ARPHA Preprints

PENSOFT

PREPRINT

Author-formatted, not peer-reviewed document posted on 06/09/2022

DOI: https://doi.org/10.3897/arphapreprints.e94515

An annotated and illustrated identification guide to common mesophotic reef sponges (Porifera, Demospongiae, Hexactinellida, and Homoscleromorpha) inhabiting Flower Garden Banks national marine sanctuary and vicinities

María Christina Díaz, Marissa Nuttall, Shirley Pomponi, Klaus Rützler, Christi Adams, Emma Hickerson, George Schmahl, Sarah Ward Klontz

ARPHA Preprints *Author-formatted, not peer-reviewed document posted on 06/09/2022* DOI: https://doi.org/10.3897/arphapreprints.e94515

An annotated and illustrated identification guide to common mesophotic reef sponges (Porifera, Demospongiae, Hexactinellida, and Homoscleromorpha) inhabiting Flower Garden Banks National Marine Sanctuary and vicinities

Maria Cristina Díaz*[1], Marissa Nuttall[2,3], Shirley A. Pomponi[1], Klaus Rützler[4], Sarah Klontz[5], Christi Adams[6], Emma L. Hickerson[2] and G.P. Schmahl[2]

1. Harbor Branch Oceanographic Institute, Florida Atlantic University, Fort Pierce, FL, U.S.A

2. Flower Garden Banks National Marine Sanctuary, Galveston, TX, U.S.A

3. CPC Inc, Galveston, TX, U.S.A

4. National Museum of Natural History, Smithsonian Institution, Washington D.C., U.S.A

5. Genetic Disease Research Branch, NHGRI, NIH, Bethesda, MD, U.S.A

6. christisavarese@gmail.com

* Corresponding Author

Abstract

Sponges are recognized as a diverse and abundant component of mesophotic and deep-sea ecosystems worldwide. In Flower Garden Banks National Marine Sanctuary region within the northwestern Gulf of Mexico, sponges thrive among diverse biological and geological habitats between 16-200+ m deep (i.e., coral reefs and communities, algal nodule and coralline algae reefs, mesophotic reefs, patch reefs, scarps, ridges, soft substrate, and rocky outcrops). We present a synoptic guide developed by studying common sponge species in the region, through direct sampling and *in situ* photographic records. A total of 63 species are included: 60 are Demospongiae (14 orders), 2 are Hexactinellida (1 order), 2 are Homoscleromorpha (1 order). Thirty-nine taxa are identified to species and 11 were identified to have affinity with, but are not identical to, a known species. Thirteen taxa could only be identified to genus level at this time, and the species remain as uncertain (*incerta sedis*), with the potential to constitute new species or variants of known species. One specimen received only a family assignation. This study extends geographic or mesophotic occurrence data for 11 known species and includes several potentially new species. This work improves our knowledge of Gulf of Mexico sponge biodiversity and highlights the importance of the region for scientists and resource managers.

Keywords. Biodiversity, Porifera, sponges, mesophotic reefs, algal reefs, Gulf of Mexico

Introduction

Flower Garden Banks National Marine Sanctuary consists of portions of 17 topographic features in the northwestern Gulf of Mexico. The reefs and banks occur along the continental shelf, from 70-120 miles off the coast of Texas and Louisiana (Fig. 1), range in depth from 16 – 220 m, and harbor coral reefs, coral communities, coralline algae reefs, rhodolith beds, and deep mesophotic communities. Extensive remotely operated vehicle explorations within the region have been conducted over the past 30 years by National Oceanic and Atmospheric Administration's (NOAA's) Flower Garden Banks National Marine Sanctuary (FGBNMS) and partners, including NOAA's Deep-Sea Coral Research and Technology Program (ONMS 2016). Over 50,000 geo-referenced images, 900 hours of video, and 38 annotation logs have been collected during those expeditions, and multiple databases have been produced. This prior work discovered that the region consists of a series of unique and interconnected habitats of banks, coral reefs, patch reefs, scarps, and ridges, featuring algal dominated areas, soft substrate features, mesophotic and deep coral communities and rocky outcrops (Schmahl et al., 2008). A comprehensive review of the biology and ecology of coral reefs, coral communities,

and mesophotic habitats in this region, including the area within the sanctuary boundaries, have documented four major reef-related habitats: i) a “coral reef zone” from approximately 0-70 m that includes the actively accreting hermatypic coral assemblages and a shallow mesophotic coral community, ii) a “coral community zone” that occurs primarily in depths less than 50 m where hermatypic coral species are present at low densities but are not dominant, iii) a “coralline algae” or mid-mesophotic zone occurring in depths 60 – 120 m and characterized by rocky outcrops with a predominance of crustose coralline algal and rhodolith (algal nodule) beds, and iv) a lower mesophotic reef occurring between 90 – 200 meters, characterized by antipatharian and alcyonarian corals, crinoids, bryozoans, sponges, azooxanthellate branching corals, and small, solitary hard corals (Schmahl et al., 2008; Semmler et al., 2017; Nuttall et al. 2022). These complex underwater features provide feeding areas, spawning sites and habitat for critical life history stages for a variety of reef organisms (Schmahl et al., 2008).

Sponges are recognized as a diverse and abundant component of mesophotic and deep-sea ecosystems (Pomponi et al., 2019, Slattery et al., 2017; Schmahl and Hickerson, 2012), and in 2017 the development of field guides was identified as a priority need in NOAA’s Science Plan for the Southeast Deep Coral Initiative (Wagner et al. 2017). In 2012, Hickerson et al. created a quick reference photo guide for 37 species that had been documented during exploratory dives between 50-110 m deep within the northwestern Gulf of Mexico. These species were studied and identified by co-authors Rützler Klontz, and Adams (Klontz et al., unpublished data). More surveys have been conducted since 2012, resulting in additional sponge specimens and imagery that required further investigation. These expeditions investigated areas that were under consideration for sanctaury expansion and officially became part of the sanctuary in 2021 (15 CFR Part 922 – Subpart L, 2021). Forty-two morphospecies of emergent sponges from the Classes Demospongiae and Hexactinellida and an unaccounted number of thin encrusting species were documented during an expedition in 2019. This study expanded the recognized sponge biodiversity of Flower Garden Banks National Marine Sanctuary region by 17 species (https://flowergarden.noaa.gov/about/spongelist.html) and includes at least six species potentially new to science: *Pleraplysilla* sp. 2, *Geodia* sp.1, *Cinachyrella* sp. 1, *Auletta* sp.1, *Petrosia* sp.1, and *Xestospongia* sp.1 (Diaz and Pomponi, unpublished data; Diaz et al., in prep).

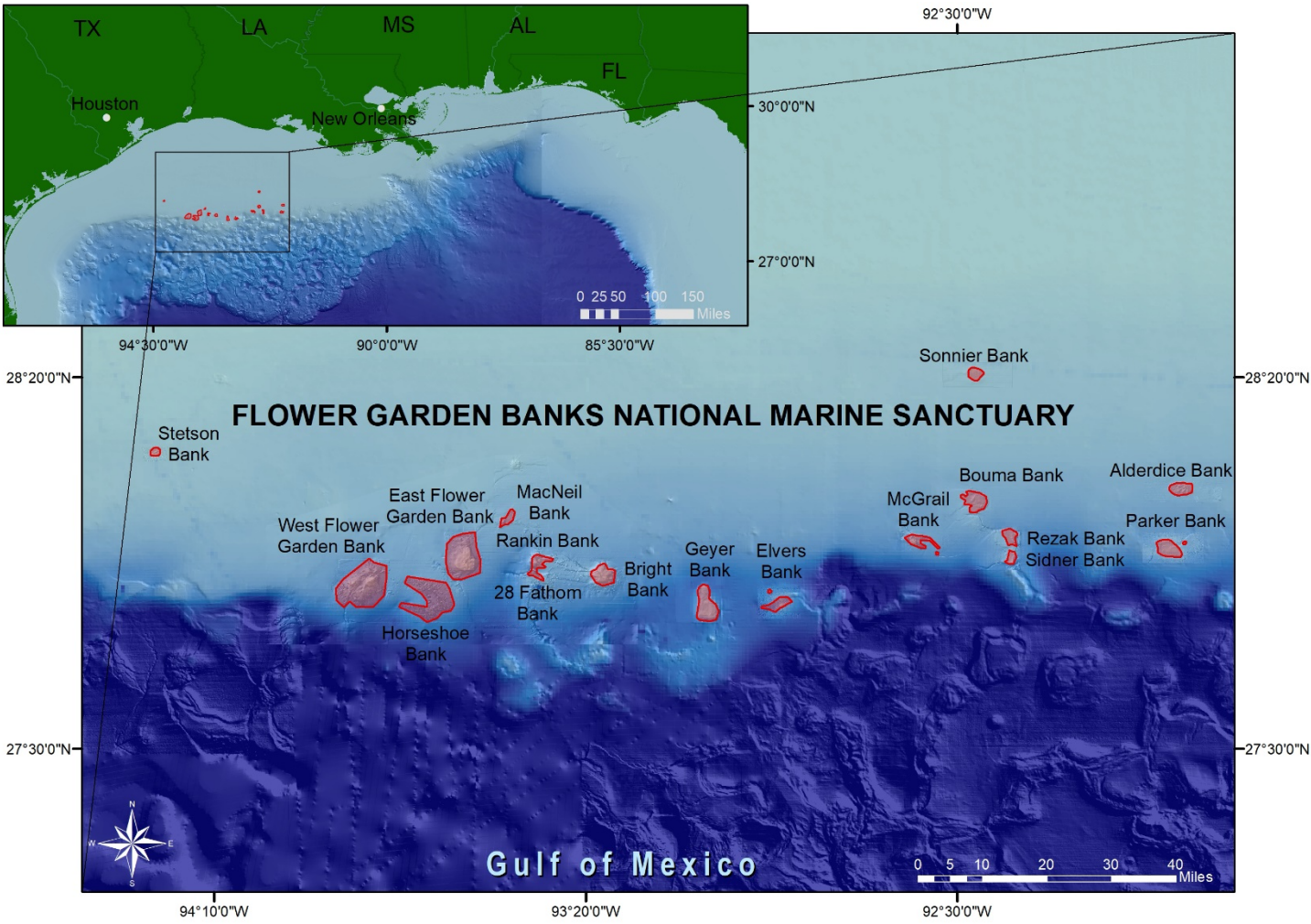


Figure 1. Map of Flower Garden Banks National Marine Sanctuary. Red polygons denote the boundaries of the sanctuary.

The major goal of this study was to update our current knowledge of Porifera biodiversity from mesophotic depths at the sanctuary region and to promote this knowledge among major stakeholders. We have developed a synoptic identification guide that can be used by a wide range of end-users (i.e., marine scientists and students, conservationists, environmental managers, naturalists, recreational divers, etc.). This identification guide summarizes the current taxonomic status and distinct features for 62 species distinguished of the common sponge species encountered in the region. This work will improve our knowledge of sponge biodiversity in the Gulf of Mexico and enhance studies of sponges from mesophotic and deep-water ecosystems in the region. Furthermore, this first illustrated guide to species at mesophotic depths in the northwestern Gulf of Mexico will facilitate the comparisons with recently studied mesophotic sponge fauna from other deep mesophotic habitats occurring at Pulley Ridge (southeast Gulf of Mexico, Diaz et al., unpublished), Cuba (Reed et al., 2018; Diaz et al., 2019) and southeast USA Deep Ecosystems in Marine Protected Areas (Diaz et al., 2021; Reed et al., 2021). The potential discovery of new species and its importance will be discussed herein.

Methods

Area of study

This study focused on topographic features in the northwestern Gulf of Mexico in and around Flower Garden Banks National Marine Sanctuary located on the continental shelf edge in the northwestern Gulf of Mexico in the USA (Fig. 1). Samples presented in this study were collected both within and adjacent to the sanctuary boundaries and occurred within one of the six habitats (coral reefs, coral communities, algal nodules, coralline algae reefs, lower mesophotic reefs, and soft substrates) described by Schmahl et al. (2008) and Semmler et al. (2017). The waters in the region are typically oligotrophic, warm tropical water that is transported from the Caribbean into the eastern Gulf of Mexico via the Loop Current and travels to the western Gulf through the action of spin-off eddies (see Fig. 6.6. Schmahl et al., 2008). The offshore location (60-130 miles off the continental coast) of these habitats typically separates them from turbid, brackish, coastal waters and the influence of coastal runoff and nearshore eutrophication. However, sporadic coastal water intrusion events have been documented in the region (Kealoha et al., 2020).

Collection methods and data

Collections were made using one of three remotely operated vehicles (ROV), including Phantom S2, owned and operated by University of North Carolina at Wilmington (UNCW) Undersea Vehicle Program, MOHAWK, owned by the National Marine Sanctuary Foundation and operated by UNCW Undersea Vehicle Program, and YOGI, owned and operated by the Global Foundation for Ocean Exploration. Specimens were photographed *in situ* using a variety of digital still cameras with scale lasers in the field of view set at 10 cm (Fig. 2). Sponges were collected using a manipulator on the ROV and either brought directly to the surface in the manipulator or placed in a sample box mounted on the ROV. Once on the surface, sponges were photographed in the lab using a digital still camera prior to preservation. Sample metadata, including location (latitude and longitude), depth, and habitat were recorded into a Microsoft Excel database archived at Flower Garden Banks National Marine Sanctuary offices in Galveston, TX. Specimens were either preserved in 95% ethanol, and occasionally in 10% formalin in sea water for histological evaluation when specimens were potential new species. Samples were stored at the Flower Garden Banks National Marine Sanctuary offices in Galveston, TX, with the exception of samples collected in 2019, which are archived at Florida Atlantic University - Harbor Branch Oceanographic Institute, Marine Biotechnology Reference Collection (http://hboi-marine-biomedical-and-biotechnology-reference-collection.fau.edu/app/data-portal). Supplementary Table 1 lists all species included in this guide, location of observations, and their abundance at each site.

Figure 2. Sample collection DFH33-542A using a manipulator mounted on an ROV. Green scale lasers, 10 cm apart, can be seen in the field of view, were used to estimate the size of the specimen.

Species data and morphological characterization

Each species within this guide is represented by an *in-situ* image, the lowest available scientific name, species author/date, higher taxonomy, depth, and sample number (indicated in the figure legend). The species data are divided in five sections: “Diagnostic features” describes distinctive morphologic features; “Distribution and abundance” refers to overall regional distribution from the World Porifera Database and other recent references (Pomponi et al., 2019) indicating countries and or regions where the species occur as well as the

number of sites within the sanctuary (i.e. East Flower Garden Bank, Geyer Bank, etc.) in which the species was observed and a qualitative range of abundances (supplementary Table 1),; "Ecology" indicates the habitat(s) where each species occurs, and the morphologically similar species with which it might be confused;" ID" indicates the individual(s) who identified the sample by their initials, and "References" provides literature where the reader can get a more detailed description including other characters such as spicules, skeletal architecture, or genetic information.

Fifty-two of the sixty-four species included on this study were identified by the analysis of one or more sample(s). Therefore, the majority (~ 84%) of the identifications were confirmed by evaluation of skeletal morphology (skeleton type, size, and architecture) as well as features of the external morphology. Skeleton analysis was carried out using methods described in Diaz and Pomponi (2018), but using a rapid tissue digestion in bleach instead of nitric acid. The taxonomic assignation for each morphotype reflects the most current classification of the World Porifera Database (De Voogd et al., 2022). The occurrence and qualitative estimate of abundance in the region is summarized in Supplementary Table 1. The occurrence at each site is characterized according to the approximate number of specimens observed as: Single (S) if only one specimen was observed, Few (F) 2-10 specimens, Many (M) 10-100 specimens, and Abundant (A) more than 100 specimens.

We use the same criteria to describe the external morphology as in the recent guide to sponges from deep marine protected areas from the southeastern USA (Diaz et al., 2021). Each morphospecies is characterized by its external appearance (shape, surface features, color patterns, oscula). Sponge shapes are described according to their 3-dimensional growth as encrusting (thin or thick but following the contour of the substrate) or massive (the sponge develops away from the substrate). The shape may represent a particular geometry (tubular, cylindrical, globular or sub-globular, cup or fan) or a particular pattern (bushy, arborescent, amorphous). "Surface" refers to details of the outer appearance; it may be smooth, convoluted, rugose, velvet, porous, or have projections that might be cone shaped (conulose), hairy (hispid), or with digitated hollow blind projections (fistulose). The smaller, incurrent water apertures (ostia) may be aggregated in papillae, clumps, or porocalices. The larger excurrent water apertures usually represent oscules or pseudo-oscules and are described by morphology (shape, presence of a membrane or collar, etc.), abundance (sparse, common, or abundant), location (apical, regularly distributed, in clumps, on a sieve plate), size (diameter, measured when they are visible), and the presence and nature of a membrane (flush, elevated, collar, transparent, colored). The sponge consistency, ranging from soft, compressible, cartilaginous, crumbly, or hard, is also a useful feature to characterize sponge species. These are useful details to characterize and distinguish the majority of sponge species. Definition of these descriptive terms for sponge external morphology can be found in the Sponge Thesaurus (Boury-Esnault and Rützler 1997).

Results

Taxonomic scope

Sixty-three species were identified from a collection of 54 samples with photographs and 10 photographs (without samples) from inside and around Flower Garden Banks National Marine Sanctuary (Supplementary Table 1), and they are synoptically described below (Figs 3-64). Two species belong to the class Hexactinellida (O. Hexasterophora). Two species, *Plakortis cf. simplex* and *Plakina versatilis* (not represented in the present guide but studied by Klontz et al., unpublished) represent the class Homoscleromorpha (Order Homosclerophorida), and 61 species represent the class Demospongiae (14 orders). The most diverse orders in terms of family diversity and species richness are: Tetractinellida (11 spp. within 5 families), Dictyoceratida (9 spp. within 4 families), Haplosclerida (10 spp within 5 families), Axinellida (5 species within 4 families), and Bubarida (5 species within one family). The most species-rich genus with several undescribed species is *Ircinia* with five species distinguished. Forty-eight species are identified either to species level or with a probable intraspecific variation of a known species (10 spp as cf.). Thirteen species were given

only a generic assignation; many of those probably represent undescribed species or require deeper taxonomic studies, such as museum type comparisons or molecular evaluation to confirm a species identification. One morphotype could only be identified to the family level: a skeletal-less member of the family Ianthellidae that thinly encrusted a portion of a Hexactinellida. If this taxonomic identification is correct, it would constitute the first association of this type ever reported.

Geographic scope

Eleven species included in this study are either first reports for the occurrence of that species at mesophotic depths, or first occurrences in the Gulf of Mexico or specifically in the northwestern Gulf of Mexico. *Biemna cribaria*, *Placospherastra antillensis, Batzella rubra, and Erylus trisphaerus* are here reported at mesophotic depths (>50 m deep) for the first time. First reports in the Gulf of Mexico include *Stellettinopsis megastylifera, Erylus alleni, and E. goffrilleri.* First reports in the northwestern area of the Gulf of Mexico include *Agelas dilatata*, *Neophrissospongia cf. nolitangere*, *Erylus trisphaerus*, and *Ircinia campana.*

The occurrence and qualitative abundance estimate for most of the species in this study, along 17 banks or features in Flower Garden Banks National Marine Sanctuary and vicinity are summarized in the Supplementary Table 1.

Species Checklist Terms

aff. – affinis; the species might appear similar but is not that species. Implies a higher degree of uncertainty compared to cf. (Sigovini et al., 2016)

cf. – confer; to be compared with. Indicates that most of the diagnostic characters correspond to a given species, but some characters are unclear. The identification is provisional but is likely to be definitive after comparing with reference material or consulting a specialist of the taxon (Sigovini et al., 2016)

FGBNMS – Flower Garden Banks National Marine Sanctuary

GOM – Gulf of Mexico

n. sp. - new species to science. Specimen has unique characters that can support the distinct and unique identity of a specific species.

spp. – species in plural. Usually refers to multiple species from a particular genus.

ARPHA Preprints *Author-formatted, not peer-reviewed document posted on 06/09/2022* DOI: https://doi.org/10.3897/arphapreprints.e94515

Phylum Porifera, Class Demospongiae, Subclass Heteroscleromorpha

O. Agelasida, F. Agelasidae

Agelas* cf. *citrina (Gotera & Alcolado, 1987)

Figure 3. *Agelas* cf. *citrina,* 50 m deep. Sample DFH9-7E.

Diagnostic features- Massive amorphous to thick crust (up to 3 cm thick), bright orange to reddish externally. The surface is convoluted with irregular folds and depressions. Oscules round, sparse, 2-5 mm wide.
Distribution and Abundance- *A. citrina* occurs on shallow coral reefs Caribbean wide and the Florida Keys. Mesophotic reefs at FGBNMS, Cuba (50-61 m deep), and South Carolina MPA (52 m). At FGBNMS, rare to moderate abundance and a widespread distribution occurring at 11 sites.
Ecology- lower mesophotic reefs and heavily silted reefs in FGBNMS region. A strong garlic-like particular odor is associated with all regional variants. This morphotype is referred to as cf. since it does not have the typical flabellate shape and orangish color. Similar species: *A. clathrodes* has key-holed and round oscules. *A. cerebriformis* has convoluted surface but it is brown and tubular.
Id. by KR, SK, CA, MCD
Reference(s)- Diaz et al., 2019, 2021; Parra-Velandia, 2014; Zea et al., 2014

Agelas clathrodes (Schmidt, 1870)

Figure 4. *Agelas clathrodes.* Photo: YG1901L3_IMG_20190831T212309Z.

Diagnostic features- Massive, flabellate, orange reddish in color. The surface is rugose, irregularly riddled by round (1-10 mm wide) and key-holed (1-4 cm long) oscula.
Distribution and Abundance- Common in shallow and mesophotic reefs in North and South Carolina, Eastern Florida, throughout the Caribbean, the Guyana shelf, and Brazil. At FGBNMS abundant and widespread distribution. It presented a medium abundance (10-100) at the Geyer Bank (up to 60 m deep).
Ecology- coral reefs, coral communities and coralline algae reefs in FGBNMS region. Similar species**:** *Agelas citrina* flabellate specimens are similar, but lack key holed oscules and usually have a lighter pinkish or yellowish color.
Id- MCD, MN
Reference(s)- Diaz et al., 2019; Parra-Velandia et al., 2014.

ARPHA Preprints Author-formatted, not peer-reviewed document posted on 06/09/2022 DOI: https://doi.org/10.3897/arphapreprints.e94515

Agelas dilatata (Duchassaing & Michelotti, 1864)

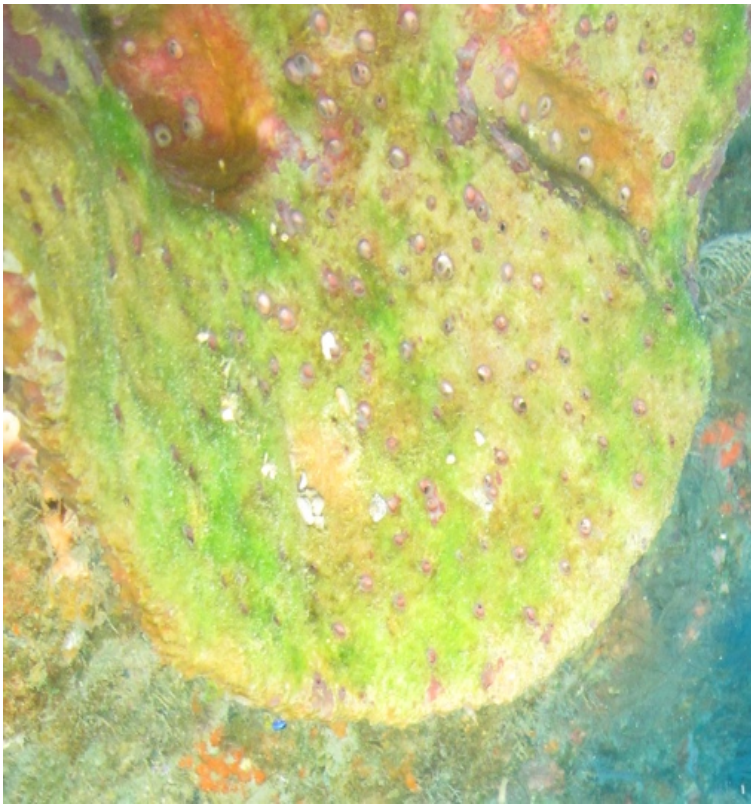


Figure 5. *Agelas dilatata*, 46 m deep. Photo: SP-49.

Diagnostic features- Flabellate to fan and cup shaped, no more than 3 cm thick, sometimes pedunculated. Brown in color. The surface is smooth with abundant and homogeneously arranged round oscules (4-10 mm) on the upperside, and small unevenly dispersed ostia (1-2 mm wide) on the underside.
Distribution and Abundance- Previously considered restricted to the Bahamian-Greater Antilles shallow coral reefs (18-30 m deep) and Cuba (90-115 m). This is the first report for the northwestern GOM where it is rare and found only at Sonnier Bank at 46 m.
Ecology- Coralline algae reefs. Specimen is overgrown by a film of green algae. A unique alkaloid isolated from a Yucatan specimen is bioactive against a multidrug resistant pathogen *Pseudomonads aeruginosa* (Pech-Puch., et al. 2020). Similar species**:** *A. dispar*, a fan-shaped brown species, which is much thicker and possesses mostly key-holed oscules
Id- MCD
Reference(s) - Diaz et al. 2019; Parra-Velandia et al., 2014.

O. Axinellida, F. Axinellidae

Ptilocaulis* cf. *walpersii (Duchassaing & Michelotti, 1864)

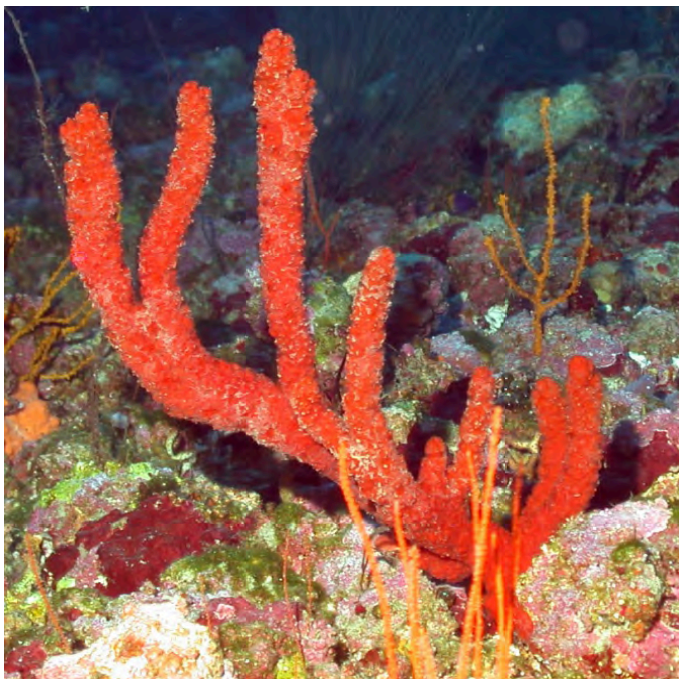


Figure 6. *Ptilocaulis* cf. *walpersii*, 60 m deep. Sample DFH6-40-1.

Diagnostic features: Flagelliform branching; single or multiple branches (approximately 1-2 cm wide, up to 50 cm height). Red to orange in color. Branches have different lengths, and they can be straight, bent, or laterally fused forming flabellate bodies. Surface rugose and porous, with flattened or rounded processes. Oscules are sparse along the side of branches, hardly visible. Branches are compressible and firm..
Distribution and Abundance- *P. walpersii* is widely distributed on shallow coral reefs Caribbean-wide, Florida, and Bermuda (0.5-35 m); recently reported at the southern GOM, 4-20 m deep (Ugalde et al., 2021). This is the first report from the northwestern GOM on mesophotic reefs. Common on Cuban mesophotic reefs. Similar species*: P. marquezi* (with oxeas and styles) and *Higginsia coralloides* (with acanthose microxeas added to large oxeas and styles). At FGBNMS, rare abundance and documented only at West Flower Garden Bank.
Ecology – Coralline algae reefs.
Id- MCD, CA
Reference- Alvarez et al., 1998; Ugalde et al., 2021

ARPHA Preprints *Author-formatted, not peer-reviewed document posted on 06/09/2022* DOI: https://doi.org/10.3897/arphapreprints.e94515

O. Axinellida, F. Heteroxidae

Myrmekioderma gyroderma (Alcolado, 1984)

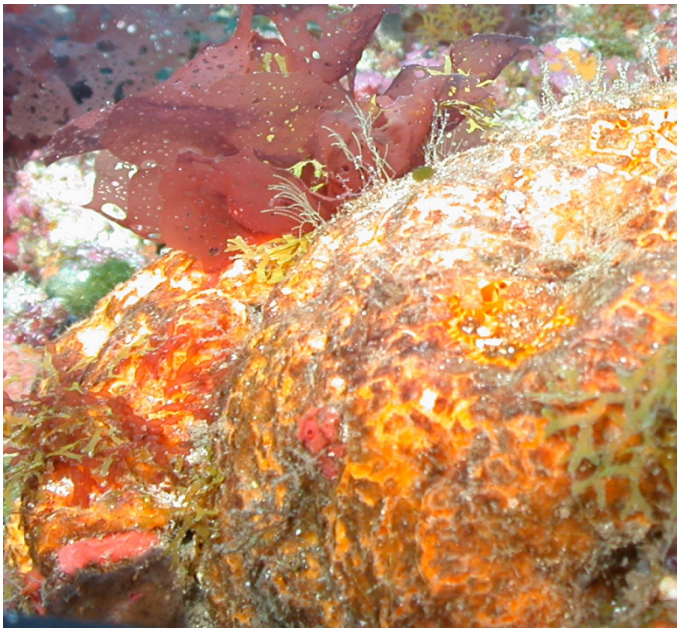


Figure 7. *Myrmekioderma gyroderma*. 54-66 m deep. Sample(s) DFH9-11A, DFH9-5B.

Diagnostic features- Massive amorphous to thick encrusting (3.5 cm thick). Brown reddish to orange in color externally, orange internally. Surface highly ornamented by plates and shallow grooves. Oscules in low abundance and irregularly arranged.
Distribution and Abundance- Shallow and mesophotic reefs, Caribbean-wide and Gulf of Mexico. At the FGBNMS the species presents low to medium abundance (2-100 individuals) at nine sites.
Ecology –Coralline algae reefs, algal nodules, lower mesophotic reefs. Similar species*:* very similar to *Didiscus oxeata*, and *Myrmekioderma rea*; this last species presents a smoother appearance and few thinner grooves. Only a spicule analysis allows to distinguish them. *Didiscus* has disscorhabds as microscleres, and *M. rea* has only straight trichodragmata, while *M. gyroderma* has twisted long trichodragmata.
Id- KR, SK, CA, MCD
Reference- Alcolado, 1984; Pomponi et al., 2019

O. Axinellida, F. Raspaillidae

Ectyoplasia ferox (Duchassaing & Miczelotti, 1864)

Figure 8. *Ectyoplasia ferox*, 55 m deep. Sample DFH9-12C.

Diagnostic features- Massive to crustose, Brown reddish to orange in color externally, orange internally. Highly ornamented surface consisting of variously shaped plates and vermiform grooves. Few oscules, all with an orange membrane.
Distribution and abundance- Caribbean-wide, SE Brazil, and northern GOM on shallow reefs. Mesophotic reefs at FGBNMS, Lesser and Greater Antilles, Florida, Bahamas, and Brazil (Pomponi et al., 2019). At FGBNMS the species was found once at one site.
Ecology – Coralline algae reefs, algal nodules. Similar species*: Myrmekioderma gyroderma* and *Myrmekioderma rea* are very similar externally; the distinction of their microscleres allows their differentiation. *Didiscus* spp. have discorhabds and *Myrmekioderma* spp. have trichodragmata (see Boury Esnault and Rützler, 1998).
Id- KR, SK, CA, MCD
Reference- Alcolado, 1984.

ARPHA Preprints Author-formatted, not peer-reviewed document posted on 06/09/2022 DOI: https://doi.org/10.3897/arphapreprints.e94515

Didiscus oxeata Hechtel, 1983

Figure 9. *Didiscus oxeata*, 55 m deep. Sample DFH9-11B.

Diagnostic features- Thickly encrusting to palmate. Brown to reddish externally, orange internally. Rugose to smooth surface. Oscules on tips of chimneys. Light colored oscular membranes. Compressible, easy to break.
Distribution and Abundance- Caribbean- wide, Gulf of Mexico and SE Brazil, very common in shallow coral reefs. Mesophotic reefs at Cuba. At FGBNMS the species is rare to low in abundance (1-10) at 5 sites.
Ecology –Coralline algae reefs, coral communities, algal nodules, lower mesophotic reefs. Similar species: This species is quite variable in color and level of rugosity. Massive and smooth forms of *Cliona varians* can be confused with it. Spicule composition allows a definitive diagnosis.
Id- KR, SK, CA, MCD
Reference- Wiedenmayer, 1977; Ugalde et al., 2021.

O. Axinellida, F. Stelligeridae

Higginsia coralloides Higgin, 1877

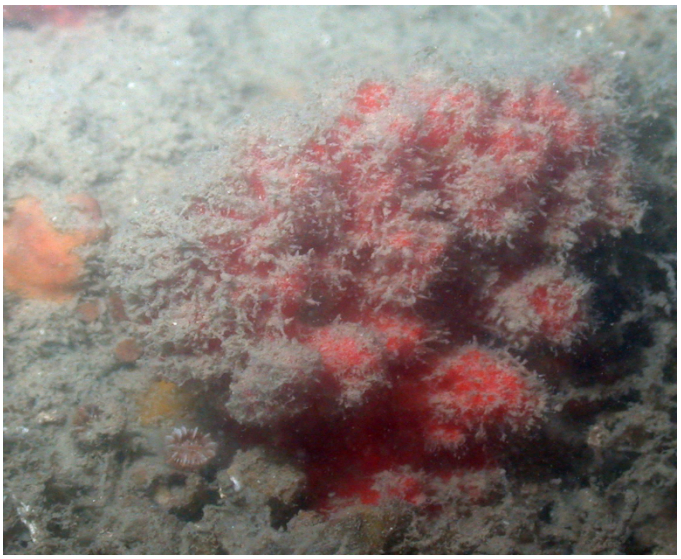


Figure 10. *Higginsia coralloides,* specimen partially buried on sediment, 56 m deep. Lots of fine sediment on sponge. Sample(s) DFH9-7A,7B.

Diagnostic features- Bushy with several digitate branches diverging from a thicker peduncle. Vermillion red alive. The surface is composed of irregular tubercules, corrugations, or conules with projecting spicules that trap sediment; similar to a cauliflower surface, with interstitial areas where inconspicuous ostia and oscula can be found. Consistency is spongy but firm.
Distribution and abundance- Shallow coral reef and hard substrate at Guyana Shelf, Grenada, Bahamas, Florida, Nicaragua, Yucatan, North Carolina, possibly Brazil (Van Soest, 2017). Mesophotic depths at Brazil, Guyana, Eastern Antilles, Florida and Bahamas, and northwestern GOM at FGBNMS. At FGBNMS it is rare to low (1-10) in abundance at six sites.
Ecology – Lower mesophotic reefs, heavily silted reefs, coralline algae reefs.
Id- KR, SK, CA, MCD
Reference- Wiedenmayer, 1977

ARPHA Preprints Author-formatted, not peer-reviewed document posted on 06/09/2022 DOI: https://doi.org/10.3897/arphapreprints.e94515

O. Biemnida, F. Biemnidae

Biemna cribaria (Alcolado & Gotera, 1986)

Figure 11. *Biemna cribaria,* 36 m deep. Photocode SP22.

Diagnostic features- Massive sub-spherical barrel growth form, with a top central dip. Color dark brown externally, tan internally. Multiple digitate projections on the surface on the top and side areas of the sponge. Oscules are aggregated on the concave upper depression.
Distribution and abundance - The sponge is rare in occurrence but reported at 20 m from Cuban and Jamaican reefs (Alcolado, 1984; Lehnert and van Soest, 1998). This is the first report at mesophotic depths and in the northwestern GOM at FGBNMS. At FGBNMS it is rare, and was observed once at Bright Bank.
Ecology - Coral communities, coralline algae reefs.
Id- MCD
Reference- Alcolado, 1984; Lehnert and Van Soest, 1998.

Neofibularia nolitangere (Duchassaing & Michelotti, 1864)

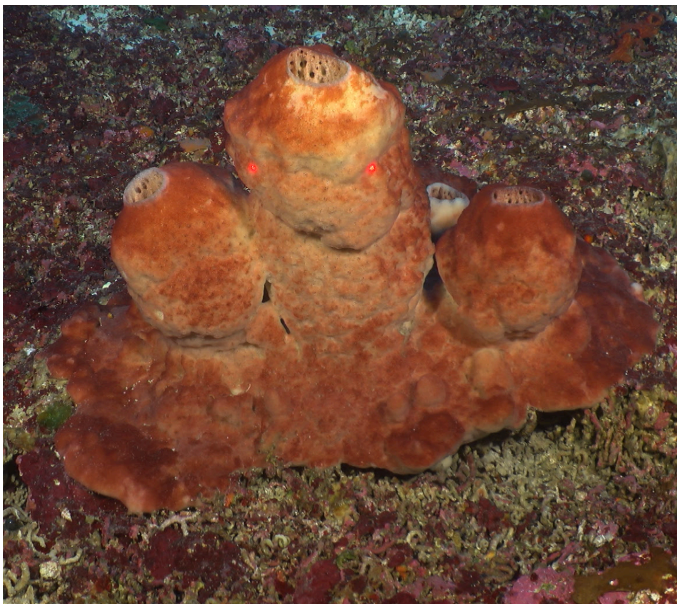


Figure 12. *Neofibularia nolitangere,* 70 m deep. Sample GFOE3-30 (8-31-19).

Diagnostic features- Massive digitiform to lobate with lobes 2 cm wide. Orange, spongy. Surface slightly rugose to conulose. Oscules 4-7 mm wide, on top of lobes, with transparent membranes. Soft, compressible.
Distribution and Abundance- *Acanthella cubensis* occurs on shallow coral reefs in Cuba, South Caribbean, Florida and North Carolina. At FGBNMS the species is from rare to medium (1-100) in abundance at 12 sites. The species occurs also at mesophotic rock pavements in South Carolina, inside proposed Charleston shelf MPA at 54 m (Diaz et al., 2021).
Ecology- Coralline algae reefs, algal nodules, lower mesophotic reefs. Similar species*:* *P. walpersii* (with only oxeas), *P. marquezii* (with oxeas and styles), while *A. cubensis* has styles in a wide size range, and sinuous strongyles.
Id. By- CA, MCD
Reference(s)- Alvarez et al., 1998

ARPHA Preprints Author-formatted, not peer-reviewed document posted on 06/09/2022 DOI: https://doi.org/10.3897/arphapreprints.e94515

O. Bubarida, F. Dictyonellidae

Acanthella cubensis (Alcolado, 1984)

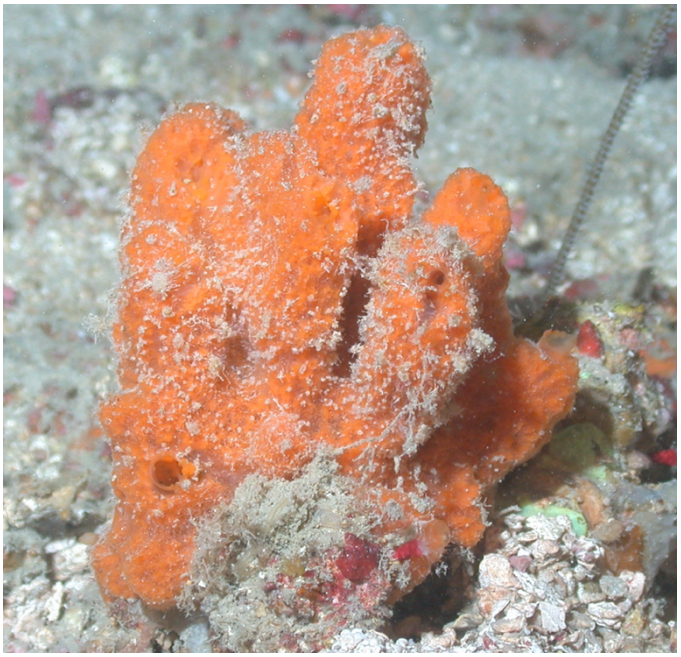


Figure 13. *Acanthella cubensis,* 63-81m deep. Sample(s) DFH9-14A DFH9-2A, DFH9-3D.

Diagnostic features- Massive base with thick lobes (10-30 cm high x10-15 cm wide), Brown to yellowish in color externally, tan internally. The surface is irregularly corrugated to velvety smooth. The oscules are on top of lobes with a thin lighter membrane. This species can grow as a thick barrel or massive crusts. The sponge is soft and friable in consistency. It is well known by its tendency to cause skin irritation.
Distribution- Coral reefs or rock pavements in shallow depths in southwestern Caribbean (Colombia and Panama), Florida and North Carolina. At FGBNMS it is low to high (2->100) in abundance at five sites. Thousands of polychaete worms swarmed from the inside of the sponge when it was collected.
Ecology –Coralline algae reefs, algal nodules, and lower mesophotic reefs.
Id- KR, SK, CA, MCD
Reference- Wiedenmayer, 1977

Acanthella* cf. *mastophora (Schmidt,1870)

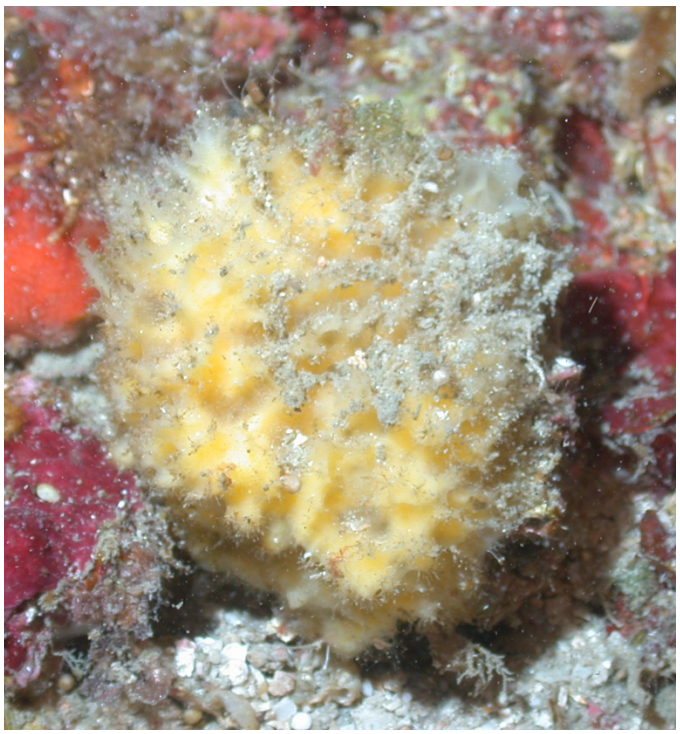


Figure 14. *Acanthella cf. mastophora* 55 m deep. Sample DFH9-13B.

Diagnostic features: Clusters of tubes (.25-1 cm in diameter), arborescent, with short and narrow peduncle; tubes anastomose and are crooked, uneven, and bumpy. Attachment area < 1cm^2 base. Orange to tan yellowish in color. The surface is felt-like, smooth visually. Oscules or vents, on top of the tubes (2-4mm in diameter). Soft and compressible in consistency.
Distribution and abundance- *A. tuberosa* is reported from 60-80 m at Guyana, southerrn Caribbean, eastern Antilles, Florida, Bahamas and southeast GOM (off Cape Sable) where it was originally described. At FGBNMS it has a wide-spread distribution, occurring at 12 sites, with abundance ranging from rare (2-10) to common (10-100 individuals).
Ecology – Coralline algae reefs, algal nodules, lower mesophotic reefs. Similar species: the protuberances of the tubes and ramose thick branches make this a unique species. The spicules include slender oxeas, styles, and wavy strongyles allowing distinction from *A. syncinularia,* with only styles and wavy strrongyles.
Id- MCD, CA
Reference- Alvarez et al., 1998

ARPHA Preprints Author-formatted, not peer-reviewed document posted on 06/09/2022 DOI: https://doi.org/10.3897/arphapreprints.e94515

Auletta tuberosa (Alvarez et al., 1998)

Figure 15. *Auletta tuberosa*, 90 m deep. Sample(s) DFH9-13A, DFH9-4A.

Diagnostic features- globular, slightly flattened (4 cm in diameter and 2-4 cm in height). Pale yellow. The surface has 'woolly'-warty appearance due to roundish papillae. Between the papillae there are furrows (1-3 mm deep). The surface is very hairy due to abundant fibrous dense filaments of unknown origin, and projecting spicule brushes. Firm and compressible, with flexible surface projections. The cf. denomination is due to predominance of oxea, instead of styles. Otherwise, it is very similar to *A. mastophora* in color, surface, and reticulate spicule arrangement.
Distribution and abundance- *A. mastophora* is found in South Florida, North Carolina, Azores and Eastern Atlantic (76-394 m deep). Widespread distribution at FGBNMS with rare to low (1-10) abundances at 9 localities.
Ecology -Coralline algae reefs, algal nodules, lower mesophotic reefs.
Id- MCD, CA
Reference- Alvarez et al., 1998.

Auletta syncinularia young specimen (Schmidt, 1870)

Figure 16. *Auletta syncinularia,* young specimen, collected on a rock at 147 m deep. Sample GFOE3-23F.

Diagnostic features: Single white tube (1-3 mm wide, 1.6 cm high). Surface rugose. One oscula on top of the tube. As adults this species grows as a cluster of smooth slender tubes (3-10 cm long, 1 cm wide), with a peduncle (2-3 cm long). Spicules are highly conserved (sinuous strongyles and 2-3 size classes of styles).
Distribution and Abundance- *A. syncinularia* is reported from the Gulf of Mexico, Florida, Barbados, and Azores (70-159 m); elsewhere, down to 200 m (Alvarez et al., 1998). At FGBNMS the species was collected once at Elvers Bank growing on a rock with Hexactinellids and black corals.
Ecology- This species was found associated with a rock where a large hexactinellid was growing (DFH3-23). Similar species include young specimens of *Auletta* sp.1 (described below).
Id- MCD
Reference- Alvarez et al., 1998.

ARPHA Preprints Author-formatted, not peer-reviewed document posted on 06/09/2022 DOI: https://doi.org/10.3897/arphapreprints.e94515

***Auletta* sp.1** n.sp.

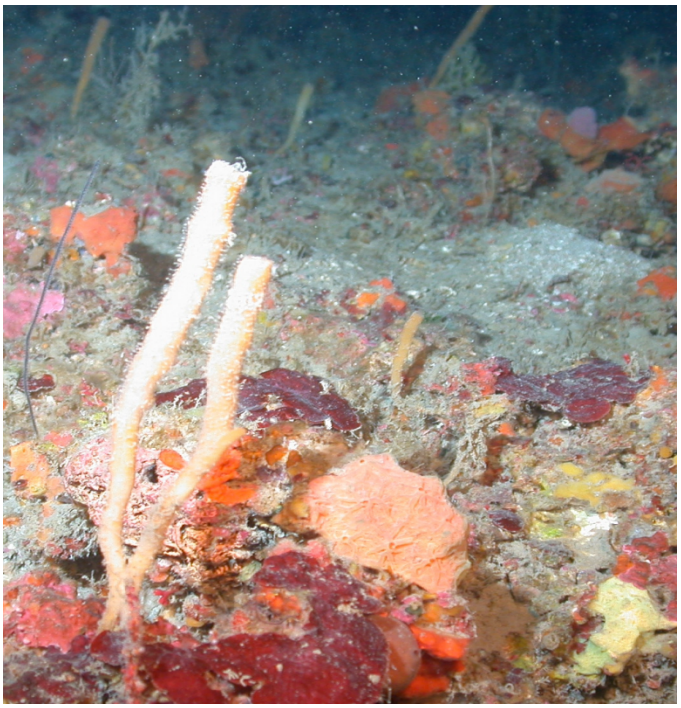


Figure 17. *Auletta* sp.1, 90 m deep. Sample(s) DFH8-15A, GFOE 3-8H.

Diagnostic features: Single or double slender tubes (0.5-1 cm in diameter), drab orange in color. Adult specimens are 8-13 cm long, and <5 mm wide (DFH8-15A). A young specimen (GFOE 3-8H) was 2 cm high and 2-4 mm wide. Surface is smooth, microscopically hispid, and porous. Oscules on top of each tube are 4 mm wide. A very thin white membrane surrounds each oscule. Tubes are compressible, but they become harder and thinner towards the base.
Distribution and abundance- Found at mesophotic reefs at FGBNMS. Wide-spread distribution in the FGBNMS with medium abundances, from low (2-10) to common (10-100 individuals) at 13 sites.
Ecology –Coralline algae reefs, algal nodules, lower mesophotic reefs. Similar species: The surface and slender tube shape of *Auletta syncinularia* is similar to this undescribed species of *Auletta*. It differs from *A. syncyuilaria* in having oxeas and anisoxeas (straight and sinuous) and lacking the 2-3 size category of styles.
Id- MCD, CA
Reference- Alvarez et al., 1998

O. Scopalinida, F. Scopalinidae

Scopalina ruetzleri (Wiedenmayer, 1977)

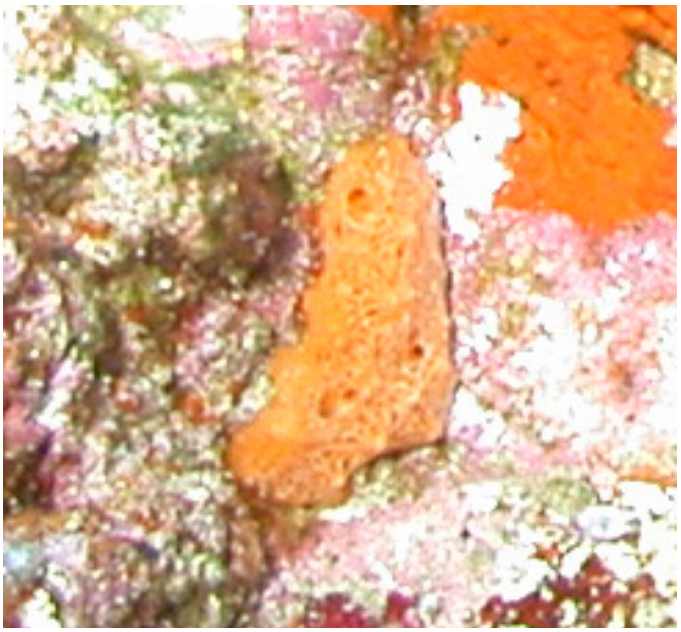


Figure 18. *Scopalina ruetzleri,* 50 m deep. Photo: SP23.

Diagnostic features- Thick encrusting, occasionally lobate, 1-2 cm thick. The color in life is bright orange to pinkish orange. The surface is conulose (1-2 mm high and 1-4 mm apart) with many large contractile ostia (500 um wide). The oscules are 1-3 mm in diameter and have a delicate, transparent membrane. The consistency is very soft, delicate, limp, and easily tom.
Distribution and abundance- Common and widespread distribution in shallow water coral reefs and mangroves in the Caribbean, Bermuda, Brazil, and GOM. At FGBNMS it had low abundance (2-10) at two sites.
Ecology- Coralline algae reefs, algal nodules.
Id- MCD
Reference- Wiedenmayer, 1977.

ARPHA Preprints *Author-formatted, not peer-reviewed document posted on 06/09/2022* DOI: https://doi.org/10.3897/arphapreprints.e94515

O. Clionaida, F. Clionaidae

Placospherastra antillensis (Van Soest, 2009)

Figure 19. **A** *Placospherastra antillensis,* with surface contracted, 55 m deep. Sample DFH9-10C. **B** *Placospherastra antillens* relaxed, showing groves with ostia (incurrent pores), and oscules (excurrent openings), 55 m deep. Sample DFH9-11C.

Diagnostic features- Thick encrusting (1-5 mm thick). Color in life orange, dark orange, brown-orange or yellowish. The surface consists of elongated plates, separated by meandering ridges and grooves with pores. The system of plates and ridges is irregular in shape. Consistency hard, rough to the touch.
Distribution and abundance- Usually under coral rubble and in reef caves, 20–23 m in Bonaire and Belize. First report at mesophotic depths. At FGBNMS the species has widespread distribution occurring at 11 sites with rare to medium abundance (1-100).
Ecology –coralline algae reefs, algal nodules, lower mesophotic reefs. Similar species: the plates and canals on the surface are similar to *Placospongia* spp. surface. The intense orange color of *P. antillensis,* and the spicules allow their differentiation.
Id- KR, SK, CA
Reference- Van Soest, 2009; Rützler et al. 2014.

ARPHA Preprints *Author-formatted, not peer-reviewed document posted on 06/09/2022* DOI: https://doi.org/10.3897/arphapreprints.e94515

O. Haplosclerida, F. Chalinidae

Haliclona sp. 1

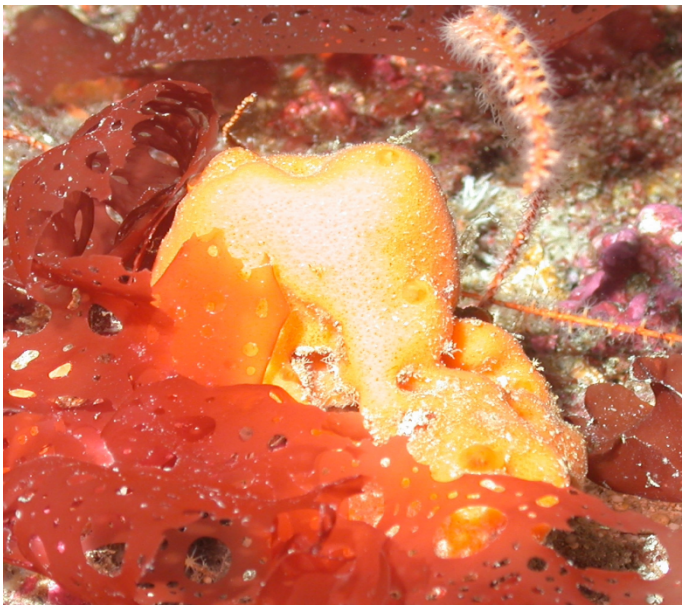


Figure 20. *Haliclona (Reniera)* sp.1, 65 m deep. Sample DFH9-6E.

Diagnostic features- Massive encrusting (1 cm thick), orange in color. Surface smooth with tiny pores. Few oscula 2-3 mm wide. Compressible, soft, and crumbly.
Distribution and abundance- Mesophotic reefs in northwestern GOM at FGBNMS, and east GOM at Pulley Ridge (Diaz, unpublished data). Rare to low abundance at two sites.
Ecology - Coralline algae reefs, algal nodules, lower mesophotic reefs. This is probably an undescribed species of *Haliclona*. Similar species: this species can be confused with smooth specimens of *Pseudaxinella belindae*, which is more orange in color and has styles for spicules instead of small oxea.
Id- CA, MCD
Reference- De Weerdt, 2000

O. Haplosclerida, F.Callyspongiidae

Callyspongia (Cladochalina) cf. *armigera* (Duchassaing & Michelotti, 1864)

Figure 21. *Callyspongia* cf. *armigera.* Species code SP42. Sample DFH6-39-6. Photo: DFH37 670020.

Diagnostic features- Short repent branch, tan in color, with thorny conules and a porous surface. Few oscula visible (3-4 mm wide). This species commonly grows as erect branches, although repent specimens are reported in thee literature.
Distribution and abundance-An occasional species in shallow coral reefs Caribbean-wide, south GOM and Florida. Found at mesophotic reefs in Cuba (52 m) and in northwestern GOM at FGBNMS, occurring in low abundance (2-10) at one site.
Ecology - Coralline algae reef. Similar species*:* the abundant thorny conules and the stiff consistency of this species allows the morphological distinction of this species. *Pleraplysilla*. sp.2, here depicted, has similar pronounced but shorter conules and the sponge is quite soft and less porous that this species.
Id- KR, SK, CA, MCD
Reference- Wiedenmayer, 1977

ARPHA Preprints *Author-formatted, not peer-reviewed document posted on 06/09/2022* DOI: https://doi.org/10.3897/arphapreprints.e94515

O. Haplosclerida, F.Petrosiidae

Neopetrosia proxima (Duchassaing & Michelotti, 1864)

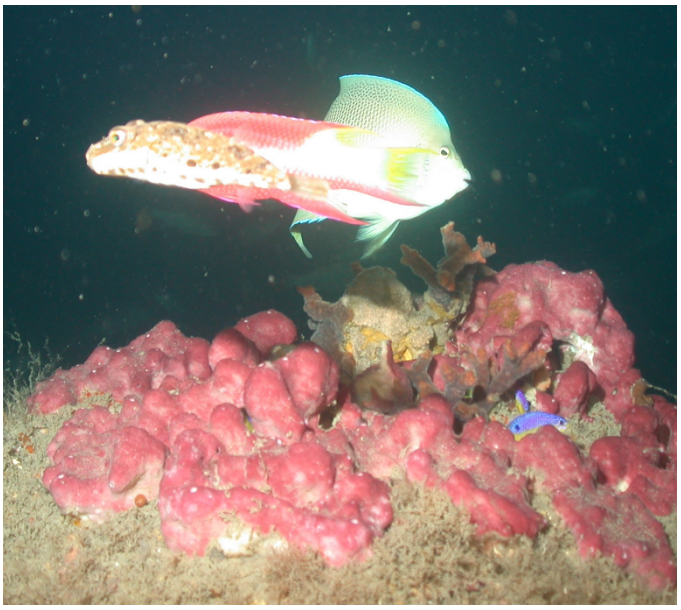


Figure 22. *Neopetrosia proxima*, 50-55 m deep. Sample(s) DFH8-37B, DFH9-7D, DFH9-9C.

Diagnostic features- Thickly encrusting to massive lobate (2-9 cm in thickness). Pinkish to brown externally, tan internally. The surface is smooth, but feels like sand paper. Abundant oscula, 2-3 mm in diameter, and 1-3 cm apart. Oscula have a white thin membrane that contrasts with the darker surface color. The sponge is very firm to hard,
Distribution and abundance- A common species at shallow rocky shores and reefs, to deeper reef habitats in a variety of wave-exposures (Zea, Henkel & Pawlik, 2014), also in caves (Perez et al., 2017). Found at mesophotic reefs on the northwestern GOM at FGBNMS and possibly in Cuba, identified as Petrosiidae CU-17 (Diaz et al., 2018). At FGBNMS the species has been found at 3 sites with abundances from rare to medium (1-100).
Ecology –Coralline algae reefs, silted lower mesophotic reefs. Similar species: This species is similar to other species of *Neopetrosia* described by Vicente et al., 2019. Details of the surface and spicules allow differentiation.
Id- KR, SK, CA, MCD
Reference- Vicente et al., 2019.

Petrosia **n.sp.1**

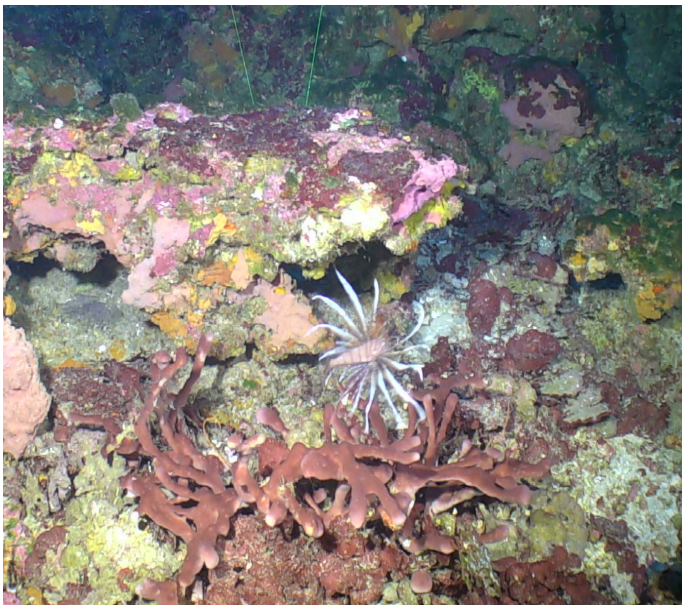


Figure 23. *Petrosia* 1 n.sp, 73 m deep. Sample DFH33-542A.

Diagnostic features- Round to flattened branching (branches 1-2 cm wide), occasionally anastomosing, with roundish tips, Branches are erect, horizontal, or creeping along the substrate. Red-brown to purple externally and tan internally in live. The tips are lighter in color. The surface is very smooth. White rimed oscula, 1-2 mm wide, separated by several cm. The sponge is compressible but firm. This is a new species currently being described.
Distribution and abundance- Mesophotic reefs and rocky pavement in the northwestern GOM at FGBNMS, east GOM at Pulley Ridge, and in South Carolina (52-72 m) (Diaz et al., 2021). At FGBNMS the species presents rare to low (1-10) distribution at four sites.
Ecology - Coralline algae reefs, algal nodules, lower mesophotic reefs. The purple color originates probably from endosymbiotic cyanobacteria *Synneccochocus spongiarium*. The flat branches, and color make it a very unique morphospecies.
Id- MCD
Reference- Van Soest, 1980.

Petrosia weinbergi (Van Soest, 1980)

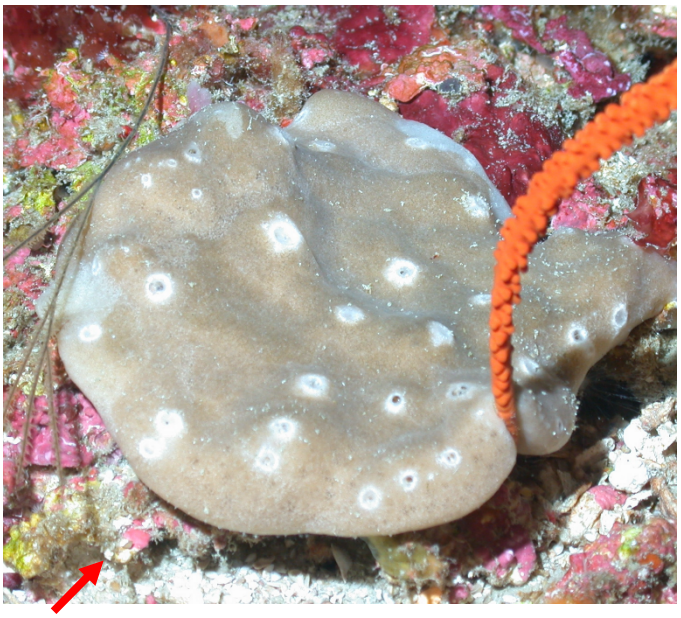


Figure 24. *Petrosia weinbergi,* 63-65 m deep. Sample(s) DFH9-3C, DFH9-6B.

Diagnostic features- Thick crusts (1-2 cm in thickness) to platey sponges growing attached onto the substrate, and with rounded borders free from the substrate. Dark green to brown in color externally and tan internally, with oscules contrasting by a wide white rim. The surface is smooth to slightly undulating. The oscules are slightly raised from the surface and white, 1-2 mm wide and 2-5 cm apart. Usually, this species forms small patches. The specimen on the photo is 8 x 6 x1.5-2 cm in size. The sponge is hard, barely compressible.
Distribution and abundance- this species is rare in shallow reefs Caribbean wide and at mesophotic reefs in the Greater Antilles, Guyana, Brazil and in the northwestern GOM at FGBNMS. At FGBNMS the species is found in rare to low (1-10) abundance at two localities. Depth ranges from 8-500 m.
Ecology - Coralline algae reef, algal nodule, lower mesophotic reef. Similar species*:* include crustose forms of *Cliona varians and Cliona aprica.*
Id- KR, SK, CA, and MCD
Reference- Pomponi et al., 2019;Van Soest, 1980, 2017.

Xestospongia muta (Schmdt, 1870)

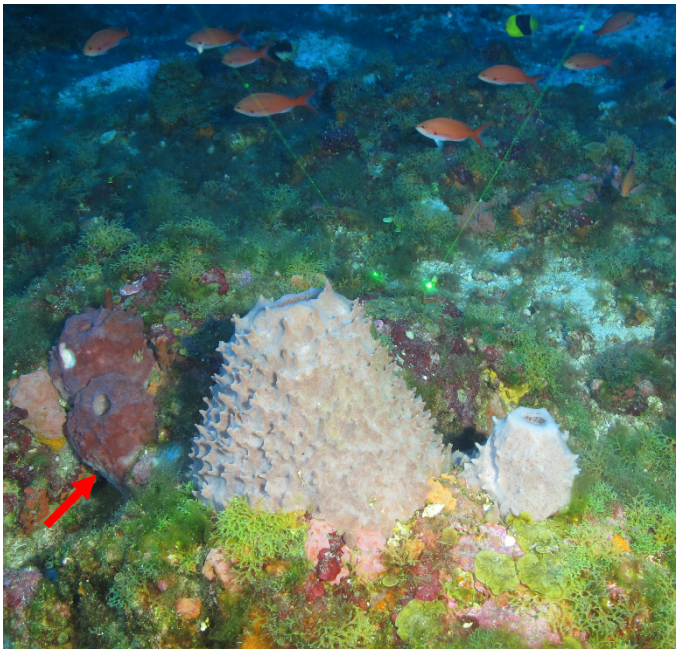


Figure 25. *Xestospogia muta* (2 specimens on the right) and *Xestospongia* sp.1 (left side red arrow) at McGrail Bank. Photo 202205114-T-161120_0004 (HBOI-FAU 05-2022).

Diagnostic features- Barrel-shaped. with a wide apical vent surrounded by a 2-5 cm wall which thickens towards the sponge base. Smaller specimens may present a cone-shaped form. Red-brown externally, tan internally. Surface ranges from smooth to irregularly ridged or pitted. Few small openings (2-3 mm in diameter) may be oscules. Inner wall without detachable dermis, rough. The detachable dermis ends on the inside rim of the vent. The atrial cavity extends to about halfway the cup's height. Consistency brittle, easily crumbled.
Distribution and abundance- An iconic species from shallow reefs in Florida, Caribbean wide, to southeastern Brazil, southern GOM, and northwestern GOM at FGBNMS. Mesophotic reefs in Cuba, South Florida, northwestern GOM at FGBNMS, and east GOM at Pulley Ridge.
Ecology – Coral reefs, coral communities, coralline algae reefs, algal nodules. Similar species*: Xestospongia* sp. 1, depicted below, is shorter, with a flat top, thicker rimmed walls, and much smaller atrium than *X. muta*.
Id- John Reed, MCD
Reference- Diaz et al., 2019; Van Soest, 1980.

ARPHA Preprints *Author-formatted, not peer-reviewed document posted on 06/09/2022* DOI: https://doi.org/10.3897/arphapreprints.e94515

Xestospongia sp.1

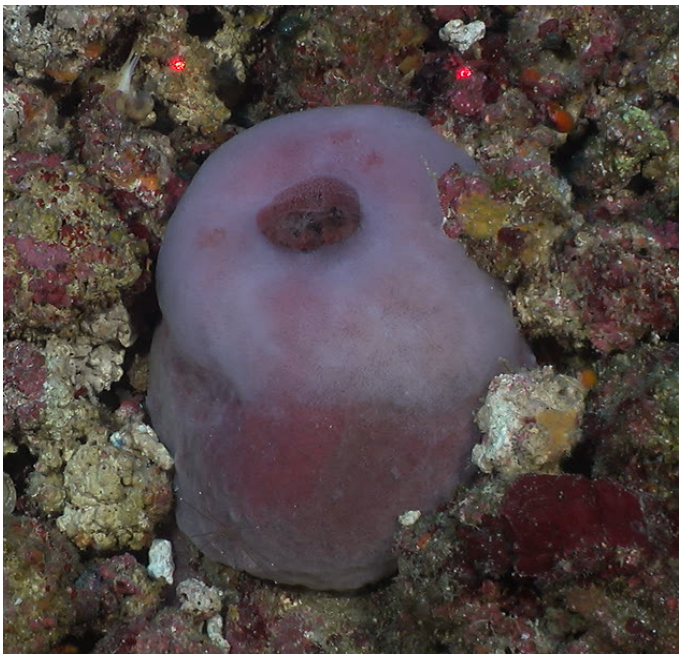


Figure 26. *Xestospongia* sp.1, 56 m deep. Sample GFOE3-27.

Diagnostic features- Massive thick barrel sponge, with rounded edges and a small apical oscule or pseudo-oscule (3 cm in diameter). The sponge top is flattened. The color is pink to dark reddish, with whitish spots, tan internally. The surface is smooth to spikey and microscopically porous. A very thin transparent membrane can be distinguished on the oscule rim, and branching thin spicule tracts can be distinguished at high magnification.
Distribution and abundance- Mesophotic reefs in Cuba, south Florida, northwestern GOM at FGBNMS region, and east GOM at Pulley Ridge. This was the most abundant species at the mesophotic reefs in Cuba, and it is currently being described by a Cuba-USA team. At FGBNMS, it has been recognized once at Geyer Bank, probably confused with *X. muta* previously.
Ecology - Algal nodules. Similar species*:* this species is similar to *X. muta* but it is fat, shorter, with a flat top, thicker walls, and smaller "atrium" than *X. muta*.
Id- KR, SK, CA, MCD
Reference- Diaz et al., 2019

O. Haplosclerida, F.Niphatiidae

Niphates erecta (Duchassaing & Michelotti, 1864)

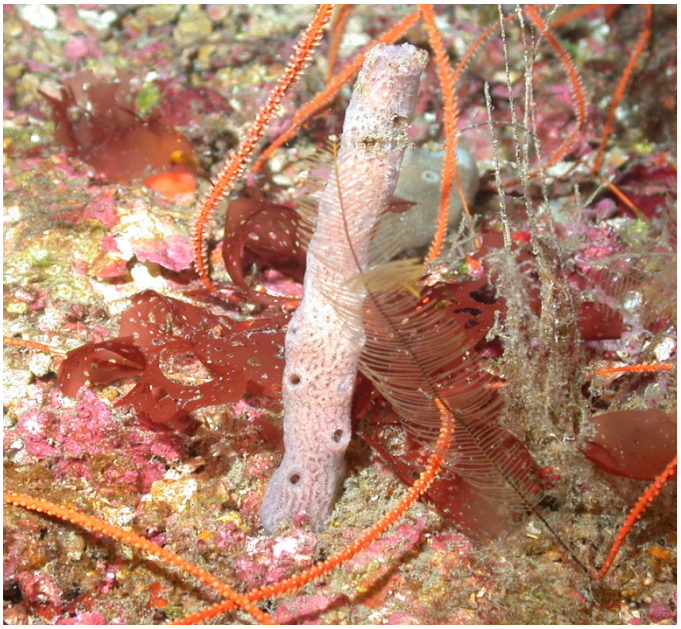


Figure 27. *Niphates erecta*, 65 m deep. Sample DFH9-6A.

Diagnostic features- Single erect branch to multiple branches or arborescent. Pink to gray in color. The surface is porous, microhispid, and rough to the touch. Many oscules dispersed along the branch with a slight elevation compared to the surface. Many oscules had a barnacle inside. The sponge is firm, slightly compressible.
Distribution and abundancee- Very common species Caribbean wide, Bermuda, Florida, and Brazil at shallow (< 50 m) and mesophotic depths (50-100 m). At FGBNMS the species is reported with rare to high abundance (1->100) at seven localities.
Ecology - Coralline algae reef, algal nodule, lower mesophotic reef. Similar species*:* *Niphates amorpha* with erect branches and *Niphates erecta* can be confused. The possible conspecificity of these two forms remains to be clarified.
Id- KR, SK, CA, MCD
Reference- Van Soest, 1980. Pomponi et al., 2019.

ARPHA Preprints *Author-formatted, not peer-reviewed document posted on 06/09/2022* DOI: https://doi.org/10.3897/arphapreprints.e94515

O. Haplosclerida, F. Phloeodyctidae

Siphonodictyon coralliophagum **forma** ***tubulosa*** (De Laubenfels, 1949)

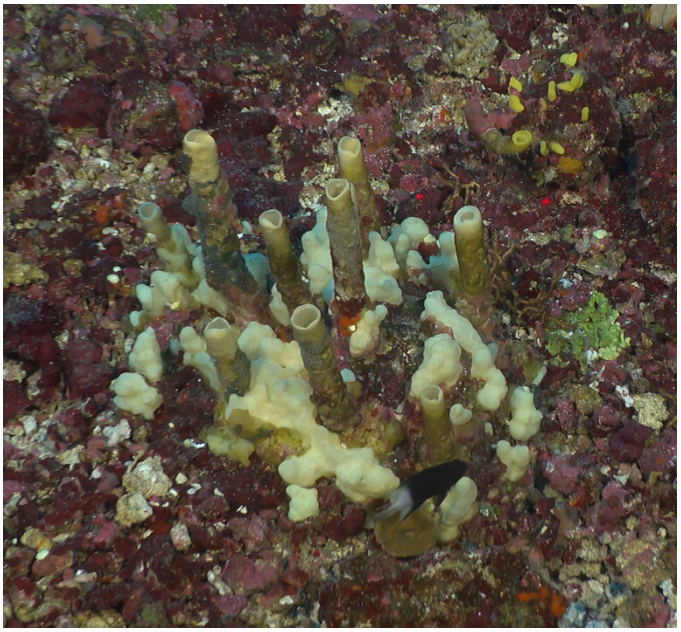


Figure 28. *Siphonodictyon coralliophagum* forma *tubulosum*, 67 m deep. Sample GFOE3-2.

Diagnostic features- Large massive sponge with abundant long yellow brown oscular tubes (3-12 cm long and 1.5-2 cm wide) that project between shorter, amorphous to digitate drab yellow fistules (1-4 cm high and <10 cm long). Fistules and tubes are soft and compressible. Only an oscular tube was collected, and it had a very smooth surface, and only oxeas as spicules. 18S sequences are 99.8% similar to sequences of *S. coralliophagum* available on Genbank. *S. coralliophagum* has 4 morphotypes (Ruetzler, 1971). Co-author Ruetzler confirmed this morphotype represents the forma *tubulosum* of this species. Currently the "forma" morphotype denominations are not accepted in the World Porifera Database.
Distribution and abundance- The species is reported between 0.3-73 m deep from Bahamas, northern GOM, Mexico, Belize, Panama, Greater and Lesser Antilles, and southern Caribbean, and southeastern Brazil. The species was seen once at Geyer Bank at FGBNMS.
Ecology – Found at algal nodule beds. This species is a bio-eroding sponge.
Id- KR, IS, MCD
Reference- Ruetzler, 1971; Ruetzler et al., 2014;

Siphonodictyon brevitubulatum (Pang, 1973)

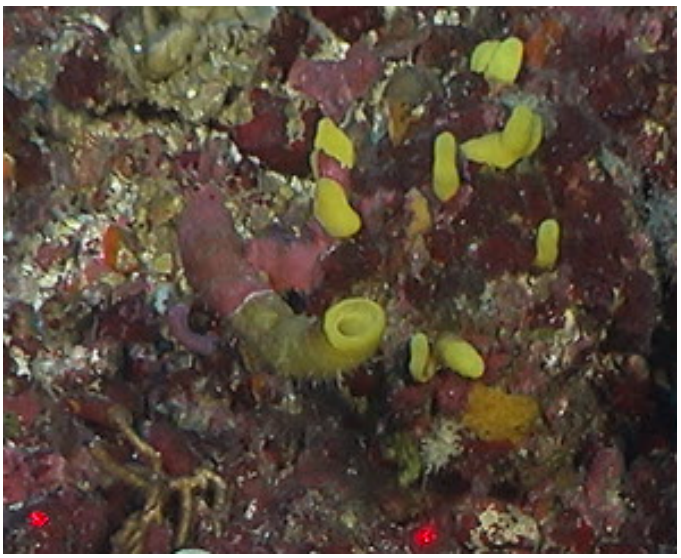


Figure 29. *Siphonodictyon brevitubulatum*, 67 m deep. Photo taken from Fig. 27.

Diagnostic features- Small abundant fistules (0.5-1 cm wide, 1-3 cm high) and rare long oscular tubes (1.5 cm in diameter), bright yellow in color. Smooth surface of fistules and oscular tubes.
Distribution and abundance- The species is reported from Jamaica, Costa Rica, Colombia and Martinique, and northwestern GOM in the FGBNMS. At the FGBNMS it was observed once at Geyer Bank, while analyzing the photo of *Syphonodictyon coralliphagum* forma *tubulosa* (top page). This is the first report of this species at mesophotic depths.
Ecology - Algal nodules. This species is a bioerodinng sponge. Similar species: *Siphonodictyum coralliophagum* has much larger and thicker bright yellow oscular tubes and fistules.
Id- MCD
Reference- Pang, 1973.

ARPHA Preprints *Author-formatted, not peer-reviewed document posted on 06/09/2022* DOI: https://doi.org/10.3897/arphapreprints.e94515

O. Poecilosclerida, F. Chondropsidae

Batzella rubra (Alcolado, 1984)

Figure 30. *Batzella rubra*, 90 m deep. Specimen observed on the photo of sample DFH9-13A

Diagnostic features- Thinly encrusting sponge, growing over dead coral or other sponges. Deep orange to bright red color in live. The surface is smooth and ornamented by lighter colored dermal canals that branch away from the oscula, wide close to the oscula and thinner away from it. The consistency is compressible where the sponge is thicker.
Distribution and abundance- This species is reported from shallow reefs in Cuba and Bahamas. This is the first report for the species at mesophotic reefs. At FGBNMS the specimen on the photo was found at east Flower Garden Bank and the species has rare to moderate abundance at ten other sites.
Ecology - Coralline algae reefs, algal nodules, lower mesophotic reefs. Similar species: the sponge can be confused with other red encrusting species but the particular dripping morphology of the dermal canals make them easy to distinguish.
Id- MCD
Reference- Alcolado, 1984; Zeat et al., 2014.

Batzella* cf. *rubra (Alcolado, 1984)

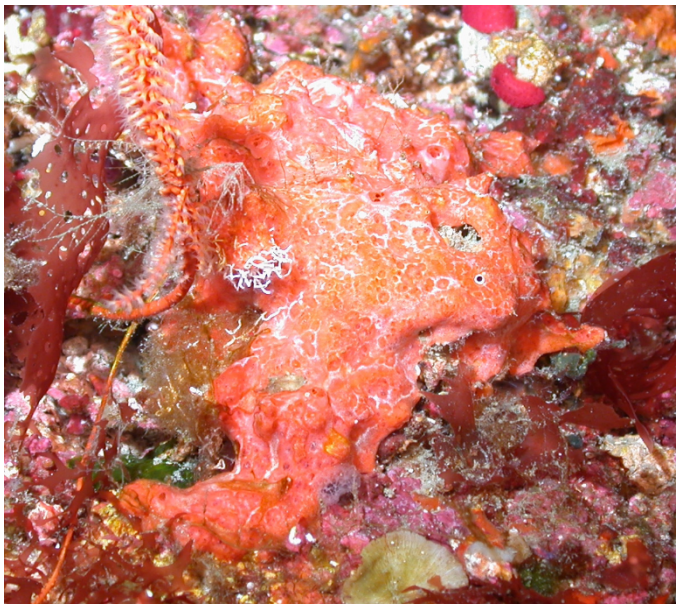


Figure 31. *Batzella cf. rubra*, 63 m deep. Sample DFH9-6F

Diagnostic features- Thinly encrusting sponge (1-10 mm thick) growing over dead coral. Orange to red color in live, black to purple in alcohol. The surface is smooth to bumpy with whitish branching dermal canals, and roundish papillae with two or three clumps of ostia. The cf. denomination is given since the rounded papillae are only described for *Batzella mollis*, a species found at the Juan Fernandez and Desventuradas islands off the Chilean Pacific coast.
Distribution and abundance- This is the first record from mesophotic reefs. At FGBNMS the species has been recorded with rare to low abundance (1-10) in three localities.
Ecology – Coralline algae reefs, algal nodules, lower mesophotic reefs. Similar species: Esteves et al. 2018, describes three tropical western Atlantic *Batzella* spp: *B. rubra* (deep orange-red, smooth), *B. ficus* (dark brown in life), and *B. cataniresis* (yellow). *Monanchora arbuscula* in its orange morphotype can be confused with *B.cf. rubra*.
Id- KR, SK, CA, MCD
Reference(s)- Esteves et al., 2018; Alcolado, 1984.

ARPHA Preprints Author-formatted, not peer-reviewed document posted on 06/09/2022 DOI: https://doi.org/10.3897/arphapreprints.e94515

O. Poecilosclerida, F. Microcionidae

Clathria sp. 1

Figure 32. *Clathria* sp. 1, 63 m deep. No sample. Photocode SP03**.**

Diagnostic features- Massive with short protruding flattened digitate branches, forming a roundish shaped bush. Color red in life. Surface minutely porous and with a transluscent veil (dermis). Oscules not visible. This species belongs to the genus *Clathria*, however species identifications require spicule analysis.
Distribution and abundance- Arborescent *Clathria* species are diverse and well-known from the Gulf of Mexico (Gomez, 2014). Documented at three sites.
Ecology - Sandy substrates. Similar species: few branching bushy *Clathria* species are described by Gomez, 2014. Few of those species have been photographed live, and their appearance changes dramatically once they are taken to the water surface.
Id- KR, SK, CA, MCD
Reference- Gomez, 2014.

O. Suberitida, F. Halichondriidae

Halichondria sp. 1

Figure 33. *Halichondria* sp.1, 55-73 m deep. Sample(s) DFH9-11D, DFH9-12D, DFH9-14E, DFH9-3E.

Diagnostic features- Massive to thick encrusting, or globular to lobate sponge with lobes up to 15 cm high. Yellow orange alive, tan pinkish in alcohol. The surface is rugose to verrucose, with deep grooves and holes <0.5 mm wide; the deep grooves, where thin ectosome is absent, have a feathery appearance. Oscula 0.5-2 cm wide, with a yellow membrane collar that is 5-8 mm high when oscules are fully open. Compressible in consistency.
Distribution and abundance - The sponge is common in the FGBNMS at mesophotic depths between 55-73 m. This is an undescribed species. The species occurs at four sites with rare to medium abundance (1-100).
Ecology –Coralline algae reefs, algal nodules, lower mesophotic reefs. Similar species: *Myrmekioderma rea*, when it grows as a thick massive crust, and massive lobate *Axynissa ambrosi*a can be easily confused with this species. The spicules and surface features are truly unique among the Halichondriidae
Id- CA, SWK, MCD
Reference- Diaz et al., 1993; Zea et al., 2014.

ARPHA Preprints Author-formatted, not peer-reviewed document posted on 06/09/2022 DOI: https://doi.org/10.3897/arphapreprints.e94515

Topsentia bahamensis (Diaz, Van Soest, and Pomponi 1993)

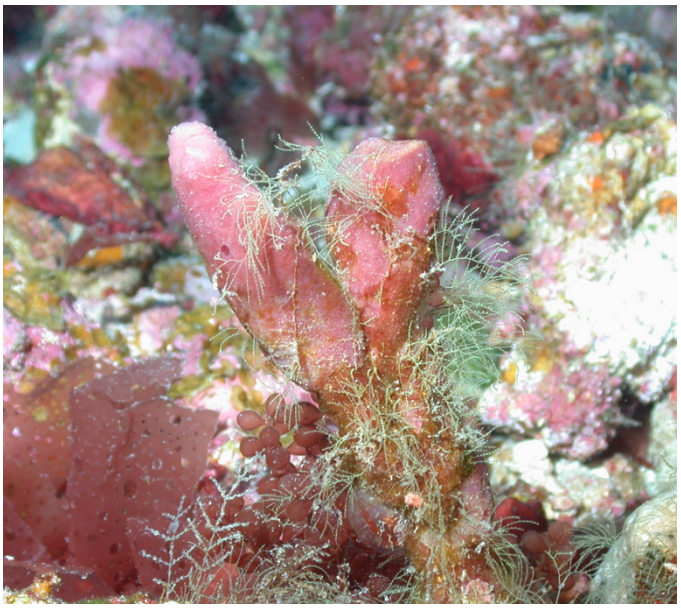


Figure 34. *Topsentia bahamensis*, 56 m deep. Sample DFH9-11F.

Diagnostic features- massive, columnar shape with round or blunt tip (10 cm high, 2-4 cm in diameter). The sponge is red-brown externally and tan internally in live. The surface is smooth visually with a sandpaper feel. Five dispersed oscula (1-3 mm in diameter). Very firm in consistency, but crumbly
Distribution and abundance – Currently reported from shallow reefs in southern GOM in northern Yucatan, and Belize and at mesophotic depths in the Bahamas and northwestern GOM at the FGBNMS.
Ecology – Coralline algae reefs, algal nodules. Similar species: *Topsentia ophirhaphidites*, which has deformed small oxea added to the larger oxea. Petrosiids in general by their brown reddish color and hard brittle consistency. Spicule study needed to distinguish.
Id- CA, SWK, MCD
Reference- Diaz et al.,1993.

O. Suberitida, F. Suberitidae

Rhizaxinella clava (Schmidt, 1870)

Figure 35. *Rhizaxinella clava,* 106 m deep. Sample(s) DFH6-42-4, DFH8-5A.

Diagnostic features- The “corn dog sponge”. A light brown clavate, stipitate sponge (15 cm tall) with a long peduncle (2 mm in diameter at attachment area) and an elongated globose soft body 1cm in diameter at its thickest part. The surface is very smooth and velvety. The oscule is slit shaped and has a collared membrane visible in the *in situ* photo. The sponge is firm but slightly compressible.
Distribution and abundance – Currently reported at mesophotic depths in the Florida Keys, Guyana, Surinam, and northwestern GOM at the FGBNMS. At FGBNMS the species is widespread, occurring at 15 sites with abundance from rare to very common (1->100).
Ecology – Coralline algae reefs, silted lower mesophotic reefs. Similar species: the “corn dog sponge” is similar externally to the “lollipop sponge”, *Stylocordyla chupachups* and to other members of the family Stylocordylidae, which are mostly present in cold deep waters.
Id- KR, CA, SWK, MCD
Reference- Pomponi et al., 2019; Van Soest, 2017.

ARPHA Preprints *Author-formatted, not peer-reviewed document posted on 06/09/2022* DOI: https://doi.org/10.3897/arphapreprints.e94515

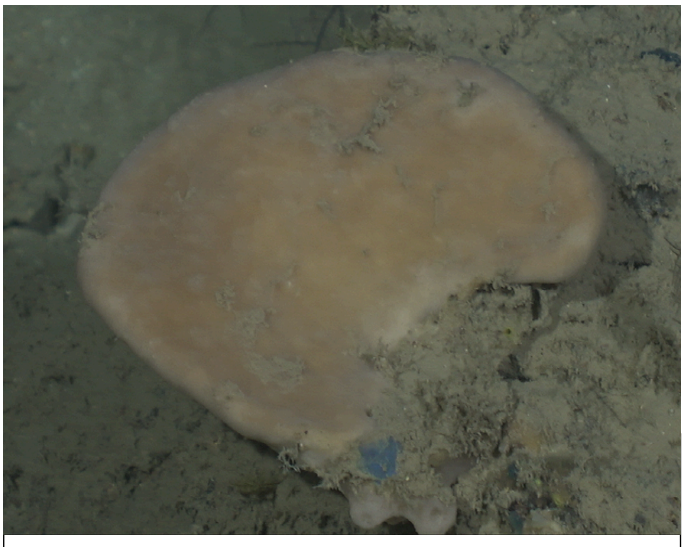
O. Tetractinellida, SO. Astrophorina, F. Corallistidae

Corallistes typus (Schmidt 1870)

Figure 36. *In-situ* photo of *Corallistes typus*, 108 m deep. Sample(s) GFOE3-23G *, DFH8-10B.

Diagnostic features- Small cups or plates, with undulating rims, walls 1-3 cm thick, usually with a thick peduncle. Brown with faintly pink tinges. The surface is smooth, with rims sometimes covered by sediment. Osculs not visible.
Distribution and abundance – Southern, eastern and northern Caribbean, Florida and Bahamas 61-914 m deep (Pomponi et al. 2001) Abundances increase from 150 m to 900 m deep. At FGBNMS the species occurs widespread at 17 sites from low to medium abundance (2-100).
Ecology - Coralline algae reefs, lower mesophotic reefs. Similar species: an integrative study of 247 "lithistid" samples from the tropical western Atlantic (Schuster et al., 2021) encounters possibly six different undescribed species of *Corallistes*, similar to *C. typus*. Species of the genus *Neophrissospongia* have a similar appearance to this species.
Id- KR, CA, SWK
Reference- Van Soest and Stentoft, 1988; Schuster et al., 2021.

Neophrissospongia* cf. *nolitangere (Schmidt, 1870)



Diagnostic features- Plate or ear-shaped sponges with 1-2 cm thick walls with rounded margins, and 8-12 cm across. Tan-brown, plate. The cf. denomination was given since minute oscules on inner surface (0.5–1 mm wide) and a pedicel described for *Neophrissospongia nolitangere* were not seen in the image or during voucher analysis.
Distribution and abundance – *N. nolitangere* is common at deep waters from the eastern Atlantic, Azores and Mediterranean. Schuster et al. (2021) report at least 4 undescribed species of this genus in the tropical western Atlantic. This is the first report of the genus for the northwestern GOM, at FGBNMS seen once at one site.
Ecology – Algal nodules. Similar species: *Corallistes typus* and other species from the same genus. *Neophrissospongia* differs from *Corallistes* by the spiny or tuberculate nature of the dichotriaene's top in the former, and the smooth nature on the later.
Id- KR, CA, SWK, MCD
Reference- Pissera and Levi, 2002; Schuster et al. 2021.

ARPHA Preprints *Author-formatted, not peer-reviewed document posted on 06/09/2022* DOI: https://doi.org/10.3897/arphapreprints.e94515

O. Tetractinellida, SO. Astrophorina, F. Ancorinidae

Stellettinopsis cf. megastylifera (Wintermann-Kilian & Kilian, 1984)

Figure 38. *Stellettinopsis cf. megastylifera,* 70 m deep. Sample(s) DFH9-13C, SSE-02-1.

Diagnostic features- round to massive sponge. Brownish gray to dirty white in color. The surface is prickly, hispid, feels like sandpaper; numerous holes up to 3-5 mm in diameter in sponge body. Few larger oscula 1-4 cm wide. Hard and dense in consistency. Species identity requires further analysis and comparative work (Sandes et al., 2020).
Distribution and abundance – The species is reported from shallow depths growing on coral reefs, rocks, sand or mangroves (3-25 m deep) in the Colombian Caribbean, Curacao, Panama, Belize, southern GOM, and Dominican Republic. Rare species. This is the first report of this species for the north GOM mesophotic. At FGBNMS, moderate abundance at three sites.
Ecology - Coralline algae reefs, algal nodules.
Id- SWK, CA, KR
Reference(s)- Sandes et al., 2020; Wintermann-Kilian and Kilian (1984).

Order Tetractinellida, SO. Astrophorina, F. Geodiidae

Erylus alleni (De Laubenfels, 1934)

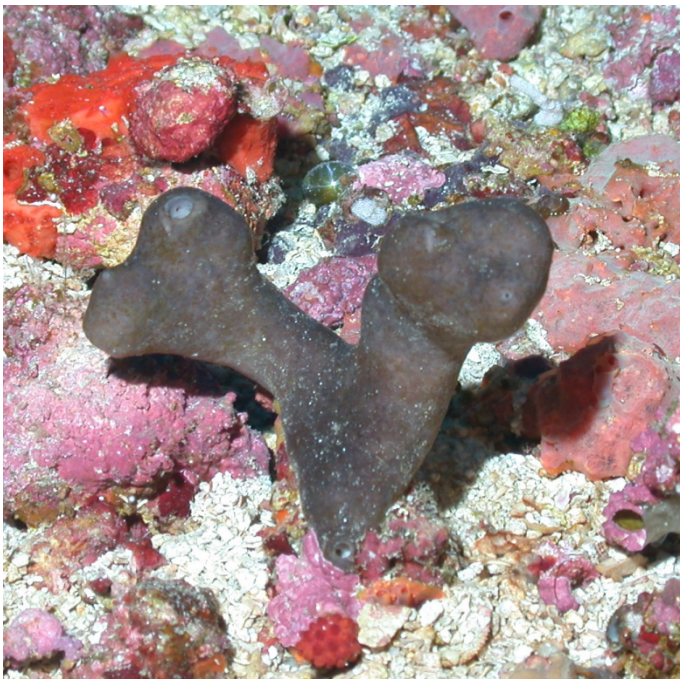


Figure 39. *Erylus alleni*, 55 m deep. Sample(s) DFH9-12E, DFH9-12F.

Diagnostic features- Stalks with heart shaped tops (3-7 cm in height, 1-3 cm wide). Dark brown in color externally, tan internally. Very smooth surface. One or two oscules per stalk located at the tips (1-5 mm wide). The oscula continued by an atrium 1-2 cm deep. Dense in consistency.
Distribution and abundance – Mesophotic depths in Puerto Rico and Brazil. Rare species. This is the first report of this species for the GOM, at FGBNMS found at rare to low abundance (1-10) at 7 sites.
Ecology - Coralline algae reefs, algal nodules. Similar species: the stalked growth form and certain spicule details (elliptical aspidasters, two categories of oxyasters) allows its differentiation with co-occuring similar species such as *E. goffrilleri* and *E. trisphaerus.*
Id- KR, CS, SWK, MCD
Reference- Mothes et al., 1999.

ARPHA Preprints Author-formatted, not peer-reviewed document posted on 06/09/2022 DOI: https://doi.org/10.3897/arphapreprints.e94515

Erylus goffrilleri (Wiedenmayer, 1977)

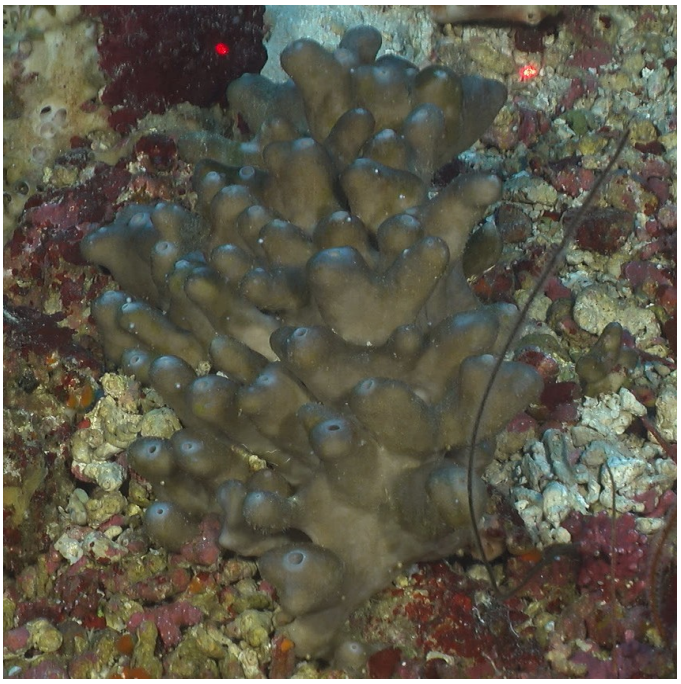


Figure 40. *Erylus goffrilleri* 69 m deep. Sample GFOE3-32

Diagnostic features- Massive amorphous to lobate. Dark brown color that lightens towards the base of the lobes. Smooth surface, slight wrinkles when out of water. One apical oscula, on top of each lobe (4-8 mm wide), with a lighter colored membrane. Compressible but dense in consistency, easy to break.
Distribution and abundance- Reported in shallow and mesophotic reefs in the Bahamas and Jamaica. First report of this species for the GOM at FGBNMS region, found at low abundance (1-10), at Geyer Bank.
Ecology- Algal nodules. Similar species: several species of *Erylus* from the tropical western Atlantic are very similar in external appearance. The calthrop-like triaenes and the tylasters allows its distinction from co-occurring species.
Id- KR, CS, SWK, MCD
Reference- Wiedenmayer, 1977.

Erylus trisphaerus (De Laubenfels, 1953)

Figure 41. *Erylus trisphaerus,* 55 m deep. Sample DFH9-12G.

Diagnostic features- Spherical, approx. 7 cm in diameter, with a roundish black apical plate (2 cm wide). The sponge color is light brown with reddish tinges. The surface is mostly smooth, with patches with sediments or turf around the apical plate, and occasionally on body side. Many oscula (2 mm wide) concentrated on the plate. Hard as a rock.
Distribution and abundance- *Geodia curacaoensis* was described from mesophotic depths in Curacao and was recorded in shallow reefs at Alacranes Reef, South GOM, and at mesophotic depths in Cuba. At FGBNMS was found in low (2-10) abundance at six sites.
Ecology - Coralline algae reefs, algal nodules, lower mesophotic reefs. Similar species: this specimen is very similar to *G. curacaoensis* but the apical sieve plate of that species is light brown and oscules are much smaller. The size of the large oxea of *G. curacaoensis* is double the size of the FGBNMS specimen.
Id- KR, CA, SWK, MCD
Reference- Ugalde et al., 2015.

ARPHA Preprints Author-formatted, not peer-reviewed document posted on 06/09/2022 DOI: https://doi.org/10.3897/arphapreprints.e94515

Geodia* cf. *curacaoensis (Van Soest et al., 2014)

Figure 42. *Geodia cf. curacaoensis* 81 m deep. Sample DFH9-12G.

Diagnostic features- Massive amorphous to lobate, dark to lighter brown. The surface is smooth with very small pores. Oscules on top of lobes, up to 1 cm wide, with a very thin dark membrane. Compressible and dense in consistency.
Distribution and abundance – This is a rare species originally described from Apalachee Bay in north Florida at 13 m deep. Since then, it has been reported from shallow reefs in Alacranes Reef. Southern GOM, Cuba, and Curacao. This is the first report from mesophotic reefs and first report from northwestern GOM at FGBNMS where it occurs with rare to low abundance (1-10) at six sites.
Ecology - Coralline algal reefs, algal nodules, lower mesophotic reefs. Similar species: the peanut shaped aspidasters, with two to three swollen areas, allows its distinction from co-occurring species of the genus.
Id- KR, CA, SWK, MCD
Reference- Ugalde et al., 2015.

O. Tetractinellida, SO. Astrophorina, F. Theonellidae

***Discodermia* sp.1**

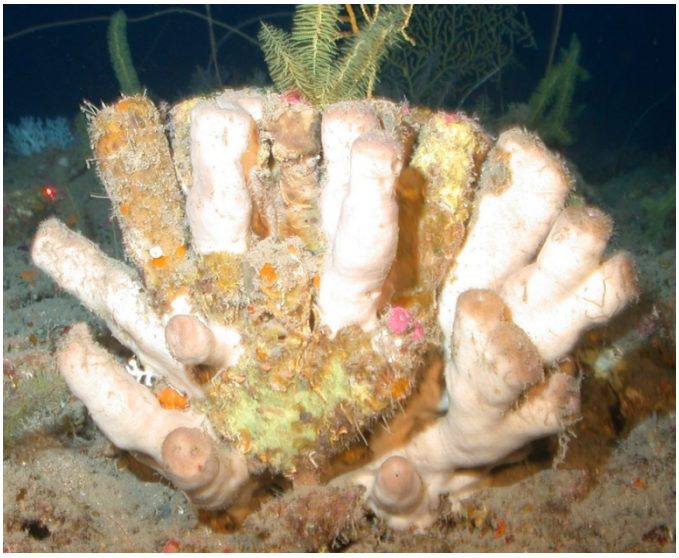


Figure 43. *In situ* photo of *Discodermia* sp., 107 m deep. No sample. Photocode SP05.

Diagnostic features- Massive columnar cluster, flattened tops of columns with one oscule on each. Smooth to rugose surface. Tan color with light brown tops. Columns 2-3 cm wide and 10-15 cm tall.
Distribution and abundance – The genus *Discodermia* is common in deep waters at the tropical western Atlantic. *D. dissoluta* is the most widespread distributed species of the genus in the region from the GOM to Brazil. The image of the specimens shown in Van Soest et al., 2014 has a columnar growth form for the species. Spicule preparations would be necessary to determine the species identity of this sponge. At FGBNMS, rare to low (1-10) abundance at two sites.
Ecology – Lower mesophotic reefs.
Id- KR, CA, SWK, MCD
Reference- Van Soest et al., 2014

ARPHA Preprints Author-formatted, not peer-reviewed document posted on 06/09/2022 DOI: https://doi.org/10.3897/arphapreprints.e94515

O. Tetractinellida, SO. Astrophorina, F. Thrombidae

Yucatania sphaeroidocladus (Hartman and Hubbard, 1999)

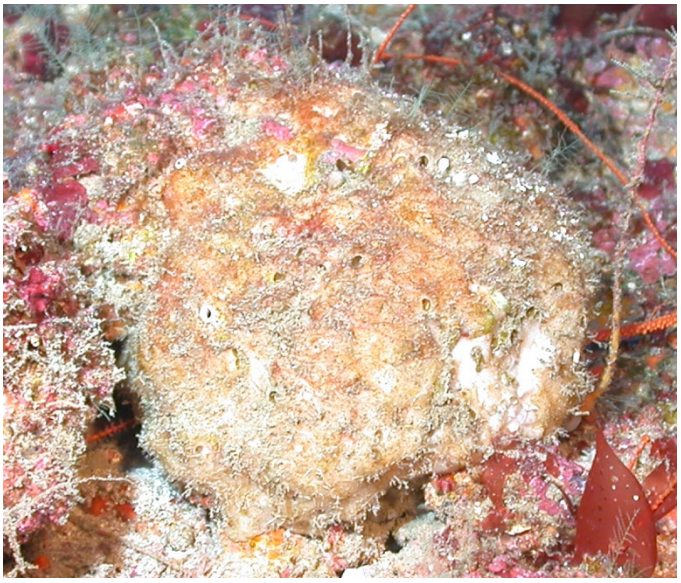


Figure 44. *In-situ* photo of *Yucatania sphaeroidocladus sp.* 64-66 m deep. Sample(s) DFH9-5C, DFH9-6D.

Diagnostic features- Encrusting to massive sponge (1 - 9 cm in thickness). Ochre brown externally in life. The sponge has a vermetid gastropod growing within its body. Surface microhispid, rough at touch, oscules numerous and scattered, rounded to oval, 1–4.5 mm wide. Some of the openings at the surface correspond to the vermetids.
Distribution and abundance- Mesophotic depths from eastern Brazil, Guiana, Trinidad, and continental platform of the Yucatan Peninsula. Widely distributed at the mesophotic depths in FGBNMS (12 sites), with rare or medium abundance (1-100).
Ecology- Coralline algae reefs, algal nodules, lower mesophotic reefs. Similar species: any massive to subglobular species that accumulate debris can be confused with this species. Spicule composition is essential for its identification.
Id- KR, CA, SWK, MCD
Reference- Gomez, 2006; Hartman and Hubbard, 1999.

O. Tetractinellida, SO. Spirophorina, F. Tetillidae

***Cinachyrella* sp.1**

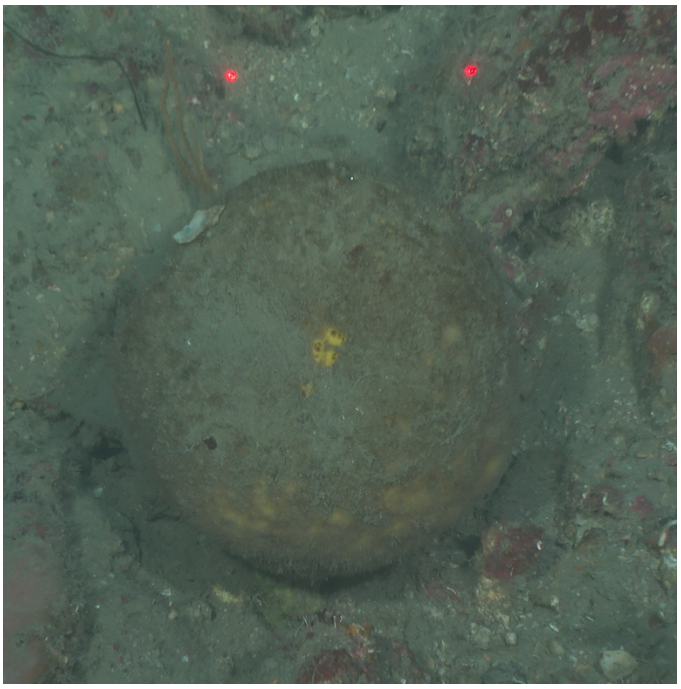


Figure 45. *In-situ* photo of *Cinachyrella* sp.1, 81 m deep. Sample GFOE3-20.

Diagnostic features- Globular sponge (12 cm wide). Neon yellow in and out, covered by sediment obscuring the sponge color. The surface appears smooth, rough to the touch; microhispid microscopically. Few apical oscules (6-8 mm wide). Dense in consistency. Long oxea: 2500-3000 x 10-50 um, small oxea-130-170 x 5, and sigma, c and s shaped, 20-30 um long, <1 um wide. This specimen was initially identified as *Tetilla* sp. However, an 18S barcoding study shows this species is 99.9 % *Cinachyrella* sp. The specimen studied lacks protrienes and aanatriaanes found in all *Cinachyrella* species from the region. The determination of this species requires further comparative work and the analyses of other genetic markers.
Distribution and abundance- At FGBNMS this species is rare, appearing once at one site.
Ecology - Coralline algal reefs. Similar species: globular yellowish species of the genus *Cinachyrella, Cinachyra*, or *Tetilla*.
Id- MCD, IS
Reference- Van Soest and Rützler, 2002

ARPHA Preprints *Author-formatted, not peer-reviewed document posted on 06/09/2022* DOI: https://doi.org/10.3897/arphapreprints.e94515

SC. Verongiimorpha, O. Chondrosida, F. Chondrosiidae

Chondrosia collectrix (Schmidt, 1870)

Figure 46. *Chondrosia collectrix,* 55 m deep. Sample DFH9-9D.

Diagnostic features- Thick encrusting (1-3 cm in thickness) to lobate, brown, black to tan in color externally with darker spotted areas, tan internally. Smooth surface, and round oscules, with elevated membranes. This species has very cartilaginous consistency.
Distribution and abundance – The species is distributed at coral reefs, seagrasses and/or mangroves in Florida, Bermuda, Caribbean wide, Brazil, and southern Gulf of Mexico. At FGBNMS is widely distributed with low to high abundance (10->100) occurring at 12 sites.
Ecology – Inhabits lower mesophotic reef and heavily silted reef, coralline algae reef, algal nodules. Similar species: *Chondrilla caribensis* is very similar in growth form and color but it lacks oscules with a collared membrane, and possess typical and abundant steraster spicules.
Id- KR, CA, SWK, MCD
Reference- Wiedenmayer, 1977.

O. Verongiida, F. Aplysinidae

Aiolochroia crassa (Hyatt, 1875)

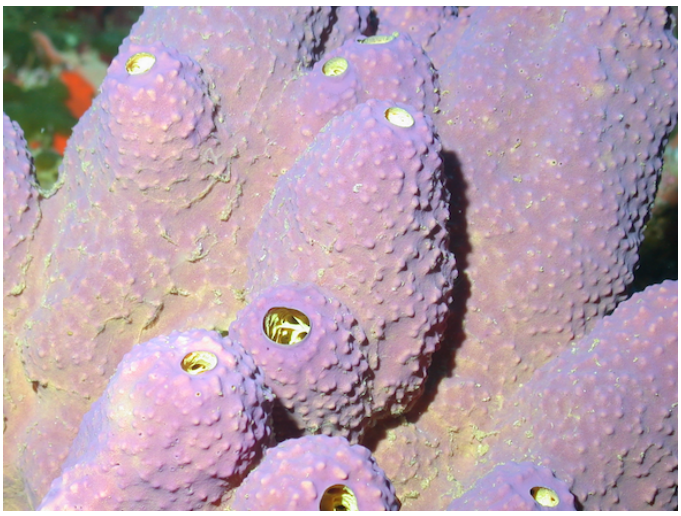


Figure 47. *Aiolochroia crassa*, 55 m deep. DFH5 Dive 11269 14 17 20.JPG

Diagnostic features- Massive/lobate to amorphous. Variable color from yellow to pink to purple. The surface has roundish conules. The oscules are on top of lobe(s), have small oscular flat membranes the same color than the sponge. Compressible and dense in consistency.
Distribution and abundance – This species is very common at shallow coral reefs in Florida, Bermuda, and Bahamas, Caribbean wide, Brazil, and Gulf of Mexico. At FGBNMS mesophotic is widely distributed at 10 sites.
Ecology –Coral communities. Similar species: some specimens of *Verongula rigida*, with low abundance of ridges at the surface, can be confused with this species.
Id- KR, CA, SWK, MCD
Reference- Wiedenmayer, 1977.

ARPHA Preprints Author-formatted, not peer-reviewed document posted on 06/09/2022 DOI: https://doi.org/10.3897/arphapreprints.e94515

Aplysina sp.1 (Higgin, 1875)

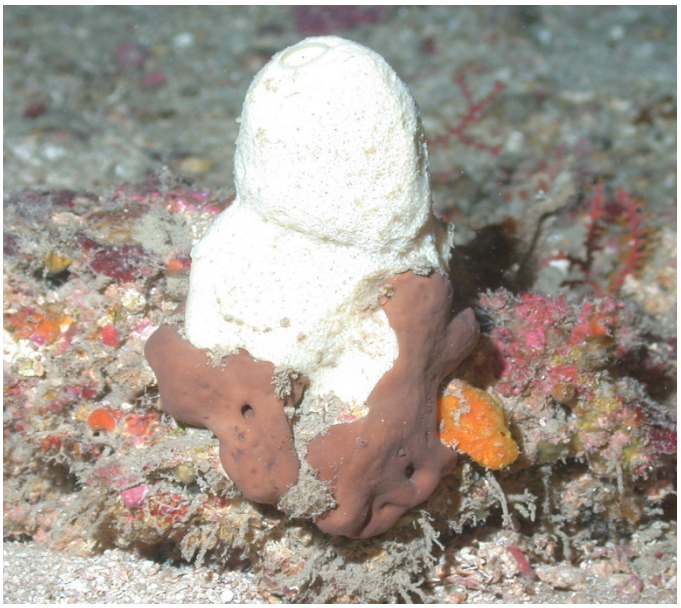


Figure 48. *Aplysina* sp.1 at 81 m deep. Sample DFH9-2B.

Diagnostic features- A single white tube (7 cm high, 3-4 cm wide); the sponge turns medium brown in alcohol. The surface is verrucose to finely conulose, and firm in consistency. One apical osculum (6 mm wide) with a thin membrane.
Distribution and abundance – This is a unique and rare species of *Aplysina*, found in mesophotic reefs at FGBNMS and Pulley Ridge. At FGBNMS it was found once at the east Flower Gardens bank.
Ecology- Found at coralline algal reef, algal nodule, lower mesophotic reef. Similar species: The overall growth form of this species is similar to *Aplysina archeri*. However, *A. archeri* tubes are usually much larger, and invariably present a pink to violet color at all its depth range of distribution (observed in Cuba at 58 and 81 m deep)
Id- KR, CA, SWK, MCD
Reference- Van Soest, 1978; Pinheiro et al., 2007.

Aplysina cf. *archeri* (Higgin,1875)

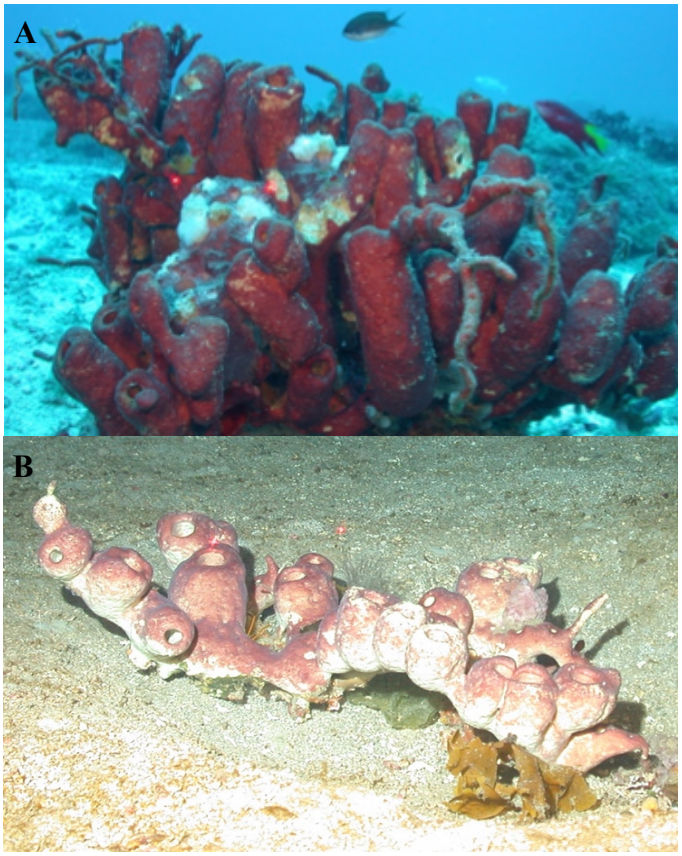


Figure 49. *Aplysina cf. archeri,* at 43-76 m deep. Photocode **A** SP04 and **B** SP25.

Diagnostic features- Clusters of short tubes that spread laterally. SP04 was 10-20 cm high, and 3-5 cm in diameter, and SP25 was 3-10 cm high 3-6 cm wide, pink to deep purple in color. Fistulose rods sporadically grow out from the tubes. Surface rugose and microconulose. Roundish tube tops, more pronounced on SP25. The specimens are tentatively identified from the photos as Aplysina cf. *archeri* considering the predominance of short roundish tubes, lateral growth tendency and the lack of samples to analyze.
Distribution and abundance- *A. archeri* is common at shallow coral reefs in Florida (Dry Tortugas) and Caribbean wide. This species might be a morphological variant of the species or a closely related species which occurs as single or clumps of elongated purplish tubes.
Ecology – Coral communities, sandy substrates. Similar species: At least three species of *Aplysina* described can be a cluster of short tubes, viz. *A. fistularis*, *A. insularis* and *A. muricyana* but their color is mostly yellow. Collection and genetic data would be very important to discern these species.
Id- MCD
Reference- Van Soest, 1978. Pinnheiro et al., 2007.

ARPHA Preprints Author-formatted, not peer-reviewed document posted on 06/09/2022 DOI: https://doi.org/10.3897/arphapreprints.e94515

Verongula rigida (Esper, 1794)

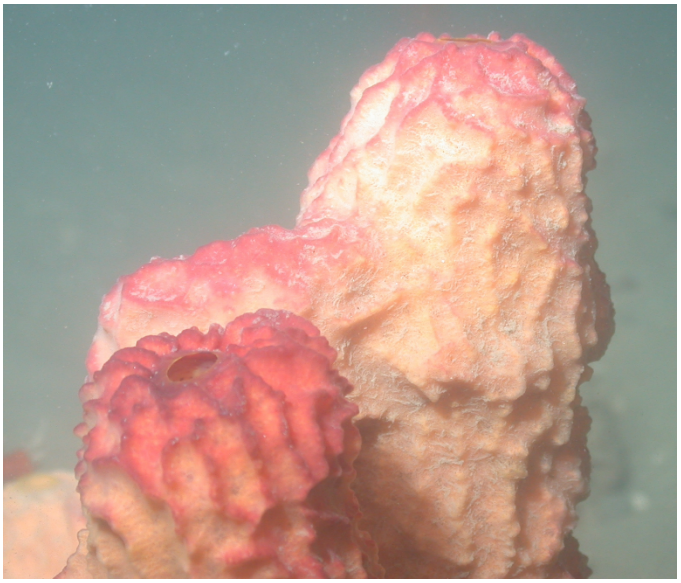


Figure 50. *Verongula rigida* at 55 m deep. Sample(s) DFH8-38B, DFH6-40-2, DFH9-9B**.**

Diagnostic features- Massive lobate to tubular species. This sample had multiple tubes of different lengths (4-20 cm high, 2-4 cm wide). Yellow reddish in color live, purple in dry or alcohol. The surface is rugose to verrucose, ribbed and smooth to the touch, not like sandpaper. One osculum (0.8-1 cm) on top of each tube, the opening extends length of sponge. Oscula with a flat diaphragm-like contractile membrane darker in color. The consistency is firm but compressible, fibrous, and tough.
Distribution and abundance – This species is common at shallow coral reefs Caribbean wide. At FGBNMS, rare, found at three sites.
Ecology – Heavily silted lower mesophotic reefs. Similar species: specimens of this species with little ribbed surface can be confused with *Aiolochroia crassa.* Some morphotypes of *Smenospongia aurea c*an also look like short tubes of *V. rigida*.
Id- KR
Reference- Wiedenmayer, 1977.

Verongula reiswigi (Alcolado, 1984)

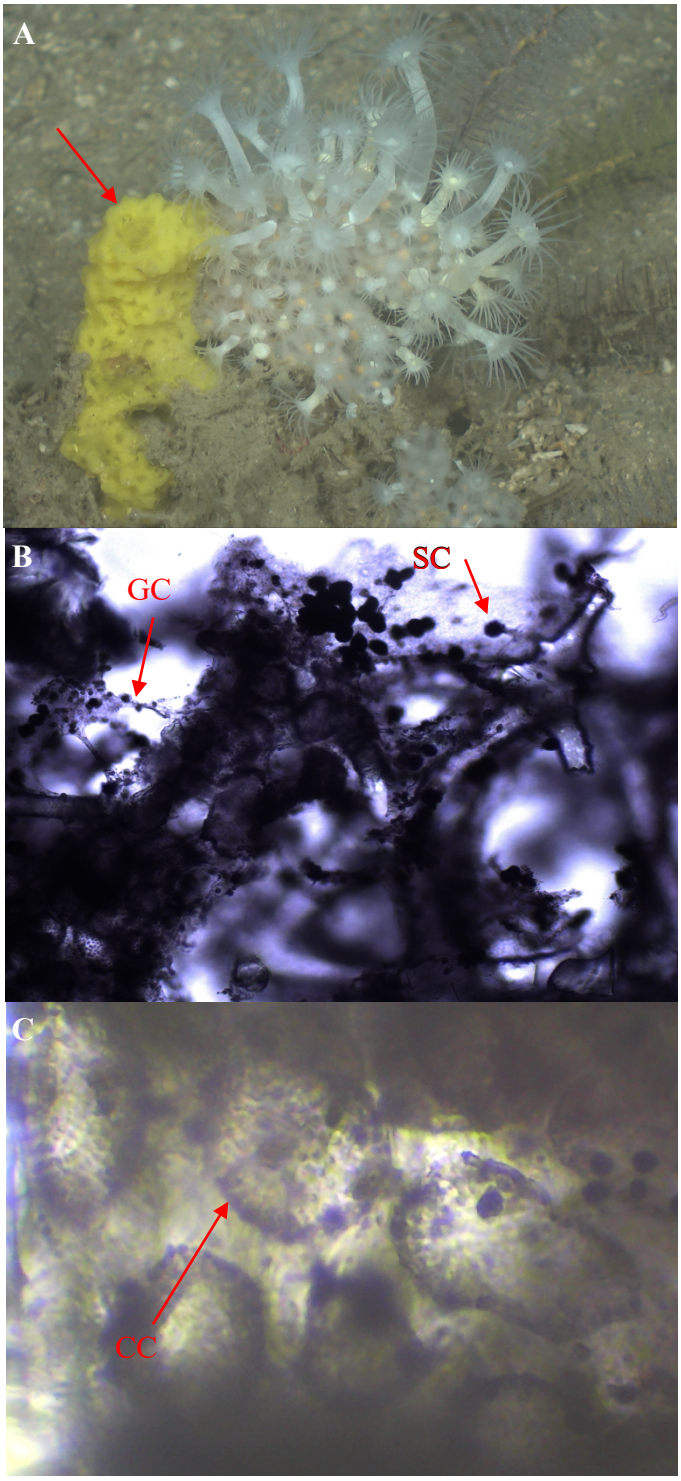
Figure 51. *Verongula reiswigi* at 76 m deep. Sample(s) SP58.

Diagnostic features- Large tube or vase, wider at the base or at the mid body. The color is yellow with green or pinkish tinges alive, purple dry or alcohol. The surface is ribbed forming a regular pattern that covers the whole sponge surface. One large opening at top of each vase (>5 cm). Oscula with a very thin membrane (1-2 mm) that surrounds the whole rim. The consistency is firm but spongy too.
Distribution and abundance – This species is rare in occurrence at shallow and mesophotic coral reefs in Florida, Bahamas, Cuba, and eastern Caribbean. At FGBNMS, seen once at one site.
Ecology – Heavily silted lower mesophotic reef. The overall shape, oscula size and surface of this species makes it unique.
Id- MCD
Reference- Alcolado, 1984; Perez et al., 2017.

ARPHA Preprints Author-formatted, not peer-reviewed document posted on 06/09/2022 DOI: https://doi.org/10.3897/arphapreprints.e94515

O. Verongiida, F. Ianthellidae

Ianthellide sp. 1.



Diagnostic features- Thin encrusting sponge, <1 mm thick, bright yellow in life, purple in alcohol. This thin sponge seems to be overgrowing the skeleton of a dictyonal hexactinellid skeletal framework. No microscleres could be seen from the hexactinellid, thus it could be dead. The conspecificity of the hexactinellid with *Iphiteon panicea* sample GFOE3-23, to the right of this yellow sample (GFOE3-23A), could not be identified. The thin sponge appears undetachable from the skeletal framework where it grows. Dark cells similar to verongid spherulous cells (SC), and granular cells (GC), and wide elliptical choanocyte chambers (CC), 30-80 µm in diameter, support the interpretation of this species as a skeletaless species of the family Ianthellidae. Two skeletaless Ianthellidae genera have been described *Hexadella* and *Vansoestia*, which have a more detachable leathery body, with surfaces ornamented by dermal canals. This is the first report of a Verongiid overgrowing an hexactinellid.
Distribution and abundance- At FGBNMS the species was collected once at Elvers Bank.
Ecology – Coralline algae reefs, lower mesophotic reefs, algal noduless.
Id- MCD
Reference- Diaz et al., 2015.

Figure 52. **A** *In-situ* photo of a thin yellow Verongid growing on an hexactinellid skeletal framework highlighted by the red arrow. Sample GFOE3-23A. **B** fragment of sponge observed under light microscope 100X; arrows show large dark cells potential spherulous cells (SC), and smaller dark cells, potential granular cells (GC). **C** Smear of a sample fragment observed with a light microcope at 400X magnification. Large ovoid choanocyte chambers were observed (red arrow).

ARPHA Preprints Author-formatted, not peer-reviewed document posted on 06/09/2022 DOI: https://doi.org/10.3897/arphapreprints.e94515

SC. Keratosa, O. Dendroceratida, F. Darwinellidae

Aplysilla aff. *sulfurea* (Schulze, 1878)

Figure 53. *Aplysilla aff. sulfurea*, preserved sample, 71 m deep. Sample(s) DFH9-14B.

Diagnostic features- Thin encrusting sponge, 1-2 mm when preserved in alcohol. Pale yellow/orange in color live. In alcohol it turns dark purple. In life the surface shows low conules, and oscules few mm wide.
Distribution and abundance- *Aplysilla sulfurea* is the type species for the genus, and it was described from the Adriatic and Mediterrranean seas and eastern Atlantic. The reports from Bermuda, Florida and southern Africa probably represent different species of similar habit and color. At FGBNMS the species is widely distributed at 14 sites with a range of abundance from rare to medium (2-100). The aff. indicates that our specimen is a different *Aplysilla* species from the Mediterranean species *A. sulfurea.*
Ecology – Coralline algae reefs, lower mesophotic reefs, algal nodules. Similar species: Very similar to *Dysidea* sp.1 described below.
Id- CA, MCD
Reference- De Laubenfels, 1950, 1953.

O. Dictyoceratida, F. Dysideidae

Dysidea sp. 1

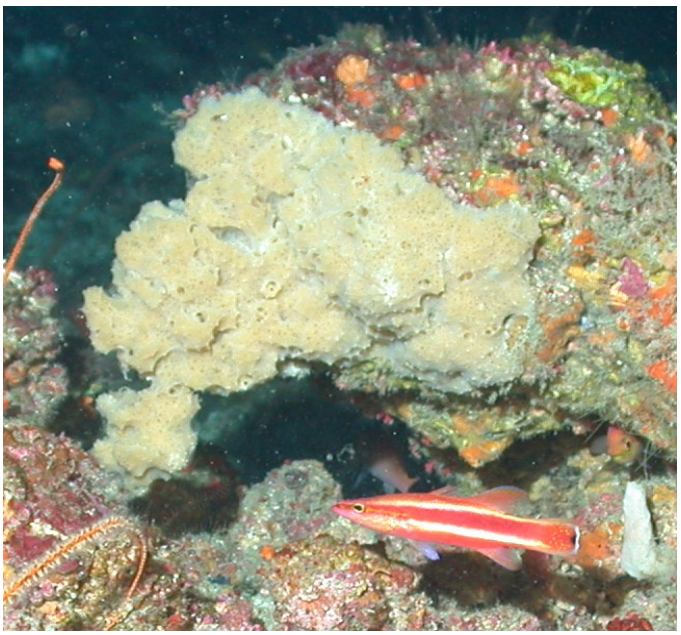


Figure 54. *Dysidea* sp.1, 69 m deep. Sample DFH9-14F.

Diagnostic features- Encrusting to massive (2-4.5 cm in thickness). Pale yellow to orange color in life. The surface is porous and with low conules. Many oscula with transparent membranes. The sponge is compressible.
Distribution and abundance- At FGBNMS the species is widely distributed at 10 sites with a range of abundance from rare (1 per site) to common (11-100).
Ecology- Coralline algae reef, lower mesophotic reef, and algal nodules. Similar species: this species is similar to Mediterranean species *D. fragilis*. There is an inaccurate citation of *D. fragilis* by deLaubenfels (1953) from the GOM. This is probably an undescribed species.
Id- KR, MCD
Reference- De Laubenfels, 1953.

ARPHA Preprints Author-formatted, not peer-reviewed document posted on 06/09/2022 DOI: https://doi.org/10.3897/arphapreprints.e94515

Pleraplysilla sp. 1 n. sp.

Figure 55. *In-situ* photo of *Pleraplysilla* sp.1, 72 m deep. Sample DFH9-14C.

Diagnostic features- Very thin crust, light pink color. The surface is smooth with irregularly distributed small conules (<1 mm high). Oscules with a collar membrane and thick canals that run towards the oscules. The conules are produced by single or branching fibers that depart from a spongin basal plate.
Distribution and abundance- Reported by Zea et al. 2014 from Bahamas and possibly Boynton Beach, FL. At FGBNMS the species is found at 7 sites with an abundance range from rare to low (1-10) at six sites, to common (11-100) at one site.
Ecology – Coralline algae reefs, lower mesophotic reefs. Similar species: very similar on external appearance to *Vansoestia caribensis*, a skeletaless sponge of the family Ianthellidae, Order Verongiida. The present species has abundant single or dendritic fibers, dark in color with an apparent pith, and some foreign spicules inside. This sponge is very similar to the species of *Pleraplysilla* depicted by Zea et al. 2014. It is a currently undescribed species.
Id- KR, SK, CA, MCD
Reference- Zea et al., 2014.

Pleraplysilla sp. 2 n. sp

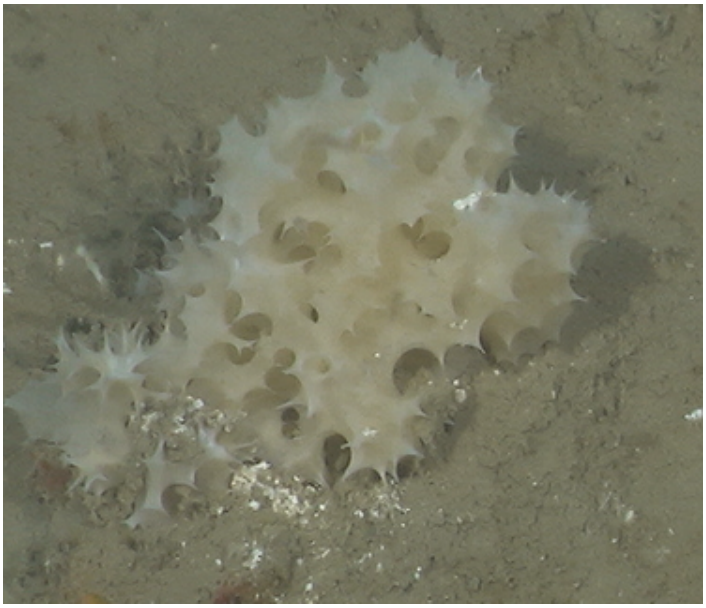


Figure 56. *Pleraplysilla* sp.2, 47 m deep. Sample GFOE3-19.

Diagnostic features- Massive bushy, 5 cm wide, 7 cm high. Tan in color in life. Sharp conules, 2-3 mm high, separated 3-5 mm. The sponge is compressible but firm. The sponge has dendritic fibers, light in color, which incorporate broken spicules. This sponge is currently identified as an undescribed species of *Pleraplysilla*. 28S analysis of this specimen clearly places it within O. Dictyoceratida, but is not within F. Dysideidae. 18S analysis places it 99.5 % similar to *Pleraplysilla spinifera,* the type of the genus which is an eastern Atlantic and Mediterranean species. This result supports the generic assignation of this new species from GOM (Diaz et al., in prep.)
Distribution and abundance- The species has been collected once from FGBNMS and once from Pulley Ridge (Diaz et al., in prep)
Ecology – Coralline algal reef. Similar species: its massive habit is similar to the shallow Caribbean mangrove *Pleraplysilla stocki.* and to *P. spinifera* from the Mediterranean.
Id- MCD, IS
Reference- Van Soest. 1978.

ARPHA Preprints Author-formatted, not peer-reviewed document posted on 06/09/2022 DOI: https://doi.org/10.3897/arphapreprints.e94515

O. Dictyoceratida, F. Irciniidae

Ircinia campana (Lamarck, 1814)

Figure 57. *Ircinia campana*, 56 m deep. Photocode(s) SP10.

Diagnostic features: Flabellate to fan or cup shaped, sometimes pedunculated. Brown, gray, pinkish, or white color in live. The surface is regularly conulose and rugose. Abundant round oscules (4-8 mm) on the inner wall surface. This might be a different species from the shallow reef species, but close genetic and morphological comparison must be carried out to distinguish *Ircinia* species (Kelly and Thacker, 2021).
Distribution and abundance- Widespread through the Caribbean at shallow coral reefs and seagrass meadows. This is the first report of the species for the northwestern GOM and at mesophotic depths. At FGBNMS, low (1-10) in abundance and only documented at Stetson Bank.
Ecology- Lower mesophotic reefs, coralline algae reefs.
Id- MCD
Reference(s) - Diaz et al. 2019.

O. Dictyoceratida, F. Irciniidae

Ircinia* cf. *campana (Lamarck, 1814)

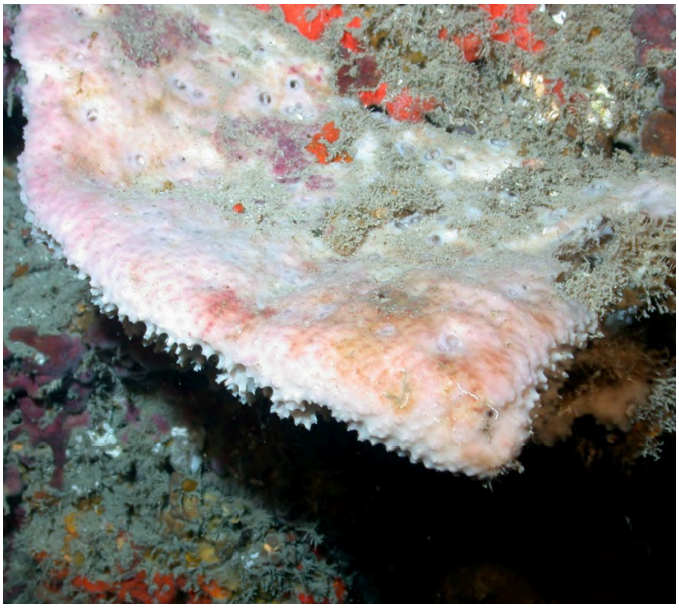


Figure 58. *Ircinia cf. campana*, 50 m deep. Sample DFH9-8A.

Diagnostic features: Flabellate to fan. Brown, gray to pinkish in color. The surface is regularly conulose. Abundant round oscules (2-3 mm) on the upper surface, sometimes clumped. The cf. is to highlight the uncommon platey shape for the species, indicating that this morphotype can represent either a different species or a variant of *Ircinia campana*. Further genetic and morphologic comparisons are required to discern the two hypotheses.
Distribution and abundance- Widespread through the Caribbean at shallow coral reefs and seagrass meadows. This is the first report of the species for the northwestern GOM and at mesophotic depths. Single specimen found at one locality.
Ecology- Coralline algal reefs.
Id- MCD
Reference(s) – Van Soest, 1978; Diaz et al. 2019.

ARPHA Preprints Author-formatted, not peer-reviewed document posted on 06/09/2022 DOI: https://doi.org/10.3897/arphapreprints.e94515

Ircinia strobilina (Lamarck,1816)

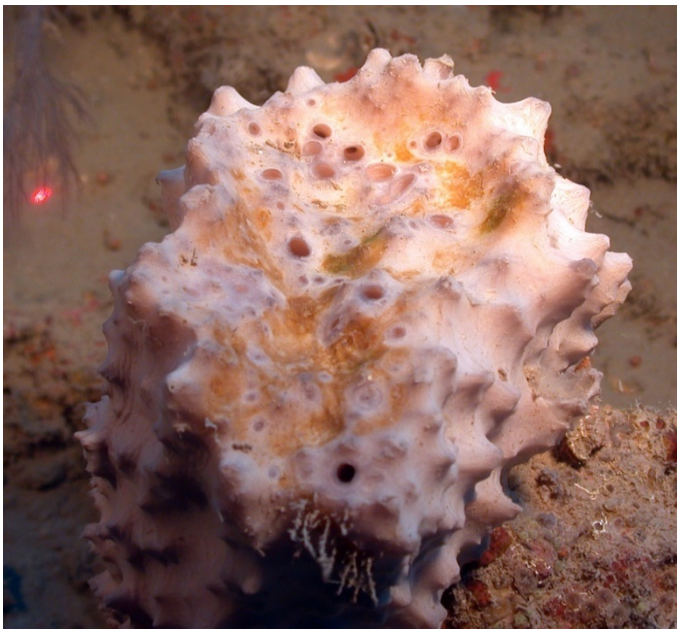


Figure 59. *Ircinia strobilina,* 50 m deep. Photocode SP09.

Diagnostic features: The sponge is sub-globular to massive and cake shaped, gray to black color in live. Large specimens show an upper depression where oscules abound. The surface has characteristic large conules (2-15 mm high, 5-15 mm apart). Oscules 4-10 mm in diameter, either single or in groups, with a thin membrane. The specimens are tough in consistency.
Distribution and abundance- Widespread through the Caribbean, Bermuda, GOM and Brazil. The species has been reported in the northern and southern GOM (de Laubenfels 1936; Green et al. 1986; Gómez 2002; 2007, 2011). This species is a common inhabitant in the coral reefs in the southern GOM. At FGBNMS the species is abundant at Stetson and Sonnier Banks.
Ecology- Coral communities, coralline algae reefs, lower mesophotic reefs.
Id- MCD.
Reference(s) – Van Soest, 1978.

Ircinia sp.1

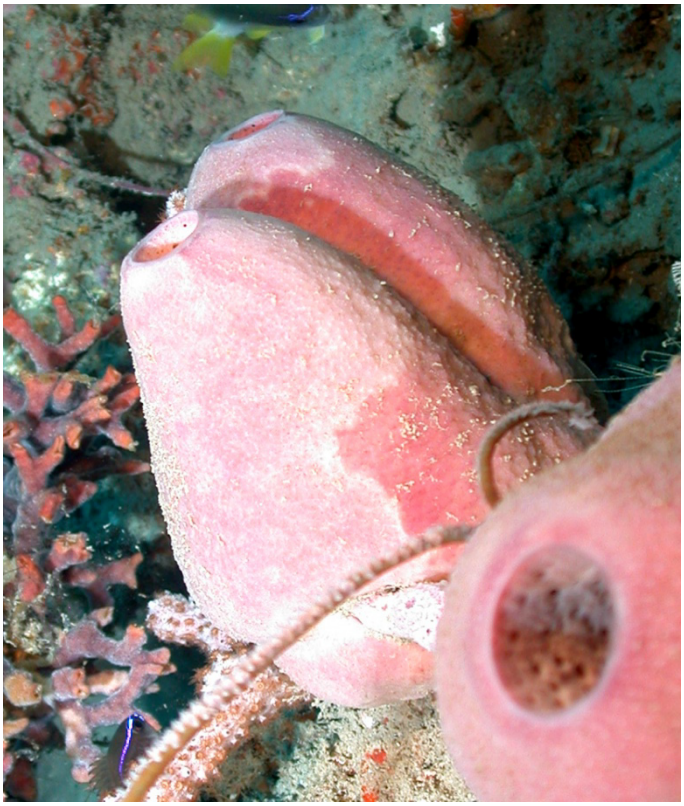


Figure 60. *Ircinia* sp. 1, 49-55 m deep. Sample(s) DFH9-8B, DFH9-7F.

Diagnostic features: Single or 2-3 tubes connected at the base. Tubes taper towards the tip. Pink to white in life. The tubes in figure are 13 cm high. The surface has minute conules homogeneously spaced. One large oscule per tube (around 2 cm in diameter) with a thin lighter membrane.
Distribution and abundance- This is an undescribed species of *Ircinia.* At FGBNMS the species was seen once at two localities. MCD has seen this species once in the Bahamas.
Ecology- Silted coralline algae reefs, silted lower mesophotic reefs. Similar species: this is a very unique *Ircinia* species.
Id- CA, KR, SK, MCD
Reference- Van Soest. 1978.

ARPHA Preprints Author-formatted, not peer-reviewed document posted on 06/09/2022 DOI: https://doi.org/10.3897/arphapreprints.e94515

Ircinia sp.2

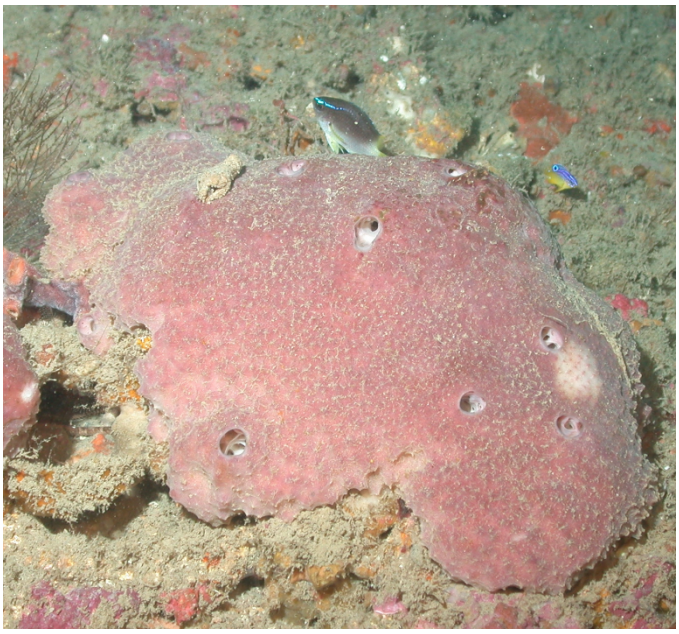


Figure 61. *Ircinia* sp.2 50 m deep. Sample DFH9-9A**.**

Diagnostic features- Cushion shape to massive (5 cm thick). The surface is finely conulose (<1 mm high, and 1-2 mm apart). Color alive is pink to reddish brown externally, tan internally. Small oscula 2-4 mm in diameter) with a white thin membrane around their rim, sparsely distributed on the sponge. The sponge is compressible but tough to cut.
Distribution and abundance- At FGBNMS the species was found once at one site.
Ecology- Coralline algal reefs. Similar species: the species appears similar to *Neopetrosia proxima* and its closest species. *N. proxima* lacks the conules, has harder consistency, and a skeleton of spicules.
Id-CA, KR, SK, MCD
Reference- Van Soest. 1978.

O. Dictyoceratida, F. Thorectidae

Smenospongia* cf. *echina (De Laubenfels, 1934)

Figure 62. *Smenospongia cf. echina*, 55-63 m deep. Sample(s) DFH9-10E, DFH9-6C.

Diagnostic features: Globular to cushion shape, dirty yellow to grayish in live, purple brownish in alcohol. The surface has shallow roundish warts (up to 1 cm wide), but feels smooth to the touch. Oscules from 2 mm to over 1 cm wide, with a slightly elevated membrane.
Distribution and abundance- *S. echina* occurs in low abundance at shallow and mesophotic reefs in Puerto Rico (60-72 m), Belize, Florida (Dry Tortugas), Cayman Islands, and Cuba. At FGBNMS the species occurs in rare to low abundance (1-10) at four sites.
Ecology – Lower mesophotic reefs, coralline algae reefs. Similar to verongiid species, *Smenospongia* spp. tends to turn purplish when collected.
Id- CA, KR, SK, MCD
Reference- Van Soest. 1978. Rützler et al., 2014.

ARPHA Preprints Author-formatted, not peer-reviewed document posted on 06/09/2022 DOI: https://doi.org/10.3897/arphapreprints.e94515

C. Homoscleromorpha, O. Homosclerophorida, F. Plakinidae

Plakortis zygompha (Schulze, 1880)

Figure 63. *Plakortis zygompha*, 81 m deep. Sample DFH9-2B.

Diagnostic features: Thick encrusting (5-10 mm thick). Pinkish-brown in life. The surface is very smooth, velvety to the touch. Dense in consistency. Sponge was overgrowing the base on an albino *Aplysina* spp. (DFH9-2B). Spicules larger than *P. zyggompha* (de Laubenfels, 1934).
Distribution and abundance- The species is originally described from mesophotic depths (84-165 m), and is also reported from Florida (Dry Tortugas), Belize (cryptic habitats), and Jamaica (mangroves). At FGBNMS the species was rare and found at only 3 sites.
Ecology –Algal reef, algal nodule, lower mesophotic reef. Similar species: *Plakortis angulospiculatus* and *P. halichondroides*, the same dark brown color and thick crustose shape, *P.zygompha* is always much thinner (< 5 mm) and oscules are much smaller. A genetic comparison would clarify the taxonomic status of the FGBNMS material.
Id- SK, KR, CA
Reference- De Laubenfels (1934); Rützler et al., 2014.

C. Hexactinella, O. Hexasterosphora, F. Dactylocalycidae

Dactylocalyx pumiceus (Stutchbury, 1841)

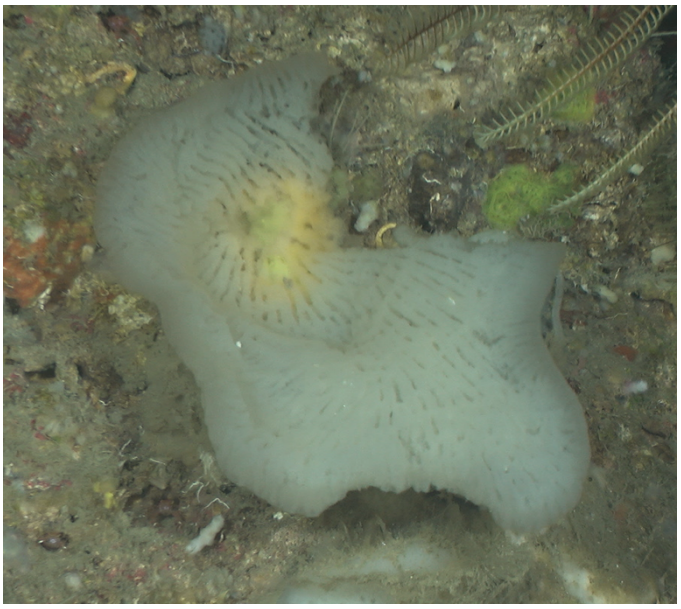


Figure 64. *In-situ* photo of *Dactylocalyx pumiceus*, 147 m deep. Sample(s) GFOE3-24.

Diagnostic features: basal funnel expanded distally forming a plate, or a cup, with a wavy rim. Inner cup surface has elongated pits or grooves, several cm long, <1 cm wide. This sample has not been studied but the overall growth form points to this species.
Distribution and abundance- This is a species of great latitudinal distribution from Florida and Gulf of Mexico to Brazil, distributed along the western coast of the Atlantic Ocean between 30^0N and S, at depth of 91-1996 m. The species is also reported off the coast of Portugal. At FGBNMS the species was collected at Elvers Bank where it was found in low (1-10) abundance
Ecology – Lower mesophotic reef.
Id- MCD
Reference- Reiswig, 2002.

ARPHA Preprints *Author-formatted, not peer-reviewed document posted on 06/09/2022* DOI: https://doi.org/10.3897/arphapreprints.e94515

Iphiteon panicea (Bowerbank, 1869)

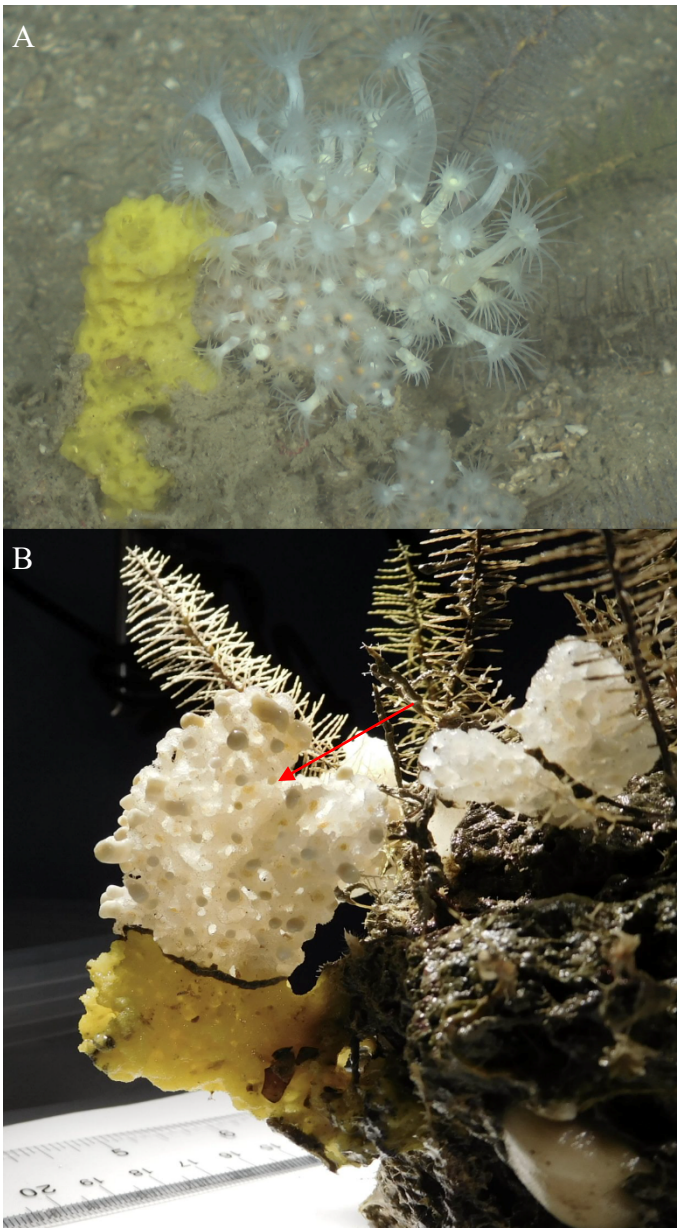


Figure 65. **A** *In-situ* photo of 147 m deep. Sample GFOE3-23 (white) and GFOE- 23A (yellow). **B** Lab photo of the specimen.

Diagnostic features: Massive flabellate white glass sponge, attached to a rock. The white elongated zoanthid, *Vitrumanthus schrieri,* partially overgrowing its surface. The skeleton study of the white hexactinellid (GFOE- 23) revealed a dictyonal siliceous rectangular to triangular framework, and spicules that agree with *Iphiteon panicea* description described by Reiswig (2002; p.1299). What appears to be a portion of this specimen with a bright yellow color in life, turned dark purple in alcohol, and it was kept as a different sample (GFOE3- 23A). Under a light microscope, the bright yellow hexactenillid appears to be a Dactylocalycidae skeletal framework, covered by thin tissue with no fibers or spicules (Fig. 51B and C). The color pattern in life and in alcohol and the type of cells and chambers suggest that this yellow tissue might represent a skeletaless verongiid of the family Ianthellidae. The hexactinellid portion of yellow color area lacked any microscleres; this would suggest that the hexactinellid might be dead, which would make the yellow species a potential epibiont for this hexactinellid. More study is required to clarify the identity of this apparent yellow hexatinellid. The trabecular surface is evident on the deck photo (Fig. 64B) with round to elongated holes (2-10 mm in diameter).

Distribution and abundance- This species has a northwestern Caribbean distribution (88-1957 m deep)**.** At FGBNMS the species was collected once at Elvers Bank.

Ecology – Lower mesophotic reefs, sandy bottoms. The zoanthid *Vitrumanthus schrieri* Kise et al., 2022 (Parazoanthidae) is originally described in association with the glass sponge *Verrucocoeloidea liberatorii* Reiswig & Dohrmann, 2014. In the case of this sample the identity of the zoanthid was obtained by barcoding data (28S gene) (Segura, unpublished). Similar species: when zoanthids are extended the species can look like *V. liberatorii*.

Id- MCD

Reference- Kise et al., 2022; Reiswig & Dorhrmann, 2014; Reiswig, 2002.

Discussion and Conclusions

The checklist of 64 sponge species in this study represents only a portion of the sponge fauna inhabiting mesophotic depths in the Flower Garden Banks National Marine Sanctuary region. Caribbean coral reefs that have been studied for years, including surveys of both open and sciophilous (shaded) habitats, such as the Belizean barrier reef (Ruetzler et al., 2014) or the Netherland Antilles (Meester et al., 1991; Van Soest, 1978, 1980, 1984; Van Soest et al., 2014), describe species richness at more than 200 sponge species. Considering the large diversity of habitats and substrates in the studied region, it is expected that similar sponge biodiversity potential is possible at the Flower Garden Banks National Marine Sanctuary. Therefore, the 64 species in this study likely represent no more than a third of the potential sponge biodiversity in the region, with a focus on some of the most conspicuous components of the sponge fauna in the sanctuary region. Even with this partial representation, there are thirteen species that could only be identified to genus level, and one to family level, demonstrating a high potential to find new species that await discovery at these mesophotic depths in the northwestern Gulf of Mexico.

Our most recent collection conducted off the Sanctuary boundaries in 2019 contributed specimens of six potentially new species: *Auletta* sp.1, *Petrosia* sp.1, *Xestospongia* sp.1, *Cinachyrella* sp.1, Ianthellidae sp.1, and *Pleraplysilla* sp.2. These include species with important biomass representation and widespread occurrence (*Petrosia* sp.1, *Xestospongia* sp.1) or with novel ecological features (Ianthellidae sp.1). Molecular analyses (using 28S and 18S genes) are in progress to complement the morphological characteristics to refine and, in some cases, confirm the identification of these mesophotic sponges (Diaz, Segura, and Pomponi, in prep).

The biological role of sponges in coral ecosystems should ignite the interest to continue studying this fauna. Sponges are known for their high diversity and biomass in shallow and mesophotic coral reefs (Diaz and Rützler, 2001; Reed et al., 2018). They are important space competitors either by occupying substrate or by overgrowing other reef organisms (Aerts et al., 1998; Pawlik, 2011), and they provide habitat for hundreds of species within or around them (Villamizar and Laughlin, 1989). Spongivory is a well-known relationship with a variety of reef fauna ranging from turtles and fish to seastars (Wulf, 1994; Bell, 2008; Mah, 2021). Sponges, through their high capacity of water filtration and their associated microbes, mediate several microbial metabolic processes, such as photosynthesis, nitrification, nitrogen fixation, denitrification, sulfate reduction, and anaerobic ammonium oxidation (anammox) (Fiore et al., 2013). Several species (i.e., *Ircinia* spp.) are known to accumulate phosphorus in granules. Therefore, sponges are known to be major players in the cycles of main nutrients like nitrogen (major compound for proteins), phosphorous (element essential for energy transfer) and carbon (the fundamental element of life on Earth). Most species with unicellular endosymbiotic cyanobacteria (*Synnechococcus spongiarium* complex) show a red, brown or purple external color in life. Examples in this guide include: *Neofibularia nolitangere, Aplysina* spp., *Verongula* spp., *Ircinia* spp., *Geodia* spp., *Erylus* spp., *Neopetrosia* spp., *Petrosia* spp., *Xestospongia* spp., etc. Sponges play a well-known role in reef accretion by gluing the reef framework (Wulff and Buss, 1979) or by generating a structurally complex hard subtrate, and in bioerosion or coral skeletons and other calcium carbonate substrates (by species of *Cliona* and *Siphonodyction*). Few studies have evaluated the dimension, diversity, or dynamics of these sponge roles at mesophotic depths. Therefore, this is an open and exciting horizon to explore, discover and quantify through the diverse and extensive sponge community in the northwestern Gulf of Mexico and elsewhere.

Acknowledgements

We would like to recognize the extensive contribution of the people who collected the specimens used in this manuscript including the crew of the R/V *Manta*, University of North Carolina at Wilmington Undersea Vehicle Program ROV pilots (Eric Glidden, Lance Horn, Glen Taylor, and Jason White), and the Global Foundation for Ocean Exploration ROV team (Joshua Carlson, Karl McLetchie, Jeff Laning, Todd Gregory, Roland Brian). The scientific results and conclusions, as well as any views or opinions expressed herein, are those of the author(s) and do not necessarily reflect the views of NOAA or the Department of Commerce. We also thank

John Reed (Harbor Branch Oceanographic Institute- FAU) for providing photos from the 2022 NOAA OER expedition to the FGBNMS region). Funding for this project was provided in part by Flower Garden Banks National Marine Sanctuary, NOAA Deep-Sea Coral Program, and the National Marine Sanctuary Foundation.

Conflict of Interest Statement

MCD was an independent contractor for the National Marine Sanctuary Foundation and MN was employed by CPC Inc. The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

References

Aerts LAM (1998) Sponge/coral interactions in Caribbean reefs: analysis of overgrowth patterns in relation to species identity and cover. Marine Ecology Progress Series 175: 241–249. doi: 10.3354/meps175241

Alcolado PM (1984) Nuevas especies de esponjas encontradas en Cuba [New species of sponges from Cuba]. Poeyana 271: 1-22.

Alvarez B, van Soest RWM, Rützler K (1998) A Revision of Axinellidae (Porifera: Demospongiae) in the Central West Atlantic Region. Smithsonian Contributions to Zoology. 598: 1-47. https://doi.org/10.5479/si.00810282.598.

Boury-Esnault N, Rützler K (1997) Thesaurus of Sponge Morphology. Smithsonian Contributions to Zoology 596: 1–55. https://doi.org/10.5479/si.00810282.596.

Bell JJ (2008) The functional roles of marine sponges Estuarine Coastal and Shelf Science 79: 341–353. http://doi.org/10.1016/j.ecss.2008.05.002.

de Weerdt WH (2000) A monograph of the shallow-water Chalinidae (Porifera, Haplosclerida) of the Caribbean. Beaufortia 50 (1): 1-67.

Díaz MC, Pomponi SA (2018) New Poecilosclerida from mesophotic coral reefs and the deep-sea escarpment in the Pulley Ridge region, eastern Gulf of Mexico: Discorhabdella ruetzleri n.sp. (Crambeidae) and Hymedesmia (Hymedesmia) vaceleti n.sp. (Hymedesmiidae). In: Klautau M, Pérez T, Cárdenas P, de Voogd N (Eds) Deep Sea and Cave Sponges. Zootaxa 4466 (1): 229-237. https://doi.org/10.11646/zootaxa.4466.1.17

Díaz MC, Busutil L, García-Hernández MR, Pomponi SA (2019) Cuba's Mesophotic Coral Reefs- Sponge Photo Identification Guide. Reed JK, Farrington F (Eds). Cooperative Institute for Ocean Exploration, Research, and Technology (CIOERT) at Harbor Branch Oceanographic Institute, Florida Atlantic University (HBOI-FAU). First Edition: June 2019. Harbor Branch Oceanographic Institute Contribution Number 2256. http://www.cioert.org/wp-content/uploads/2019/06/D%C3%ADaz-et-al-Cubas-Mesophotic-Coral-Reefs-Sponge-Photo-Identification-Guide-Edition-1.pdf.

Díaz MC, Pomponi SA, Farrington S, Reed JK (2021). Photo Identification Guide of the Sponges inhabiting the Shelf-edge Marine Protected Areas and Deep-water Reefs of the Southeastern USA, 1st Edition. Harbor Branch Oceanographic Institute Contribution Number 2294. http://www.cioert.org/expeditions/mesophotic-reef-ecosystems.

Diaz MC, Rützler K (2001).Sponges: An essential. Component of Caribbean Coral Reefs. Bulletin of Marine Science, 69(2): 535¬-546.

Díaz MC, Pomponi SA, van Soest, RWM (1993) A systematic revision of the central West Atlantic Halichondrida (Demospongiae, Porifera). Part III: Description of valid species. In: Uriz MJ, Rützler K (Eds) Recent Advances in Ecology and Systematics of Sponges. Scientia Marina. 57 (4): 283-306.

Diaz MC, Segura I, Pomponi, SA (in prep) New sponge species discovered while exploring mesophotic reefs the Flower Gardens Bank National Marine Sanctuary Region (If submitted it will go in).

Esteves EL, de Paula, TS, Lerner C, Lôbo-Hajdu, G, Hajdu E (2018) Morphological and molecular systematics of the 'Monanchora arbuscula complex' (Poecilosclerida : Crambeidae), with the description of five new species and a biogeographic discussion of the genus in the Tropical Western Atlantic. Invertebrate Systematics 32: 457-503. https://doi.org/10.1071/is16088

Kealoha AK, Doyle SM, Shamberger KEF, Sylvan JB, Hetland RD, DiMarco SF (2020) Localized hypoxia may have caused coral reef mortality at the Flower Garden Banks. Coral Reefs 39:119-132.

Kelly JB, Thacker RW (2021) New shallow water species of Caribbean Ircinia Nardo, 1833 (Porifera: Irciniidae) Zootaxa 5072(4): 301-323. https://doi.org/10.11646/zootaxa.5072.4.1

Kise H, Montenegro J, Santos MEA, Hoeksema BW, Ekins M, Ise Y, Higashiji T, Fernandez-Silva I, Reimer JD (2022) Evolution and phylogeny of glass-sponge-associated zoantharians, with a description of two new genera and three new species Zoological Journal of the Linnean Society Volume 194, Issue 1, January 2022, Pages 323-347. https://doi.org/10.1093/zoolinnean/zlab068

Laubenfels MW de (1934) New sponges from the Puerto Rican deep. Smithsonian Miscellaneous Collections 91(17): 1-28.

Laubenfels MW de (1950) The porifera of the Bermuda archipelago. Transactions of the Zoological Society of London 27(1): 1-154.

Laubenfels MW de (1953). Sponges from the Gulf of Mexico. Bulletin of Marine Science of the Gulf and Caribbean 2(3): 511-557.

Lehnert H, van Soest RWM (1998) Shallow water sponges of Jamaica. Beaufortia. 48 (5): 71-103.

Gómez P (2006) Yucatania clavus, new genus and species of the family Thrombidae (Porifera: Demospongiae: Astrophorida) from the continental shelf off Yucatan, Mexico. Proceedings of the Biological Society of Washington 119 (3): 339-345.

Gómez P (2014). The genus Clathria from the Gulf of Mexico and Mexican Caribbean, with redescription and resurrection of Clathria carteri (Poecilosclerida: Microcionidae). Zootaxa 3790(1): 51-085. https://doi.org/10.11646/zootaxa.3790.1.3

Hartman WD, Hubbard R (1999) A new species of Thrombus (Porifera : Demospongiae : Astrophorida) from Trinidad, West Indies. Bulletin of Marine Science 64 (1): 1-8.

Meesters E, Knijn, R, Willemsen P, Pennartz R, Roebers, G, van Soest RWM (1991) Sub-rubble communities of Curaçao and Bonaire coral reefs. Coral Reefs 10: 189-197

Mothes B, Lerner CB, Silva, CMM (1999). Revision of Brazilian Erylus (Porifera: Astrophorida: Demospongiae) with description of a new species. In: Hooper JNA (Ed) Origin and Outlook. Memoirs of the Queensland Museum 44: 369-380.

Nuttall MF, Hickerson EL, Blakeway RD, Schmahl GP and Sammarco PW (2022) Do Oil and Gas Lease Stipulations in the Northwestern Gulf of Mexico Need Expansion to Better Protect Vulnerable Coral

Communities? How Low Relief Habitats Support High Coral Biodiversity. Front. Mar. Sci. 8:780248. doi: 10.3389/fmars.2021.780248

Office of National Marine Sanctuaries. 2016. Flower Garden Banks National Marine Sanctuary Expansion Draft Environmental Impact Statement. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Office of National Marine Sanctuaries, Silver Spring, MD.

Pang RK (1973).The systematics of some Jamaican excavating sponges (Porifera). Postilla 161: 1-75.

Parra-Velandia FJ, Zea, S, Van Soest RWM (2014). Reef sponges of the genus Agelas (Porifera: Demospongiae) from the Greater Caribbean. Zootaxa. 3794(3): 301. https://doi.org/10.11646/zootaxa.3794.3.1

Pawlik JR (2011). The chemical ecology of sponges on Caribbean reefs: natural products shape natural systems. Bioscience 61, 888–898. doi: 10.1525/bio.2011.61.11.

Perez T, Diaz MC, Ruiz C, Condor-Lujan B, Klautau M, Hajdu E, Lobo-Hajdu G, Zea S,

Pomponi SA, Thacker RW, Carteron S, Tollu G, Pouget-Cuvelier A, Thlamon P,

Marechal J-P, Thomas OP, Ereskovsky AV, Vacelet J, Boury-Esnault N (2017) How a collaborative integrated taxonomic effort has trained new spongiologists and improved knowledge of Martinique Island (French Antilles, eastern Caribbean Sea) marine biodiversity. PLOS ONE 12(3): e0173859 DOI 10.1371/journal.pone.0173859.

Pech-Puch D, Pérez-Povedano,M, Martínez-Guitián M, Lasarte C, Vázquez Ucha J, Bou G, Rodriguez J, Beceiro A, Jiménez C (2020) In Vitro and In Vivo Assessment of the Efficacy of Bromoageliferin, an Alkaloid Isolated from the Sponge Agelas dilatata, against Pseudomonas aeruginosa. Marine Drugs 18 (6):326. http://doi.org/10.3390/md18060326.

Pinheiro US, Hajdu E, Custódio, MR (2007) Aplysina Nardo (Porifera, Verongida, Aplysinidae) from the Brazilian coast with description of eight new species. Zootaxa 1609: 1-51

Pisera A, Lévi C (2002). Family Corallistidae Sollas, 1888. In: Hooper JNA, Van Soest RWM (Eds) Systema Porifera. A guide to the classification of sponges. 1 Kluwer Academic/ Plenum Publishers: New York, Boston, Dordrecht, London, Moscow 312-320. ISBN 0-306-47260-0.

Pomponi SA, Kelly M, Reed JK Wright AE (2001) Diversity and bathymetric distribution of lithistid sponges in the tropical western Atlantic. Bulletin of the Biological Society of Washington 10: 344-353.

Pomponi SA, Diaz MC, Van Soest RWM, Bell LJ, Busutil L, Gochfeld DJ, Kelly M, Slattery M (2019) Sponges. In: Loya Y, Puglise KA, Bridge T (Eds) Mesophotic coral ecosystems of the world. Springer, New York.

Reiswig, HM (2002) Family Dactylocalycidae Gray, 1867. pp. 1293-1300. In: Hooper JNA, van Soest RWM (2002 [2004]). Systema Porifera. A guide to the classification of sponges (2 volumes). Kluwer Academic/Plenum, NY. 1708 + XLVIII. ISBN 978-1-4615-0747-5

Reiswig HM, Dohrmann M. 2014. Three new species of glass sponges (Porifera: Hexactinellida) from the West Indies, and molecular phylogenetics of Euretidae and Auloplacidae (Sceptrulophora). Zool J Linn Soc-Lond. 171(2):233-253. http://dx.doi.org/10.1111/zoj12138

Reed JK, González-Díaz P, Busutil López L, Farrington S, Martínez-Daranas B, Cobián Rojas D, Voss J, Diaz MC, David A, Hanisak MD, González Mendez J, García Rodríguez A, González-Sánchez PM,

Viamontes Fernández J, Estrada Pérez D, Studivan M, Drummond F, Pomponi. SA (2018) Cuba's mesophotic reefs and associated fish communities. Revista de Investigaciones Marinas 38 (1): 56- 125. ISSN: 1991-6086.Harbor Branch Oceanographic Institute Contribution Number 2151. http://www.cioert.org/wp-content/uploads/2018/09/2018-Reed-et-al-Cubas-Mesophotic-Coral-Reefs-and-Associated-Fish-Communities-RIM-pub.pdf

Reed, John K., Stephanie Farrington, María Cristina Díaz, Shirley A. Pomponi, Dennis Hanisak. 2021. Photo Identification Guide of the Benthic Taxa Inhabiting the Mesophotic Reefs of the Florida Keys National Marine Sanctuary. 220 pp. Harbor Branch Oceanographic Technical Report Number 197. http://www.cioert.org/wp-content/uploads/2021/09/2021-Reed-et-al-FKNMS-Mesophotic-Reefs-Photo-Guide.pdf

Rützler K (1971) Bredin-Archbold-Smithsonian Biological Survey of Dominica: Burrowing Sponges, Genus Siphonodictyon Bergquist, from The Caribbean. Smithsonian Contribution to Zoology 77: 1-37.

Rützler K, Piantoni C, Van Soest RWM, Díaz MC (2014) Diversity of sponges (Porifera) from cryptic habitats on the Belize barrier reef near Carrie Bow Cay. Zootaxa 3805(1): 1-129. https://doi.org/10.11646/zootaxa.3805.1.1

Sandes J, Lira J, Pinheiro U, Muricy G (2020) Taxonomy of Melophlus Thiele, 1899 and Stellettinopsis Carter, 1879, with description of two new species from Brazil (Demospongiae: Astrophorina). Marine Biodiversity 50(2). https://doi.org/10.1007/s12526-019-01037-8

Schmahl GP, Hickerson EL, Precht WF (2008) Biology and Ecology of Coral Reefs and Coral Communities in the Flower Garden Banks Region, Northwestern Gulf of Mexico. In: Riegl BM, Dodge RE (Eds) Coral Reefs of the USA. Springer Netherlands, Dordrecht, 221-261.

Schmahl, G.P., E.L. Hickerson, and M. F. Nuttall (2012) Science-based design of coral protected areas in the Gulf of Mexico. Proceedings of the 12th International Coral Reef Symposium, Cairns, Australia, 9-13 July 2012

Santos Neto C, Nascimento E, Cavalcanti T, Pinheiro U (2018) Taxonomy of Oceanapia Norman, 1869 (Demospongiae: Haplosclerida: Phloeodictyidae) from the Brazilian coast. Zootaxa 4455 (2): 363 https://doi.org/10.11646/zootaxa.4455.2.6

Schuster A, Pomponi SA, Pisera A, Cárdenas P, Kelly M, Wörheide G, Erpenbeck D (2021) Systematics of 'lithistid' tetractinellid demosponges from the Tropical Western Atlantic-implications for phylodiversity and bathymetric distribution. PeerJ 9: e10775.

Semmler R, Hoot WC, Reaka ML (2016). Are mesophotic coral ecosystems distinct communities and can they serve as refugia for shallow reefs? Coral Reefs 36, 433–444. https://doi.org/10.1007/s00338-016-1530-0

Sigovini, Marco & Keppel, Erica & Tagliapietra, Davide. (2016). Open Nomenclature in the biodiversity era. Methods in Ecology and Evolution. 7. 1217-1225. 10.1111/2041-210X.12594.

Slattery M, Lesser MP, Gochfeld DJ et al (2017) Biogeographic connectivity of Caribbean mesophotic sponge communities. In: Gochfeld, DJ, Wright CA (eds) Proceedings of the AAUS 36th Scientific Symposium. American Academy of Underwater Sciences, Dauphin Island, pp 67–70.

Ugalde D, Gomez P, Simoes N (2015).Marine sponges (Porifera: Demospongiae) from the Gulf of México, new records and redescription of Erylus trisphaerus (de Laubenfels, 1953). Zootaxa 3911 (2): 151–183.

Ugalde D, Fernandez JCC, Gómez P, Lôbo-Hajdu G, Simões N (2021) An update on the diversity of marine sponges in the southern gulf of Mexico coral reefs. Zootaxa 5031 (1): 001–112. https://mapress.com/zt/article/view/zootaxa.5031.1.1

Van Soest RWM (1978) Marine sponges from Curaçao and other Caribbean localities. Part I. Keratosa. In: Hummelinck PW, Van der Steen LJ (Eds) Uitgaven van de Natuurwetenschappelijke Studiekring voor Suriname en de Nederlandse Antillen. No. 94. Studies on the Fauna of Curaçao and other Caribbean Islands. 56 (179): 1–94.

Van Soest RWM (1980) Marine sponges from Curaçao and other Caribbean localities. Part II. Haplosclerida. In: Hummelinck PW, Van der Steen LJ (Eds) Uitgaven van de Natuurwetenschappelijke Studiekring voor Suriname en de Nederlandse Antillen. No. 104. Studies on the Fauna of Curaçao and other Caribbean Islands. 62 (191): 1-173.

Van Soest RWM (2017) Sponges of the Guyana Shelf. Zootaxa 4217: 1-225 https://doi.org/10.11646/zootaxa.4217.1.1

Van Soest RWM, Stentoft N (1988) Barbados Deep-Water Sponges. In: Hummelinck PW & Van der Steen LJ (Eds) Uitgaven van de Natuurwetenschappelijke Studiekring voor Suriname en de Nederlandse Antillen. No. 122. Studies on the Fauna of Curaçao andother Caribbean Island. 70(215): 1-175.

Van Soest RWM, Rützler K (2002) Family Tetillidae Sollas, 1888. Pp. 85-98. In: Hooper JNA Van Soest RWM (Eds) Systema Porifera: a guide to the classification of sponges. Kluwer, Plenum, New York, pp. i-xlviii, 1-1704

Vicente J, Ríos JA, Zea S, Toonen RJ (2019) Molecular and morphological congruence of three new cryptic Neopetrosia spp in the Caribbean. PeerJ. 7: e6371, 30 pp. https://doi.org/10.7717/peerj.6371

Villamizar E, Laughlin RA (1991) Fauna Associated with the Sponges Aplysina archeri and Aplysina lacunosa in a Coral Reef of the Archipiélago de Los Roques, National Park, Venezuela. In: Reitner J, Keupp H (eds) Fossil and Recent Sponges. Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3E642-75656-6_44

Wagner D, Etnoyer PJ, Schull J, David AW, Nizinski MS, Hickerson EL, Battista TA, Netburn AN, Harter SL, Schmahl GP, Coleman HM & Hourigan TF (2017). Science Plan for the Southeast Deep Coral Initiative (SEDCI): 2016-2019. NOAA Technical Memorandum NOS NCCOS 230, NOAA National Ocean Service, Charleston, SC 29412. 96 pp.

Wintermann-Kilian G, Kilian EF (1984). Marine Sponges of the Region of Santa Marta (Colombia). Part II. Homosclerophorida, Choristida, Spirophorida, Hadromerida, Axinellida, Halichondrida, Poecilosclerida. Studies on the Neotropical Fauna and Environment 19(3): 121-135.

Wulff, J. L. (1994). “Sponge feeding by Caribbean angelfishes, trunkfishes, and filefishes,” in Sponges Time Space, eds R. W. M. van Soest, T. M. G. van Kempen, J. C. Braekman (Rotterdam: Balkema), 265–271.

Wulff JL and Buss LW (1979) Do sponges help hold coral reefs together? Nature 281, 474–475. doi: 10.1038/281474a0

Wiedenmayer F (1977) Shallow-water sponges of the Western Bahamas. Experientia Supplementum 28: 1-287 pls 1-43.

Zea S, Henkel TP, Pawlik JR (2014) The Sponge Guide: a picture guide to Caribbean sponges. 3rd Edition. www.spongeguide.org.