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A NEW SPECIES OF *THROMBUS* (PORIFERA: DEMOSPONGIAE: ASTROPHORIDA) FROM TRINIDAD, WEST INDIES

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ABSTRACT

A new species of the sponge genus *Thrombus* (Porifera: Demospongiae: Astrophorida) is described from a single specimen collected at a depth of 21.5 m on a hard bottom off Monos Island, located off the northwest coast of Trinidad, W. I. The sponge lives symbiotically with a species of vermetid gastropod, *Siliquaria modesta* Dall. The associated organisms form a mound measuring 2 m in diameter, covering an area of about 3.2 m^2. Named *Thrombus sphaeroidocladus*, the sponge is the only species of the genus with representatives of all three categories of spicules known for the genus, namely, simple acanthotriaenes, acanthotrichotriaenes and amphiasters. Also diagnostic is the abortive nature of the clads of the simple acanthotriaenes.

Five species of sponges have been described in the genus *Thrombus*. They occur at depths ranging from 30 to 1378 m and have been reported from the eastern North Atlantic, tropical western North Atlantic, the Indian Ocean and the western Pacific Ocean. The species described here is defined by the abortive, rounded clads of the acanthotriaenes. It is the largest specimen so far described within the genus *Thrombus* and occurs in shallower water (21.5 m) than any other species reported at present. Sponges of this genus are nowhere common judging from the few records so far reported.

METHODS

Specimens were collected by SCUBA diving and were fixed in 70% ethyl alcohol after being brought to the surface. Microtome sections, 15 μm in thickness, were stained with alum hematoxylin and Mallory's triple stain. Scanning electron micrographs of spicules were taken of gold-palladium coated specimens on an ETEC Autoscan U-1.

DESCRIPTION

Thrombus sphaeroidocladus new species

Material Examined.—Biscayne Reef, Monos Island, Trinidad, West Indies (10°41′N, 61°41′W), 21.5 m, 24 March 1982. Eleven fragments of a single large specimen were collected.

Diagnosis.—The sponge is an extensive, thick encrustation around living vermetid snails; acanthotriaenes with reduced, rounded clads are embedded in the surface tissue of the sponge and protrude beyond the exopinacoderm with the cladome upright; these same spicules occur at random throughout the choanosome; acanthotrichotriaenes are arranged between the rhabdomes of the simple acanthotriaenes beneath the surface of the sponge with cladomes at or below the surface; amphiasters are distributed throughout the sponge but are especially common lining the water channels.

External Features.—The sponge is coextensive with a large bed, measuring over 2 m across and covering an area of about 3.2 m^2, of the gastropod *Siliquaria modesta* Dall (l88l). The depth of the bed reached 50 cm, but it is uncertain whether living sponge

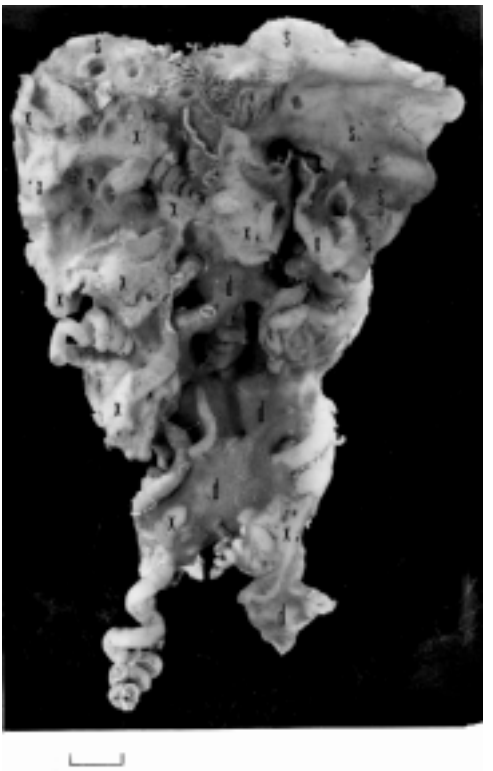

Figure 1. Fragment of holotype (YPM No. 9361) representing a wedge cut out of the living specimen. The top of the photograph comprises the surface (marked by small s's) of the sponge- gastropod association. The openings are the external apertures of the *Siliquaria* shells from which the animals emerge when feeding. Sponge oscules are not apparent. Light-colored areas (marked by small x's) are cut sponge surfaces severed from the adjacent fragment. Other, darker surfaces (marked by small d's) represent the exopinacoderm of the sponge that bears ostia opening into reservoirs of sea water extending deep into the interior of the sponge-gastropod association. Scale = 1 cm.

tissue extended to the base of the bed of snails. Of the eleven fragments of the sponge available for study, one (Fig. 1) extended to a depth of 15 cm below the surface of the sponge; living sponge tissue was present at this depth. At the surface the sponge tissue is continuous for the most part and ranges in thickness from 25 to 40 mm based on the fragments available for study. Most of the gastropods open out at the surface of the sponge with the openings surrounded by sponge tissue; the openings of the *Siliquaria* vary from 5 mm to 2 cm apart. The gastropod shells range up to 15 cm in length and are oriented in a plane perpendicular to or slightly oblique to the surface of the sponge. Sponge tissue extends down between the shells but does not fill all the space between them. About one-third to one-half the space between them is free of sponge tissue. At the surface of the sponge occur occasional depressions, 1 cm or less in diameter; such depressions first narrow and then widen out to form the extensive cavities just mentioned; into these the *Siliquaria* shells extend to varying depths down to at least 15 cm. The closed, coiled ends of the gastropods may lie free in the cavities or may be covered by sheets of living sponge tissue with surfaces bearing ostia that open into the cavities (and are thus external to the sponge) through which aerated sea water must flow in life. Some of the *Siliquaria* have

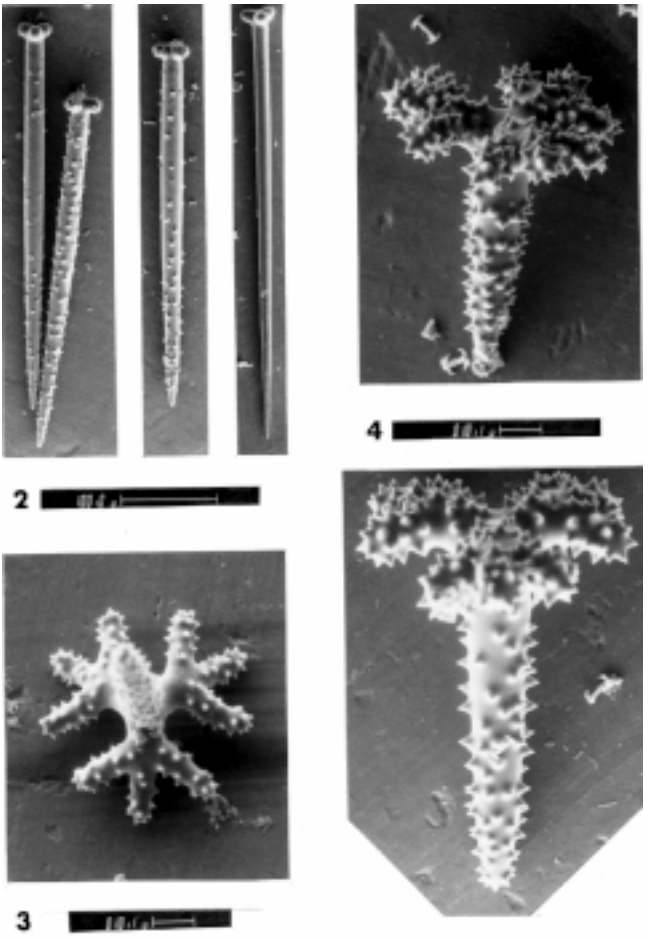

Figure 2. Four acanthotriaenes with reduced, rounded clads, showing a range of spination patterns; spines are absent on the immature triaene on the right. Scanning electron micrograph. Scale = 100 μm.
Figure 3. Acanthotrichotriaene with the rhabdome pointing toward the viewer. The spined, trifurcate clads are clearly shown. Scanning electron micrograph. Scale = 10.1 μm.
Figure 4. Acanthotrichotriaenes of two sizes viewed from the side. Scanning electron micrographs. Scale = 10.1 μm.

the uncoiled ends of their shells opening into the internal cavities 5 cm or more beneath the sponge surface. It is probable that living sponge tissue does not extend to a depth greater than 15 cm or perhaps somewhat more beneath the surface of the sponge, but samples from greater depths have not been available for study. Most of the 50 cm mound observed by the collector of the sponge (R.H.) might have consisted of dead *Siliquaria* shells. The area covered by this sponge is among the largest ever reported for a species of the phylum Porifera.

The surface color in life was gray; the interior was white. After preservation in 70% alcohol the surface color ranges from biege to light tan; the internal color is buffy-tan. Ostia and oscula were not apparent.

Table 1. Dimensions of spicules of *Thrombus sphaeroidocladus*. L = length, W = width

Category	Range (μm)	Mean (μm) ± SD	n
ECTOSOMAL REGION OF SPONGE			
	Acanthotriaenes		
Rhabdome, L	296–480	416 ± 43.0	40
Rhabdome, W	12–30	23 ± 4.2	40
Clad, L	7–18	12.7 ± 2.2	40
Clad, W	10–20	14.6 ± 2.9	29
Distal spines, L	1.0–7.0	4.1 ± 1.5	38
Proximal spines, L	1.4–7.0	4.0 ± 1.3	37
	Acanthotrichotriaenes		
Rhabdome, L	50–78	64 ± 8.6	25
Rhabdome, W	6.4–16	12.2 ± 2.4	25
Rhabdome spines, L	0.6–4.0	2.3 ± 0.6	48
Axial clad, L	20–30	24.9 ± 2.3	25
Axial clad, W	4–14	10.2 ± 2.2	25
Spines of clad, L	1.5–3.6	2.3 ± 0.5	50
	Amphiasters		
Axis, L	5.6–8.0	6.7 ± 0.5	20
Spines, L	1.6–3.2	2.4 ± 0.4	40
Spines, L (opposite end of axis)	1.6–3.6	2.3 ± 0.7	13
ENDOSOMAL REGION OF SPONGE			
	Acanthotriaenes		
Rhabdome, L	248–448	405 ± 33.4	40
Rhabdome, W	10–32	24.6 ± 5.7	40
Clads, L	6.4–16	11.5 ± 2.2	40
Clads, W	10–24	17.2 ± 2.2	40
Distal spines, L	0.4–7.2	4.4 ± 1.8	38
Proximal spines, L	0.6–8.0	4.5 ± 2.0	39
	Amphiasters		
Axis, L	5.6–9.6	6.7 ± 0.86	20
Axis, W	0.9–1.2	1.0 ± —	10
Actines, L	1.6–4.0	2.3 ± 0.42	40
Actines, L. (opposite end of axis)	1.4–3.2	2.2 ± 0.54	30

Siliceous Spicules.—Three categories of spicules occur, namely, (1) acanthotriaenes with spheroidal, aborted clads at the proximal end and with the distal end pointed, (2) acanthotrichotriaenes with trifid clad ends and (3) amphiasters. Dimensions of the spicules are given in Table 1.

Among the acanthotriaenes (Figs. 2,6), the rhabdome is widest proximad of the midpoint and narrows to about half the widest value at the point at which the clads arise. Spines are most densely distributed at the distal end of the spicule and tend to be sparser or sometimes absent in the midregion of the spicule. The clads are short and rounded and are generally wider than long. The clads are spinose, but the spines are smaller than those of the rhabdome. Immature spicules (with rhabdomes 10 μm wide, e.g.) lack spines or have only slight indications of spine development. Five percent of the acanthotriaenes measured were immature and lacked spines altogether; about two percent lacked proxi-

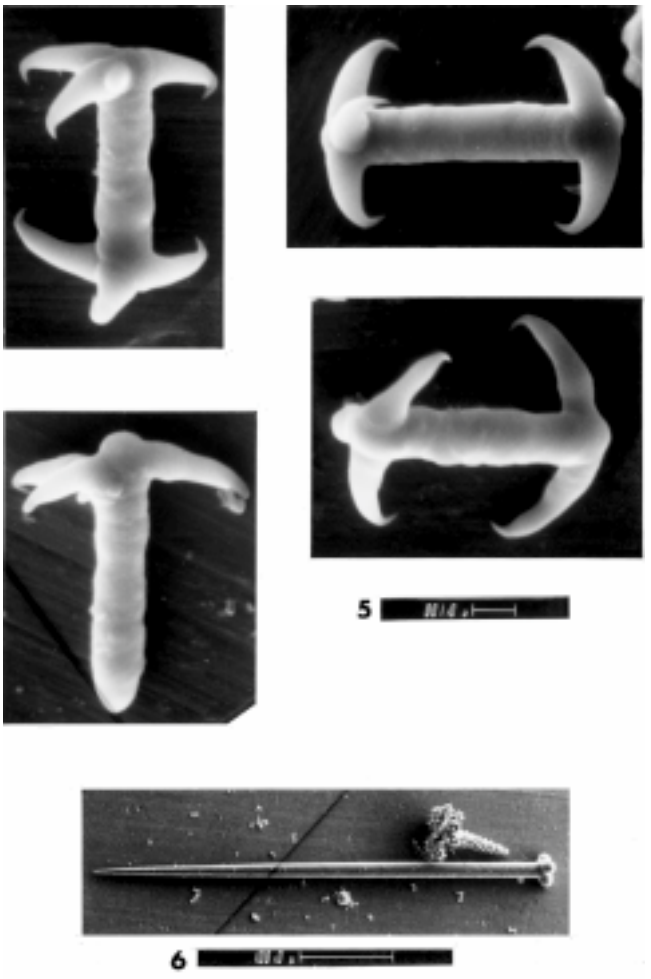

Figure 5. Four amphiasters with varying numbers of spines. Spicule on lower left lacks spines at one end. Scanning electron micrographs. Scale = 1 μm.
Figure 6. Relative sizes of the three spicule types. Minute amphiasters are distributed over the background. Scanning electron micrograph. Scale = 100 μm.

mal spines. In rare instances one of the three clads of a spicule has grown longer than usual and bends toward the distal end of the rhabdome in the manner of a plagiotriaene. Among three such spicules found the length of the spiny, long clad ranged from 22 to 30 μm.

Acanthotriaenes are distributed throughout the sponge. In the endosome they are oriented at random and occur in moderate density. Triaenes, oriented with their densely spined distal ends fixed in the surface of the sponge and the cladome protruding from the sponge, form a dense layer at the surface.

Lying between the surface-embedded distal ends of the triaenes with rounded clads occur acanthotrichotriaenes (Figs. 3,4,6) forming here a discrete layer with the clads parallel to and lying just beneath the surface of the sponge. Others are distributed down to a depth of about 600 μm below the surface. They are mostly wanting from the endosomal

region of the sponge, but a very few do occur. The trichotriaenes are densely spined except on the proximal part of the rhabdome (usually the proximal 5 to 10 μm) and the adjacent undersides of the clads proximal to their trifid terminations.

Amphiasters (Figs. 5,6) are distributed throughout the sponge and are localized around water channels and at the surface. Characteristically there are 3 to 5 curved spines at one end of the axis and 0 to 3 spines at the opposite end. Under high magnification the axis is marked by zones of thickening suggesting that silicon dioxide is added in successive rings along its length. The spines curve distally toward the axis.

Sponge Tissues and Cells.—Two cell types are common in the surface tissues, namely, fiber cells and lophocytes, some of the latter of which show active fibrillogenic activity. Spongin fibers occur throughout the sponge but are especially common around spicules. The fibers range from 2.5 to 4.5 μm in thickness and are often aligned in parallel patterns or form reticulations. Small cells, scarcely 2.5 μm in diameter and abundant just beneath the surface, may be sperm cells.

Cells in the choanosome are difficult to resolve because of poor fixation. Choanocyte chambers, where definable, are small, ranging from 20 to 24 μm in diameter. In some, spermatogenesis is in progress. The most common cell in the choanosome is rounded, ranges in diameter from 20 to 25 μm and encloses a uniformly distributed mass of granules. These granular cells are similar to the "granule cells" reported by Sollas (1888) in *T. challengeri*. The cells in *T. sphaeroidocladus* are closely to loosely packed in the mesohyl. Sometimes the granules are condensed around the periphery of the cell leaving a central vacuity, a configuration that may result from poor fixation.

Range and Habitat.—This sponge is known only from one large specimen living on a rock slope at a depth of 21.5 m on Biscayne Reef, Monos Island, Trinidad, West Indies (10°41′N, 61°41′W) as of 24 March 1982. The sponge is essentially a thick encrustation growing over a bed of the gastropod *Siliquaria modesta* Dall covering an area of 3.2 m^2.

Etymology.—The specific name is derived from *sphaer*, Greek, sphere; *-oid*, Greek, like; *clad*, Greek, branch. The name refers to the distinctive spheroidal shape of the clads of the simple acanthotriaenes.

Holotype.—Eleven fragments of the holotypic specimen were collected and have been deposited at the following institutions: Peabody Museum of Natural History, Yale University, New Haven, Connecticut (YPM No. 9338, six fragments; YPM No. 9361, one fragment, figured; YPM No. 9362, one fragment, source of figured and measured spicules); National Museum of Natural History, Smithsonian Institution, Washington, D. C. (USNM No. 42649); The Natural History Museum, London, England; Institute of Marine Affairs, Carenage P.O., Trinidad and Tobago, W. I. (IMA No. 107). These holotype fragments range in form and size from large, wedge-shaped specimens, up to 75×52 mm in surface dimensions and 140 mm in depth, to small pieces of irregular form, 35×20 mm on the largest end and 65 mm deep.

Comparison with Other Species.—The genus *Thrombus* was set up by Sollas (1886, 1888) for the species *T. challengeri*, an encrusting sponge epizooic on another sponge. The genus was diagnosed as bearing trichotriaenes and sometimes amphiasters. It has a thin ectosome not sharply differentiated from the choanosome; its mesohyl contains large granular cells and collencytes; the canal system is diplodal. In addition to *T. challengeri*, Sollas included the following species: *abyssi* (Carter, 1873), *kittoni* (Carter, 1874), *ornatus* Sollas, 1888. Lehnert (1998) has described *T. jancai* from Jamaica, W.I. Table 2 compares the known records of species of *Thrombus*. See also Table 1 in Lehnert (1998).

Table 2. Species of *Thrombus* compared.

Species	Habitat	Acanthotriaenes	Trichotriaenes	Amphiasters	Geographical distribution
T. abyssi Carter, 1873	Growing over coral, *Lophelia*; 64 × 44 mm in major dimensions.	—	Rhabdome, 59 µm. Chord of cladome, 55 µm. Cladome not terminal.	Axis, 5 µm (L)	English Channel, 923 m For additional records of *T. abyssi*, see Lehnert (1998).
T. abyssi var. *niger* Topsent, 1904	Growing on hexactinellid fragments; 53 × 30 mm in major dimensions.	—	Rhabdome, 65 × 10 µm. Chord of cladome, 63 µm.	Axis, 5 µm (L)	Azores, 1,360 m
T. challengeri Sollas,1886, 1888	Encrusting the sponge *Rhizochalina*. Spiral shells in sponge. Sponge is 43 × 35 mm in major dimensions.	Plagiotriaenes: rhabdome, 100 × 12 µm ; clads, 55 × 12 µm. Dichotriaene: rhabdome, 75 × 12 µm .	Rhabdome, 55 µm. Axial clad, 36 µm	—	Vanuatu (New Hebrides), 240 m
T. jancai Lehnert, 1998	Growing on side of cave, covering area of ca. 2 m^2 and 1 cm thick.	Rhabdome, 126 × 8.7 µm. Clads, 46 µm. Most are acanthodichotriaenes. Calthroplike triaenes occur with clads ±25 µm.	Rare	Axis, 4–6 µm. (L)	Jamaica, W.I. 30 m
T. kittoni Carter, 1874	Spicules from arenaceous deposit.	Rhabdome, 153 × 28 µm. Clad chord, 111 µm. Not divided at ends. Spreading upwards & outwards.	—	—	Coló n, Panama
T. kittoni (record of Soest & Stentoft, 1988)	Encrusting vermetids; covering several mm^2.	Some plagio- and dichotriaene developmental stages.	Rhabdome, 75–120 × 12–20 µm. Cladome chord, 150 µm. Clads divided or not at ends.	—	Barbados, 100 m.
T. ornatus Sollas, 1888	One spicule found in bottom debris.	—	Rhabdome, 65 µm. Cladome chord, 55 µm.	—	Seychelles
T. sphaeroidocladus Hartman & Hubbard, present paper	Covering area 2 m across; growing with *Siliquaria*.	Rhabdome, 416 × 23 µm. Reduced clad, 12.7 × 14.6 µm.	Rhabdome, 64 × 12 µm. Cladome chord, 65 µm.	Axis, 6.7 × 1 µm. Spines, 2.3 µm.	Trinidad, W.I., 21.5 m.

Although the three major spicule types characteristic of the genus *Thrombus* are all found in the aggregate of previously described species, only *T. sphaeroidocladus* has all three of these spicule types in the same species with the acanthotrichotriaenes localized in a specific region of the sponge. Further, the acanthotriaenes of *T. sphaeroidocladus* are unique in having much reduced, rounded clads. *T. sphaeroidocladus* is the largest species of the genus and one of the largest known sponges at least in terms of areal extent. Finally, *T. sphaeroidocladus* is the most shallow occurring member of the genus *Thrombus.*

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