

Morphological Diagnoses of Sponges Collected at Shelf-edge MPAs from Eastern Florida to North Carolina, between depths of 51 and 150 m, during CIOERT Expeditions (2018-2019)

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Table of Contents

Summary	2
<i>Leiodermatium lynceus</i> Schmidt (1870)	3
Sample 12-VI-19-1-005	3
<i>Penares</i> sp. 1	4
Sample 12-VI-19-1-007	4
<i>Epilolasis</i> cf. <i>profunda</i> Díaz, Van Soest and Pomponi, 1993	5
Sample 12-VI-19-2-001	5
<i>Cliona</i> cf. <i>tumula</i> Friday et al., 2016	6
Samples: 13-V-18-2-002, and 14-VI-19-1-002	6
<i>Aaptos</i> sp. 1	7
Samples 14-VI-19-3-1 and 16-VI-19-2-1	7
<i>Neofibularia nolitangere</i> (Duchassaing & Michelotti, 1864)	8
Sample 14-VI-19-4-001	8
<i>Cliona</i> aff. <i>celata</i> Grant, 1826	9
Sample 15-VI-19-4-1	9
<i>Clathria</i> (<i>C.</i>) sp.1 Topsent, 1889	10
Sample 15-VI-19-1-001	10
<i>Clathria</i> (<i>C.</i>) <i>foliacea</i> Topsent, 1889	11
Sample 17-VI-19-1-001	11
Acknowledgements	12
References	12

Summary

This paper is a result of the taxonomic analyses of the sponges collected during the NOAA Ship *Pisces* expeditions in 2018 and 2019 with the University of North Carolina, Wilmington (UNCW) *Mohawk* ROV. This is part of a 9-year project conducted by NOAA National Marine Fisheries (NMF) in collaboration with the Cooperative Institute for Ocean Exploration, Research, and Technology (CIOERT) at Harbor Branch Oceanographic Institute, Florida Atlantic University (HBOI-FAU) to document and monitor the Marine Protected Areas (MPAs) of the southeastern U.S. continental shelf (eastern Florida to North Carolina, 50-165 m deep). The most prominent and conspicuous sponges were collected with the intention of evaluating the biodiversity of this important benthic group in these mesophotic habitats. Eleven sponge samples were collected, and taxonomic evaluation, studying the internal and external morphology, resulted in: 1) three well recognized species from the Tropical Western Atlantic (*Leiodermatium lynceus*, *Neofibularia nolitangere*, *Clathria foliacea*), 2) four species with sibling recognized species but with major morphological differences that might require the description of new species (*Epipolasis* cf. *profunda*, *Cliona* cf. *tumula*, *Cliona* aff. *celata*), and 3) three species that only could receive generic assignments (*Penares* sp.1, *Clathria* sp.1, and *Aaptos* sp.1). These results show that more than half of the species collected represent unknown species to science, or unknown variations of recognized species. Careful comparison with species types and observations of spicules under SEM would allow the necessary evidence to characterize and classify these new species or varieties. We suggest further characterization of these novel fauna considering their level of abundance and distribution in the MPAs studied. A synoptic description of each species studied, with live, deck and microscopy photographs is here presented.

Table 1. Sponge samples identified from *Mohawk* ROV collections off southeastern U.S. shelf-edge MPAs.

Sample Number	Depth (m)	Locality	Taxonomic ID
12-VI-19-1-005	165	Northern South Carolina MPA- Iceberg Scar	<i>Leiodermatium lynceus</i>
12-VI-19-1-007	160	Northern South Carolina MPA- Iceberg Scar	<i>Penares</i> sp.1
12-VI-19-2-001	160	Northern South Carolina MPA- Iceberg Scar	<i>Epipolasis</i> cf. <i>profunda</i>
13-V-18-2-002	70	North Florida MPA	<i>Cliona</i> cf. <i>tumula</i>
14-VI-19-1-002	100	Outside Edisto MPA	<i>Cliona</i> cf. <i>tumula</i>
14-VI-19-3-001	55	Edisto MPA	<i>Aaptos</i> sp.1
14-VI-19-4-001	60	Edisto MPA	<i>Neofibularia nolitangere</i>
15-VI-19-4-001	70	Outside Georgia MPA	<i>Cliona</i> aff. <i>celata</i>
16-VI-19-2-001	51	Outside North Florida MPA	<i>Aaptos</i> sp.1
15-VI-19-1-001	60	Outside Georgia MPA	<i>Clathria</i> sp.1
17-VI-19-1-001	55	North Florida MPA	<i>Clathria foliacea</i>

***Leiodermatium lynceus* Schmidt (1870)**
Class Demospongiae, O. Tetractinellida, F. Azorizidae.

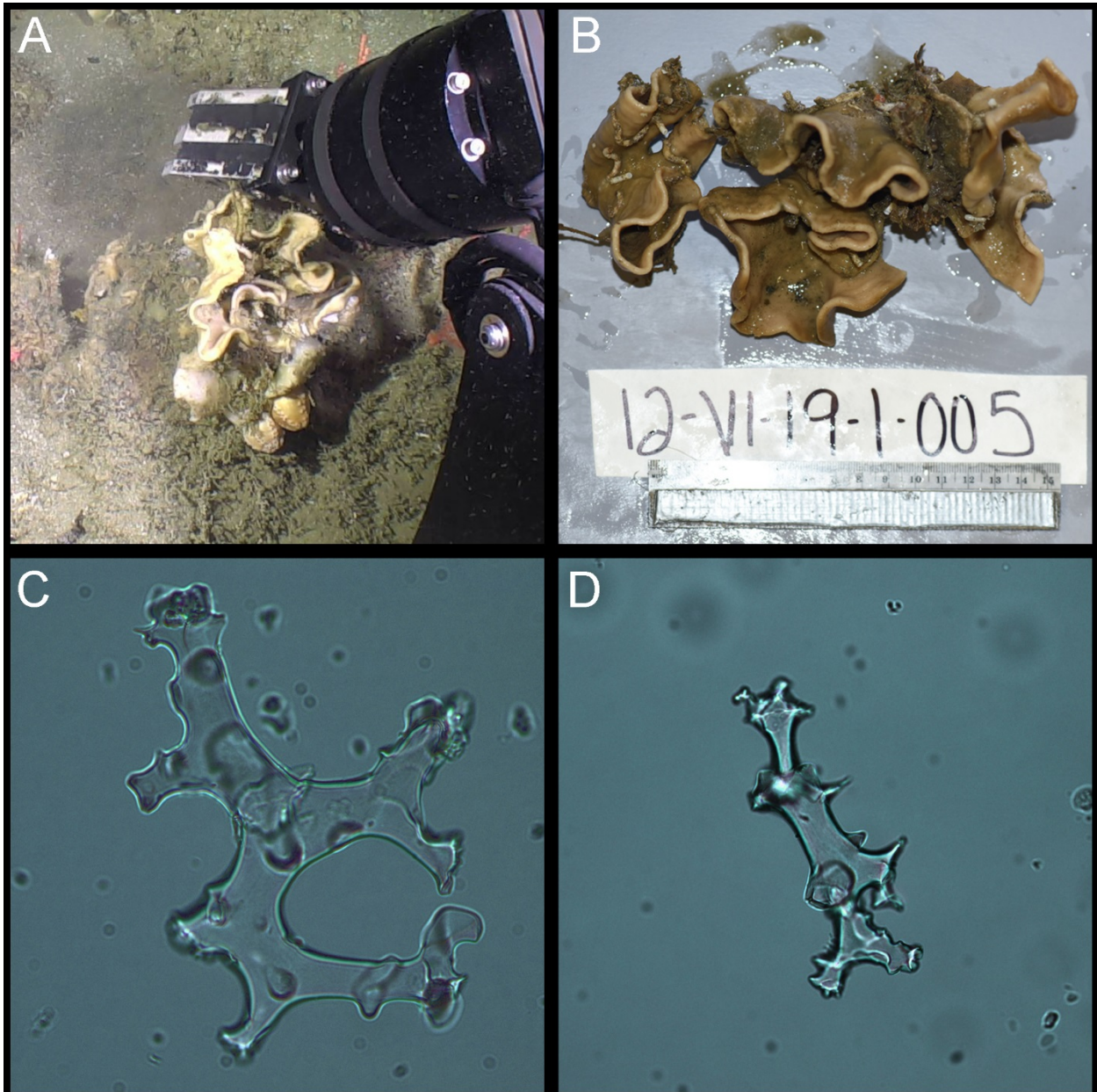


Figure 1. A) Live photo of sample 12-VI-19-1-005; B) Lab photo; C) monocrepid desmas, spinose ends; D) smooth shafts sometimes with bifurcated spines.

Sample 12-VI-19-1-005. Thin folded fans (4-5 cm high, 2-5 mm in thickness), with smooth surface, and hard as a rock. Tan internally and externally. The skeleton is conformed by: monocrepid desmas (200-300 x 20-40 μm), with spinose ends, smooth shafts and sometimes with bifid spines, and thin wispy oxeas (200-300 x 1 μm) disposed in few bundles. The sample belongs to the species *Leiodermatium lynceum* Schmidt (1870). Reference: (Van Soest and Stentoft 1988).

Penares sp. 1

Class Demospongiae, O.Tetractinellida, F. Ancorinidae

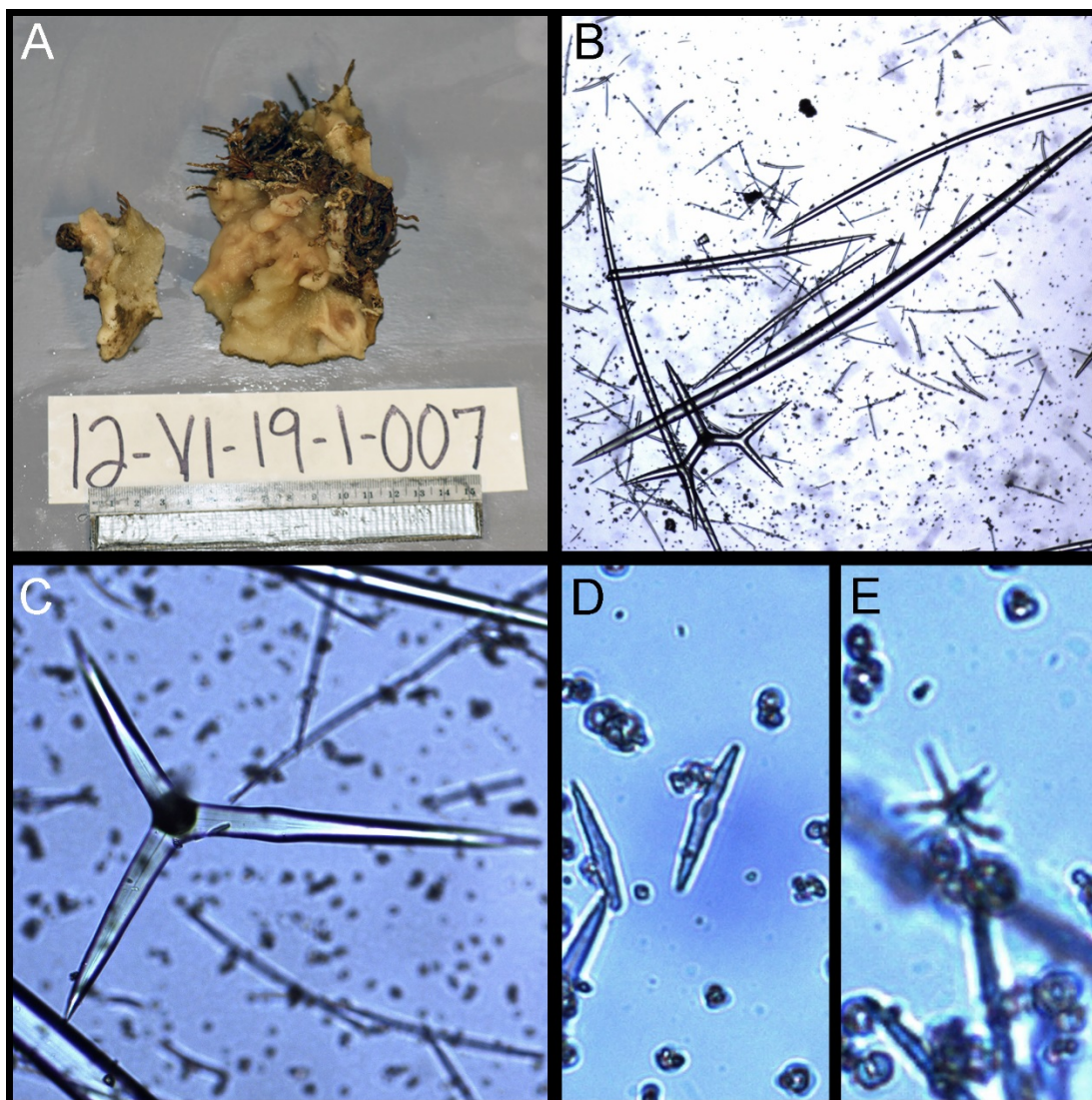


Figure 2. A) Lab photo of *Penares* sp.; B) large and smaller categories of oxea, and dichotriaene; C) orthotriaene; D) centrotylote strongyle; E) sanidaster.

Sample 12-VI-19-1-007. Massive, flabellate (1-4 cm in thickness), irregularly folded, and with few small oscular projections (oscles 2 mm wide). Tan externally and internally live. Macroscopically smooth surface, but microhispid under the microscope. Consistency dense, compressible but hard. Skeleton composed of large oxea, large orthotriaenes, dichotriaenes, small oxea in at least 3 size classes, a small fat centrotylote strongyle, and sanidasters. *Penares mastoidea* has similar habit but it lacks dichotriaenas and the orthotriaenas are much larger. This is probably an undescribed species of *Penares*. References: (Van Soest and Stentoft 1988; Sim-Smith and Kelly 2019).

***Epilolasis cf. profunda* Díaz, Van Soest and Pomponi, 1993**
Class Demospongiae, O. Suberitida, F. Halichondriidae

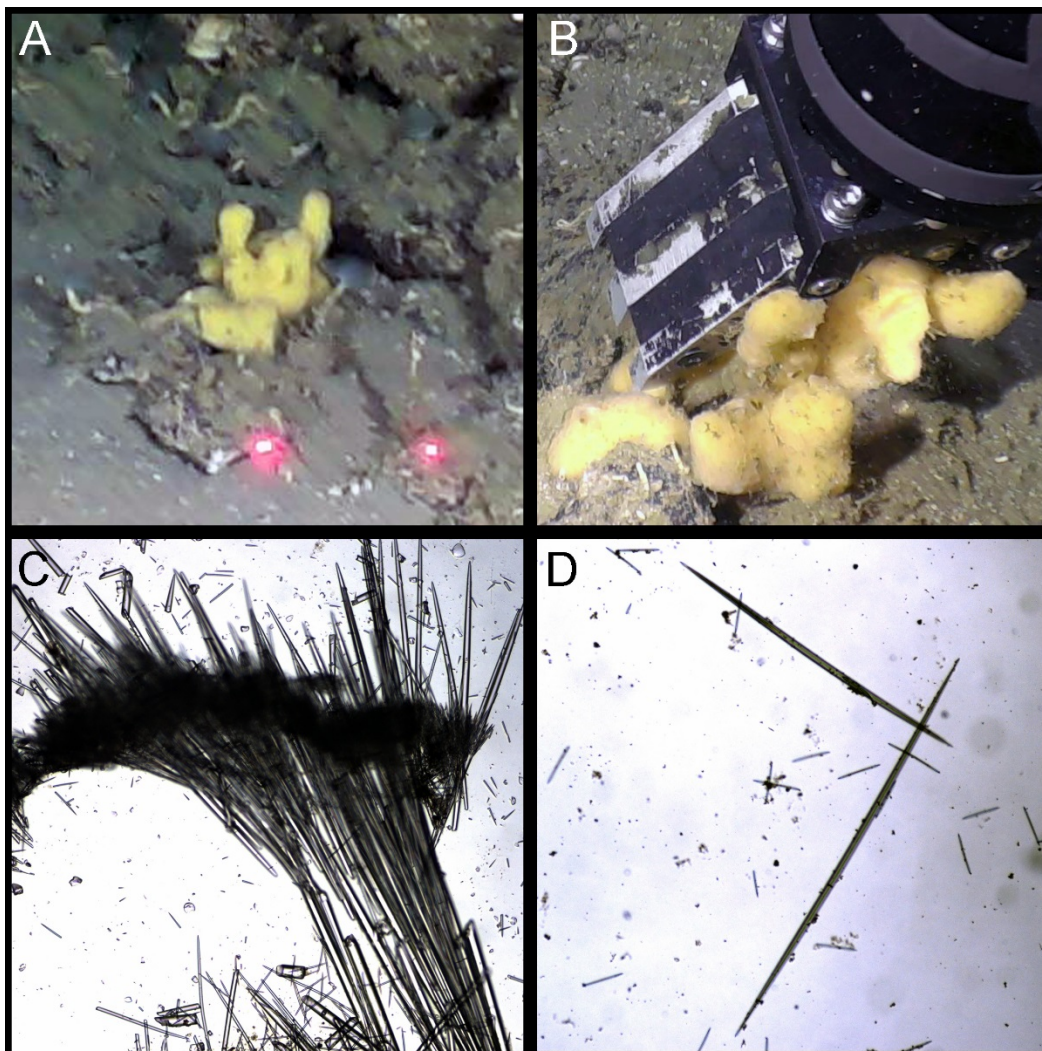


Figure. 3. A) Live specimen, lasers 10 cm; B) close-up; C) sub-radial spicule arrangement, and palisade; D) large and small oxea.

Sample 12-VI-19-2-001. Massive-lobate, lobes 4-6 cm high and 3-4 cm wide. Light yellow internally and externally. Microscopically hispid, macroscopically round shallow apertures on the side of some lobes (3-5 mm wide). Consistency compressible-hard. Round oscules with membranes, on top of lobes (5-10 mm wide). The skeleton is formed by oxea in two size classes: I: (400-1400 x 5-20 μ m), II: (150-170 x 5 μ m). Large oxea are sub-radially arranged in the choanosome, piercing through the surface, and small oxea form a dense palisade-like ectosome. *E. profunda* Díaz et al., 1993, and *E. tubulata* are found in deep waters of the Tropical Western Atlantic. The present specimen is similar in shape and spicules to *E. profunda* but lacks trichodragmata and its spicules are smaller, therefore we refer to this species as (cf.) to denote its similarity but keep it as probably a different species. Reference: (Díaz et al. 1993).

***Cliona cf. tumula* Friday et al., 2016**
Class Demospongiae, O. Clionaida, F. Clionaidae

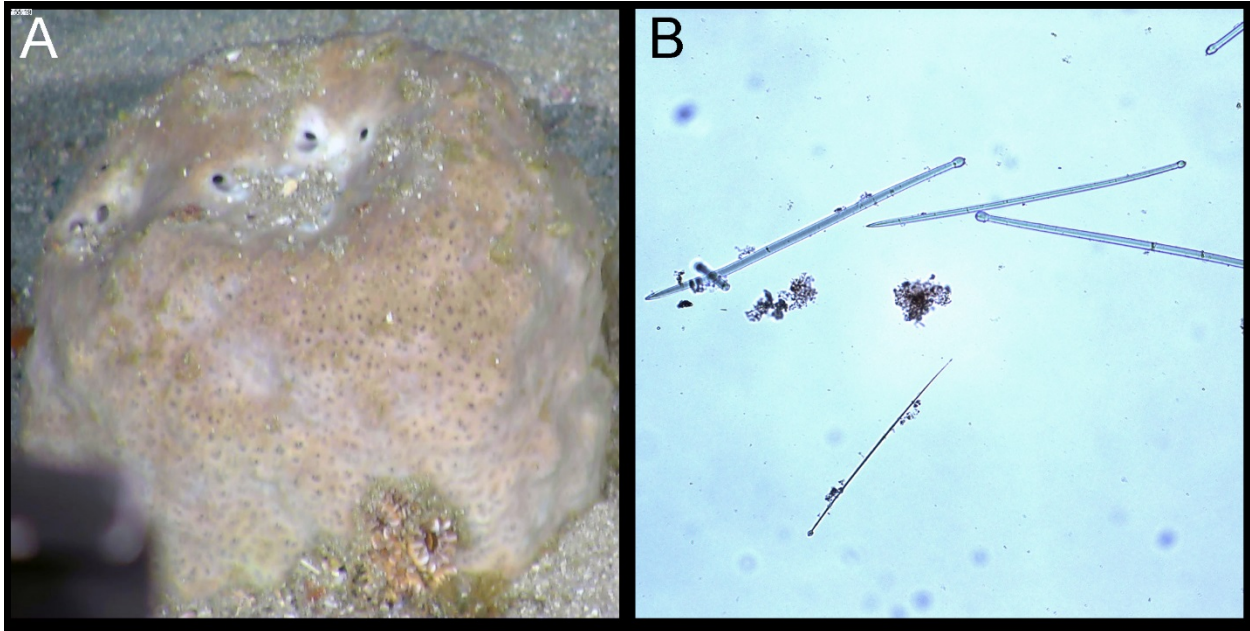


Figure 4. A) Live specimen; B) tylostyles.

Samples: 13-V-18-2-002, and 14-VI-19-1-002. Massive to thick crusts. Live gray reddish to brownish externally, tan internally. Surface smooth, rough to touch, and with very shallow and flat papillae that consist of a clump of 3-5 holes that are 0.5-1 mm each. Megascleres are tylostyles- (200-500 x 10-15 um) with swollen heads (20-25 um), and microscleres very thin sinuous microrhabds to spinorhabds, bent once or twice, some slightly spirally bent (20-25 x 1 um). Lots of sand and foreign material grains inside the body. The sponge is similar to a species recently described from shallow reefs on the Florida Keys and with sand conglomeration. However, the papillae morphology, and the extremely thin microscleres are different from *C. tumula* description. Scanning electron microscopy of microscleres, and comparison with the holotype of *C. tumula* would allow to discern if this is an undescribed species of *Cliona*. Reference: (Rützler 2002; Friday et al. 2013).

***Aptos* sp. 1**
Class Demospongiae, O. Suberitida, F. Suberitidae

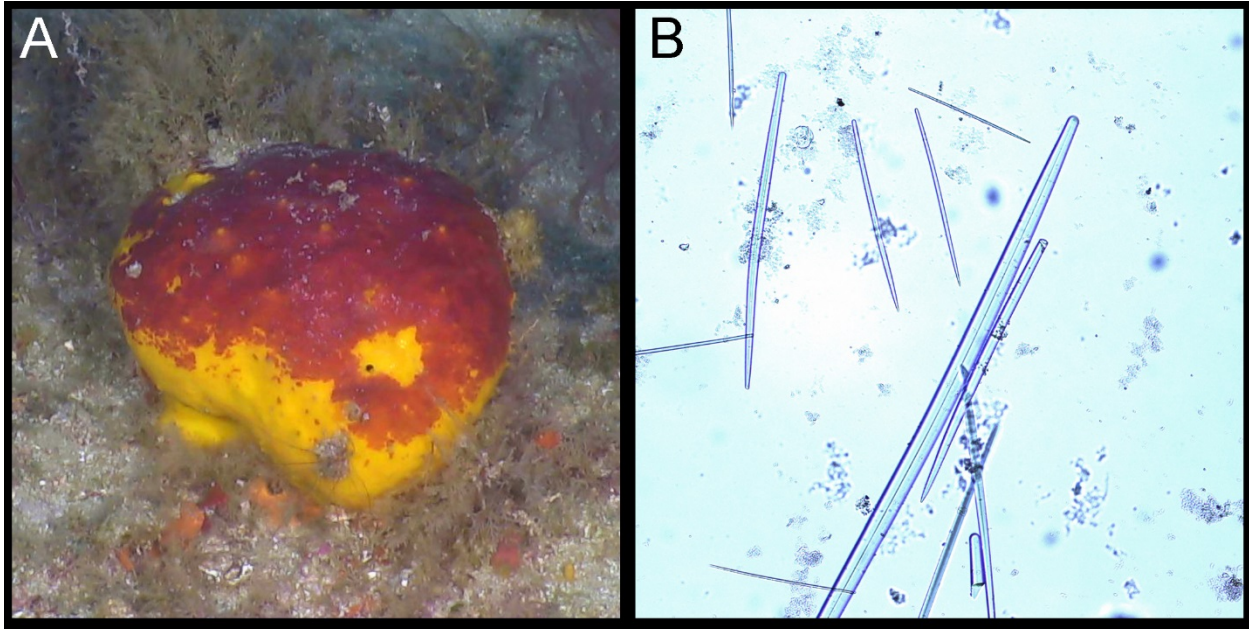


Figure 5. A) Live specimen; B) styloids.

Samples 14-VI-19-3-1 and 16-VI-19-2-1. Massive, subspherical (10 cm in diameter). Yellow-orange to red brownish externally, and orange internally. Smooth surface visually, rough to the touch. Consistency dense and hard. Oscules barely visible in live photo; there are whitish, few contracted oscules 1-2 mm wide, spread on the upper side of the specimen. Skeleton formed by I. *strongyloxea* (styloids) (1075-1375 x 25-50 μ m), with smooth tips, and II. smaller styles (200-500 x 5-20 μ m). Oxea (300-350 x 10-15 μ m) with slightly hastate tips are found in low frequency. Skeleton is organized as a dense sub-radial arrangement of spicules towards the surface and strewn spicules, in less density towards the body's interior. This species is different either in habit and/or spicule dimensions with the three Caribbean species of *Aptos* currently recognized (*A. bergmani*, *A. duchassaingi*, and *A. pernucleata*), and with the bright yellow *Aptos* sp. CU-01 from Cuba (Díaz et al. 2019). There is one described species in the Western Atlantic with similar habit, *Aptos hajdui* Carvalho et al., 2013. This species occurs between 50-101 m deep and is considered endemic of the Portuguese basin in Rio Grande Do Norte State, Brazil. *A. hajdui* is subspherical, has a smooth surface, small rare oscula, and orange live color. However, *A. hajdui* has much thinner spicules, lacks oxeas, and the tips of its *strongyloxeas* are mucronate. *Aptos* sp.1 has closer spicules to *Aptos pernucleata* (sensu Wiedenmayer, 1977), and similar habit to *A. hajdui*. A closer comparison with the type of *A. hajdui*, particularly of the size ranges in a much larger number of spicules (see Carvalho et al., 2013) would probably allow to establish the potential conspecificity with this geographically distant species. References: (Wiedenmayer 1977; Carvalho et al. 2013; Díaz et al. 2019).

Neofibularia nolitangere (Duchassaing & Michelotti, 1864)

Class Demospongiae, O. Biemnida, F. Biemnidae

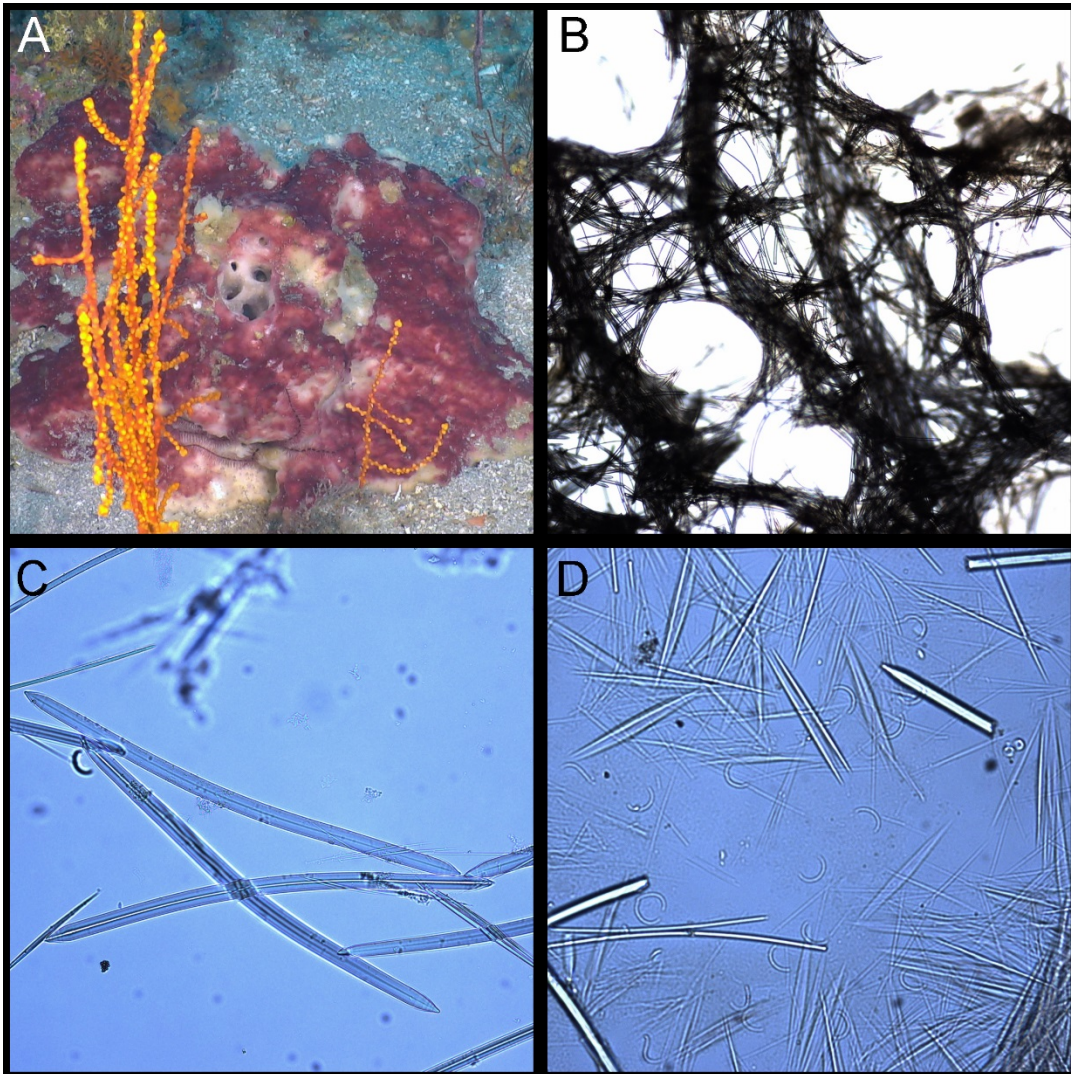


Figure 8. A) Live specimen; B) anisotropic spicule reticle bound by spongin; C) oxeas; D) raphids in trichodragmata, and sigmas.

Sample 14-VI-19-4-001. Massive, thick encrusting, rugose, with irregular surface. Color red-wine and tan externally, and tan internally. Consistency: crumbly. One apical oscule, 2-3 cm wide. Skeletal elements are oxea hastate (300-380 x 8-12 μ m) as megascleres, and microscleres of two types: raphids (100 μ m long, < 1 μ m in thickness, arranged in trichodragmata, especially on the ectosome) and sigmas (20-30 x 1-2.5 μ m) dispersed on the body. Spicule reticulation bound by varying quantities of spongin (often strongly developed) with spicule tracts 50-100 μ m thick. Reference: (Van Soest 1984).

***Cliona* aff. *celata* Grant, 1826**

Class Demospongiae, O. Clionaida, Clionaiidae

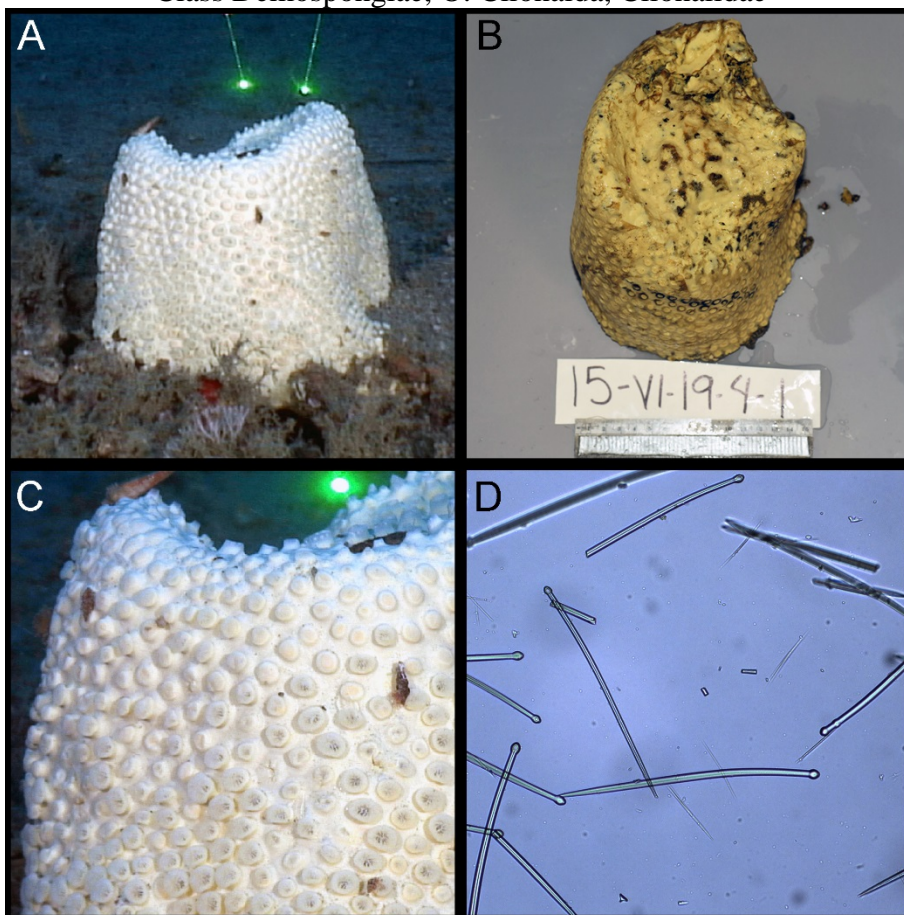


Figure 9. A) Live specimen, lasers 10 cm; B) lab photo; C) closeup of live specimen; D) stylostyles, and very thin toxa.

Sample 15-VI-19-4-1. Massive, stump like, irregularly flattened on the top. 15 cm wide and high. Subspherical forms can be found. Dirty white to tan color in and out. Unique “bubble-wrap” appearance, with a surface consisting on round bumps (4-12 mm high, 7-16 mm in diameter, 2-16 mm apart in life) that have a small central round opening (2-3 mm wide) on top. In life the bumps look more like small balloons. Oscules (at least 1 cm wide) with thick collared membranes, are distinguished on the specimen’s top. Skeleton formed by tylostyles arranged in loose tracts (100-200 μ m wide) that run loosely towards the surface, and at the surface a para-tangential conglomeration of megascleres is formed. Spicules are tylostyles (280-420 x 10-12.5 μ m) and toxa (70-90 x <1 μ m); the later may form aggregations in packets (raphids). This species has been found in other MPA areas such as Gray’s Reef and in South Carolina. The species is assigned to genus *Cliona*, by its overall skeletal arrangement of tylostyles, and its external morphology. Several species of *Cliona* lack spirasters and possess toxa. This morphospecies has been referred as *Cliona celata*; however, some populations of the worldwide distributed *C. celata* have been found to represent different species after genetic analyses. This particular morphospecies is here referred as *Cliona* aff. *celata*, until further comparative studies are done. References: (Rützler 2002; Xavier et al. 2010; de Paula et al. 2012).

***Clathria (C.) sp.1* Topsent, 1889**
Class Demospongiae, O. Poecilosclerida, F. Clathriidae

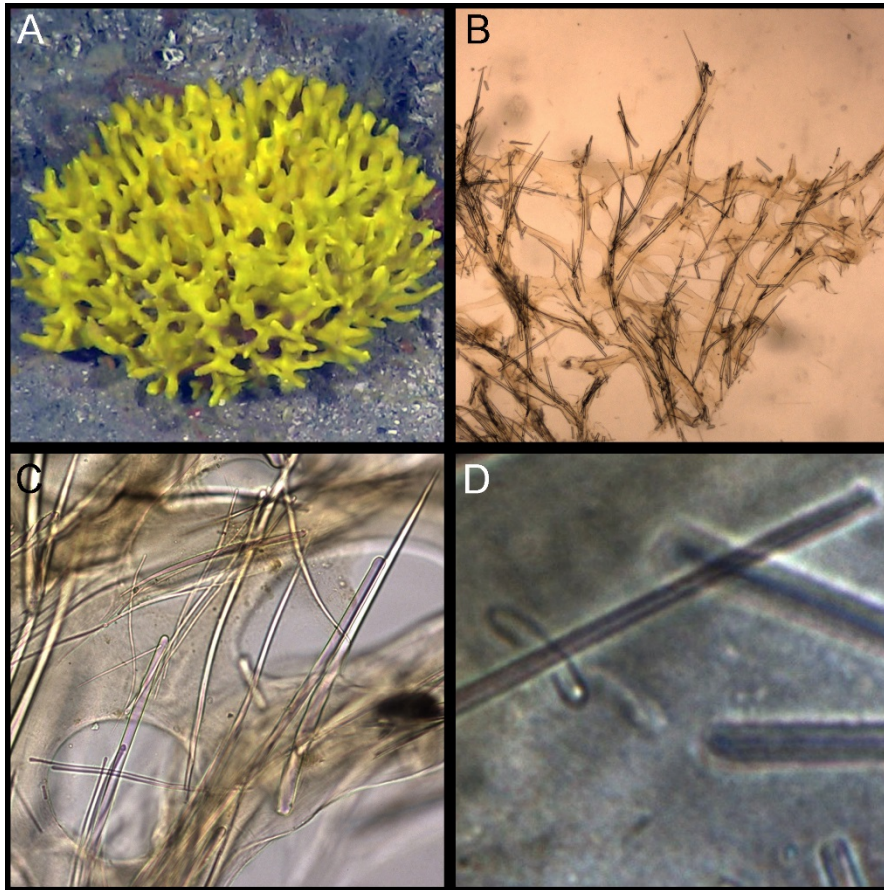


Figure 10. A) Live specimen; B) cross section of plumose fiber reticle cored by spicules; C) long thin tylostyles, and subtylostyles; D) isochela.

Sample 15-VI-19-1-001. Small bush (7 cm wide, 8 cm high), with flattened or cylindrical branches (2-10 mm wide), that end in a dichotomy. Bright yellow live, tan in alcohol. Microhispid surface, and stiff consistency. Oscules not visible. Skeleton present as a spongin plumo-reticulation with coring and plumose styles to subtylostyles, and many thin sinuose tylostyles embedded on the reticle together with toxas, and few isochelas. Echinating acanthostyles, subtylostyles to styles in wide size range (250-800 x 3-8 μ m), thick styles with microspined heads (250-300 x 8 μ m), long very thin tylostyles bent (350-400 x 1-2 μ m), acanthostyles I (25-30 x 2-3 μ m), and II (100-200 x 3-8 μ m), and sharply bent toxa (300 x 3-5 μ m). The overall habit of this specimen resembles one of the live morphologies of *C. carteri* shown by (Gomez 2014). However, its color, the shape of the toxa and the isochela, and the large amount of sinuose thin tylostyles make this morphospecies unique among Tropical Western Atlantic *Clathria* species. It probably represents an undescribed species of *Clathria*. Dr. Patricia Gomez agreed with this opinion when consulted (Feb. 2020). A close comparison with the type and SEM study of the spicules would allow to solve this issue. Reference: (Gomez 2014).

***Clathria (C.) foliacea* Topsent, 1889**
Class Demospongiae, O. Poecilosclerida, F. Microcionidae

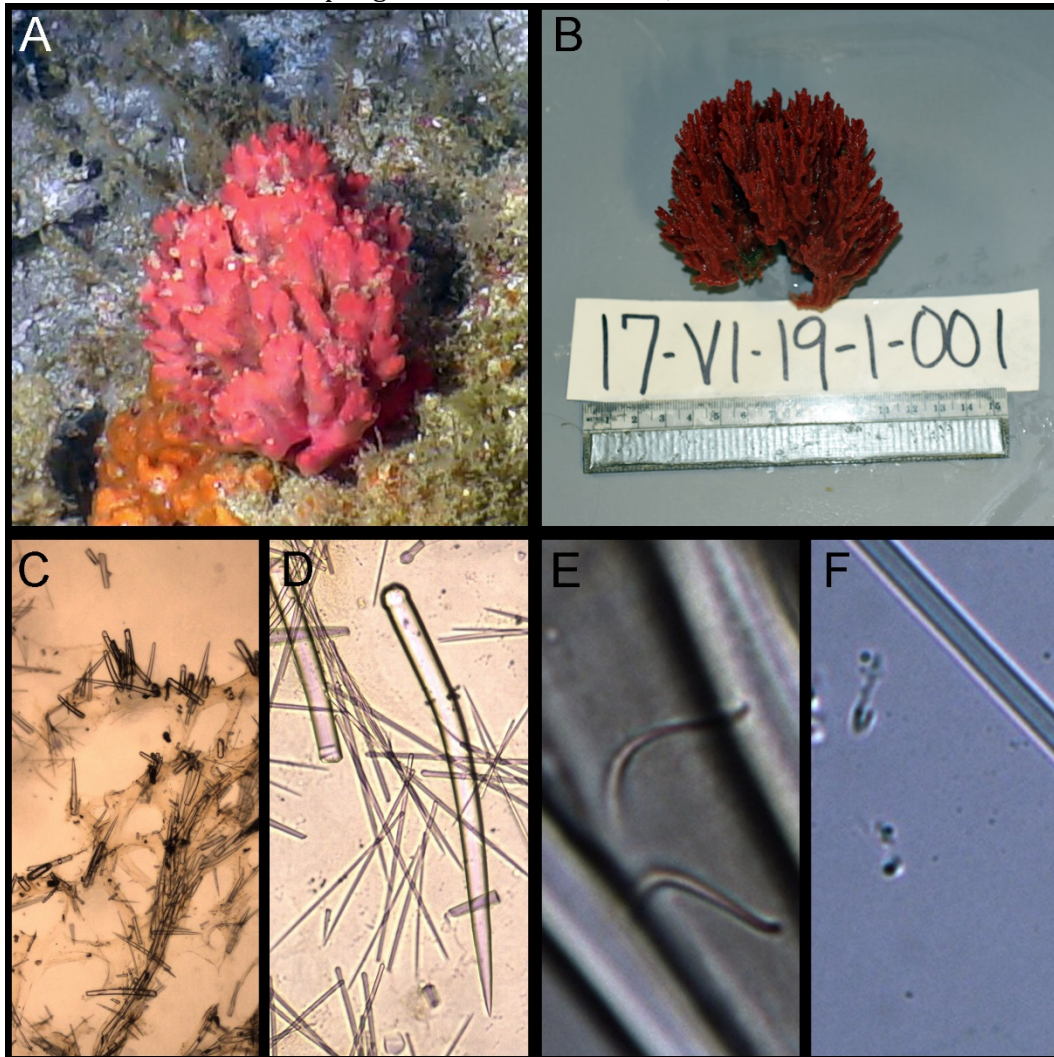


Figure 11. A) Live specimen; B) lab photo; C) plumose reticle; D) large smooth, and thinner subtylostyles to styles; E) horned toxa; F) thin subtylostyles with twisted isochela.

Sample 17-VI-19-1-001. Massive (10 cm wide, 9 cm high), with barely protruding lobes (1-2 cm wide). Surface visually smooth, microscopically hispid. Dull red in and out live, bright red on deck. Oscules on top of some lobes 5-10 mm wide, they seem to have an extended membrane the same color than the surface. Bushy, generally with flabellate and ridged branches when taken out of the water. Stout styles to subtylostyles, microspined on the head, and few spines along shaft (300-440 x 10-20 μm). Subtylostyles smooth (280-300 x 5 μm). Isochela with one twisted chela (10-12 x <1 μm). Horned shaped toxa (<100 μm long, 1 μm wide), with ends pointing up. The species fits the description of *Clathria (C.) foliacea* (sensu Gomez 2014). Reference: (Gomez 2014).

Acknowledgements

In 2009, the South Atlantic Fishery Management Council (SAFMC) established eight deepwater Marine Protected Areas (MPAs) along the outer continental shelf off the southeastern U.S. in addition to the *Oculina* Habitat Area of Particular Concern (OHPAC) in 1984. As a result, NOAA National Marine Fisheries (NMF) was tasked with documenting and characterizing the benthic habitats, benthic biota, and fish populations within and adjacent to the protected areas within the jurisdiction of the SAFMC. This work is part of a 9-year collaboration with the Cooperative Institute for Ocean Exploration, Research, and Technology (CIOERT) at Harbor Branch Oceanographic Institute, Florida Atlantic University (HBOI-FAU), University of North Carolina at Wilmington (UNCW), and College of Charleston. In 2018, collection equipment added to the UNCW *Mohawk* ROV enabled collections of benthic organisms for the first time. This paper is a result of the taxonomic analyses of the sponges collected on the NOAA Ship *Pisces* expeditions in 2018 and 2019.

We gratefully acknowledge funding for research support and ROV operations by the NOAA Coral Reef Conservation Program (CRCP) and the South Atlantic Fishery Management Council (CRCP Fishery Management Council Coral Reef Conservation Cooperative Agreements- Grant #: FNA17NMF4410271). We also acknowledge the NOAA Office of Ocean Exploration and Research (OER Grant #: NA14OAR4320260), and the NOAA Office of Marine and Aviation Operations (OMAO) which provided support for ship time.

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