about 100  $\mu\text{m}$  beyond the surface.

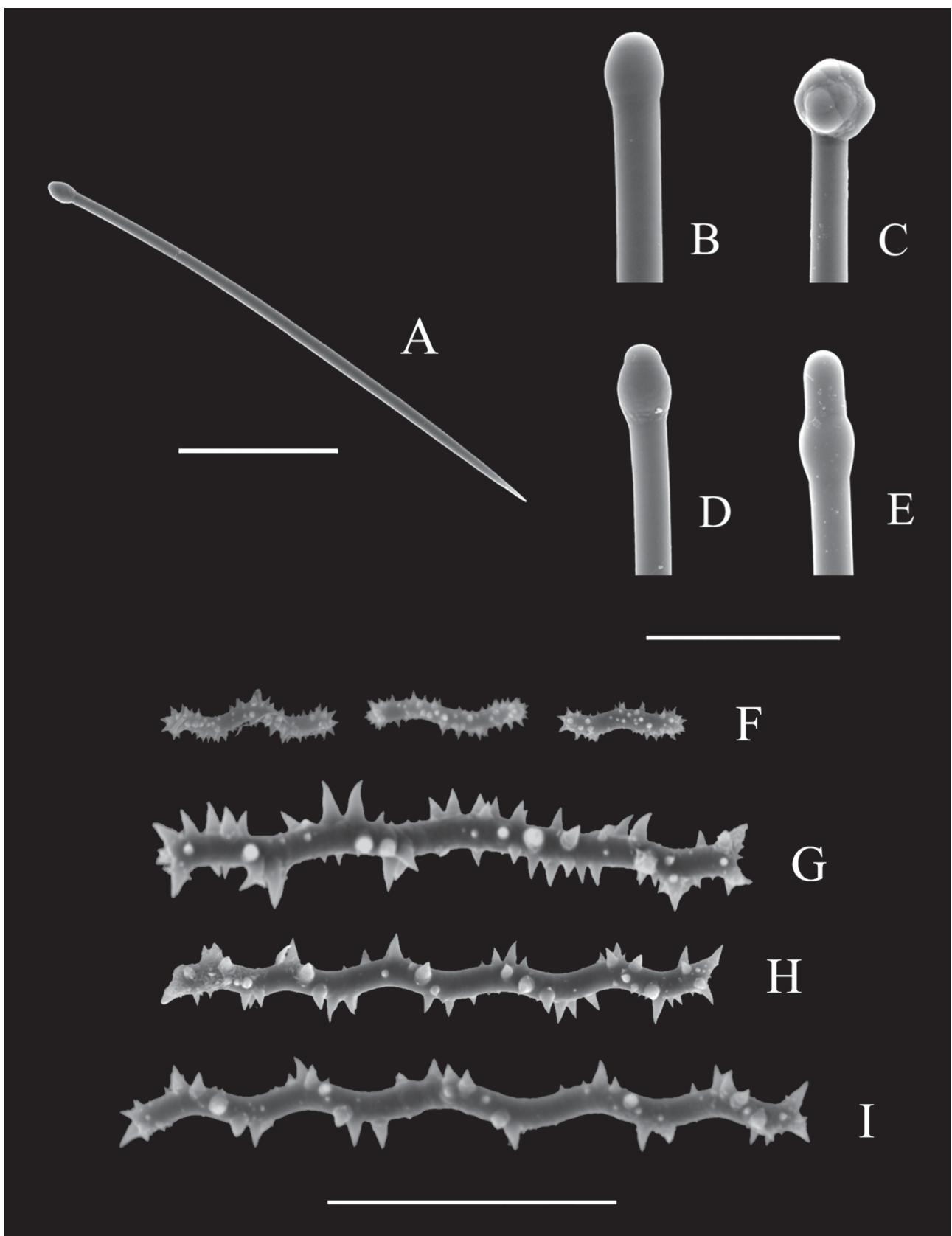
Mat of anastomosing fibres extends below the *C. lobata* ectosome two or more cm, colour golden brown, consistency unyielding and almost rock hard in alcohol. Fibres form tight mesh with openings of 180–240  $\mu\text{m}$  (Fig. 3C); all interfibre spaces filled by *C. lobata* choanosome and a few sand grains; fibres cored, knarled and lumpy; secondary fibres dominate; 60–250  $\mu\text{m}$  diameter; laminated in part (Fig. 3D); and free of debris except for occasional tylostyles incorporated into walls (Fig. 3E). Primary fibres 350–900  $\mu\text{m}$  diameter formed from fusion of secondary fibres to form lumpy plates about 1 mm below the surface. No tertiary fibres; no identifiable ectosome. No evident excavation chambers. Colour in life dull yellow.

RBCM 981-144-6: this specimen has been misplaced but is included in the material examined in anticipation of its recovery.

KML 1016: substrate possibly coralline algae, largely consumed, cannot identify remnants.



**FIGURE 3.** *Cliona lobata* Hancock, 1849. A, Side view of upper surface showing erect tylostyles and protruding dictyoceratid fibre (right), scale bar 100 µm; B, Top view of upper surface showing sieve pores, scale bar 1 mm; C, Portion of dictyoceratid fibre with soft tissue removed, scale bar 1 mm; D, lamellated wall & central pith of dictyoceratid fibre, scale bar 10 µm; E, spicule enclosed by wall of dictyoceratid fibre, scale bar 10 µm.



**FIGURE 4.** *Cliona lobata* Hancock, 1849. A, tylostyle, scale bar 50  $\mu\text{m}$ ; B, tylote head; C, multilobed head; D, subterminal style; E, stylote head with a subterminal swelling, scale bar 20  $\mu\text{m}$ ; F, small spiraster, scale bar 40  $\mu\text{m}$ ; G–I, large spiraster, scale bar 40  $\mu\text{m}$ .

**Spicules.** Spicules from the three specimens qualitatively similar; tylostyle heads varying from tylote and subtylote (Fig. 4A, B, D) to stylote with subterminal swelling (Fig. 4E). Some tylostyles with multilobate heads (Fig. 4C). Spirasters in two size classes, large with shaft bent back and forth, typically 9–10 times; the spines roughly following a spiral around the shaft. Small spirasters with spines more equally distributed along the shaft, which still bends 2–3 times. Large spirasters (Fig. 4G–I) with relatively sparse spines, their lengths equal to or greater than one half the shaft diameter. Small spirasters (Fig. 4F) with relatively abundant spines, their length less than one-half the shaft diameter. In larger spirasters length to diameter ratio varies considerably but greater than 10 to 1; in small spirasters length to diameter ratio less than 5 to 1. The two size classes may or may not overlap.

#### RBCM 981-144-6

Spicule Type	Fig.	Length	Width
Tylostyle	4A–E	124–(169)–216	3.0–(4.6)–5.4
Large spiraster	4 G–I	37–(65)–79 + 99	
Small spiraster	4F	12–(19)–32	

#### KML 1016

Spicule Type	Length	Width
Tylostyle	141–(181)–226	3.2–(4.8)–5.5
Large spiraster	37–(44)–64 N=24	
Small spiraster	9.9–(18)–34.7	

**Remarks.** KML 1012 is the first published record in the NE Pacific of a boring clionaid occurring within a reticulum of coarse spongin fibres. Pat Bergquist in a letter to Jeff Goddard, the discoverer, (pers. comm.) suggested that it might be a chimera of a *Cliona* sp. and a dictyoceratid close to, but distinct from *Petrosaspongia*. Chimeras between sponge species in the field are extremely rare (Little 1966, Maldonado 1998). However, epizoics among sponges are more common (Rützler 1970, Sarà 1970, Wulff 2006). *Spheciopspongia symbiotica* Hechtel, 1984 is an example of an association between a clionaid and a verongid.

Two species of *Petrosaspongia* have been described, *P. nigra* Bergquist, 1995 from New Caledonia and *P. pharmamari* Uriz & Cebrian, 2006 from the Canary Islands. The fibre skeleton of KML 1012 is similar to these two species in relative proportion of primary and secondary fibres and their diameters, the presence of foreign debris in primary but not secondary fibres, coring in primary fibres, laminated secondary fibres, and a tight meshwork of anastomosing fibres. It has a very hard, incompressible skeleton unique to the genus. However, the KML 1012 skeleton differs significantly from the two known species in being knarled and lumpy rather than relatively smooth and in having cored secondary fibres.

Our specimen was tightly adherent to the rock substrate and had a rock-like texture. We suggest that it could have provided a stable, attached skeletal framework (perhaps with a shell-sand component) for the *C. lobata*. In a similar association the poecilosclerid *Desmacella austini* Lehnert, Conway, Barrie & Krautter 2005 occupies the fused glass skeleton remaining when all or a portion of the hexactinellid *Aphrocallistes vastus* Schulze, 1887 dies (Austin 2012, Lehnert *et al.* 2005).

Some of the fibres had incorporated tylostyles into the spongin coating. These spicules were the same form and size as in *C. lobata*. Therefore, the dictyoceratid was alive when it was first invaded by *C. lobata*. However, only the fibres of the dictyoceratid were present when the sponge was collected. Samples of the choanosome and ectosome from all parts of the specimen had large populations of tylostyles and were, therefore, unlikely to represent part of the dictyoceratid.

At least superficially the *C. lobata* would be classified as a  $\beta$  form, with an ectosome over the surface. We are unable to find any reports of a  $\beta$  form of *C. lobata*. However, the lack of a solid layer of calcium carbonate would disallow the development of exclusively subsurface galleries with only papillae at the surface. The papillae with pore sieves are flush with the surface in our specimen while Topsent (1888, 1900) described them as up to 230  $\mu\text{m}$  in height with a diameter of 400  $\mu\text{m}$  in exhalent papillae and 150–170  $\mu\text{m}$  in inhalant papillae. It is likely that most

species of *Cliona* have contractile papillae (e.g. Fig. 1 A, B, C). Von Lendenfeld (1897) illustrated a pore sieve papilla flush with the surface of a coralline alga in a specimen of *Pione vastifica* while Goreau & Hartman (1963) illustrated an expanded pore sieve papilla and oscular papilla in *Cliona celata*. Pore sieves in the related *Spheciopspongia* are 15 to 70 times larger than those in *Cliona* (e.g., Rützler 2002, Carballo *et al.* 2004, de Laubenfels 1930). In *Cliona* we suggest that the pores are of an appropriate size (22 µm) to filter out extracted calcium carbonate chips (e.g., 20–60 µm per Rützler & Rieger 1973) during burrowing.

The tylostyle sizes were fairly similar among the three specimens. However RBCM 981-144-6 (from Nootka I., BC) had a spiraster which was much longer (99 µm) than any others. This spiraster was the same diameter as the shorter ones but had 13 twists or zig-zags compared to up to 10 in shorter spirasters. Arndt (1935) reported that when gemmules are formed in *C. lobata*, spirasters of 126 µm or more are covering their surfaces. We may have a similar case in the Nootka I. specimen. The sizes of the small spirasters were similar among the three samples.

Table 1 lists descriptions of specimens regarded as *Cliona lobata*. Records without descriptions or repeating those of others are largely excluded.

When Hancock (1849) described *C. lobata* from Guernsey (English Channel) he reported that tylostye heads were often irregularly rounded, sometimes slightly elliptical, and generally not exactly terminal. This conforms to our material. However, Hancock gave the tylostyle length as 1/100th of an inch (= 254 µm) which is considerably longer than the maximum tylostyle length in our material. He did not mention any spirasters.

In 1867 Hancock reported spirasters from a specimen of *C. lobata* obtained from the west coast of Scotland. He described the spirasters as cylindrical, rather stout, arched, zig-zagged, strongly spined, ends obtuse and about 50 µm in length. These are comparable in form to the large spiraster in our material. Hancock did not mention a second type of spiraster.

Rützler & Stone (1986) re-examined the spicule slides Hancock had made 120 years earlier. For the holotype of *C. lobata* they discovered that the tylostyles were shorter than Hancock had indicated (180 and 200 µm instead of 250 µm). They also stated that there were apparently two size classes of spirasters averaging 50 µm and 15 µm in length). These are evident in their Fig. 3C. These average sizes are approximately the same as in our material except for a larger average size (65 µm) of the large spirasters in RBCM 981-144-6 from BC.

Topsent (1900) described material from France as *C. lobata*. The tylostyles are similar in form and also in size to our material (range 139–(158)–178 µm). He found the spirasters in the same individual varied in length and in spination. Topsent (1888, 1900) illustrated two basic types of spirasters which appear identical to those in our material. Based on his illustration the large spiraster ranged from 47 µm or less up to 65 µm, about the same as in KML 1016 but less than in KML 1012 and RBM 981-144-6. The small spirasters ranged from 10 µm to 30 µm, about the same as in our material. Stephens (1915) found a *Cliona* off Cape Town, South Africa which she said agreed in every particular with *C. lobata* as described by Topsent (1900).

In the NW Atlantic, Old (1941) identified material collected from Long Island, NY to Chesapeake Bay (VA) as *C. lobata*. However, he did not describe or figure two different categories of spirasters. Hartman (1958) found *C. lobata* to be common on oyster beds in Long Island Sd. Specimens from this area again have the same complement and form of spicules as those in our material. Hartman measured 50 spicules of each spicule type for six specimens from one locality. For tylostyles the maximum size ranged from 209 µm to 250 µm compared to 200, 214 and 226 µm for our specimens. For the large spirasters, the maximum size ranged from 35 µm to 50 µm (Hartman 1958). This is quite a bit less than the 65 µm maximum size spirasters of Topsent (1900) and much less than the maximum size of spirasters in our NE Pacific material. Hartman did not include the mean size in his measurements of the large spirasters presumably because the numbers counted (shown as a percentage) ranged from 3 to 8.

In the NW Pacific Burton (1935) listed *C. lobata* from the Sea of Japan with no comment on characters. Hoshino (1977) described a specimen in southern Japan with tylostyles 365–440 µm long and spirasters 20–30 µm long. These measurements are very different from those of *C. lobata* in Europe. We consider the Japanese specimen to be a member of another species.

We found only a few records with descriptions in the Indo-Pacific. De Laubenfels (1954) reported *C. lobata* from several atolls in the West-Central Pacific. He illustrated only one type of spiraster, which, if correctly figured, is much more slender than *C. lobata* of Hancock 1867. This form and the single size class would preclude de Laubenfels' sample material from belonging to *C. lobata*. Also, the tylostyles in his sample averaged 12 µm in thickness compared to 2–5 µm in N. Atlantic material.

TABLE 1. Comparison of spicule sizes of *Clioma lobata* Hancock, 1849, from different descriptions and geographic regions.

Author date	Tylostyle Length	Tylostyle Width	Large Spiraster Length	Small Spiraster Length	Locale
KML 1012	66–(163)–214	3.7–(5.1)–6.2	37–(47)–74	12–(17)–22	Washington State
RBCM 981–144–6	124–(169)–216	3.0–(4.6)–5.4	37–(65)–79 + outlier 99	12–(19)–32	Nootka, BC
KML 1016	141–(181)–226	3.2–(4.8)–5.5	37–(44)–64	9.9–(18.0)–34.7	Santa Barbara, CA
Hancock 1849	av. 254 head often irreg.				Guernsey, England
Holotype	av. 254 head as in 1849				W. coast of Scotland
Hancock 1867	av. 200	av. 5			Guernsey, England
Others					W. coast
Rützler & Stone 1986					Scotland
Holotype	av. 180	av. 5			N.E,S, France
Others	225–230, 180–200, agrees with Topsent	3–5			S. Atlantic off S. Africa
Topsent 1900					New York–N. Carolina
Stephens 1915			agrees with Topsent		Japan
Old 1941	150–250	3–4	15–50	not clear	
Hartman 1958	148–250	1–4	26–50	7–26	
Hoshino 1977	365–440	7–10	20–30 small range	not mentioned	
de Laubenfels 1954	av. 240	av. 12	27–40 wavy	no mention	W. central Pacific
Burton 1937	200	4	10–65	?	Manaar N. Indian O.
Vacelet & Levi 1976	200–300	5–9	15–30		Madagascar
Rosell 1994	188–(280)–340				Mediterranean

Burton (1937) identified material from the Gulf of Manaar (Indian Ocean) as *C. lobata*. He provided a diagnosis including a figure which fits a description by Topsent (1900) but did not remark on the material in hand other than to note a specimen had a bright red colour. *C. lobata* elsewhere has been described as yellow, (e.g., Topsent 1900, Hartman 1958), which makes the identification by Burton suspect. Vacelet *et al.* (1976) described specimens they considered to be *C. lobata* from Madagascar with tylostyles 200–300 µm long and spirasters 15–30 µm long. They did not mention or figure two size classes, but reported that *C. lobata* in Europe has spirasters about twice the size of their specimens. In our view the small maximum size for the large spiraster, the lack of two size classes of spirasters and the long tylasters suggest that the Madagascar material is not *C. lobata*.

More recently, Rosell (1994) collected specimens she identified as *C. lobata* between 30 and 330 m depth in the NW Mediterranean. These had long tylostyles 188–(280)–340 µm with round or subterminal heads. Spirasters showed two extreme morphologies with intermediates. Type I: thin, curved, 10–(25)–55 µm; Type II: thick and straight with big spines (5–20 µm). Compared to our material as well as that of Topsent (1900) and Hartman (1958) and photos of the type spicules by Rützler & Stone (1986) Rosell's spiraster spines appear much longer relative to the spiraster shaft in both spiraster types and particularly in the 2nd spiraster type. Rosell suggested that the descriptions by Topsent (1900) and Hartman (1958) were erroneous and might have been the result of an accidental mixing of spicules. We consider that the specimens described by Rosell are some other species and the descriptions by Topsent and Hartman are of *C. lobata*. Volz (1939) reported that *C. lobata* in the Mediterranean was restricted to the coast of France.

**Conclusions.** KML 1016 from southern California fits well in spicule types and sizes with the *C. lobata* holotype description and photograph by Rützler & Stone (1986), and also fits well with the description by Topsent (1900) for material from the NW Atlantic. Based on the available evidence, we conclude that KML 1016 is *C. lobata*. *C. lobata* infests oyster beds in the Atlantic and could well have been introduced with attempts to establish American oyster culture in the NE Pacific. Barnacles supporting populations of *C. lobata* on ships could be another source for inter-ocean introductions. The material described by Hartman (1958) and Old (1941) from the NW Atlantic may be *C. lobata* if we accept that the shorter maximum sizes of spirasters (35–50 µm) are within the size variability for the species. The other sponge material from Washington (KML 1012) and BC (RBCM 981-144-6) fits the descriptions and figures for the *C. lobata* holotype and the description by Topsent (1900) except that the maximum size of the large spiraster in the Washington and BC material is longer (74 µm, 79 µm and 99 µm). The report by Arndt (1935) of still longer spirasters (126 µm or longer) coating the gemmules in *C. lobata* suggests that we might have seen a large spicule from a gemmule. It also indicates a considerable range in the phenotypic expression of spiraster length. The sample from southern California was located 1400 km south of the Washington sample and 1700 km south of the BC sample. The southern California site is within the warm temperate zone (22–25 °C) while the Washington and BC sites are within the cold temperate zone, (8–16 °C). Also, the silica concentration is low in southern California compared to that in Washington and BC (Phelps 1937, Tully & Dodimead 1957, Austin 2012). Several investigators have reported that demosponge spicules tend to be thinner with decreasing latitude and/or increasing temperature (Hentschel 1929, Hartman 1958, Stone 1970, Simpson 1978). Spicules also tend to be thinner and sometimes shorter in lower concentrations of silica (Stone 1970, Jones 1991, Bavestrello *et al.* 1993, Mercurio *et al.* 2000). Which spicule type is affected and how it is affected may vary. In *C. lobata* the large range in lengths of spirasters both within a population and within each individual sponge suggests that spiraster length might increase with lower temperatures and higher silica concentrations such as in the cold temperate NE Pacific. Given that the differences in spiraster maximum sizes may be genetic, ecophenotypic or associated with gemmulation, DNA barcoding might provide some guidance.

**Bathymetric range.** Low littoral to 1265 m depth.

**Geographic distribution.** N Atlantic from Cape Verde Islands (off West Africa) to Sweden, SW Atlantic off Cape Town, South Africa, NE Atlantic from Louisiana (USA) to Newfoundland (Canada), NE Pacific British Columbia, Washington, S. California (this paper). Records in the Mediterranean (in part), NW Pacific and the Indo-Pacific are dubious.

## Genus *Pione* Gray, 1867

### *Pione gibraltaensis* n. sp.

Fig. 5A–H

**Etymology.** The specific epithet is derived from the type locality, Gibraltar I. (Barkley Sound, BC) where KML 1018 was found.

**Material examined.** Holotype: KML 1018, KML sta.149/76, Gibraltar I., Barkley Sd., BC, ( $48^{\circ} 54.77'N$ ,  $125^{\circ} 15.35'W$ ), high tide pool 3 m above low tide level, Aug. 9, 1976, coll. W.C. Austin. Paratype: KML 1019, KML sta. 37/79, head of Pendrell Sd., BC, ( $50^{\circ} 17.9'N$ ,  $124^{\circ} 43.0'W$ ), mid intertidal, May 2, 1979, coll. W.C. Austin.

**Description.** *Macroscopic features.* KML 1018 excavating shell of living mussel (*Mytilus californianus* Conrad, 1837), in alpha form; papillae not contracted; oscular papilla a low truncated cone about 800 µm in basal diameter; the orifice diameter and the wall height each about 1/3 of the basal diameter; ostia bearing papilla an elevated dome, the height almost equal to the basal diameter which ranged from 0.3–0.7 mm. Around the periphery of the dome 16–20 cellular strands reinforced by tylostyles extend from the base to the top of the dome. Oscular pores range in size from 0.8–1 mm diam; spaced at approximately 6 mm intervals; ostial pores 0.3–0.6 mm diam., spaced at approximately 1 mm intervals. Pores enter erosion pits directly, without canals, erosion pits initially oval about 0.8 x 1.6 mm by 3 mm deep; as increase in size interconnect to form channels; inter chamber pores typically 0.2 mm, some to 0.5 mm diam.; few openings into the interior of the mussel; these 0.2–0.6 mm diam. Colour in life greenish yellow.

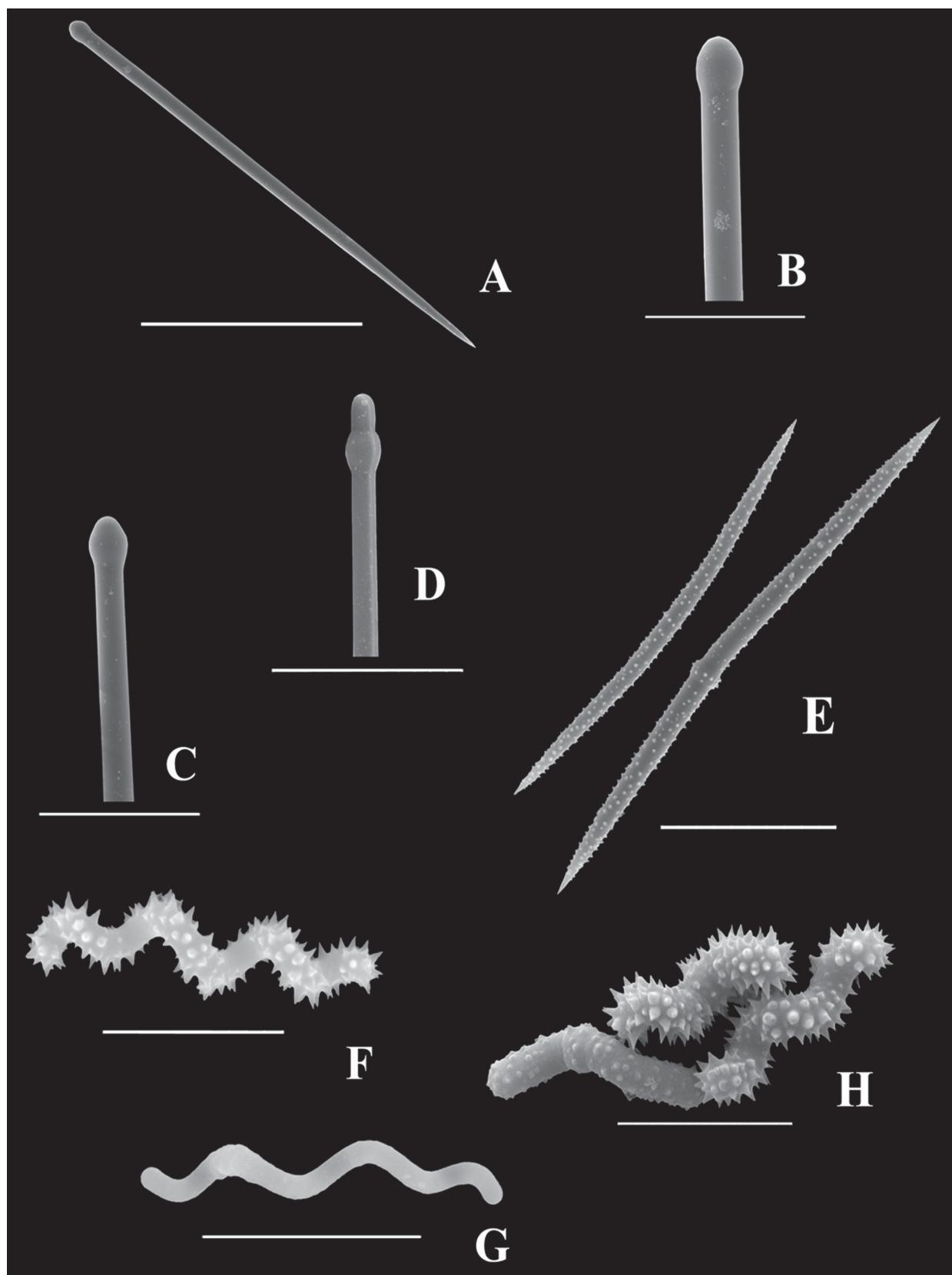
KML 1019 excavating empty Japanese oyster shells (*Crassostrea gigas* Thunberg, 1793), in alpha form. Papillae retracted; ostial pores 0.2–0.6 mm diam., oscular pores 0.8–1.2 mm diam., both types on inside and outside surface of oyster. These open directly into excavation chambers; these initially oval about 2.8 x 4 mm diam. but coalesce to become channels; interchamber pores 0.4–0.6 mm diam. Colour in life unknown.

*Microscopic features. Spicules.* Spicule types include tylostyles, acanthoxea, and two classes of spirasters. Tylostyles form a fence around the papillae with the points extending beyond the tissue; about 2/3 with well rounded tyle (Fig. 5A) but some, about 1/3, with tyle just back from the end giving a mucronate or subtylote appearance (Fig. 5B, C); a few with the tyle well back from the head which is stylote (Fig. 5D). Acanthoxeas abundant in the endosome; straight or bent and often with an annular swelling at the midpoint of the spicule (Fig. 5E). The widest spicule is not necessarily the longest. Width measured midway along the acanthoxeas but adjacent to any central swelling. Spines moderately visible in spirasters, but some thin spirasters appear smooth under a light microscope.

Spirasters strongly helical with the number of bends typically 5 or 6 (Fig. 5F, G) but occasionally down to 1 or 2 and in one case with 7; no absolutely straight spirasters seen; a few spirasters appeared stretched out so that some of the turns were quite shallow; ends of spirasters rounded, not truncated. Spirasters of two types: type 1 (Fig. 5F) thicker and spiny; type 2 (Fig. 5G) thinner and smooth. In addition in one SEM preparation there was a third category with incipient spines (Fig. 5H on left). Counts were made to assess the relative abundance of the spicule types. Under the light microscope of 200 spirasters counted 20 or 10% appeared smooth. Under SEM of 427 spirasters counted 10 (2%) smooth and 8 (2%) with incipient spines. Smooth spirasters the same length as spiny spirasters but typically thinner.

### KML 1018

Spicule Type	Fig.	Length	Width
Tylostyle	5A–D	173–(215)–288	2.5–(4.4)–6.9
Acanthoxea	5E	54–(84)–110	2.5–(4.4)–6.1
Spiny spiraster	5F	7.4–(22.3)–36.8	
Smooth spiraster	5G	13.5–(15)–18	



**FIGURE 5.** *Pione gibraltarensis* n. sp. A, tylostyle, scale bar 100 µm; B, C, subtylote heads, scale bar 30 µm; D, subterminal tyle, scale bar 30 µm; E, acanthoxea, scale bar 30 µm; F, spiny spirasters, scale bar 10 µm; G, smooth spiraster, scale bar 10 µm; H, spiny spirasters, scale bar 10 µm.

Spicule Type	Fig.	Length	Width
Tylostyle		144–(214)–260 N=60	4.5–(6.1)–9.4 N=60
Acanthoxea		74–(88)–136 N=60	3.4–(4.5)–5.5 N=60
Spiny spiraster	5H right	9.9–(17.7)–37.2 N=60	2.0–(2.5)–3.0 N=60
Smooth spiraster	5H left	13 N=1	2.7–(5.3)–9.9 N=60

**Remarks.** We assigned our specimens to the genus *Pione* Gray, 1867 based on the presence of acanthose oxeas coupled with tylostyles and microrhabdose spirasters (Rützler 2002). The taxonomic status of various species of *Pione* has been subject to differing interpretations on degree of conspecificity, (e.g., Topsent 1900, Rützler & Stone 1986, Rosell & Uriz 1997, 2002). Table 2 lists the described species of *Pione* with characterization of spicule size, form and surface.

Two features that set our material (KML 1018, 1019) apart from other species of *Pione* are the maximum length of the spirasters (29 µm, 37 µm) and the maximum number of turns (6 & 7). Only three species have spirasters at least 20 µm in length and with maxima of 5–6 turns. One of these, *P. spirilla* Old, 1941, differs from our specimens in having acanthoxea about 70% longer than in our specimens (170 µm vs. 93 & 110 µm). The other two have been identified as *P. vastifica* by Hartman (1958) and Old (1941). They differ from our material in the shorter lengths of their spirasters. However, they also differ from *P. vastifica* sensu strictu which has spirasters with 0–4 turns and up to 12 µm long (see p. 181, Fig. 12 in Rützler 2002).

These taxa and *P. margaritifera johannae* (Topsent, 1932) are the only *Pione* spp. described as having smooth spirasters as in our material. In the BC specimens smooth spirasters occur in small numbers, are thinner than the axial cylinder of the spined spirasters, and some have incipient spines (Fig. 5H on left) and likely would be seen as “smooth” under a light microscope. These features taken together do not preclude that the smooth spirasters may be growth stages.

**Conclusions.** KML 1018 and KML 1019 do not exactly fit the descriptions for any species of *Pione*. However, the size and turns of the spirasters are only marginally greater than described by Old (1941) for material he identified as *P. vastifica*. This material should be re-evaluated. We cannot exclude the possibility that the spiraster greater length and number of turns are ecophenotypic responses to the high silica content of the water in BC as discussed under *C. lobata*. However, until demonstrated otherwise, we will assume that these differences are genetic and are sufficient to warrant erecting a new species. We propose the name *P. gibraltaensis* n. sp.

**Bathymetric range.** High to mid intertidal.

**Geographic distribution.** Barkley Sound and Pendrell Sound (BC, Canada). The Japanese oyster, *Crassostrea gigas* (Thunberg, 1793) has been repeatedly imported into Pendrell Sound as a source for seed oysters for commercial oyster farms in BC. *P. gibraltaensis* may well be an introduced species.

## Family Polymastiidae Gray, 1867

### Genus *Polymastia* Bowerbank, 1864

**Comparison of North Pacific *Polymastia*.** Table 3 provides comparisons of known north Pacific *Polymastia* with regard to their spicules, water depth and geographic ranges. The first four species were recorded from the NE Pacific (de Laubenfels 1936, Lambe 1895, this paper). The last seven species in the table occur in the NW Pacific (Koltun 1959, 1962, 1966, 1970a, 1970b; Plotkin 2002; Tanita *et al.* 1989). The fistulae shape and size of multifistulate *Polymastia* from the north Pacific are compared in Table 4, and the appearance of preserved multifistulate *Polymastia* from the NW Pacific is shown in Fig. 6. All species known from the NE Pacific are multifistulate, therefore north Pacific species with only a single fistula (*P. hispidissima* Koltun 1966) were excluded from further consideration.

**TABLE 2.** *Pitone* species with spirasters. Species in ( ) have been synonomized. Original describers in bold, notable characters in bold, species with at least 4-6 turns in spirasters are in bold.

Species	Describer	Distrib. Colour	Tylostyle length	Oxea length	Spiraster surface	Spiraster turns	Spiraster length
KML 1018	here-in	BC greenish yellow BC	170–280	63–93	Thick spines thin smooth SEM	1–6	15–37
KML 1019	here-in		190–250	60–110	Spines +incipient spines	1–6	<b>14–29</b>
<i>abyssorum</i>	Carter 1874	UK	<b>804</b>	<b>352</b>	Smooth		
<i>angelae</i>	Urteaga & Pastorino 2007	Argentina	128–238	2	Spines SEM	spiral (0–4)	<b>84</b> 9.6–15.6
( <i>canadensis</i> )	Rützler & Stone 1986	NW Atl to <i>vastifica</i> Carballo, <i>et al.</i> 2004	190	120 <b>nos.</b> <b>centrotolyte</b>	Spiny	3–4 nos. <b>centrotolyte</b>	12
<i>carpenteri</i>	Rützler & Stone 1986	W Mexico	105–267	50–126	Spines	0	8–18
<i>carpenteri</i>	Hentschel 1909	SW Austr	250	63–130	Spines	0	13
<i>carpenteri</i> var. <i>gracilis</i>	Rützler & Stone 1986	?	224–304	72–90	Smooth, rare	0–1	8–20
<i>cervina</i>	Rützler & Stone 1986	?	250	40–80	Spiny	0–4	20
( <i>concharum</i> )	Thiele 1898	Japan	150–250	90	rough +/-	1–2	10–15 +
( <i>corallinooides</i> )	Rützler & Stone 1986	UK	<b>300–350</b>	100	Spiny	0–4	11
<i>dendritica</i>	Rützler & Stone 1986	W Mexico	160	70	Spiny wide	0–1, few	14x3
<i>fryeri</i>	Rützler & Stone 1986	IndoPacific	200	75 <b>very rare</b>	? thin Spiny	3–5	14x1 10–15
<i>hancocki</i>	Schmidt 1862	Adriatic	456um?	- size info	Missed	missed	
<i>hixoni</i>	Lendenfeld 1886	E Australia	<b>500</b>	200	Spiny	0–2	30
<i>indica</i>	Topsent 1891	Ceylon	<b>310–430</b>	?	Thick +	0–3	12x2
<i>lampa</i>	de Laub 1950	Bermuda	150–210	70	Thin +/-	13x1	
<i>lampa</i>	Pang 1973	Jamaica	236–388	60–116	Spiny	0	10
<i>lampa</i>	Rützler 1974	Bermuda	107–320	51–115	Spiny	0	9–22
<i>margaritifera</i>	Dendy 1905	red/yellow varies	250	60+ <b>spir</b> <b>intermed</b>	<b>Thick spiny +thin</b>	SEM	<b>4</b> 24
<i>margaritifera</i>	Hentschel 1909	SW Austr	189–260	25–55+ <b>spir</b> <b>intermed</b>	Spiny	3	10–15

.....continued on the next page

TABLE 2. (Continued)

Species	Describer	Distrib.	Tylostyle length	Oxaea length	Spiraster surface	Spiraster turns	Spiraster length
<i>margaritifera johannae</i>	Topsent 1932	California?	210–265	Spirasters part smooth	thick spiny thin smooth	Most str. few	3–4 13–65
<i>mazatlanensis</i>	Rützler & Stone 1986	W Mexico	200	100	Spiny	0–3	10
<i>mazatlanensis</i>	Carballo, <i>et al.</i> 2004	W Mexico	red	140–262	50–126 thin smooth	0–2–4	9–17
<i>muscoidea</i>	Rützler & Stone 1986	Peru?	180	110	Spiny	1 centro-tylote	13
( <i>northumbriica</i> )	Rützler & Stone 1986	UK	330	82	Spiny	1–5	14
<i>rhabdophora rhombia</i>	Hentschel 1914	Tropic Atl IndoPacific	170–224	50–85	Spiny	0	11–15
<i>robusta spinosa</i>	Rützler & Stone 1986	NW Atl Indopac	300	130	Spiny	0–1	12
<i>spirilla</i>	Old 1941	NW Atl	160–200	40–130 x 4–12 stout	Spiny	0–1	8–16
	Rützler & Stone 1986	Indopac	290	120	Spiny	0	17
	Old 1941	NW Atl	160–230	80–170 few smooth	Spiny, rarely smooth	3–5	9–20
<i>stationis</i>	Nassino 1883	Black Sea	245–313	75–175	unclear	twisted	9–13
<i>truitii</i>	Old 1941	NW Atl	190–225	110–130	Spiny	0–1	7–12
<i>vastifica</i>	Rützler & Stone 1986	Scotland	300	100	Spiny	0–3	12
<i>vastifica</i> [?]	Dc Laub 1957	Hawaii	240–300	75–85	Spiny	Str. only truncate	8–18
<i>vastifica</i>	Old 1941	NW Atl	160–250	50–110 spiny/smooth	Spiny	3–6	6–23
<i>vastifica</i>	Hentschel 1909	SW Austral	200–344	64–68	Does not say	5–6	10–14
<i>vastifica</i>	Hartman 1958	NW Atl	200–296 144–234 164–295	96–144 62–131 70–164	<b>Spiny,</b> <b>in figure, 1 is</b> <b>smooth</b>	2–5	13–17
<i>vastifica</i>	Volz 1939	Adriatic	280–306	Few smooth 95–132	Thick & thin spiny	Thick & thin spiny	9–16
<i>vastifica</i>	Rützler 2002	Scotland red/yellow	300	100	Spiry, some SEM	0–4	12
<i>vastifica</i>	Rosell 1994	Mediterran.	170–360	60–150	Spiny SEM	0–2	5–16
<i>vastifica</i>	Topsent 1933	Tunisia	260–290	55–110 smooth	Spiny, often smooth	2 truncate	9–20
<i>velans</i>	Hentschel 1909	SW Austral	168–230	100–140	Spiny	0–3	<b>30–40</b>
							11–20

TABLE 3. North Pacific *Polymastia* species comparison based on spicule dimensions, architecture and distribution.

Species	Ectosome with tylosyle palisade	Principal Spicules		Intermediate Spicules		Small Tylostyles		Surface Echinating Styles to Subtylostyles		Depth Range (m)
		Type	L/W Range (μm)	Type	L/W Range (μm)	L/W Range (μm)	W: 3–10	Principal styles	Observatory Inlet, British Columbia	
<i>Polymastia piscesae</i>	Yes	Styles to subtylostyle	L: 860–1600 W: 15–25	Subtylostyles to tylostyles	L: 230–580 W: 13–25 rare	L: 88–220 W: 5–25	Principal styles	Observatory Inlet, British Columbia	213	
<i>Polymastia pacifica</i>	Yes	Tylostyles	L: 500–1000 W: 13–20	Tylostyles	L: 65–460 W: 5–25	Continuous with Intermediat	L: 900–2500 W: 10–17	S California to S British Columbia	15–180	
<i>Polymastia pachymastia</i>	Yes	Styles to subtylostyle	L: 500–2646 W: 12.8–37.5	Tylostyles	L: 143–560 W: 5–25	L: 55–210 W: 1.5–7.5	Principal styles	Observatory Inlet, British Columbia	0–50	
<i>Polymastia kuriensis<sup>j</sup></i>	Yes	Styles to strongyloxe as	L: 610–2450 W: 9–28	Tylostyles to subtylostyle	L: 320–750 W: 12.5–40	L: 108–630 W: 3–12.5	Continuous with Intermediat	L: 720–1990 W: 4.4–12.5	Kurile Islands, the Okhotsk Sea and Bering Sea to Kodiak Island, Alaska	50–301
<i>Polymastia granulosa<sup>3</sup></i>	Yes	Subtylostyle	L: 484–970 W: 7.5–15	Subtylostyles	L: 271–500 W: 5.7–11.5	L: 96–198 W: 1.5–5	Principal Subtylostyles	Kannonzukadashi, Amadaiba, Japan	0–84	
<i>Polymastia laganoides</i>	No	Tylostyles	L: 1500 W: 20	Tylostyles	L: 479 W: 1.3	L: 117 W: 3	Principal tylostyles	Commander Islands	100	
<i>Polymastia affinis<sup>5</sup></i>	Yes	Styles	L: 737–1478 W: 15–30	Tylostyles	L: 400–670 W: 10–15	L: 81–140 W: 2–8	Principal styles	Kamchatka coast, S Kuril Islands; S coast of Jigashima, Okinoyama, Japan	102–303	
<i>Polymastia hispidissima</i>	Yes	Styles to subtylostyle	L: 872–2680 W: 13–46	Tylostyles	L: 435–1072 W: 19–46	L: 107–221 W: 4–8	Principal styles	Sea of Japan, eastern coast of the southern and middle Kuril Islands	44–1530	
<i>Polymastia toporoki</i>	Yes	Styles to subtylostyle	L: 670–1800 W: 13–30			L: 130–190 W: 4–6	None	Southern Kuril Islands	60–80	
<i>Polymastia fluegeli</i>	Yes	Tylostyles	L: 180–1750 W: 8–22			L: 65–110 W: 3–6	Principal styles	Aleutians, Alaska	82	

L/W= length/width

<sup>1</sup> Spicule complement includes rhipides and surface echinating styles with barbed heads

<sup>2</sup> by Koltun (1966); renamed *Polymastia pacifica* by Plotkin (2002); *P. pacifica* Lambe 1893b has priority.

<sup>3</sup> Spicule size ranges based on Bergquist (1968) for New Zealand specimens; Japanese specimens fit within Bergquist ranges.

<sup>4</sup> Not noted for Japanese specimens reported by Taniai *et al.* (1989).

<sup>5</sup> In both Russian and English text *Polymastia affinis* styles are noted as 737–478 μm but almost certainly an error as size because in other species ordering is from smaller to larger. Also in Fig. 42 (Koltun 1966) such a spicule measured 14 mm and it was reported to be magnified 100 times, thus =1400 μm.

**TABLE 4.** North Pacific *Polymastia* fistula comparison.

Species	Source	Exhalant Larger Than Inhalant Fistulae	Shape of Fistulae	Mean Size of Fistulae (LxW at base) (mm)
<i>Polymastia piscesae</i> n. sp.	W.C. Austin	Yes	Pointed, conical	20 x 3.25
<i>Polymastia pacifica</i>	W.C. Austin	Yes	Rounded apex, conical	4.5 x 2–7 x 2
<i>Polymastia pachymastia</i>	W.C. Austin	Yes	Large, cylindrical	30 x 15
<i>Polymastia kuriensis</i>	W.C. Austin	No	Button-like, conical	1 x 1.5
<i>Polymastia laganoides</i>	Lambe	Not given	Wide, conical	?
<i>Polymastia affinis</i>	Thiele	Not given	Small, papillose	1 x ?
<i>Polymastia hispidissima</i>	Koltun	Not applicable <sup>1</sup>	Cylindrical or leaf-like	15 x ?
<i>Polymastia toporoki</i>	Koltun	Not given	Pointed, conical	45 x 9
<i>Polymastia fluegeli</i>	Lehnert, Stone & Heimler	Not given	Wide, conical	? x 10

<sup>1</sup> Described specimens had only one fistula per sponge

? No data

### *Polymastia kuriensis* Koltun, 1962

Fig. 6A, 7A–D

*Polymastia laganoides* of Burton, 1935, non Lambe 1895.

**Material examined.** KML 1020, PBS sta. 63-74, off Kodiak I., Alaska, (58° 07.8'N, 150° 52.0'W), 126 m depth, no date, coll. unknown, one specimen.

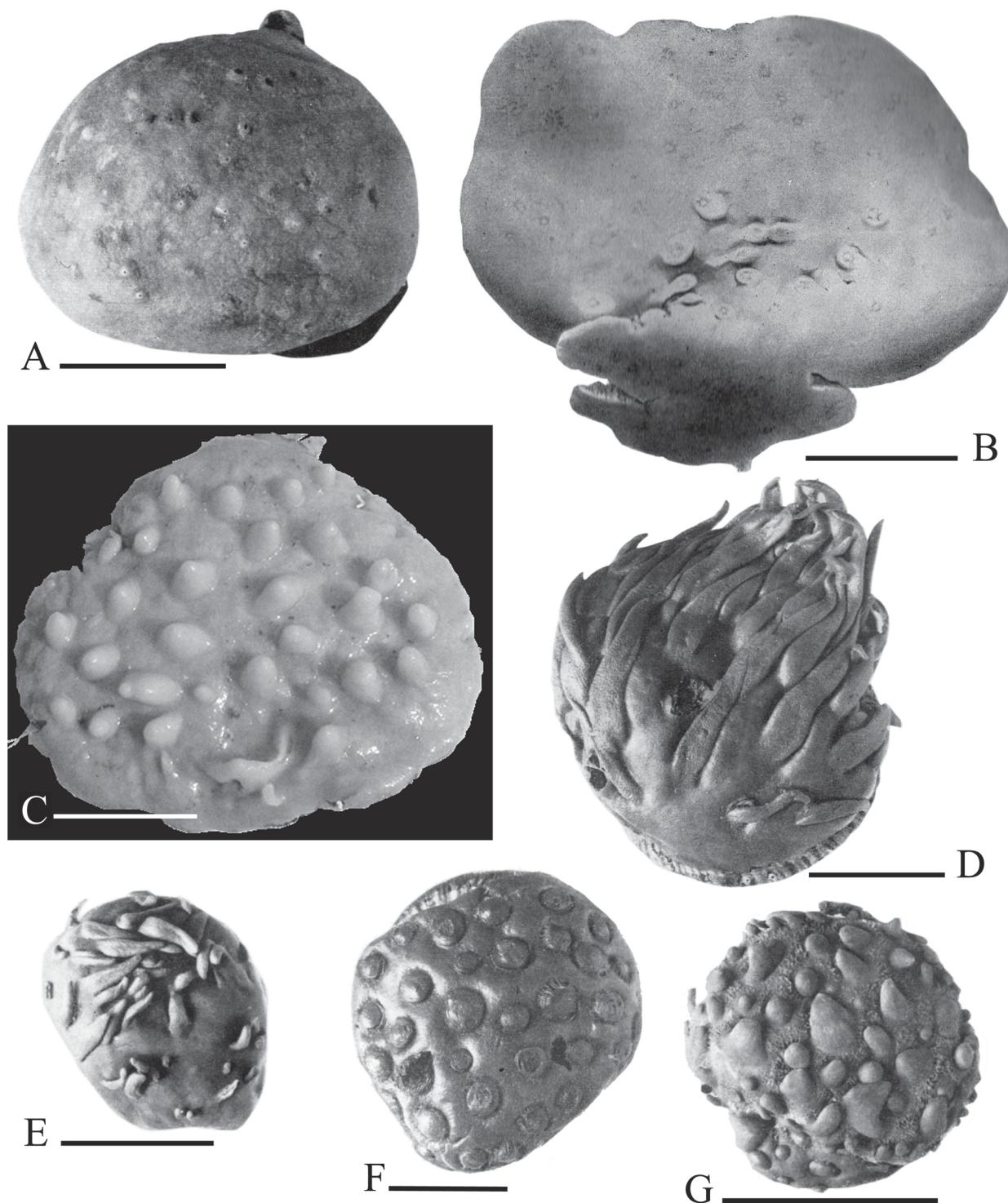
**Description.** *Macroscopic features.* Specimen not observed in life. Sponge cushion-shaped, 5 cm diameter fragment, 2 cm thick. Papillae small and conical with rounded apices, 1 mm high x 1.5 mm wide at base; multiple papillae on fragment (Fig. 6A). Oscula not observed on preserved specimens but from internal structure located on the apices of fistulae. Sponge surface hispid with spicules projecting up to 1 mm above surface surrounding papillae; fistulae microhispid, with spicules projecting less than 100 µm above surface. Main body of sponge papillose. Consistency woody, not compressible. Colour of main sponge body in alcohol brown; fistulae lighter shade of brown.

*Microscopic features.* Cortex 0.7 mm thick with small amount of collagen. Fistulae either inhalant or exhalant; exhalant canals 200 to 400 µm diameter. Choanosomal principal multispicular tracts packed tightly with spicules held by only small amount of spongin cementing tracts; tracts composed of styles to strongloxeas, oriented with heads toward base; tracks originating at base of sponge, extending toward surface or penetrating it (Fig. 7A). Principal multispicular tracts carrying up through fistulae, slightly penetrating surface. Multispicular tracts surrounding central exhalant canal. Subtylostyles to tylostyles scattered randomly throughout cortex and choanosome.

*Spicules.* Spicules of three types: 1) abundant straight styles to strongloxeas (Fig. 7B) composing principal spicule tracts; 2) less abundant subtylostyles to tylostyles (Fig. 7C) with long sharp points, some subtylote, vaguely fusiform, straight or slightly curved; 3) very thin, raphide-like spicules (Fig. 7D) with a single recurved spine at one end, visible only by SEM. Spicule measurements are from the one specimen examined.

KML 1020

Spicule Type	Fig.	Length	Width
Styles to strongloxeas	7 B	610–(1393)–2450	9.0–(16.0)–28.0
Styles to subtylostyles	7 C	108–(243)–630	3.0–(6.5)–12.5
Thin spicules (spined)	7 D	720–(1490)–1990	4.4–(8.5)–12.5



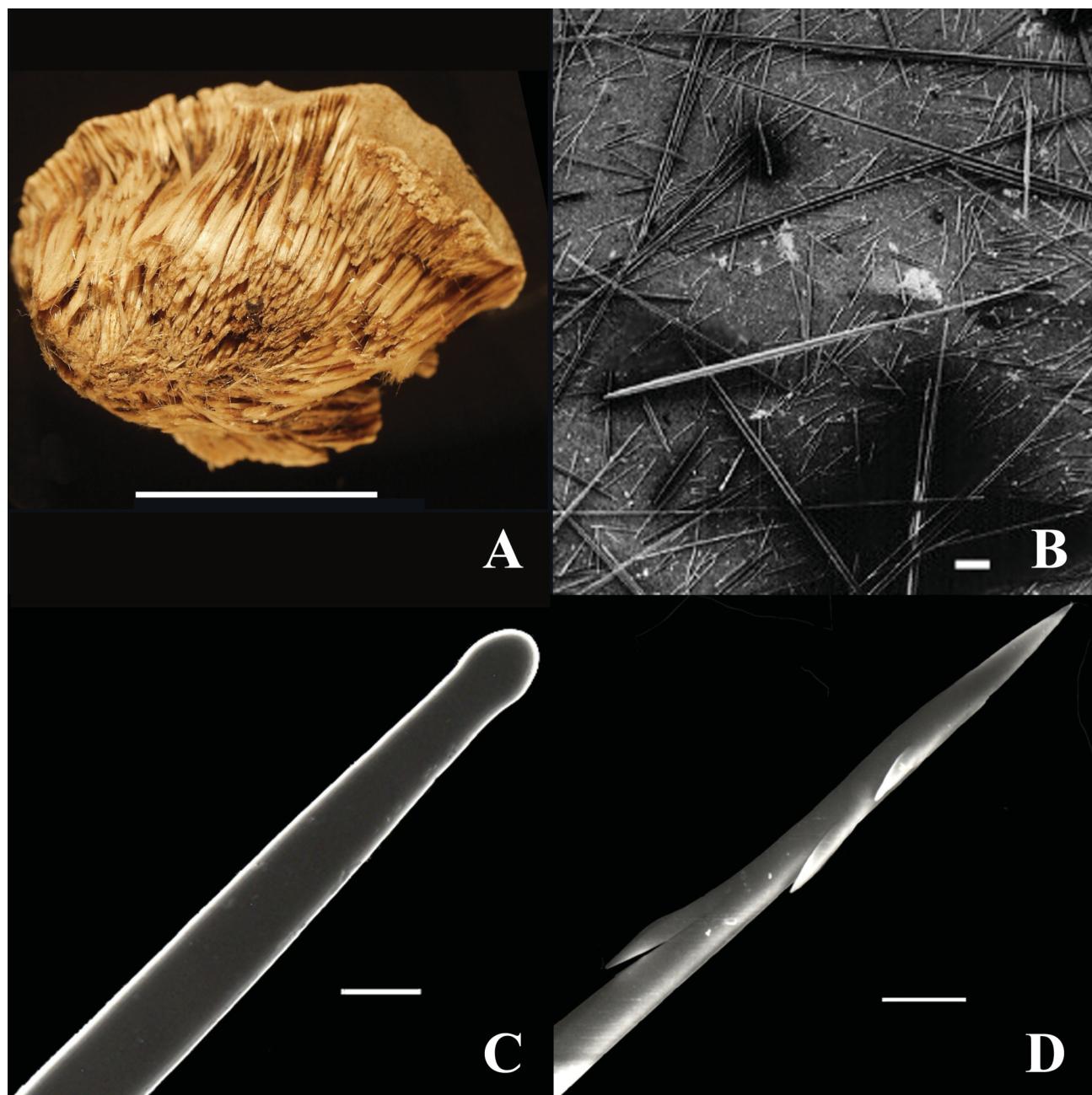
**FIGURE 6.** Multifistulate *Polymastia* spp. in the NW Pacific. Numbers, form and size of fistulae. Scale bar, 3 cm on all but C where scale bar 5 cm. A, *P. kurilensis* Koltun; B, *P. laganoides* Burton; C, *P. fluegeli* Lehnert *et al.*; D, large *P. toporoki* Koltun; E, small *P. toporoki*; F, *P. affinis* Thiele, fistulae contracted; G, *P. affinis*, fistulae expanded. A, D–G from Koltun 1966; B from Lambe 1895, courtesy Royal Society of Canada; C from Stone *et al.* 2011.

**Remarks.** Koltun (1962) described *Polymastia kurilensis* from the Kurile Islands. It has the same spicule types and similar sizes as our specimen. The thin, recurved-spined spicules are characteristic and have not been reported for any other North Pacific species of *Polymastia*. As noted above, the recurved spines are only visible under high magnification with a light microscope or by SEM. The only other North Pacific *Polymastia* with a cushion-like

form and a few wart-like fistulae is *P. laganoides* Lambe 1895. But this species does not have recurved-spined spicules and spicules ranging from styles to tylostyles. Given the characteristic recurved-spined spicules, a similar spicule complement, similar form, and a sample depth of 126 m for our specimen, compared to the reported distribution range of 50 to 301 m for *P. kurilensis*, we conclude that our specimen belongs to this species.

**Bathymetric range.** Depth range 50 to 301 m.

**Geographic distribution.** Range extension from the Kurile Islands, the Okhotsk Sea (Kamchatka Peninsula, Russia) and Bering Sea east to Kodiak I. (AK, USA).



**FIGURE 7.** *Polymastia kurilensis* Koltun, 1962. A, thick cross section, scale bar 10 mm; B, long and short spicules, scale bar 100  $\mu$ m; C, head of subtylostyle, scale bar 10  $\mu$ m; D, barbed end of thin onychaete-like spicule, scale bar 10  $\mu$ m.

#### *Polymastia pachymastia* de Laubenfels, 1932

Fig. 8A–J

*Polymastia pacifica* of Green & Bakus 1994

**Material examined.** Holotype: USNM 22062, Point Lobos, Carmel, central California, (approx. 36° 31'N, 121° 57'W), littoral, Jul. 12, 1930, coll. M. W. de Laubenfels.

Other material: KML 1021, KML sta. 56/70, Wizard I., Barkley Sd., BC, (48° 51.6'N, 125° 09.4'W), 4–8 m depth, Mar. 20, 1970, coll. W.C. Austin; BMSC 429, KML sta. 3/72, Dixon I., Barkley Sd., BC, (48° 51.2'N, 125° 07.2'W), 9 m depth, Jul. 1972, coll. W.C. Austin; KML 1022, KML sta. 252/76, Mills Peninsula, Barkley Sd., BC, (48° 49'N, 125° 09.8'W), 12 m depth, Nov. 3, 1976, coll. W.C. Austin; KML 1023, KML sta. 174/76, Houston Stewart Channel, Haida Gwaii, BC, (52° 09.5'N, 131° 05.6'W), 20–24 m depth, Aug. 3, 1976, coll. W.C. Austin; CASIZ 000167, Garapata Canyon, Monterey County, CA., (approx. 36° 27'N, 121° 55'W), no depth or collection date, coll. D. Elvin/W. Lee; KML 1024, KML sta. 577/77, Beaver Pt., Saltspring I., BC, (48° 46.1'N, 123° 22.5'W), no depth, Jun. 23, 1977, coll. W.C. Austin; CMN off Amchitka, Alaska, (51° 19.3'N, 178° 55.0'W), no depth, Sept. 5, 1969, coll. unknown; CMN off Rifle Range Point, Amchitka, Alaska, no coordinates or depth, Sept. 4, 1969, coll. C. O'Clair; CMN St. Makarine Bay, Amchitka, Alaska, Sept. 17, 1969, coll. C. O'Clair; CMN off Amchitka, Alaska, (51° 25.4'N, 179° 16.5'E), no depth, Oct. 8, 1969, coll. C. O'Clair; RBCM 977-156-2, Hope I, BC, (50° 54.3'N, 129° 56.3'W), 24.4 m depth, Jul. 18, 1977, coll. P. Lambert; RBCM 980-340-2, Coal Hbr, Holberg Inlet, BC, (50° 35'N, 127° 34.6'W), less than 12 m depth, July 3, 1980, coll. P. Lambert; RBCM 980-342-4, Shapland Cover, BC, (50° 29.5'N, 127° 47.5'W), less than 15 m depth, July 4, 1980, coll. P. Lambert; RBCM 999-213-8, Moresby I., Haida Gwaii, BC, (52° 8.45'N, 131° 8.07'W), 47.1–52.2 m depth, Jul. 18, 1999, coll. P. Lambert.

Field Images: Koskimo I., Quatsino Sd., BC, (approx. 50° 27'N, 127° 53'W), 20 m depth, Jul. 30, 1975, photo N. McDaniel; near Entrance I., Strait of Georgia, BC, (approx. 49° 12'N, 123° 48'W), no depth, Jul. 14, 1973, photo N. McDaniel; Raza Passage, Kinghorn I., BC, (approx. 50° 18'N, 125° 00'W), 25 m depth, Aug. 12, 1976, photo N. McDaniel; Vivian I., BC, (approx. 49° 50'N, 124° 42'W), no depth or date, photo N. McDaniel; Chrow Islands, Barkley Sd., BC, (approx. 48° 55'N, 125° 29'W), no depth or date, photo N. McDaniel; Discovery Passage, BC, (approx. 50° N, 125° 11'W), no depth or date, 4 photos, N. McDaniel.

**Description.** *Macroscopic features.* Form massive with digitate fistulae projecting up to 2 cm above main body of sponge (preserved). Basal diameter of fistulae 1–2 cm, but smaller diameters occur in smaller specimens. NE Pacific *Polymastia pachymastia* can reach up to a meter in diameter and 3 cm thickness based on specimens we have examined and/or photographed. Fistulae open and elongate (Fig. 8A) or contracted and closed (Fig. 8B). A single apical osculum on many fistulae. Ostia not observed. Fistulae soft with smooth surface, while main body tough, wood-like and coarsely hispid. Fistular colour ranging from white (Fig. 8A, B) to yellow (Fig. 8C, D), while main body consistently brown from adhering sediment or covered by coralline algae.

*Microscopic features,* Fig. 8E. Ectosome of body forming cortical layer approximately 1.5 mm thick, continuous with ectosome of fistulae, where cortex thinner (0.5 to 1 mm thick). Cortex packed with tylostyles at right angles to surface, apices outward and forming palisade. Mesh of spicules tangential to surface in lower ectosome (Fig. 8E, portion visible mid-right). Large styles penetrate body surface, projecting >1 mm, apices out. Within body large tylostyles interspersed with small tylostyles, while in fistulae small tylostyles occasionally forming brushes and fewer large tylostyles echinating fistular surface. Palisade of both intermediate and small spicules (tylostyles II and III), rather than only distinctly small tylostyles; large, thin styles penetrating the surface irregularly, extending past surface as far as 2 mm (Fig. 8E, top right). Fistulae macroscopically smooth, but microhispid with large tylostyles, apices out, extending up to 100 µm beyond surface. Choanosome: skeleton composed of radiating, closely packed multispicular tracts of large spicules. Tylostyles II, together with styles I, form the ascending multispicular tracts in the choanosome (Fig. 8E, bottom), 200–800 µm diameter ascending to, penetrating, and supporting cortical layer of ectosome. Smaller tylostyles (Figs. 8G, H, J) scattered among principal tracts.

*Spicules.* Spicule complement includes two size classes of styles and three classes of tylostyles. Styles I are sometimes very slightly subtylote. Styles II are very long, straight and thin and echinate the main sponge body; tylostyles I are short, stout, fusiform; some with subterminal heads, some polytylote and are abundant in cortex and choanosome; tylostyles II are long, fusiform, some with subterminal heads, some polytylote and are abundant and in same locations as tylostyles I; tylostyles III are small, thin straight, some with subterminal heads, and are abundant. Length and width ranges may overlap in Tylostyles I and II in some specimens and Tylostyles I and II may be just one highly variable spicule type. Table 5 lists spicule measurements from five specimens, and Table 6 lists the relative percentages of the three tylostyle types in the ectosome of four *P. pachymastia* specimens plus the USNM type specimen we examined.

**TABLE 5.** *Polymastia pachymastia* de Laubenfels, 1932, Spicule Size Range Comparison. N=25, or specified.

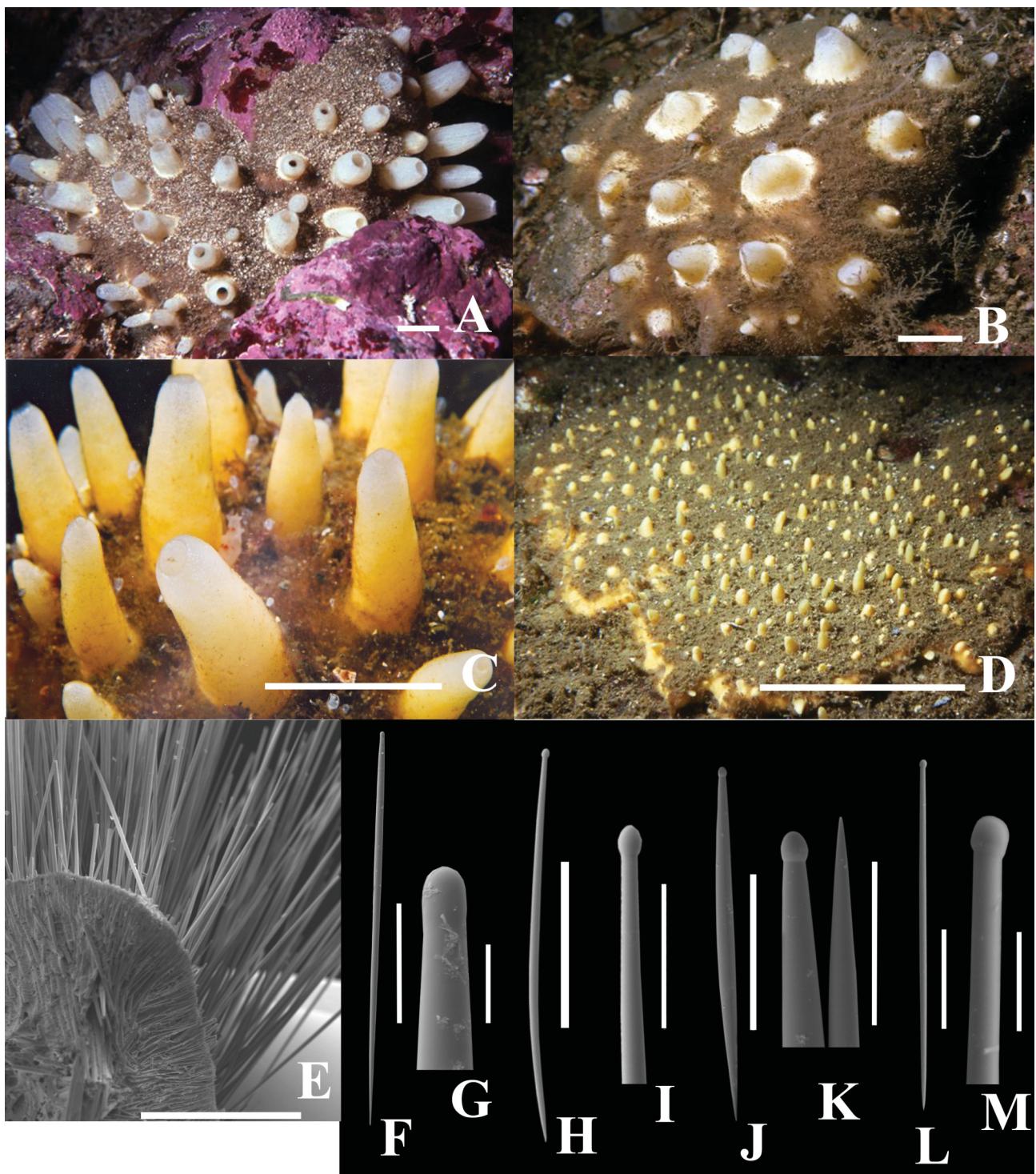
Spicule Type	Fig.	Length	Width
BMSC 429		Dixon Island, Barkley Sound	
Styles I	8F, I	960–(1425)–2646	12.8–(26.8)–37.5
Styles II	none	2200–(3038)–3340 N=4	22.5–(23.9)–25.0
Tylostyles I	8G	143–(277)–380	5–(18.1)–25
Tylostyles II	8G	450–(582)–750	13.8–(29.5)–40
Tylostyles III	8H, J	55–(137.5)–172.5	1.5–(4.4)–7.5
RBCM 977-156-2		Hope Island, Bull Harbour	
Styles I		700–(892)–1070	15.0–(18.7)–22.5
Styles II		2550–(3600)–4425	12.5(23.3)–28.8
Tylostyles I		180–(252)–390 N=50	10.0–(16.2)–25.0
Tylostyles II		320–(438)–690	12.5–(20.1)–40.0
Tylostyles III		125–(158)–188	3.8–(5.1)–8.8
RBCM 980-340-2		Holberg Inlet, Coal Harbour	
Styles I		500–(784)–1090 N=50	15.0–(23.5)–41.3
Styles II		1250–(1533)–1875	22.5–(29.4)–41.0
Tylostyles I		200–(335)–390 N=50	7.5–(13.6)–20.0
Tylostyles II		350–(453)–620	10.0–(13.8)–18.3
Tylostyles III		118–(165)–215	2.8–(4.3)–5.0
RBCM 980-342-4		Shapland Cove	
Styles I		720–(917)–1100	13.8–(18.2)–21.3
Styles II		1500–(2731)–3475	10.0–(16.1)–22.5
Tylostyles I		200–(268)–380	7.5–(15.1)–25.0
Tylostyles II		320–(499)–710 N=50	15.0–(23.7)–33.8
Tylostyles III		130–(174)–210	3.8–(4.8)–6.3
RBCM 999-213-8		Morseby Island, Rose Inlet	
Styles I		790–(1137)–1440	13.8–(21.1)–27.5
Styles II		2125–(2263)–2400 N=2	10.0–(12.5)–15.0
Tylostyles I		200–(307)–410	11.3–(16.4)–21.8
Tylostyles II		420–(542)–650	16.3–(22.6)–30.5
Tylostyles III		90–(136)–183	3.0–(4.5)–5.5

**TABLE 6.** Percent of Tylostyle Types in the *Polymastia pachymastia* de Laubenfels, 1932, Ectosome.

Specimen	Proportion Range		
	Tylostyle I	Tylostyle II	Tylostyle III
Holotype	18–32%	5–21%	47–78%
BC 1	16–30%	6–16%	63–72%
BC 2	13–51%	3–10%	46–84%
BC 3	27–43%	2–11%	53–65%
BC4	37–56%	5–7%	39–57%
Total	13–56%	2–21%	39–84%

Tylostyles I: 143–380 µm      Tylostyles II; 450–750 µm      Tylostyles III: 55–173 µm

BC specimens were random samples from the south to central coast.



**FIGURE 8.** *Polymastia pachymastia* de Laubenfels, 1932. A, fistulae expanded and oscula open, scale bar approx. 1 cm; B, fistulae contracted and oscula closed, scale bar approx. 1 cm; C, yellow specimen, scale bar approx. 1 cm; D, large specimen, scale bar approx. 10 cm; E, SEM cross section showing palisade of small tylostyles in ectosome, and long styles extending beyond ectosome, scale bar 1 cm; F, style I, scale bar 500 µm; G, head of style I, scale bar 20 µm; H, tylostyle I, scale bar 100 µm; I, tylostyle I head, scale bar 30 µm; J, tylostyle III, scale bar 300 µm; K, head and foot of tylostyle III, scale bar 100 µm; L, tylostyle II, scale bar 50 µm; M, head of tylostyle II, scale bar 10 µm.

**Remarks.** De Laubenfels (1932) noted a relative scarcity of small tylostyles in the ectosome of the type specimen. This would set *Polymastia pachymastia* apart from other NE Pacific *Polymastia* (*P. kurilensis*, *P. pacifica*, *P. piscesae*). However, our re-examination of the type specimen from central California (Table 5) indicated the ectosome had a palisade composed of 47% to 78% small tylostyles interspersed among the larger

spicules. In four specimens from BC the small tylostyles (tylostyles III) are as abundant, or more abundant, than the long (type II) tylostyles in the ectosome (Table 3). *Polymastia laganoides* Lambe, 1893b (Table 3) is the only species recorded in the north Pacific that lacks a palisade of small tylostyles. Small tylostyles are present in the ectosome but are irregularly distributed. *Polymastia laganoides* has only a few wartlike fistulae (Fig. 6B).

De Laubenfels (1932) named *P. pachymastia* for its characteristic short, wide fistulae. Specimens we have examined may have shorter or longer fistulae, but the basal diameter is wide compared to other species recorded from the North Pacific, except for *Polymastia affinis* Thiele, 1898 (Fig. 6G). The bases of the fistulae are up to 1.1 cm in diameter in both species. The height of the fistulae may be not much greater than the width, and they form blunt cones (Fig. 6G, Fig. 8B).

The two species differ as follows: style II is somewhat longer in *P. affinis* than in *P. pachymastia* while style I is 80% longer in *P. pachymastia* than in *P. affinis*. Also, *P. affinis* is recorded from 102–303 m depth (Koltun 1966); while *P. pachymastia* occurs in intertidal and shallow (0–40 m) waters. Shallow water (13–16 m) specimens in Sagami Bay, Japan identified as *P. affinis* (Tanita *et al.* 1989) are most likely another species based on the short (520–750 µm) large subtylostyles.

**Conclusions.** An absence or paucity of small tylostyles in a cortical palisade of *P. pachymastia* is not supported by the evidence in our study, and hence cannot be invoked to set off *P. pachymastia* from other North Pacific species. The form and size of the fistulae differ from other recorded North Pacific species of *Polymastia* except for *P. affinis*. Differences in style length and bathymetric distribution from *P. affinis* support maintaining *P. polymastia* as a separate species. *P. pachymastia* is easily distinguished visually from other *Polymastia* found within its range based on the large (1–2 cm) basal diameter of the fistulae.

**Bathymetric range.** Intertidal to 40 m depth; most common in the shallow subtidal,

**Geographic distribution.** Southern California to Aleutian I., Alaska (USA).

**Ecology.** We frequently encountered *Polymastia pachymastia* in shallow water along the NE Pacific coast. It settles on hard substrates but can tolerate a moderate level of sediment deposition, possibly due to the oscula and ostia being located on raised fistulae. We found it on both horizontal and inclined surfaces and in current-swept or calm waters.

### *Polymastia pacifica* Lambe, 1893b

Fig. 9A–G

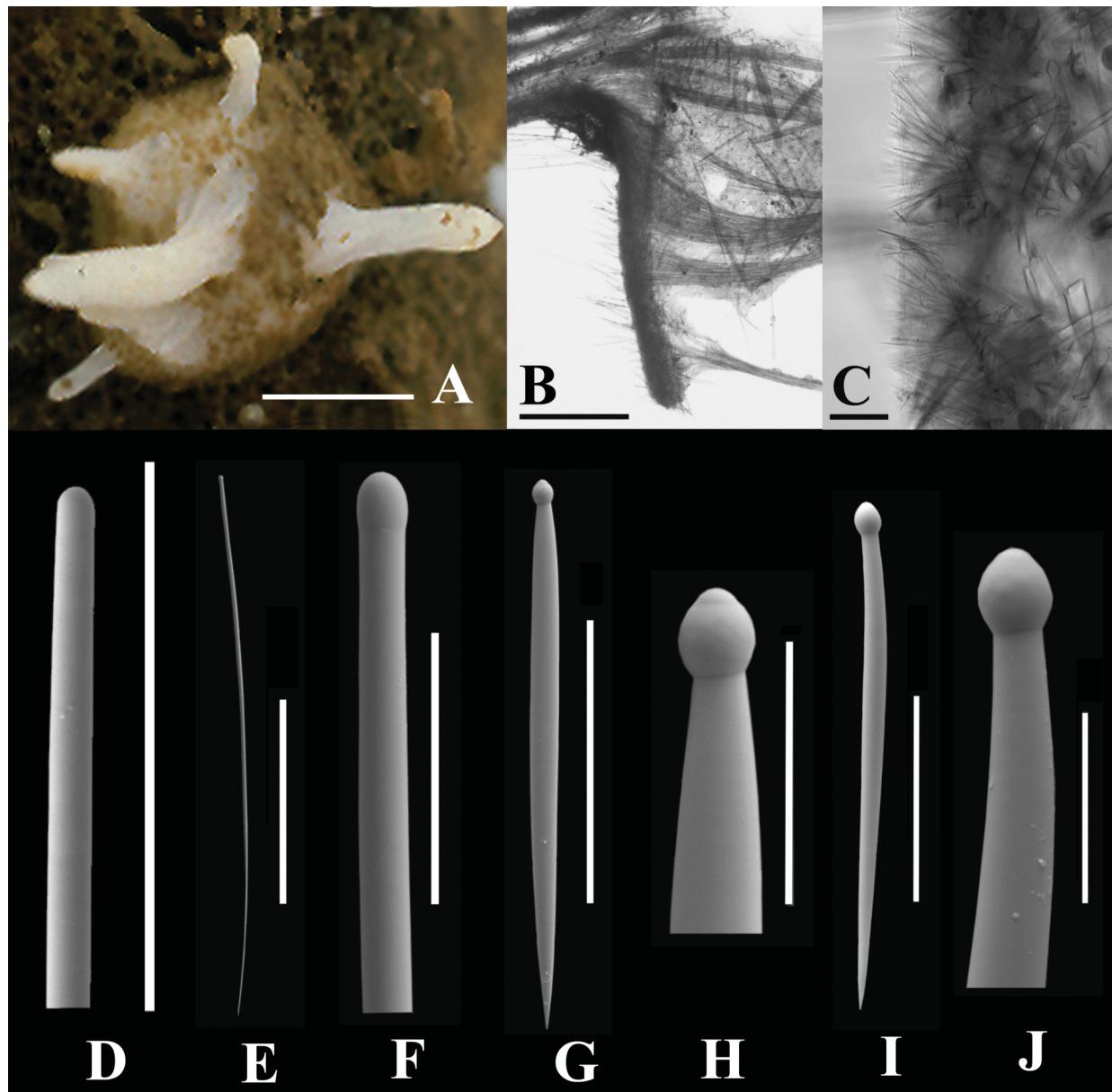
Non *Polymastia pacifica* Koltun, 1966, a junior synonym.

**Material examined.** Holotype: CMN 1900-2885, near Comox, Strait of Georgia, BC, (approx. 49° 42'N, 124° 50'W), 73 m depth, Jun. 24, 1885, coll. G. M. Dawson.

Other material: KML 1026, KML sta. 19/76, Princess Royal Reach, Jervis Inlet, BC, (50° 01.0'N, 123° 56.5'W) 30, 70 m depth, Mar. 15, 1976, coll. W.C. Austin; KML 1027, sta. 25/76, entrance to Prince of Wales Reach, Jervis Inlet, BC, (49° 47.6'N, 123° 56.8'W), Mar. 16, 1976; coll. W.C. Austin; KML 1028, KML sta. 27/76, Cullodon Point, Jervis Inlet, BC, (49° 47.5'N, 124° 04.6'W), no depth, Mar. 17, 1976, coll. W.C. Austin; KML 1029, KML sta. 137/76, S. of Swale Rock, Barkley Sd., BC, (48° 55.0'N, 125° 13.1'W), 45, 52 m, depth, Aug. 3, 1976, coll. W.C. Austin; KML 1337, NM 291, Croker I., Indian Arm, BC, (49° 25.76'N, 121° 51.89'W), 15 m depth, Sept. 20, 2012, coll. N. McDaniel; KML 1339, NM 292, Croker I., Indian Arm, BC, (49° 25.76'N, 121° 51.89'W), 15 m depth, Sept. 20, 2012, coll. N. McDaniel; KML 1340, NM 293, Croker I., Indian Arm, BC, (49° 25.76'N, 121° 51.89'W), 15 m depth, Sept. 20, 2012, coll. N. McDaniel.

Field images, KML 1030, Pulalli Point, South Fingers Wall, Dabob Bay, Hood Canal, Washington, (47° 44.0'N, 122° 51.2'W), 20–30 m depth, Apr. 4, 2009, coll. & photo Janna Nichols, Greg Jensen; KML 1337, NM 291, Croker I., Indian Arm, BC, (49° 25.76'N, 121° 51.89'W), 15 m depth, Sept. 20, 2012, photo N. McDaniel.

**Description.** *Macroscopic features.* (Fig. 9A). Sponge forming encrustations 7–30 mm long by 7–12 mm wide by 2–10 mm thick. Fistulae largely cylindrical but some slightly flattened, 2–7 (occasionally to 15) mm high and 1.5–2 mm in diameter. Number of fistulae from 1 per smallest sponge to 18 in largest sponge observed. Oscula at the summit of some fistulae, 0.5–1 mm diameter; other fistulae appearing blind. Surface hispid from projecting spicules; surfaces of fistulae basally microhispid and apically smooth. Consistency firm and only slightly compressible. Live colour: fistulae beige to white, basal part brown due to entrapped silt.



**FIGURE 9.** *Polymastia pacifica* Lambe, 1893b. A, large living specimen, scale bar 1 cm; B, cross section showing fibre tracts extending to ectosome, scale bar 1 mm; C, palisade of small tylostyles in ectosome, scale bar 50 µm; D, head of style I, scale bar 50 µm; E, subtylostyle II, scale bar 500 µm; F, head of subtylostyle II, scale bar 50 µm; G, tylostyle I, scale bar 200 µm; H, head of tylostyle I, scale bar 50 µm; I, tylostyle II, scale bar 30 µm; J, head of tylostyle II, scale bar 10 µm.

**Microscopic features.** (Fig. 9B, 9C). Ectosome composed of cortical layer 0.5 mm thick, nearly cartilaginous. Palisade of tylostyles of all sizes embedded in cortex, apices outward; short tylostyles concentrated in ectosome. Long thin subtylostyles II with apices projecting outward up to 1 mm from main sponge body, originating in choanosome. Fistulae supported by tracts of short tylostyles. Tracts forming distinct canals in fistulae, terminating in osculum at apex. Tylostyles apically arranged more or less in parallel with long axis of fistulae with majority of apices pointing up. Tylostyles penetrating surface of fistulae basally up to 300 µm and main body up to 700 µm. Choanosome with long styles to subtylostyles I in radiating tracts 100–200 µm thick with intermediate and small tylostyles in random distribution throughout. Disposition of long, thin, surface-echinating subtylostyles at right angle to surface. No apparent basal specialization of choanosomal skeleton.

**Spicules.** Spicule complement including very long, thin styles to subtylostyles I echinating the main sponge body (Fig. 9D), long, thin subtylostyles II (Fig. 9E–F), long thin tylostyles I (Fig. 9G) and shorter fusiform, occasionally bent, tylostyles II (Fig. 9I,) with well developed heads; both tylostyles occasionally polytylote. Tylostyles II occasionally with subterminal heads (Fig. 9J). Spicule measurements from five specimens are listed in Table 7.

**TABLE 7.** *Polymastia pacifica* Lambe, 1893, spicule dimensions.

	Spicule Type	Length	Width	N
KML1026	Subtylostyles	900–(1405)–2000	10–(15.1)–17	25
	Tylostyles I	500–(803)–1000	13–(17)–20	25
	Tylostyles II	65–(352)–460	5–(18)–25	25
KML1297	Subtylostyles	522–(850)–2205	9.9–(15.5)–19.8	50
	Tylostyles I	177–(265)–443	5.0–(12.2)–22.3	50
	Tylostyles II	67–(89)–161	2.5–(3.6)–7.4	50
KML1322	Subtylostyles I	310–(675)–1120	7.5–(13.9)–22.5	100
	Subtylostyles II	1000–(1392)–2325	7.5–(13.0)–20.0	50
	Tylostyles I	148–(323)–630	4.5–(13.2)–25	100
	Tylostyles II	70–(101)–205	2.5–(4.2)–7.5	100
KML1323	Subtylostyles I	290–(670)–940	7.5–(13.6)–17.5	100
	Subtylostyles II	640–(1555)–2500	7.5–(12.9)–17.5	50
	Tylostyles I	140–(335)–690	7.5–(13.3)–22.5	100
	Tylostyles II	62.5–(95)–170	2.5–(3.4)–8.75	100
KML1324	Subtylostyles I	350–(774)–1050	6.5–(11.9)–22.5	100
	Subtylostyles II	1100–(1647)–2325	10.0–(14.3)–20.0	50
	Tylostyles I	110–(304)–510	4.5–(11.2)–27.5	100
	Tylostyles II	31.5–(61)–102.5	2.5–(3.8)–5.5	100

**Remarks.** Lambe (1893a) described four spicule types, viz. two types of subtylostyles (739–1205 x 13–19 µm, forming radial multisicular tracts, and 1000–3000 µm, echinating the main body surface), and two types of tylostyles (191–630 x 19 µm in the inner cortex, and 108 x 6 µm, forming a palisade in the ectosome and scattered in the choanosome). The smaller tylostyles II that we measured fit Lambe's ectosomal tylostyles and are located in this position in our specimens. The long subtylostyles (to 2500 µm in our specimens) echinate the body and are not found in the fistulae.

*Polymastia pacifica* is here distinguished from *P. pachymastia* based on its distribution (ranging from shallow [15 m] to deep [at least 100 m] for *P. pacifica* vs. mostly shallow to intertidal for *P. pachymastia*) and spicule compliment (*pachymastia*: 2 styles to subtylostyles, 3 tylostyles; *pacifica*: 2 subtylostyles, 2 tylostyles). *Polymastia pacifica* has invariably small (0.5–3 mm basal diameter) fistulae, whereas *P. pachymastia* has many large (1–2 cm basal diameter) fistulae. Very small individuals of *Polymastia pacifica* typically have only one or two fistulae. The fistulae of *P. pachymastia* are conical ( $L/W < 2.2$ ) while in *P. pacifica* they are cylindrical ( $L/W > 3$ ). *Polymastia pacifica* fistulae are similar to small *P. toporoki* but, unlike *P. toporoki*, fistulae do not grow close together in larger specimens; *P. pacifica* has four types of spicules (two tylostyles and two subtylostyles to styles), whereas *P. toporoki* has only two types of tylostyles.

*Polymastia pacifica* reported for the Aleutians (Stone *et al.* 2011) is bright orange in life and several cm thick which is uncharacteristic of any specimens we have examined which are white with the main body usually discoloured brown from sediment and a main body a few mm thick.

**Conclusions.** There are no other *Polymastia* species recorded from the north Pacific which have small, cylindrical fistulae. We conclude that *Polymastia pacifica* is a distinct species. The synonymy of *Polymastia pacifica* Koltun 1966 not Lambe 1893b needs to be addressed.

**Bathymetric range.** From 15 to at least 180 m depth.

**Geographic distribution.** Southern British Columbia in Jervis Inlet, Indian Arm, Barkley Sd., Comox and in Hood Canal (Washington). Records from southern California (Green & Bakus 1994) are based on the supposition that presence of small tylostyles in the cortex palisade excludes *P. pachymastia*, and their material probably represents *P. pacifica*. Records from the Aleutian Islands, Alaska may not be this species (see previous comment).

**Ecology.** This species occurred on dead hexactinosan sponges in Jervis Inlet in areas where currents are weak. It also occurred on rocks at Pulali Point, Hood Canal, which has only weak currents and in similar conditions in Indian Arm and Sechelt Inlet, BC.

***Polymastia piscesae n. sp.***

Fig. 10A–I

**Etymology.** The species was named after *PISCES IV*, the submersible used to collect this species and many others in BC deep waters.

**Material examined.** Holotype: RBCM 009-00054-001, KML sta. 186/83, Observatory Inlet, BC, (55° 16.9'N, 129° 48.4'W), 213 m depth, coll. W.C. Austin, 1 specimen.

**Description.** *Macroscopic features.* Fig. 10A. Sponge cushion-shaped; sampled fragment about 6 cm in greatest diameter by 1.2 cm thick, smooth in some regions, microhispid in others (spicules protrude 0.3–0.5 mm). Fistulae 1–1.8 cm high by 2.5–4 mm wide at base. Fistulae densely distributed across sponge surface (2 per mm<sup>2</sup>), conical or flattened with pointed apices. Three fistulae in the sample contain an osculum; the others are thinner and pointed with no indication of an apical opening. A cross section 1 mm back of the apex revealed 10 equal-sized 100 µm diameter canals. Colour in alcohol grey; fistulae cream colour.

*Microscopic features,* Fig. 10B. Ectosome of main body cortical, 0.8 to 1 mm thick, with palisade of small tylostyles, apices outward, piercing surface. Underlain by intermediate tylostyles, mostly tangential to surface. Small tylostyles abundant.

Fistulae canals lined by tangential layer of intermediate tylostyles. Intermediate-size tylostyles at surface, forming discontinuous superficial palisade and extending up to 100 µm beyond the surface. Principal multispicular tracts radiating from choanosome into base of fistulae, but not penetrating fistular surface.

Choanosome composed of radiating multi-spicule tracts up to 5 mm thick, composed of principle styles or occasional subtyloites. Intermediate and small tylostyles scattered throughout choanosome. Principal spicules extending into ectosome, may or may not penetrate outer surface.

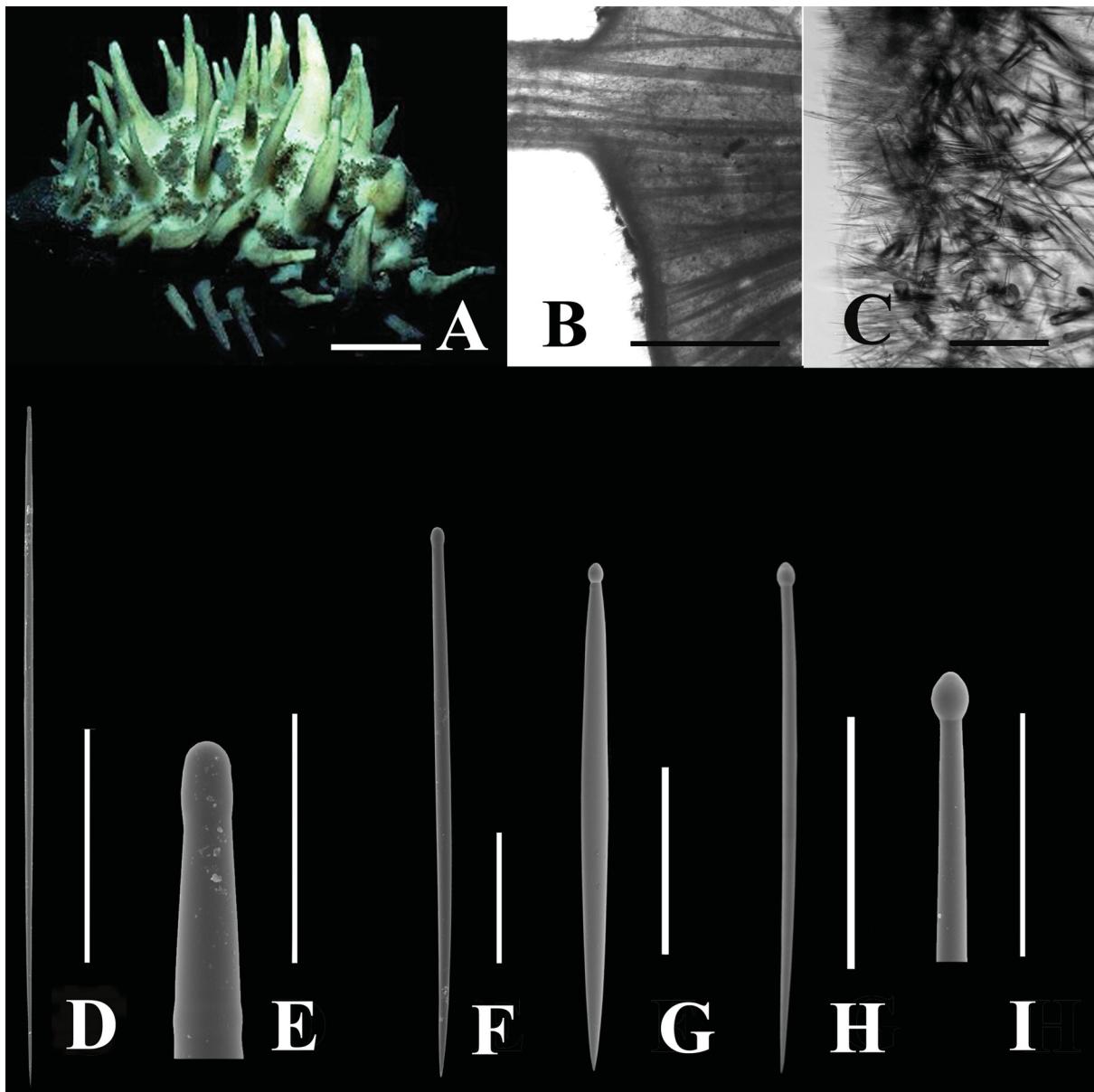
*Spicules.* Principal styles to subtylostyles straight to slightly curved (I). Intermediate tylostyles to subtylostyles (II), slightly curved, rarely fusiform; small tylostyles.

Holotype RBCM 009-00054-001

Spicule Type	Fig.	Length	Width
Styles to subtylostyles I	10D, E	860–(1268)–1600	15–(20)–25
Subtylostyles to tylostyles II	10F–G	230–(384)–580	9–(10)–13
Subtylostyles to tylostyles III	10H, I	88–(164)–220	3–(7)–10

**Remarks.** *P. piscesae n. sp.* is compared with other *Polymastia* species known from the N. Pacific in Table 3, Table 4 and Fig. 6. *Polymastia kurilensis* has only two types of tylostyles with the smaller forming an ectosomal palisade in contrast to three types of tylostyles and the lack of spines in *P. piscesae n. sp.* *Polymastia pachymastia* has stouter fistulae than *P. piscesae n. sp.*, a different spicule compliment, and occurs in intertidal to shallow depths. *Polymastia pacifica* has cylindrical fistulae which are much smaller than the cone-shaped fistulae in *P. piscesae n. sp.* *Polymastia granulosa* Brøndsted, 1924 has principal subtylostyles which are approximately 40% of the length of those in *P. piscesae n. sp.* *Polymastia lagamoides* lacks a palisade of small tylostyles, and has fistulae which are low warty protuberances; its megascleres are exclusively tylostyles rather than styles to subtylostyles. *Polymastia affinis* Thiele, 1898 has very large (to 6 mm) echinating styles, and fistulae are small and papillose, which is again different from *P. piscesae n. sp.* Both *Polymastia affinis* Thiele, 1898 and *Polymastia fluegeli* Lehnert, Stone & Heimler, 2005 have shorter and fatter fistulae than those in *P. piscesae n. sp.*

Differences in size and form between two types of fistulae in *P. piscesae* suggest they have separate inhalant and exhalent functions. This is confirmed by the presence of 10 equal-sized canals with no larger central canal in the thinner pointed fistulae indicating that they are solely inhalant.



**FIGURE 10.** *Polymastia piscesae* n. sp. A, large living specimen, scale bar approx. 1 cm; B, cross section showing fibre tracts extending to ectosome, scale bar 3 mm; C, palisade of small tylostyles in ectosome, scale bar 300 µm; D, style I, scale bar 500 µm; E, head of style I, scale bar 50 µm; F, subtylostyle II, scale bar 100 µm; G, tylostyle II, scale bar 50 µm; H, fusiform tylostyle III, scale bar 200 µm; I, head of tylostyle III, scale bar 10 µm.

In terms of the abundance, shape (elongate pointed inflated or flattened cones) and size (0.8 cm diam, 1.7 cm) of the fistulae, our specimen externally bears a strong resemblance to the smaller (5 cm x 6 cm) specimen of “*Polymastia robusta toporoki*” figured in Koltun (1966; Fig. 7). Koltun (1966) included *Polymastia euplectella* Resvoj 1927 as a synonym of *Polymastia robusta*. However, Plotkin (2004) considered *Polymastia euplectella* to be a valid species and he reported several differences from *Polymastia robusta* as characterized by Boury-Esnault (1987). These characters include: fistula length—*P. euplectella* (2–5 cm), *P. robusta* (0.2–0.8 cm), *P. piscesae* n. sp. (1–1.7 cm); exhalent and inhalant fistula—*P. euplectella* (present), *P. robusta* (absent), *P. piscesae* n. sp. (present); number of spicule types—*P. euplectella* (3), *P. robusta* (2), *P. piscesae* n. sp. (3).

The fistulae of *P. euplectella* are considerably larger than in our species. *Polymastia euplectella* has also not been recorded from the Pacific. *Polymastia robusta* has only 2 spicule types, lacking an intermediate tylostyle size class. It also does not have separate exhalent and inhalant fistulae as in *P. piscesae*.

**Conclusions.** We conclude that our specimen represents a new species based on differences in form and differential function of the fistulae from all North Pacific species. *Polymastia euplectella* has larger fistulae and occurs only in the Atlantic.

**Bathymetric range.** 213 m depth.

**Geographic distribution.** Known from the type locality only, Observatory Inlet, BC.

## Genus *Radiella* Schmidt, 1870

### *Radiella endeavourensis* n. sp.

Fig. 11A–H

**Etymology.** The species is named after Endeavour Ridge, the site of hydrothermal vent systems off Washington and British Columbia, where the holotype was collected.

**Material examined.** Holotype: RBCM 009-00052-001, sta, A1448, Endeavour Ridge, BC/Washington, (approx. 47° 42'N, 129° 13'W), 2500 m depth, May 4, 1984, coll. V. Tunnicliffe, 1 specimen.

**Description.** *Macroscopic features.* (Fig. 11A, B). Sponge size 11.1 x 7 x 6 mm high. Form: subspherical, upper surface convex, lower surface concave. Three or more conical fistulae range from 0.2–1 mm in diameter and 0.2–1.5 mm in height. Spicule tracts radiate to and along the fistulae. Main body of the sponge hispid with spicules extending beyond the surface 0.5–0.9 mm. Preserved sponge firm but compressible. Colour in life unknown; colour in alcohol variegated brown with white papillae and a white fringe around the base.

*Microscopic features* (Fig. 11C, D). Ectosome up to 2 mm thick. Low density portion up to 1 mm thick adjacent to the choanosome; largely supported by relatively few spicules (fusiform tylostyle type II) with no particular orientation. Periodically multispicular tracts 0.2–0.3 mm in diameter with tangentially aligned (sub)tylostyles I radiate from the choanosome to a layer of short fusiform tylostyles II which form a palisade at right angles to the surface, and are disposed randomly throughout the sponge. Some subtylostyles extend beyond the surface as noted above. A layer of straight, thin subtylostyles radiates out from the center of the lower surface where it forms a thatch.

**Spicules.** Spicules are composed of three types: 1) Principal tylostyles (I) fusiform, bent on the long axis, typically tylote but may be subtylote with ovoid heads; 2) Smaller fusiform tylostyles (II); 3) Straight, thin subtylostyles up to 2.6 mm long (many broken and could have been longer). Only 10 unbroken subtylostyles were found.

Holotype RBCM 009-00052-001

Spicule Type	Fig.	Length µm	Width µm
(Sub)Tylostyle I	11E, F	1070–(1697)–2230	20–(24.3)–30
Tylostyle II	11G, H	360–(541)–730	12.4–(16.8)–20
Subtylostyles	No fig.	to 2.6 mm, N=10	30, N=10

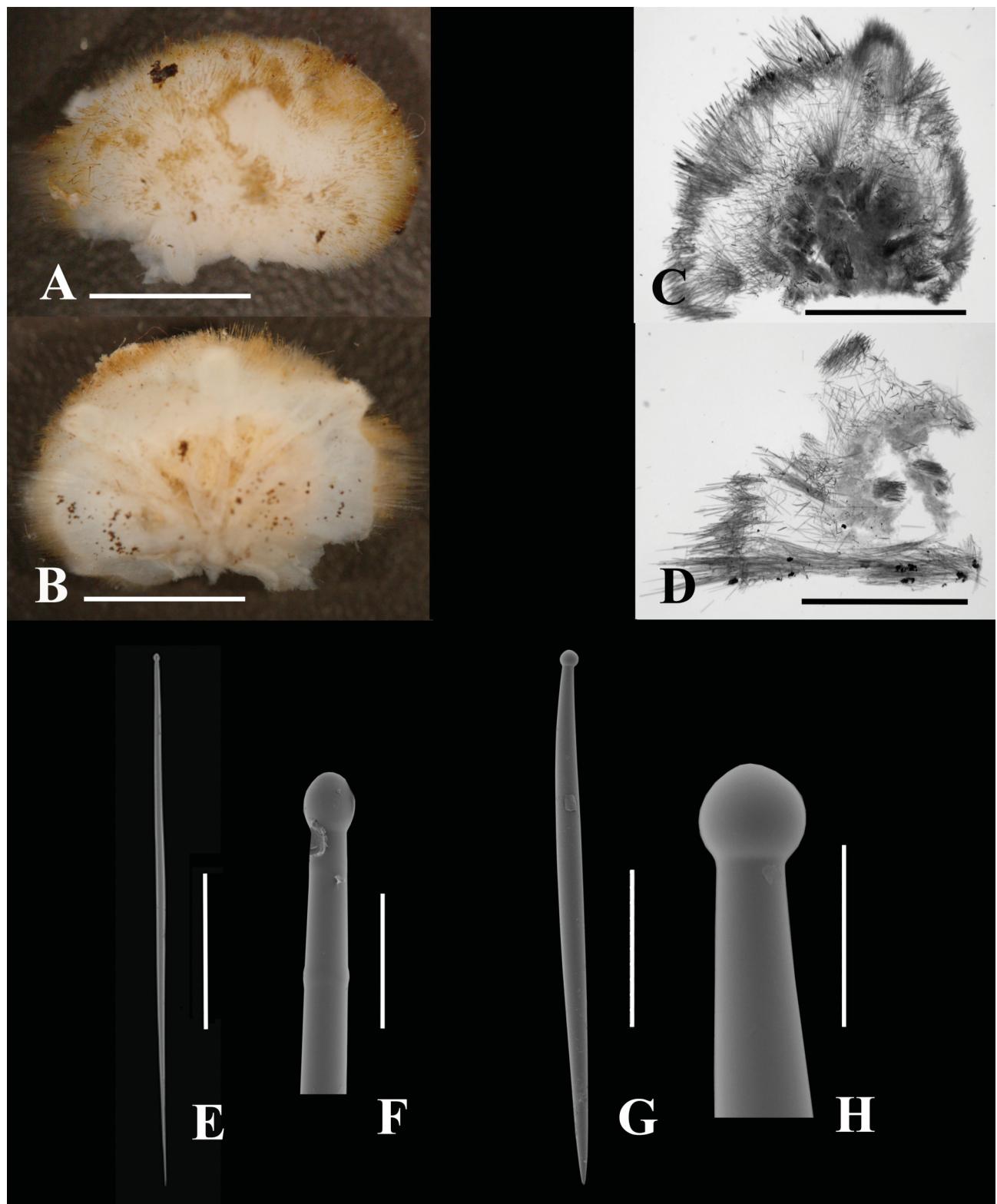
**Remarks.** Our sponge fits the diagnosis for *Radiella* (synonym *Trichostemma*) (Boury-Esnault 2002). Given that *Radiella* spp. are deep water, we compared our specimen with known species from all oceans (Table 8). Character sets are based on: *R. sarsii* (Plotkin 2004, Uriz & Rosell 1990); *R. sol.* (Boury-Esnault 2002); *R. hemisphaericum* (Koltun 1966, Plotkin 2004); *R. straticularis* (Wilson 1925); *R. irregularis* (Ridley & Dendy 1887); *R. antarctica* (Plotkin & Janussen 2008); *R. endeavourensis* n. sp. (Austin *et al.*) this paper.

Table 8 compares *Radiella* species. Not included in Table 8 are: *Radiella conica* (Hansen 1885) and *R. alvea* (Hansen 1885) as there is insufficient information about them (Atlantic Arctic).

In comparing our specimen from Endeavour Seamount with other species we note the following:

- Our multi-oscular specimen differs from two species with a single osculum: *R. sarsii* and *R. antarctica*.
- Our specimen has minimum size ectosomal tylostyles of 360 µm compared to minimal sizes ranging from 125–290 µm in four other species where there are measurements (*R. antarctica*, *R. hemisphaericum*, *R. sarsii*, and *R. sol*).

- Our specimen has spicules both randomly arranged and clearly radially arranged in the choanosome compared to only randomly arranged in two other species (*R. sarsii*, *R. irregularis*).
- Our specimen has only two layers in the ectosome compared to three layers in *R. straticularis*.



**FIGURE 11.** *Radiella endeavourensis* n. sp. A, upper surface of preserved specimen, scale bar 5 mm; B, cross section, scale bar 5 mm; C, showing peripheral palisade of megascleres, scale bar 3 mm; D, thick section, scale bar 3 mm, note layer of megascleres parallel with lower surface (lower left); E, (sub)tylostyle I, scale bar 500 µm; F, head of same, scale bar 50 µm; G, tylostyle II, scale bar 100 µm; H, head of same, scale bar 20 µm; (no image of large styles).

TABLE 8. *Radiella* Species Comparisons

Character	<i>sarsii</i>	<i>sol</i>	<i>hemisph</i>	<i>stratic</i>	<i>irreg</i>	<i>antarc</i>	<i>endeav</i>
Location	NE Atl Arctic S. Pacif.	Cuba	NE Atl Arctic	Phil	Chile	Antarc	NE Pac
Depth in m	10–225 –2630	1116	175–790	2021	3950	2086–4800	2500
Fistulae No.	1	15	2–many	6–8	2+	1	1 lg, 3+ sm.
Fistulae height		1 mm		0.5 mm		0.5–4 mm	1.5 mm
Body size/form	1 cm	2 cm	3–6.5 cm	0.9–2 cm		0.9 cm	1.1 cm
Upper surface	Concave			Concave	1.7 cm		
Lower surface	Convex			Convex	Concave <sup>1</sup>		
Upper ectosome				Convex	Convex		
choanosome	confused		Palisade + tangent Radial tracts	3 layered	Bouquets + palisade	2 layered	
Lower ectosome	thatch		Thatch + thin palisade ?		Radial tracts confused	Radial tracts	
Principals µm	Tylote 871–2900	Subtylo 795–2290	Style–subtylo 2280–5400	1000–2000	Often much >500	Envelope Princip.	
Intermed µm	Subtyl 152–290	Tylostyles 460–620	?	300–900	Common 500	Thatch Subtylo 957–2686	Princip. Thatch Subtylo 1070–2230
small		490–618				No sep. Size class	Size class
Ectosomal µm	Subtyl 250–600	Tylotyles 290–390	Tylo 160–305	Tylo 500x12	Project up to 1 mm	Subtylo 125–350– 1271	Tylo 360– 730
large		5090–6030		Style–subtylo 4990–8010	Present But no details	Subtylo 700 2500–5600	subtylostyles 2600
Basal Fringe µm	Tylot/sub 5090–6030	Subtylo >5000			0	0	0
Peripheral not basal cortex	0	0	0		10	Weakly hispid (1 mm)	Weakly Hispid (0.5 mm)
No. specimens							1
Upper surface							

<sup>1</sup>reversed in 1 specimen: Upper surface convex and lower surface concave.

**Conclusion.** The four features noted in our specimen are not found together in any other adequately described species. Ideally more specimens would help to identify infraspecies variability. Also, more characters could be assessed by looking at types for several species which were poorly described in the 1880s. However, at this time we propose that our specimen be considered a new species, *R. endeavourensis*.

**Bathymetric range.** 2500 m depth.

**Geographic distribution.** Endeavour Ridge, 47° 42'N, 129° 13'W. This constitutes the first record for a *Radiella* sp. from the NE Pacific.

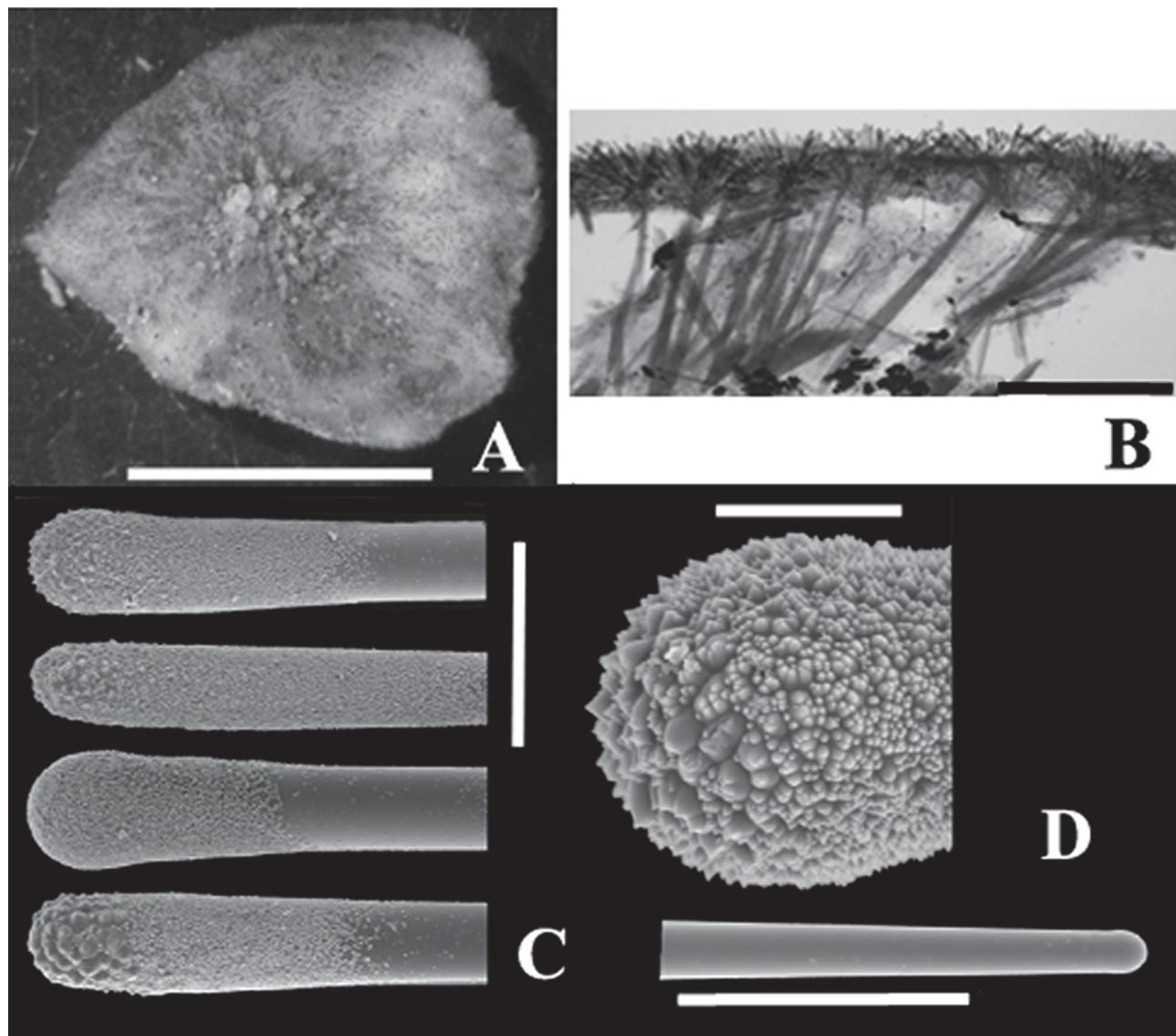
**Ecology.** There is no substrate information on the single specimen we examined. The sponge was not attached to anything when collected.

### Genus *Sphaerotylus* Topsent, 1898

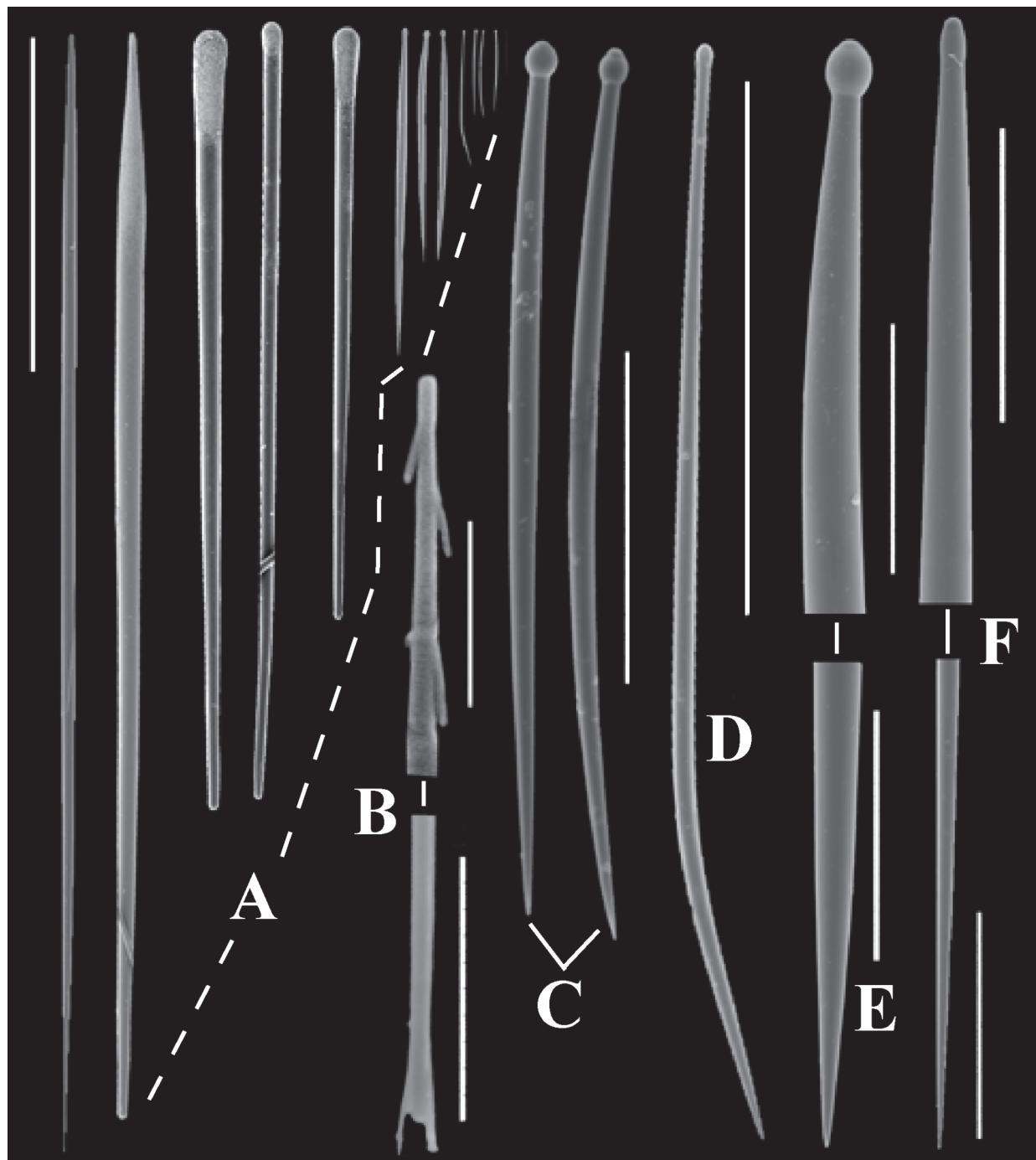
#### *Sphaerotylus raphidophora* n. sp.

Figs. 12A–D, 13A–F

**Etymology.** The species name, *raphidophora*, reflects its raphide bearing character.



**FIGURE 12.** *Sphaerotylus raphidophora* n. sp. A, whole specimen preserved in alcohol, scale bar 1 cm; B, section showing tracts of megascleres radiating out to ectosome with protruding exotyles, scale bar 2 mm; C, exotyles showing expanded and stylote end, scale bar 100  $\mu$ m; D, detail of expanded end, scale bar 20  $\mu$ m.



**FIGURE 13.** *Sphaerotylus raphidophora* n. sp. (cont.) A, composite of all spicule types at same magnification, scale bar 500  $\mu\text{m}$ ; B, raphides, scale bar upper 3  $\mu\text{m}$  and lower 5  $\mu\text{m}$ ; C, small tylostyles, scale bar 50  $\mu\text{m}$ ; D, small subtylostyle, scale bar 100  $\mu\text{m}$ ; E, medium tylostyle, scale bar 50  $\mu\text{m}$ ; F, large subtylostyle, scale bar 100  $\mu\text{m}$ .

**Material examined.** Holotype: USNM 1231336, NOAA 2004 Exploring Alaska's Seamounts Expedition, *Alvin* Dive 4040, Giacomini Seamount, Gulf of Alaska, ( $56^{\circ} 25.43'\text{N}$ ,  $146^{\circ} 22.28'\text{W}$ ), 862 m depth, Aug. 16, 2004.

**Description. Macroscopic features.** Specimen irregular button shape about 1.6–1.7 cm in diameter by 6.9 mm (Fig. 12A). No papillae present; however, one or more may have broken off. Colour in alcohol “yellow-brown”.

**Microscopic features.** Skeleton composed of a palisade of megascleres, many with rounded tips protruding from the surface. Longitudinal tracts of megascleres radiate out through the choanosome to end at the base of the ectosome (Fig. 12B).

**Spicules.** Spicule complement includes exostyles (Fig. 13A), two classes of tylostyles (small, Fig 13C, D), (medium, Fig. 13E), large subtylostyles (Fig. 13F), and raphides (Fig. 13B). Megascleres in the ectosome include

exyles which have a granulated head ranging from stylote to tylote (Fig. 12C, D). They are strongylote rather than stylote at the other end. Small styles to tylostyles occur in the ectosome (Fig. 13C) while large subtylostyles form the longitudinal tracts in the choanosome (Fig. 13D). Additional medium size tylostyles occur between the tracts (Fig. 13E). Raphides bundled in trichodragmata (Fig. 13B) were found in samples from four different locations in the specimen.

Holotype USNM 1231336

Spicule Type	Fig.	Length	Width
Exotyle	13A	568–(890)–1374 N=40	26.0–(38.9)–49.9 N=36
Small tylostye	13C, D	104–(172)–271 N=182	2.0–(3.6)–6.6 N=72
Medium tylostye	13E	228–(418)–613 N=181	10.5–(13.4)–17.8 N=37
Large subtylostyle	13F	711–(1107)–1615 N=77	10.3–(20.4)–25.4 N=32
Raphide	13B	60.8–(72.4)–80.0 N=4	

**Remarks.** We compared spicules in our species with those in *Sphaerotylus* species listed in the World Porifera Database (van Soest *et al.* 2012) (Table 9).

**TABLE 9.** Comparison of spicule sizes ( $\mu\text{m}$ ) and particularly the form and size of the exyles in the species of *Sphaerotylus* listed in van Soest *et al.* (2012) with species described in this paper. The \*denotes that size cut-off between medium and large subtylostyles could have been at about 500  $\mu\text{m}$ .

Spicule type.	Austin <i>et al.</i> this paper	Boury-Esnault <i>ravidophora</i>	Koltun <i>capitatus</i>	Kirkpatrick <i>schoenus</i>	Hentschel <i>vanhoeffeni</i>
Exotyles	s. Alaska	Barents Sea	Arctic	Antarctic	Antarctic
	568–1374	650–950	600–1250	760	504–1080
	stylote-tylote	tylote	subtylote-tylote	spherulote	club
Lg.subtylostyles	granules	granules	granules	granules	granules
	711–1615	753–950	650–1504	1120	840–1416
	Med. tylostyles	314–656	416–605	ca. 365	272–480
Sm.subtylostyles	159–271	213	below part	218	
	Sm. tylostyles	109–141	96–230	ca. 150	104–136
	Raphides	nil	nil	nil	nil
Spicle type	Austin <i>et al.</i> this paper	Koltun / Plotkin <i>verenae</i>	Koltun / Plotkin <i>sceptrum</i>	Kirkpatrick <i>exotylotus</i>	Koltun <i>antarcticus</i>
Exotyles	Off BC/ Washington	NW Pacific	NW Pacific	Antarctic	Barents Sea
	1008–1459	200–250	500–850	8000	5000–7500
	stylote-subtylote	scepter-club	chalice	style-mushroom	mushroom
Lg.subtylostyles	smooth	granules	granules	granules	granules
	1075–1373*	600–1400	700–1700	2800	1100–2100
	Med. tylostyles	370–600	200–500	400	200–792
Sm.subtylostyles		200–400			
	Sm. tylostyles	100–160	100–180	146	102–160
	Raphides	nil	nil	nil	nil

The exotyles and large tylostyles of our species are approximately the same size range as those reported by Koltun (1966) for *S. capitatus* (Koltun, 1966 as *S. schoenus*). *Sphaerotylus schoenus* is currently considered a junior synonym of *S. capitatus*. However, Sollas (1882) only named the species, giving no description nor declaring a type specimen. *Sphaerotylus schoenus* was considered a *nomen nudum* by e.g., Kirkpatrick (1908) and Boury-Esnault (2002).

Our species differs from all other described species of *Sphaerotylus* in having raphides in trichodragmata. These were obvious in samples taken from four different locations in the specimen, and are unlikely to be contaminants. The raphides are not simple cylinders but have lateral branches. Raphides are not unknown among the Polymastiidae. They occur in the genus *Spinularia* (Boury-Esnault 2002).

*Sphaerotylus raphidophora* also differs from *S. capitatus*, *S. schoenus* of Koltun 1966, and *S. exotylotus* Koltun 1970 in having longer exotyles and from *S. antarcticus* Kirkpatrick 1907 and *S. borealis* Swarschewsky 1906 in having much shorter exotyles (Table 9). The large subtylostyles of *S. raphidophora* are also longer than those in *S. capitatus*. The mushroom shaped exotyles of *S. antarcticus* and *S. borealis* differ from those of all other described species of *Sphaerotylus*.

**Conclusions.** We propose that our specimen be considered a new species, *S. raphidophora*, but additional material should be examined from the vicinity of the type locality.

**Bathymetric range.** 862 m depth.

**Geographic distribution.** Giacomini Seamount, Gulf of Alaska.

#### *Sphaerotylus verenae* n. sp.

Fig. 14A–K

**Etymology.** *verenae* refers to Verena Tunnicliffe, Professor in the Biology Department and the School of Earth & Ocean Sciences, University of Victoria, who collected the samples while diving in the submersible *Alvin* off the coast of Washington and BC.

**Material examined.** Holotype: RBCM 009-00053-001, *Alvin* Dive A1443, Endeavour Ridge, off BC/Washington, (47° 48.5'N, 129° 07.5'W), 2220 m depth, Aug. 29, 1984, coll. V. Tunnicliffe, 1 specimen. Paratype: CMNI 2009-0027, KML 1033, *Alvin* Dive A1439, Endeavour Ridge, off BC/Washington, (47° 57.6'N, 129° 06.4'W), 2150 m depth, Aug. 25, 1984, coll. V. Tunnicliffe, 1 specimen.

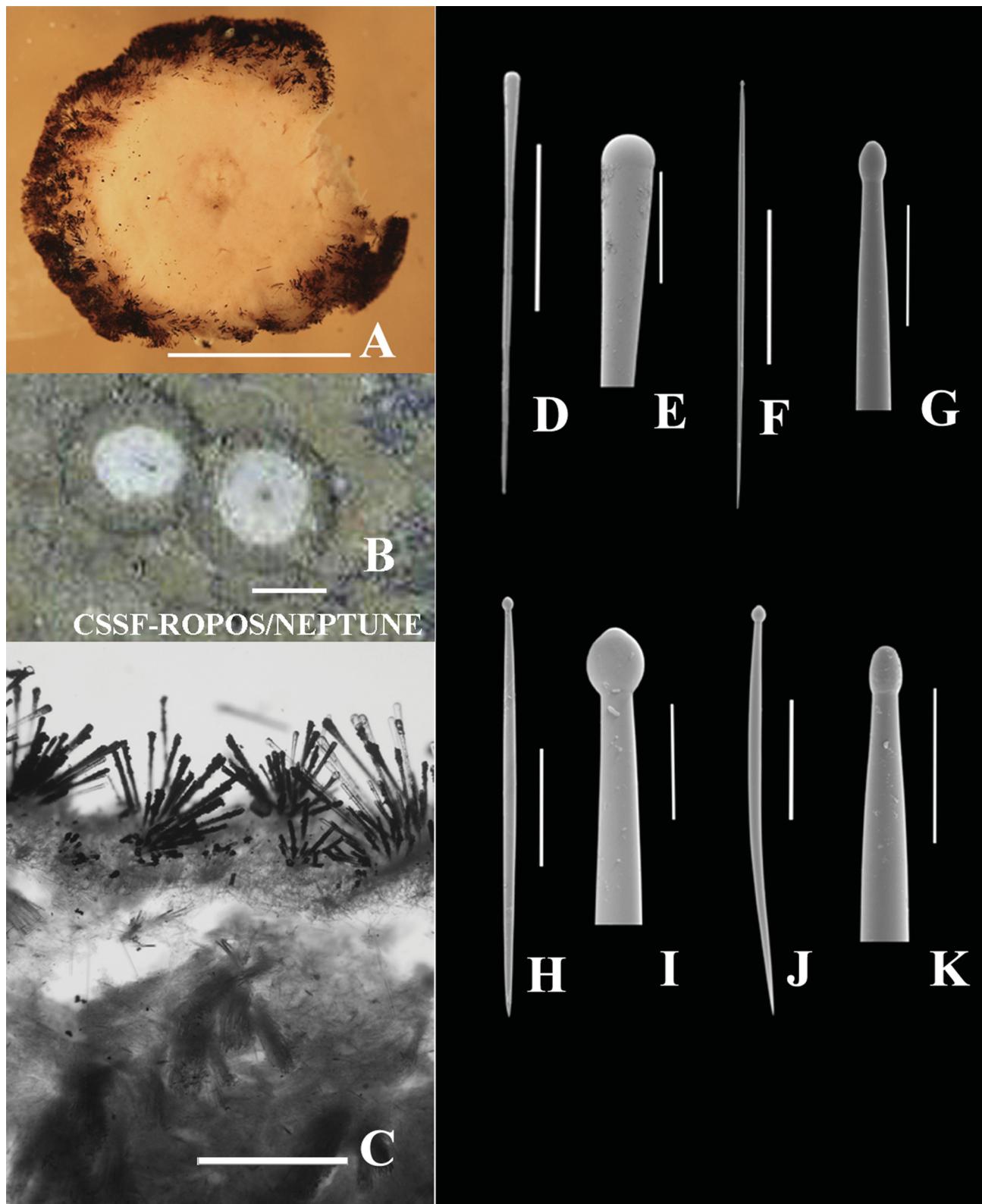
Other material: KML 1033, *Alvin* Dive A1439, Endeavour Ridge, off BC/Washington, (47° 57.6'N, 129° 06.4'W), 2150 m depth, Aug. 25, 1984, coll. V. Tunnicliffe, 2 small specimens; KML 1034, *Alvin* Dive A1436, Rift Valley Floor, (47° 55'N, 129° 06'W), 2196 m depth, Aug. 22, 1984, coll. V. Tunnicliffe, 1 specimen.

Field images without vouchers: CSSF-ROPOS/NEPTUNE: Endeavour Ridge, (47° 57'N, 129° 06'W), off BC/Washington, 2142 m depth, Sept. 14, 2011, several specimens.

**Description.** *Macroscopic features.* (Fig. 14A, B). The largest individual (2.0 cm) has a flattened button shape while the smaller individuals (0.9 cm) are hemispheric. One has a centrally located short papilla with an apical osculum. Colour alive white centre with dark brown peripheral band, in preservative yellowish centre with peripheral brown band.

*Microscopic features.* The ectosome is composed of a dense layer of tangentially arranged medium and small tylostyles with an outer layer of vertically aligned small tylostyles to form a palisade (Fig. 14C). In at least the preserved material this layer is quite tough except in the central region which is soft and easily macerated. This region lacks the layer of tangentially arranged tylostyles. Exotyles project from the ectosome in radiating tufts except in the central area where they are absent. The bases of the exotyles are anchored in the tangential layer. The choanosome includes tracts of large subtylostyles extending to the ectosome (Fig. 14C).

*Spicules.* Spicule types include exotyles, and three classes of subtylostyles/tylostyles. The exotyles have smooth, not granulated heads, and are blackened along part of their length. They are cone shaped; the wide top of the cone rounded, and the narrow bottom of the cone ending in a bulb or substyle. A few exotyles have slightly inflated heads.



**FIGURE 14.** *Sphaerotylus verenae* n. sp. A, Holotype, large specimen preserved in alcohol, scale bar 1 cm; B, in situ specimens, scale bar approximately 1 cm; ; C, section showing tracts of megascleres radiating out to ectosome with exotyles protruding from ectosome, scale bar 1 mm; D, exotyle, scale bar 500  $\mu$ m, and E, head, scale bar 100  $\mu$ m; F, large subtylostyle, scale bar 500  $\mu$ m, and G, head, scale bar 50  $\mu$ m; H, medium tylostyle, scale bar 100  $\mu$ m, and I, head, scale bar 20  $\mu$ m; J, small tylostyle, scale bar 50  $\mu$ m, and K, head, scale bar 10  $\mu$ m.

Spicule Type	Fig.	Length	Width
Exotyle	14D, E	1008–(1275)–1459	19–(48)–67
Large subtylostyle	14F, G	870–(1023)–1500	9.6–(17.5)–21.1
Medium subtylostyle	14H, I	280–(531)–670	7.5–(11.6)–17.5
Small tylostyle	14J, K	96–(114)–142	2.4–(4.0)–5.5

**Remarks.** Table 9 includes the *Sphaerotylus* species recorded in the Porifera Data Base (van Soest *et al.* 2012). *Sphaerotylus verenae n. sp.* differs from the other eight species in having smooth rather than rough exotyle heads. Otherwise, it is similar in spicule forms and size range to *S. capitatus* (including *S. schoenus*). The exotyles in *S. verenae n. sp.* are somewhat longer than the Antarctic *S. vanhoeffen* and the raphid bearing *S. raphidophora*, and are much longer than in *S. sceptrum* and *S. exotylotus*. They are much shorter than in *S. antarcticus* and *S. borealis*.

**Conclusions.** Koltun (1966) in his description of *S. capitatus* (as *S. schoenus*) stated that the head of the exotyles is usually rough and finely dentate. Boury-Esnault (2002) described the exotyle head of *S. capitatus* as a slightly spiny sphere. The spination or roughening is evident in her photograph of type material (Fig. 4D, p. 206). The exotyle heads that we observed in five Endeavour Ridge specimens were invariably smooth under both the light microscope and with SEM. We consider this is a sufficient difference to propose that this material represents a new species *S. verenae n. sp.*

**Bathymetric range.** From 2150–2220 m depth.

**Geographic distribution.** Endeavour Ridge off the British Columbia/Washington coast.

## Genus *Tentorium* Schmidt, 1870

### *Tentorium aff. semisuberites* (Schmidt, 1870)

Fig 15A–J

Northern Hemisphere: *Thecophora semisuberites* Schmidt 1870; *Tentorium semisuberites* Vosmaer 1885; Boury-Esnault 2002; Plotkin 2004.

Southern Hemisphere: Ridley and Dendy 1887; Boury-Esnault and van Beveren 1982; Plotkin & Janussen (2008).

**Material examined.** KML 1341, NM 294, Sakinaw Rock, Sechelt Inlet, BC, (49° 34.075'N, 123° 48.238'W), 24 m depth, Sept. 27, 2012, coll. N. McDaniel; KML 1300, KML 1301, NM 275, supplementary ident. Nos. T1, and T2, Sakinaw Rock, Sechelt Inlet, BC, (49° 34.075'N, 123° 48.238'W), 24 m depth, Feb. 16, 2012, coll. N. McDaniel; KML 1342, Sakinaw Rock, Sechelt Inlet, BC, (49° 34.075'N, 123° 48.238'W), 24 m depth, Dec. 11, 2012, coll. N. McDaniel; KML 1343, Sakinaw Rock, Sechelt Inlet, BC, (49° 34.075'N, 123° 48.238'W), 24 m depth, Dec. 11, 2012; coll. N. McDaniel.

Field images lacking vouchers at same location as above: taken of T4, Feb. 20, March 6, Apr. 12, May 10, and Sept. 27, 2012; T3, May 10, 2012, photos by N. McDaniel and L. Lehmann, first recorded in Agamemnon Channel, BC, at 15–18 m depth, Nov. 17, 2002 by A. Lamb and B. Hanby (photo page 78, Lamb & Hanby 2005). The above two locations are 20 km apart.

**Description.** *Macroscopic features.* KML 1341, expanded in field (Fig. 15A): columnar, somewhat arched on top of column; diameter 6 mm; pores occupy most of space at top of column, none on the sides, single osculum in centre on a papilla. Contracted, preserved in 95% ethyl alcohol: hemispherical, 4 mm high, 3.2 mm in diameter with a basal skirt where the sponge is attached to the substrate around the periphery; unable to distinguish osculum. In field observed rapid (about 5 second) contraction (Fig. 15B) following mechanical disturbance of water with concomitant change from cylindrical to hemispherical shape and contraction of pores so no longer apparent. Attached to bedrock. Colour alive white on top of cylinder, light tan on sides of cylinder. KML 1300, KML 1301. Funnel shaped (Fig. 15C) 5 mm diameter at base, apex of funnel decreases in width to a thread-like tendril (approx. 200 µm in diameter, up to 40 cm long). No ostia are visible; the funnel apex occupies the position of the osculum and nipple shown in Fig. 15A. There are periodic swellings along the tendril towards its distal end. These are

approximately 300 µm in diameter by 700 to 800 µm long. Between the swellings the tendril is approximately 100 µm in diameter. In KML 1342 and KML 1343 the sponges are both cone shaped, 3.6 mm diameter at base by 12 mm high, each with an incipient tendril about 2.5 cm long; two spheres are attached at the end of one tendril.

**Microscopic features.** KML 1341 ectosome with a fence of short tylostyles oriented with pointed ends out and extending beyond the surface 200 µm; choanosome with longitudinal tracts running from the base to the apex of the sponge ending in brushes about 100 µm across. Form a solid layer around the periphery of the sponge (Fig. 15E). KML 1300 the longitudinal fibre tracts continue into funnel and out along the tendril where they form the wall of the tendril while short tylostyles project out at right angles to the tendril.

**Spicules.** KML 1341 non-tendril stage.

Spicule Type	Fig.	Length	Width
Large subtylostyle	15G	530–(738)–1050	8.8–(12.3)–17.5
Small Tylostyle	15H	120–(251)–510	5.8–(9.2)–15.0

KML 1301 tendril stage: main body (N=20)

Spicule Type	Fig.	Length	Width
Large Subtylostyle	15F, G	672–(794)–1152	7–(11)–12
Small Tylostyle	15H, I	99–(147)–202	5–(6.2)–7

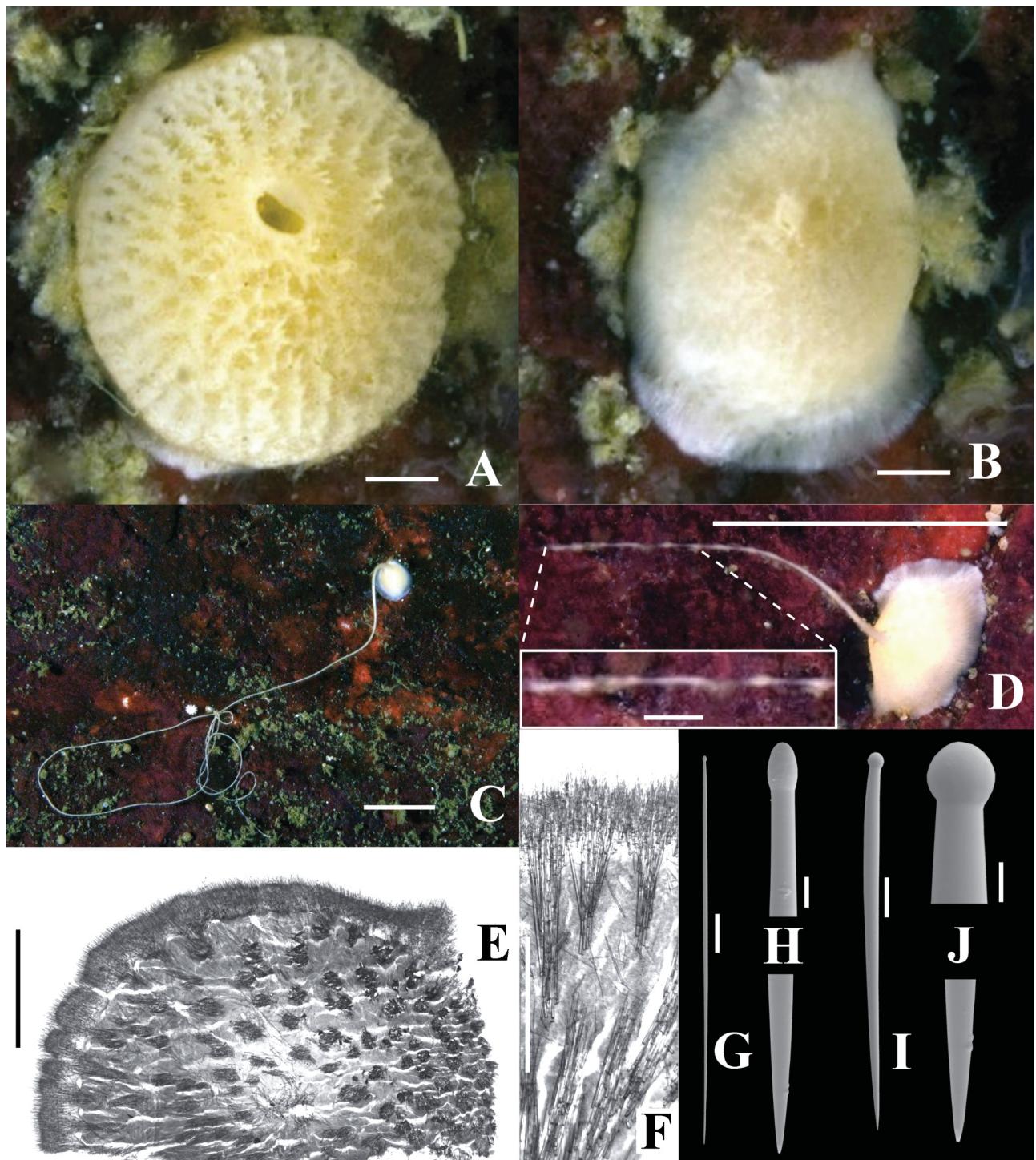
KML 1301 tendril stage: tendril (N=20)

Spicule Type	Fig.	Length	Width
Large Subtylostyle	15F, G	700–(892)–1152	7–(12)–17
Small Tylostyle	15H, I	220–(382)–595	7–(8)–9

**Remarks.** Three species of *Tentorium* are presently recognized (van Soest *et al.* 2012). *T. aff. semisuberites* differs from *Tentorium papillatum* (Kirkpatrick, 1908) in having only one (or possibly a few) rather than numerous papillae. *T. aff. semisuberites* differs from *T. levantinum* Ilan, Gugel, Galil, & Janussen, 2003 which has the form of a pyramid rather than a hemisphere or cylinder. *Tentorium aff. semisuberites* cannot be differentiated from *T. semisuberites* based on most characters (*T. semisuberites* here refers to North Atlantic populations). Both have a columnar or globular growth form, the texture of both is rough on top but smooth on the sides; both have one osculum although larger specimens in Norway may have 2–3 oscula; both have ostia restricted to the top; both may be of similar size (typically 3.5 mm high) although some specimens in the western Atlantic may be 1.5 cm high. Both have a fence of fusiform tylostyles in the ectosome. These range from 120 to 510 µm in length in *T. aff. semisuberites* and 270 to 670 µm in *T. semisuberites*. The principle fusiform subtylostyles form tracts running the length of the sponge. They range from 530 to 1050 µm in *T. aff. semisuberites*, and 950 to 2400 µm in *T. semisuberites*. This 2 ½ fold difference among the principle tylostyles is large; however, Plotkin & Janussen (2008) measured seven specimens and the maximum length of the principle tylostyle ranged from 920 to 1482 µm.

**Conclusions.** The significant differences in maximum sizes of the principle tylostyles may indicate genetic differences or, alternatively, may be a reflection of significant differences in the height of the sponges and hence in length of the spicule tracts. *Tentorium semisuberites* has also been reported from several locations in the Antarctic (Boury-Esnault & van Beveren 1982; Plotkin & Janussen 2008). The absence of records between the Antarctic and the Azores suggests that *T. semisuberites* may be a candidate for bipolar distribution. Our report of *T. aff. semisuberites* from the cold temperate NE Pacific may reflect discontinuous distribution, or inadequate sampling in the Bering Sea and adjacent arctic waters. DNA bar coding might help resolve the relationships among these populations. Until then we have elected to refer to our material as *T. aff. semisuberites*.

**Geographic distribution.** *T. aff. semisuberites*: southern BC; *T. semisuberites*: Northern Hemisphere: Atlantic Arctic, N. Atlantic south to Azores. Although recorded in western Greenland, the Gulf of St. Lawrence and off Nova Scotia (Lambe 1896), we could find no records for the Canadian Arctic or the Bering Sea.



**FIGURE 15.** *Tentorium* aff. *semisuberites* (Schmidt, 1870). A, KML 1341 expanded, scale bar approx. 1 mm; B, KML 1341 contracted, scale bar 1 mm; C, KML 1301. sponge with tendril, scale bar 1 cm; D, another tendril sponge, scale bar 1 cm; inset portion of tendril with possible propagules, scale bar 1 mm; E, KML 1341 cross section, scale bar 1 mm; F, KML 1341 longitudinal section, scale bar 0.5 mm; G, KML 1341 large subtylostyle, scale bar 100  $\mu$ m; H, KML 1341 large subtylostyle head, scale bar 10  $\mu$ m; I, KML 1341 small tylostyle, scale bar 20  $\mu$ m; J, KML 1341 small tylostyle head, scale bar 5  $\mu$ m.

*T. cf. semisuberites*: Southern Hemisphere: South Indian Ocean: Kerguelen I, South Atlantic: Inaccessible I, South Georgia, Antarctic: Western Ross Sea (Plotkin & Janussen 2008).

**Bathymetric range.** *T. aff. semisuberites* 18–24 m (here-in); *T. semisuberites*: 26–3193 m depth (Barthel & Tendal 1993).

**Ecology.** Where have tendrils been recorded? A sponge with a tendril was first reported in British Columbia by

Lamb & Hanby (2005). It has not been seen since by these authors (pers. comm.). On Feb. 16, 2012 one of the present authors (N. McDaniel) found two sponges each with a long tendril (Fig. 15C). These were collected (KML 1300=T1, and KML 1301=T2). Mar. 6, 2012 two more sponges with tendrils (T3 & T4) were found at the same location. These were left in situ. The same two sponges, KML 1342, Sakinaw Rock, Sechelt Inlet (BC) ( $49^{\circ} 34.075'N$ ,  $123^{\circ} 48.238'W$ ), 24 m depth, Dec. 11, 2012, coll. N. McDaniel; KML 1343, Sakinaw Rock, Sechelt Inlet (BC) ( $49^{\circ} 34.075'N$ ,  $123^{\circ} 48.238'W$ ), 24 m depth, Dec. 11, 2012; coll. N. McDaniel, were inspected on Apr. 12, 2012. On each the tendril was gone and its location on the sponge was occupied by a single osculum. These sponges and five others were found again May 10, 2012 and Sept. 27, 2012. Two more sponges were found with short (2.5 cm) tendrils. These were observed two months earlier than in the previous year which suggests to us that these were in an early growth stage of the tendrils. The location and form of the spheres on the end of the tendril in KML 1343 suggests that they are propagules.

The only published reference we could find to *T. semisuberites* tendrils in other geographic regions was by Koltun (1966). He reported that sometimes the sponge becomes greatly stretched out into a thin stalk with a length of 20 cm. The specimen shown in his Figure 12, plate XXXI looks identical in size and form to ours. However, Koltun regarded this form as an aberration. Alexander Plotkin found several sponges with long threads in the Russian Arctic which he initially identified as aberrant morphs of *Tentorium semisuberites* (pers. comm. to N. McDaniel). Barthel & Tendal (1993) observed what they called buds emanating from the base of some specimens. The relationship of these buds to those in the tendrils at the top of our sponges is unclear.

Battershill & Bergquist (1990) described asexual reproduction in *Polymastia granulosa* which showed some similarities to what we are observing here. A portion of the sponge pinches off and subsequently becomes much elongated and thread-like (6 cm). It then subdivides into a number of bead-like propagules which subsequently disperse by crawling away. In *T. aff. semisuberites* the tendril elongates while it is still attached to the papilla and incipient osculum of the sponge. We suggest that the tendrils can achieve such great length because the sponge continues to grow in the region of the papilla-tendril interface. At some point the tendril contents form a discontinuous series of beads as shown in Fig. 15D. These appear similar to the beads described by Battershill & Bergquist (1990). We surmise that these are comparable to the propagules which these authors described as separating and crawling away for short distances. So one function of the tendril could be to disperse the propagules. *Tentorium aff. semisuberites* may occur on both hard and soft substrates. In the latter situation the sponge is described as having roots or alternatively of forming a broad basal plate, sometimes accompanied by agglutinating foraminiferans or spicules (Barthel & Tendal 1993). We speculate that the tendril may serve as moorage maintaining each propagule at the sediment or rock surface while it becomes stabilized with roots or a broad basal plate. There is no direct evidence to indicate whether the tendril stage sponge itself resulted from sexual or asexual reproduction. We hope to make additional observations to support or refute our speculations in the coming years.

## Genus *Weberella* Vosmaer, 1885

### *Weberella perlucida* n. sp.

Fig. 16A–F

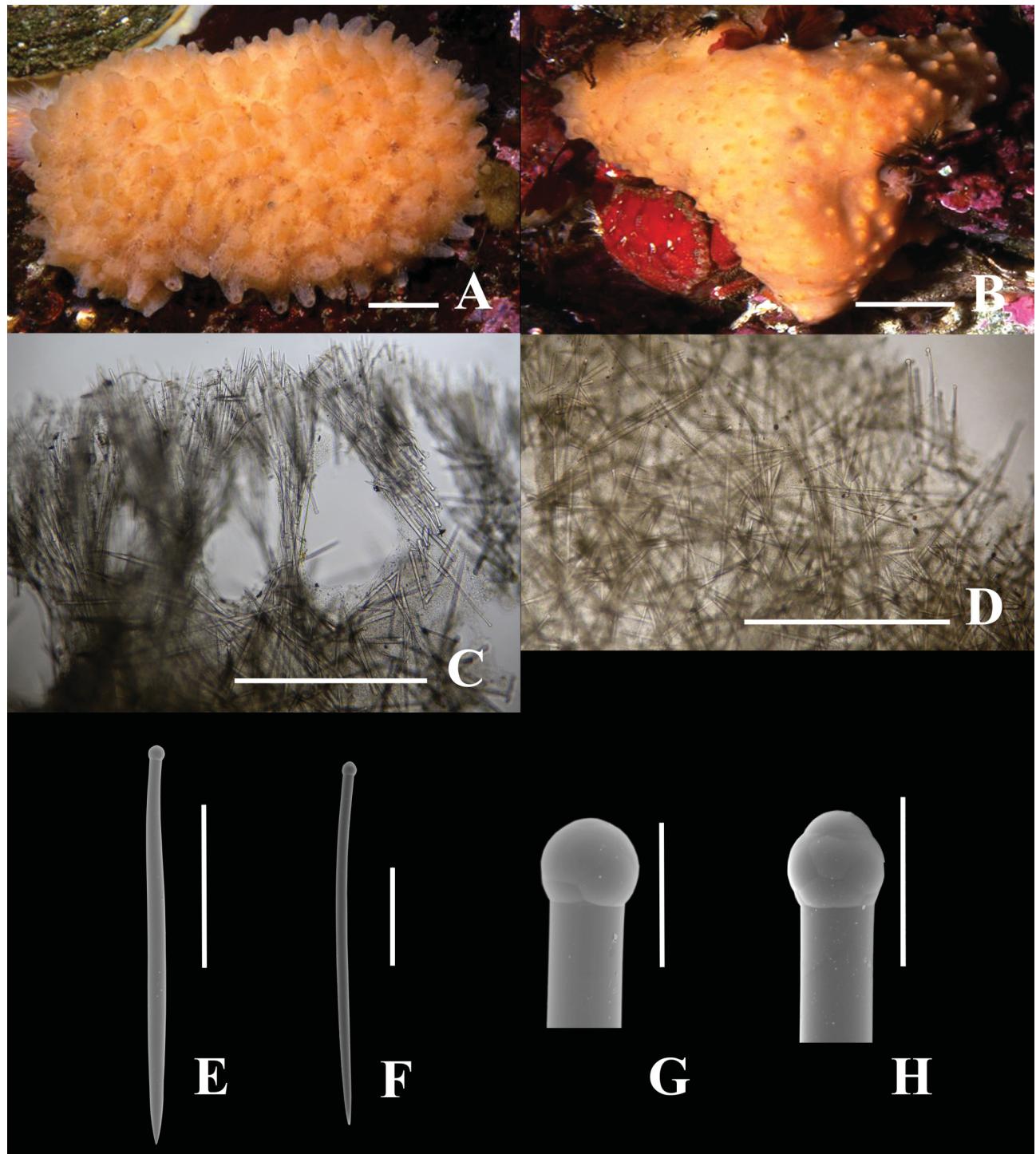
**Etymology.** The species name derives from the translucent papillae (the literal translation of the Latin is transparent).

**Material examined.** Holotype: RBCM 982-64-1, NM 60, Stubbs Island, BC, ( $50^{\circ} 36.2'N$ ,  $126^{\circ} 49.8'W$ ), 10 m depth, Aug. 30, 1976, coll. & photo N. McDaniel.

Field images lacking vouchers: RBCM 35 mm slide 3001, Helby I, Barkley Sd., BC, (approx.  $48^{\circ} 51'N$ ,  $125^{\circ} 10'W$ ), <30 m depth, Jul. 16, 1977, photo B. Cooke; RBCM 35 mm slide 3974, Arbutus I., Satellite Channel, BC, ( $48^{\circ} 42.37'N$ ,  $125^{\circ} 26.16'W$ ), <30 m depth, Apr. 1977, photo, B. Cooke; Stephensen Islets, BC, (approx.  $50^{\circ} 34.9'N$ ,  $126^{\circ} 52.4'W$ ), <30 m depth, Sept. 1976 and May 6, 1978, 2 photos, N. McDaniel.

**Description.** *Macroscopic features.* Sponge ovoid cushion-shaped to irregularly subcylindrical; cushion shapes up to 40 mm in average diameter; subcylinders up to 150 mm long. Average thickness 20 mm. Surface covered by short cylindro-conical papillae, semi-transparent in life (Fig. 16A). Papillae highly contractile (Fig. 16B), and in contracted state are 1–3 mm high by about 2 mm in diam. at their base. Oscula at the summit of

papillae; when expanded are 0.5 mm diam. The non-papillar surface smooth to the unaided eye. When preserved, the papillae are contracted somewhat, the oscula closed, any transparency is lost and the colour turns dull yellow. Consistency firm and cork-like. Colour in life yellow with an orange cast (Austin *et al.* 2012).



**FIGURE 16.** *Weberella perlucida* n. sp. A, holotype, papillae expanded, scale bar approx. 1 cm; B, papillae contracted, scale bar approx. 1 cm; C, spicules of ectosome in columns, flaring out at periphery of sponge, scale bar 300 µm; D, non-aligned spicules of choanosome, scale bar 300 µm; E, large tylostyle, scale bar 200 µm; F, small tylostyle, scale bar 50 µm; G, H, tylostyle heads, one with accessory knob at end, scale bar 30 µm.

*Microscopic features.* Ectosome cortical and composed of short tylostyles, with apices directed outward. Spicules arranged in distinct columnar bundles which splay out just below the surface to form interlocking brushes (Fig. 16C). The area between the columns forms a space below the roof of splayed out spicules. Cortex 500 µm

thick: spicules project up to 50 µm beyond surface. Papillae formed by outfoldings of the general ectosomal surface with a central canal that leads to the osculum on the papilla summit. Cortical layer continues into the papillae. Choanosomal skeleton formed of randomly disposed spicules with no clear radial or other pattern (Fig. 16D).

**Spicules.** Spicules form two classes of tylostyles, the larger in the main body (tylostyle I) and the shorter in the cortex (tylostyle II). Forty spicules of each type were measured.

Holotype. RBCM 982-64-1

Spicule Type	Fig.	Length	Width
Large Tylostye	16E	450–(601)–700	17–(20.3)–25
Small Tylostye	16F	99–(147)–202	5–(6.2)–7

Microscleres absent.

**Remarks.** *Weberella* has been considered a synonym of *Polymastia* by some (e.g., Koltun 1966) and not by others (e.g., Lévi 1973). *Weberella* is considered a valid genus in the Systema Porifera (Boury-Esnault 2002).

Our species differs from *Weberella bursa* Müller, 1806, the type species, as follows: the papillae are dense and the interpapillary distance is less than papillary diameter in *W. perlucida* n. sp. while the interpapillary distance is up to 5 times the papillary diameter in *W. bursa*. The small tylostyles of *W. bursa* do not penetrate the surface whereas in *W. perlucida* n. sp. they form distinct dermal brushes.

The large tylostyles are somewhat longer (450–700 µm) than those of *W. bursa* (340–650 µm) while the small tylostyles are somewhat shorter (90–202 µm) than those of *W. bursa* (125–270 µm). *Weberella bursa* is recorded in the NE Atlantic from the Arctic to the Iberomoroccan Gulf; from 130–960 m depth (Boury-Esnault 2002) whereas *W. perlucida* n. sp. is a shallow water species (10–30 m in depth) known only from BC to date.

In addition to the type species, *Weberella bursa*, two other species have been described: *Weberella verrucosa* Vacelet, 1960 and *Weberella namibiensis* Samaai & Gibbons, 2005. Our species differs from *W. verrucosa* as follows: *Weberella verrucosa* specimens are normally pedunculate and more hispid than in *W. perlucida* (Vacelet 1960, Uriz 1975). Tylostyles in the ectosome of *W. verrucosa* do not form columnar bundles splaying out into brushes (Uriz 1975). Choanosomal tylostyles are 350–600 µm long and those of the ectosome 100–160 µm long (Uriz 1975), while in *W. perlucida* they reach lengths of 700 µm and 200 µm, respectively. *Weberella verrucosa* is recorded from the Mediterranean at depths of 64–100 m.

Our species differs from *W. namibiensis* as follows: *W. namibiensis* appears to be free-living without attachment to the substrate. It has only a few papillae. The primary tylostyles are larger: to 837 µm (Samaai & Gibbons 2005). The species has been recorded in shallow water (12–14 m) on the Namibian coast, Atlantic Ocean.

**Conclusions.** The lack of radiating choanosomal fibres and the presence of compact connective tissue in our species fits the diagnosis for *Weberella*. *Weberella perlucida* n. sp. is distinct from the three known species of *Weberella*.

**Bathymetric range.** 10 to 30 m depth.

**Geographic distribution.** To date only recorded in BC: Satellite Channel, Barkley Sound, Discovery Passage and Weyton Passage.

**Ecology.** This species is most common in current-swept habitats attached to rocky substrates in the shallow subtidal zone.

## Family Suberitidae Schmidt, 1870

### Genus *Aaptos* Gray, 1867

#### *Aaptos simplex* (Lambe, 1893b)

Fig. 17A–G

*Suberites simplex* Lambe, 1893b, *Suberites simplex* Lambe, 1893b of Austin & Ott 1987.

**Material examined.** Holotype: CMNI 1900–2895 (previously 2708), near Comox, Strait of Georgia, BC, (approx. 49° 42'N, 124° 50'W), 73 m depth, Jun. 24, 1885, coll. G. M. Dawson.

Other material: KML 1046, off Sandspit, Hecate Strait, BC, (approx. 53° 15'N, 131° 44'W), no depth, Jul. 29, 1960, coll. D. B. Quayle; KML 1037, KML sta. 226/70, Gordon Channel, BC, (50° 54.4'N, 127° 39.1'W), 290–436 m depth, Sept. 16, 1970, coll. W.C. Austin, 1 specimen; KML 1041, KML sta. VT2/80, Dark Cove, Jervis Inlet, BC, (49° 48.8'N, 123° 57.0' W), 150 m depth, May 19, 1980, coll. V. Tunnicliffe, 1 specimen; KML 1045, 5VT19/81, Dark Cove, Jervis Inlet, BC, (49° 48.8'N, 123° 57.0' W), 187 m depth, Feb. 24, 1981, coll. W.C. Austin, 1 specimen on dead *Aphrocallistes vastus* skeleton; KML 1040, KML sta. 80/75, Junction Passage, Barkley Sd., BC, (48° 57.0'N, 125° 48.6'W), 181–201 m depth, Apr. 17, 1975, coll. W.C. Austin, 1 specimen; KML 1039, KML 55/75, NW of Poet Nook, Barkley Sd., BC, (48° 53.5'N, 125° 03.5'W), 26–126 m depth, Apr. 14, 1975, coll. W.C. Austin, 1 specimen; KML 1038, KML sta. 61/75, East of Soquel Bank, BC, (48° 42.5'N, 125° 10.9'W), 55 m depth, Apr. 15, 1975, coll. W.C. Austin, 1 specimen; VT16/81, KML 1043, VT10/80, Squally Reach, Saanich Inlet, BC, (48° 33.3'N, 123° 32.8'W), 63 m depth, 1980, coll. V. Tunnicliffe, 9 specimens; KML 1042, VT580, Elbow Point, Saanich Inlet, BC, (48° 32.7'N, 123° 32.5'W), 63–99 m depth, Nov. 18, 1980, coll. V. Tunnicliffe, numerous specimens; KML 1044, VT 14/80 Elbow Pt., Saanich Inlet, BC, (48° 32.7'N, 123° 32.5'W), 65 m depth, 1980, coll. V. Tunnicliffe, abundant on collected rock; KML 1036, KML sta. 67/68, off Whytecliffe Park, BC, (48° 22.2'N, 123° 17.5'W), 20 m depth, Aug. 16, 1968, coll. W. C. Austin, 2 specimens, 1 on dead *Aphrocallistes vastus* skeleton.

**Description.** *Macroscopic features.* Hemispherical with no obvious oscula. Often a flattened skirt around the base. Surface smooth and hard to the touch. One specimen with six small papillae, absent in others. Specimens range in size up to about 11 mm in diameter. Colour alive yellowish white (Fig. 17A).

*Microscopic features.* (Based on specimen KML 1036 from Sta. 7/68 Whytecliffe Park, BC). Ectosome about 800 µm thick, and clearly set off from the choanosome. Choanosome, in contrast to *Suberites* spp., with long megascleres aligned in well developed spicule tracts fibres radiating toward and supporting a palisade of shorter megascleres in the ectosome (Fig. 17B).

*Spicules.* The megascleres of the ectosome appear to fall in long or short size categories; the long megascleres constitute less than 5% of the total. The shorter megascleres are all tylostyles, while longer megascleres are almost all fusiform subtylostyles. The megascleres in the radiating spicule tracts of the choanosome are the longest.

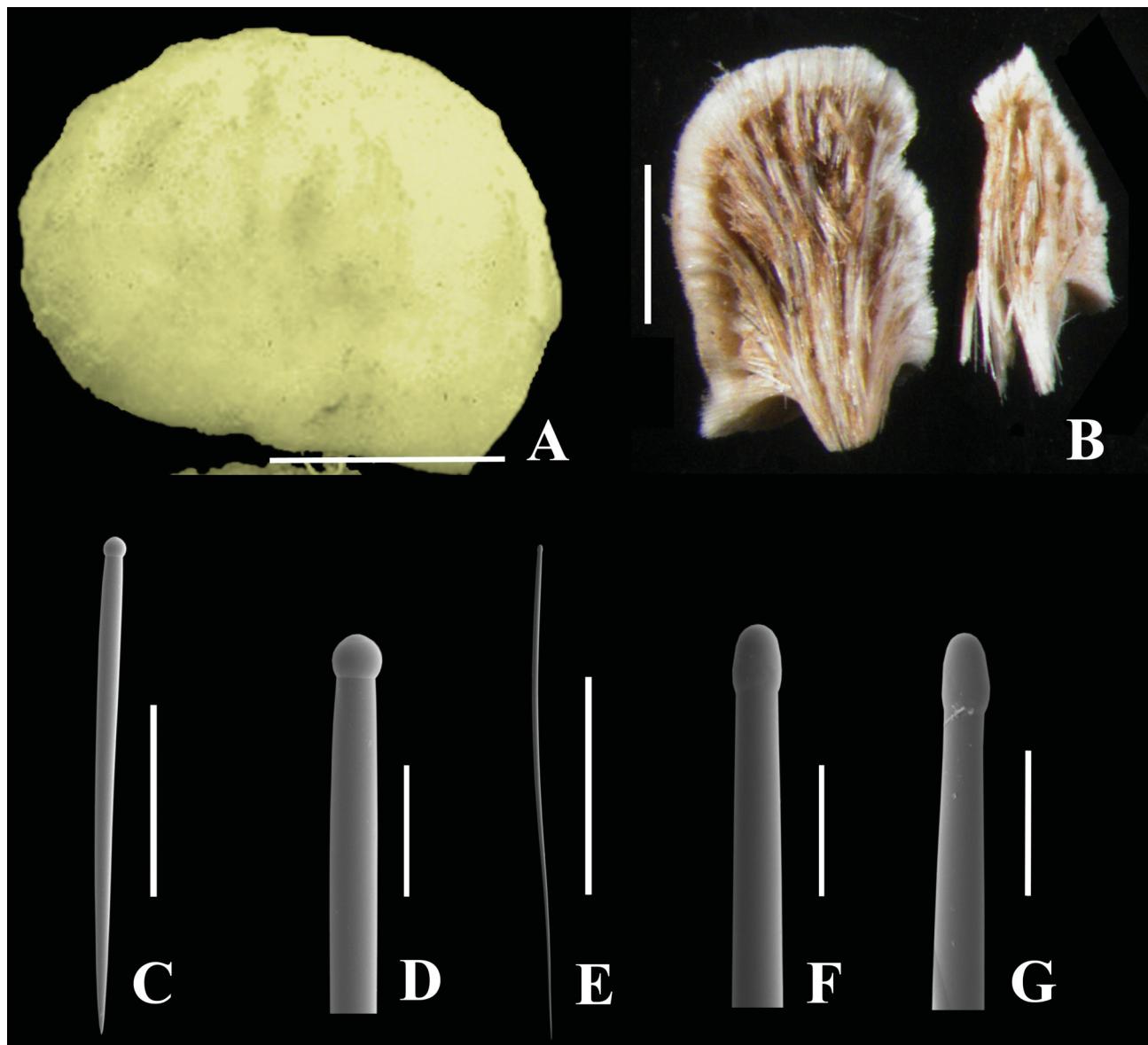
#### KML 1036

Location	Spicule Type	Fig.	Length	Width
Ectosome	Tylostyle	16C, D	140–(255)–400 N=25	8–(12)–15 N=25
<5%	Fusiform subtylostyle	none	500–(627)–790 N=20	10–(13)–16 N=20
Choanosome	Fusiform subtylostyle	16E–G	550–(900)–1110 N=25	13–(13)–15 N=23

**Remarks.** Fusiform subtylostyles are similar to strongyloxeia except that the blunt end is subtylote rather than stylote. Their fusiform shape can be seen in the tapering toward the blunt end (Fig. 17G) as well as toward the pointed end. At least one of the megasclere classes has a blunt end which is very close to a style (Fig. 17G) which would place it in the category of strongyloxeia.

Lambe described the long megascleres as “straight, very gradually pointed, smooth tylostyli with moderately well marked elongated heads”. His figure does not suggest a fusiform shape. Otherwise, the macro and microscopic structure of our material fits well with that described by Lambe from the holotype.

*Aaptos* is defined as belonging to the Suberitidae with a radiate skeleton of strongyloxeas in three size classes the smallest of which form a dense ectosomal palisade. There are no microscleres (van Soest 2002). Redescription of the holotype of *Aaptos aaptos* (Schmidt, 1864) by Kelly-Borges & Bergquist (1994) reported strongyloxeia of two size categories 1053–(1502)–1911 and 490–(705)–955. It did not mention or figure large fusiform subtylostyles. However, illustrations of the tylostyles of the type by Lendenfeld (1897) reproduced by van Soest (2002) did figure three of the four largest megascleres as fusiform subtylostyles and the fourth as a fusiform style or strongyloxeia in *A. aaptos* from the Adriatic. The tapering of the megascleres in *A. simplex* is certainly not as marked as in some species of *Aaptos* (e.g., *Aaptos niger* Hoshino, 1981) but is also not qualitatively different from that in the type species as figured by Lendenfeld (1897). *Suberites simplex* is a synonym of *A. simplex* in Austin *et al.* (2012).



**FIGURE 17.** *Aaptos simplex* (Lambe, 1893b). A, live specimen collected from Whytecliffe Park, BC, scale bar approx. 5 mm; B, dried section normal to surface showing well developed multispicular tracts radiating to well defined ectosome, scale bar 2 mm; C, tylostyle, scale bar 100 µm; D, tylostyle head, scale bar 30 µm; E, large fusiform subtylostyle, scale bar 500 µm; F, subtylostyle head, scale bar 30 µm; G, head approaching the stylote condition of strongyloxeia, scale bar 30 µm.

The megasclere size range in our material is not as great as that in *A. aaptos* with two non-overlapping size categories of strongyloxeia. But the range is comparable to e.g., *A. niger* Hoshino, 1981 with a range of 540–1310 µm. The thick radiating fibers made up of the long megascleres in *A. simplex* are comparable to those in *A. aaptos* (Kelly-Borges & Bergquist 1994, van Soest 2002).

Lehnert *et al.* (2008) described *Aaptos kanuux* as a new species from the Bering Sea. It has ectosomal tylostyles 104–215 x 4–8 µm; choanosomal strongyloxeia 794–2132 µm x 15–22 µm, and choanosomal fusiform subtylostyles 485–770 x 8–10 µm. The large maximum size of the megascleres is about twice that in *A. simplex* and they are strongyloxeas, not fusiform subtylostyles. The latter constitute a category of medium size megascleres. Lehnert *et al.* (2008) compared *A. kanuux* with five congeners known from the North Pacific or North Atlantic. They concluded, largely on the basis of megasclere form and size, that *A. kanuux* is not conspecific with any of them. Based on the table by Lehnert *et al.* (2008), *A. simplex* does not have the same spicule size range and/or complement as any of the other species of *Aaptos* recorded from the northern hemisphere or with *A. kanuux*. While the colour in life of *A. simplex* is yellowish white, and that of *A. kanuux* is mustard yellow, a dramatic colour range from white to bright yellow has been observed in at least one other hadromerid, *Polymastia pachymastia*.

**Conclusions.** Based on the tapering of the megascleres, their large size range, and the radiating skeleton, we consider that our specimens are members of the genus *Aaptos* and belong to the species *A. simplex*. The definition of the genus might be modified to encompass fusiform subtylostyles as well as fusiform styles or strongyloxeae. *Aaptos simplex* characters do not fit descriptions for any of the six species of *Aaptos* recorded from the northern Hemisphere. However, megasclere size ranges are based on measurements from a 5 mm specimen of *A. simplex*. The *A. kanuux* specimens ranged from 9–19 mm.

**Bathymetric range.** 20–290 m depth.

**Geographic distribution.** Saanich Inlet to off Sandspit (BC, Canada).

**Ecology.** *Aaptos simplex* is one of the first organisms to appear above the anoxic layer in BC fjords in oxygen tensions of 0.2 ml/l (Tunnicliffe 1981).

## Genus *Homaxinella* Topsent, 1916

### *Homaxinella amphispicula* (de Laubenfels, 1961)

Fig. 18A–F

*Syringella amphispicula* de Laubenfels, 1961

**Material examined.** Holotype: USNM 22707, Griffin Bay, Washington, (48° 29'N, 122° 58'W), 45 m deep.

Other material: KML 1051, KML 225/70, Gordon Channel, BC, (50° 53.0'N, 127° 30.3'W), 91–46 m depth, Sept. 16, 1970, coll. W.C. Austin; KML 1051, NM 126, Copper Bluffs, BC, (50° 06'N, 125° 16'W), 4–15 m depth, Apr. 16, 1978, coll. & photo N. McDaniel; VT19/81, Dark Cove, Jervis Inlet, BC, (49° 48.8'N, 123° 57.0'W), 36 m depth, Feb. 24, 1981, coll. W.C. Austin; KML 1049, KML sta. 161/70, Porlier Pass, BC, (49° 00.2'N, 123° 35.2'W), 12–15 m depth, Aug. 8, 1970, coll. W.C. Austin, 1 specimen; KML 1048, KML sta. 88/75, N. of Moreton I., Barkley Sd., BC, (48° 53.2'N, 125° 19.9'W), 30–37 m depth, Apr. 18, 1975, coll. W.C. Austin, 1 fragment; KML 1047, KML sta. 61/69, Bamfield, Barkley Sd., BC, (48° 50.1'N, 125° 08.1'W), 18 m depth, Jun. 2, 1969, coll. W.C. Austin, 1 specimen; KML 1050, KML sta. 94/82, N. tip of Pender I., in Navy Channel, BC, (48° 49.40'N, 123° 19.20'W), 20 m depth, May 27, 1982, coll. W.C. Austin; VT16/81, McCurdy Pt, Saanich Inlet, BC, (48° 37.7'N, 123° 31.1'W), 99 m and 76 m depth, Feb. 4, 1981, coll. V. Tunnicliffe/W.C. Austin; VT10/80, Squally Reach, Saanich Inlet, BC, (48° 33.4'N, 123° 32.5'W), 63 m depth, May 18, 1980, coll. V. Tunnicliffe/W.C. Austin; VT14/80, Elbow Pt., Saanich Inlet, BC, (48° 32.8'N, 123° 32.4'W), 65 m depth, Nov. 20, 1980, coll. V. Tunnicliffe.

Field images without vouchers: Fearney Pt., Agamemnon Channel, BC, (49° 38.7'N, 124° 05'W), photo N. McDaniel; Skookumchuk Narrows, BC, (approx. 49° 44.2'N–123° 53.8'W), Jan. 1977, photo N. McDaniel; Turn I., BC, (approx. 50° 21'N, 125° 27'W), photo N. McDaniel; West Race Rock, Juan de Fuca Strait, BC, (48° 17.9'N, 123° 32.3'W), photo N. McDaniel; Dawley Passage, SE Meares I., BC, (49° 08'N, 125° 47'W), photo N. McDaniel.

Comparative material: *Homaxinella subdula*, USNM, ex. British Museum Nat. Hist. 65112 (R1384), Eddystone, U.K., (50° 10.8'N, 04° 10.8'W), May 1930, coll. M. Burton, ID M. Burton. *Homaxinella subdula*, USNM, ex. British Museum, Type R1384, East coast Lundy I, Outer Knoll, U.K., (51° 11.3'N, 4° 38'W), coll. J.D. George.

**Description.** *Macroscopic features.* Erect, branching with occasional anastomosing, root-like processes attached to the substrate (Fig. 18A, B). Consistency tough, wiry, with firm surface, but readily bent; size up to 10 cm with branch diameters of 5–10 mm; colour in life pale yellow.

*Microscopic features.* Axial skeleton is condensed, with bundles of spicules oriented parallel to the long axis of sponge (Fig. 18C). Extra-axial bundles of spicules extend from the axial spicules to the surface (Fig. 18D); they may project beyond the surface.

*Spicules.* Megascleres basically thin straight styles (Fig. 18E, F) with abrupt apices; some slightly swollen as incipient subtylotes. Size ranges are given in Table 10.

**Remarks.** This species was originally placed in the genus *Syringella* by de Laubenfels (1961). Hooper (2002) noted that “*Syringella*” is not a valid taxon and the next available name is *Parasyringella* Topsent, 1928 which is a subgenus of *Raspailia*. “*Syringella*” *amphispicula* does not otherwise fit the diagnosis of *Parasyringella* which is unbranched and has bouquets of ectosomal styles. Most Raspailiidae have acanthorhabds and those which do not are otherwise different from “*S.*” *amphispicula*. Two genera of Suberitidae are arborescent with branches similar to

the stem: *Plicatellopsis* and *Homaxinella*. Both have an axially condensed skeleton. The former has well developed extra-axial bundles of spicules extending from the axis to the surface, while the latter has similarly oriented bundles which are poorly developed or absent after preservation (van Soest 2002). *Plicatellopsis* has, in addition, a pallisade of small spicules in the ectosome which is absent in *Homaxinella*. The spicules are tylostyles, with small tyles in *Plicatellopsis* and styles in *Homaxinella* (van Soest 2002).

**TABLE 10.** *Homaxinella* spp. styles & subtylostyles range, mean length & width in µm.

Location	Sta. 94/82 <i>amphispicula</i>	No. 126 <i>amphispicula</i>	Holotype <i>amphispicula</i>	Eddystone, UK <i>subdula</i>
Ectosome length	260–(536)–710 N=25	270–(540)–710 N=25		
Ectosome width	6–(11.5)–20 N=25	4.6–(8.8)–14 N=25		
Choanosome length	270–(621)–830 N=25	325–(605)–850 N=25		
Choanosome width	7–(16.3)–20 N=25	5–(11)–16 N=25		
*Combined length	260–(579)–830 N=50	270–(573)–850 N=50	360–(571)–760 N=15	270–(416)–550 N=10
*Combined width	6–(13.9)–20 N=50	4.6–(9.9)–16 N=50	6–(12.4)–17.5 N=15	3.8–(4.7)–7.5 N=8

The overall form of specimens examined by us looks much like *Homaxinella subdula* (Bowerbank, 1866) and is quite different from that in the type species of *Plicatellopsis*, *P. arborescens*. However, the branches of *H. subdula* are typically at right angles to the main stalk while they form roughly a 45° angle to the stalk in *Homaxinella amphispicula*. Van Soest *et al.* (2012) placed the de Laubenfels' *Syringella amphispicula* species in *Plicatellopsis*.

Our specimens of both *H. amphispicula* and *H. subdula* have typical styles but also some megascleres which are clearly incipient subtylostypes (Fig. 18F, G). This includes the holotype of *H. amphispicula* which we examined, and the holotype of *H. subdula* when re-examined by Burton (1935). De Laubenfels (1961) stated that the spicules of *H. amphispicula* were exclusively tylostyles. However, no megascleres could be described as tylostyles in any of the material we examined including the holotype of *H. amphispicula* (Fig. 18C, D). *Plicatellopsis* spp. are characterized as having exclusively tylostyles.

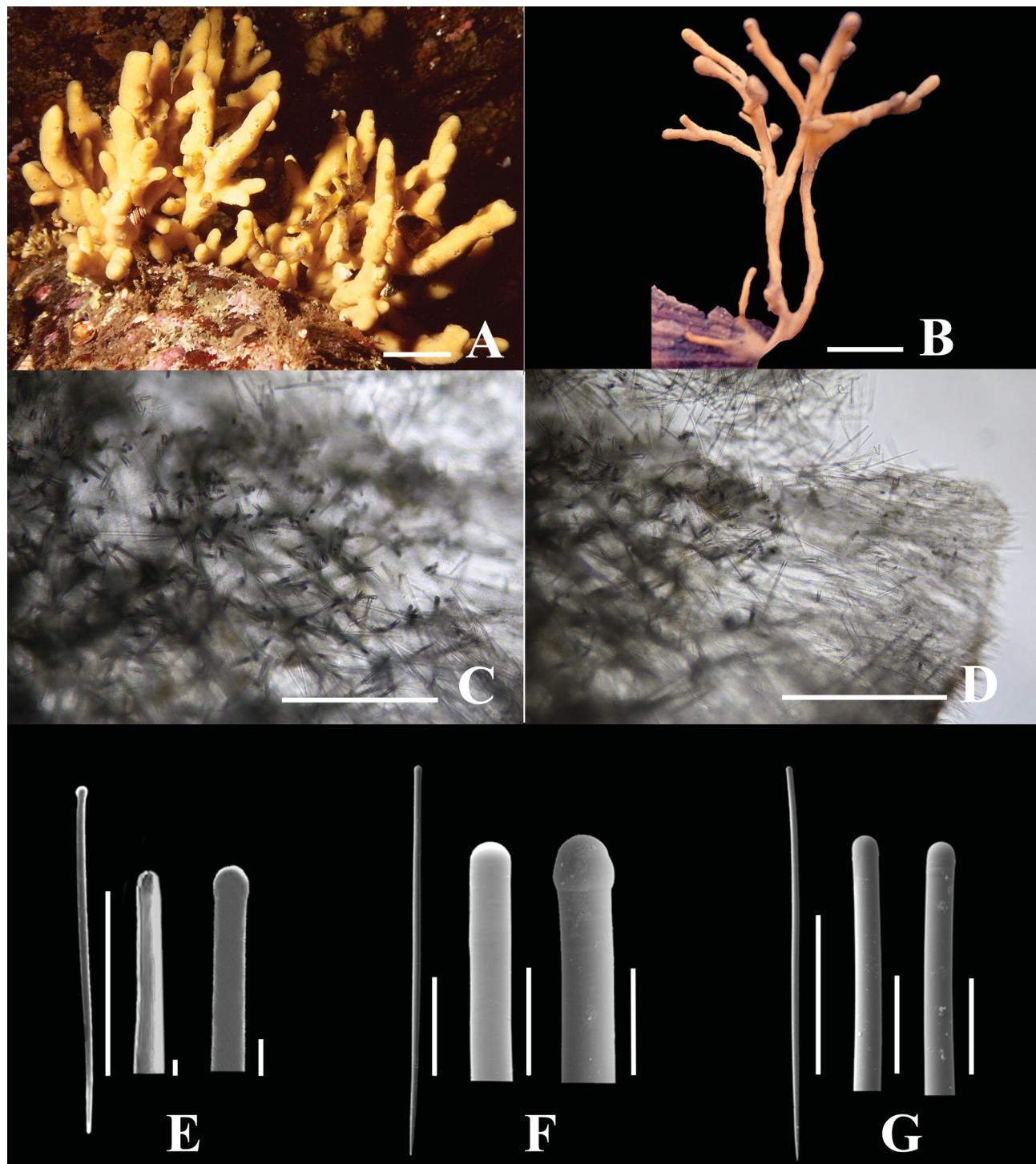
The upper size limit and mean size of styles in *H. amphispicula* are considerably larger than those in *H. subdula* from the UK based on our specimens (above) and descriptions by Picton & Morrow (2005) and van Soest (2002). However, the styles fall within the large range given by Koltun (1959) of 195–863 µm for some 75 specimens identified as *H. subdula* with a recorded range extending from the NE Atlantic to the Bering Sea, Okhotsk Sea, Sea of Japan, and the southern Kurils.

We reviewed the literature to assess whether or not populations in the NE Pacific are conspecific with one or more of the other species of *Homaxinella* described from the NW Pacific. Burton (1935) reported *Pachaxinella* (= *Homaxinella*) *subdula* as occurring in the Sea of Japan and neighbouring areas but he provided no spicule sizes or information on branching. Five other species of *Homaxinella* have been described from the Sea of Japan. *Homaxinella brevistyla* Hoshino, 1981 (styles 300–470 µm) and *Axinella echidnaea* (Ridley, 1884) (styles 400–1500 µm) can be excluded based on style size. *Homaxinella tanitai* Hoshino, 1981 (Tanita 1968) (styles 370–630 µm) is likely excluded based on specimens being unbranched although they might be juveniles as the largest was 3.5 cm. *Homaxinella infundibula* Tanita *et al.* 1989 can be excluded based on spicule length (480–970 µm) and funnel shape. *Homaxinella ramosimassa* Tanita *et al.* 1989 can be excluded based on spicule length (570–980 µm) and the tight ramifying and anastomosing form. Two additional species from the Philippines can be excluded based on form. *Homaxinella acanthelloides* Lévi, 1961 has hollow branches and *Homaxinella domantayi* Lévi, 1961 has flattened lamellar branches.

**Conclusions.** We do not agree with van Soest *et al.* (2012) in the reassignment of *Syringella amphispicula* to *Plicatellopsis*. Rather, we propose that *S. amphispicula* should be assigned to *Homaxinella*. The differences in form and megasclere size are sufficient to warrant separation of *H. amphispicula* from N. Atlantic populations of *H. subdula* at the species level. We suggest that the *H. subdula* of Koltun (1959) encompasses more than one species. The information available in the literature indicates that *H. amphispicula* is not conspecific with any species reported from the NW Pacific although it may be the species which Burton (1935) identified as *Pachaxinella subdula* in the Sea of Japan and the Sea of Okhotsk.

**Bathymetric range.** 10 to 70 m depth.

**Geographic distribution.** Washington (USA) and British Columbia (Canada).



**FIGURE 18.** *Homixinella amphispicula* (de Laubenfels, 1961). A, expanded specimen, scale bar approx. 2.5 cm; B, contracted specimen, scale bar 1.3 cm; C, axial skeleton in cross section, scale bar 500 µm; D, extra-axial bundles of spicules running to surface, scale bar 500 µm; E, styles and subtylostyles sta. 94/82, scale bar left 100 µm, middle and right 10 µm; F, styles and subtylostyles of holotype *H. amphispicula* USNM, scale bar left 100 µm, middle and right 30 µm; G, styles of *Homixinella subdula* from the UK, scale bar left 200 µm, middle and right 30 µm.

**Ecology.** *H. amphispicula* occurs on rock but is also attached to shells on otherwise soft bottoms and ranges from low to high tidal current environments. It and *Aaptos simplex* are the first recognizable sessile species occurring above anoxic conditions in the Saanich Inlet fjord. Small (2–3 cm) individuals are erect, cylindrical and unbranched. Like many other suberitids *H. amphispicula* can contract to a considerable degree.

### Genus *Prosüberites* Topsent, 1893

#### *Prosüberites saanichensis* n. sp.

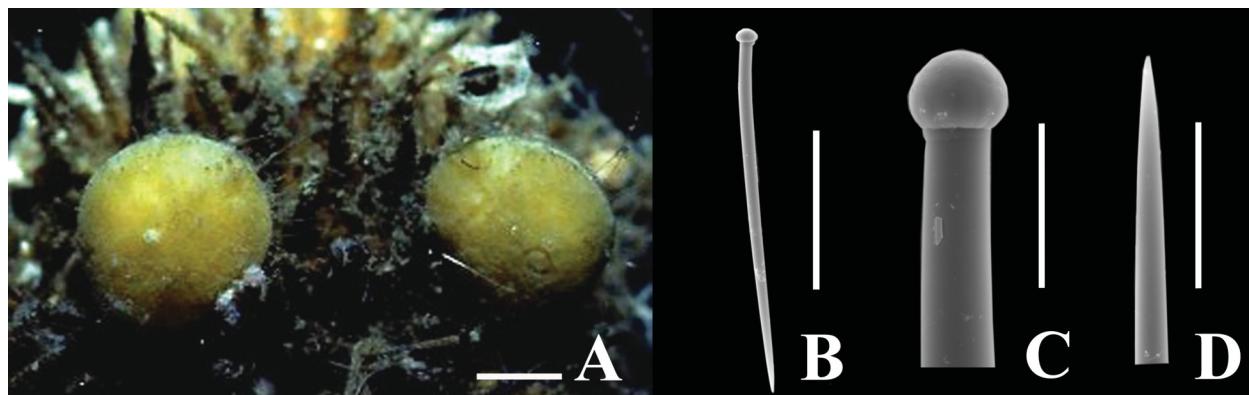
Fig. 19A–D

**Etymology.** Named after the type locality, Saanich Inlet, BC, Canada.

**Material examined.** Holotype: RBCM 982-67-1, VT sta. 14/80, Elbow Point, Saanich Inlet, BC, (48° 32.8'N, 123° 32.4'W), 65 m depth, Sept. 14, 1980, coll. V. Tunnicliffe. Paratype: CMNI 2009-0026, KML 1053, KML sta. 179/83, N. of Maple Bay, Portland Canal, BC, (55° 26.7'N, 130° 01.1'W), 33 m depth, Oct. 25, 1983, coll. W.C. Austin.

Other material: KML 1054, KML sta. 17/76, Princess Royal Reach (Jervis Inlet), BC, (50° 01.1'N, 124° 56.5'W), 33m Mar. 15, 1976, coll. W.C. Austin; KML 1055, VT sta. 8/80, Willis Point, Saanich Inlet, BC, (48° 34.7'N, 123° 29.2'W), 112 m depth, Nov. 21, 1980, coll. V. Tunnicliffe.

**Description.** *Macroscopic features.* (Fig. 19A). Encrusting, less than 1 mm thick. Shape variable, from roughly circular patches 0.5 to 10 mm diameter to meandering tracts 3 to 10 mm wide that extend up to 50 mm. Oscula 1 mm by 1.5 mm diameter and inconspicuous. Pores not evident. Surface microhispid in some areas, smooth in others. Consistency soft and slightly fleshy. Colour in life yellow brown



**FIGURE 19.** *Prosüberites saanichensis* n. sp. A, live specimens on brachiopods, scale bar 5 mm; B, tylostyle, scale bar 50 µm; C, head of tylostyle, scale bar 20 µm; D, pointed end of tylostyle, scale bar 20 µm.

**Microscopic features.** Ectosome about 200 µm thick, pierced in places by erect vertically disposed spicules, apices outward, extending to 500 µm beyond the general surface. No evident fence of short tylostyles in the ectosome. Heads of longer spicules reach down to the attachment surface of the sponge. Choanosome about 800 µm thick, contains both erect spicules and smaller unoriented spicules.

**Spicules.** Megascleres exclusively tylostyles, typically with suberitid spherical heads; a few curved slightly near head and a few strongly lote.

Holotype RBCM 982-67-1

Spicule Type	Fig.	Length	Width
Tylostyles	19B–D	200–(611)–900	7–(12.5)–25

Spicule Type	Fig.	Length	Width
Tylostyles		190–(503)–950	8–(11)–18

Microscleres absent.

**Remarks.** We placed our material in the genus *Prosüberites* based on the absence of any distinctly localized size category of tylostyles (van Soest 2002). We have compared our specimens with descriptions of known species world wide.

A form with similar size spicules (175–925 µm x 7.0–17 µm) occurs in central California (*Prosüberites* sp. of Hartman [1975]); its colour alive, described as gold or hazel, yellow-brown or olive-brown, is similar to our species. However it is only recorded from the intertidal; while our species has been found no shallower than 33 m in BC. It has also been described as having densely packed small upright tylostyles 250 µm long in the ectosome which would place it in the genus *Protosüberites* (van Soest 2002).

Thiele (1898) described three species of *Prosüberites* from Japan. *Prosüberites sagamensis* has spicules from 400 to 900 µm long but they are thicker (30 µm) than those of our species. Both *Prosüberites inconspicuus* and *Prosüberites exiguum* have shorter tylostyles. Koltun (1966) made no mention of the genus for far eastern seas of the USSR. The tylostyles of *Prosüberites longispinus* Topsent 1893 from E. Atlantic and Mediterranean are up to 2 mm long, while those of *P. psammophilus* (Pulitzer-Finali 1978) from the West Indies are up to 1600 µm long and those of *P. laughlini* Diaz, Alvarez & van Soest 1987 from Venezuela are up to 1855 µm long. *P. oleteira* de Laubenfels 1957, from Hawaii has tylostyles 230 µm long while *P. conulosus* (Burton 1930) from the Indian Ocean has tylostyles up to 560 µm long.

**Conclusions.** The difference in spicule sizes sets our species apart from other species with the exception of the unnamed species from California. That species is described as having an ectosome of densely packed tylostyles 250 µm in length (Lee *et al.* 2007) which indicates that it is a member of the genus *Protosüberites* as defined by van Soest (2002). The size of spicules and colour difference from described species in the northern hemisphere leads us to conclude the sponge is a new species.

**Bathymetric range.** 33 to 187 m.

**Geographic distribution.** To date found at Princess Royal Reach (Jervis Inlet), Portland Canal, Alice Arm and Saanich Inlet, all inner coast, southern to central BC fjords.

**Ecology.** This is a small encrusting form found on the skeletons of dead hexactinellid sponges or other hard substrates. It frequently occurs on the brachiopod *Terebratulina unguicula* Carpenter 1864. This sponge can occur in oxygen concentrations down to less than 0.2 ml/L (based on observations from a submersible).

### Genus *Suberites* Nardo, 1833

#### *Suberites concinnus* Lambe, 1895

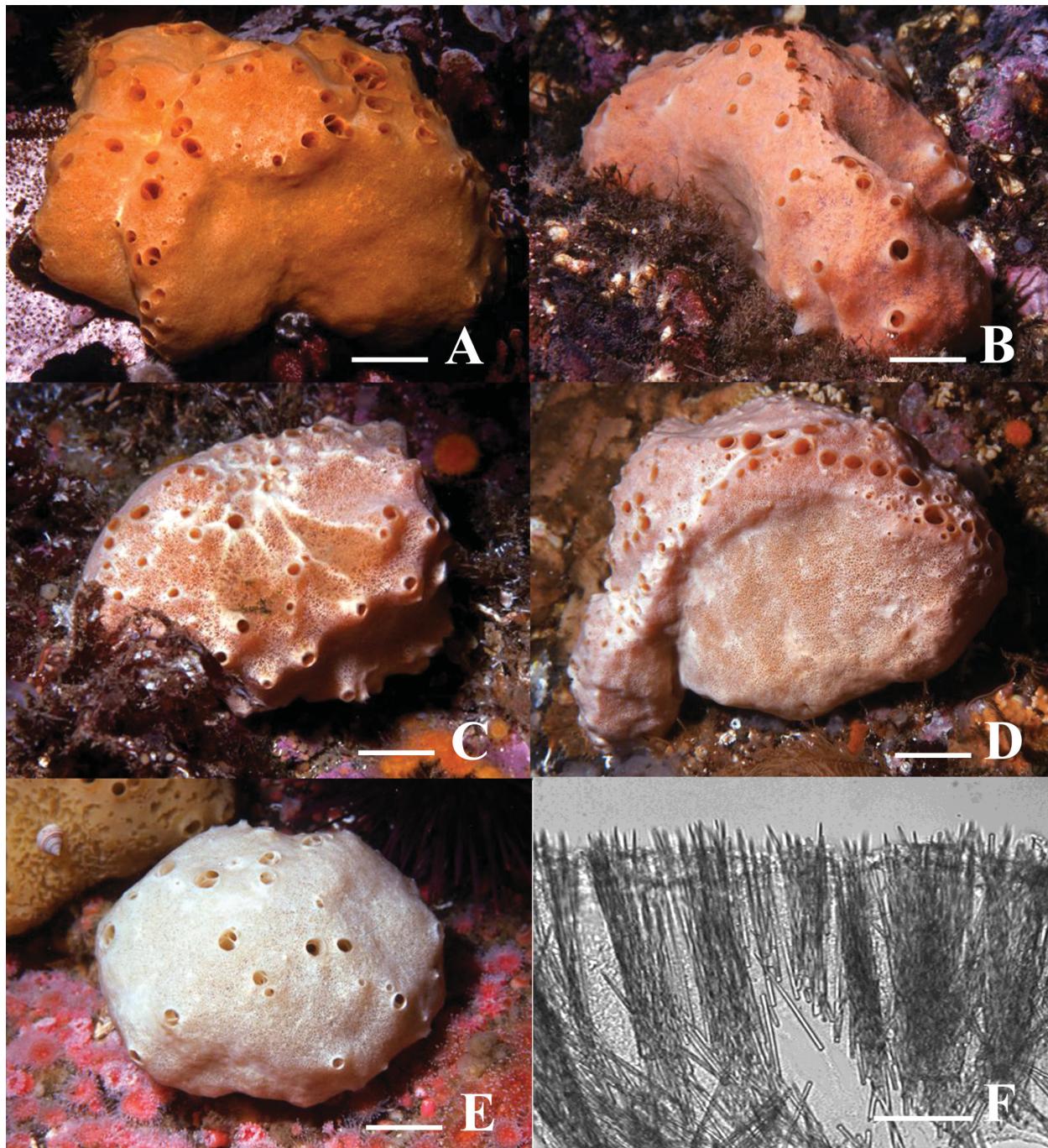
Figs. 20, 21

*Suberites montiniger*: Koltun 1966; Austin 1985; Austin & Ott 1987  
Non: *Suberites montiniger* Carter, 1880

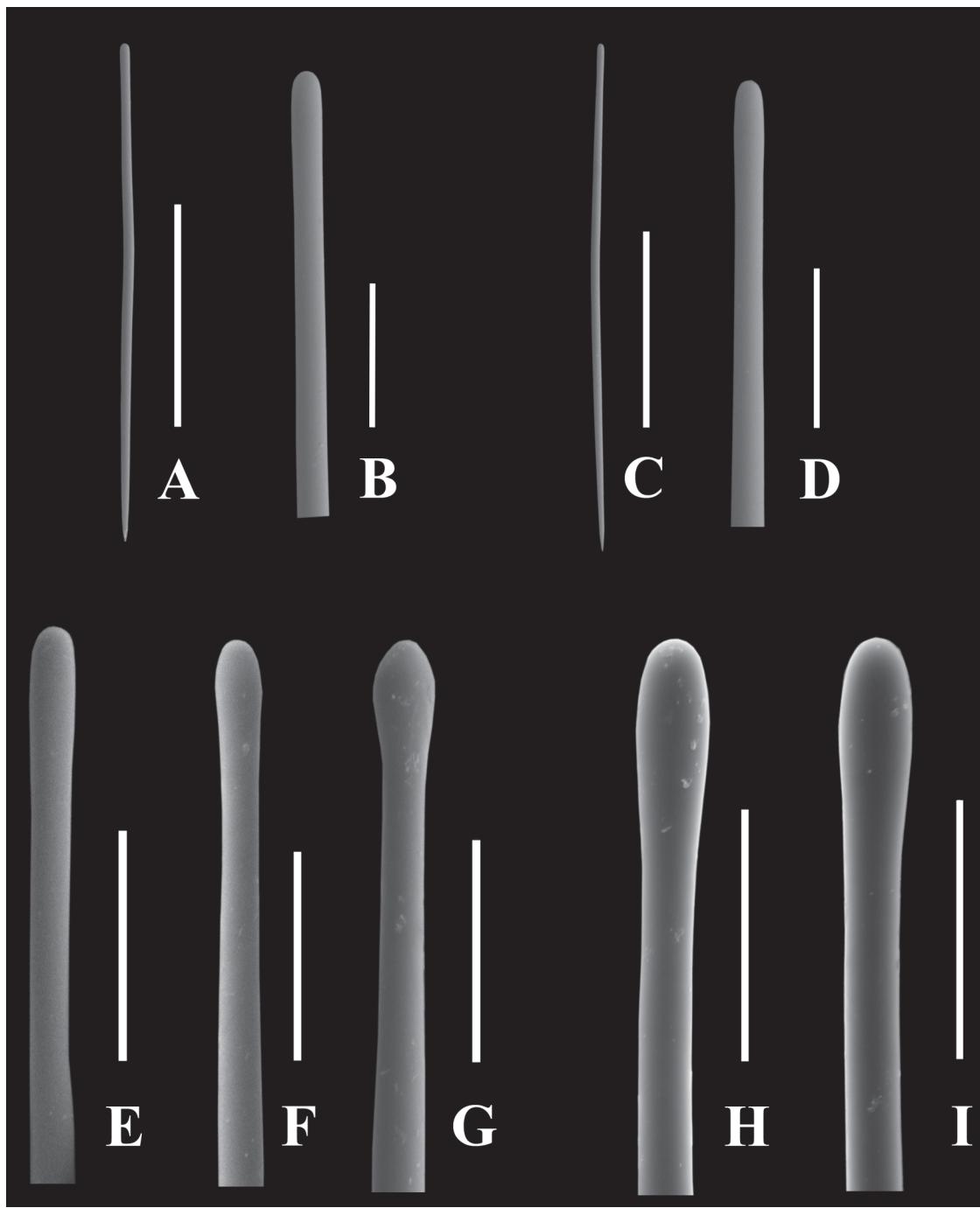
**Material examined.** Syntype: CNM 1900–2822 (previously 2553), Bering I., Commander Islands, USSR, (55° 0.1'N, 166° 16.4'W), found on beach, coll. L. Stejneger, 1882–1883.

Other material: RBCM 976-1038-6, Hatie I., Portland Canal, BC, (55° 17'N, 129° 59'W), Mar. 23, 1976, coll. P. Lambert; RBCM 974-224-2, Winter Inlet, BC, (approx. 54° 49'N, 130° 26'W), no depth, Jun. 13, 1974, 3 specimens; RBCM 974-552-1, Wales I., BC, (approx. 54° 42'N, 130° 28'W), no depth, Jul. 29, 1974; RBCM 974-390-5, Grace Point, BC, (approx 54° 38'N, 130° 26'W), no depth, 1974, coll. P. Lambert; RBCM 974-230, Brundage Inlet, Dundas I., BC, (approx. 54° 37'N, 130° 50'W), no depth, Jun. 19, 1974; RBCM 974-563-2, Coghlan Arch near Banks I., BC, (approx. 54° 27'N, 130° 41'W), no depth, 1974; RBCM 976-104-21, Langara I., BC, (approx. 54° N, 133° W), Apr. 30, 1976; KML 1060, KML sta. 174/76., Houston Stewart Channel, BC, (52° 09.5'N–131° 05.6'W), 24 m depth, Aug. 31, 1976, coll. W.C. Austin; KML 1058, KML 602/77, Houston Stewart

Channel, BC, (approx.  $52^{\circ} 9'N$ ,  $131^{\circ} 5'W$ ), 1977, coll., W.C. Austin; CMN H31, Kitas Bay, BC, (approx.  $51^{\circ} 27'N$ ,  $127^{\circ} 44'W$ ), no depth, Jul. 20, 1964, coll. E.L. Bousfield; KML 1057, PEI 169, Dimsey Point, Rivers Inlet, BC, ( $51^{\circ} 27'N$ ,  $127^{\circ} 44'W$ ), 5 m depth, no date, coll. & photo N. McDaniel; KML 1056, KML sta. 270/70, Pine I., BC, ( $50^{\circ} 58.5'N$ ,  $127^{\circ} 43.7'W$ ), 20 m depth, Sept. 15, 1970, coll. W.C. Austin; RBCM 977-158-5, Boxer Pt., Nigei I., BC, ( $50^{\circ} 50'N$ ,  $127^{\circ} 39'W$ ), 25 m depth, no date, coll. unknown.; RBCM 977-139-08, Minstrel I., BC, (approx.  $50^{\circ} 37'N$ ,  $126^{\circ} 17'W$ ), 25 m depth, Jul. 8, 1977; KML 1059, PEI 83, Steep I. W of Gowland Harbour, BC, ( $50^{\circ} 4.8'N$ ,  $123^{\circ} 15.3'W$ ), 20 m depth, Mar. 6, 1977, coll. & photo, N. McDaniel; KML 124/76, East of Effingham I., BC, ( $48^{\circ} 52.7'N$ ,  $125^{\circ} 17.2'W$ ), 24, 50 m depth, Jul. 26, 1976, coll. W.C. Austin; KML 1061, KML sta. 124/76, E of Effingham I., BC, ( $48^{\circ} 52.7'N$ ,  $131^{\circ} 05.6'W$ ), 24–50 m depth, no date, coll. W.C. Austin.



**FIGURE 20.** *Suberites concinnus* Lambe, 1895. Scale bar on A–E is approx. 3 cm; A, orange morph; B, light orange ectosome, orange choanosome, asymmetrical morph; C, white star burst over light orange ectosome, orange choanosome morph; D, white ectosome, orange choanosome, asymmetrical morph; E, white ectosome, white choanosome, spherical morph; F, tangential section through ectosome showing brushes of megascleres, scale bar 100  $\mu$ m.



**FIGURE 21.** *Suberites concinnus* Lambe, 1895 (cont.). A, style, scale bar 100  $\mu\text{m}$  and B, head in ectosome of typical specimen, scale bar 20  $\mu\text{m}$ ; C, style, scale bar 100  $\mu\text{m}$  and D, head in choanosome of typical specimen, scale bar 20  $\mu\text{m}$ ; E, style and F, G, (incipient) subtylostyles of specimen: RBCM 974-563-2, scale bar 20  $\mu\text{m}$ ; H, I, head of subtylostyles in specimen: NOAA 27218 of *Suberites montiniger*, scale bar 20  $\mu\text{m}$ .

Field images without vouchers: Gordon Rock, E of Malcolm Island, BC, (approx. 50° 35'N, 126° 53'W), photo N. McDaniel; Plumper Rock, E. of Malcolm I., Weynton Pass, 4 km NW of NW Point on Hanson I., BC, (approx. 50° 35'N, 126° 49'W), photo N. McDaniel; Discovery Passage, BC, (approx. 50°N, 125° 11'W), 4 photos N. McDaniel; Race Rocks, BC, (approx. 48° 18'N, 123° 32'W), photo N. McDaniel; Active Pass, BC, (approx. 48° 52'N, 123° 18'W), photo N. McDaniel.

Comparative material: *Suberites montiniger*, NOAA 27218, Stefansson Sd., Beaufort Sea, (70° 19'N, 147° 35'W), 6 m depth, no date, coll. unknown.

**Description.** *Macroscopic features.* (Fig. 20A–E). Irregularly globular, typically 11 cm long by 7 cm wide by

5 cm thick. Oscula range from one to many; in life may be on short chimneys. Soft and porous alive; contracts 70% to moderately hard to soft rubbery texture when preserved in alcohol. In life surface may be white to orange covering a brownish orange to white interior.

*Microscopic features.* (Fig. 20F). Surface megascleres in tufts oriented vertically. Choanosomal megascleres randomly oriented. Together these form layer about 300 µm thick.

*Spicules* (Fig. 21A–I). Megascleres of KML 1056 examined in detail; exclusively styles, most straight, some with slight bend. No difference in spicule type or size between the ectosome and choanosome. Megascleres of nine additional specimens from range of BC localities examined for presence of styles and incipient subtylostyles summarized in Tables 11 and 12, and Figs. 21 E–G). SEMs from a specimen of *Suberites montiniger* from the Beaufort Sea included for comparison (NOAA, cat. 27218) (Figs. 21 H–I).

#### KML 1056

Location	Spicule Type	Fig.	Length	Width
Ectosome	Style	21A–B	190–(224)–260	5–(5.0)–6
Choanosome	Style	21C–D	200–(229)–250	5–(5.2)–6

Microscleres absent.

**TABLE 11.** Per cent styles and per cent incipient subtylostyles in specimens of *Suberites concinnus* Lambe, 1895, and one specimen of *S. montiniger* Carter, 1880 (No. 27218).

ID. No.	Number of spicules Assessed	% Styles	% Incipient Sub-Tylostyles
RBCM 977-139-8	60	100	0
RBCM 974-552-1	60	98.3	1.7
RBCM 976-1038-6	60	100	0
RBCM 974-224-2	60	100	0
RBCM 976-104-21	60	98.3	1.7
RBCM 974-230-1	60	98.3	1.7
RBCM 974-228-1	60	100	0
RBCM 974-390-5	25	100	0
RBCM 974-563-2	68	49 (Fig. 21D, E)	51 (Fig. 21F, G)
KML 1056	57	100	0
NOAA 27218	100	1	99 (Fig. 21H, I)

**TABLE 12.** Comparison of macrosclere sizes in specimens of *Suberites concinnus* Lambe, 1895, and one specimen of *S. montiniger* Carter, 1880 (NOAA 27218) (20 spicules counted for each specimen).

Identification No.	Length in µm	Width in µm
RBCM 977-139-8	230–(233)–240	5–(5)–5
RBCM 974-552-1	200–(228)–240	4.3–(5)–5.5
RBCM 976-1038-6	190–(223)–240	4.5–(5)–5.5
RBCM 974-224-2	220–(234)–260	4–(5)–7.5
RBCM 976-104-21	190–(212)–260	4–(5)–5
RBCM 974-230-1	210–(233)–250	4–(5)–5
RBCM 974-228-1	190–(222)–240	4.5–(5)–4.9
RBCM 974-390-5	90–(220)–250	4–(5)–5
RBCM 974-563-2	220–(237)–260	5–(5)–5
NOAA 27218	280–(318)–360	4–(7)–9

**Remarks.** We searched for records of *Suberites* from the northern hemisphere with styles or subtylostyles but not tylostyles. Three species are recorded in the Porifera database by van Soest *et al.* (2012): *Suberites concinnus* Lambe, 1895, *Suberites montiniger* Carter, 1880, and *Suberites montalbidus* Carter, 1880. *Suberites montalbidus* invariably has centrotylote microxea or microstrongyles (Carter 1880; Vosmaer 1882; Fristedt 1885, 1887; Lambe 1895) and so can be excluded from further consideration.

Lambe's specimens of *S. concinnus* ranged from the Gulf of Alaska to Bering I. at the west end of the Aleutians. Burton (1935) recorded a typical specimen from Saghalian Bay, Kol, Sea of Okhotsk from 3–8 m.

Lambe (1895) described and figured the smooth styles in his specimens. They ranged from 229–301 x 5 µm. The maximum size is 40 µm larger than that found in the material we examined. However, we did not search for the largest spicule but rather measured a random sample of 20 spicules.

Koltun (1966) placed *S. concinnus* in synonymy with *Suberites montiniger* (Carter 1880). His rationale was not explicit. He stated that, typically, the megasclere size range in *S. montiniger* is 200–270 x 3–6 µm, comparable to the size range we find in *S. concinnus*. But Koltun also observed that a few specimens had megascleres ranging from 330–600 x 10 µm—much longer than we find in specimens in British Columbia or southern Alaska. The megascleres in our specimen of *S. montiniger* from the Beaufort Sea are significantly longer (Table 12, mean 318 µm) than in our specimens of *S. concinnus* (means 212–237 µm). The megascleres in Koltun's material were characterized as subtylostyles not styles. One might surmise that Koltun did not consider the difference between styles and subtylostyles as significant. Our examination of spicules in nine additional specimens (Table 11) revealed one example with significant numbers of incipient subtylostyles. But 50% of the spicules were styles. It was collected in the same region as many of the other specimens with a low % of subtylostyles. On the other hand, 99% of the spicules observed were subtylostyles and 1% were styles on examination of a specimen we consider to be *Suberites montiniger sensu strictu* from the Beaufort Sea. The subtylostyles in this specimen of *S. montiniger* have a significantly longer swollen head (Fig. 21 H, I) than the incipient subtylostyles of one specimen of *S. concinnus* (Fig. 21 F, G).

Except for Koltun (1966) who merged the two species, neither Carter (1880), Vosmaer (1882) nor Hentschel (1916) mentioned the relative proportion of styles to subtylostyles among megascleres in their descriptions of *S. montiniger*.

*Suberites montiniger* and *S. cocinnus* may differ in biogeographic zones. Records of *S. montiniger* are from 70–80 degrees N in the Barents Sea and Greenland Sea (Carter 1880; Vosmaer 1882; Hentschel 1916, 1929; Swartschewsky 1906) and from the Beaufort Sea (this paper). Records of *S. concinnus* are from 50–60 degrees N in the Sea of Okhotsk, Bering Sea, Gulf of Alaska and British Columbia (Lambe 1895, Burton 1935, this paper). One exception is an identification of *S. montiniger* from 48 degrees N in the northern part of the Sea of Japan by Burton (1935). We suggest that this record needs verification.

Topsent (1915), Hentschel (1916) and Koltun (1966) note that a specimen referred to *S. montiniger* by Lambe (1895) is not this species as it has subtylostyles averaging 16 µm in diameter compared to 5–6 µm for *S. montiniger*. We agree but will not attempt to assign it to another species.

**Conclusions.** In our opinion the difference in prevalence of styles versus subtylostyles and differences in spicule mean size and range, coupled with largely different zoogeographic zones (Arctic vs. cold temperate and boreal) supports maintaining *S. concinnus* as a separate species from *S. montiniger*. The one specimen among eleven which has a significant number of (incipient) subtylostyles (RBCM 974-563-2, Table 11) may be an anomaly or possibly a hybrid. Also, these subtylostyles are different from those in our specimen of *S. montiniger*: the tyle is shorter and with a more angular apex. Finally, the size range and mean of spicules in RBCM 974-563-2 fit the other *S. concinnus* specimens, not the *S. montiniger* specimen (NOAA 27218) (Table 12).

**Bathymetric range.** 3 to 118 m depth.

**Geographic distribution.** Sea of Okhotsk (Russia) east to the Gulf of Alaska (USA) and south to southern BC (Canada).

**Ecology.** This species is restricted to current swept rocks.

#### *Suberites lambei* n. sp.

Fig. 22A–E

**Etymology.** Named for Lawrence M. Lambe of the Geological Society of Canada who described many sponges from western Canada and Alaska during the period 1893–1895.

**Synonymy.** *Laxosuberites* sp.? of Austin & Ott (1987)

**Material examined.** Holotype: RBCM 982-66-1, George Fraser I., Barkley Sd., BC, (48° 54.5'N, 125° 30.8'W), low littoral, Jul. 29, 1976, coll. W.C. Austin. Paratype: CMNI 2009-0028, KML 1103, KML sta. 141/84, Skedans, BC, (56° 6.2'N, 131° 13.1'W), littoral, Jul. 4, 1984, coll. W.C. Austin.

Other material: KML 1078, PEI 38, Chatham Sd., BC, (approx. 54° 22'N, 130° 35'W), no depth, no date, coll. M. LeBlanc, 1 specimen; KML 1076, KML sta. 621/77, Rennell Sd., Haida Gwaii, BC, (approx. 53° 23'N, 132° 32'W), no depth, no date, coll. W.C. Austin, 1 specimen; KML 1064, Sivart Rock, Haida Gwaii, BC, (approx. 52° 32'N, 131° 36'W), 11 m depth, Feb. 12, 1967, coll. D.B. Quayle; KML 1077, KML sta. 589/77, Woodruff Bay, Haida Gwaii, BC, (51° 58.8'N 131° 02'W), littoral, no date, coll. W.C. Austin, 1 specimen; KML 1074, KML sta. 145/76, Drum Rock, Barkley Sd., BC, (48° 53.5'N, 125° 23.3'W), low littoral, Aug. 8, 1976, coll. W.C. Austin, 1 specimen; KML 1067A, KML 45/76, Ross Islets, Barkley Sd., BC, (48° 52.4'N, 125° 09.5'W), no depth, no date, coll. W.C. Austin, 1 specimen; KML 1072, KML sta. 72/72, Cree I., Barkley Sd., BC, (48° 52.2'N, 125° 19.9'W), low littoral, no date, coll. W.C. Austin; KML 1067, KML sta. 163/72, Dixon I., Barkley Sd., BC, (48° 51.2'N, 125° 07.4'W), 9 m depth, Jul. 17, 1972, coll. W.C. Austin, 2 specimens; RBCM 973-5-1, Helby I., Barkley Sd., BC, (approx. 48° 51'N, 125° 10'W), no depth, 1973, coll. P. Lambert; RBCM 977-160-17, Hussar Pt., Nigei I., BC, (approx. 48° 51'N, 127° 39'W), no depth, no date; KML 1071, KML sta. 143/75, off Self Point, Helby I., Barkley Sd., BC, (48° 50.9'N, 125° 09.6'W), 8 m depth, Jul. 14, 1975, coll. W.C. Austin, 1 specimen; KML 1068, KML sta. 113/71, Nudibranch Point, Barkley Sd., BC, (48° 49.9'N, 125° 10.4'W), low littoral, no date, coll. W.C. Austin, 1 specimen; KML 1070, KML sta. 252/76, S of Blow Hole, Mills Peninsula, Barkley Sd., BC, (48° 49.3'N, 125° 09.8'W), 10 m depth, Nov. 4, 1976, coll. W.C. Austin, 1 specimen; KML 1079, KML sta. 48/84, Blue Stone Cave, Barkley Sd., BC, (48° 49.3'N, 125° 09.8'W), mid-littoral pool, Jul. 12, 1984, coll. & photo W.C. Austin, 1 specimen; KML 1073, KML sta. 138A/75, Bordelais Islets, Barkley Sd., BC, (48° 49.1'N, 125° 02.7'W), low littoral, Jul. 12, 1975, coll. W.C. Austin, 1 specimen; KML 1065, KML sta. 184/75, Gowan Point, Pender I., BC, (48° 49'N, 123° 19'W), low littoral, May 25, 1975, coll. & photo W.C. Austin, 1 specimen; KML 1062, KML sta. 80/73, Execution Rock Cave, Barkley Sd., BC, (48° 48.8'N, 125° 19.6'W), low littoral, May 5, 1973, coll. W.C. Austin, 1 specimen; KML 1066A, KML sta. 164G/75, Execution Rock Cave, Barkley Sd., BC, (48° 48.8'N, 125° 10.6'W), low littoral, no date, coll. W.C. Austin, 1 specimen; RBCM 973-24-10, Wain Rock, Saanich Inlet, BC, (48° 41.2'N, 123° 2.4'W), littoral, Apr. 4, 1973, coll. W.C. Austin; KML 1066, KML sta. 35/69, Botanical Beach, Port Renfrew, BC, (48° 31.0'N, 124° 33.3'W), May 5, 1969, coll. W.C. Austin; KML 1069, KML sta. 125E/75, Cape Flattery Cave, Washington, (48° 23.0'N, 124° 43.5'W), low littoral, Jun. 25, 1975, coll. W.C. Austin, 1 specimen; RBCM 975-97-1, San Juan Trail, Sooke, BC, (approx. 48° 21'N, 123° 44'W), no depth, Mar. 1, 1975, coll. J. Edwards; KML 1063 & 1079A, KML sta. 86/90, North of Cambria, central California, (35° 34.8'N, 121° 07.1'W), low littoral, Dec. 31, 1990, coll. W.C. Austin, 1 specimen.

**Description.** *Macroscopic features.* (Fig. 22 A, B). Cushion-shaped, typically 6 cm x 8 cm x 2 cm thick but may be 0.6–6 cm thick. Surface either papillate or smooth; holotype without papillae. Two to a few 1–2 mm diameter oscula flush with and scattered over the surface in preserved material. Firm rubbery consistency; velvety to the touch. Colour alive brownish yellow.

*Microscopic features.* (Fig. 22C) Ectosome about 200 µm thick; supported by vertically aligned tylostyles. Ectosome not sharply demarcated from the choanosome which contains tylostyles without any apparent orientation.

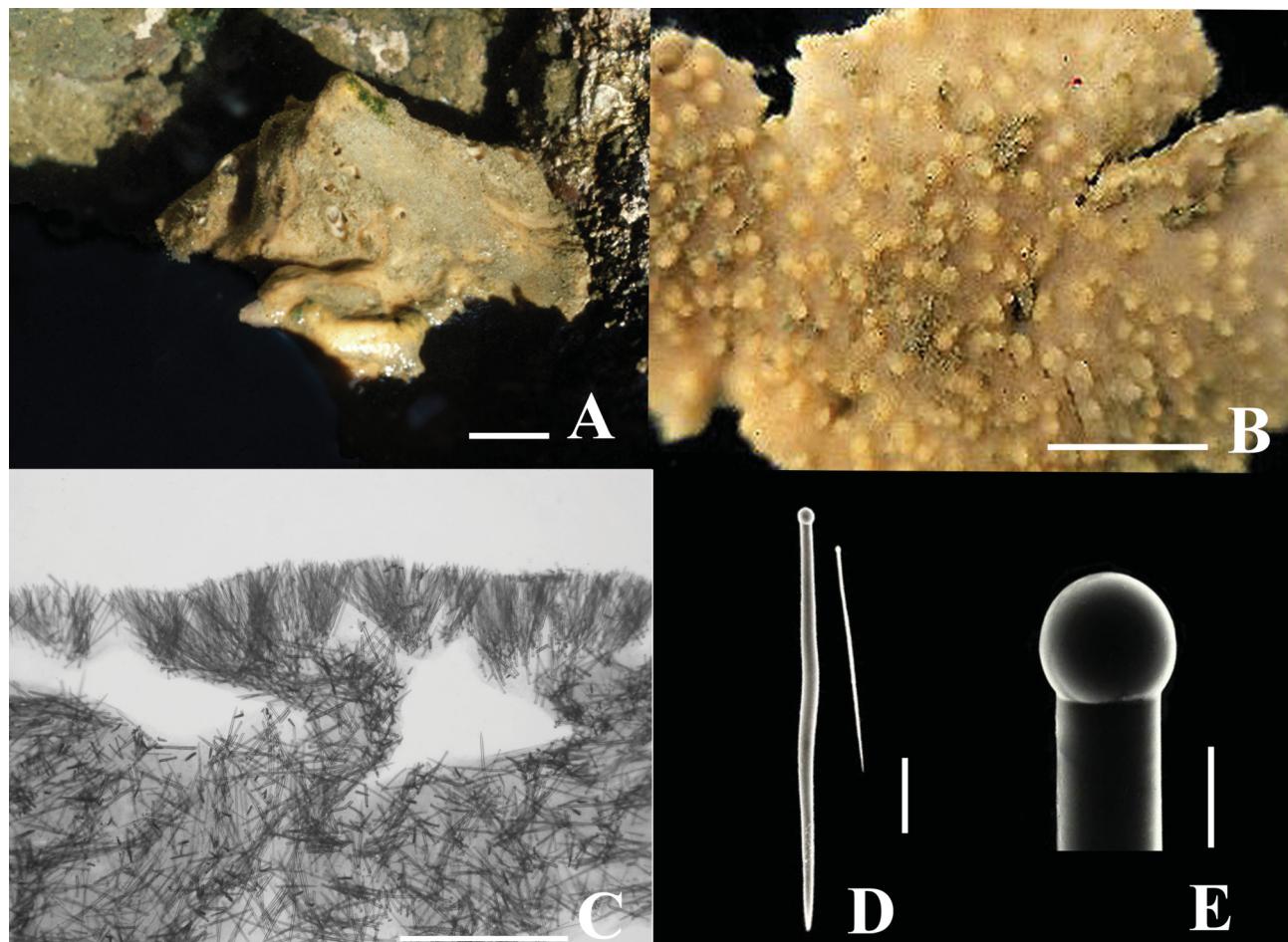
*Spicules.* Megascleres exclusively tylostyles, heads spherical, shaft straight or slightly bent, apices long and gradually pointed.

KML 1079 (Blue Stone Cave, with papillae)

Location	Spicule Type	Length	Width
Ectosome	Tylostyle	172–(364)–480 N=26	7–(11)–15 N=26
Choanosome	Tylostyle	200–(392)–510 N=25	5–(12)–18 N=25

Holotype : RBCM: 982-66-1 (George Fraser I., without papillae)

Location	Spicule Type	Fig.	Length	Width
Ectosome	Tylostyle	none	125–(426)–560	2–(13)–25
Choanosome	Tylostyle	22D, E	250–(454)–600	4–(13)–25



**FIGURE 22.** *Suberites lambei* n. sp. A, massive morph, no papillae, scale bar approx. 2 cm; B, thin morph with papillae, scale bar approx. 2 cm; C, transverse section, scale bar 1 mm; D, large and small tylostyles, scale bar 100  $\mu$ m; E, tylostyle head, scale bar 10  $\mu$ m.

**Remarks.** The range in form from thin crusts to thick cushions, while marked, is less than the polymorphism described by Topsent (1900) in the NE Atlantic *Suberites carnosus* (Johnston 1842) as encrusting (*S. carnosus incrustans*); lobed (*S. carnosus depressus*), digitate with the digits forming branches (*S. carnosus flavus*), ramosc long subcylinders here and there anastomosing (*S. carnosus ramosus*), bulbous and pedunculate or sessile (*S. carnosus typicus*). The presence or absence of papillae in thin forms is not obviously correlated with any environmental character.

We compared *Suberites lambei* n. sp. with other species in the temperate north Pacific. The key feature which sets this species apart from others in the NE Pacific is the width of the tylostyles which averages 13–15  $\mu$ m with extremes of 25–27 and 30  $\mu$ m. However, we have found two specimens which do not have any spicules more than 17.5  $\mu$ m wide. Lambe (1895) briefly described a specimen with spicules averaging 16  $\mu$ m in thickness from southern Alaska. However, based on his drawing and description of a long oval head, the megascleres are subtylostyles rather than tylostyles which precludes it from belonging to *S. lambei*. Lambe doubtfully referred his specimen to *S. montiniger* Carter, 1880. Koltun (1966) pointed out that the megascleres are much thicker (16  $\mu$ m) than in *S. montiniger* (3–6  $\mu$ m, rarely 10  $\mu$ m in diameter) and must belong to some other species.

Other reports of massive encrusting *Suberites* sp. from central and southern California (Hartman 1975, Bakus

& Green 1987, Lee *et al.* 2007) described the spicules as tylostyles over the range 160–(384)–580 µm x 2–(7)–14 or 15 µm. We have found large encrusting *Suberites* with thick (max. 20 µm) tylostyles from Cambria, central California which we tentatively assign to *S. lambei* with the suggestion that spicules at lower latitudes may be thinner (e.g., Hentschel 1929, Hartman 1958).

*Suberites japonicus* (Thiele, 1898) has tylostyles up to 21 µm wide but these tylostyles may be 1 mm long according to Koltun (1966). Thiele (1898) in the original description reported larger tylostyles as about 800 µm long and 12 µm wide. Tanita (1963) recorded large tylostyles as 460–980 µm long x 10–15 µm wide while Hoshino (1981) recorded large tylostyles from 560–(730)–815 µm x 7–(10)–12 µm. In any event the tylostyles of *S. japonicus* are much longer than those of *S. lambei*.

**Conclusions.** *Suberites lambei* is a distinct, recognizable species based on the shape, length and thickness of the tylostyles. The presence or absence of papillae could be genetic or ecophenotypic.

**Bathymetric range.** Low littoral to 10 m depth.

**Geographic distribution.** Sivalt I., Queen Charlotte I. (BC) to Cambria (central California). Note: there is a gap in records for Oregon and northern California.

**Ecology.** Typically occurs in the low intertidal on exposed rock surfaces in areas of wave surge. However, a population has been found in a tidepool in the upper intertidal within a cave. These sponges are contractile. Two specimens lost 53% and 63% of their volume over 10 hours in cool air. The nudibranch *Doris montereyensis* (Cooper 1862) has been observed feeding on *S. lambei*.

### *Suberites latus* Lambe, 1893

Fig. 23

*Suberites latus* Lambe, 1893b.

Lee *et al.* 2007: Key 16 *Suberites montalbidus* of Lambe, 1895.

*Ficulina suberea* var. *lata* de Laubenfels, 1932.

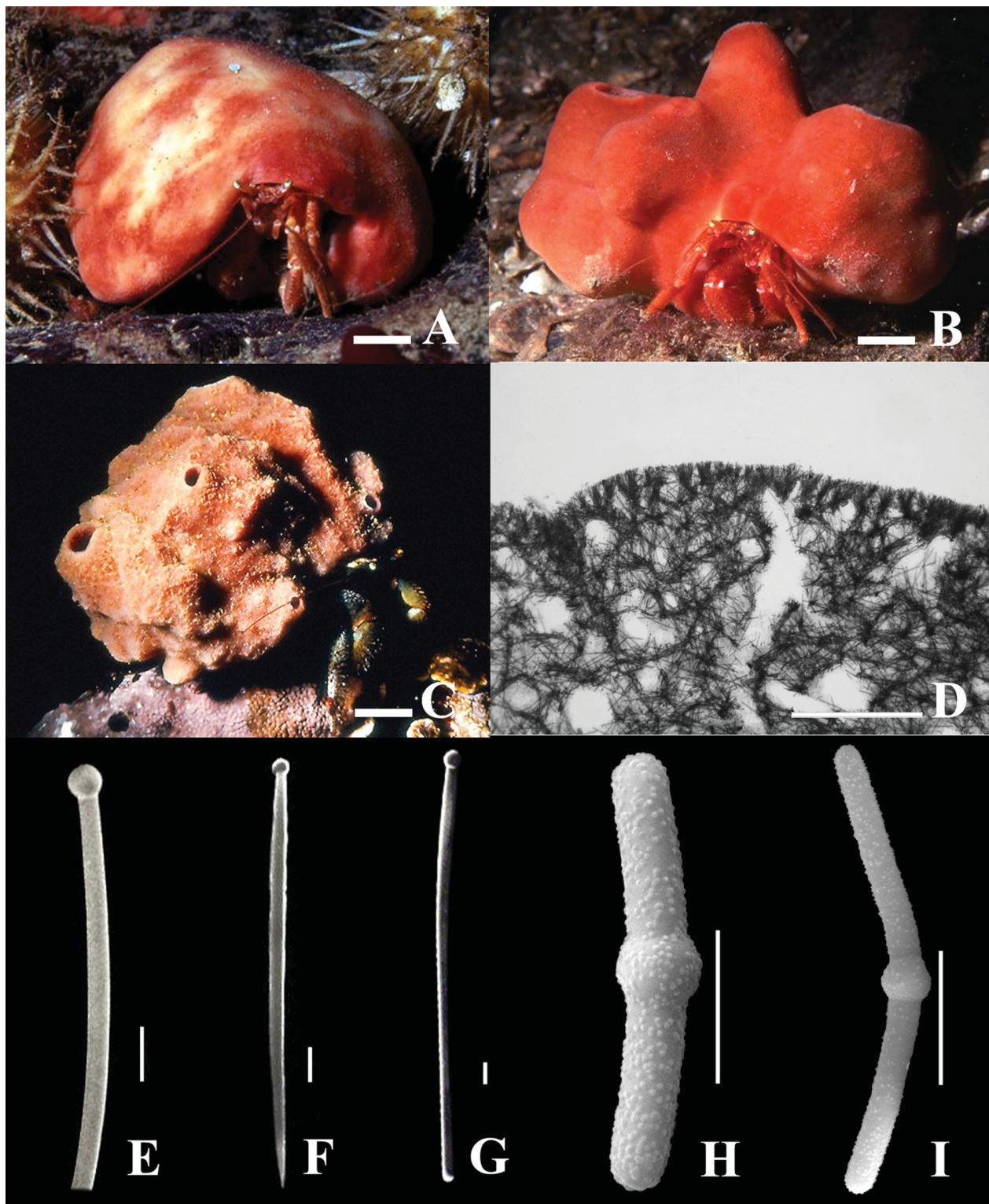
*Choanites suberea* var. *lata* de Laubenfels, 1961.

*Suberites domuncula* (Olivi, 1792) *ficus* of Koltun 1966.

*Suberites ficus* (Johnston, 1842) of Bakus & Green 1987.

**Material examined.** NOAA 027212, Boulder Patch, Stefansson Sd., Beaufort Sea, Alaska, (70° 19.25'N, 147° 35.1'W), 6 m depth, no date, 1 specimen; NOAA 022120, Chukchi Sea, South Alaska, (65° 45.50'N, 167° 50.00'W), no depth, no date, 1 specimen; NOAA 018307, Bering Sea, Alaska, (65° 16.0'N, 166° 36.0'W), 12.7 m depth, no date; KML 1080, PBS sta. 63, 74, Kodiak, Alaska, (58° 07.8'N, 150° 51.0'W), 126 m depth, Aug. 31, 1963, coll. PBS, 1 specimen; KML 1082, PBS sta. 69, 11, S. of Rose Spit, Graham I., BC, (54° 10.3'N, 131° 5.5'W), 17 m depth, Jun. 1969, coll. PBS, 2 specimens; KML 1081, 16 km SW Archibald, BC, (approx. 54° 06'N, 131° 06'W), May 16, 1964, coll. PBS/JAT, 4 specimens; KML 1083, KML sta. 77/76, Skincuttle Inlet, BC, (52° 19.8'N, 131° 12.4'W), 150 m depth, Sept. 1, 1976, coll. W.C. Austin, 2 specimens; RBCM 780-267, Nakwakto Rapids, BC, (51° 06'N, 127° 30'W), 1 specimen; KML 1084, KML sta. 63, 3, Malcolm I., BC, (50° 37.7'N, 127° 01.8'W), 60 m depth, Jan. 12, 1963, coll. D.B. Quayle, 10 specimens; KML 1085, PBS sta. N-7, Lawn Point, Haida Gwaii, BC, (approx. 53° 25'N, 131° 55'W), Beacon bearing 243°, 28 m depth, Aug. 25, 1960, coll. D.B. Quayle, 1 specimen; KML 1090, KML sta. 70/75, Thiepval Channel, Barkley Sd., BC, (48° 54.2'N, 125° 19.7'W), 22 m depth, May 16, 1975, coll. W.C. Austin, 1 specimen; KML 1089, KML sta. 160/75, W. Satellite Passage, BC, (approx. 48° 52'N, 125° 11'W), no depth, 1975, coll. W.C. Austin, 1 specimen; KML 1087, KML sta. 105/76, N of Diana I., Barkley Sd., BC, (48° 51.1'N, 125° 11.9'W), 22–31 m depth, Jul. 8, 1976, coll. W.C. Austin, 1 specimen; KML 1102, KML sta. 67/87, Barkley Sd., BC, (approx. 48° 51'N, 125° 14'W), no depth, Jul. 19, 1987, coll. W.C. Austin, 1 specimen; KML 1088, KML sta. 261/72, off Barkley Sd., BC, (48° 47'N, 125° 34'W), 66 m depth, Aug. 15, 1976, coll. W.C. Austin, 1 specimen; KML 1091, KML sta. 63/68, Saltspring I., BC, (48° 42.6'N, 123° 29.2'W), 45 m depth, Aug. 25, 1963, coll. W.C. Austin, 1 specimen; KML 1086, KML sta. 201/76, W side Gilbert I., Barkley Sd., BC, (38° 52.0'N, 125° 19.8' W), 9 m depth, Nov. 24, 1971, coll. W.C. Austin, 1 specimen.

Field images, no vouchers: Welcome Passage, BC, (approx. 49° 30'N, 123° 56'W), 2 photos, N. McDaniel; Howe Sd., BC, (approx. 49° 25'N, 123° 23'W), 2 photos, N. McDaniel; Port Hardy, BC, (approx. 48° 45'N, 127° 28'W), photo, N. McDaniel.



**FIGURE 23.** *Suberites latus* Lambe, 1893. A, B, typical smooth surface morph, scale bar approx. 1 cm; C, rough surface morph, scale bar approx. 1 cm; D, section normal to surface, scale bar 1 mm; E, curved tylostyle; F, straight tylostyle; G, tylostrongyle; H, I, fat and thin acanthose centrotylote strongyles, scale bars E–I, 10 µm.

**Description. Macroscopic features.** (Fig. 23A, B, C). Body form ranges from thin crust on a snail shell to massive amorphous forms up to 10 cm long by 4 cm high by 6 cm wide. Individuals almost always contain one hermit crab (*Pagurus stevensae* Hart, 1971). Oscula sparse, flush with the surface, 2–3 mm in diameter in preserved samples. In life a firm rubbery consistency which is smooth to the touch. Brownish yellow to brownish red-orange in life.

*Microscopic features.* (Fig. 23D). Ectosome with dense layer of relatively short tylostyles aligned normal to surface; pointed ends extend less than 0.1 mm beyond surface. Choanosome with irregularly distributed, relatively long tylostyles.

*Spicules.* Megascleres are two size classes of tylostyles, data given from KML 1085. Tylostyles 1 (shorter, Fig. 23F) are restricted to ectosome. Tylostyles 2 (longer, Fig. 23E) occur in both ectosome and choanosome. Both long and short tylostyles may be straight (Fig. 23F) but are generally curved or sinuous (Fig. 23E). The tyle is symmetrical or sometimes tilted to one side. It is occasionally lobed or expanded below the apex which is then styloid.

Tylostyles terminating at the cavity containing the hermit crab are strongylote rather than oxeote (Fig. 23G). We also measured large tylostyle lengths of seven specimens from southern BC to 2500 km north off Kodiak (Alaska) (Table 13).

Microscleres are choanosomal centrotylote strongyles (Figs. 23H–I) or oxeas; common, rare or apparently absent. In our material shaft is microspined; may be thick (5  $\mu\text{m}$ ) or thin (2.5  $\mu\text{m}$ ); tyle may occasionally be excentric. KML 1085 except for those with \* which are from KML 1102.

Location	Spicule Type	Fig.	Length	Width
Ectosome	Tylostyle 1	23F	103–(130)–153	5.0–(6.9)–10.0
	Tylostyle 2	23E	203–(261)–360	5.0–(8.4)–12.5
Choanosome	Tylostyle 2	23E	218–(300)–345	5.0–(7.4)–10.0
	Centrotylote strongyles	23H, I	20–(29)–60 N=12 18–(23)–33 N=25*	

**TABLE 13.** Range and maximum size of large tylostyles of *Suberites latus* Lambe, 1893, from a variety of locations from southern BC to Kodiak Alaska.

Registration Numbers	Location in BC	Tylostyle length $\mu\text{m}$ N=20
KML 1102	Barkley Sound, BC; shallow	288–(311)–345
KML 1090	Thiepval Channel, Barkley Sound, BC; 22m	269–(318)–394
KML 1087	Diana I, Barkley Sound; BC; 30m	288–(331)–365
KML 1085	Lawn Point, BC; 28m	211–(250)–307
KML 1084	Malcolm Island, BC; 60m	278–(324)–355
KML 1080	Kodiak, AK; 126m	307–(336)–374
KML 1080A	Kodiak, AL.; 90m	269–(308)–336

**Remarks.** Lambe (1895) commented that his rationale (Lambe 1893b) for considering *S. latus* a distinct species was based on the absence of centrotylote strongyles. He subsequently found one or two of these spicules in some of the specimens he had named *S. latus*. He concluded that *S. latus* was, therefore, not distinct from *S. suberea* (Montagu, 1818). De Laubenfels (1932) pointed out that the tylostyles of Lambe's specimens were on average longer (294–524  $\mu\text{m}$ ) than those of *S. suberea* (Montagu 1818) in British seas, and recommended that *Ficulina suberea latus* be retained as a subspecies.

Lambe (1893b) stated that his specimens included two size classes of tylostyles; the larger ranging from 294–524  $\mu\text{m}$  x 13  $\mu\text{m}$ , and the smaller averaging 170  $\mu\text{m}$  x 9  $\mu\text{m}$ . The larger tylostyles are about 1/3 longer than the longest in specimens examined by us (Table 13). Lambe's specimens came from localities off northern Vancouver I. and the adjacent mainland. Five of the specimens in Table 13 came from 20 to 200 km of the localities reported by Lambe.

In 1895 Lambe reported on 60 specimens from Alaska. He stated that the maximum length of the tylostyles for these was 406  $\mu\text{m}$ . This size is much closer to those we provide in Table 13 which also includes two specimens from Alaska.

De Laubenfels (1961) reported *Choanites suberea* var. *lata* as common and frequently occurring on hermit crab shells in the vicinity of Friday Harbor, Washington. He reported tylostyles ranging from 5  $\mu\text{m}$  x 280  $\mu\text{m}$  to 6  $\mu\text{m}$  x 180  $\mu\text{m}$  (a misprint for 380 or 480?) and centrotylote microstrongyles 24  $\mu\text{m}$  long.

We compared our specimens with those reported from central and southern California. De Laubenfels (1932) gave spicule measurements for two specimens from central and southern California as 70 µm x 5 µm to 590 µm x 12 µm. He does not state whether hermit crabs or their cavities were present.

Bakus & Green (1987) described a sponge from 183 m off Pt. Conception, California. It was growing on a gastropod shell. It had two classes of tylostyles 190–(424)–680 µm x 7–(09)–11 µm and 120–(413)–657 µm x 1–(3)–4 µm and centrotylote strongyles 20–(30)–48 µm by 1–(2)–2.5 µm. They considered it as a member of *S. ficus*. The mean and maximum length of the tylostyles are 30% and 75% greater than the maximum mean and maximum longest lengths we measured in BC material.

Lee *et al.* (2007) described *Suberites latus* from southern to northern California as subtidal and often associated with a hermit crab or mollusk shell. The tylostyle range was from 90–(197–321)–680 µm x 2.5–5.1–(8.6)–12 µm. Centrotylote strongyles were rare. They ranged from 12.3–(21.2–28.5)–56 µm. The maximum length of the tylostyles was again 75% longer (680 µm) than the longest found by us (394 µm).

De Laubenfels (1935) described *Suberites mineri* from the surveys of the *Albatross* during 1911 off Baja California. No data were recorded on precise locality or depth, and while the *Albatross* was working off the Baja California coast, stations ranged from the intertidal to depths of 3200 m (Anon. 1921). According to de Laubenfels, microstrongyles were abundant, ranging from 18–36 µm in length, but tylostyles were of one kind only, averaging 340 µm by 10 µm. He found no small cortical tylostyles which would preclude the species from membership in the genus *Suberites* as defined by van Soest (2002) in the Systema Porifera. One of our reviewers commented that the species was common on the flat bottoms of the Mexican Pacific area; but if its spicule complement is as described by de Laubenfels, it is not closely related to *Suberites latus*.

Is *S. latus* a distinct species, or a subspecies of a cosmopolitan *S. ficus*? The types and size range of spicules given by van Soest (2002) for *S. ficus* (small tylostyles 100–250 µm, large tylostyles 350–500 x 5–10 µm, centrotylote microstrongyles 15–50 µm) approximate those in *S. latus* from the NE Pacific. Van Soest (2002) further observed that the large tylostyles of *S. ficus* occur in a wide size range. This is comparable to the wide variation in maximum size reported above by various authors for *S. latus*. Solé-Cava & Thorpe (1986) reported that three morphotypes of *S. ficus* from the Irish Sea had spicule types and mean sizes which were indistinguishable. However, they had significant genetic differences which, since they were sympatric, indicated genetic isolation. They concluded that the morphotypes represent three separate species within a *S. ficus* complex. Van Soest (2002) agreed that *S. ficus* is very likely to be a complex of sibling species.

**Conclusions.** Van Soest *et al.* (2012) consider *S. latus* to be a valid species separate from *S. ficus* (World Porifera Database, consulted November 2012). We concur and suggest that all sponges with hermit crabs, two size classes of tylostyles and centrotylote strongyles from southern California to Alaska are members of a *S. latus* species complex. The two *Suberites latus* populations from southern to central California, and BC to Alaska may represent sibling species. This species complex would be a good candidate for DNA bar coding.

**Bathymetric range.** 6–183 m depth.

**Geographic distribution.** Southern California to the Bering Sea (Alaska, USA) and possibly north.

**Ecology.** The association of *Suberites latus* with *Pagurus stevensae* provides the hermit crab with a home which can be enlarged as it grows. The mobile sponge can range beyond rock substrate onto soft or unconsolidated sediment. The styloid ends of those tylostyles ending at the hermit crab canal may be responsible for the slippery surface which could aid the rapid retreat of the hermit crab from predators. The gastropod shell on which the sponge initially settled has disappeared in larger sponges (de Laubenfels 1961 and pers. observation).

## Family Tethyidae Gray, 1848

### Genus *Tethya* Lamarck, 1814

#### *Tethya californiana* de Laubenfels, 1932

Figs. 24A–M, 25A–L, 26A–G, 27–29

*Tethya aurantium* var. *californiana* de Laubenfels, 1932; *Tethya aurantium* in part

Non *T. californiana* Sarà & Corriero, 1993.

*Tethya leysae* Heim & Nickel, 2010

**Material examined.** Syntype: USNM No. 21495, Pescadero Point, CA, (36° 33.6'N, 121° 57.1'W) intertidal, Jul. 25, 1926, coll. M.W. de Laubenfels.

Other material: RMMU I-2078, San Jose Creek, CA, (36° 31.6' N, 121° 55.6'W), 9 m depth, coll. H.M. Reiswig; CASIZ 067731, Hopkins Marine Station, CA (36° 38'N, 121° 56'W), no depth given, Aug. 14, 1988, coll. unknown; CASIZ 053441, Gerstie Cove, Salt Point State Park, CA, (38° 10'N, 123° 18'W), 10–12 m depth, May 31, 1984, coll. S. Ward, B. Van Syoc, D. Catinia; KML 1131, PBS 128, Hecate Strait 30 km east of Sandspit, (53° 19.5'N, 131° 15.1'W), 30 m depth, Aug. 1960, coll. unknown; KML 1092, PBS 62-26, Houston Stewart Channel, BC, (52° 08.0'N, 131° 09.9'W), 27 m depth, Aug. 15, 1962, coll. unknown, 10 specimens; KML 1093, KML sta. 83/76, Self Pt., Barkley Sd., BC, (48° 50.1'N, 125° 09.6'W), 4 m depth, Jun. 24, 1976, coll. W.C. Austin; KML 1094, KML sta. 144/76, N of Batley Island, Barkley Sd., BC, (48° 52.5'N, 125° 21.7'W), 24 m depth, Aug. 8, 1976, coll. W.C. Austin; KML 1095, KML sta. 169/76, Flamingo Inlet, BC, (52° 13.3'N, 131° 21.2'W), 15 m depth; KML 1097, KML sta. 35/79, Vananda Cove, BC, (49° 45.7'N, 124° 32.8'W), 15–17 m depth, May 2, 1979, coll. W.C. Austin, 20 specimens; RBCM 976-01083-001, Tasu Sound, BC, east facing side of small bay on south side of the “Gap”, (52° 44.3'N, 132° 05.4'W), less than 15 m depth, Aug. 14, 1975, coll. P. Lambert; RBCM 975-00776-002 off Cape Scott, BC, (50° 47'N, 128° 30'W), no depth given, date before 1981, coll. unknown; RBCM 980-00333-005, Hall Bank, 4 km N of entrance to Forward Inlet, BC, (50° 29.7'N, 128° 01.5'W), less than 8 m depth, June 29, 1960, coll. P. Lambert, 1 specimen; RBCM 980-00348-003, McBride Bay SW of Tahsis Narrows, BC, (49° 51.1'N, 126° 42.9'W), less than 18 m depth, Jul. 8, 1980, coll. P. Lambert; RBCM 976-01073-001, Otter Cove, Discovery Passage, BC, (50° 19.7'N, 126° 26.4'W), less than 38 m depth, Aug. 2, 1976, coll. P. Lambert; KML 1303, Wizard Islet, Barkley Sd., BC, (48° 51.4'N, 125° 09.7'W), 12 m depth, Apr. 12, 2012, coll. S. Gray & S. Friesen; KML 1302, Hopkins Marine Station, Pacific Grove, CA, (36° 37.24'N, 121° 54.1'W), 8 m depth, Mar. 5, 2012, coll. J. Watanabe.

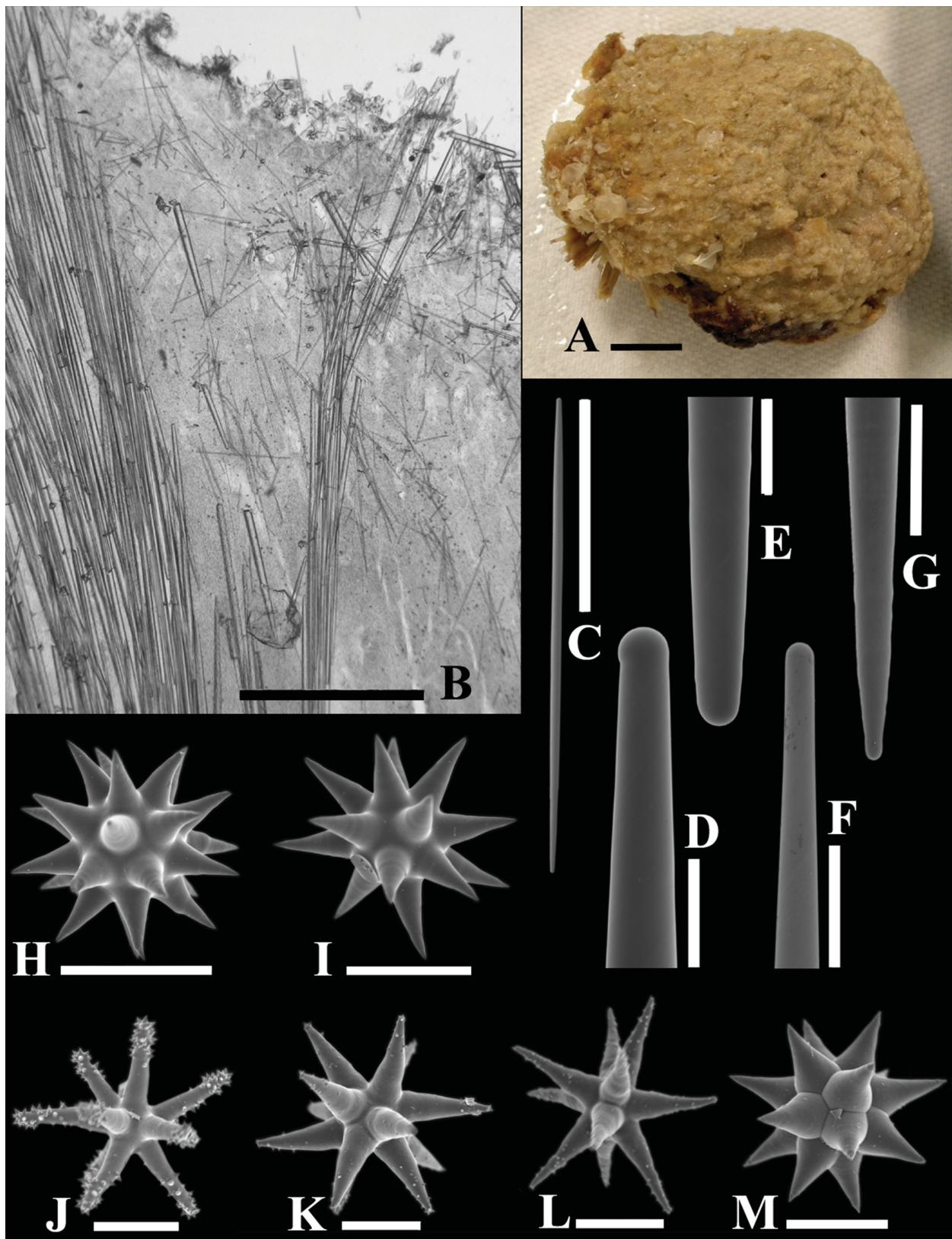
Field images: Chrow I., Barkley Sd., BC, (approx. 48° 54.4'N, 125° 28.3'W), 15 m; Mar. 4, 1976, photo N. McDaniel; Discovery Pass, BC, (approx. 50° 10'N, 125° 21'W), 4 photos N. McDaniel; Ballenas I., BC, (approx. 49° 21'N, 124° 09'W), photo N. McDaniel; NE Texada I., BC, (approx. 49° 45'N, 124° 33'W), photo N. McDaniel; Flattop I., Strait of Georgia, BC, (approx. 40° 09.1'N, 123° 41.5'W), photo N. McDaniel.

**Description.** *Macroscopic features*. (Fig. 24, 25, 26). Syntype: USNM No. 21495; hemispherical, size 5 cm diameter; surface (preserved) appears tattered, boundaries of tubercles not visible (Fig. 24B), but warty per de Laubenfels (1932); colour in life yellow, preserved drab (de Laubenfels 1932).

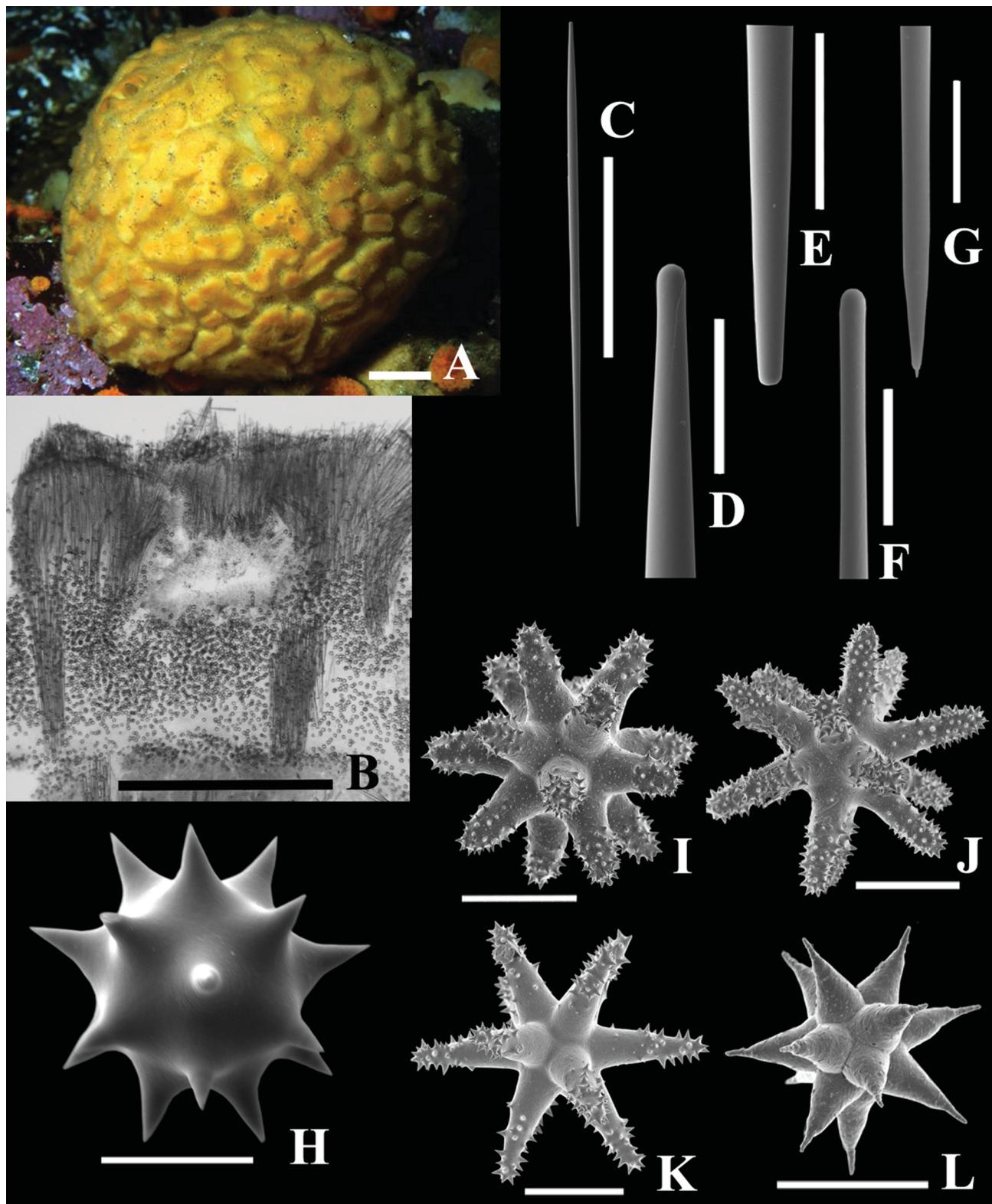
No differences in macroscopic features noted among other specimens from California or BC; hemispherical; size ranges from 3 to 10 cm diameter; tubercles with broad gutters between them *in situ* (e.g., Fig. 25A) with a rough texture; gutters closed or nearly so and outer edges of tubercles in contact when sponge contracted (e.g., Fig. 25B); with a smooth texture; consistency firm in all preserved specimens; no evidence of surface sloughing; colour alive yellow (Fig. 25A) to rust red orange; preserved drab.

*Microscopic features* (Fig. 24, 25, 26, Tables 14, 15). There have been some differences in the definitions of terms for spicules in Tethyidae. We provide our definitions of spicule types for *Tethya* spp. in this paper based largely on Sarà (2002) and Boury-Esnault & Rützler (1997). Additional spicule types in the Tethyidae that are not represented in our material are not included in this annotated list.

- main megascleres: in radiating bundles.
- auxiliary megascleres: interstitial.
- anisostyloides: distal end (foot) smaller diameter than proximal end (head).
- styloides: fusiform, distal end (foot) a point; sides narrow toward rounded end (head).
- styles: straight sides, distal end (foot) a point; diameter of rounded end (head) = to that of shaft.
- megasters = large euasters R/C=megaster ray length divided by the centrum diameter.
- spherasters R/C <1.
- oxymeristasters = sphaeroxyasters R/C 1–2; oxyasters R/C >2
- micrasters = small euasters all spiny.
- acanthostyloides: spiny cylindrical rays with rounded ends.
- acanthotylasters: spiny cylindrical rays with slight terminal knobs.
- acanthoxyasters: spiny conical rays with pointed ends.
- oxymeristasters: smooth rays with pointed ends (may be small megasters).



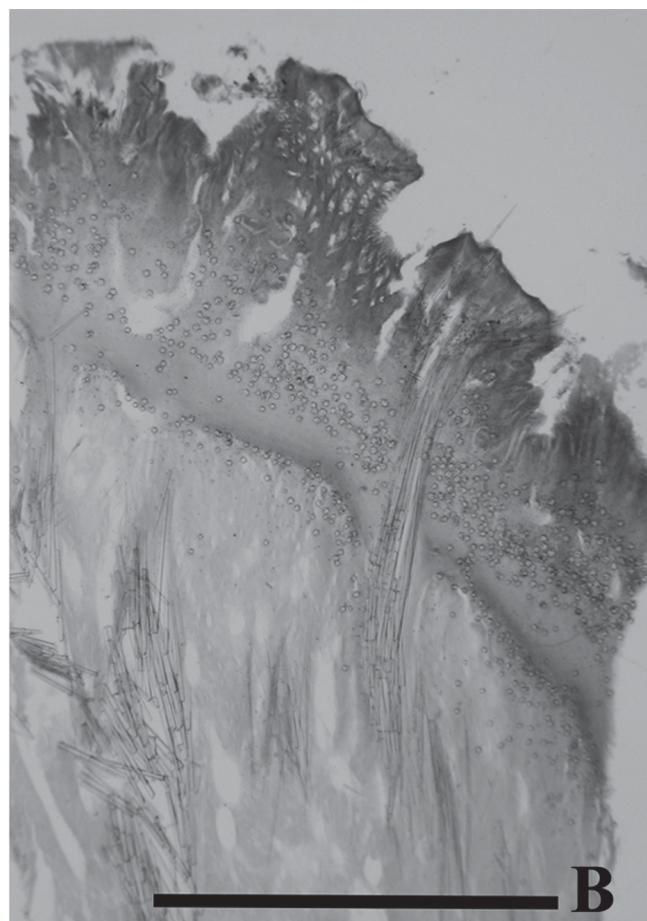
**FIGURE 24.** *Tethya californiana* de Laubenfels, 1932. Syntype: USNM No. 21495, Pescadero Point. CA; A, whole specimen showing external sloughing, scale bar 1 cm; B, cortex and outer choanosome, no alveolar layer of multiple lacunae; C, anisostyly, scale bar 1 mm; D, head of anisostyly, scale bar 100  $\mu$ m; E. foot of anisostyly, scale bar 100  $\mu$ m; F, head of anisostyly, scale bar 30  $\mu$ m; G, almost pointed foot of anisostyly, scale bar 30  $\mu$ m; H, megaster, scale bar 50  $\mu$ m; I, megaster, scale bar 30  $\mu$ m; J, acanthostylylaster, scale bar 10  $\mu$ m; K, acanthoxysphaeraster, scale bar 5  $\mu$ m; L, acanthoxysphaeraster, scale bar 5  $\mu$ m; M, oxysphaeraster, scale bar 10  $\mu$ m.



**FIGURE 25.** *Tethya californiana* de Laubenfels, 1932. A, Chrow Islet, BC, expanded specimen, scale bar approx. 1.5 cm; B, KML 1094 Batley I., BC; cross section of cortex, scale bar 3 mm; C, anisostylyle, scale bar 1 mm; D, head of anisostylyle, scale bar 100  $\mu$ m; E, foot of anisostylyle, scale bar 100  $\mu$ m; F, head of style, scale bar 30  $\mu$ m; G, foot of style, scale bar 30  $\mu$ m; H, cortical megastars, scale bar 30  $\mu$ m; I, incipient acanthotylaster, scale bar 5  $\mu$ m; J, acanthostrongylaster, K, acanthoxysphaeraster, scale bar 5  $\mu$ m; L, oxysphaeraster, scale bar 5  $\mu$ m.



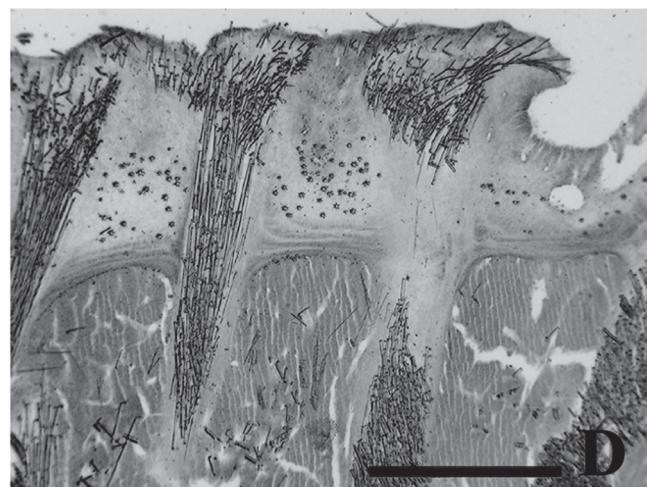
A



B



C



D

**FIGURE 26.** *Tethya californiana* de Laubenfels, 1932. Cross sections of cortex; A, Winter Hbr, Hall Bank, BC, scale bar 3 mm; B, McBride Bay, Tahsis Narrows, BC, scale bar 3 mm; C, RMMU I-2078, San Jose Creek, Pt. Lobos, Carmel, CA, scale bar 0.5 mm; D, CASIZ 067731, Hopkins Marine Station, Pacific Grove, CA, scale bar 2 mm.

Syntype: USNM No. 21495 (from Pescadero Pt.) in cross section (Fig. 24B); cortex with some vacuoles or canals but not highly vacuolated; outer margin not well defined; appears to be sloughing off material; megasters scarce. Cross sections of five additional specimens, two from central California and three from BC, all showed a dense cortex with some vacuoles or canals and a well defined outer margin (Fig. 24B, 26A–D). Megasters abundant in three wave exposed coast specimens (Fig. 25B, 26A, C), but in moderate numbers in one protected coast specimen (Fig. 26B). The specimen from Hopkins Marine Station, CASIZ 067731, (Fig. 26D) has moderate numbers of megasters. It could have been taken from a protected or moderately wave exposed location.

Tracts of macroscleres can be seen to radiate to the surface in cross sections. In the syntype the number of megasclere bundles to tubercles could not be established, but in the remaining five specimens it appeared to be one bundle per tubercle (Fig. 25B, 26A–D).

*Spicules.* Fig. 24C–M and Fig. 25C–L illustrate spicule morphology in the syntype USNM 21495, Pescadero Pt., CA, and the Batley I., BC, KML 1094 specimens respectively.

Megascleres include the main anisostylosyles (Fig. 25C, D, E), strongyloxeas and styles (Fig. 25F, G). Tracts filled mainly with anisostylosyles (Fig. 24C, D, E & Fig. 25C, D, E) with 0 to 22% strongyloxeas (Tables 14, 15); interstitial megascleres primarily styles (Fig. 25F, G). Interstitial anisostylosyles and strongyloxeas were present but their relative abundance and size ranges were not assessed. Microscleres include megasters and euasters. Megasters (Fig. 24H, I & Fig. 25H) predominantly in the cortex but also in the choanosome. Other microscleres are euasters of four types: acanthostylosylasters (Fig. 24J, 25J, K), incipient acanthotylasters (Fig. 25I), oxyxpherasters (Fig. 24M, 25L) and acanthoxyspherasters (Fig. 24K). The acanthoxyspherasters and acanthostylosylasters were slightly more spiny in the Hopkins Marine Station specimen than in the syntype. They were significantly more spiny and robust in the Batley I. specimen (Fig. 25I, J, K) than in the syntype (Fig. 24J, K, L).

Size ranges and means, relative abundance, and for megasters, the ratio of ray length to centrum diameter, are listed for southern California Channel Islands specimens (CASIZ 053441), for the Pescadero Pt (central CA) syntype (USNM 21495), for nearby specimens from San Jose Creek (central CA) (RMMU-I-2078) and Hopkins Marine Station (central CA) (CASIZ 067731), (Table 14 columns A, B, C, D). The same parameters are listed for specimens from four localities in BC (Table 15 columns A, B, C, D).

Megasters and their R/Cs are shown in 10 specimens ranging from southern California to northern BC (Fig. 27), and the range and mean of the R/Cs for these specimens are plotted against latitude (Fig. 28).

**Remarks.** Sarà & Corriero (1993) redescribed *Tethya aurantium californiana* de Laubenfels and raised the variety to species status. They stated that the gift of material from the California Academy of Sciences allowed them to redescribe *T. californiana*. This material was identified as Cal. 1 and Cal. 2 from Santa Cruz Island. They described in detail the structure of the cortex with an alveolar layer and lacunae (Fig. 28). They did not indicate that any of the material they looked at lacked such a structure. They also borrowed the syntype labeled *Tethya aurantium* var. *californiana* from the British Museum.

We looked at Cal. 3 (CASIZ 053441) representing four specimens from the same site as Cal. 1 and Cal. 2. The cortex had an alveolar layer and lacunae as they described (Fig. 29). This is detailed in the description of *Tethya vacua* below. We looked at a section of the syntype of *T. californiana* from the U.S. National Museum (USNM 21495, Pescadero Pt. central CA) (Fig. 24B) and were unable to identify a cortical structure such as they described. However, the type was not in good condition. Syntypes represent the same species based on both their collection from the same precise locality on the same day and their agreement with the original description in morphology and spiculation.

We looked at two other specimens collected four and seven km from the syntype (RMMU I-2078, San Jose Creek, CASIZ 067731, Hopkins Marine Station). Like the syntype, they have a solid or only slightly vacuolated cortex (Fig. 26C, D). We conclude that the cortical structure which Sarà & Corriero described refers to specimens Cal. 1 and Cal. 2 but not to the syntype. They stated that "...the highly specialized multilayered inhalant system represents a hitherto unknown form".

The R/C values for megasters provide additional evidence of two morphotypes, one (Cal. 1–3) from the Channel Islands in southern California and the other exemplified by the *T. californiana* syntype of de Laubenfels from Pescadero Pt. (central California). Sarà & Corriero (1993) reported an R/C of 0.8 to 1.2 for megasters (Table 16, column B). In their drawings the R/C ranges from 0.9–1.45, but in a sample measured in their photograph, R/Cs ranged from 0.7–1.0 with a mean of 0.81. R/Cs based on photographs are suspect as it is not possible to focus up

TABLE 14. Comparison of characters in specimens of *Tethya* spp. from southern to northern California.

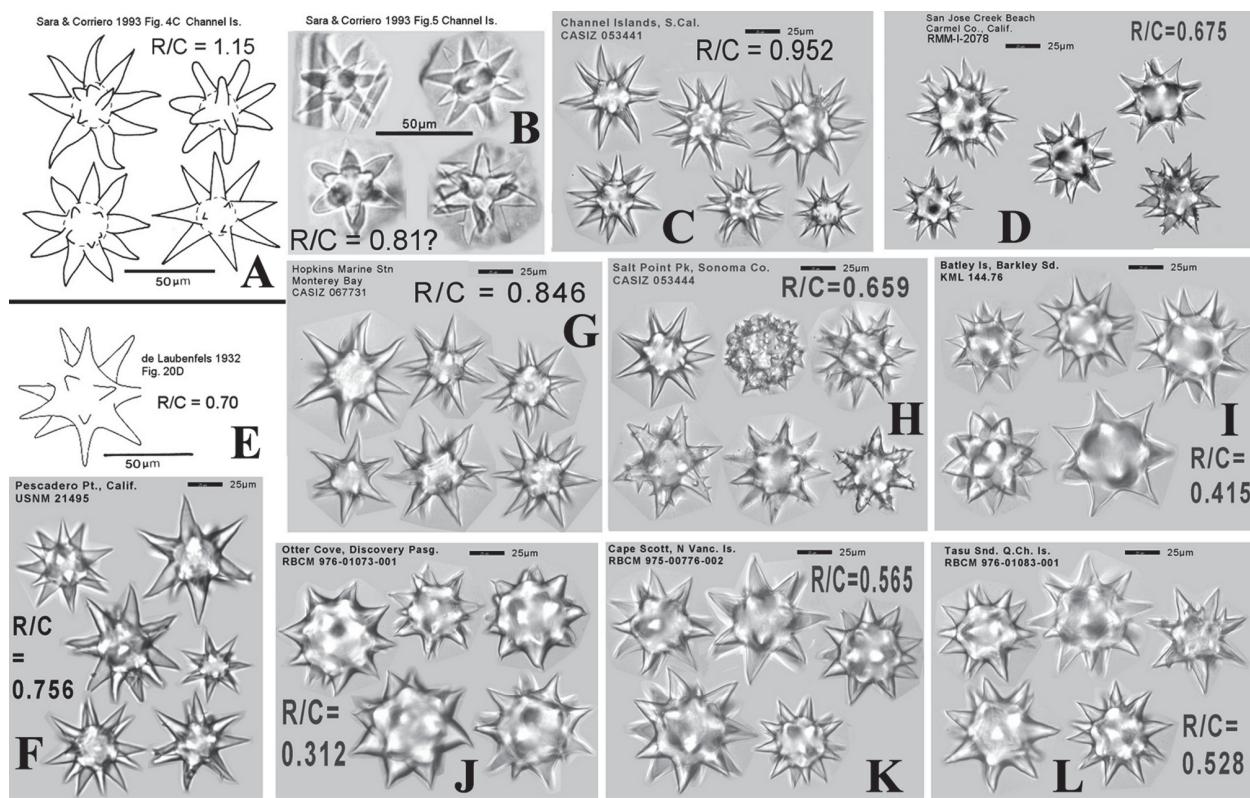
Spicule type	Channel I, CA, CASIZ 053441	Pescadero Pt., Carmel, CA Syntype USNM 21495	San Jose Creek, Carmel, CA RMMU I-2078	Hopkins Marine Station, Pacific Grove, CA CASIZ 067731
	A	B	C	D
main anisostyyles L	1854-(2365)-2890	1758-(2105)-2441	1151-(1535)-1991	1461-(2007)-2655
main anisostyyles W	26-(44)-57	34-(46)-59	18-(27)-40	22-(38)-48
main anisostyyles #	dominant	dominant	dominant	dominant
main strongyloxeas L	1295-(1859)-2765	1564-(1995)-2317	932-(1293)-2285	1447-(2007)-2423
main strongyloxeas W	19-(28)-43	26-(39)-52	13-(20)-30	20-(31)-47
main strongyloxeas #	0%	0%	22%	0%
main tylostyyles L				
main tylostyyles W	0	0	0	0
main tylostyyles #				
aux styles L	545-(911)-1255	480-(691)-979	308-(559)-1046	430-(763)-1320
aux styles W	4-(12)-19	5-(11)-22	6-(10)-17	5-(9)-16
aux styles #	dominant	dominant	dominant	dominant
cort. megaster diam	51-(78)-90	41-(65)-87	47-(79)-95	44-(75)-95
cort. megaster R/C	0.6-(0.9)-1.1	0.58-(0.76)-0.99	0.57-(0.70)-0.84	0.71-(0.85)-0.95
cort. megaster No. rays	13-(16)-21	13-(17)-20	13-(16)-19	12-(150-19)
cort. megaster #	few	few	abundant	common
choano megaster diam	27-(56)-83	33-(49)-75	46-(67)-80	63-(68)-73
choano megaster R/C	0.8-(1.0)-1.3	*	0.54-(0.65)-0.84	0.80-(0.85)-0.91
choano megaster No. rays	12-(15)-19	12-(13)-14	13-(17)-24	10-(14)-17
choano megaster #	few	only 3	common	only 2
acanthoxyspheraster diam.		11-(18)-31	15-(18)-19	12-(18)-24
acanthoxyspheraster #		some	common	common
acanthostylylaster diam	0	20-(21)-27	13-(18)-23	10-(14)-19
acanthostylylaster #	common	rare	common	some
acanthotylaster diam	0	0	0	0
acanthotylaster #				
oxyspheraster diam	20 (thin)	13-(26)-37 (fat)	22-(25)-30 (fat)	16-(21)-25 (fat)
oxyspheraster #	1	1	7	6

[sizes in  $\mu\text{m}$ , (n)= mean size, # = number, diam = diameter, \* 2 of 3 were developmental stages, R/C not assessed].

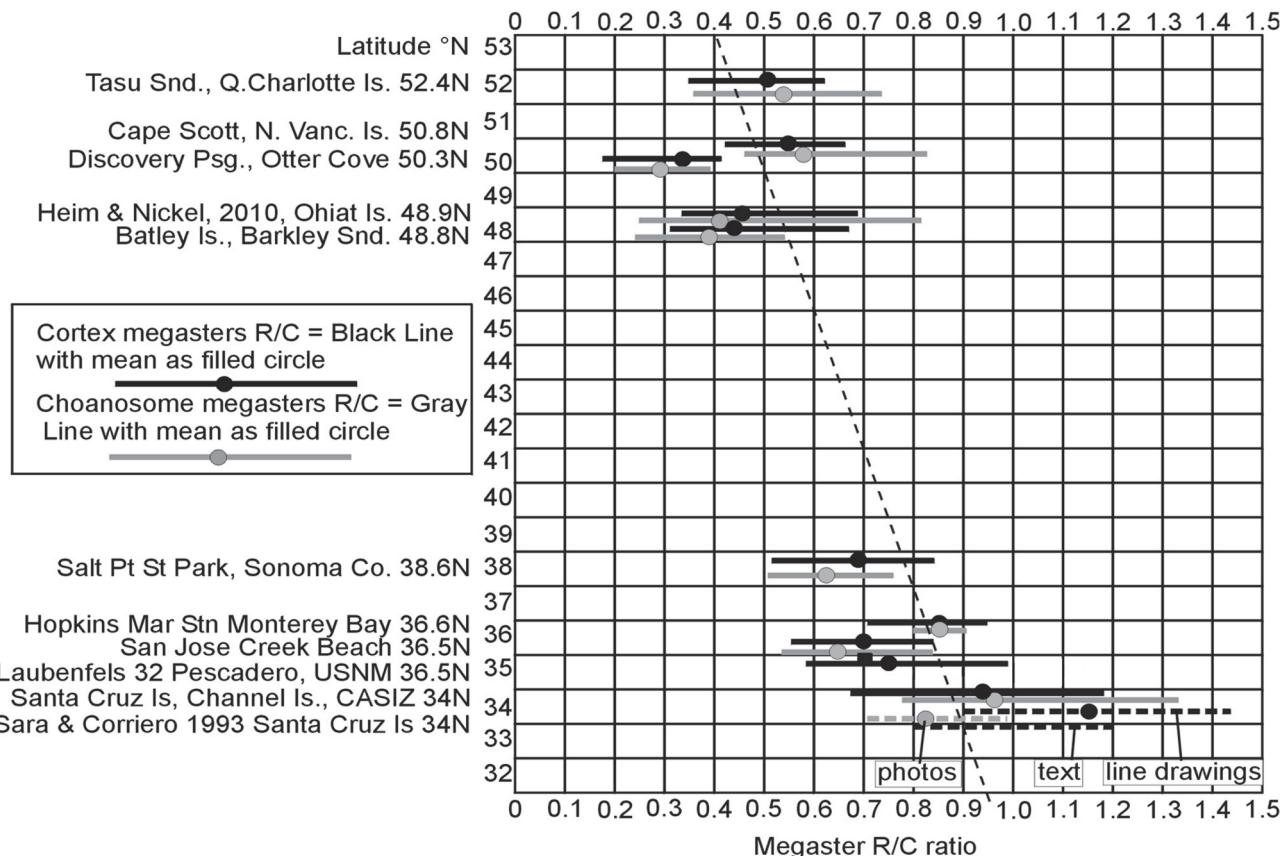
**TABLE 15.** Comparison of characters in specimens of *Tethya californiana* (de Laubenfels) from southern to northern BC  
 [sizes in µm,(n) = mean size, # = number, diam = diameter]  
 [no. of microscleres not assessed as would not justify additional SEM time]

Spicule Types	Batley I., BC KML 1094	Discovery Pass, BC RBCM 976-01073-001	Cape Scott, BC RBCM 975-00776-002	Tasu Sd., BC RBCM 976-01083-001
main anisostyles L	A 1379-(2175)-2691	B 1308-(1820)-2483	C 1507-(2043)-2438	D 1568-(2357)-2860
main anisostyles W	25-(49)-62	38-(52)-92	28-(42)-52	24-(42)-59
main anisostyles #	dominant	dominant	dominant	dominant
main strongyloxeas L	1130-(1353)-2094	1031-(1429)-2630	1160-(1494)-2019	1376-(1727)-2214
main strongyloxeas W	18-(34)-53	10-(28)-41	6-(22)-39	15-(24)-39
main strongyloxeas #	9%	9%	8%	8%
main tylostrongyles L				
main tylostrongyles W	0	0	0	0
main tylostrongyles #				
aux. styles L	315-(662)-1005	382-(670)-969	428-(715)-1096	431-(869)-1272
aux. styles W	8-(15)-29	5-(14)-27	4-(7)-13	10-(14)-16
aux. styles #	common	common	common	common
cort. megaster diam	49-(81)-95	47-(78)-99	46-(81)-96	37-(44)-49
cort megaster R/C	0.31-(0.43)-0.67	0.18-(0.33)-0.41	0.43-(0.55)-0.67	0.35-(0.51)-0.62
cort megaster No. rays	14-(18)-23	15-(18)-23	14-(18)-22	12-(16)-26
cort megaster #	abundant	abundant?	common	common
choano megaster diam	22-(67)-96	17-(51)-71	31-(78)-94	20-(54)-83
choano megaster R/C	0.24-(0.39)-0.54	0.20-(0.29)-0.39	0.46-(0.58)-0.83	0.36-(0.54)-0.73
choano megaster No. rays	13-(18)-22	13-(17)-23	14-(18)-21	12-(15)-19
choano megaster #	common	?	?	?
acanthoxyspheraster diam.				
acanthoxyspheraster #	1	not assessed	not assessed	not assessed
acanthostyngylaster diam	9-(14)-19	8-(14)-18	12-(14)-17	11-(14)-19
acanthostyngylaster #	abundant	abundant	abundant	abundant
acanthotylaster diam	13-15			
acanthotylaster #	2	not assessed	not assessed	not assessed
oxyxpheraster diam	14-19	12-(14)-15	4	not assessed
oxyxpheraster #	3			not assessed

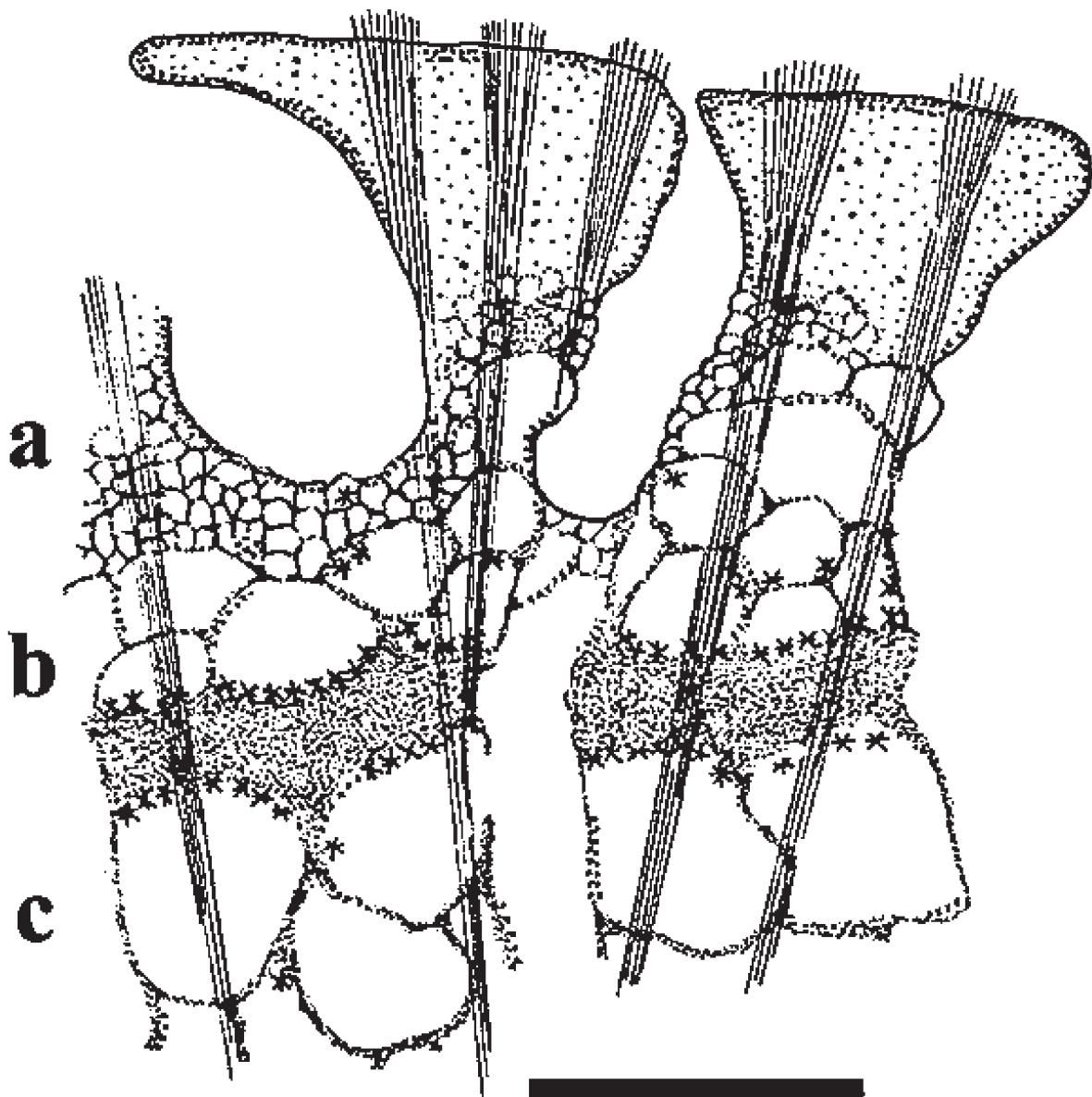
[sizes in µm,(n) = mean size, # = number, diam = diameter]



**FIGURE 27.** *Tethya* spp.. Comparison of megasters of specimens from southern California (A–C) central California (D–G), northern California, (H), and BC (I–L).



**FIGURE 28.** Relationship of cold temperate NE Pacific *Tethya* species megaster R/Cs (ratio of megaster spine length to centrum diameter) to latitude.



**FIGURE 29.** *T. californiana* of Sara & Corriero, 1993 courtesy of *Ophelia* (journal); a=alveolar layer of smaller vacuoles, b=larger cortical vacuoles; c=largest choanosomal vacuoles. Scale bar 1 mm.

and down. Other than the photographs, the R/Cs approximate what we found in the specimen (CASIZ 053441) from the Channel Islands (0.92), and are greater than that figured by de Laubenfels (1932) (R/C 0.7, Table 16, column C) or measured by us in the syntype (mean 0.76) (and in other specimens from Central California [means 0.85, 0.68]). This again indicates that Sarà & Corriero's redescription of *T. californiana* was based, at least significantly, on Channel Island material, not on the syntype from Pescadero Pt. Whether or not R/C values are of genetic significance is discussed later.

Another difference between Cal. 3 and the syntype includes larger auxiliary styles in Cal. 3. However, when the other specimens from central California are included, the difference is much less. In Cal. 3 acanthoxyasters appear to be absent and only one thin spineless oxyaster was found (Fig. 30J). On the other hand oxyasters with a large centrum and broad rays (R/C 0.64) were present in small numbers (1–6) in central California specimens (Fig. 24M).

There is biogeographic information to support considering the two morphotypes as representing two separate species. Point Conception is considered to be a major biogeographic boundary separating cold temperate and warm temperate biotas (e.g., Wares *et al.* 2001). The Channel Islands collecting sites for Cal. 1, 2 & 3 lie south, while the

Pescadero Pt., site for the USNM 21495 syntype, lies north of Point Conception. It is not unexpected that a *Tethya* species in the south would be different from that in the north. Moreover, the cold temperate biota continues northward without a dramatic change for some 1,800 km or more (e.g., Briggs 1974).

Given that Cal. 1, 2 and 3 represent a separate species from the USNM 21495 syntype, what is the status of this syntype as a variety of *T. aurantium* (Pallas 1766)? At least three characters separate the USNM 21495 syntype and supplementary specimens (CASIZ 067731, RMMU-I-2078) from *T. aurantium sensu strictu*: 1) anisostyngyles dominate rather than strongyloxeas; 2) the megasclere bundles broaden only slightly as they penetrate the cortex (Fig. 25H) rather than sharply fanning out within the cortex (Sarà 2002, p. 248, Fig. 1A); and 3) the cortical megasters have mean R/Cs of 0.7 compared to 0.49 (Table 16, column C and E).

Does *T. californiana*, based on our revised description, differ from other described species in the east Pacific and NW Pacific? Heim & Nickel (2010) listed the type locality, form, habitat and spicules for all *Tethya* spp. recorded from the eastern Pacific coasts of North, Central and South America. Six species occurring in Mexico (*T. ensis* Sarà, Gómez & Sarà, 2001, *T. mexicana* Sarà, Gómez & Sarà, 2001, *T. ovum* Sarà, Gómez & Sarà, 2001, *T. paroxeata* Sarà, Gómez & Sarà, 2001, *T. socius* Sarà, Gómez & Sarà, 2001, and *T. californiana* of Sarà, Gómez & Sarà, 2001) have exclusively strongyloxeas in the fascicles. Sarà *et al.* (2001) regard the 54 specimens representing *T. californiana* from the Gulf of California as this species regardless of the fact that they have exclusively strongyloxeas rather than primarily, to exclusively, anisostyngyles. *Tethya taboga* (de Laubenfels, 1935) from Panama and Mexico has predominantly strongyloxeas but also some anisostyngyles; *T. papillosa* (Thiele, 1905) from Chile has only strongyloxeas; *T. sarai* Desqueyroux-Faúndez & van Soest, 1997, from the Galapagos has predominantly strongyloxeas, and *T. strongylata* Sarà, Bavestrello & Cacomo, 2000 from the Galapagos has short, plump strongyles. Based on the above, the megasclere type alone serves to differentiate *T. californiana* from other species recorded from the eastern North and South Pacific. We did not assess the other characters listed by Heim & Nickel.

In the NW Pacific four species have been described from Japan. According to Hoshino (1981), three of these have exclusively “styles” (which we would term strongyloxeas based on their fusiform shape): *T. aurantium*, *T. diploderma*, and *T. japonica*. *Tethya deformis* also has styles or strongyloxeas according to Thiele (1898) and as corroborated by Hajdu *et al.* (2013).

With one exception, *T. californiana* as redescribed differs from those species of *Tethya* known from the east Pacific and from the NW Pacific. There is one other species to compare with *T. californiana*, the recently described *T. leysae* of Heim & Nickel (2010) from Ohiat I. (Barkley Sound, BC). This species was erected based on both morphological and genomic differences from *T. californiana* as redescribed by Sarà & Corriero (1993). However, we have demonstrated that the description by Sarà & Corriero was primarily based on specimens from southern California *not* on the type specimens of de Laubenfels from central California. The morphological differences are sufficient to support considering the southern California specimens as representing a separate species.

When we compare morphological characters of *T. leysae* with our redescription of *T. californiana* they have the following similarities:

- solid cortex with few lacunae
- lacking an alveolar (highly vacuolated) layer in the exocortex
- at least anisostyngyles in the fascicles
- rays of fascicles do not fan out but remain fairly compact
- only a single fascicule (rather than two or three) at the surface of each tubercle

They have the following differences (*T. leysae* compared to *T. californiana*):

- cortex packed with megasters vs. few to modest numbers
- cortical megaster R/C mean value 0.41 (Table 16D) vs. 0.7 (Table 16B)
- oxeas rather than styles form a third category of megasclere vs. oxeas absent
- strongyloxeas present vs. absent
- tylostrongyles absent vs. present
- acanthoxysphaerasters with abundant coarse spines (Fig. 24K) vs. with few, spindly spines (Fig. 25K, L)
- acanthostrongylasters
- with nearly cylindrical branches (Fig. 25I, J) vs. tapering branches (Fig. 24J)

**TABLE 16.** Comparison of characters recorded in the literature for *Tethya aurantia* of de Laubenfels 1932, *T. californiana* Sarà & Corriero 1993, *T. leysae* Hein & Nickel 2010 and *T. aurantium* (Pallas 1766) per Sarà 2002.

Spicule type	Gulf Calif. Sarà 2001	SCal Sarà 1993	CCal delaub 1932	Ohiat BC Heim 2010	Atlantic Sarà 2002
<i>californiana?</i>	CASIZ 053441	USNM 21495	<i>aurantia</i> C	NHM 2009.5.1.1 <i>leysae</i> D	MSNG 49670 <i>aurantium</i> E
A	B				
main anisostyngyles L		size not given	500–3000	1580–(2049)–2540	
main anisostyngyles W	0	dominant	40	18–(34)–53	
main anisostyngyles #	1000–(1539)–2375				few
main strongyloxeas L	12–21–43				400–2500
main strongyloxeas W		some		1580–(2049)–2540	5–30
main strongyloxeas #	dominant			18–34–53	dominant
main tylostyngyles L		800–2200			
main tylostyngyles W		10–40			
Main tylostyngyles #		rare			
aux. anisostyngyles L				Oxaeas?	
aux. anisostyngyles W					490–(1055)–1490
aux. strongyloxeas L	270–(725)–995			7–(19)–30	
aux. strongyloxeas W	1–9–28	300–800		490–(1055)–1490	
aux styles L		5–10		7–(19)–30	
aux styles W		25–80	to 66+		
cort. megaster diam	20–(54)–83			41–(84)–115	18–(62)–105
cort+choan					
0.4–(0.7)–1.2	0.4–(0.7)–1.2	1–1.2	0.7	0.25–(0.4)–0.81	0.4–(0.49)–0.6
Gen 0.6–0.8	Gen 0.6–0.8				
cort megaster R/C		16		8–20	
choano megaster diam	20–(54)–83	cort+choan		24–(68)–81	
choano megaster R/C					0.34–(0.47)–0.69
choano megaster No. rays					0.4–(0.49)–0.6
acanthoxyspheraster: diam.	8–(11)–13			12–18	
acanthoxyspheraster				10–19	10–(130–15 cortex
#					15–(19)–25 choan
acanthostyngylaster #	Some	some		?	Dom.
acanthostyngylaster diam	8–(11)–13	9–13	up to 27	8–10	10–(13)–15 cortex
#	Most	abundant		?	
acanthotyaster diam	8–(11)–13	9–13	up to 27	4–6	10–(13)–15 cortex
#	Few	some		?	
oxypheraster diam	4–8	4–8	abundant	4–10	
oxypheraster #	0	some		?	
sphaerule diam	8–13	8–13		few	

[sizes in  $\mu\text{m}$ , (n) = mean size, # = number, diam = diameter]

**We address below the apparent differences:** We compared the density of megasters in specimens from habitats exposed to, and protected from, oceanic waves and swells. The results are summarized in Table 17. The sample sizes are small, but for both California and BC, the megascleres are dense in exposed habitats but sparse in protected habitats. A possible exception is the sparse megasters in the *T. californiana* syntype. Pescadero Pt., the syntype locality is a recurved “stubby finger” of land where the outer side of the finger is wave exposed but the inner side is protected and faces landward toward aptly named Stillwater Cove. This exposure difference is reflected in the white surf evident on the seaward side but absent on the landward side as seen on Google Earth. The problem is we do not know precisely where the syntype was collected. Also, unlike the other specimens, the syntype had lost portions of the cortex, perhaps related to scouring in its intertidal habitat. The other specimens were all from shallow subtidal habitats.

**TABLE 17.** Comparison of megaster density in cortex of *Tethya* sp. with exposure to waves or swell.

	Fully exposed	Semi exposed	Semi protected	Protected	Depth	Megaster density
British Columbia						
<b>Ohiat I, BC</b> per Heim & Nickel 2010	X				10–25m	High H&N (Fig. 3)
KML 1094, <b>Batley Island</b> , Barkley Sd., BC	X				24 m	High (Fig. 25B)
RBCM 980-00333-005 <b>Winter Hbr, Hall Bank</b> 4 km N of entrance to Forward Inlet, BC		X			<8 m	High (Fig. 26A)
RBCM 980-00348-003 <b>McBride Bay</b> SW of Tahsis Narrows, BC			X		<18 m	Moderate (Fig. 26B)
California						
RMMU-I-2078 <b>San Jose Creek, Pt. Lobos</b> , Carmel CA	X				9 m	High (Fig. 26C)
CASIZ 067731 <b>Hopkins Marine Station</b> , Pacific Grove, CA		X			< 18 m	Moderate (Fig. 26D)
Syntype USNM 21495 <b>Pescadero Pt.</b> , Carmel, CA			X?*		Low inter-tidal	Low (Fig. 24B)

[\* degree of protection dependent on precise location which is unknown]

Unless we are sampling sister species in both California and BC, the differences in megaster density likely reflect ecophenotypic plasticity. Sarà & Manara (1991) state that dense packing of megasters may protect the cortex in *T. aurantium*. This might be associated with toughness of the sponge in localized high wave energy or strong swell environments comparable to, e.g., ecophenotypic changes in *Halichondria panicea* toughness and denser spicule packing in high wave environments (Palumbi 1986). The outer coast sponges came from the shallow subtidal where under high swell and wave conditions the velocity and acceleration of water flow and the associated drag and lift can become increasingly severe (Denny & Wethey 2001).

As defined above, R/C value is based on the megaster ray length divided by the diameter of the centrum. Heim & Nickel (2010) defined it as the ratio of ray length to radius of the centrum, but stated (pers. comm.) that the term “radius” was a *lapsus calami*. The (R/C) value has been used as a systematic character in *Tethya* spp. However, the possibility of ecophenotypic differences cannot be necessarily excluded. Along the coast from southern California to northern British Columbia there is a decrease in R/C values (Figs 27, 28). This is roughly correlated with decrease in temperature (e.g., Strub 2010) and increase in ambient silica (Austin 2012) with increasing latitude. Most interesting to us was the very low R/C value for a specimen from Discovery Pass, BC (R/C 0.312). Discovery Pass has extremely strong tidal currents ( $8 \text{ m sec}^{-1}$ ) with near constant vertical mixing of the water such that silica at the surface is continuously in the range of at least 40  $\mu\text{M}$  (Thomson *et al.* 1980).

Heim & Nickel reported the presence of oxeas as both main and auxiliary megascleres along with

anisostylostrongyles and styrlostrongyleas. They did not indicate which spicule type is dominant. We have been unable to confirm the presence of oxeas in any of the BC or California specimens. The size ranges and means of the main anisostylostrongyles and styrlostrongyleas are close to those of the *T. californiana* syntype (Table 14, column B).

Styrlostrongyleas did constitute 8–9% of primary megascleres in four BC specimens, but 0% in two central CA specimens including the *T. californiana* syntype. However, in a third central CA specimen, 22% of the megascleres were styrlostrongyleas (Table 14, column C).

De Laubenfels (1932) stated that tylostrongyles were the secondary spicules in *T. californiana* but did not illustrate them. We did not find any tylostrongyles in the USNM 21495 syntype or in other specimens collected in central California so its absence in the BC specimens of *T. leysae* is not unexpected.

If micraster spines and ray thickness are correlated with increase silica as megaster R/Cs may be, we suggest the following: with increased silica slightly spined oxyasters (Fig. 24K, L) become heavily spined, bluntly pointed strongylasters (Fig. 26 K), and spined, bluntly pointed strongylasters become thick, rounded ray spiny strongylasters (Fig. 26I, J). While experimental evidence is needed, the above scenario would explain the apparent differences in micrasters between central California and BC specimens.

Heim & Nickel (2010) determined the nucleotide sequences for mitochondrial cytochrome oxidase subunit 1 (CO1) in the holotype and paratype of *Tethya leysae*. They compared these with the sequences in CO1 of *T. californiana* (Genbank AY561978) obtained from Carmel-by-the-Sea less than three km from the collecting site for the *T. californiana* holotype. The two species differed by four base pairs and two amino acid pairs. Heim & Nickel characterized these as extensive nucleotide and amino acid exchanges.

Four base pairs out of an effective length of 658 nt (Heim & Nickel 2010) is only a divergence of 0.6%. This would be considered to represent intraspecies divergence for some sponges (Huang *et al.* 2008). The threshold for interpretation as representing two separate species rather than reflecting intraspecies variability is placed at 2.5% generally by CBoL (Hebert *et al.* 2003) or e.g., 3.76% for sponges (Huang *et al.* 2008). While recent information (e.g., Wörheide 2006) that some sponges (or at least CO1) may evolve slowly relative to e.g., crustaceans, the nucleotide base pair divergences between 11 species of *Tethya* listed by Heim & Nickel (2010) were almost all double digits and ranged up to 81, which is equivalent to divergences up to 12% and all but aquarium species of unknown provenance had at least a 16 nt divergence = to 2.4%.

**Conclusions.** The specimens from the Channel Islands, southern California are different at the species level from *T. californiana* from Pescadero Pt., central California. *T. californiana* (USNM 21495 syntype) is maintained as a species, not a variety based on differences with *T. aurantium sensu strictu*. Given that *T. californiana* applies to the syntypes selected by de Laubenfels 1932, the material described from southern California (Cal. 1, 2, and 3) requires a new name. With the exception of presence of oxea, none of the differences between *T. leysae* and *T. californiana* (revised description) are compelling as necessarily reflecting genotypic characters at the species level. Given that we were unable to find oxeas in any BC material at our disposal, we question the presence of oxeas as a significant character in the types of *T. leysae*. Three characters: R/C values, density of megasters in the cortex, and robustness of spination in acanthostylostrongylasters and acanthoxyspherasters likely reflect ecophenotypic variability associated with environmental conditions (silica availability and exposure to waves, swells and tidal currents). Given the paucity of morphological differences, a difference of 4 nt in CO1 between *T. leysae* and *T. californiana* (based on a specimen from near the type locality) is not sufficient to justify separate species status but could represent differences at opposite ends of the 1500 km long cline from southern California to northern BC. We propose that *T. leysae* be considered a synonym of *T. californiana*. *T. californiana* is not synonymous with any of the other *Tethya* species described from the eastern Pacific or the NW Pacific.

**Bathymetric range.** Intertidal to 30 m depth.

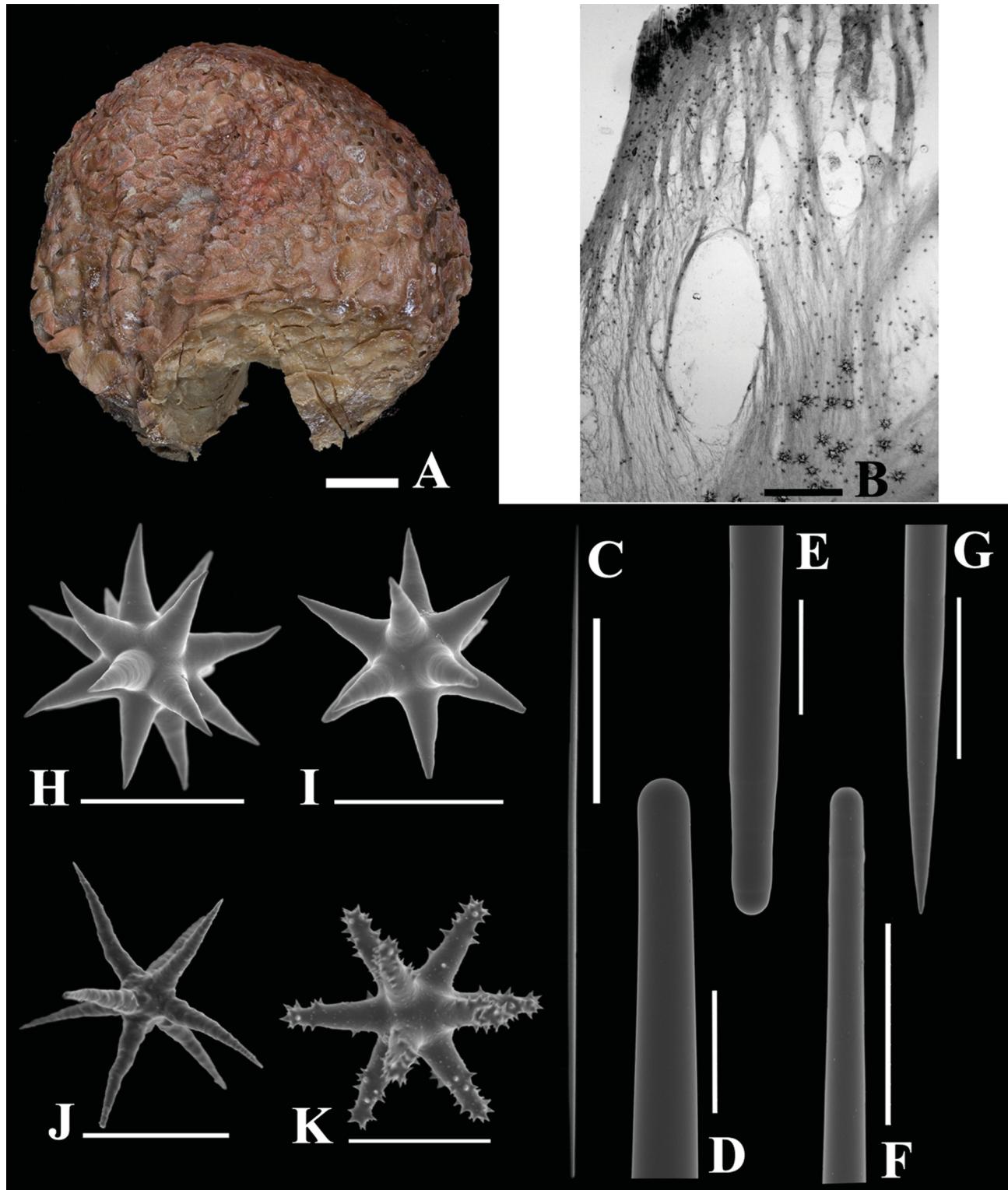
**Geographic distribution.** Northern British Columbia, southern British Columbia (Canada), Washington, northern California, central California (USA).

**Ecology.** Found from wave exposed to protected waters; contracts when mechanically stimulated.

#### *Tethya vacua* n. sp.

Fig. 30A–K

**Etymology.** The species name, *vacua*, refers to the empty vacuolated cortex in the specimens.



**FIGURE 30.** *Tethya vacua* n. sp. A, Holotype (CASIZ 053441), scale bar 1 cm; B, cross section of holotype, smaller vacuoles of outer cortex (above) and larger vacuoles of inner cortex below; C, anisostomyle, scale bar 500 µm; D, head of anisostomyle, scale bar 50 µm; E, foot of anisostomyle, scale bar 50 µm; F, head of strongyloxea, scale bar 30 µm; G, foot of strongyloxea, scale bar 30 µm; H, megaster scale bar 50 µm; I, megaster scale bar 40 µm; J, oxysphaeraster, scale bar 10 µm; K, acanthostrongylaster, scale bar 10 µm.

**Synonymy.** *Tethya californiana* of Sarà & Corriero, 1993, in part.

**Material examined.** Holotype CASIZ 053441, (Cal. 3) Channel Islands, southern California, (34° 0'N, 120° 0.1'W), 9 m depth, Dec. 24, 1981, coll. France & Efford. Paratype 1, = CASIZ 1842878; Paratype 2, RBCM 011-00038-001 = CASIZ 053441. For DNA sequencing CASIZ 184729; [KML 1132] = CASIZ 053441.

**Description.** *Macroscopic features.* (Fig. 30A). Hemispherical, holotype 6.3 cm long diam., 5.8 cm short diam by 3.2 mm in height; four other specimens in same lot with diam. ranging from 3.1 cm to 5.2 cm by 3.2 to 3.9 cm in height; surface with smooth fungiform tubercles (Fig. 30A); 1–2 bundles of megascleres radiate out to each tubercle. Colour in life is reddish brown (morocco on museum label).

*Microscopic features.* (Fig. 30B) Cortex 1–3 mm thick; the outer cortex filled with elongate vacuoles 100–200  $\mu\text{m}$  long by about 50  $\mu\text{m}$  wide; the inner cortex filled with larger vacuoles 250  $\mu\text{m}$ –350  $\mu\text{m}$  long x 10–200  $\mu\text{m}$  wide; outer choanosome with vacuoles approximately 800  $\mu\text{m}$  long x 300  $\mu\text{m}$  wide. Without serial sections, cannot exclude likelihood that some of vacuoles are in fact cross sections of canals.

**Spicules.** (Table 14, column A; Fig. 30C–K). Main megascleres making up the fascicles primarily anisostyloides with few strongyloxeas; interstitial auxillary megascleres are styles (Fig. 30C–G); megasters (Fig. 30H, I; Fig 26C; Table 14, column A) have an R/C value of 0.6–(0.9)–1.1 in the cortex and 0.8–(1.0)–1.3 in the choanosome. They are present but not abundant in the cortex. Euasters are acanthostyloides and rare oxyphaeasters which have thin rays and small centrum with an R/C of 2.5.

**Remarks.** We commented at the beginning of remarks under *T. californiana* that our specimens (Cal. 3 = CASIZ 053441) were collected by the same people on the same day, at similar depths and in nearly the same locality as Cal. 1 and 2 described by Sarà & Corriero (1993). A thick section of Cal. 3 (Fig. 30B) appears similar to the illustration by Sarà & Corriero (Fig. 28) (based on Cal. 1 and 2) in having a highly vacuolated cortex with a peripheral layer of smaller vacuoles equivalent to those they termed alveolae. The vacuoles are more elongate in Cal. 3. This could be the result of differential contraction of the specimen. The following characters are similar to identical between Channel I. Cal. 3 and Channel I. Cal. 1 & 2: sizes of the megascleres (Table 14, column A and Table 16, column B); dominance of anisostyloides over strongyloxeas; styles predominant auxillary macroscleres; the R/C values of the megasters (Table 14, column A and Table 16, column B); acanthostyloides and thin armed oxyasters.

There is one apparent difference between Cal. 1 & 2 as described by Sarà & Corriero (1993) and Cal. 3 as observed by us. We were unable to find any spiny oxyasters (acanthoxyasters) while Sarà & Corriero (1993) drawings depicted fine spines on 3 of 4 oxyasters (their Fig. 4D). They also referred to spined rays in both stonylasters and oxyasters. However, the one SEM they showed of an oxyaster does not have visible spines. We find that the presence or absence of spines can only be determined on SEMs in our material, and we only found one SEM of an oxyaster (Fig. 30J). It has no spines. More material is needed to resolve this apparent difference.

If indeed Cal. 1 and 3 represent the same species, and this species is not *T. californiana*, (as concluded above) then this species requires a name. It is not synonymous with any of the eastern Pacific or NW Pacific species based on the predominance of anisostyloides or other differences in megascleres (as described in more detail under *T. californiana*).

Sarà *et al.* (2001) recorded what they called *T. californiana* (*sensu* Sarà & Corriero) from the Gulf of California. However, the specimens had only strongyloxeas not any anisostyloides.

**Conclusions.** The material from southern California (Cal. 1, 2 and 3) represents a new species *T. vacua n. sp.* which is not synonymous with any other described species from the eastern Pacific or the NW Pacific.

**Bathymetric range.** 9 m depth.

**Geographic distribution.** Channel Islands, California (USA).

## Acknowledgements

We thank Drs. Daniel Faber, former Director, Canadian Aquatic Identification Centre; Arthur Clarke, former Curator of Invertebrates, National Museum of Natural Sciences of Canada; Rita O'Clair, former Assistant Curator, National Museum of Canada; Charles O'Clair, National Museum of Canada; Colin Levings, Pacific Environment Institute, West Vancouver, BC and the staff of the Bamfield Marine Station for making facilities and materials available to us. Gordon Miller, Head, Library Services & Scientific Archives at the Pacific Biological Station, provided expertise in literature searches. Alexander Plotkin provided helpful comments on the Polymastiidae. Welton Lee excised material from specimens provided by the California Academy of Sciences and described their outer appearance. Christina Pietrowski of the California Academy of Sciences provided photos of the *Tethya vacua n. sp.* SEM work was carried out at Simon Fraser University and University of Victoria. Partners in diving and

shore collecting included Geoff Grognet, Myriam Preker, Mary Lou Malott, Mike LeBlanc, Gary Silver, Doug Swanston and Chad Thorpe. We thank Janna Nichols and Greg Jensen for searching out a cryptic *Polymastia* in Hood Canal, WA. Jim Watanabe, Siobhan Gray and Jeff Goddard obtained key specimens of *Tethya*. Sub-scuba zone material was collected from the submersibles *PISCES IV*, *DELTA* and the ROV *ROPOS*. We thank their respective crews for their expert support in collecting material. Many of the earlier dives were made jointly with Verena Tunnicliffe. George Schmahl kindly provided access to the specimen of *Sphaerotylus raphidophora*. Partial funding was provided by a Discovery Grant from the Natural Sciences and Engineering Research Council of Canada to HMR. Neil McDaniel, McDaniel Photography, took most of the *in situ* underwater photographs and gave his permission to use them.

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