P. S. Z. N. I: Marine Ecology, 12 (3): 211–226 (1991)
Accepted: January 2, 1991

ISSN 0173-9565

Comparative Morphology, Ecology, and Fatty Acid Composition of West Indian *Spheciospongia (Demospongea)*

VANCE P. VICENTE[1], KLAUS RÜTZLER[2]* & NÉSTOR M. CARBALLEIRA[3]

[1] U.S. Fish and Wildlife Service, Caribbean Field Office, P. O. Box 491, Boquerón, Puerto Rico 00622.
[2] Department of Invertebrate Zoology, National Museum of Natural History, Smithsonian Institution, Washington, D. C. 20560, U.S.A.
[3] Department of Chemistry, University of Puerto Rico, Rio Piedras, Puerto Rico 00931.

With 5 figures and 4 tables

Key words: *Clionidae* systematics, coral-reef sponges, Caribbean Sea, morphological variability, spicules, fatty acids.

Abstract. The morphological variability of the common West Indian loggerhead sponge, *Spheciospongia vesparium,* is examined in light of the latest morphological and ecological information and new biochemical criteria, that is, composition and concentration of fatty acids. A typical and a yellow ecophenotypical form are distinguished. Comparing this species with its next relatives in the same zoogeographical region it is found that *S. othella,* first described from Bermuda, cannot be maintained as a separate species. *S. cuspidifera,* previously misinterpreted as *"Xestospongia tierneyi",* is confirmed as a distinct species of *Spheciospongia,* whereas *"Prianos" tierneyi* is considered a morphological variant of *S. vesparium.*

Problem

The loggerhead sponge *Spheciospongia vesparium* (LAMARCK) *(Clionidae, Hadromerida)* and its close relative *S. othella* DE LAUBENFELS from Bermuda have been the only recognized species of the genus in the West Indian region up to this time. *S. vesparium* is a major component of shallow benthic habitats and plays an important role in near-shore ecological processes; it forms patch reef-like bioherms (WIEDENMAYER, 1978, 1980) and is an important refuge for juvenile and adult invertebrate and fish populations (PEARSE, 1934; DE LAUBENFELS, 1953; WESTINGA & HOETJES, 1981). This sponge usually attains a large size, and in fact has been considered the largest sponge of the world (DE LAUBENFELS, 1950). Specimens of *S. vesparium* are generally abundant on seagrass beds or

* Direct requests for reprints to this author.

other depositional bottoms (DE LAUBENFELS, 1953; TIERNEY, 1954; WIEDENMAYER, 1980), where they promote habitat complexity. Like at least one other clionid, *Anthosigmella* (= *Cliona*) *varians* (DUCHASSAING & MICHELOTTI), and a chondrosiid, *Chondrilla nucula* SCHMIDT, *S. vesparium* may also influence nutrient concentrations in sea water (CORREDOR *et al.*, 1988), particularly in view of its capability of pumping large water volumes. It prefers environments with good water circulation but is also able to rid itself of sediment falling on the incurrent sieves by creating a reverse flow (STORR, 1976).

The morphological plasticity of *Spheciospongia* has caused taxonomic confusion at times. For instance, there are disagreements as to whether *S. othella* from Bermuda (DE LAUBENFELS, 1950; RÜTZLER, 1974) can be considered distinct from *S. vesparium* (for discussion see WIEDENMEYER, 1977 a) using solely morphological (including skeletal) traits as criteria. Ecophenotypic expressions differ significantly between specimens of *S. vesparium* even within biotopes (DE LAUBENFELS, 1950, 1953; HECHTEL, 1965). WIEDENMAYER (1977 a), for example, found three distinct morphological habits of *S. vesparium* in the Bahamas. Inquiline-induced morphological differences (external as well as internal) within localities may also exist because almost without exception numerous symbionts are found inside loggerheads. For example, a single 185-liter *S. vesparium* specimen contained over 17,000 individuals of animals (primarily synalpheid shrimps, crabs, and polychaetes) (PEARSE, 1934).

Chromatic variations in loggerhead sponges have also been found on regional and local spatial scales and have been interpreted taxonomically in different ways. For instance, LITTLE (1963) describes the color of *S. vesparium* collected from the Florida Gulf of Mexico coast as creamy brown to dark brown, whereas WIEDENMAYER (1977 a) describes some specimens from the Bahamas as purplish or brownish black, others as having a mottled, dark green-olivaceous hue. HECHTEL (1965) and DE LAUBENFELS (1936) described loggerhead sponges as near black or grayish black, which is the most commonly observed color in Caribbean specimens. Yellow specimens or specimens pallidly mottled have been thought to differ taxonomically. Yellow specimens of *S. vesparium* led DE LAUBENFELS to believe that a new species or race could exist in the turbid waters of the northern Gulf of Mexico (DE LAUBENFELS, 1953: 537). Furthermore, the pallid form of *Spheciospongia* specimens from Bermuda was one of the important criteria to designate *S. othella* as a new species (DE LAUBENFELS, 1950). Finally, HECHTEL (1965: 58) recognized the need for more specimens to clarify the number of species of *Spheciospongia* in the West Indies.

In Puerto Rico, two different types of *Spheciospongia* are found. One coincides in external morphology with the description of "habit a" in WIEDENMAYER (1977 a: 168): "Commonly stubby cylinders, attaining large size, up to 1 m in diameter, with the inhalant area on the sides, and usually several, clustering oscules in the center of the plateau." This is the most ubiquitous form on the north coast of Puerto Rico and will be referred to in this paper as the "typical form". The other Puerto Rican *Spheciospongia* are always yellow or yellow cream and have only been found in turbid environments on the west and Caribbean coast of the island; they will be referred to in this paper as the "yellow form". The shape of the yellow form is often similar to "habit c" described in WIEDENMAYER (1977 a: 168): "Conical, volcano-shaped, up to 50 cm

in basal diameter, usually wider than high ... commonly with one huge apical oscule, which has an elevated collar, and leads to a very wide atrium."

Examination of other material relevant to this study revealed that the *"Xestospongia tierneyi"* of other authors (for instance, WIEDENMAYER, 1977 a) also belongs to *Spheciospongia* and that it has long been known as *Spirastrella cuspidifera* (LAMARCK). *Prianos tierneyi* DE LAUBENFELS, on the other hand, was found to be an extreme form of the highly plastic *S. vesparium* group. In light of this new information, the taxonomic status of *S. othella* will also be reconsidered.

Fatty acid composition and relative concentration are utilized as additional criteria in this taxonomic revision of *Spheciospongia*. For comparison, the basket sponge *Xestospongia muta* (SCHMIDT) (order *Petrosiida*) was also analyzed.

Material and Methods

Specimens for taxonomic and chemical analysis were collected by SCUBA diving on the inner-sublittoral benthic communities of the western and southwestern coasts of Puerto Rico at depths of 2–20 m (Fig. 1). The typical form of *S. vesparium* was collected from clear-water hard bottoms at Rincón. The yellow form of *Spheciospongia* was collected from turbid hard bottoms at Aguada near the mouth of Rio Carrizales and from the base of Cayo Enrique reef at La Parguera. *Spheciospongia cuspidifera* was collected from Cayo Enrique reef at La Parguera, *Xestospongia muta* from the shelf edge south of La Parguera. All material was transported live to the laboratory after collection,

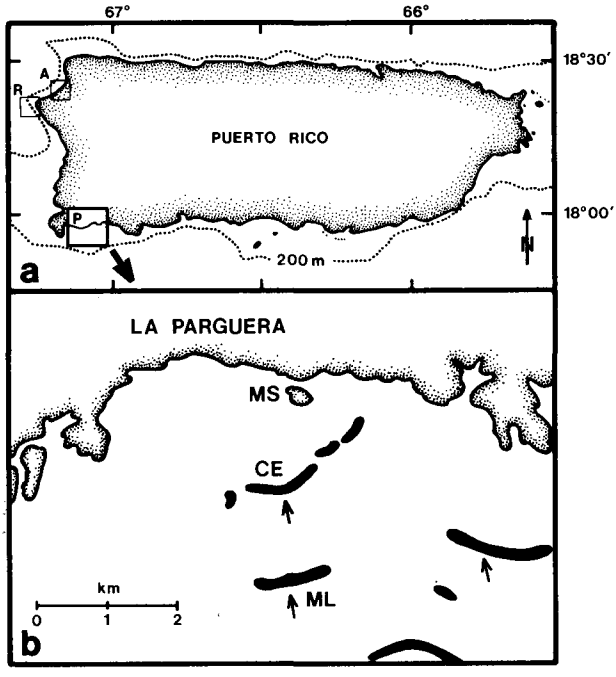

Fig. 1. Collecting localities off Puerto Rico. a: General view (A = Aguada; P = La Parguera; R = Rincón). b: Enlarged view of La Parguera region; arrows indicate the reef-front habitats surveyed (CE = Cayo Enrique reef; ML = Media Luna reef; MS = Marine Station).

except for *Spheciospongia othella*, which had previously been collected from Bermuda (RÜTZLER, 1974) and was not available live for this study.

External morphological characters of live sponges such as color, surface texture, shape, and oscular properties were recorded in the field, and underwater photographs of specimens in their habitats were taken (Nikonos IV camera, Ektachrome film, and electronic flash). Large specimens were fixed in 10% formalin in sea water overnight and then rinsed for 2 h and sun-dried; small specimens and fragments of the large sponges were stored in 10% formalin in sea water or in 70% ethylene alcohol.

Spicule preparations for light microscopy examination were made by boiling sponge fragments (1 cm^3) in a beaker (25 cm^3) in 100% nitric acid (HNO_3). After total digestion, the acid was neutralized with calcium carbonate ($CaCO_3$). The precipitates were washed three times with distilled water and twice in ethanol (100%) by centrifuging, decanting, and resuspending precipitates with fresh water and alcohol solutions. Megasclere measurements included total length of tylostyles, maximum width of tylostyle shaft, width of tylostyle neck, and maximum width of tylostyle head. Total length of microscleres (spirasters) as well as position and characters of the spines were also noted. For scanning electron microscope viewing, clean spicules were dried on a small circular cover slip and coated with 20 nm of gold. A Cambridge Stereoscan Mark II A was used at 3000–8500 times magnification (see RÜTZLER, 1974).

For fatty acid analyses, specimens of both forms of *Spheciospongia vesparium* (typical and yellow), of *S. cuspidifera*, and of *Xestospongia muta* were collected by cutting them a few centimeters above the base. The sponges were transported to the laboratory in labeled plastic bags inside an ice chest. In the laboratory, they were carefully washed and cleaned from allochthonous components (*e. g.*, macrosymbionts and sediments) while submerged in sea water. Each specimen was cut into small fragments. Lipids were extracted with chloroform-methanol (1:1, v/v). The neutral lipids, glycolipids, and phospholipids were separated by column chromatography on ammonium hydroxide-treated silicic acid (100–200 mesh) following the procedure of PRIVETT *et al.* (1973). The phospholipid classes were investigated by preparative thin layer chromatography (TLC) on silica gel with chloroform-methanol-water (65:25:4, v/v/v) as solvent. The fatty acyl components of the phospholipids were obtained as their methyl esters by reaction of the phospholipids with methanolic hydrogen chloride (CARREAU & DUBACQ, 1978) followed by purification on column chromatography eluting with hexane-ether (9:1, v/v). The resulting methyl esters were analyzed by gas chromatography-mass spectrometry (GC-MC) using a Hewlett Packard 5995 A gas chromatograph-mass spectrometer equipped with a 30 mm × 0.32 mm fused silica column coated with SE-54. For the location of double bonds, N-acylpyrrolidide derivatives were prepared by direct treatment of the methyl esters with pyrrolidine-acetic acid (10:1, v/v) in a capped vial (1 h at 100 °C) followed by ethereal extraction from the acidified solution and purification by preparative layer chromatography (PLC). Hydrogenations were carried out in 10 ml of absolute methanol and catalytic amounts of platinum oxide (PtO_2).

Fatty acid types and their relative percent composition were analyzed by cluster analysis to detect if the specimens analyzed fell into natural groups. The amalgamation method used was the Average-Linkage method described in SOKAL & MICHENER (1958). Dendrograms were constructed using average-linkage.

Results

1. Family *Clionidae* GRAY

Diagnosis. *Hadromerida* of massive, encrusting, or endolithic (limestone-excavating) habit, with tylostyles and delicate spirasters which are usually confined to peripheral body parts and canal linings. Tylostyles can be modified to styles and strongyles; spirasters can have reduced or complex spines and can form spiny rods and amphiaster-like variants. Auxiliary microscleres in some species include microxeas, acanthomicroxeas, and raphids (see also RÜTZLER, 1986: 122).

Remarks. This emended diagnosis is the sole responsibility of one of us (K. R.), who considers the related family *Spirastrellidae* distinct in their encrusting habit and in having robust spirasters which occur in several size classes packed throughout the body. Some workers prefer to include the *Spirastrellidae* in the *Clionidae* (R. W. M. VAN SOEST, Amsterdam, pers. comm.).

2. Genus *Spheciospongia* MARSHALL

Diagnosis. Massive *Clionidae* with robust tylostyles in great abundance forming a tangential network of indistinct strands or felted without orientation and minute spirasters in small numbers concentrated in the ectosome and the canal linings. Tylostyles are commonly modified to styles, tylostrongyles, and strongyles. Excavating limestone substrates during early stage of life history.

a. *Spheciospongia vesparium* (LAMARCK)

Distribution and synonymy. North Carolina: GEORGE & WILSON (1919) (as *Spirastrella andrewsii* and *Poterion atlantica*), DE LAUBENFELS (1947), WELLS *et al.* (1960); Bermuda: VERRILL (1907) (as *Heterocliona cribaria*), DE LAUBENFELS (1950), RÜTZLER *et al.* (1974), RÜTZLER (1986) (as *Spheciospongia othella*); Florida and Gulf of Mexico: SCHMIDT, 1870 (as *Papillina cribrosa*), DE LAUBENFELS (1953) (as *Prianos tierneyi*), TIERNEY (1954), LITTLE (1963), STORR (1964); Dry Tortugas: PEARSE (1934), DE LAUBENFELS (1936); Belize: BOWERBANK (1872) (as *Hymeniacidon pulvinatus*), CARTER (1879) (as *Spongia dysoni*), RÜTZLER & MACINTYRE (1982); Bahamas: DE LAUBENFELS (1949), WIEDENMAYER (1977 a), PULITZER-FINALI (1986); Jamaica: GEORGE & WILSON (1919) (as *Spirastrella andrewsi*), HECHTEL (1965), PULITZER-FINALI (1986); Cuba: ALCOLADO (1986); Hispaniola: VICENTE & DE CALVENTI (1979), PULITZER-FINALI (1986), GOENAGA & VICENTE (1988); Puerto Rico: VICENTE (1974), PULITZER-FINALI (1986); Lesser Antilles: DUCHASSAING & MICHELOTTI (1864) (as *Thalysias vesparia*); Venezuela: ALVAREZ *et al.* (1990). For additional synonymy and biogeographical information see WIEDENMAYER (1977 a : 167).

Material examined. Typical form, USNM 30498; Rincón, Puerto Rico; 9 m; 20 Feb 1980. Yellow form, USNM 30134; Aguada, Puerto Rico; 8 m; 20 Feb 1980. Yellow form, USNM 30509; Aguada, Puerto Rico; 16 m; 22 Jul 1980.

Diagnosis. Very large (0.2–1.0 m in diameter), massive, cake or volcano-shaped *Spheciospongia,* either purplish to brownish black or bright yellow to yellow orange, with ostia grouped in sieve areas, and oscula either large and single or small and clustered (Fig. 2).

External morphology. The typical (blackish) and the yellow-yellow orange forms of this species differed mostly in external morphological characters and in habitat. The general shape of these sponges was found to vary with their environment. Under clear oceanic conditions, both forms are cake-shaped, whereas in turbid habitats the yellow forms are volcano-shaped.

The inhalant pore sieves are evenly distributed in yellow forms inhabiting hardgrounds exposed to clear oceanic conditions, but they are clustered on

Table 1. *Spheciospongia vesparium*, spicule dimension (μm) for specimens from different geographic locations ($\bar{x}$ = mean, s = standard deviation, n = number measured, – = not given in the reference cited).

form and location	tylostyle length				tylostyle width			
	range	$\bar{x}$	s	n	range	$\bar{x}$	s	n
typica, Florida (Gulf)	214–482	386	–	10–20	–	9	–	10–20
typica, Dry Tortugas	445–600	–	–	–	9–10	–	–	–
typica, Bahamas	215–400	341	–	–	3–10	7	–	–
typica, Jamaica	156–472	–	–	75	5–15	–	–	75
othella, Bermuda	116–374	280	–	75	2–9	6	–	75
typica, USNM 30498, Puerto Rico	196–463	391 ± 63		25	6–11	8.9 ± 1.9		25
pallida, USNM 30134, Puerto Rico	316–476	414 ± 43		25	6–15	9.4 ± 2.6		25
pallida, USNM 30509, Puerto Rico	187–467	396 ± 72		25	4–13	9.3 ± 2.3		25

elevations – as in the typical form – when growing in turbid environments. The sieves in both forms may be covered with *Parazoanthus*. The oscules are always different in the two forms. The typical form has numerous oscules (usually more than 20), which are always small (all about 1 cm in diameter). The yellow form has large (2–10 cm in diameter) and few (less than 5) oscules, which are often septate and surrounded by brightly colored collars, 1–3 cm in height; these collars collapse rapidly when touched.

The typical form (habit *a* of WIEDENMAYER, 1977 a) is dominant in well-lit hard ground habitats of low topographic relief exposed to oceanic conditions throughout the inner-sublittoral zone of Puerto Rico. The yellow form, on the other hand, is usually found on hard bottoms near river mouths (*e. g.*, Aguada) or in depositional coral reef environments (*e. g.*, at the base of reef fronts at La Parguera).

Spicules. Tylostyle lengths and widths of the typical form of *Spheciospongia vesparium* are indistinguishable from specimens of the yellow forms (Table 1). Likewise, the mean length of microscleres (spirasters) in the typical specimen is similar to that of both yellow specimens. Furthermore, the spirasters in both forms were very similar in morphology (Fig. 3 a, b).

Fatty acids. The fatty acid composition was very similar in both forms of *Spheciospongia vesparium* (Table 2).

Remarks. A closely related black sponge, *Spheciospongia othella* from Bermuda, was redescribed in detail by RÜTZLER (1974). Its tylostyles are different from both forms of *S. vesparium* by averaging only 70 % of the typical length and 60 % of the width (Table 1). Spirasters and other morphological features are very similar to typical *S. vesparium*.

The holotype of *Prianos tierneyi* DE LAUBENFELS (1953) was also re-examined (USNM 23408, Dry Tortugas, 7 m, coll. 30 Oct 1948). WIEDENMAYER (1977 a) erroneously transferred this species to the genus *Xestospongia* and redescribed it based on material that we know belongs to *Spheciospongia cuspidifera* (see below). Both authors overlooked the minute and rare spirasters that are present

Table 1. Continued.

spiraster length				reference
range	$\bar{x}$	s	n	
9–18	–	–	10–20	LITTLE, 1963
12–15	–	–	–	DE LAUBENFELS, 1936
4–12	–	–	–	WIEDENMAYER, 1977 a
12–30	–	–	50	HECHTEL, 1965
8–26	14	–	75	RÜTZLER, 1974
11–28	16.1 ± 4.8		25	this study
6–20	13.2 ± 4.0		25	this study
9–20	14.1 ± 3.1		25	this study

in both sponges and were confused by the unusually pure complement of strongylote modifications of the tylostyles. We have examined a number of *S. vesparium* from near the *Prianos tierneyi* type locality (southwestern Florida) and found 6–8 % pure strongyles, 22–28 % styles, and 64–72 % tylostyles, none close to the number of strongyles (73 % with 3 % styles and 24 % tylostyles or tylostrongyles) in the only remaining type specimen of *P. tierneyi*. Nevertheless, our observations on *S. cuspidifera* (below) convince us that strongylote megascleres can be a common modification within the genus; we therefore transfer *P. tierneyi* to *Spheciospongia*. Even the author of *Prianos tierneyi* (DE LAUBENFELS, 1953: 535) stated "... In fact, the whole appearance suggests *Spheciospongia*."

b. *Spheciospongia cuspidifera* (LAMARCK)

Distribution and synonymy. Bahamas: WIEDENMAYER (1977 a, 1977 b) (as *Xestospongia tierneyi*); Hispaniola: PULITZER-FINALI (1986); Puerto Rico: VICENTE (unpublished); Belize: RÜTZLER (in preparation).

Material examined. USNM 34640: Cape Fear, South Carolina; 34 m; 7 Aug 1981. USNM 30172: Bimini, Bahamas; 6–10 m; 1965. USNM 9056: Cape Hutia, Cuba; depth unknown; 14 May 1914. USNM 30501: Rincón, Puerto Rico; 12 m; 30 May 1980. USNM 32841: St. John, Virgin Islands; depth unknown; 23 June 1983. USNM 32360: Glover's Reef, Belize; 12–15 m; July 1977. USNM 41414: Carrie Bow Cay, Belize; 8 m; 12 Aug 1989. USNM 31089: Providencia Islands, Colombia; 8 m; December 1980.

Diagnosis. *Spheciospongia* forming erect single or staghorn-like, branching, hollow cylinders, 30 × 5 cm, anchored in coral sand and tapering towards the top. Tan to walnut-brown, without conspicuous aquiferous openings (Fig. 4).

External Morphology. Detailed descriptions of this sponge are found in TOPSENT (1933), WIEDENMAYER (1977 a), and RÜTZLER (in preparation). The brown color is due to the presence of zooxanthellae in the ectosome (RÜTZLER, 1990). In some specimens, circular openings may be seen on the sponge surface

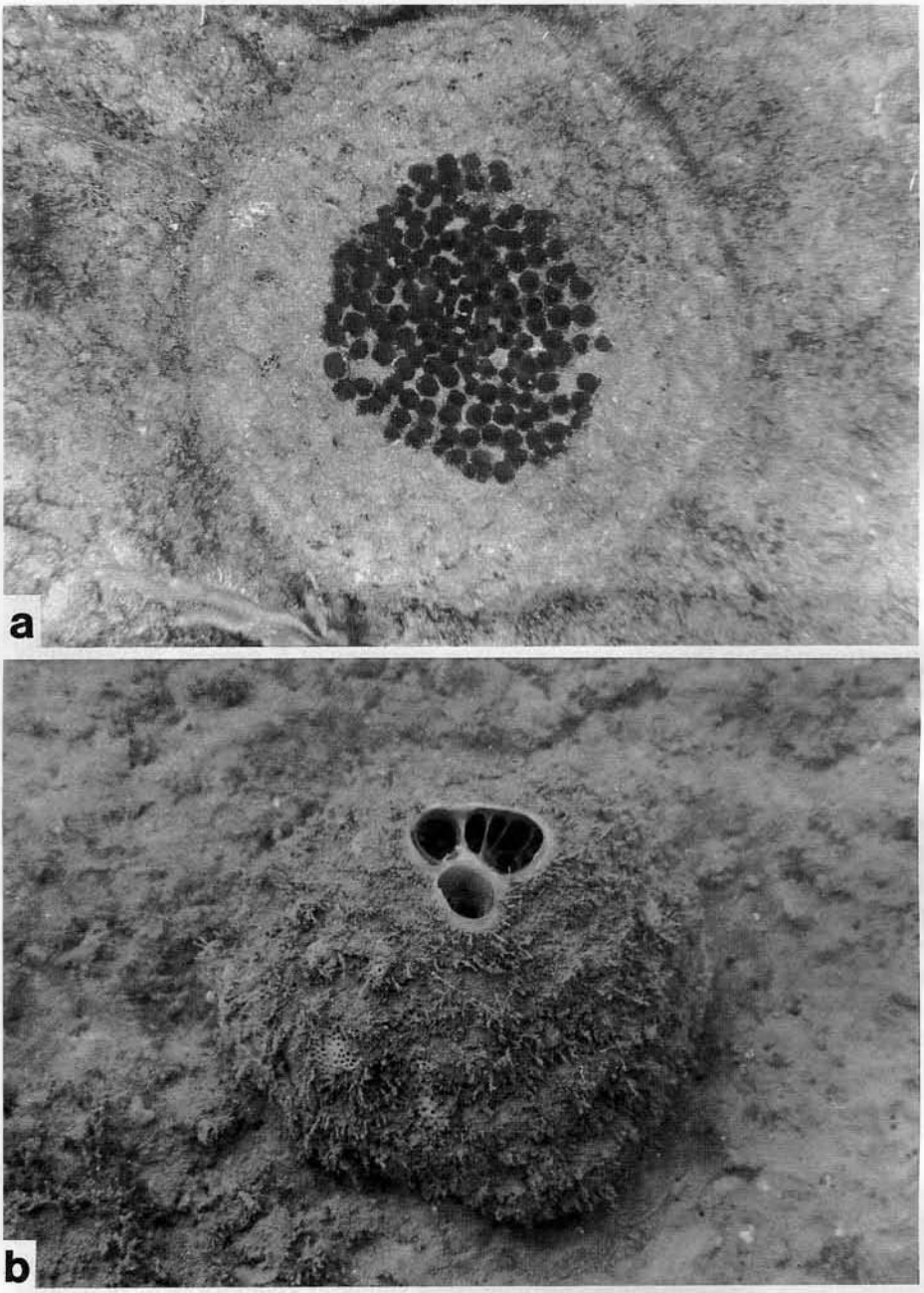

Fig. 2. *Spheciospongia vesparium* in its natural habitat. a: f. *typica*, Rincón, Puerto Rico, 9 m. b: f. *pallida*, Aguada, Puerto Rico, 14 m. (Picture width = 70 cm).

near the base; these are caused by the presence of the barnacle *Membranobalanus* sp.

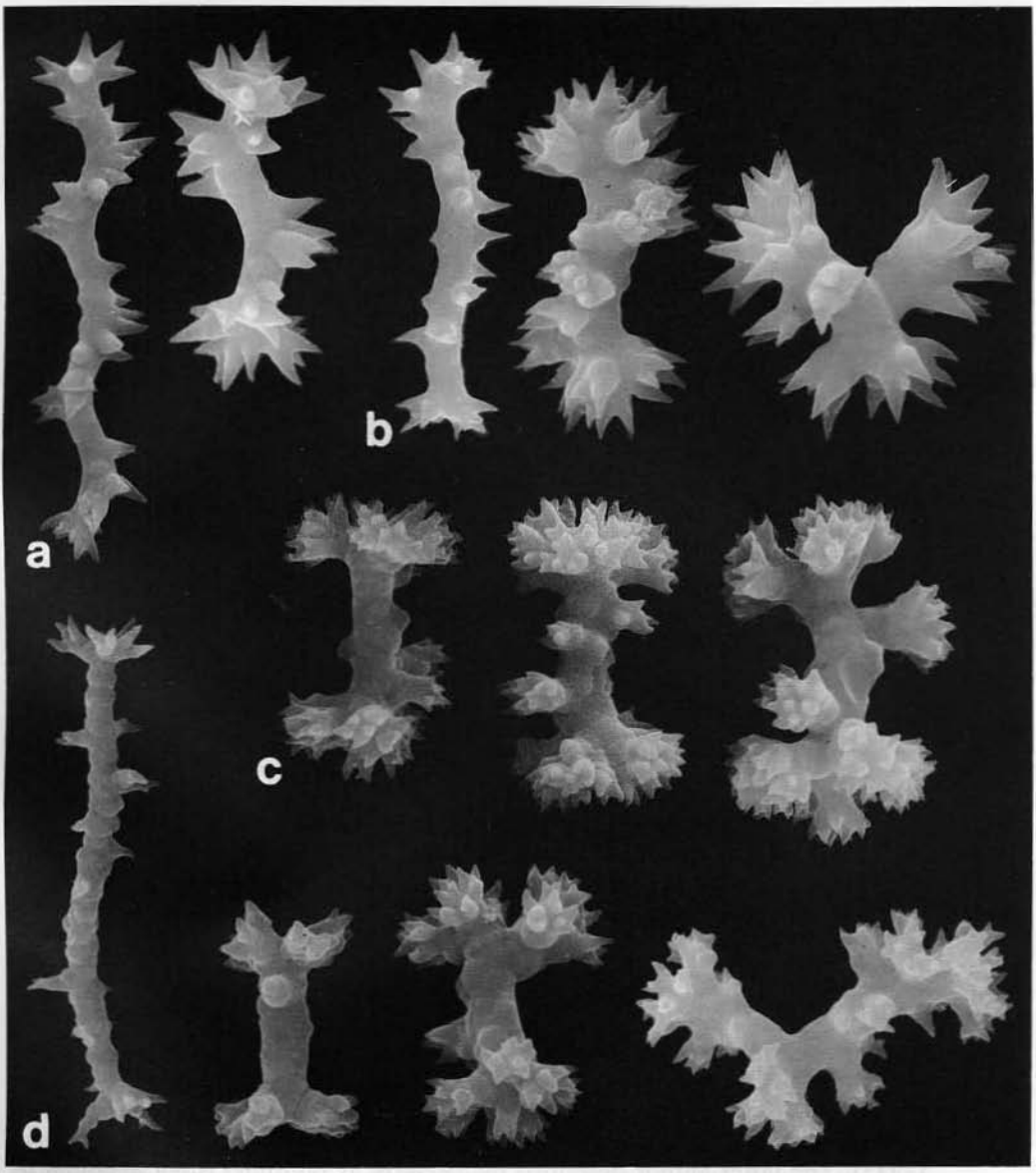

Fig. 3. Spiraster-type microscleres in *Spheciospongia*. a: *S. vesparium* f. *typica*. b: *S. vesparium* f. *pallida*. c: *Prianos tierneyi*, holotype (USNM 23408). d: *S. cuspidifera*. (Magnification = 4000 ×).

Spicules. Dimensions of megascleres and microscleres are given in Table 3. Megascleres often appear as strongyles, but close examination reveals the tylostyle origin. The relative abundance of tylostyles and strongyles and other derivatives (styles, tylostrongyles) varies with geographic location (Table 4). Microscleres are spirasters and their derivatives (Fig. 3 d).

Fig. 4. *Spheciospongia cuspidifera*, habit of two specimens from Puerto Rico (dry; 0.3 × natural size).

Fatty acids. The fatty acid analysis (Table 2) shows clearly that this species is close to *Spheciospongia vesparium* and that it has no ties to the genus *Xestospongia* in the *Petrosiida*.

Remarks. This sponge was named *Alcyonium cuspidiferum* by LAMARCK (locality unknown) and redescribed and transferred to *Spirastrella* by TOPSENT (1933). The latter author described megascleres as tylostyles often modified to tylostrongyles (190–525 μm × 5–13 μm) and spirasters (8–12 μm), some modified to small (4–6 μm) amphiasters. "Staghorn sponge" would be an appropriate common name.

Discussion

The different expressions in shape, color, oscula, porus arrangement, and habitat types found in *Spheciospongia vesparium* first suggested that two species exist in Puerto Rico – a typical and a yellow one. However, the morphology and

Table 2. Fatty acid composition (%) in *Spheciospongia* and *Xestospongia* (– = not present).

fatty acid	*S. vesparium*		*S.*	*X.*
	typica	*pallida*	*cuspidifera*	*muta*
1. 4,8,12-Trimethyltridecanoic (16 : 0)	23.0	21.0	24.3	–
2. Octadecenoic (18 : 1)	17.7	22.4	13.1	–
3. Tetradecanoic (14 : 0)	1.9	–	18.9	2.4
4. Hexadecanoic (16 : 0)	19.3	29.9	12.9	10.0
5. Octadecanoic (18 : 0)	–	–	5.0	4.9
6. Nonadecanoic (19 : 0)	–	0.4	0.8	1.2
7. Docosanoic (20 : 0)	12.3	5.7	4.0	12.5
8. Heneicosanoic (21 : 0)	1.8	1.5	3.9	–
9. Behenic (22 : 0)	1.2	0.7	–	–
10. Tricosanoic (23 : 0)	0.7	–	–	–
11. Lignoceric (24 : 0)	4.1	0.7	–	–
12. 5,9-Pentacosadienoic (25 : 2)	2.1	–	3.1	–
13. 5,9-Hexacosadienoic (26 : 2)	15.3	14.6	14.0	–
14. 3,7,11-Trimethyldodecanoic (15 : 0)	–	–	–	3.3
15. 12-Methyltetradecanoic (15 : 0)	–	–	–	9.4
16. Pentadecanoic (15 : 0)	–	–	–	1.4
17. 14-Methylpentadecanoic (16 : 0)	–	–	–	1.3
18. 5,9-Hexadecadienoic (16 : 2)	–	–	–	10.5
19. 9-Hexadecenoic (16 : 1)	–	–	–	11.5
20. 12-Methylhexadecanoic (17 : 0)	–	–	–	10.2
21. 15-Methylhexadecanoic (17 : 0)	–	1.0	–	1.9
22. 14-Methylhexadecanoic (17 : 0)	–	1.0	–	1.7
23. Heptadecanoic (17 : 0)	–	1.0	–	1.1
24. 16-Methyloctadecanoic (19 : 0)	–	–	–	7.7
25. Behenic (21 : 0)	–	0.1	–	1.6
26. 5,9,19-octacosatrienoic (28 : 3)	–	–	–	7.4
27. Pentacosanoic (25 : 0)	0.6	–	–	–

dimensions of spicules are identical in the two forms, making a separation difficult. In some instances, both forms of *S. vesparium* have been observed growing next to each other. This suggests that distinctions other than ecophenotypic ones exist. The differences in fatty acid composition (Table 2) are reflected in the dendrogram (Fig. 5). As it has been shown that fatty acid type may reflect genotype while fatty acid concentrations may reflect the environment (COHEN *et al.*, 1988), we suspect that the two forms are polymorphic and propose that the yellow form be referred to as *Spheciospongia vesparium* f. *pallida*.

Our observations led to a reconsideration of the taxonomic status of the Bermudan *Spheciospongia othella*. External morphological criteria utilized by DE LAUBENFELS (1950) in separating *S. othella* from *S. vesparium* are invalidated by the variable morphological manifestations we observed on regional and local scales. WIEDENMAYER (1977 a) arrived at a similar conclusion. The small megasclere size of *S. othella* was also used by DE LAUBENFELS as a criteria for describing it as new. Although *S. othella* spicules are indeed smaller (RÜTZLER, 1974), we found that this character is quite variable and may reflect differences in environment rather than genome. As an example, tylostyle length and width,

Table 3. *Spheciospongia cuspidifera*, spicule dimensions (μm, n = 25) for specimens from different geographic locations ($\bar{x}$ = mean, s = standard deviation).

specimen number; geographic location	megasclere length range	$\bar{x}$	s	megasclere width range	$\bar{x}$	s
USNM 34640; Cape Fear, South Carolina	250–510	376.4	71.9	7.5–10.0	8.8	1.3
USNM 30172; Bimini, Bahamas	180–600	328.8	79.8	5.0–12.5	8.3	1.9
USNM 9056; Cape Hutia, Cuba	230–480	396.4	65.9	5.0–10.0	8.8	1.5
USNM 30501; Rincón, Puerto Rico	310–460	396.9	52.6	7.5–12.0	11.3	1.9
USNM 32841; St. John, Virgin Islands	200–450	358.4	73.6	5.0–12.5	9.2	2.1
USNM 32360; Glover's Reef, Belize	190–470	343.6	81.6	5.0–12.5	9.6	2.0
USNM 41414; Carrie Bow Cay, Belize	240–590	398.4	83.8	7.5–12.5	10.7	1.6
USNM 31089; Providencia I., Colombia	260–450	345.6	82.9	5.0–10.0	7.6	1.1

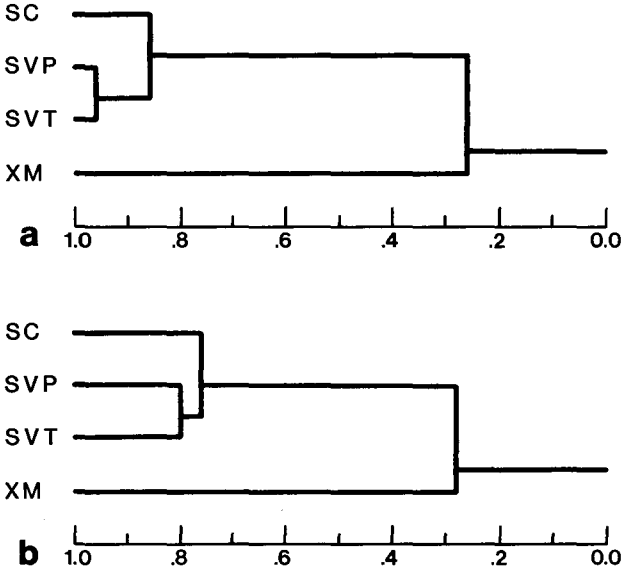

Fig. 5. Dendrograms of similarity of fatty acid content in four sponge species.
a: Clusters resulting from combination of fatty acid type and relative concentration.
b: Clusters based on fatty acid type alone. (SC = *Spheciospongia cuspidifera;* SVP = *S. vesparium* f. *pallida;* SVT = *S. vesparium* f. *typica;* XM = *Xestospongia muta*).

Table 3. Continued.

microsclere length			microsclere width		
range	x̄	s	range	x̄	s
10.0–17.0	12.8	2.6	3–3	3.0	0.0
9.0–13.6	11.1	2.0	3–5	4.2	1.1
8.0–9.0	8.5	0.6	3–3	3.0	0.0
10.0–13.0	11.4	1.3	2–3	2.4	0.6
9.0–10.0	9.8	0.4	2–5	3.0	1.2
9.0–22.5	13.0	5.7	3–4	3.2	0.5
10.0–12.5	11.0	1.4	5–10	7.2	1.9
8.0–10.0	8.7	0.8	3–5	3.6	0.9

as well as spiraster length in *S. vesparium* (typical form) vary geographically (Table 1). Furthermore, Bermudan specimens of other siliceous sponges, such as *Chondrilla nucula* (DE LAUBENFELS, 1950), also have smaller spicules than specimens of the same species collected from the Bahamas (WIEDENMAYER, 1977 a). The fact that *Prianos tierneyi*/*Xestospongia tierneyi* were misinterpreted

Table 4. *Spheciospongia cuspidifera*, percentage distribution of megasclere types in specimens from different geographic locations.

specimen number; location	tylostyles	strongyles	styles	tylostrongyles
USNM 34640; Cape Fear, South Carolina	20.6	36.3	19.9	23.3
USNM 30172; Bimini, Bahamas	2.4	91.5	1.2	4.9
USNM 9056; Cape Hutia, Cuba	56.5	41.9	1.6	0.0
USNM 30501; Rincón, Puerto Rico	62.3	23.6	13.1	1.0
USNM 32841; St. John, Virgin Islands	4.4	67.1	0.4	28.0
USNM 32360; Glover's Reef, Belize	11.4	40.7	10.6	37.4
USNM 41414; Carrie Bow Cay, Belize	47.8	10.5	29.3	12.5
USNM 31089; Providencia I., Colombia	14.6	1.7	83.7	0.0

by spongiologists on the species as well as generic and higher levels is entirely due to the plasticity of spicule morphology and ignorance about geographic and ecological variability of sponge populations.

Comparing fatty acids between *Spheciospongia vesparium* f. *typica, S. vesparium* f. *pallida, S. cuspidifera,* and *Xestospongia muta* we found 26 types in different proportions, 13 of them (50%) endemic to *Xestospongia* (Table 2). A typical fatty acid of the *Clionidae,* 4,8,12-trimethyltridecanoic acid (also detected in *Anthosigmella* [= *Cliona*] *varians* and *C. aprica* PANG), was found in important amounts in specimens of all *Spheciospongia* species (Table 2). Although this acid may occur in small quantities in other sponge species, it is found in significant amounts only in the *Clionidae;* it is therefore interpreted as a key component of the phospholipid fatty acid mixture of this family. Other acids abundant to the three *Spheciospongia* specimens analyzed are octadecanoic acid (18 : 1) (a mixture of $\triangle^9$ and $\triangle^{11}$), hexadecanoic acid (16 : 0), docosanoic acid (20 : 0), and 5,9-hexacosadienoic acid (26 : 2). The results of cluster analyses are presented in Fig. 4. Based on fatty acid composition and concentration, *Xestospongia muta* is not closely related to any of the species of *Spheciospongia.* On the other hand, both dendrograms suggest a close systematic affinity between both forms (typical and yellow) of *S. vesparium,* as well as between the two species, *S. vesparium* and *S. cuspidifera.*

Summary

The sponge genus *Spheciospongia* (order *Hadromerida*) is considered to be a member of the *Clionidae* rather than *Spirastrellidae.* In view of its great morphological variability only two species are recognized in the tropical western Atlantic: the loggerhead sponge, *S. vesparium* – the type species – for which two habits can be dinstinguished (black, forma *typica,* and yellow, forma *pallida*); and the staghorn sponge, *S. cuspidifera,* which in recent literature was wrongly identified as *Xestospongia tierneyi.* DE LAUBENFELS' (1953) *Prianos tierneyi* is now recognized as a variant of *S. vesparium* f. *typica.* Examination of specimens from many localities throughout the region shows considerable variability of megascleres in both species, with almost pure complements of tylostyles or strongyles as the extremes. Fatty acid composition confirms that strongyle-bearing specimens are not related to *Xestospongia* but are proper members of *Spheciospongia.*

Acknowledgements

We are grateful to KATHLEEN P. SMITH for editorial assistance, BELINDA ALVAREZ for microscope measurements, and MOLLY K. RYAN for help with the illustrations. This is contribution number 307, Caribbean Coral Reef Ecosystems (CCRE) program, National Museum of Natural History, Washington, D. C.

– –, 1976: Field observations of sponge reactions as related to their ecology. In: F. W. HARRISON & R. R. COWDEN (Eds.), Aspects of Sponge Biology. Academic Press, New York, San Francisco and London: 277–282.

TIERNEY, J. Q., 1954: The Porifera of the Gulf of Mexico. Fisher. Bull. Fish. Wildl. Serv., **55:** 259–261.

TOPSENT, E., 1933: Eponges de LAMARCK conservées au Museum de Paris. Arch. Mus. Nat. Hist. Nat., Paris (Ser. 6), **10:** 1–60.

VERRILL, A. E., 1907: Porifera. In: The Bermudan Islands. Trans. Connecticut Acad. Arts. Sci., **12:** 330–344.

VICENTE, V. P., 1974: Occurrence and distribution of the major types of epibenthic communities at Punta Higuero. In: Power Plant Environmental Studies, University of Puerto Rico, Puerto Rico Nuclear Center (PRNC), **174:** 57–103.

– – & I. BONNELI DE CALVENTI, 1979: Nuevo record de esponjas marinas para la República Dominicana y discusión de su importancia en el ambiente marino. Proc. Assoc. Is. Mar. Labs. Caribb., **14:** 8.

WELLS, H. W., M. J. WELLS & I. E. GRAY, 1960: Marine sponges of North Carolina. J. Elisha Mitchell Sci. Soc., **76:** 200–245.

WESTINGA, E. & P. C. HOETJES, 1981: The intrasponge fauna of *Spheciospongia vesparia* (Porifera, Demospongiae) at Curaçao and Bonaire. Mar. Biol., **62:** 139–150.

WIEDENMAYER, F., 1977 a: Shallow-water sponges of the western Bahamas. Exp. Suppl. 28, Birkhäuser Verlag, Basel & Stuttgart; 278 pp.

– –, 1977 b: The Nepheliospongiidae CLARKE 1900 (Demospongea, Upper Devonian to Recent), an ultraconservative, chiefly shallow-marine sponge family. Eclogae Geol. Helv., **70:** 885–918.

– –, 1978: Modern sponge bioherms of the Great Bahama Bank. Eclogae Geol. Helv., **71:** 699–744.

– –, 1980: Shallow water sponges of the Bahamas. In: W. D. HARTMAN, J. W. WENDT & F. WIEDENMAYER (Eds.), Living and Fossil Sponges. Sedimenta 8, Comparative Sedimentology Laboratory, University of Miami, Florida: 146–168.