Biodiversity and Ecological Dynamics of Sciophilous Benthic Communities on Artificial Plates: Emphasis on Reef Sponges

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Biodiversity and Ecological dynamics of sciophilous benthic communities on artificial plates: Emphasis on reef sponges

By
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Submitted to the Faculty of the
Oceanographic Center
in partial fulfillment of the requirements for
the degree of Master of Science with a specialty in:

Marine Biology and Environmental Science

Nova Southeastern University

October, 2015
Thesis of
Caidra Elizabeth Hassanzada

Submitted in Partial Fulfillment of the Requirements for the Degree of

Masters of Science:

Marine Biology and Marine Science

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October, 2015

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Acknowledgments:

Thank you to Andia Chavez-Fonegra for providing me with the opportunity to do a thesis. Your support and guidance has been invaluable during this process. Thank you to my thesis advisor Dr. Reigl for providing me with a lab, and for pushing me to be my best. Thank you to my committee member Dr. Lopez for providing me with the many materials, and valuable insights that played a big part in the completion of my thesis. To my closest advisor, professor, and friend Christina, thank you for everything you have done. You have been there every step of the way for which I am forever grateful for. Your constant support has helped me become not only a better scientist but also a better person. Thank you to Dr. Edlin Castro Guerra for your assistance with the statistical analysis of this paper.


Thank you to my husband and mother for their ongoing advise, patience, and support these past few years. It is because of you that I have come so far.

Finally, I would like to thank Nova Southeastern University faculty and staff for providing me with the resources and knowledge to make this all possible.
Abstract:

Low light intensity habitats harbor unique sciophilous benthic communities and are a source of novel and unique sponge fauna. However, the community structure of these habitats is poorly studied to date. Thus, this study attempts to understand the composition and structure of sciophilous sponge populations in southeast Florida. Fifty limestone plates were placed on a shallow reef in Fort Lauderdale for two years (2010-2012). To identify the sponge community and their patterns over time, all plates were photographed at the end of each year. Then, samples were taken from each of the live sponge specimens observed on the plates and processed in the laboratory for taxonomical identification. A total of 45 different sponge species were found, the majority corresponding to the Poecilosclerida Order. Eighteen were identified to species level, twenty-two to genus, and five were undetermined. Eight sponges constitute new records to Florida, and four are potentially new species. The most dominant species include Oscarella sp.1, Dysidea etheria, Mycale sp.1, Halisarca caerula and Tedania ignis. Species richness significant varied among years, and species cover among sectors (inner and outer reef). However, sponge assemblages were similar between years with slightly variation between sectors. This study found a diverse and complex composition and structure of sponges that is quite distinct from the sponge assemblages on the open reefs. A guide of the biodiversity of cryptic sponge species was created to facilitate further studies in low light intensity habitats.

Keywords: Encrusting Sponges, Sponge assemblages, Species Richness, Cryptic Habitat
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1.0 Introduction:

Coral reefs represent one of the most bio diverse and ecologically productive tropical marine environment on the planet (Diaz, 2011). While many parts of this ecosystem have been heavily studied, there are still other portions where research has only begun to brush the surface, this is the case of cryptic habitats in which sciophilous benthic communities thrive (Ruetzler et al, 2014) (Van Soest, 2009). Sciophilous benthic communities are populations of organisms that grow better in areas of low light intensity or shade, and include bacteria, red algae and a wide array of invertebrate phyla such as sponges, ascidians, and bryozoans. The distribution of sciophilous communities, is not limited to light deficient areas of the deeper parts of the ocean. Contrary, a wide variety of these communities can be found in the shallower parts of a reef and hidden within crevices, undersides of plate-shaped corals, and rubble among others (Buss, 1979).

As the degradation of coral reefs has increased over the past century “artificial growth plates” have begun to play an important role in the study and restoration of reef environments (Baine, 2001). The use of artificial plates allows scientists to look at recruitment, growth, competition, and survival rate of benthic species such as corals and invertebrates, and thus deduce the best way to increase their populations on both natural and artificial reefs (Baine, 2001). Plates are also useful to study the possible roles that certain benthic groups beside corals play in building a reef, and help us to understand what the most important structural components of a reef environment are (Baine, 2001).

Sponges play an important role in coral reefs both structurally and functionally (Bell, 2008). Millions of years of evolution have provided them with unique properties including the ability to impact the carbonate framework, water filtering capabilities which can alter the water column and chemical and physical attributes which make them strong space competitors (Bell, 2008). With an overall diversity greater than all coral groups, and in some cases algae combined, and a living biomass that may exceed all other epibenthos in certain areas, sponges are formidable creatures in their own right (Diaz and Rutzler, 2001). Sponges can be found all across the globe in a variety of shapes and forms and are not solely constricted to the tropics (Bell, 2008). They can be found all over a reef from the top of the reef crest, to shaded crevices, to the deeper parts of the
reef environment (references). Sponges limited to such shaded environments are known as cryptic or sciophilous sponges. These sponges tend to have a less robust form compared to other reef sponges and their low ability to block the sun’s harmful rays restricts them to areas of low light intensity (Bickford, 2007). Recently it was demonstrated that cryptic reef habitats occupied by sponges are major sinks of dissolved organic matter, thus being essential in the Carbon and other geobiochemical cycles in this ecosystem (Jasper M. de Goeij et al, 2008) (Jasper M. de Goeij et al, 2013). Overall very few studies have been conducted on the community structure of these communities, for example Kobluk and Van Soest (1989) produced an annotated list of 92 species from cave sponges in reefs in the Netherlands Antilles, and Meesters et al., (1991) analyzed the abundance of major groups of organisms in these sites. Recently, two taxonomic studies on sciophilous sponges at Belize Ruetzler et al., (2014) and the Netherland Antilles Van Soest, (2009) demonstrated the importance of these habitats as a source of novel and unique sponge fauna and included more than fourteen new species.

Thus, considering the lack of studies on cryptic habitats and the potential biodiversity that they hide, the present study attempts to determine the composition and structure of sciophilous sponge populations in a shallow reef in southeast Florida. This study includes the use of artificial substrates (limestone plates) as an approach that facilitates the recruitment and manipulation of the sciophilous benthic communities, and that simultaneously avoid disturbance to the already established communities in the environment.
2.0 Materials and Methods:

2.1 Artificial Plate Setup

On July 15, 2010 fifty 20 x 20 cm limestone plates were placed at twenty three feet on the shallow terrace reef in Fort Lauderdale, Florida, USA (N26 08 530, W-80 05 794, Figure 1). Five divers took the plates and placed them randomly on the reef in groups of five. Five of these groups were placed on the inside of the reef, and the other five groups on the outside of the reef, they were all fifteen meters apart (Figure 2). Plates were tagged and attached with cable ties to PVC pipes that were hammered into the substrate (Figure 4).

2.2 Plate photographing

The plates were left down on the reef for two years and photos of the shaded part of the plates were taken on August 30, 2011 and July 5, 2012. For the first years, pictures were taken when plates were still on the reef. On the second year, photos of the plates were also taken inside aquarium tanks after collection. Sponges in each photograph were outlined in pen and categorized, later each sponge cover was obtained using the CPCE program (Kohler et al. 2006).

2.3 Sponge sampling for identification

Between August 7 and 13th of 2012, all plates were removed from the Fort Lauderdale reef and placed in a small cooler where they were then transported by boat to the wet laboratory at the Oceanographic Center. Plates were then submerged into five (12.5 by 30 by 12.8 inch) glass salt-water tanks, where they were maintained for another three weeks. In order to increase water quality and oxygen flow, the water in the tanks was replaced twice a day. The, individual plates were placed in small trays with salt water and placed under a dissecting microscope, sponge samples were collected from live specimens and observations of color, texture, and growth forms were register to help with further species identification. Sponge samples were fixed with 95% ethanol and placed in test tubes for further taxonomical identification. Plates, then were dried under the sun for a week, and placed in plastic bags to preserve dried tissues with spicules.
2.4 Taxonomic determinations

To digest sponge tissue, samples of each sponge were taken from the fixed specimens, and placed in a 24 well plate with Clorox. After 24 hours, drops of Clorox with sponge skeleton (spicules) were placed on slides and observed under a compound microscope. Spicules from each sponge were identified, photographed, and recorded on identification forms, and each spicule type was measured (n=10-25). A systematic study of all samples was carried out in the lab with Dr. Maria Cristina Diaz, together we were able to identify up to the genus and in some cases the species level. Various literature sources including the World Porifera Database were used. For five of the sponges that we had only gotten to genus, more detailed descriptions of visual characteristics and spicule measurements (n=25 per spicule type) were taken. In order to corroborate identification and evaluate if they are new species, samples were sent to experts. Two species that lack any skeleton *Oscarella sp*, and *Halisarca caerulea* were identified solely on their unique external appearance.

2.5 Sponge species abundances

Once the identification of each sponge was completed, the photographs of the top and bottom of each plate, for both years, were placed into Coral Point Count with Excel Extensions. The area covered and the number of individuals for each species was calculated. This data was used to estimate species richness, abundance, and to compare community composition between the inner and outer reef, and between both years of study. These calculations were then placed into excel. Appendix 1-X represents all the tables build.

2.6 Data analysis

The expected richness of sponges was projected using Species Accumulation Curve and 999 permutations of samples (Primer 7) with data from 2011 and 2012. Differences between sectors of the reef (inner and outer) and years (2011 and 2012) were evaluated with a two-way crossed model using univariate analysis of variance (ANOVA) for richness, and abundance of sponges, and a distance based multivariate analysis of variance (PERMANOVA) for assemblage structure (Anderson et al. 2008). For this, a dissimilarity
matrix was constructed using the Bray-Curtis coefficient of similarity for the square roots of the abundances of each species (Clarke 1993). The transformation was used to down-weight the importance of highly abundant species on the estimation of similarities, and to increases the relative importance of rare species. The statistical significance of each term in the ANOVA and PERMANOVA were obtained using a random subset of 999 permutations of residuals under a reduced model. Differences in richness and abundances are shown using means plots, while differences in assemblage structure are represented using canonical analysis of principal coordinates (CAP) (Anderson & Willis 2003). Shade plot and SIMPER analyses were used to identify the most important species contributing to the pattern of differences detected (Clarke et al. 2014). All these analyses were carried out with the software PRIMER v7 and PERMANOVA add-on (PRIMER-E Ltd, Plymouth, UK). These analyses were carried with the advice and/or help of Dr. Andia Chaves Fonnegra at NSU, USA, and Dr. Edlin Castro Guerra at Universidad de Oriente, Margarita, Venezuela). Both collaborators will be co-authors on a paper describing the ecological results of this study.
Figure 1: Arial view of study site.
**Figure 2:** Arrangement and distribution of plate setup on the reef. Plate numbers are represented in the boxes which were distributed into ten groups between the inner and outer reef.

**Figure 3:** Underwater photographs of the upper and the lower side of the plates, showing recruited organisms.
Figure 4: Schematic of anchoring of plates
3.0 Results:

3.1 Taxonomic results

3.11 Sponge species associated to artificial sciophilous habitats in Fort Lauderdale Florida

From a total of 45 distinct sponges encountered on the plates, 40 were studied taxonomically. Thirty three sponges belonged to the Class Demospongiae, two to the Class Homoscleromorpha, and five to the class Calcarea (Table 1). Eighteen sponges were identified to species level, and eight of them constitute new additions to the sponge fauna of Florida (World Porifera Database) including (World Porifera Database). This includes *Halisarca caerula* (Vacelet & Donadey, 1987), *Aplysilla rosea* (Barrois, 1876), *Chelonaplysilla betinensis* (Zea and Vansoest), *Chelonaplysilla erecta* (Tsurnamal, 1967), *Myrmikeoderma laminatum* (Rützler, Piantoni, Van Soest & Díaz, 2014), *Strongylacidon rubra* (Van Soest, 1984), *Clathria affinis* (Carter, 1880), and *Clathria compechae* (Hooper, 1996). In addition, four new sponges are proposed as new species and their descriptions are included in the next section. Other 22 sponges were identified to genus, and five more were not identified taxonomically due to lack of sufficient skeletal material and little external morphological distinctness. None of the sponges were found growing on the top of the plates.

Table 1. Sponges reported from sciophilous habitats in Florida from artificial plates placed in shallow water coral reefs in Fort Lauderdale. Taxa denominations and distribution follows Porifera classification from World Porifera Database (August 2015) and Morrow & Cardenas, (2015).

<table>
<thead>
<tr>
<th>Taxa (CLASS, SUBCLASS, Order, family, species)</th>
<th>Distribution</th>
<th>Authorship</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>HOMOSCLEROMORPHA</td>
<td></td>
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<tr>
<td>Homosclerophorida</td>
<td>Oscarellidae</td>
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<td></td>
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</tr>
<tr>
<td></td>
<td><em>Oscarella</em> sp. 1</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Florida, ND</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Collin et al., (2005)</td>
<td></td>
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</tr>
</tbody>
</table>

**DEMOSPONGIAE**

**Subclass CERACTINOMORPHA**

**Dendroceratida**

<table>
<thead>
<tr>
<th>Darwinellidae</th>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Van Soest (1980)</td>
</tr>
</tbody>
</table>

- *Aplysilla rosea*
  - France, Mediterranean Sea, North Atlantic
  - Barrois, 1876

- *Chelonaplysilla betinensis*
  - Caribbean
  - Zea and Van Soest, 1986
  - Zea and Van Soest (1986)

- *Chelonaplysilla erecta*
  - Caribbean, Brazil, Gulf of Mexico
  - Tsurnamal, 1967
  - Van Soest (1978)

**Dictyoceratida**

<table>
<thead>
<tr>
<th>Dysideidae</th>
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<tbody>
<tr>
<td></td>
<td>Van Soest (1984)</td>
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</tbody>
</table>

- *Dysidea etheria*
  - France, Gulf of Mexico, North Atlantic, Red Sea
  - De Laubenfels, 1936

**Subclass HETEROSCLEROMORPHA**

**Chondrillida**

<table>
<thead>
<tr>
<th>Chondrilliidae</th>
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</table>

| *Chondrilla caribensis* | Caribbean, Belize, ND            |
|                        | Rutzler, Duran, and Piantoni, 2007 |
|                        | Rutzler, Duran, and Piantoni (2007) |

**Halisarcidae**
<table>
<thead>
<tr>
<th><strong>Halisarca caerulea</strong></th>
<th>Caribbean, Belize, Venezuela, Panama</th>
<th>Vacelet and Donadey, 1987</th>
<th>Collin et al., (2005)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Clionaidae</strong></td>
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<td><strong>Clionaidae</strong></td>
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<tr>
<td><strong>Cliona sp. 1</strong></td>
<td>Florida</td>
<td>ND</td>
<td>Pang (1973)</td>
</tr>
<tr>
<td><strong>Suberitida</strong></td>
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<td><strong>Terpios fugax</strong></td>
<td>Belize, Caribbean, Indian Ocean, North Atlantic</td>
<td>Duchassaing and Michelotti, 1864</td>
<td>Ruetzler (1986)</td>
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<td><strong>Axinellida</strong></td>
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<td><strong>Heteroxydidae</strong></td>
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<td><strong>Poecilosclerida</strong></td>
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<td><strong>Chondropsidae</strong></td>
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<tr>
<td><strong>Batzella sp. 1</strong></td>
<td>Florida</td>
<td>ND</td>
<td>Van Soest (1984)</td>
</tr>
<tr>
<td><strong>Batzella sp. 2</strong></td>
<td>Florida</td>
<td>ND</td>
<td>Van Soest (1984)</td>
</tr>
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<td><strong>Chondropsis sp. 1</strong></td>
<td>Florida</td>
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<td>Van Soest (1984)</td>
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<td><strong>Strongylacidon rubra</strong></td>
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<td>Van Soest, 1984</td>
<td>Van Soest (1984)</td>
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<td><strong>Coelosphaeridae</strong></td>
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<td><strong>Lissodendoryx sp. 1</strong></td>
<td>Florida</td>
<td>ND</td>
<td>Ruetzler et al., (2007)</td>
</tr>
<tr>
<td>Hymedesmiidae</td>
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<tr>
<td>Iotrochotidae</td>
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<tr>
<td><em>Iotrochota birotulata</em></td>
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<td>Higgin, 1877</td>
<td>Van Soest, (1984)</td>
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<tr>
<td>Microcionidae</td>
<td></td>
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<tr>
<td><em>Clathria affinis</em></td>
<td>Caribbean, Belize, Mexico, Indian Ocean</td>
<td>Carter, 1880</td>
<td>Van Soest (1984)</td>
</tr>
<tr>
<td><em>Clathria</em> sp. 1</td>
<td>Florida</td>
<td>ND</td>
<td>Van Soest (1984)</td>
</tr>
<tr>
<td><em>Clathria</em> sp. 2</td>
<td>Florida</td>
<td>ND</td>
<td>Van Soest (1984)</td>
</tr>
<tr>
<td><em>Clathria</em> sp. 3</td>
<td>Florida</td>
<td>ND</td>
<td>Van Soest (1984)</td>
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<tr>
<td><em>Clathria</em> sp. 4</td>
<td>Florida</td>
<td>ND</td>
<td>Van Soest (1984)</td>
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<tr>
<td>Mycalidae</td>
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<tr>
<td><em>Mycale laevis</em></td>
<td>Caribbean, Gulf of Mexico, Belize, Greater Antilles</td>
<td>Carter, 1882</td>
<td>Van Soest (1984)</td>
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<td>Carribean, Florida, Gulf of Mexico, Netherlands</td>
<td>Duchassaing and Michelotti, 1864</td>
<td>Van Soest, (1984)</td>
</tr>
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<tr>
<td><strong>Mycale sp.1</strong></td>
<td>Florida</td>
<td>ND</td>
<td>Van Soest (1984)</td>
</tr>
<tr>
<td><strong>Mycale sp.2</strong></td>
<td>Florida</td>
<td>ND</td>
<td>Van Soest (1984)</td>
</tr>
<tr>
<td><strong>Mycale sp. 3</strong></td>
<td>Florida</td>
<td>ND</td>
<td>Van Soest, (1984)</td>
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<tr>
<td><strong>Tedaniidae</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>Tedania ignus</strong></td>
<td>Florida, Carribean, Gulf of Mexico, Greater Antilles</td>
<td>Duchassaing and Michelotti, 1864</td>
<td>Van Soest (1984)</td>
</tr>
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<td><strong>Tedania sp. 1</strong></td>
<td>Florida</td>
<td>ND</td>
<td>Van Soest (1984)</td>
</tr>
<tr>
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<td><strong>CALCAREA</strong></td>
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<td><strong>Calcareous sp. 3</strong></td>
<td>Florida</td>
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### 3.12 Synoptic guide to sponge species inhabiting sciophilous artificial substrate in South Florida

Below a diagnostic characterization for all species is given in the form of a synoptic guide of the sciophilous species encountered. The following guide intends to provide external diagnostic characteristics that would allow a non-expert to identify species encountered in sciophilous habitats in South Florida. Several species are extremely similar externally despite belonging to different genera and even orders. Therefore, we mention the spicule composition, and in some cases their size range if those characteristics are necessary to distinguish them.

This guide will facilitate future ecological studies of these communities

---

#### Oscarella sp. 1

**Identification** - Thin encrusting, canals with rope like pattern on the surface. Cream to light brown in color. Smooth surface and soft consistency. Oscules 1-2 mm in diameter. No spicules.

**Distribution** - Bottom of limestone plates

**Notes** - Photo by A. Chavez-Fonegra. Identification based on lack of skeleton, and external appearance which is very similar to an undescribed species of *Oscarella* from the Caribbean.
**Chondrilla caribensis**

**Identification** - Thin to thick encrusting forming sheets and mounds. Yellow, to brown, and white in color. Smooth surface with a tough consistency. Small oscules (1-3 mm) scattered on mounds. Spicules are spherasters (20-25 um across).

**Distribution** - Coral reefs

**Notes** - Photo by A. Chavez-Fonegra.

---

**Halisarca caerulea**

**Identification** - Thin encrusting (1-2 mm thick). Blue to violet or white. Smooth and slimy surface with thin canals (1 mm wide) converging on star shaped oscules (2-3 mm in diameter). No spicular skeleton.

**Distribution** - On dead coral

**Notes** - Photo by A. Chavez-Fonegra. New addition to the sponge fauna of Florida via the World Porifera Database.

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**Aplysilla rosea**


**Distribution** - Bottom of limestone plates

**Notes** - Photo by A. Chavez-Fonegra. New to the sponge fauna of Florida via the World Porifera Database.
**Chelonaplysilla betinensis**

**Identification**- Thin to thick encrusting. Light to dark purple. Surface smooth, soft. Large oscules (2-5 mm in diameter) randomly distributed. Does not have proper spicules.

**Distribution**- Reefs and rocky substrates

**Notes**- Photo by A. Chavez-Fonegra. New to the sponge fauna of Florida via the World Porifera Database.

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**Chelonaplysilla erecta**

**Identification**- Thin encrusting to lobate (0-3 cm high). Black. Conulose surface, conules (0.7-1.4 mm high). Soft and flexible. Irregularly spaced oscules (0.6-1.6 mm wide). Does not have proper spicules.

**Distribution**- Reefs and rocky substrates, occasionally mangrove roots.

**Notes**- Photo by A. Chavez-Fonegra. New to the sponge fauna of Florida via the World Porifera Database.

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**Dysidea etheria**

**Identification**- Thin crust to small cushions (3mm to 10cm diameter). Pale violet to blue. Soft with a conulose surface. Conules (1-2mm high, 1-2mm apart). Few oscules (.5cm wide). Does not have proper spicules.

**Distribution**: Common, vertical hard substrates and occasionally grows on mollusk shells.

**Notes**: Photo by A. Chavez-Fonegra
**Cliona sp. 1**

**Identification**- Thin encrusting with a porous surface. Dark veins run throughout the sponge with a white sheen on top. Bright red in color. Smooth surface with a soft consistency. Oscules not present. Spicules include tylostyles (275-287.5 x 3-5 um) tylostyle heads (6-7.5 um), and microrhabds (12.5 to 17.5 x 1 um).

**Distribution**- Bottom of limestone plates.

**Notes**- Photo taken by A. Chavez-Fonegra.

---

**Terpios fugax**

**Identification**- Thin encrusting (1mm) in thickness. Dark black to blue in color. Smooth surface with a soft consistency. Minute oscules. Spicules include tylostyles with flattened, lobed tyles (170-360 um).

**Distribution**- Bottom of limestone plates.

**Notes**- Photo taken by A. Chavez-Fonegra

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**Myrmekioderma laminatum**

**Identification**- Thin encrusting. Orange in color. Smooth surface with a soft consistency. Oscules (1-2 mm in diameter) scattered in low abundance. Spicules include large oxea (680-1000 um), acanthoxeas (226-410 um), and raphids (110 um).

**Distribution**- Bottom of limestone plates.

**Notes**- Photo taken by A. Chavez-Fonegra. New addition to the sponge fauna of Florida via the World Porifera Database.
**Batzella sp. 1**

**Identification**- Thick encrusting to cushion. Black with white sheen on surface. Soft in consistency. Smooth surface pierced by ostia. Large oscules randomly distributed (2-4 mm in diameter). Spicules include long thin strongyles (147-205 x 2-3 um).

**Distribution**- Bottom of limestone plates

**Notes**- Photo by A. Chavez-Fonegra

**Batzella sp. 2**

**Identification**- Thin encrusting. Brown to gold in color. Smooth surface with a soft consistency. No oscules present. Spicules include strongyles (200-215 x 5-6 um).

**Distribution**- Bottom of limestone plates.

**Notes**- Photo taken by A. Chavez-Fonegra

**Chondropsis sp. 1**

**Identification**- Thin encrusting with a smooth, porous surface. Bright orange. Soft and fluffy in consistency. Oscules not visible. Spicules include thin strongyles (180-190 x 2-3 um), two size classes of sigmas with the larger (32.5 x 2-3 um) and the smaller (27 x 1 um), and thin chela with reduced teeth (12 x .5 um).

**Distribution**- Bottom of limestone plates

**Notes**- Photo by A. Chavez-Fonegra
**Strongylacidon rubra**

**Identification**- Thin encrusting with a porous surface. Dark to light orange in color. Smooth surface with a soft consistency. Oscules not visible. Spicules include strongyles (167-200 um) and two sizes of sigmas with the larger being (20-30 um) and the smaller (9-15 um).

**Distribution**- Bottom of limestone plates

**Notes**- Photo taken by A.Chavez-Fonegra. New addition to the sponge fauna of Florida via the World Porifera Database.

**Lissodendoryx sp. 1**

**Identification**- Thin encrusting with a porous surface. Orange in color. Micro-conulose with a soft consistency. Oscules not visible. Spicules include tylotes (187-225 x 2-5 um), strongyles (187-240 x 5-10 um), and thin microspined oxea (87-140 x 1-2 um).

**Distribution**- Bottom of limestone plates.

**Notes**- Photo by A. Chavez-Fonegra

**Hymedesmia sp. 1**

**Identification**- Thin to thick encrusting with dark veins running throughout and a porous surface. Conulose surface. Red in color. Soft and fuzzy surface. Oscules not visible. Spicules include ancanthostyles (125 x 5 um), oxea (275-287 x 9-10 um),tylostyles (250-300 x 3 um), strongyles (250 x 3-5 um), and isochela (22.5 x 5 um).

**Distribution**- Florida

**Notes**- Photo by A. Chavez-Fonegra

**Iotrochota birotulata**

**Identification**- Encrusting to branching (1-5 cm wide) with a conulose surface. Black with green patches. Consistency touch yet compressible. Oscules (1-3 mm diameter). Spicules include strongyles (146-230 um), styles (142-242 um), and birotulates (10-15 um).

**Distribution**- Reefs, mangroves, and seagrass

**Notes**- Photo by A. Chavez-Fonegra
**Clathria affinis**

**Identification**- Thin encrusting. Orange in color. Smooth surface. Soft. Small oscules (1-2 mm in diameter). Spicules include tylostyles with microspined heads (342-538 um), styles with acanthoses head (178-602 um), acanthostyles (85-107 um), palmate isochela (18-20 um), and toxa (114-190 um).

**Distribution**- Coral reefs and rocky substrates

**Notes**- Photo by A. Chavez-Fonegra. New addition to the sponge fauna of Florida via the World Porifera Database.

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**Clathria calla**

**Identification**- Thin to thick encrusting with a porous surface. Bright orange in color. Conulose surface with a spongy consistency. Oscules not visible. Spicules include tylostyles (186-266 um), echinating styles (114-228 um), palmate isochela (16-25 um), and toxa in two size categories with the larger (95-169 um), and the smaller (27-42 um).

**Distribution**- Bottom of limestone plates

**Notes**- Photo by A. Chavez-Fonegra

---

**Clathria campecheae**

**Identification**- Thin encrusting with a porous surface. Smooth surface with a soft consistency. Orange in color. No oscules. Spicules include styles with spiny heads (400-880 um), subtylostyles with microspined heads (230-660 um), acanthostyles (70-190 um), palmate isochela (12-17um), and toxa (42-380 um).

**Distribution**- Bottom of limestone plates.

**Notes**- Photo by A. Chavez-Fonegra. New to the sponge fauna of Florida via the World Porifera Database.
**Clathria echinata**

**Identification**- Thin encrusting with a porous surface. Bright red to orange in color. Conulose surface with a soft consistency. Oscules (1-2 mm in diameter). Spicules include styles (150-550 um), stylostyles (210-450 um), toxa (190-280 um), raphide-like toxas (60-90 um), and cleistochelas (9-13um).

**Distribution**- Bottom of limestone plates.

**Notes**- Photo by A. Chavez-Fonegra.

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**Clathria spinosa**

**Identification**- Thin encrusting with a porous surface. Micro-conulose surface. Red to orange. Rough in consistency. Oscules (1-2 mm in diameter). Spicules include tylostyles (215-293 um), styles with blunt heads (169-410 um), palmate isochela (13-18 um), toxa in two size categories with the smaller (22-71 um) and the larger (200-273 um).

**Distribution**- Florida

**Notes**- Photo by A. Chavez-Fonegra.

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**Clathria sp. 1**

**Identification**- Thin encrusting to cushion with a porous surface. Bright orange. Conulose surface. Soft in consistency. Oscules not visible. Spicules include styles (187-265 x 10 um), styloides (100-150 x 5 um), strongyles (232-250 x 7-8 um), toxa in two size classes with the larger (140 x 5 um), and the smaller (60 x 3 um), and palmate isochela (30 x 2 um).

**Distribution**- Bottom of limestone plates

**Notes**- Photo by A. Chavez-Fonegra
**Clathria sp. 2**

**Identification**- Thin encrusting with white veins running throughout. Peach with a white sheen on surface. Soft. Smooth surface. Oscules not observed. Spicules include oxea (190-240 x 2-5 um), two sizes of acanthostyles with the larger (130-200 x 5-8 um), and the smaller (60-90 x 3-5 um), and two size classes of isochela with the larger (25-30 um), and the smaller (12-15 um).

**Distribution**- Bottom of limestone plates

**Notes**- Photo by A. Chaves-Fonegra

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**Clathria sp. 3**

**Identification**- Thin encrusting with a porous surface. Black to dark brown in color. Conulose surface with a soft consistency. Oscules (1-2 mm in diameter) scattered. Spicules include two size classes of styles with the larger (360-450 x 5-8 um) and the smaller (180-280 x 2-3 um), and isochela (12-15 um).

**Distribution**- Bottom of limestone plates

**Notes**- Photo by A. Chavez-Fonegra

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**Clathria sp. 4**

**Identification**- Thin encrusting with a porous surface. Orange in color. Conulose surface with a soft consistency. No oscules present. Spicules include two size classes of acanthostyles with the larger (110-150 x 5-8 um) and the smaller (60-80 x 3-5 um), two size classes of styles with the larger (260-320 x 5-6 um) and the smaller (125-200 x 2-3 um), subtylostyles (350-400 um x 8-10 um), and isochela (25-30 um).

**Distribution**- Bottom of limestone plates.

**Notes**- Photo by A. Chavez-Fonegra.
Mycale laevis

**Identification**- Think to thickly encrusting (5 cm thick) with canals. Orange to yellow. Smooth, porous surface with canals converging on oscules. Fragile yet compressible. Round oscules (2-4 mm wide) elevated by transparent collar membrane. Spicules include styles and strongylostyles (475-570 um), anisochela (68-84 um), sigmas (12-34 um), and trichodragmata (52-72 um).

**Distribution**- Coral reefs and hard bottom. Under edges of plate like stony coral.

**Notes**- Photo by A. Chavez-Fonegra.

Mycale laxissima

**Identification**- Thin encrusting, low massive, or tubular. (< 5 cm thick). Range from black, purple, orange, or cream. Conulose surface (1-5 mm high) covered in white membrane. Tough and flexible. Oscules (1-10 mm across). Spicules include subtylostyles (200-240 um), sigmas(70-80 um), and inisochela (16-23 um).

**Distribution**- Coral reefs, occasionally in mangrove peat.

**Notes**- Exudes a sticky mucus. Photo by A.Chavez-Fonegra

Mycale sp. 1

**Identification**- Thin encrusting. Takes on many different shades of orange or red. Smooth porous surface. Soft in consistency. Oscules not visible. Spicules include long thin mycalostyles with elongated heads (260-308 x 2-3 um), and wiggly tylostlyes (260-308 x 3-5 um). Microscleres absent.

**Distribution**- Bottom of limestone plates

**Notes**- Photo by A. Chaves-Fonegra
**Mycale sp. 2**

**Identification**- Thin encrusting with a porous surface. Thick veins throughout creating leaf like pattern. Smooth surface. Red in color. Soft in consistency. No oscules apparent. Spicules include subtylostyles (260-287 x 3-5 um), toxa (50-87 um), anisochela (), and two size classes of sigma with the larger (75-87 um) and the smaller (12-20 um).

**Distribution**- Bottom of limestone plates

**Notes**- Photo by A. Chavez-Fonegra

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**Mycale sp. 3**

**Identification**- Thin encrusting with a porous surface. Bright red in color with a white sheen. Smooth with a soft consistency. Oscules (1-3 mm in diameter). Spicules include sigma(77-87 um), toxa (50-87 um), subtylostyles (275-287 x 3-8 um), and anisochela (17-20 um).

**Distribution**- Bottom of limestone plates.

**Notes**- Photo by A. Chavez-Fonegra

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**Tedania ignis**

**Identification**- Encrusting to lobate (up to 15 cm thick) with a smooth surface. Bright red to orange in color. Soft and easily torn. Oscules found on top of lobes (1-2 mm wide). Spicules include tylotes (180-248 um), styles (202-281 um), onychaetes in two size categories with the larger (154-247 um) and the smaller (30-95 um).

**Distribution**- Shallow reefs, sea grass bed, mangroves

**Notes**- Photo by A. Chaves-Fonegra
**Tedania sp. 1**

**Identification**- Thin to thick encrusting. Dark to light brown or orange. Smooth surface and soft in consistency. Small oscules (1-2 mm in diameter). Spicules include strongyles (175-200 x 3-5 um), onychaete (87-125 x 1 um), and tylotes (187-237 x 2-3 um).

**Distribution**- Bottom of limestone plates

**Notes**- Photo by A. Chaves-Fonegra

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**Tedania sp. 2**

**Identification**- Thin encrusting with a porous surface. Thick black vein like patterns run throughout. Dark red in color. Smooth with a soft consistency. No oscules present. Spicules include thin microspined onychaete (122-162 x 1 um), strongyles (225-250 x 5-8 um), and thin tylotes (175-212 x 2-3 um).

**Distribution**- Bottom of limestone plates

**Notes**- Photo by A. Chavez-Fonegra

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**Clathrina sp. 1**

**Identification**- Thin encrusting to a flat cushion (1-3 cm diameter). Surface is smooth with some protruding spicules, a reticulation of thin tubes. Yellow. Soft yet delicate consistency. One single central oscule. Spicules are triactines (60-120 um).

**Distribution**- Shallow subtidal under rocks and overhangs.

**Notes**- Photo by A. Chaves-Fonegra. New addition to the sponge fauna of Florida via the World Porifera Database.
Calcarea sp. 1

**Identification**- Thin to thick encrusting. Surface is smooth and porous. Cream to light yellow. Soft in consistency. Oscules not visible.

**Distribution**- Florida

**Notes**- Photo by A. Chavez-Fonegra
3.13. Taxonomic description of four common sciophilous sponge species, currently undescribed.

Among the 22 species that were identified only to genus level, only five occurred more than once on our artificial plates. Of those, four species are described here in more detail, as a preamble to evaluate if they constitute new species to science.

**Order: Poecilosclerida**

**Family: Chondropsidae**

**Genus: Batzella sp. 1**

**Material studied:**

**Coordinates:** N26.08.530/ W80.05.794. Collected by Andia Chavez-Fonegra and Caidra Rice on 9/15/14. 23 ft deep.

SHAPE AND SIZE- Thin encrusting, to cushion less than five millimeters in thickness

COLOR (EXTERNAL/INTERNAL)- Black/black

SURFACE- Smooth and pierced by ostia

CONSISTENCY- Soft

APERTURES (OSCULES, AND OSTIA) - Round oscules 1.2 mm in diameter. Small ostia regularly present throughout the surface.

ODOR, MUCUS, EXHUDATE- not observed

SKELETAL ELEMENTS- Thin strongyles 147-205 um in length, 2-3 um in width.

SKELETAL ARRAGEMENT- not observed

ECOLOGY - Common, found under nine limestone plates. It persisted from year one to year two on some plates.

REMARKS- Batzella has ten species worldwide, three of which are Caribbean species: *B. rubra*, *B. rosea*, and *B. fusca*. Batzella Fusca is described by Van Soest as the only known dark colored
Caribbean *Batzella* species. It has a thin crust (less than .5 mm), dark brown in color with purple veins. Spicules include strongyles (213-277 um). Our specimen is thicker and lacks the purple veins. Van Soest 2009 discusses *Strongylacidon bermudae* (De Laubenfels, 1950) as a similar species which lacks microscleres but has a dark coloration. We considered that, and our species differs from *S. bermudae* in having much smaller osculae, lacking a conulose surface, and it has a white sheen to the surface.

Figure 5: Skeletal representation of *Batzella sp.1*, A. cross section of a specimen showing sparse arrangement of spicules, B. photo of a strongyle.
Order: Poecilosclerida

Family: Mycalidae

Genus: *Mycale* sp.1

Material studied:

Coordinates: N26.08.530/ W80.05.794. Collected by Andia Chavez-Fonegra and Caidra Rice on 9/15/14. 23 ft deep.

SHAPE AND SIZE- Thin encrusting

COLOR (EXTERNAL/INTERNAL) – Ranging from orange to red

SURFACE- Smooth, porous

CONSISTENCY- Soft

APERTURES (OSCULES, AND OSTIA) – none

ODOR, MUCUS, EXHUDATE- not observed

SKELETAL ELEMENTS- Spicules include long thin mycalostyles with elongated heads (260-308 x 2-3 um), and flexuous tylostlyes (260-308 x 3-5 um). Microscleres absent.

SKELETAL ARRAGEMENT- not observed

ECOLOGY- Common, found on the bottom of 19 limestone plates

REMARKS- This species has unique flexuous tylostyles, with elongated heads, and thick spicular filaments, and it lacks of any microclere component. We consulted Dr. Rob Van Soest (Naturalis, Netherlands) to aid in the identification of this species. He has seen this sponge on both sides of the Atlantic and he suggested that this species as an awkward “reduced” *Mycale*. The skeleton with loose spicule tracts is reminiscent of Mycalidae. However, the only proof of its *Mycale* affinities must await the genetic study of this species.
Figure 6. Skeletal representation *Mycale sp.* 1. A. cross section of sparse arrangement of spicules. B. Mycalostyle

A.  

---

B.  

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Order: Poecilosclerida

Family: Mycalidae

Genus: *Mycale* sp. 2

Material studied:

**Coordinates:** N26.08.530/ W80.05.794. Collected by Andia Chavez-Fonegra and Caidra Rice on 9/15/14. 23 ft deep.

SHAPE AND SIZE- Thin encrusting with red veins throughout

COLOR (EXTERNAL/INTERNAL) - Red

SURFACE- Smooth, porous

CONSISTENCY- Soft

APERTURES (OSCULES, AND OSTIA) – not apparent

ODOR, MUCUS, EXHUDATE- not observed

SKELETAL ELEMENTS- Spicules include subtylostyles (260-287.5 x3-5 um), toxa (50-87um), anisochelea (5-7 um), and two size classes of sigma with the larger (75-87 um) and the smaller (12-20 um).

SKELETAL ARRAGEMENT- not observed

ECOLOGY- Common, found on the bottom of four limestone plates

REMARKS- The combination of a red intense color and corrugated surface is atypical of common Caribbean *Mycale* species. The most recent studies of sciophilous sponges (Van Soest, 2009; Ruetzler et al., 2014) do not depict any species with these characteristics. Consultation of a specialist on this sponge group (Dr. Hajdu) will be carried out. Possibly a careful comparison and genetic study will be necessary to determine it status.
Figure 7. Skeletal representation *Mycale sp.*2. A. Mycalostyles. B. Mycalostyles and sigma. C. Mycalostyles and toxa, D. Anisochela
Order: Poecilosclerida

Family: Tedaniidae

Genus: *Tedania sp. 1*

Material studied:

**Coordinates:** N26.08.530/ W80.05.794. Collected by Andia Chavez-Fonegra and Caidra Rice on 9/15/14. 23 ft deep.

SHAPE AND SIZE - Thin to thick encrusting

COLOR (EXTERNAL/INTERNAL) - Dark to light brown

SURFACE - Smooth

CONSISTENCY - Soft

APERTURES (OSCULES, AND OSTIA) – small oscules (1-2mm in diameter)

ODOR, MUCUS, EXHUDATE - not observed

SKELETAL ELEMENTS - Spicules include strongyles (175-200 x 3-5 um), onychaete (87-125 x 1 um), and tylotes (187-237 x 2-3 um).

SKELETAL ARRAGEMENT - not observed

ECOLOGY - Common, found on the bottom of five limestone plates

REMARKS - This species have the typical spicule complement of the two other Caribbean species *Tedania ignis* and *Tedania klaussi*. The brown color of most specimens seem consistently different with the two other Caribbean species. However this morphology could represent a younger stage of one of these species. Therefore, genetic and longer term studies would be required to determine its specific distinctness.
Figure 8. Skeletal representation *Tedania sp.1*. A. Strongyles and onychaete. B. Tylote
3.2. Ecological Results

3.21. Frequency of Occurrence of Sponge Species on the Underside of Artificial Plates

Forty five species were distinguished among the 50 plates placed in the inner and outer areas of the reef. Most species occurred only once (twenty six) while only eighteen species are found in two or more plates. The most common species were: *Oscarella sp.1, Dysidea etheria, Mycale sp.1, Halisarca caerula*, and *Tedania ignis* which were found on ten or more plates (Table 2).

Table 2: Frequency of appearance of sponges per species that was encountered in each recruitment plate for 2011, and 2012.

<table>
<thead>
<tr>
<th>Species</th>
<th># of plates 2011</th>
<th># of plates 2012</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Oscarella sp.1</em></td>
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</tr>
<tr>
<td><em>Dysidea etheria</em></td>
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</tr>
<tr>
<td><em>Mycale sp.1</em></td>
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<td><em>Halisarca caerula</em></td>
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<td><em>Chelonaplysilla erecta</em></td>
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<tr>
<td><em>Chondropsis sp.1</em></td>
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</tbody>
</table>
3.22. Species richness and Area Coverage: Species Area Curve and Anova

During the two-year study the expected richness of sponge fauna reached a maximum number of forty five species. The species area curve did not reach a plateau, suggesting a greater potential for the number of species to increase in the studied area (Figure 9).

Significant differences in species richness was found among years, richness was higher in 2012 than in 2011, but not among sectors of the reef (Figure 10, Table 3). However, differences in sponge cover were significant among the inner and outer reef, with higher values for the inner reef, but not between years (Figure 11, Table 4).
Figure 9. Species accumulation curve with 2011 and 2012 data

Figure 10. Average (±SD) of species richness per plate at two reef sectors (inner and outer) for 2011, and 2012.
Table 3. ANOVA of richness values comparing sectors, years, and sectors x years (p-value obtained with 999 permutations under the reduced model).

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<th>MS</th>
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</tr>
</tbody>
</table>

Figure 11. Average (±SD) of sponge cover per plate at two reef sectors (inner and outer) for 2011 and 2012.
Table 4. ANOVA of area coverage values comparing sectors, years, and sectors x years (p-value obtained with 999 permutations under the reduced model).

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>P(perm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sector</td>
<td>1</td>
<td>92451</td>
<td>92451</td>
<td>14.454</td>
<td>0.001</td>
</tr>
<tr>
<td>Year</td>
<td>1</td>
<td>5455.8</td>
<td>5455.8</td>
<td>0.853</td>
<td>0.362</td>
</tr>
<tr>
<td>Sector x Year</td>
<td>1</td>
<td>153.8</td>
<td>153.8</td>
<td>0.024</td>
<td>0.862</td>
</tr>
<tr>
<td>Res</td>
<td>74</td>
<td>4.73E+05</td>
<td>6396.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>77</td>
<td>5.74E+05</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3.23. Sponge species assemblages

Sponge species assemblages based on species cover did not vary between reef sectors or years with an ANOSIM (Figure 12). However, a slight variation between reef sectors was detected with the two way PERMANOVA analysis (Figure 13).

Figure 12. Non-metric MDS analysis of sponge assemblages per plate between years and between two reef sectors (inner and outer).
3.24. Relative abundance of Sponges

Ten species including *Mycale sp. 1, Oscarella sp. 1, Halisarca caerula, Dysidea etheria, Tedana ignis, Tedania sp. 1, Chelonaphysilla erecta, Batzella sp. 1, Mycale sp. 2, and Mycale laxissima* were the main contributors to the differences between the inner and the outer reef sponge fauna associated to the underside of the recruitment plates (Table 5).

The inner reef had a higher abundance of *Mycale sp. 1* than the outer reef, and this species was the main factor that contribute to distinguish both sectors (Table 5, Figure 14). In addition, *Mymekioderma laminatum, Terpios fugax, Mycale laevis, and Cliona sp.* were only found on the inner reef plates. Three species, *Mycale sp.1, Dysidea etheria, and Tedania sp. 1* presented the highest abundance in the inner reef covering up to 300 cm² per plate. In the outer reef, *Halisarca caerula* had the highest abundance reaching values up to 80 cm² (Figure 15).

Species richness between 2011 and 2012 showed that all sponges present in 2011 were also in 2012, but not all species in 2012 were found in 2011 (Figure 14). New species
found in 2012 include *Batzella sp. 2*, *Mycale laevis*, and *Terpios fugax* among others. Abundance also increased in 2012 when compared to 2011 (Figure 14).

Table 5. Simper analysis of species contributions to the dissimilarity within sectors (inner and outer reef).

<table>
<thead>
<tr>
<th>Species</th>
<th>Inner Reef</th>
<th>Outer Reef</th>
<th>Av.Abund</th>
<th>Av.Abund</th>
<th>Av.Diss</th>
<th>Diss/SD</th>
<th>Contrib%</th>
<th>Cum.%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mycale sp. 1</td>
<td>4.05</td>
<td>1.18</td>
<td>14.69</td>
<td>0.83</td>
<td>17.05</td>
<td>17.05</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oscarella sp. 1</td>
<td>2.92</td>
<td>2.86</td>
<td>13.28</td>
<td>0.91</td>
<td>15.42</td>
<td>32.47</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Halisarca caerula</td>
<td>0.75</td>
<td>1.2</td>
<td>5.96</td>
<td>0.62</td>
<td>6.92</td>
<td>39.39</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dysidea etheria</td>
<td>1.18</td>
<td>0.87</td>
<td>5.61</td>
<td>0.72</td>
<td>6.51</td>
<td>45.89</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tedania ignus</td>
<td>0.81</td>
<td>0.94</td>
<td>5.12</td>
<td>0.51</td>
<td>5.94</td>
<td>51.84</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tedania sp. 1</td>
<td>1.23</td>
<td>0.52</td>
<td>5.11</td>
<td>0.41</td>
<td>5.93</td>
<td>57.76</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chelonaplysilla erecta</td>
<td>0.54</td>
<td>0.93</td>
<td>4.13</td>
<td>0.55</td>
<td>4.8</td>
<td>62.56</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Batzella sp. 1</td>
<td>0.19</td>
<td>0.89</td>
<td>2.92</td>
<td>0.48</td>
<td>3.39</td>
<td>65.95</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mycale sp. 2</td>
<td>0.66</td>
<td>0.39</td>
<td>2.84</td>
<td>0.38</td>
<td>3.29</td>
<td>69.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mycale laxissima</td>
<td>0.37</td>
<td>0.27</td>
<td>2.21</td>
<td>0.22</td>
<td>2.56</td>
<td>71.81</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Figure 14. Sponge occurrence on plates 2011-2012 represented by a shade plot, which is a visual display of the data matrix itself, with rows being the 20 most abundant species and columns the 78 plates. Rectangles represent the presence of a species and the grey shading that increase in intensity. White denotes absence of that species in the sample and the full black represents the maximum abundance in the matrix. The cluster projected with row represents similarity based on species frequency of appearances in the plates. This plot helps in identifying the contribution of species to the pattern of difference between sectors.
A.

**Sponges on plates 2011-2012**

Transform: Square root
Resemblance: S17 Bray-Curtis similarity (+d)

**Sector**
- Inner Reef
- Outer Reef

B.

**Sponges on plates 2011-2012**

Transform: Square root
Resemblance: S17 Bray-Curtis similarity (+d)

**Sector**
- Inner Reef
- Outer Reef
4.0 Discussion:

4.1 Taxonomy of sciophilous sponges associated to artificial reefs:

This is the first study of sponges inhabiting habitats on artificial plates in southeast Florida, and contributes to describe and understand biodiversity of the cryptic habitats in shallow coral reefs. In the Greater Caribbean Sea, two studies have explored the sponge biodiversity of cryptic habitats in the past five years. Van Soest (2009) characterized fifty six species from rubble and caverns in the Dutch islands of Curacao, Aruba and Bonaire describing thirteen new species to science. Ruetzler et al., (2014) described one hundred
and twenty two species from rubble, the underside of coral colonies, and other cryptic habitats from Belize Barrier reef with fourteen new species. The present study detected fort five different species with eight new records of sponge species in Florida, and four potential new species.

Sciophilous sponges are still understudied due to the difficulty for divers to reach cryptic habitats and collect sponges in their intact shapes. Although we did our best to identify all collected species, there is a high possibility that we have undescribed species among the twenty two species that were identified to genus. The four potential new species described in this study (*Mycale* sp.1, *Mycale* sp.2, *Batella* sp. 1, and *Tedania* sp. 1.) are in process to confirm. For these species sub-samples along with spicule photos and in depth descriptions will be sent to experts in each particular taxonomic group. The other eighteen species that were described only to genus might be unique morphotypes of known species or might represent young specimens lacking a complete set of skeletal elements found in the adults (Zea, 1993).

The sponge fauna found on the underside of the plates are very similar to that found in other cryptic habitats on Caribbean reefs (Ruetzler et al, 2014). This assemblages are dominated by thin encrusting sponges (not tubes, branches, cups, or massive as in the open reef or in the mangroves). The Poecilosclerida genera (*Mycale, Tedania, Hymedesmia, Batzella, and Clathria*) are the most diversified in this habitat. This could suggest a preferential recruitment of Poecilosclerida on cryptic or sciphilious habitats. Among the most common species, only six are found in open reefs or other habitats (i.e *Tedania ignis* and *Dysidea etheria* that inhabit both mangrove roots and seagrass beds) (Diaz, 2011). Therefore the majority of the species recorded under the plates are cryptic specialized species.

Forty five species on the underside fifty plates placed on the reef may seem like a small number compared to the species richness of an open reef which has species in the hundreds. However when you look at the total area represented by the 50 plates (2 m2), then the number of sponges found is relatively high (Alcolado, 1999; Gochfeld et al, 2007; Villamizar et al, 2013; Zea, 2001).
4.2 Ecological Patterns

4.21 Sponge species frequency of occurrence on the underside of artificial plates:

Sixty percent of the species encountered on the underside of the experimental plates were found only in one plate during the entire study. This pattern of low frequency for most species is common for sponges inhabiting open reef habitats and mangroves (Diaz, 2011; Diaz and Ruetzler, 2009). The low larvae recruitment rate described for reef sponges (Zea, 1993a) could be an explanation for this pattern of species occurrence where most species are rare, and the number of species increase as more time for recruitment is allowed.

4.22 Structure and dynamics of sponge populations:

The species accumulation curve (figure 9) never reached a plateau, indicating that if we increase the number of plates or the area studied more species will be recorded for this type of environment. In comparison, previous studies in cryptic and light exposed environments found that species richness is never stable (Zea, 1993).

Species richness on the plates increased significantly from 2011 to 2012. This may indicate that recruitment is accumulative through the years and that sponge assemblages in cryptic habitats might be dynamic through time in terms of composition (Becerro, et al, 2012). Partial mortality and unpredictable recruitment in artificial plates were found to produces unpredictable patterns in this type of benthic assemblages (Sutherland and Karlson, 1977).

Sponge area coverage was higher in the inner than in the outer reef. This is possible due to a higher growth and settlement of sponges in the inner reef, and demonstrated variation within a small spatial scale. A study done by Zea on recruitment of sponges onto artificial plates found that recruitment of sponges was higher and mortality of younger sponges lower in plates that were closer to adult sponge aggregations (Zea, 1993). The outer reef is also possibly a less suitable habitat for sponges due that this sector is the edge of the reef next to a sand patch, where higher sedimentation levels could have played a role in reducing sponge cover (Nunez et al., 2012). In addition, potential larvae sources might also be
greater on the inner reef, since little to no potential larvae source is available on the sand patches between the reefs (Villamizar et al., 2013). Besides sedimentation and larval source abundance, it is also possible, that cryptic sponge assemblages are limited and/or modulated by environmental and biological factors such as hydrodynamics, (Zea, S. 1993; Nunez et al, 2012).

In the present study, Mycale sp. 1, Dysidea etheria, and Tedania sp. 1 dominated on the inner reef plates while Halisarca caerulea dominated on the outer reef plates. Thus not only did they vary in size but also sectors of the reef. The fact that a handful of species dominated in terms of area coverage, indicates a possible spatial competitive superiority of those dominant species compared to the rest. This competitive ability might be composed of higher growth rates and/or allelochemistry (Jackson and Buss, 1975; Wulff, 2006). A study done in 2005 found that while the over-growth ability of a species is dependent on sponge morphology, the ability to resist overgrowth is associated with the production of allelochemicals (Engel and Pawlik, 2005).

Limestone plates were useful to encounter cryptic sponges, and facilitated the manipulation of thin encrusting species. The plates represented a form of shaded artificial substratum for sponges to settle on (Ruetzler et al, 2014; Zea, 1993; Sutherland and Karlson, 1977). Therefore, this experimental approach could be useful to study sciophious species and their implications in other reef processes. Simultaneously, the methodological approach used in the study avoid disturbance to the already established communities in the environment. Further studies of sponge recruitment in cryptic artificial habitats could include larger plates distributed between three reef tracts, and a lengthier period of submersion with a more in depth study of the plates from year to year.
5.0 Conclusion:

This study added eight species of sponges to the previously recorded Florida sponge fauna and four possible new species to science. This relatively large number of rare species, which cannot be readily found in the sponge regional (Greater Caribbean) literature invites to explore natural cryptic habitats as a source of novel biodiversity.

An in depth guide of the cryptic sponge species found in this study has also been created. This guide will be used to help facilitate further studies on cryptic sponges.

Artificial limestone plates were useful to study recruitment and development of cryptic sponge assemblages, demonstrating a diverse and complex assemblage quite distinct from the sponge assemblages on the open reefs. Cryptic sponge assemblages varied in small spatial scale within the reef depending on the area of the reef (inner or outer rim) where they are located, and probably due to certain physicochemical (sediment, water dynamics) and biological (larvae abundance) factors. Further studies are required to understand the life histories of the sciophilous sponge species, and successional patterns in these communities.
Literature Cited:


