Mar Biodiv (2018) 48:545–573
DOI 10.1007/s12526-017-0727-y

SENCKENBERG

ORIGINAL PAPER

Deep-sea glass sponges (Hexactinellida) from polymetallic nodule fields in the Clarion-Clipperton Fracture Zone (CCFZ), northeastern Pacific: Part I – Amphidiscophora

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Received: 23 February 2017 / Revised: 10 April 2017 / Accepted: 2 May 2017 / Published online: 7 July 2017

Abstract The Clarion-Clipperton Fracture Zone (CCFZ) in the northeastern Pacific is the world's largest area for potential deep-sea mining of polymetallic nodules. Furthermore, it is one of the largest, most remote and least investigated ecosystems worldwide. Sponges (Porifera) represent one of the main groups of benthic deep-sea megafauna. This is the first study on taxonomy of amphidiscophorid sponges from polymetallic nodule fields in the CCFZ, and includes descriptions of six known and three new species: *Hyalonema (Onconema) clarioni* sp. nov., *Hyalonema (Prionema) breviradix* sp. nov. and *Poliopogon microuncinata* sp. nov.

Keywords Deep-sea sponges · Deep-sea mining · Polymetallic nodules · Hyalonema · Poliopogon

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Communicated by S. Gollner

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Introduction

The Clarion-Clipperton Fracture Zone (CCFZ) in the northeastern Pacific is the world's largest area for potential deep-sea mining of polymetallic nodules. It is enclosed by the Clarion Fracture Zone in the North and the Clipperton Fracture Zone in the South, while it extends from the west coast of Mexico to Hawaii and covers an area of 5.2 million km^2 (Petersen et al. 2016). Polymetallic nodules are rich in iron oxides (Fe), manganese oxides (Mn), nickel (Ni), copper (Cu), cobalt (Co) and other metals, as well as rare earth elements (Hein et al. 2013; Petersen et al. 2016). Deep-sea mining of polymetallic nodules causes serious long-term habitat disturbance and impacts the ecology of deep-sea fauna; especially benthic communities are affected. Sponges (Porifera) represent one of the main groups of benthic deep-sea megafauna (Rex and Etter 2010; Van Soest et al. 2012; Vanreusel et al. 2016). Two groups of sponges are known to be common deep-sea inhabitants: carnivorous sponges (Demospongiae, Cladorhizidae) and glass sponges (Hexactinellida). Hexactinellida are the dominating group of sponges living on polymetallic nodule fields in the CCFZ, and this study is focused on the Amphidiscophora, while Part II is focused on the Hexasterophora.

Recent studies on the taxonomy of hexactinellid deep-sea sponges from the northeastern Pacific are scarce, although one study with nine new species from the Aleutian Islands has been published by Reiswig and Stone (2013) and a second study with six new species from the northeastern Pacific by Reiswig (2014). Recent studies focusing on taxonomy of amphidiscophorid sponges from the northeastern Pacific do not exist, only ecological studies where amphidiscophorid sponges were mentioned have been published, e.g. by Beaulieu (2001a, b). Stalked

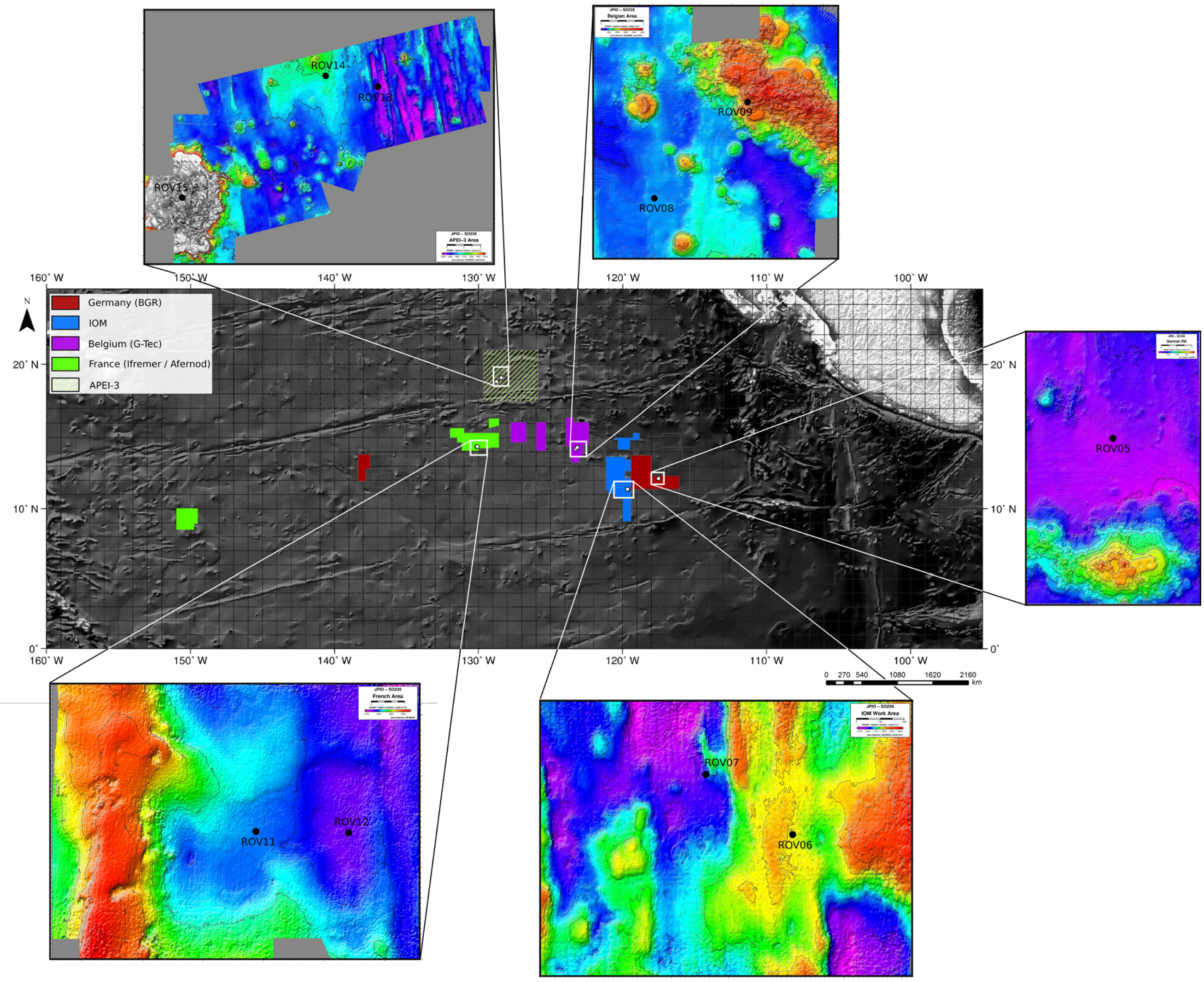

Fig. 1 Map of ROV sample stations within the CCFZ

amphidiscophorid sponges can serve as microhabitats for species-rich epifaunal communities of suspension feeders and create "habitat islands" in the abyssal deep sea (Beaulieu 2001a). A recent study also shows that octopods are associated with sponges, as they attach egg clutches to stalks of dead specimens for brooding (Purser et al. 2016).

Table 1 Sample stations of Amphidiscophora from SO239

Station	ROV Dive	Area	Latitude N (start - end)	Longitude W (start - end)
SO239/64-1	5	BGR	11° 48.97′ - 11° 48.31’	117° 30.13′ - 117° 30.13’
SO239/82-1	6	IOM	11° 3.45′ - 11° 3.66’	119° 37.89′ - 119° 37.65’
SO239/101-1	7	IOM	11° 4.49′ - 11° 4.73’	119° 39.39′ - 119° 39.48’
SO239/131-1	8	GSR	13° 52.39′ - 13° 52.44’	123° 15.03′ - 123° 14.88’
SO239/135-1	9	GSR	13° 58.69′ - 13° 59.06’	123° 8.94′ - 123° 8.64’
SO239/157-1	11	IFREMER	14° 2.09′ - 14° 2.19’	130° 7.13′ - 130° 6.82’
SO239/161-1	12	IFREMER	14° 2.07′ - 14° 2.41’	130° 5.60′ - 130° 5.72’
SO239/189-1	13	APEI-3	18° 47.80′ - 17° 48.13’	128° 18.53′ - 128° 18.20’
SO239/200-1	14	APEI-3	18° 49.22′ - 18° 49.60’	128° 25.55′ - 128° 25.48’
SO239/212-1	15	APEI-3	18° 32.83′ - 18° 32.57’	128° 44.88′ - 128° 44.93’

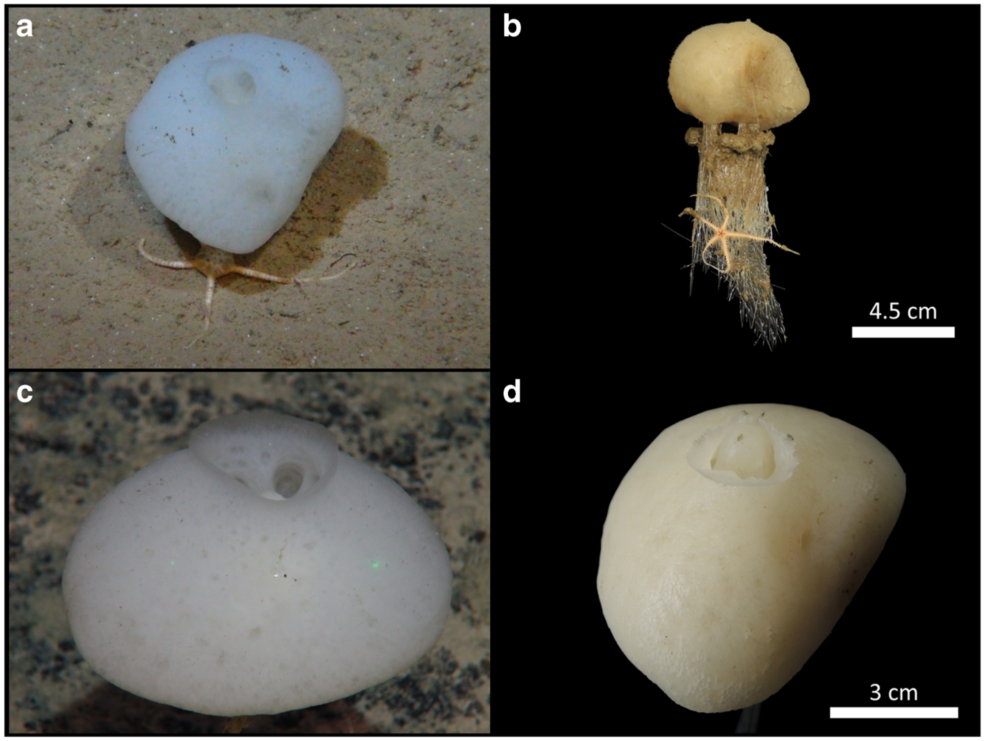

Fig. 2 Habitus of *Hyalonema (Corynonema) depressum*: **a** and **b**) SMF 12052, **c** and **d**) SMF 12083

This study is part of the JPI Oceans working program "Ecological Aspects of Deep-Sea Mining". Main objective is the species identification of amphidiscophorid sponges in the CCFZ and an assessment of potential ecosystem threats caused by deep-sea mining of polymetallic nodules. Results will help to determine species diversity and establish a picture-based species catalog that can be used for future purposes, e.g. pre-mining monitoring. Furthermore, results will also help to understand, how benthic megafauna is adapted to life on polymetallic nodule fields.

Material and methods

Investigated sponge material originates from the expedition SO239 *EcoResponse* (Assessing the Ecology, Connectivity and Resilience of Polymetallic Nodule Field Systems), which lasted from 3. Oct. 2015 to 30. Apr. 2015 and was performed by the RV *Sonne*. The expedition is part of the research program "Ecological Aspects of Deep-Sea Mining" that is in turn part of the European long-term research initiative JPI Oceans (Joint Programming Initiative Healthy Seas and Oceans). The study area of the expedition is located within the Clarion-Clipperton Fracture Zone (CCFZ) in the northeastern Pacific (8° to 18° N and 90° to 130° W). The following four license areas were part of the study area: BGR (Bundesanstalt für Geowissenschaften und Rohstoffe, Germany), GSR (G-TEC Minerals Resources NV, Belgium), IFREMER (Institut français de recherche pour l'exploitation de la mer, France,) and IOM (Interoceanmetal, Bulgaria, Cuba, Czech Republic, Poland, Russian Fed. and Slovakia). Furthermore, the APEI 3 (Area of Particular Environmental Interest) was also part of the study area.

All 19 sponges analyzed in here were sampled with the ROV (Remotely Operated Vehicle) *Kiel 6000* of the GEOMAR research institute and originate from 10 sample stations (Fig. 1 and Table 1). Specimens were sampled with a hydraulically operated arm and stored in purpose-built boxes until the ROV was back on deck. Sponges were collected from the boxes and transferred into buckets filled with cooled seawater (temperature ca. +4 °C). Specimens of each dive were brought to the lab, placed in a dissecting dish, photographed and preserved in denatured EtOH (96%). The sponges were transported to the Senckenberg Research Institute and Nature Museum in Frankfurt am Main, Germany. Spicule preparations were performed for examination with light and scanning electron

Table 2 Body size of *Hyalonema (Corynonema) depressum*, values in [cm]

	SMF 12052	SMF 12071	SMF 12083
Body height	4.3	6.6	6.1
Body width	5.5	8.3	5.2
Basalia length	8.7	-	46.7

microscopy (SEM). In addition, all sponges collected during the expedition SO239 EcoResponse were deposited and inventoried at the Senckenberg Research Institute and Nature Museum. Identified specimens and their metadata were electronically cataloged with SMF numbers, and information is available in the SESAM database (Senckenberg Sammlungsmanagement – www.sesam.senckenberg.de).

Results

Hexactinellida Schmidt, 1870.

Amphidiscophora Schulze, 1886.

Amphidiscosida Schrammen, 1924.

Hyalonematidae Gray, 1857.

***Hyalonema* Gray, 1832**.

***Hyalonema (Corynonema)* Ijima, 1927**.

***Hyalonema (Corynonema) depressum* (Schulze, 1886)**.

Hyalonema (Corynonema) depressum: Schulze, 1886: 60; Schulze 1887: 217, pls. XXXV-XXXVI.

Material:

SMF 12052, station SO239/064-1 in BGR license area at reference site, 11° 48.97′ N/117° 30.13′ W – 11° 48.31′ N/117° 30.13′ W, 4325.6 m; SMF 12071, station SO239/082-1 in IOM license area at nodule site, 11° 03.45′ N/119° 37.89′ W – 11° 03.66′ N/119° 37.65′ W, 4337.5 m; SMF 12083, station SO239/135-1 in GSR license area at seamount, 13° 58.69′ N/123° 08.94′ W – 13° 59.06 N/123° 08.64′ W, 3889.4 m.

Description:

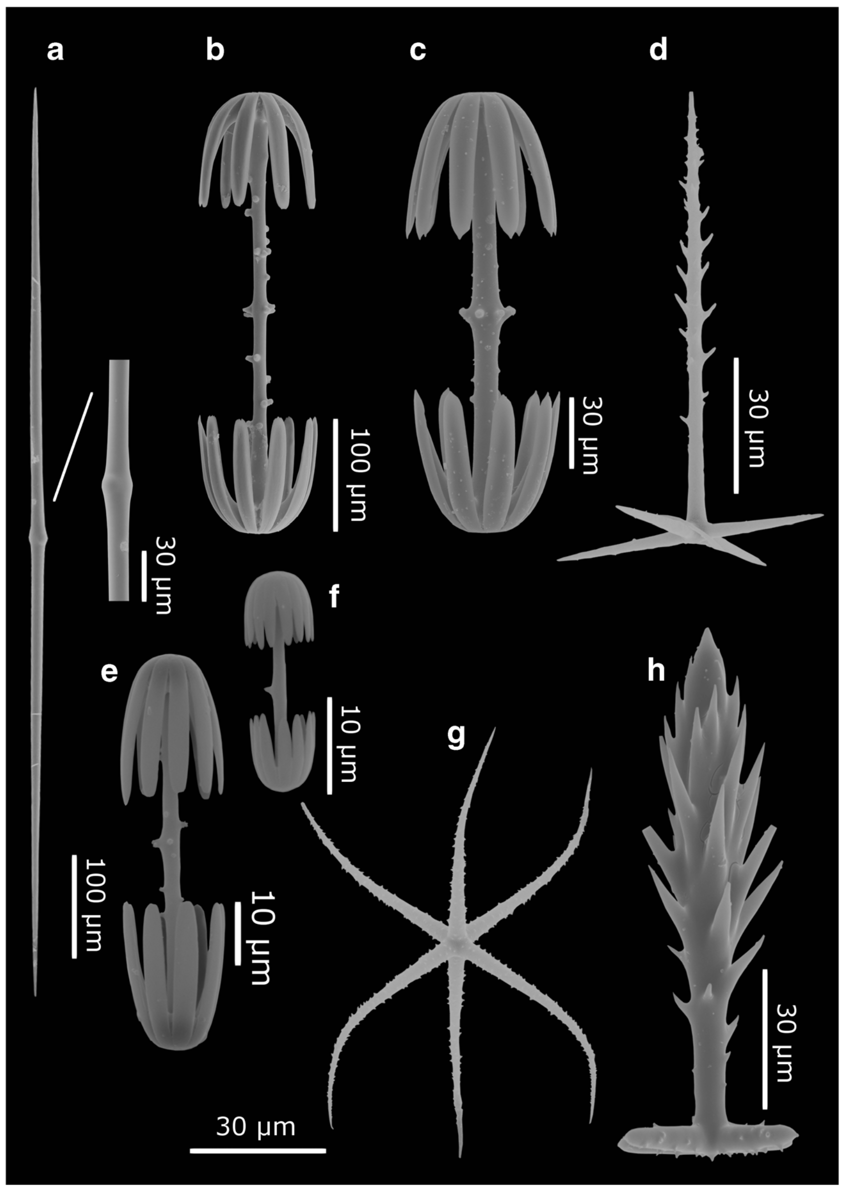

Fig. 3 Spicules of *Hyalonema (Corynonema) depressum*: **a**) Diactin with central thickening, **b**) Macramphidisc 1, **c**) Macramphidisc 2, **d**) Gastral pinular pentactin, **e**) Mesamphidisc, **f**) Micramphidisc, **g**) Microhexactin, **h**) Dermal pinular pentactin

Habitus – Lophophytose sponge with a spherical white body looking slightly compressed and irregular, growing on sediment inside and outside of polymetallic nodule areas as well as seamounts. The osculum is surrounded by a smooth and thin margin. The atrial cavity is subdivided by four radial septa which merge into an apical cone. Specimens have one or few bundles of anchoring basalia, usually gathered in a compact twisted tuft but sometimes also scattered. Anchoring basalia have a spicule length from 8.7–46.7 cm. The body width measures 5.2–8.3 cm and the body height 4.3–6.6 cm (Fig. 2a–d and Table 2).

Megascleres – Diactins are smooth and straight, they have a length of 800–4400 μm and usually a distinct thickening in their central part (Fig. 3a). Hypodermal and/or hypoatrial pentactins are smooth and have a length of 870–2475 μm and a basis diameter of 310–1325 μm. Choanosomal hexactins are also smooth and have a diameter of 310–1460 μm. Parenchymal monactins are very rare; they have a size between 1157 and 1550 μm. Gastral pinular pentactins have only short spines on their distal ray, which is 105–300 μm long. The basis out of tangential rays has a diameter of 68–200 μm (Fig. 3d). Dermal pinular pentactins have a distal ray, which is clavate and has an apical cone. The length is between 93 and 155 μm, and the tangential ray diameter 33–83 μm (Fig. 3h and Table 3).

Microscleres – Three different types of amphidiscs are present: macramphidiscs are either slender, have a spined shaft with central tyle and slightly bifurcate teeth or more robust and have a smooth shaft with central tyle and mucronate teeth. Their total length is between 90 and 410 μm, with an umbel length of 40–123 μm and an umbel width of 40–118 μm (Fig. 3b and c). Mesamphidiscs have a total length of 35–210 μm, umbels sometimes have a twist with a length of 13–73 μm and a width of 10–70 μm (Fig. 3e). Micramphidiscs have a length of 15–

Table 3 Spicule size of *Hyalonema (Corynonema) depressum*, values in [μm] are given as follows: minimum – mean – maximum (number of spicules measured)

	SMF 12052	SMF 12071	SMF 12083
Diactins			
Length	1175 – 1643 – 2450 (30)	850 – 1863 – 4400 (30)	800 – 1408 – 1750 (30)
Choanosomal pentactins			
Length	1200 – 1870 – 2475 (14)	1125 – 1582 – 1875 (7)	870 – 948 – 1025 (2)
Basis diameter	525 – 654 – 1050 (14)	625 – 996–1325 (7)	310 – 485 – 660 (2)
Choanosomal hexactins			
Diameter	-	310 – 552 – 1250 (30)	520 – 762 – 1460 (30)
Parenchymal monactins			
	1157 – 1354 – 1550 (2)	-	-
Macramphidiscs			
Length	-	240 – 360 – 410 (30)	90 – 166 – 240 (30)
Umbel length	-	80 – 104 – 123 (30)	40 – 54 – 80 (30)
Umbel width	-	85 – 106 – 118 (30)	40 – 54 – 70 (30)
Mesamphidiscs			
Length	-	90 – 146 – 210 (16)	35 – 56 – 78 (30)
Umbel length	-	30 – 54 – 73 (16)	13 – 19 – 25 (30)
Umbel width	-	20 – 50 – 70 (16)	10 – 14 – 20 (30)
Micramphidiscs			
Length	18 – 24 – 30 (30)	15 – 21 – 33 (30)	15 – 22 – 33 (30)
Umbel length	5 – 7 – 8 (30)	5 – 6 – 13 (30)	5 – 6 – 10 (30)
Umbel width	5 – 7 – 8 (30)	5 – 5 – 10 (30)	5 – 6 – 8 (30)
Microhexactins			
Diameter	73 – 99 – 135 (30)	55 – 77 – 98 (30)	58 – 75 – 100 (30)
Gastral pinular pentactins			
Length	105 – 156 – 300 (18)	-	-
Basis diameter	68 – 142 – 200 (18)	-	-
Dermal pinular pentactins			
Length	103 – 127 – 155 (30)	133 – 143 – 150 (30)	93 – 110 – 123 (30)
Basis diameter	43 – 63 – 80 (30)	43 – 59 – 83 (30)	33 – 48 – 58 (30)

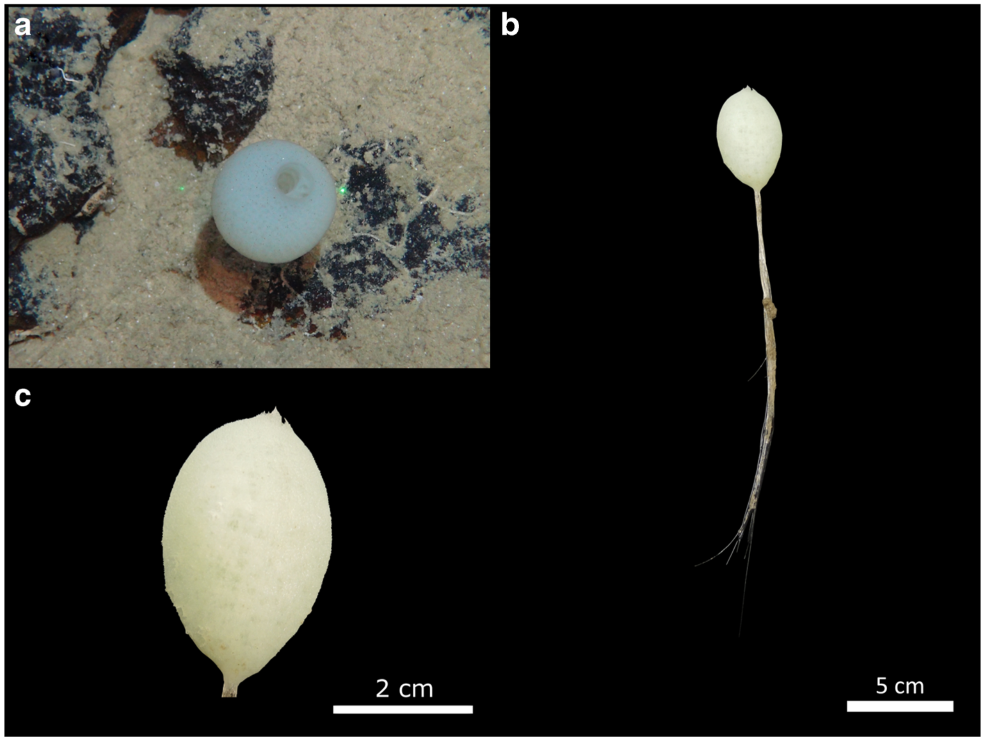

Fig. 4 Habitus of *Hyalonema (Corynonema) tylostylum*: **a**-**c**) SMF 12093

33 µm, an umbel length of 5–12 µm and an umbel width of 5–10 µm (Fig. 3f). Both mesamphidiscs and micramphidiscs are lacking a central tyle, but have spines on their shaft. Microhexactins have a diameter of 55–135 µm and acanthous rays, which are usually curved (Fig. 3g and Table 3).

Remarks:

The species *H. (C.) depressum* was described by Schulze (1886) as *Stylocalyx depressus*. While Schulze's descriptions of the habitus completely match the results of this study, descriptions of the spiculation are slightly different, e.g. Schulze described tetractins with echinated ends, which are lacking in our specimens. Gastral pinular pentactins are lacking in the preparations of SMF 12071 and SMF 12083, probably due to subsampling errors. SMF 12052 is more irregular in shape and its anchoring basalia protrude from several points of the lower body; macramphidiscs and mesamphidiscs are also lacking. Confusion with other species of the subgenus *Hyalonema (Corynonema)* is possible, e.g. with *Hyalonema (Corynonema) cupressiferum* Schulze, 1893, which is described to occur in the area around Hawaii. However, microscleres of both species show some characteristic differences. Dermal pinular pentactins of *H. (C.) depressum* are much smaller; its pinular rays have a length of 83–160 µm, but pinular rays of *H. (C.) cupressiferum* have a length of 500 µm. Umbels of macramphidiscs and mesamphidiscs in *H. (C.) depressum* have a length of 1/4–1/3 of the amphidisc length, but it is more than one third in *H. (C.) cupressiferum*. Furthermore, rays of microhexactins are curved in *H. (C.) depressum* and straight in *H. (C.) cupressiferum*.

Hyalonema (Corynonema) tylostylum **Lendenfeld, 1915**.

Hyalonema (Corynonema) tylostylum: Lendenfeld, 1915: 229, pls. 69–70.

Material:

SMF 12093, station SO239/135-1 in GSR license area at seamount, 13° 58,69′ N/123° 8,94′ W – 13° 59,06′ N/123° 8,64′ W, 3889.1 m.

Description:

Habitus – Lophophytose sponge with a spherical to ovoid white body growing on sediment of a seamount. The osculum is surrounded by a thin and slightly lacerated margin. A thin tuft of anchoring basalia protrudes from the central part of the lower body. Body height is 4.4 cm and body width 2.8 cm, while anchoring basalia measure 18.8 cm in length (Fig. 4a–c and Table 4).

Table 4 Body size of *Hyalonema (Corynonema) tylostylum*, values in [cm]

	SMF 12093	Lendenfeld, 1915
Body height	4.4	5.0–7.5
Body width	2.8	3.3–5.0
Basalia length	18.8	-

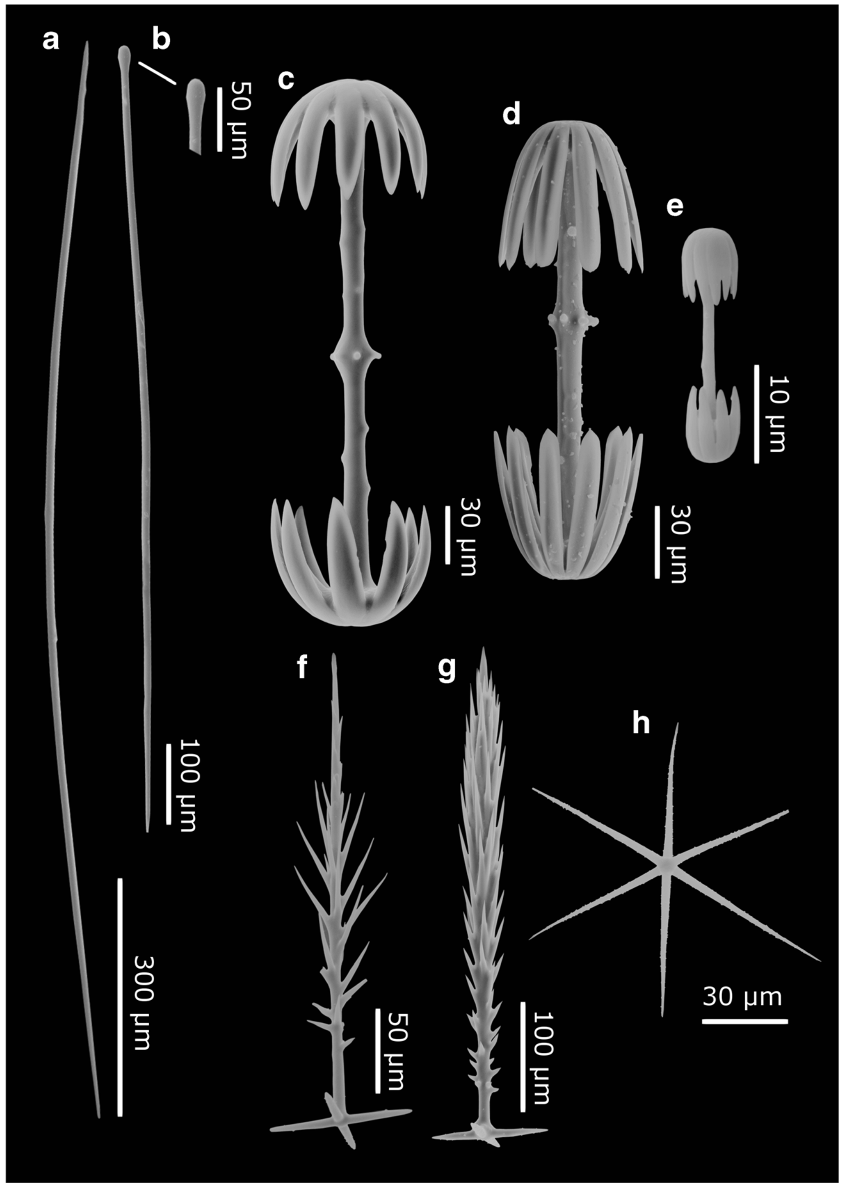

Fig. 5 Spicules of *Hyalonema (Corynonema) tylostylum*: **a**) Diactin with central thickening, **b**) Tylostyles, **c**) Macramphidisc 1, **d**) Macramphidisc 2, **e**) Micramphidisc, **f**) Gastral pinular pentactin, G) Dermal pinular pentactin, H) Microhexactin

Megascleres – Smooth diactins are curved and only few have a central thickening that varies in size, they measure 900–2125 μm in length (Fig. 5a). Tylostyles are smooth and usually straight, only few are curved, they have a length of 590–1300 μm (Fig. 5b). Choanosomal pentactins are smooth with conical rays and they are 600–825 μm long, while the basis with its tangential rays measures 663–1400 μm in diameter. Choanosomal hexactins have smooth conical rays and a diameter of 600–2275 μm. Gastral pinular pentactins have a pinular ray tapering towards the end and only few, but long spines. The pinular ray has a length of 180–330 μm, while the basis diameter is between 45 and 110 μm (Fig. 5f). Dermal pinular pentactins have a pinular ray which ends in a comparably acute apical cone. They are larger than the gastral pinular pentactins, their pinular ray measures 330–420 μm in length, and the basis 50–80 μm in diameter (Fig. 5g and Table 5).

Microscleres – In *H. (C.) tylostylum*, two types of macramphidiscs and one type of micramphidiscs are present, while mesamphidiscs are absent. Macramphidiscs (1) have broad and short umbels with blunt teeth in combination with a slightly spined shaft that bears a central tyle. The total length measures 210–290 μm, umbel length 30–70 μm and umbel width 55–80 μm (Fig. 5c). Macramphidiscs (2) are larger in total size, and have longer umbels with rather mucronate teeth and fewer spines on their shaft, although they also have a tyle. They have a length of 280–390 μm with umbels that are 70–120 μm long and 90–120 μm broad (Fig. 5d). Micramphidiscs have tight umbels where teeth are attached over their total

Table 5 Spicule size of *Hyalonema (Corynonema) tylostylum*, values in [µm] are given as follows: minimum – mean – maximum (number of spicules measured)

	SMF 12093	Lendenfeld, 1915
Diactins		
Length	900 – 1347 – 2125 (30)	600–3400
Tylostyles		
Length	590 – 945 – 1300 (2)	800–3100
Choanosomal pentactins		
Length	600 – 680 – 825 (13)	500–800
Basis diameter	663 – 909 – 1400 (13)	600–1000
Choanosomal hexactins		
Diameter	600 – 1125 – 2275 (11)	400–1300
Macramphidiscs (1)		
Length	210 – 238 – 290 (12)	116–240
Umbel length	30 – 45 – 70 (12)	34–85
Umbel width	55 – 68 – 80 (12)	19–53
Macramphidiscs (2)		
Length	280 – 232 – 390 (14)	260–410
Umbel length	70 – 97 – 120 (14)	95–148
Umbel width	90 – 108 – 120 (14)	60–114
Micramphidiscs		
Length	18 – 28 – 35 (30)	29–49
Umbel length	5 – 7 – 10 (30)	5–11
Umbel width	5 – 7 – 10 (30)	5–9
Microhexactins		
Diameter	113 – 142 – 178 (30)	104–140
Gastral pinular pentactins		
Length	180 – 265 – 330 (30)	120–245
Basis diameter	45 – 65 – 110 (30)	90–136
Dermal pinular pentactins		
Length	330 – 387 – 420 (30)	340–379
Basis diameter	50 – 63 – 80 (30)	54–84

length. They measure 18–35 µm in length with umbels that are 5–10 µm long and broad (Fig. 5e). Microhexactins have straight acanthous rays and measure 113–178 µm in diameter (Fig. 5h and Table 5).

Remarks:

The species *H. (C.) tylostylum* was described by Lendenfeld (1915), who collected two specimens in 4063 m depth near to the Sarmiento Ridge at the coast of northern Peru. Both specimens were damaged but the description of habitus and spiculation matches results of this study. Results indicate that living individuals have a white color instead of brown (Fig. 4a), basalia can have a length up to 18.8 cm and occurrence of tylostyles can be confirmed although the latter are rather diactin derivates with clavate ends instead of true tylostyles as described by Boury-Esnault and Rützler (1997). Furthermore, two types of macramphidiscs are present and most of the size measurements can be confirmed. The only exception is that umbels of macramphidiscs (1) are narrower in Lendenfeld's specimens. The species is easy to identify due to the occurrence of tylostyles which are frequent compared to other *Hyalonema* spp.

***Hyalonema (Cyliconemaoida)* Dohrmann, 2017.**

***Hyalonema (Cyliconemaoida) campanula* Lendenfeld, 1915.**

Hyalonema (Cyliconemaoida) campanula: Lendenfeld, 1915: 245, pl. 81.

Material:

SMF 12098, station SO239/135-1 in GSR license area at seamount, 13° 58.69′ N/123° 8.94′ W – 13° 59.06′ N/123° 8.64′ W, 3891.7 m.

Description:

Habitus – Lophophytose sponge with bell-like white body growing on sediment of a seamount. A limpet-shaped cone from which the basalia originate is located in the center of the depression of the upper body and is surrounded by oscula, which are covered by a sieve plate. Body height, as well as body width are 14.6 cm and basalia length is 57.4 cm (Fig. 6a–d and Table 6).

Megascleres – Smooth diactins are straight to slightly curved and have a central thickening, and they measure 1175–3575 µm in length (Fig. 7a). Pinular diactins, choanosomal pentactins and hexactins are not present in the spicule preparations. The only exception is a hexactin with one of the rays that has a tylote termination (Fig. 7e). Gastral pinular pentactins have a long and straight pinular ray with short spines that is 810–1000 µm long. The pinular ray is conical, and its spines have their maximum size somewhere between 200 and 500 µm away from the basis. The diameter of the basis with its tangential rays measures 140–220 µm, and the tangential rays have several spines at their outer ends (Fig. 7d). Dermal pinular pentactins are not present in the preparations (Table 7).

Microscleres – Macramphidiscs have bell-shaped umbels out of straight to slightly curved teeth with rounded ends, a straight axis with spines, and a central tyle. Total length of the macramphidiscs is between 150 and 290 µm, umbels measure 48–84 µm in length and 25–53 µm in diameter (Fig. 7b). Mesamphidiscs are rare, their axis is almost smooth and comparably short with 68–85 µm. Umbel teeth are straight and measure 30 µm in length and 28–38 µm in width. Micramphidiscs have umbels out of straight teeth, which are joined over more

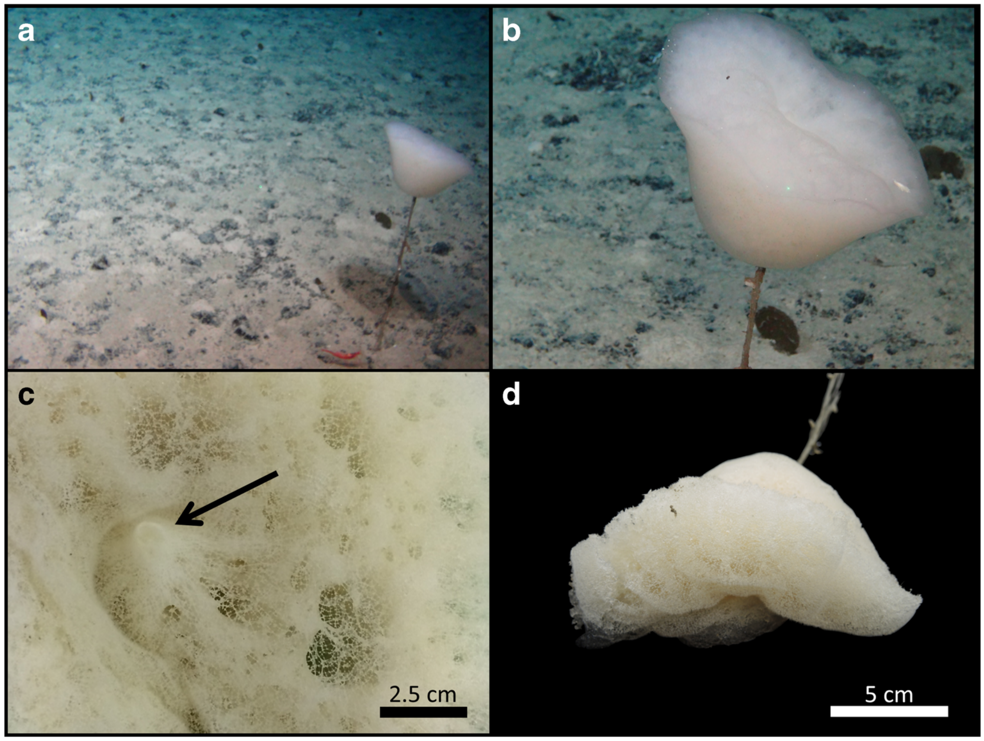

Fig. 6 Habitus of *Hyalonema (Cyliconemaoida) campanula*: **a**–**d**) SMF 12098

than half of their total length. Umbels of micramphidiscs are more round and compact than umbels of macramphidiscs. Micramphidiscs measure 20–40 µm in length and their umbels are 5–13 µm long and broad (Fig. 7c). Microhexactins are rare, they have curved acanthous rays and a diameter of 105 µm (Fig. 7f and Table 7).

Remarks:

The species *H. (L.) campanula* was described by Lendenfeld (1915), who collected a single fragmentary specimen at 3811 m depth in the Southern Tropical Pacific. The species' name refers to the macramphidisc umbels that look like bellflowers. Results indicate that living individuals have a white color with a bell- or funnel-shaped body, a small central conus, and a sieve plate covering the oscula (Fig. 6a–c). Spicule morphology and size measured by Lendenfeld and results of this study are in good accordance, only diactins had up to double size in SMF 12098, which is the largest described specimen so far. Pinular diactins, choanosomal pentactins and hexactins are lacking in our preparations, as well as dermal pinular pentactins. Confusion with other species of the subgenus *Hyalonema (Cyliconemaoida)* is possible, e.g. with *Hyalonema (Cyliconemaoida) divergens* Schulze, 1887 that occurs in the Southwest Pacific. The habitus of both species is very similar although the body of *H. (L.) campanula* is more bell-shaped. Spiculation is also different as macramphidiscs of *H. (L.) divergens* can have a size of 500 µm compared to a maximum of 290 µm described for *H. (L.) campanula*. Microhexactins of *H. (L.) divergens* have smooth rays, while those of *H. (L.) campanula* are acanthous.

***Hyalonema (Cyliconemaoida) ovuliferum* Schulze, 1899**.

Hyalonema (Cyliconemaoida) ovuliferum: Schulze, 1899: 13, pl. 3.

Material:

SMF 12074, station SO239/101-1 in IOM license area at reference site, 11° 4.49′ N/119° 39.39′ W – 11° 4.73′ N/119° 39.48′ W, 4373.6 m; SMF 12076, station SO239/131-1 in GSR license area at nodule area, 13° 52.39′ N/123° 15.03′

Table 6 Body size of *Hyalonema (Cyliconemaoida) campanula*, values in [cm]

	SMF 12098	Lendenfeld, 1915
Body height	14.6	-
Body width	14.6	-
Basalia length	57.4	7.0

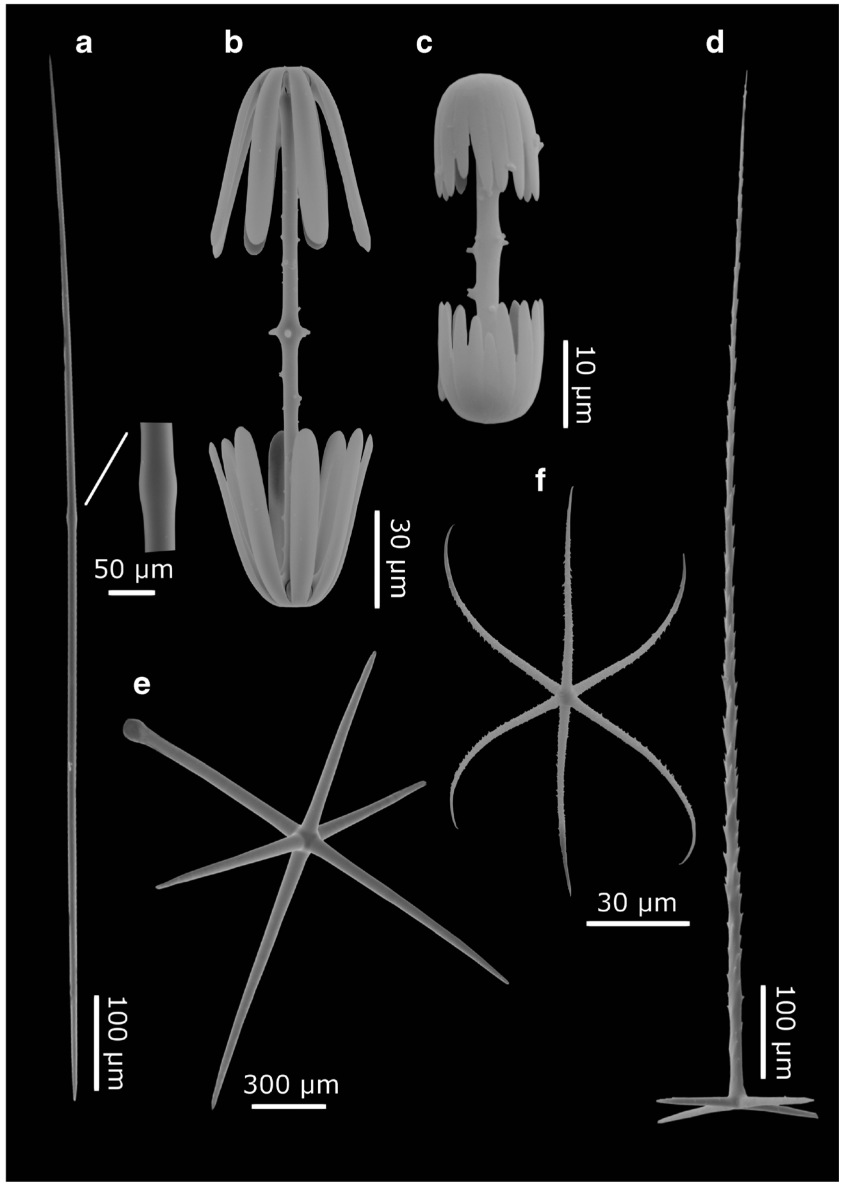

Fig. 7 Spicules of *Hyalonema (Cyliconemaoida) campanula*: **a**) Diactin with central thickening, **b**) Macramphidisc, **c**) Micramphidisc, **d**) Gastral pinular pentactin, **e**) Hexactin with rounded end, **f**) Microhexactin

W – 13° 52.44′ N/123° 14.88′ W, 4477.4 m; SMF 12089, station SO239/157-1 in IFREMER license area outside track OMCO-1, 14° 2.09′ N/130° 7.13′ W – 14° 2.19′ N/130° 6.82′ W, 4950.9 m; SMF 12091, station SO239/157-1 in IFREMER license area outside track OMCO-1, 14° 2.09′ N/130° 7.13′ W – 14° 2.19′ N/130° 6.82′ W, 4952.1 m; SMF 12095, station SO239/161-1 in IFREMER license area outside track OMCO-2, 14° 2.07′ N/130° 5.60′ W – 14° 2.41′ N/130° 5.72′ W, 4997.5 m; SMF 11708, station SO239/200-1 in APEI 3, 18° 49.22′ N/128° 25.55′ W – 18° 49.60′ N/128° 25.48′ W, 4668.5 m; SMF 11692, station SO239/200-1 in APEI 3, 18° 49.22′ N/128° 25..55′ W – 18° 49.60′ N/128° 25.48′ W, 4668.7 m.

Description:

Habitus – Lophophytose sponge with ovoid white body growing on sediment inside and outside of polymetallic nodule areas. The osculum is surrounded by a smooth, thin margin and its atrial cavity is subdivided into several compartments. Specimens have one thin tuft of basalia which protrudes from the central lower body. Body height measures 2.1–4.6 cm, body width 1.7–3.9 cm and the basalia length 10.5–30.9 cm (Fig. 8a–d and Table 8).

Table 7 Spicule size of *Hyalonema (Cyliconemaoida) campanula*, values in [cm] are given as follows: minimum – mean – maximum (number of spicules measured)

	SMF 12098	Lendenfeld, 1915
Diactins		
Length	1175 – 1613 – 3575 (17)	1000–1500
Pinular diactins		
Length	-	730–1200
Choanosomal pentactins		
Length	-	≤ 1000
Basis diameter	-	230–1000
Choanosomal hexactins		
Diameter	-	550–1300
Macramphidiscs		
Length	115 – 150 – 180 (30)	150–290
Umbel length	40 – 49 – 55 (30)	48–84
Umbel width	35 – 45 – 55 (30)	25–53
Mesamphidiscs		
Length	68 – 77 – 85 (3)	77–118
Umbel length	30 – 30 – 30 (3)	30–43
Umbel width	28 – 32 – 38 (3)	40–47
Micramphidiscs		
Length	20 – 29 – 40 (30)	18–26
Umbel length	5 – 9 – 13 (30)	5–11
Umbel width	5 – 8 – 13 (30)	5.5–10
Microhexactins		
Diameter	105 – 105 – 105 (1)	50–100
Gastral pinular pentactins		
Length	810 – 939 – 1000 (14)	230–810
Basis diameter	140 – 184 – 220 (11)	86–160
Dermal pinular pentactins		
Length	-	100–165
Basis diameter	-	74–116

Megascleres – Diactins are smooth and have a central thickening that can be very slight or distinct. They have a length from 470 to 2425 µm and thus great variability in size Fig. 9a). Pinular diactins have one smooth and one acanthous part, with a distinct central thickening in between. Pinular diactins are rare (or absent, e.g. SMF 12074 and SMF 12076) and have a length from 880 to 2425 µm (Fig. 9b). Choanosomal pentactins are smooth and have a length from 180 to 1000 µm, while the diameter of their basal part measures 270–1225 µm (Fig. 9o). Choanosomal hexactins are also smooth and have a diameter from 290 to 1550 µm (Fig. 9n). Basalia are acanthous and their anchors have an arrow-like shape with six teeth (Fig. 9k). Gastral pinular pentactins are frequent (only absent in SMF 11708), but easily break apart due to their thin and whip-like morphology. Pinular and tangential rays are partly acanthous, as the pinular rays bear spines at the first third of their total length and the tangential rays at their outer parts. Gastral pinular pentactins measure 223–1375 µm in length and have a basis diameter from 70 to 220 µm (Fig. 9m). Dermal pinular pentactins are rare (or absent, e.g. in SMF 12074, SMF 12076 and SMF 11708) and have acanthous pinular and basal rays, similar to the gastral pinular rays. They measure 150–360 µm in length and have a basis diameter from 68 to 163 µm (Fig. 9l and Table 9).

Microscleres – Two groups of amphidiscs are present: macramphidiscs are variable in structure and size as their shafts are smooth or spined and short or long. Only their umbels have a consistent shape with 6–8 freestanding teeth and have rounded ends. Some macramphidiscs have an extremely short shaft so that teeth of opposite umbels touch each other. Macramphidiscs with reduced umbels can also be present. Macramphidisc length measures 48–138 µm, umbel length 13–50.0 µm and umbel width 13–50.0 µm (Fig. 9c–g). Micramphidiscs have smooth or spined shafts but a consistent size range and compact umbels with 9–11 freestanding slender teeth. Micramphidisc length measures 20–70 µm, umbel length 5–28 µm and umbel width 8–28 µm (Fig. 9h and i). Microhexactins are rare (or absent, e.g. SMF 11708 and SMF 11692), have smooth rays with curved ends and a diameter from 50 to 118 µm (Fig. 9j and Table 9).

Remarks:

The species *H. (L.) ovuliferum* was described by Schulze (1899), who collected a single specimen at 2869 m depth, west of the Prince of Wales Island in the Gulf of Alaska. The species' name refers to its ovoid or ellipsoid macramphidiscs, which are also described in here (Fig. 9e and f). This study includes data of seven specimens (spicules of five specimens were measured) that were sampled at 4373.6–4997.5 m depth. The habitus of all collected specimens is similar, but different from the description by Schulze (1899), who mentioned a funnel-shaped habitus. The specimen described by Schulze (1899) was obviously heavily damaged and, therefore, it can be stated that *H. (L.) ovuliferum* has an ovoid shape with central osculum and a separated atrial cavity (Fig. 8ad). It was previously planned to subdivide two types of *H. (L.) ovuliferum* with SMF 11708 and SMF 11692 as type I and all others as type II, because we found distinct differences in macramphidisc morphology and presence/absence of microhexactins as mentioned in the description. However, due to great accordance of other features, e.g. occurrence of pinular diactins, micramphidisc morphology or length of gastral pinular pentactins, all specimens were

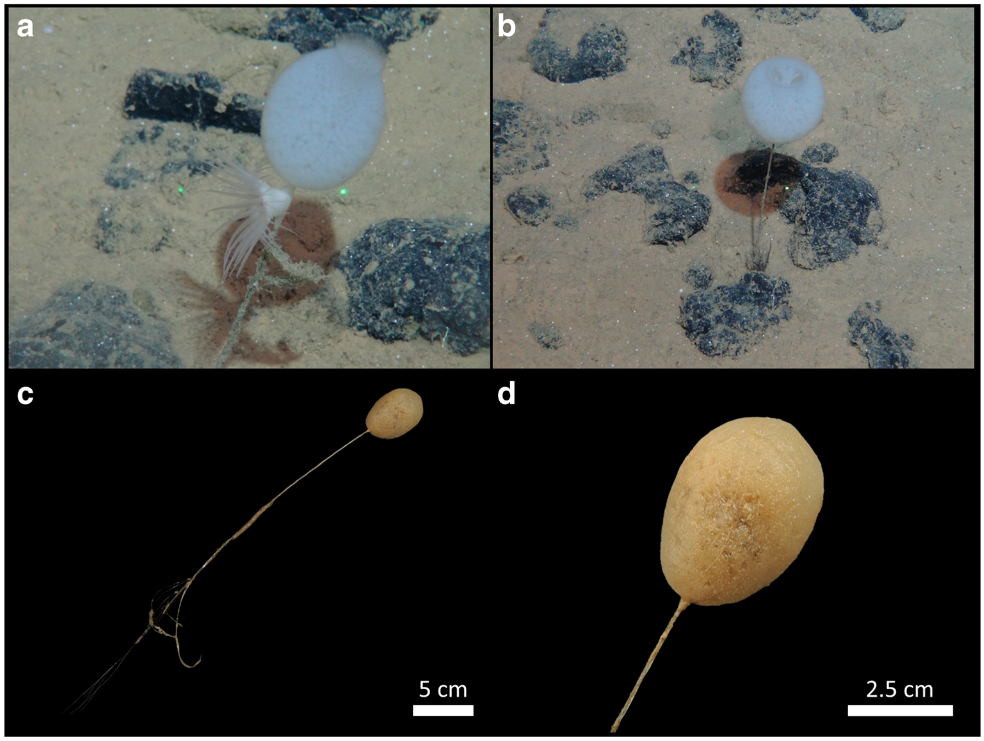

Fig. 8 Habitus of *Hyalonema (Cyliconemaoida) ovuliferum*: **a**) SMF 12089, **b**) SMF 12091, **c** and **d**) SMF 12095

described as one type of *H. (L.) ovuliferum*. Body and spicule size measurements by Schulze (1899) are similar to results of this study, although Schulze's spicule size measurements are insufficient compared to the current state of scientific knowledge. The only closely related species which also occurs in the CCFZ is *H. (L.) campanula*, but they show well-defined differences in habitus and spicule morphology.

***Hyalonema (Onconema)* Ijima, 1927**.

***Hyalonema (Onconema) agassizi* Lendenfeld, 1915**.

Hyalonema (Onconema) agassizi: Lendenfeld, 1915: 172–200; pls. 41–47.

Material:

SMF 12069, station SO239/64-1 in BGR license area at reference site, 11° 48.97′ N/117° 30.13′ W – 11° 48.31′ N/117° 30.13′ W, 4324.6 m.

Description:

Habitus – Lophophytose sponge with spherical white body growing on sediment in polymetallic nodule areas. It has a small osculum with central conus which exceeds the margin of the osculum. The anchoring basalia are gathered in a bundle of approximately 10–20 spicules and have a length of 36.8 cm. Body height and width are 6.3 cm (Fig. 10a–c and Table 10).

Megascleres – Smooth diactins are straight and have a central thickening. Their length is between 775 and 1775 µm (Fig. 11a). Two types uncinates are present: uncinates (I) are straight to slightly boomerang-shaped and short with 310–580 µm; uncinates (II) are straight and long with a central thickening and 620–1350 µm length (Fig. 11b). Choanosomal pentactins are smooth and have a distal ray with a length of 570–1375 µm. Tangential rays can be irregular and show different lengths in the same spicule, measured values for diameter are between 330 and 1800 µm (Fig. 11h).

Table 8 Body size *Hyalonema (Cyliconemaoida) ovuliferum*, values in [cm]

	SMF 12074	SMF 12076	SMF 12089	SMF 11708	SMF 11692	Schulze, 1889
Body height	4.6	4.1	3.9	2.1	2.5	4.0
Body width	3.9	2.2	2.9	1.7	1.8	3.5
Basalia length	30.1	30.9	24.8	10.5	12.9	11.0

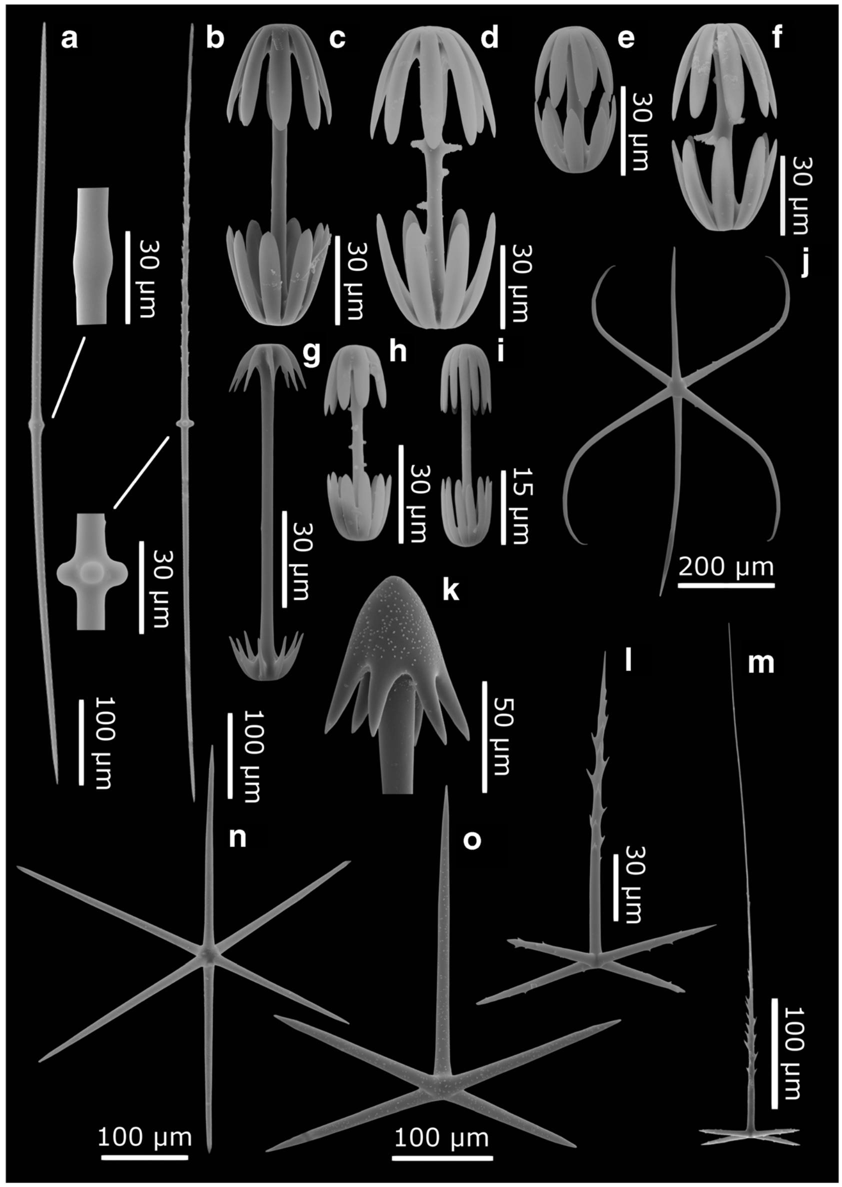

Fig. 9 Spicules of *Hyalonema (Cyliconemaoida) ovuliferum*: **a**) Diactin with central thickening, **b**) Pinular diactin with central thickening, **c–f**) Macramphidiscs, **g**) Incompletely developed macramphidisc, **h** and **i**) Micramphidiscs, **j**) Microhexactin, **k**) Anchor of basalia, **l**) Dermal pinular pentactin, **m**) Gastral pinular pentactin, **n**) Hexactin, **o**) Pentactin

Choanosomal hexactins are smooth and have straight rays, their diameter measures 300–950 µm. Gastral pinular pentactins have a distal ray with apical cone and short spines, dermal pinular pentactins have a distal ray tapering towards the end and long spines. Gastral pinular pentactins have a length of 105–130 µm and a basis diameter of 40–68 µm (Fig. 11g). Dermal pinular pentactins have a length of 80–123 µm and a basis diameter of 40–80 µm (Fig. 11j and Table 11).

Microscleres – Three types of amphidiscs are present: macramphidiscs are frequent, while mesamphidiscs and micramphidiscs are rare. Macramphidiscs have a smooth shaft, only a central tyle is present, and umbels with 8–12 round teeth. Macramphidiscs have a length of 115–290 µm, an umbel length of 43–80 µm and an umbel width of 40–75 µm (Fig. 11c). Mesamphidiscs are more slender than macramphidiscs, their umbels are comparably slender with up to 14 teeth and their shaft is covered with small spines. Mesamphidiscs have a length of 30–60 µm, an umbel length of 10–33 µm and an umbel width of 8–15 µm (Fig. 11d). Micramphidiscs have a smooth shaft and umbels with up to 16 round teeth, which are interconnected over most of their length. Micramphidiscs have a length of 15–25 µm, an umbel length and width of 5–8 µm (Fig. 11e). Microhexactins are

Table 9 Spicule size of *Hyalonema (Cyliconemaoida) ovuliferum*, values in [cm] are given as follows: minimum – mean – maximum (number of spicules measured)

	SMF 12074	SMF 12076	SMF 12089	SMF 11708	SMF 11692	Schulze, 1889
Diactins						
Length	660 – 1150 – 2425 (30)	470 – 993 – 2075 (30)	550 – 1016 – 2300 (30)	775 – 1397 – 2000 (30)	640 – 1005 – 1600 (30)	-
Pinular diactins						
Length	-	-	980 – 1070 – 1150 (6)	1150 – 1326 – 1500 (2)	880 – 1694 – 2425 (30)	-
Choanosomal pentactins						
Length	330 – 466 – 600 (7)	180 – 437 – 900 (30)	240 – 454 – 1000 (9)	450 – 642 – 925 (6)	240 – 446 – 575 (13)	-
Diameter	410 – 639 – 875 (7)	270 – 483 – 700 (30)	360 – 537 – 1225 (9)	350 – 471 – 650 (6)	340 – 713 – 1200 (13)	-
Choanosomal hexactins						
Diameter	360 – 609 – 1225 (30)	290 – 493 – 760 (30)	290 – 493 – 930 (30)	500 – 947 – 1550 (24)	310 – 746 – 1150 (17)	-
Microhexactins						
Diameter	50 – 73 – 153 (30)	55 – 72 – 108 (30)	63 – 78 – 118 (30)	-	-	60–80
Macramphidiscs						
Length	48 – 71 – 118 (30)	50 – 81 – 118 (30)	63 – 87 – 138 (30)	78 – 92 – 125 (30)	70 – 101 – 115 (30)	≤ 280
Umbel length	20 – 28 – 40 (30)	13 – 28 – 40 (30)	20 – 31 – 48 (30)	33 – 39 – 50 (30)	25 – 36 – 43 (30)	-
Umbel width	20 – 28 – 43 (30)	13 – 27 – 43 (30)	20 – 29 – 48 (30)	35 – 41 – 50 (30)	28 – 40 – 48 (30)	-
Micramphidiscs						
Length	23 – 34 – 43 (30)	23 – 34 – 60 (30)	23 – 32 – 50 (30)	45 – 56 – 63 (6)	20 – 51 – 70 (30)	≥ 16
Umbel length	5 – 12 – 18 (30)	5 – 10 – 28 (30)	5 – 9 – 18 (30)	15 – 21 – 25 (6)	8 – 18 – 25 (30)	-
Umbel width	78 – 12 – 18 (30)	8 – 10 – 18 (30)	8 – 9 – 15 (30)	15 – 19 – 23 (6)	10 – 18 – 28 (30)	-
Gastral pinular pentactins						
Length	223 – 448 – 820 (23)	245 – 491 – 660 (30)	300 – 508 – 790 (30)	-	390 – 806 – 1375 (9)	-
Basis diameter	75 – 103 – 130 (23)	70 – 101 – 143 (30)	75 – 105 – 140 (30)	-	100 – 166 – 220 (9)	-
Dermal pinular pentactins						
Length	-	-	150 – 201 – 250 (30)	-	200 – 250 – 360 (20)	300–400
Basis diameter	-	-	68 – 92 – 115 (30)	-	90 – 121 – 163 (20)	80–100

frequent and their rays are straight and acanthous, and they measure 65–118 μm in diameter (Fig. 11f). Hexactin acanthophores are rare and have plenty of spines covering their rays. Acanthophores have a diameter of 85–102 μm (Fig. 11i). Gastral and dermal pinular pentactins are frequent and similar in size, but their distal rays differ in thickness (Table 11).

Remarks:

The species *H. (O.) agassizi* was described by Lendenfeld (1915), who investigated 11 specimens and three fragments that were collected in the eastern tropical Pacific. The species was named to honor Alexander Agassiz (* 1835 – † 1910), who was in charge of the Albatross expedition where the material was collected. The habitus of *H. (O.) agassizi* is variable as Lendenfeld (1915) describes it as cake-, pear- and top-shaped, whereas the specimen of this study is spherical and ball-shaped (Fig. 10a–c). However, body height and width, as well as basalia length of all described specimens by Lendenfeld (1915) and SMF 12069 are similar. Two types of uncinates are present in this species, one small and straight to boomerang-shaped type (I) and another large and straight type with central thickening (II). The second type was originally described as microhexactin derivate, due to its size and the fact that only some have a central thickening, we assume it is rather an uncinate-derivate than a microhexactin derivate. Diactins, choanosomal pentactins and hexactins in this study are smaller than described by Lendenfeld

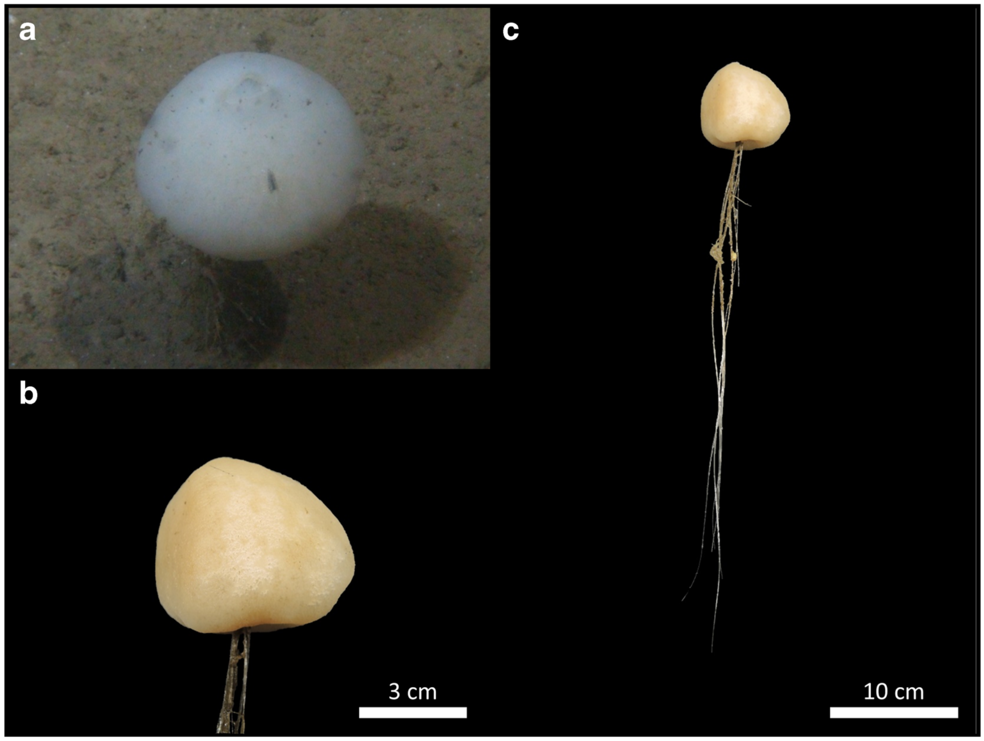

Fig. 10 Habitus of *Hyalonema (Onconema) agassizi*: **a**-**c**) SMF 12069

(1915), probably because these larger spicule types easily break apart in the preparations for the light microscope which we used for spicule size measurements. Lendenfeld (1915) described four different types of amphidiscs: (I) large macramphidiscs, (II) small macramphidiscs, (III) large micramphidiscs and (IV) small micramphidiscs. This study shows due to the spicule morphology it is possible to differentiate three types: (I) macramphidiscs, (II) mesamphidiscs and (III) micramphidiscs (Fig. 11c–e). Acanthophores, stout acanthophores, and spheres were also described by Lendenfeld (1915), but only acanthophores were present in SMF 12069. Gastral and dermal pinular pentactins can be differentiated by their distal rays, gastral pinular pentactins have an apical cone and dermal pinular pentactins a distal ray, which tapers towards the end. Confusion with other species of the subgenus *Hyalonema (Onconema)* is possible, especially with *Hyalonema (Onconema) obtusum*. It seems impossible to differentiate both species by their habitus, only spicule morphology is different for diactins, macramphidiscs and microhexactins. Diactins of *H. (O.) obtusum* are slightly curved instead of straight, teeth of macramphidisc umbels are more spread and microhexactin rays are always curved.

Table 10 Body size of *Hyalonema (Onconema) agassizi*, values in [cm]

	SMF 12069	Lendenfeld, 1915 (Form A + B)
Body height	6.3	6.6–8.1
Body width	6.3	4.8–6.1
Basalia length	36.8	9.0–40.0

***Hyalonema (Onconema) clarioni* sp. nov.**

Material:

Holotype: SMF 11704, station SO239/189-1 in APEI 3, 18° 47.80′ N/128° 18.53′ W – 18° 48.13′ N/128° 18.20′ W, 4910.2 m.

Description:

Habitus – Lophophytose sponge with round tulip-shaped body, wide osculum with great atrial cavity and straight stalk. The lower body is spherical; on top is a large osculum surrounded by a thin and smooth margin. The well-developed atrial cavity is subdivided by several septa forming a central conus in their middle. A stalk of straight anchoring basalia arises from the center of the lower body.

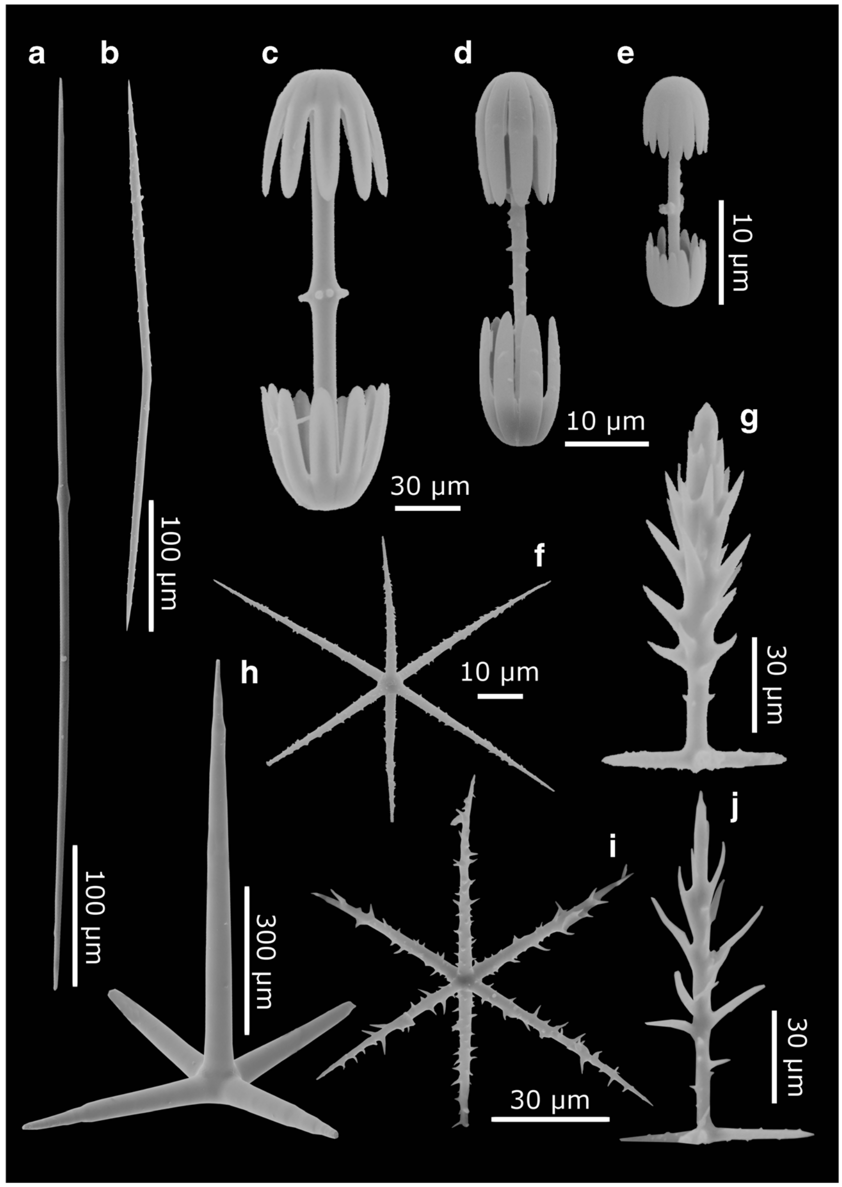

Fig. 11 Spicules of *Hyalonema (Onconema) agassizi*: **a**) Diactin with central thickening, **b**) Uncinate, **c**) Macramphidisc, **d**) Mesamphidisc, **e**) Micramphidisc, **f**) Microhexactin, **g**) Gastral pinular pentactin, **h**) Pentactin, **i**) Acanthophore, **j**) Dermal pinular pentactin

H. (O.) clarioni sp. nov. has a body height ad body width of 7.4 cm, the osculum diameter measures 3.0 cm and the anchoring basalia have a length of 29.0 cm (Fig. 12a–d and Table 12).

Megascleres – The diactins are smooth and straight, and most of them have a central thickening. They have a length of 1150–2325 µm (Fig. 13a). Choanosomal pentactins are smooth and all rays are straight, although tangential rays are inclined and show towards the distal ray by enclosing an angle smaller than 90°. Tangential rays do often have different lengths within the one spicule and the basis diameter exceeds in most cases the spicule length. Hypodermal and/or hypoatrial pentactins have a length of 305–570 µm and a basis diameter of 240–1125 µm (Fig. 13k). Choanosomal hexactins have smooth and straight rays with a diameter of 280–1112 µm (Fig. 13l). Uncinates are straight and have a central thickening, and one end of the spicule is covered with spines. Their central thickening is usually more distinct than the thickening of the diactins and uncinates are thinner and shorter than diactins. They have a length of 230–680 µm (Fig. 13f). Dermal pinular pentactins have a distal ray with apical cone and long spines, while tangential rays are short and covered with small spines. The longest spines protrude from the middle of the distal ray and can be slightly curved. Dermal pinular pentactins have a length of 108–125 µm and a basis diameter of 20–83 µm (Fig. 13e and G). Gastral pinular pentactins are

Table 11 Spicule size of *Hyalonema (Onconema) agassizi*, values in [cm] are given as follows: minimum – mean – maximum (number of spicules measured)

	SMF 12069	Lendenfeld, 1915
Diactins		
Length	775 – 1210 – 1775 (30)	300–7000
Uncinates I		
Length	310 – 427 – 580 (30)	330–800
Uncinates II		
Length	620 – 946 – 1350 (30)	-
Acanthophores		
Diameter	85 – 94 – 102 (6)	85–230
Choanosomal pentactins		
Length	570 – 896 – 1375 (30)	300–1500
Basis diameter	330 – 707 – 1800 (30)	500–2600
Choanosomal hexactins		
Diameter	300 – 577 – 950 (30)	400–6000
Macramphidiscs		
Length	115 – 221 – 290 (30)	48–310
Umbel length	43 – 65 – 80 (30)	10–80
Umbel width	40 – 67 – 75 (30)	10–86
Mesamphidiscs		
Length	30 – 49 – 60 (30)	35–64
Umbel length	10 – 18 – 33 (30)	14–23
Umbel width	8 – 11 – 15 (30)	8–14
Micramphidiscs		
Length	15 – 21 – 25 (30)	13–36
Umbel length	5 – 6 – 8 (30)	4–13
Umbel width	5 – 6 – 8 (30)	4.7–9
Microhexactins		
Diameter	65 – 83 – 118 (30)	44–160
Gastral pinular pentactins		
Length	105 – 119 – 130 (30)	83–153
Basis diameter	40 – 53 – 68 (30)	40–170
Dermal pinular pentactins		
Length	80 – 111 – 123 (30)	82–114
Basis diameter	40 – 57 – 80 (30)	42–76

smaller than dermal pinular pentactins. Their distal ray tapers towards the end and is covered with small spines. Tangential rays are short and almost smooth. Gastral pinular rays have a length of 50–98 µm and a basis diameter of 40–49 µm (Fig. 13j and Table 13).

Microscleres – Three types of amphidiscs are present: macramphidiscs have umbels broader than long, consisting of 6–9 teeth, which cover less than one fourth of the spicule length. The umbel teeth are broad and paddle-shaped, and have a central fissure. The shaft is almost smooth, only a small tyle of fistules is present and can be located in the middle or shifted towards one of the umbels. Macramphidiscs have a length 123–188 µm, an umbel length of 28–40 µm and an umbel width of 43–58 (Fig. 13b). Mesamphidiscs have umbels longer than broad that consist of 7–8 teeth with rounded ends and cover approximately one third of the spicule length. Mesamphidisc umbels look rather slender compared to macramphidisc and micramphidisc umbels. Their shaft is almost smooth, only small bumps are present. Mesamphidiscs have a length of 25–53 µm, an umbel length of 10–18 µm and an umbel width of 8–13 µm (Fig. 13c). Micramphidiscs have umbels with approximately 12 teeth, while the number can vary within the same spicule. Furthermore, some micramphidiscs have umbels with a small cap-like structure on top. Umbel teeth show parallel to the shaft which can be smooth or sometimes covered with fistules. Micramphidiscs have a length of 13–23, an umbel length of 5–8 and an umbel width of 5–8 µm. Microhexactins have acanthous rays that can be straight or curved and measure 53–155 µm in diameter (Fig. 13i and Table 13).

Remarks:

The habitus of *H. (O.) clarioni* sp. nov. lacks characteristic features, as other species also have a tulip-shaped body. The spicule morphology of *H. (O.) clarioni* sp. nov. is characteristic, at least within the subgenus *H. (Onconema)*. Macramphidiscs have a rather uncommon shape with umbels broader than long and paddle-like teeth. However, the shape of macramphidiscs is not unique and similar to species of other subgenera, e.g. *Hyalonema (Coscinonema) conus* Schulze, 1886. Still, the spicule composition qualifies the specimen as new species that we name *Hyalonema (Onconema) clarioni* sp. nov. and thus refer to the sample area.

The subgenus *Hyalonema (Onconema)* includes three species which all occur in the Pacific. Two of these three species are also described in this study, only *Hyalonema (Onconema) uncinata* Tabachnick & Lévi, 2000 occurs in the SW Pacific. The habitus of *H. (O.) clarioni* sp. nov. looks similar than *H. (O.) obtusum* as both species have a tulip-shaped body with wide osculum and the spicule morphology is closer to *H. (O.) agassizi* as both species have similar dermal and gastral pinular pentactins, as well as microhexactins. Although similarities to other species of *H. (Onconema)* are present it is easy to identify *H. (O.) clarioni* sp. nov. due to its characteristic macramphidiscs. Uncinates are also characteristic as they are straight and have a central thickening, most uncinates of *H. (O.) agassizi* are bent in their middle and most uncinates of

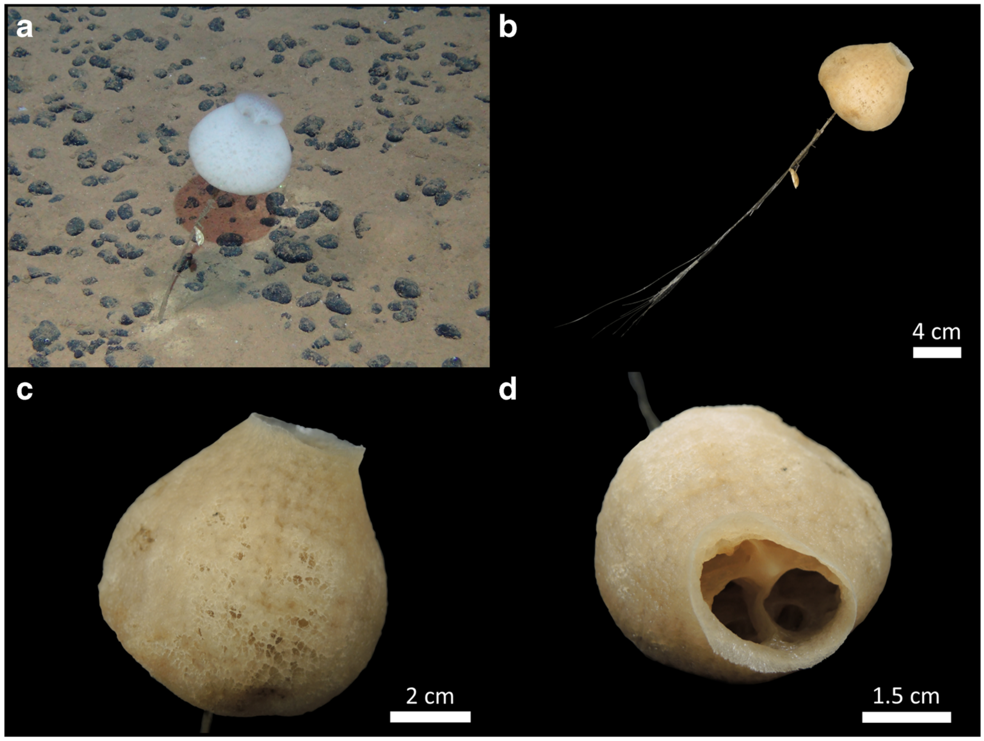

Fig. 12 Habitus of *Hyalonema (Onconema) clarioni* sp. nov.: **a**–**d**) SMF 11704

H. (O.) obtusum are straight but lack a central thickening.

***Hyalonema (Onconema) obtusum* Lendenfeld, 1915**.

Hyalonema (Onconema) obtusum: Lendenfeld, 1915: 153–171; pls. 33–40.

Material: SMF 12053, station SO239/64-1 in BGR license area at reference site, 11° 48.97′ N/117° 30.13′ W – 11° 48.31′ N/117° 30.13′ W, 4325.7 m; SMF 12054, station SO239/64-1 in BGR license area at reference site, 11° 48.97′ N/117° 30.13′ W – 11° 48.31′ N/117° 30.13′ W, 4326.5 m; SMF 12072, station SO239/82-1 in IOM license area at nodule site, 11° 03.45′ N/119° 37.89′ W – 11° 03.66′ N/119° 37.65′ W, 4346.5 m.

Description:

Habitus – Lophophytose sponge with ovoid and tulip-shaped white body growing on sediment inside and outside of polymetallic nodule areas. The osculum is surrounded by an upright standing smooth margin and a conus is present in the middle of the central cavity. The tuft of anchoring basalia consists of approximately 50–80 slightly twisted spicules and protrudes from the central part of the lower body, where it creates a small notch. The body height of *H. (O.) obtusum* measures 5.2–7.3 cm, the body width is 5.8–9.4 cm, and its tuft of anchoring basalia has a length from 18.2–43.6 cm (Fig. 14a–d and Table 14).

Table 12 Body size of *Hyalonema (Onconema) clarioni* sp. nov., values in [cm]

	SMF 11704
Body height	7.4
Body width	7.4
Osculum diameter	3.0
Basalia length	29.0

Megascleres – Diactins are variable in shape and size but always smooth. They can be straight or slightly curved and some have a central thickening. Size measurements show a diactin length of 870–2450 µm (Fig. 15a). Pentactins are very rare, variable in size and always smooth. Their basal rays are inclined towards the distal ray forming an angle less than 90°. The length of the distal ray is between 525 and 1475 µm, while the basis diameter measures 435–1050 µm. Hexactins are frequent, variable in size and have smooth rays with the same or different in lengths. The hexactin diameter ranges from 365 to 2025 µm (Fig. 15g). Uncinates are frequent and consistent in shape with the spines being more distinct at the distal part. They are always straight and have a length of 290–950 µm which is rather variable (Fig. 15b). Dermal pinular pentactins have a distal ray that is longer than the distal ray of the dermal pinular

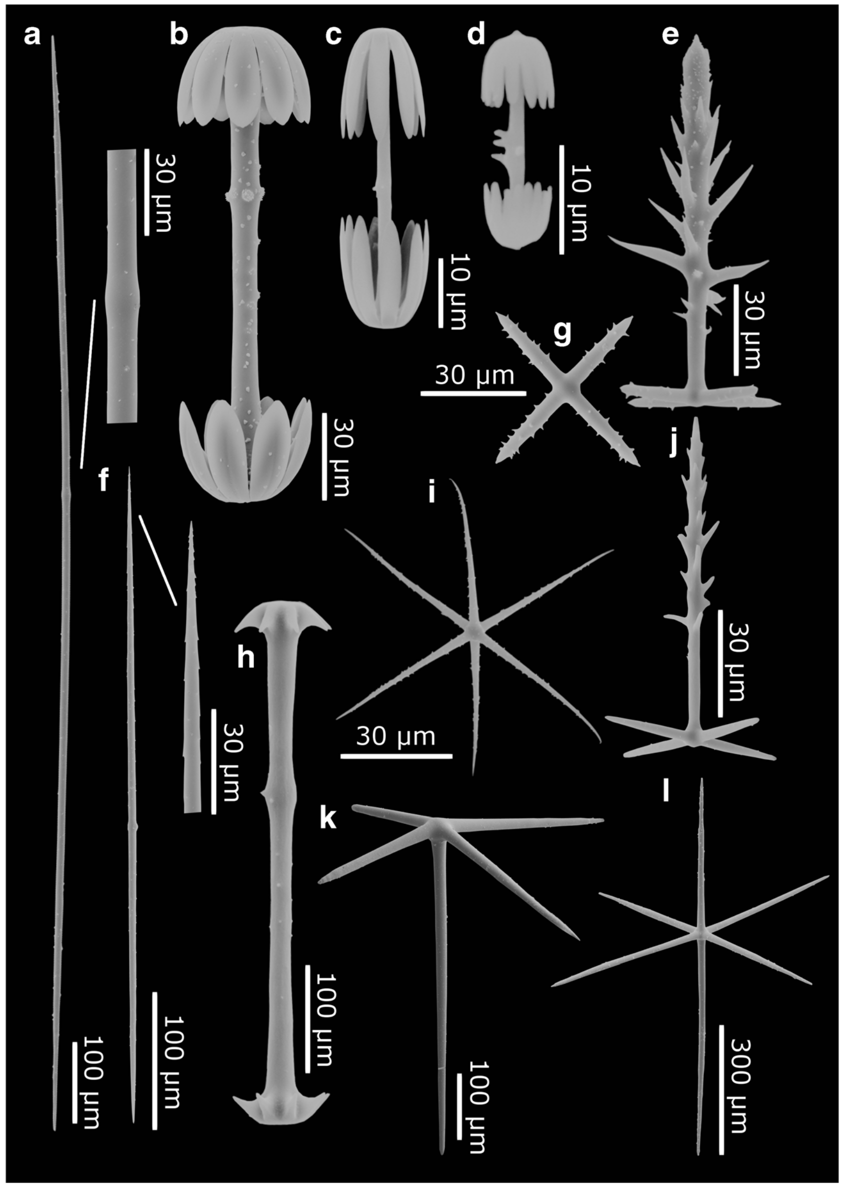

Fig. 13 Spicules of *Hyalonema (Onconema) clarioni* sp. nov.: **a**) Diactin with central thickening, **b**) Macramphidisc, **c**) Mesamphidisc, **d**) Micramphidisc, **e**) Dermal pinular pentactin, **f**) Uncinate with central thickening, **g**) Tangential rays of dermal pinular pentactin, **h**) Incomplete Macramphidisc, **i**) Microhexactin, **j**) Gastral pinular pentactin, **k**) Choanosomal pentactin, **l**) Choanosomal hexactin

pentactins. It is covered with spines and ends as a thick conus. Lateral rays are comparably short; their second half is covered with a small number of tiny spines, and they have rather blunt ends. Dermal pinular pentactins have a length of 120–230 μm, and their basis diameter is 40–90 μm (Fig. 15h). Gastral pinular pentactins have a shorter distal ray with pointed end but comparably long lateral rays. Lateral rays of gastral pinular pentactins are covered by spines over their whole length, and their ends are pointed. The diameter of the lateral rays can even exceed the length of the distal ray. Gastral pinular pentactins have a length of 80–160 μm and a basis diameter of 65–170 μm (Fig. 15i and Table 15).

Microscleres – Three groups of amphidiscs are present: Macramphidiscs are rare and consistent in shape and size (SMF 12053 and SMF 12054) or frequent and inconsistent in shape and size (SMF 12072). The shaft is variable in length, covered with spines, and its tyle is sometimes shifted away from its center. Umbels are short, but well developed and bear usually 8–9 free teeth with rounded ends having an orientation parallel to the shaft. Only one type of macramphidiscs is present in SMF 12053 and SMF 12054 (Fig. 15d), but two types

Table 13 Spicule size of *Hyalonema (Onconema) clarioni* sp. nov., values in [μm] are given as follows: minimum – mean – maximum (number of spicules measured)

	SMF 11704
Diactins	
Length	1150 – 1512 – 2325 (30)
Uncinates	
Length	230 – 536 – 680 (30)
Pentactins	
Length	305 – 400 – 570 (8)
Basis diameter	240 – 520 – 1125 (30)
Hexactins	
Diameter	280 – 588 – 1112 (30)
Macramphidiscs	
Length	123 – 150 – 188 (30)
Umbel length	28 – 34 – 40 (30)
Umbel width	43 – 51 – 58 (30)
Mesamphidiscs	
Length	25 – 36 – 53 (30)
Umbel length	10 – 13 – 18 (30)
Umbel width	8 – 10 – 13 (30)
Micramphidiscs	
Length	13 – 19 – 23 (30)
Umbel length	5 – 6 – 8 (30)
Umbel width	5 – 6 – 8 (30)
Microhexactins	
Diameter	53 – 72 – 155 (30)
Gastral pinular pentactins	
Length	50 – 80 – 98 (4)
Basis diameter	40 – 46 – 49 (4)
Dermal pinular pentactins	
Length	108 – 117 – 125 (30)
Basis diameter	20 – 50 – 83 (30)

are present in SMF 12072 (Fig. 15c and d). Macramphidiscs have a total length of 135–400 μm, an umbel length of 55–130 μm and an umbel width of 50–125 μm. Mesamphidiscs are rare (SMF 12053 and SMF 12054) or frequent (SMF 12072), but overall consistent in shape and size. The shaft is covered with spines and has a central tyle. Umbels have eight separate teeth with rounded ends having an orientation parallel to the shaft which they cover to more than half. The mesamphidiscs have a length of 80–220 μm, an umbel length of 40–75 μm and an umbel width of 20–75 μm (Fig. 15e). Micramphidiscs are frequent and consistent size, only their shape can be different. The shaft is smooth or covered with spines and sometimes it has a slight thickening in its center. Umbels of micramphidiscs have approximately 8–16 interconnected teeth, whereas the number can differ in both umbels of the same micramphidisc. Umbel teeth have round ends and slightly incline towards the shaft. Micramphidiscs have a length of 15–45 μm, an umbel length of 5–15 μm and an umbel width of 5–10 μm (Fig. 15f). Microhexactins are frequent, have a consistent diameter and always acanthous and curved rays. Their diameter measures 33–133 μm (Fig. 15j and Table 15).

Remarks:

The species *H. (O.) obtusum* was described by Lendenfeld (1915), who collected two specimens in the Tropical Pacific. The species name refers to the rounded spines on the shaft of the macramphidiscs. Lendenfeld (1915) subdivided two varieties: *H. (O.) obtusum* var. *gracilis* with slender and *H. (O.) obtusum* var. *gracilis* with stout spicules. Although we have spicules with different properties, we do not see the same pattern here, and therefore combine Lendenfeld's size measurements to one dataset (Table 15). The habitus of the SMF specimens is close to the original species description *H. (O.) obtusum* var. *gracilis*, as all specimens have a central conus; only the osculum size is different, as SMF 12053 and SMF 12072 have a small and SMF 12054 a wide osculum (Fig. 14a and b). The other specimen of Lendenfeld (1915) that was described as *H. (O.) obtusum* var. *robusta* was only a fragment and destroyed whilst trawling. The spiculation described by Lendenfeld (1915) is in accordance with descriptions in this study, although we do not have any pinular diactins, acanthophores or tylostyles, which are rather rare types of spicules. The only inconsistency in both descriptions is the classification of amphidiscs as Lendenfeld (1915) subdivides four groups of amphidiscs: large macramphidiscs, small macramphidiscs, large micramphidiscs and small micramphidiscs. In this study, we try to stick to the simple classification of macramphidiscs, mesamphidiscs and micramphidiscs, even if it means that we have greater size variation.

***Hyalonema (Prionema)* Lendenfeld, 1915**.

***Hyalonema (Prionema) breviradix* sp. nov**.

Material:

Holotype: SMF 12070, station SO239/64-1 in BGR license area at reference site, 11° 48.97′ N/117° 30.13′ W – 11° 48.31′ N/117° 30.13′ W, 4324.6 m.

Description:

Habitus – Lophophytose sponge with white disc-shaped body growing on sediment in reference area. A clearly developed central osculum is lacking, as well as a central cavity which is unusual for *Hyalonema* spp. A tuft of short and thin

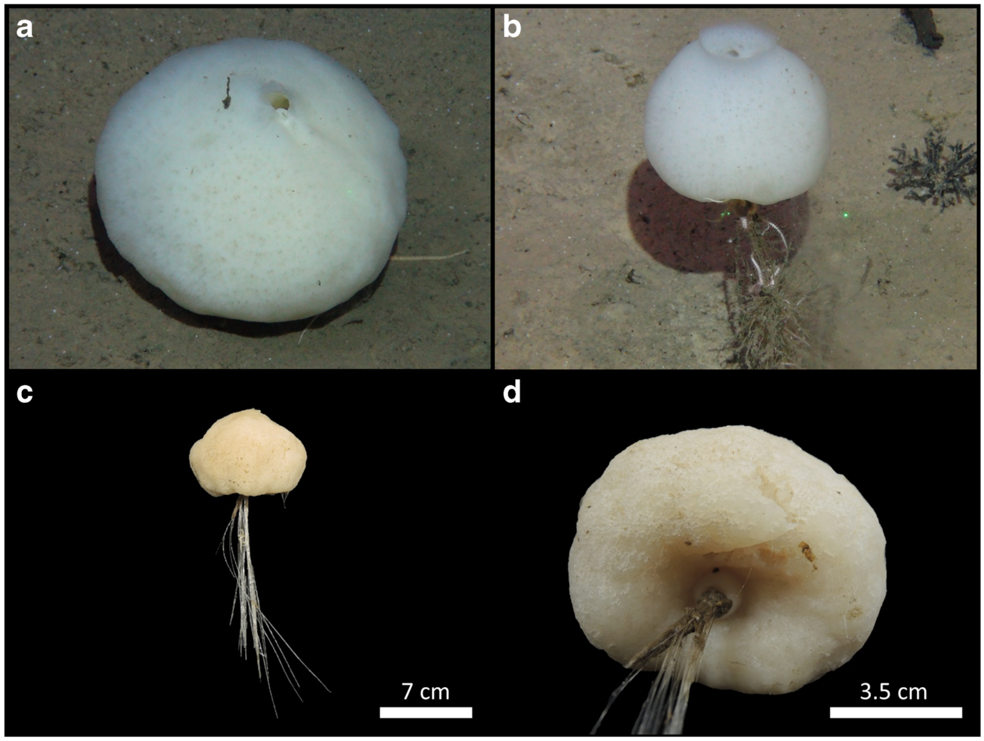

Fig. 14 Habitus of *Hyalonema (Onconema) obtusum*: **a**) SMF 12053, **b-d**) SMF 12054

anchoring basalia is present, still it seems like the sponge is growing directly on the sediment surface. The small bundle of anchoring basalia consists of approximately 40–60 spicules, measuring up to 1.7 cm in length. The sponge body measures 3.4 cm in height and 5.4 cm in width (Fig. 16a–d and Table 16).

Megascleres – Diactins are smooth and have a distinct central thickening. They can be straight or slightly bent at their central part and have a length of 850–2475 μm (Fig. 17a). Choanosomal pentactins are smooth and have a distal ray that is usually longer than the diameter of the basal rays. The distal ray measures 375–2325 μm, while the diameter of the basal rays measures 430–2175 μm (Fig. 17b). Choanosomal hexactins are also smooth, and measure 425–2225 μm in diameter (Fig. 17i). Anchoring basalia bear spines over their whole length and have small round ends with numerous small anchors (Fig. 17j). Gastral pinular pentactins are numerous and have an apical cone. The distal ray is covered with spines that are longest in its central part. Most spines are slightly bent towards the distal ray, which has a length of 80–110 μm, while the basis diameter is between 35 and 65 μm (Fig. 17f). Despite the presence of gastral pinular pentactins, gastral pinular hexactins are also occasionally present. The long distal ray of the pinular hexactins tapers towards the end and is covered with a small number of thin spines. The short distal ray is smooth and also tapers towards the end. Gastral pinular hexactins have a length of 110–190 μm and a basis diameter of 65–150 μm (Fig. 17h). Dermal pinular pentactins are slightly larger than their gastral counterparts. The distal ray tapers towards the end and

Table 14 Body size of *Hyalonema (Onconema) obtusum*, values in [cm]

	SMF 12053	SMF 12054	SMF 12072	Lendenfeld, 1915
Body height	5.2	6.9	7.3	4.7–6.5
Body width	5.8	9.4	7.9	3.0–4.2
Basalia length	30.8	18.2	43.6	3.5

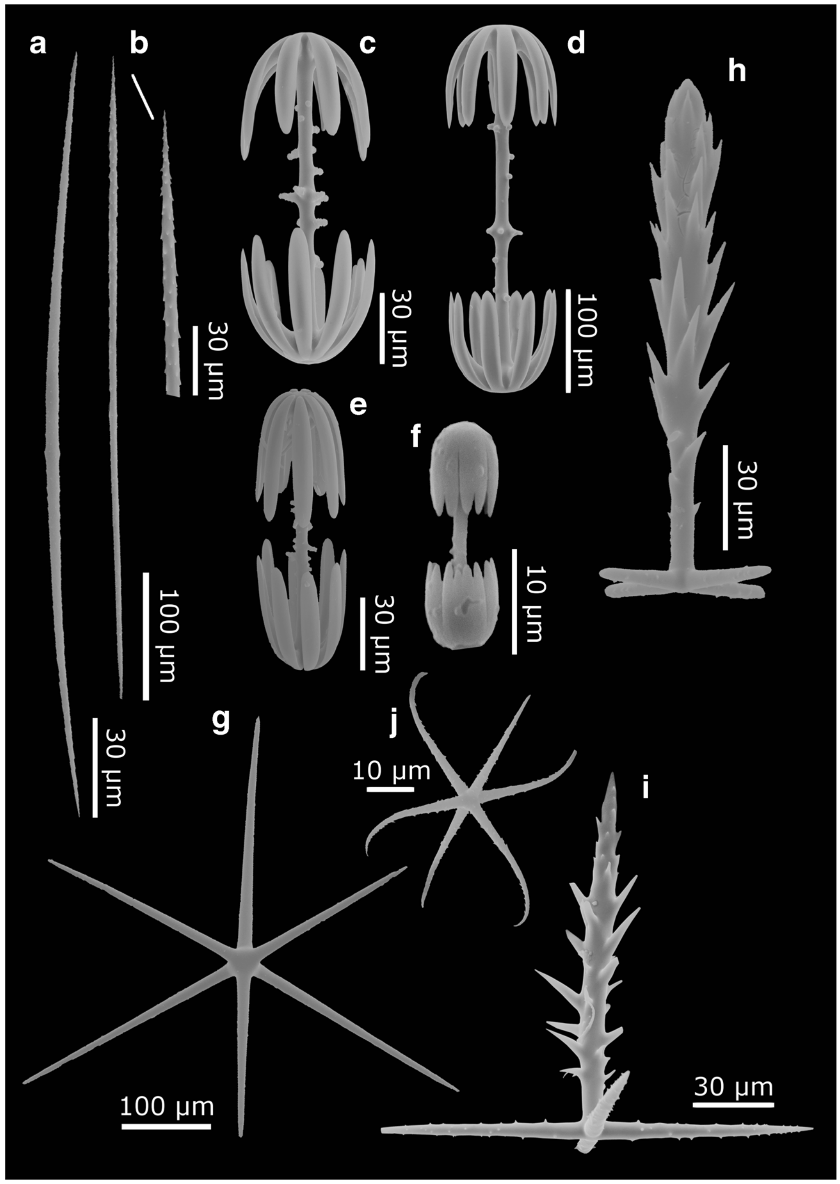

Fig. 15 Spicules of *Hyalonema (Onconema) obtusum*: **a**) Diactin with central thickening, **b**) Uncinate, **c** and **d**) Macramphidisc, **e**) Mesamphidisc, **f**) Micramphidisc, **g**) Hypodermal and -gastral pentactin, **h**) Dermal pinular pentactin, **i**) Gastral pinular pentactin, **j**) Microhexactin

is covered with rudimentary spines, which are greatest in size close to the central part. Dermal pinular pentactins measure 90–150 µm in length and have a basis diameter of 65–150 µm (Fig. 17g and Table 17).

Microscleres – Three types of amphidiscs–macramphidiscs, mesamphidiscs and micramphidiscs–can be differentiated, although macramphidiscs and mesamphidiscs were not as frequent as micramphidiscs. Macramphidiscs have slender umbels with 7–9 round teeth that are slightly bent to the outside. Their shaft has a central wreath and is covered by spines. The macramphidiscs have a length of 390–520 µm, umbels have a length of 120–155 µm and width of 90–130 µm (Fig. 17c). Mesamphidiscs have long umbels with serrated teeth edges which is the main characteristic of the subgenus *Hyalonema (Prionema)*. The umbels have 7–8 teeth and often cover more than 75% of the total mesamphidisc length. The teeth have rounded ends and are slightly bent to the inside. Mesamphidiscs measure 130–255 µm in length, umbels have a length of 60–105 µm and width of 40–60 µm (Fig. 17d). Micramphidiscs have umbels with 8–12 rounded teeth, and the number of teeth per umbel

Table 15 Spicule size of *Hyalonema (Onconema) obtusum*, values in [cm] are given as follows: minimum – mean – maximum (number of spicules measured)

	SMF 12053	SMF 12054	SMF 12072	Lendenfeld, 1915
Diactins				
Length	870 – 1608 – 2425 (30)	1000 – 1733 – 2250 (30)	1000 – 1638 – 2450 (30)	500–3500
Uncinates				
Length	290 – 441 – 570 (30)	400 – 523 – 690 (30)	325 – 637 – 950 (30)	580–1100
Pentactins				
Length	-	530 – 685 – 840 (2)	525 – 1083 – 1475 (3)	470–1860
Basis diameter	-	435 – 503 – 570 (2)	570 – 861 – 1050 (3)	480–1500
Hexactins				
Diameter	376 – 868 – 1925 (30)	365 – 745 – 1475 (30)	390 – 857 – 2025 (30)	350–2000
Macramphidiscs				
Length	310 – 351 – 400 (13)	320 – 345 – 370 (2)	135 – 262 – 380 (30)	235–356
Umbel length	80 – 103 – 130 (13)	100 – 103 – 105 (2)	55 – 89 – 115 (30)	70–100
Umbel width	105 – 116 – 125 (13)	110 – 115 – 120 (2)	50 – 94 – 125 (30)	70–110
Mesamphidiscs				
Length	90 – 154 – 220 (15)	110 – 152 – 180 (7)	80 – 107 – 140 (30)	86–212
Umbel length	40 – 56 – 70 (15)	40 – 59 – 75 (7)	30 – 43 – 60 (30)	32–80
Umbel width	35 – 55 – 75 (15)	40 – 51 – 60 (7)	20 – 35 – 50 (30)	16–69
Micramphidiscs				
Length	15 – 19 – 45 (30)	15 – 18 – 23 (30)	15 – 21 – 38 (30)	12–68
Umbel length	5 – 6 – 15 (30)	5 – 6 – 8 (30)	5 – 8 – 15 (30)	3.8–25
Umbel width	5 – 6 – 10 (30)	5 – 6 – 8 (30)	5 – 7 – 10 (30)	4–26
Microhexactins				
Diameter	45 – 63 – 78 (30)	45 – 61 – 78 (30)	33 – 73 – 132 (30)	42–80
Gastral pinular pentactins				
Length	80 – 101 – 130 (7)	90 – 127 – 160 (30)	-	73–145
Basis diameter	85 – 116 – 150 (7)	65 – 127 – 170 (30)	-	70–180
Dermal pinular pentactins				
Length	120 – 154 – 185 (17)	130 – 145 – 160 (9)	155 – 195 – 230 (30)	137–172
Basis diameter	50 – 68 – 90 (17)	40 – 62 – 70 (9)	50 – 66 – 80 (30)	20–100

can differ in the same micramphidisc. Furthermore, micramphidisc umbels can have a twist that was also observed for some of the macramphidiscs. The shaft of the macramphidiscs is covered with numerous small spines and possesses a central thickening. Micramphidiscs measure 18–25 µm in length, umbels have a length 5–10 µm and a width of 5–8 µm (Fig. 17e). Microhexactins are numerous and have curved acanthous rays. Their diameter is between 63 and 108 µm (Fig. 17k and Table 17).

Remarks:

The disc-shaped habitus is an uncommon feature in the subgenus *Hyalonema (Prionema)*, although two species with disc-shaped body have been described by Lendenfeld (1915): *Hyalonema (Prionema) azuerone* Lendenfeld, 1915 and *Hyalonema (Prionema) fimbriatum* Lendenfeld, 1915. A new characteristic is the rudimentary anchoring basalia, which do not form a proper stalk so that the sponge body seems to grow on the sediment surface (Fig. 16a). However, there is a tiny tuft with anchoring basalia of 1.7 cm length that completely roots in the sediment (Fig. 16c and d). Anchors have a round head with irregularly arranged small teeth of different size. Other characteristics are the macramphidiscs with short umbels and slightly outwards showing round teeth, mesamphidiscs with long umbels and serrated inwards showing teeth as well as

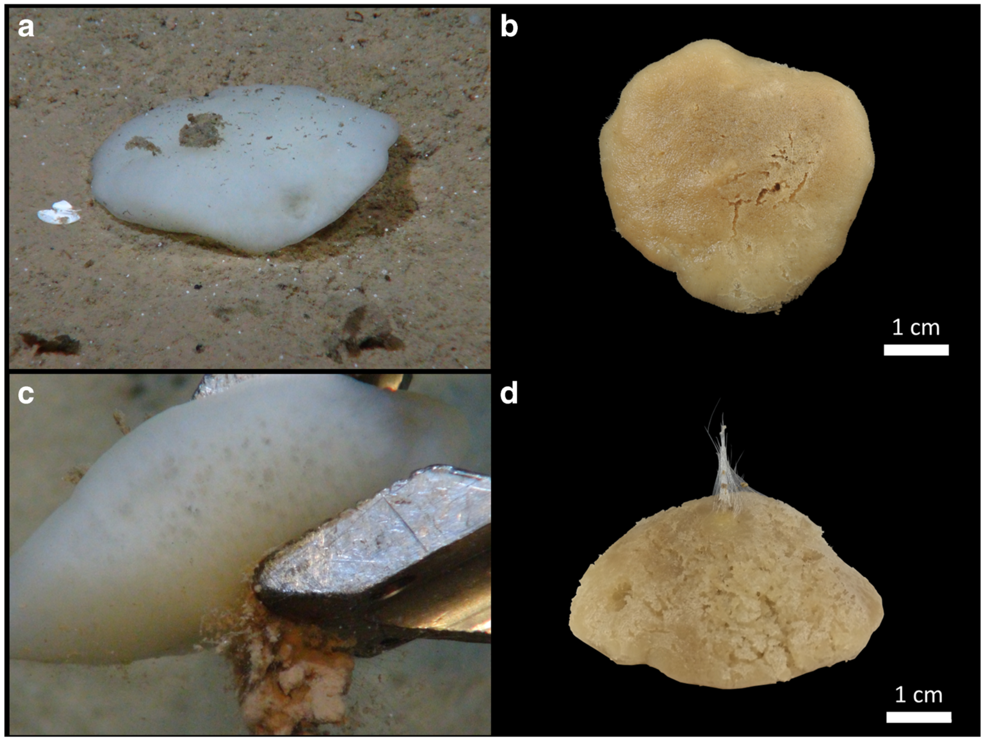

Fig. 16 Habitus of *Hyalonema (Prionema) breviradix* sp. nov.: **a**-**d**) SMF 12070

the occurrence of numerous pinular hexactins. The latter characteristics, especially the short and rudimentary root tuft, qualify the specimen as the new species *Hyalonema (Prionema) breviradix* sp. nov.

The subgenus *Hyalonema (Prionema)* includes ten species, and seven of them are known to occur in the Pacific. Two of these seven species occur in the SE Pacific region and five in the central to NE Pacific region. Among these five central to NE Pacific species are two that can be confused with *H. (P.) breviradix*: *Hyalonema (Prionema) azuerone* Lendenfeld, 1915 and *Hyalonema (Prionema) fimbriatum* Lendenfeld, 1915. *H. (P.) azuerone* has also a disc-shaped habitus, but with an irregular lacerated margin. Furthermore, Lendenfeld (1915) found fragments of large stalk spicules. Therefore, he guessed that a stalk was present in the living sponge before it was sampled and that would be a great characteristic to differentiate between both species. To date, we are only able to differentiate by spicule morphology, e.g. macramphidisc teeth of *H. (P.) azuerone* are bent to the inside instead of the outside and pinular pentactins are larger with an obviously higher number of spines on their distal ray. *H. (P.) fimbriatum* is the second species that can be confused with *H. (P.) breviradix*. The habitus is disc-shaped and circular, but living sponges are probably also stalked, as Lendenfeld (1915) mentions a rounded protuberance that he found on one of his specimens. Spicules of *H. (P.) fimbriatum* are very similar: macramphidiscs have short umbels with teeth slightly bent to the outside, mesamphidiscs are serrated and have teeth slightly bent to the inside, only micramphidiscs are different as they have broad and short umbels, whereas *H. (P.) breviradix* has micramphidiscs with rather slender and medium to long umbels. Gastral and dermal pinular pentactins look also quite similar, but pinular hexactins are absent in *H. (P.) fimbriatum* and numerous in *H. (P.) breviradix*. Furthermore, *H. (P.) fimbriatum* has many different acanthophore types, whereas *H. (P.)breviradix* is lacking acanthophores.

Table 16 Body size of *Hyalonema (Prionema) breviradix* sp. nov., values in [cm]

	SMF 12070
Body height	3.4
Body width	5.4
Basalia length	1.7

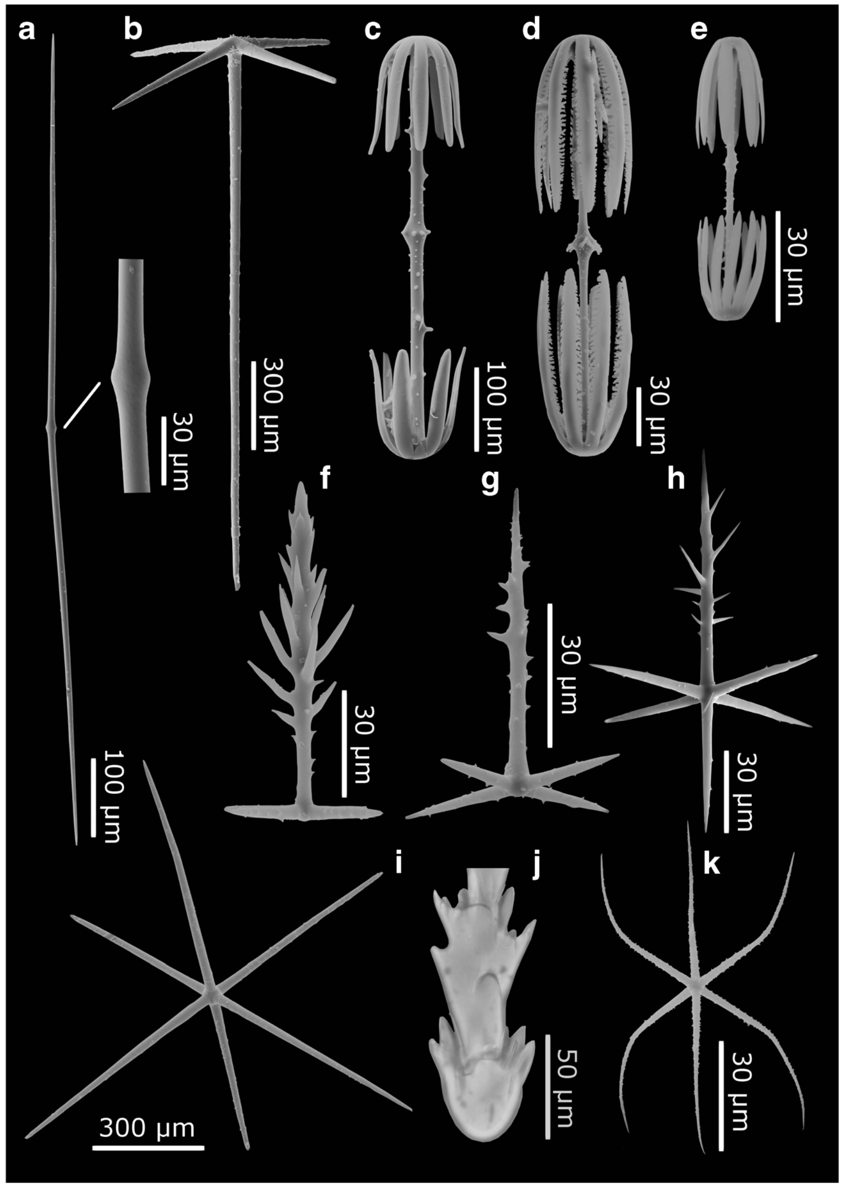

Fig. 17 Spicules of *Hyalonema (Prionema) breviradix* sp. nov.: **a**) Diactin with central thickening, **b**) Pentactin, **c**) Macramphidisc, **d**) Mesamphidisc, **e**) Micramphidisc, **f**) Gastral pinular pentactin, **g**) Dermal pinular pentactin, **h**) Pinular hexactin, **i**) Hexactin, **j**) Anchor of basalia, **k**) Microhexactin

Pheronematidae Gray, 1870.

Poliopogon **Thomson, 1878**.

Poliopogon microuncinata **sp. nov**.

Material:

Holotype: SMF 11698, station SO239/212-1 in APEI 3 at seamount, 18° 32.83′ N/128° 44.88′ W – 18° 32.57′ N/128° 44.93′ W, 1673.1 m.

Description:

Habitus – Lophophytose sponge with white fan-shaped body growing on basaltic rock of a seamount. The basis and some thicker parts of the body are slightly yellow. The surface of the sponge body is covered by a layer of small spines and a network of subatrial canals covered by atrial/gastral pinnules forming a structure similar to a sieve plate. The collected fragment has a size 11.8 cm in height and 12.1 cm in length and was ripped out of the upper part of the specimen (Fig. 18a–d and Table 18).

Megascleres – Diactins are very long, curved and smooth. They have rounded ends and a central thickening or tyle. Only one complete diactin has been measured and is 17,262 µm long. Choanosomal hexactins have smooth and straight rays, but their length is variable, including length differences

Table 17 Spicule size of *Hyalonema (Prionema) breviradix* sp. nov., values in [cm] are given as follows: minimum – mean – maximum (number of spicules measured)

	SMF 12070
Diactins	
Length	850 – 1464 – 2475 (30)
Pentactins	
Length	375 – 1701 – 2325 (26)
Basis diameter	430 – 1000 – 2175 (26)
Hexactins	
Diameter	425 – 989 – 2225 (30)
Macramphidiscs	
Length	390 – 458 – 520 (21)
Umbel length	120 – 135 – 155 (21)
Umbel width	90 – 106 – 130 (21)
Mesamphidiscs	
Length	130 – 214 – 255 (20)
Umbel length	60 – 85 – 105 (20)
Umbel width	40 – 51 – 60 (20)
Micramphidiscs	
Length	18 – 21 – 25 (30)
Umbel length	5 – 7 – 10 (30)
Umbel width	5 – 7 – 8 (30)
Microhexactins	
Diameter	63 – 85 – 108 (30)
Gastral pinular pentactins	
Length	80 – 92 – 110 (30)
Basis diameter	35 – 49 – 65 (30)
Dermal pinular pentactins	
Length	90 – 114 – 150 (30)
Basis diameter	75 – 124 – 160 (30)
Pinular hexactins	
Length	110 – 148 – 190 (24)
Basis diameter	65 – 122 – 150 (24)

among rays of the same spicule. Hexactins have a diameter of 320–1325 μm. Choanosomal pentactins have smooth rays, and their tangential rays have a characteristic non-rectangular arrangement (Fig. 19e). It was not possible to measure their length and diameter because all spicules were broken. Pinular hexactins have smooth tangential rays in the center, a smooth proximal ray and a pinular distal ray. Their length is 500–925 μm and their diameter is 290–485 μm (Fig. 19a). Macrouncinates are straight and have a length of 2125–7000 μm. Dermal pinular pentactins have a pinular ray, which is densely covered with spines and ends in a long terminal spine. Acanthous and slightly curved tangential rays can show a non-rectangular arrangement, similar to the choanosomal pentactins. Dermal pinular pentactins have a length of 205–390 μm and a diameter of 105–220 μm (Fig. 19j). Gastral pinular pentactins are scarce and have nearly the same spicule morphology than dermal pinular pentactins, only the terminal spine is shorter and thicker. They have a length of 150–174 μm and a diameter of 125–180 μm (Fig. 19i and Table 19).

Microscleres – Microuncinates are dagger-shaped. They have two pointed ends and a thickening at approximately two thirds of their length, while the shorter end is covered with spines. Microuncinates are frequent and their size is between 33 and 55 μm (Fig. 19h). Amphidiscs of three different size classes are present: macramphidiscs have broad umbels with 7–8 teeth that protrude in parallel direction to the shaft. Umbel teeth have rounded ends and look slender due to the broad arrangement. The shaft is slender and covered with tubercles, a central tyle or thickening is absent. Macramphidiscs have a length of 144–210 μm, an umbel length of 40–88 μm and an umbel width of 32–80 μm (Fig. 19b). Mesamphidiscs are frequent and have mushroom-like umbels. Their umbels have 7–8 teeth with rounded ends that show in parallel direction to the shaft. Umbel teeth short as they cover only one fourth of the total mesamphidisc length. The shaft is slender, lacking a tyle and covered with tubercles. Mesamphidiscs have a length of 93–150 μm, an umbel length of 15–45 μm and an umbel width 16–35 μm (Fig. 19c). Micramphidiscs have a look which is similar to the mesamphidiscs, although their umbel teeth are interconnected. Micramphidisc umbels have 10–12 teeth with rounded ends that cover approximately one sixth of the spicule length. The shaft is lacking a tyle and covered with tubercles. Micramphidiscs have a length of 47–95 μm, an umbel length of 5–15 μm and an umbel width of 8–18 μm (Fig. 19d). Microhexactins are frequent and have acanthous rays, which have a constant length within spicules. Microhexactins have a diameter of 95–230 μm (Fig. 19g). Micropentactins also have acanthous distal and tangential rays, and the diameter of their tangential rays can exceed the length of the distal ray. Micropentactins have a length of 45–145 μm and a diameter of 75–240 μm (Fig. 19f and Table 19).

Remarks:

A fragment was ripped off from the upper part of the sponge that we have studied (Fig. 18c–d). A new feature within the genus *Poliopogon* is the occurrence of dagger-shaped microuncinates, which is why we describe the species *Poliopogon microuncinata* sp. nov.

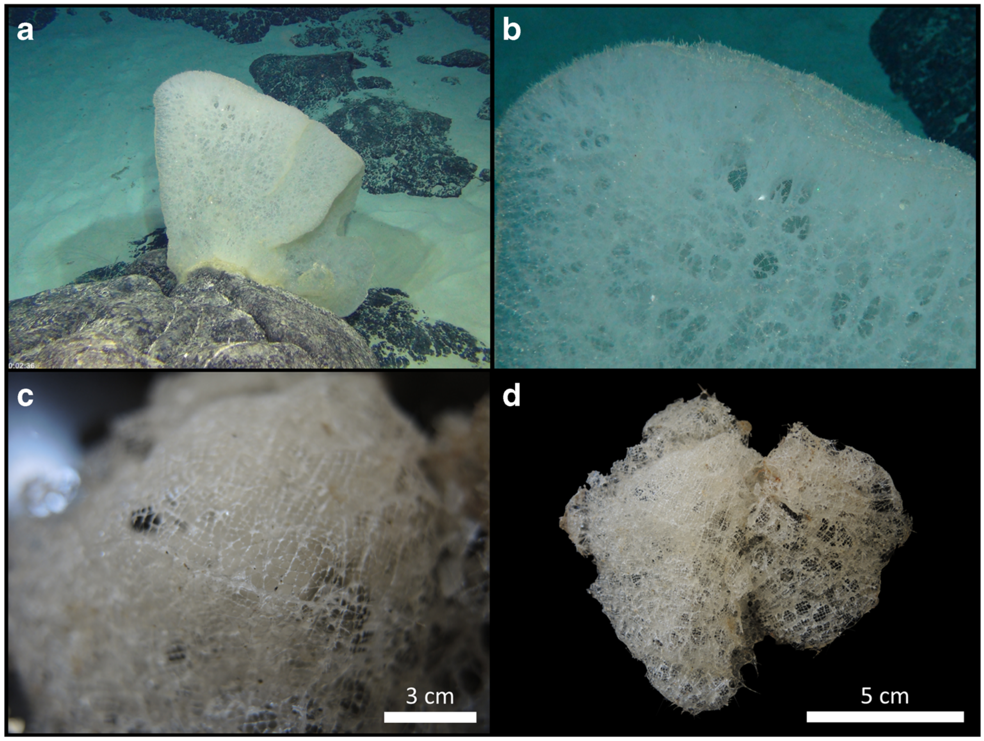

Fig. 18 Habitus of *Poliopogon microuncinata* sp. nov.: **a**–**d**) SMF 11698

(Fig. 19h). Furthermore, macramphidiscs have a characteristic morphology with broad umbels, slender umbel teeth and small tubercles covering the shaft and scepters were absent in all preparations, while pinular hexactins were present.

The genus *Poliopogon* includes seven species of which all occur in the Pacific, except for the type species *Poliopogon amadou* Thomson, 1878 that was collected in the Tropical Atlantic. Among the other six species, only one can be confused with *P. microuncinata* sp. nov., and that is *P. canaliculatus* Wang, Wang, Zhang & Liu, 2016. Both species grow on hard substrate, and have characteristic subatrial canals and similarities in spicule morphology. Diactins, choanosomal hexactins and pentactins, and macrouncinates, as well as pinular pentactins, have a similar morphology. Both species are easy to confuse, especially on the basis of their pinular pentactins, as these have a long terminal spine on the pinular ray, which is described as characteristic for *P. canaliculatus*. A difference is the occurrence of pinular hexactins and microuncinates as well as amphidisc morphology. Pinular hexactins have a pinular ray that looks like the ends of scepters, while these monaxonic spicules were absent in all preparations. Microuncinates are present in *P. canaliculatus*, but they look like smaller macrouncinates, whereas microuncinates in *P. microuncinata* sp. nov. are dagger-shaped and rather look like microscleres that occur in species of the genus *Sericolophus* Ijima, 1901. Macramphidiscs of *P. microuncinata* sp. nov. are smaller than in *P. canaliculatus*, and have broader umbels with fewer teeth and more tubercles covering the shaft. Anchoring basalia were lacking in the fragment we studied, as it was ripped off from the top of the sponge. Thus, we can only assume that *P. microuncinata* sp. nov. has two-teethed anchoring basalia, as most other species do.

Table 18 Fragment size of *Poliopogon microuncinata* sp. nov., values in [cm]

	SMF 11698
Body height	11.8
Body width	12.1

Discussion

Deep-sea glass sponges are benthic suspension feeders with a fragile morphology and are sensitive to disturbance (Leys 2013). Although most amphidiscophorid sponges have a lophophytose fixation method and grow on sediment between polymetallic nodules, it is obvious that

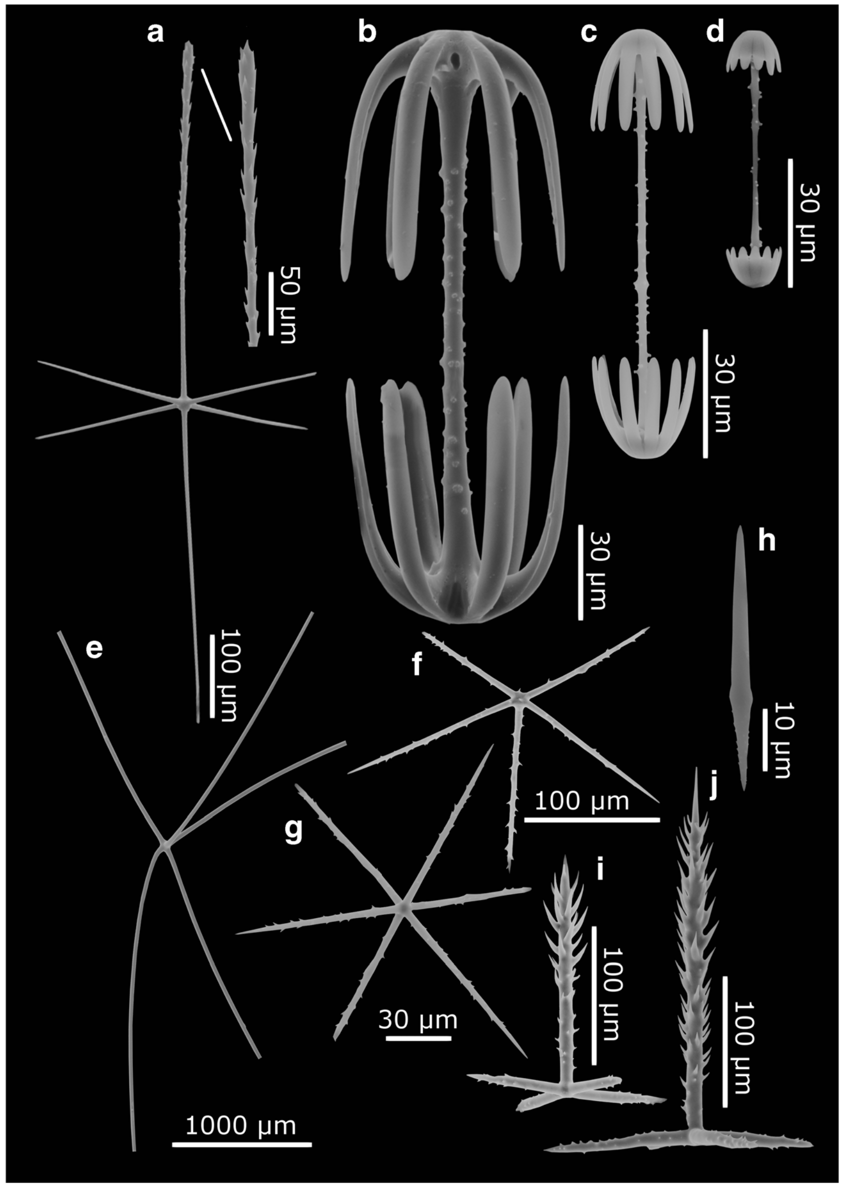

Fig. 19 Spicules of *Poliopogon microuncinata* sp. nov.: **a**) Pinular hexactin, **b**) Macramphidisc, **c**) Mesamphidisc, **d**) Micramphidisc, **e**) Part of choanosomal pentactin, **f**) Micropentactin, **g**) Microhexactin, **h**) Microuncinate, **i**) Gastral pinular pentactin, **j**) Dermal pinular pentactin

nodule mining will cause severe and permanent damage due to physical impact by dredging, as well as sediment resuspension and redeposition processes (Glover and Smith 2003; Vanreusel et al. 2016). A study on metabolic responses of the demosponge species *Geodia barretti* (Bowerbank, 1858) to suspended bottom sediments have been carried out to investigate potential damage to benthic suspension feeders by gas and oil activities in the northern Atlantic. Results showed that cyclic long-term exposure to bottom sediments and drilling caused a permanent drop in oxygen consumption of 60% (Kutti et al. 2015). A study about the effects of sediments on glass sponges showed that small amounts of resuspended sediment are already having an influence on the pumping rate, and that fine sediments such as deep-sea clays are clogging the choanocyte chambers (Leys 2013, Tompkins-MacDonald and Leys 2008). These phenomena will affect not only sponges, but sponge-associated organisms such as cnidarians, crustaceans, echinoderms and mollusks as well, largely due to substrate loss.

Table 19 Spicule size of *Poliopogon microuncinata* sp. nov., values in [cm] are given as follows: minimum – mean – maximum (number of spicules measured)

	SMF 11698
Diactins	
Length	17,262 (1)
Hexactins	
Diameter	320 – 801 – 1325 (7)
Pentactins	
Length	-
Diameter	-
Macrouncinates	
Length	2125 – 4185 – 7000 (5)
Microuncinates	
Length	33 – 41 – 55 (30)
Pinular hexactins	
Length	500 – 748 – 925 (11)
Diameter	290 – 401 – 485 (11)
Macramphidiscs	
Length	144 – 180 – 210 (13)
Umbel length	40 – 70 – 88 (13)
Umbel width	32 – 60 – 80 (13)
Mesamphidiscs	
Length	93 – 122 – 150 (30)
Umbel length	15 – 30 – 45 (30)
Umbel width	16 – 27 – 35 (30)
Micramphidiscs	
Length	47 – 62 – 95 (30)
Umbel length	5 – 11 – 15 (30)
Umbel width	8 – 12 – 18 (30)
Microhexactins	
Diameter	95 – 158 – 230 (30)
Micropentactins	
Length	45 – 96 – 145 (30)
Diameter	75 – 168 – 240 (30)
Gastral pinular pentactins	
Length	150 – 164 – 174 (5)
Basis diameter	125 – 150 – 180 (5)
Dermal pinular pentactins	
Length	205 – 252 – 390 (30)
Basis diameter	105 – 157 – 220 (30)

Acknowledgements The EcoResponse cruise with the R/V *Sonne* was financed by the German Ministry of Education and Science BMBF as a contribution to the European project JPI-Oceans "Ecological Aspects of Deep-Sea Mining". The authors acknowledge funding from BMBF under contract 03F0707E. Furthermore, we want to thank Prof. Dr. Jens Greinert and M.Sc. Florian Gausepohl (GEOMAR – Helmholtz Centre for Ocean Research, Kiel) for support with station maps.

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