

# **TAXONOMIC LIST OF THE SHALLOW WATER ECHINODERMS OF PUERTO RICO WITH NEW INFORMATION FOR LA PARGUERA**

by

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## ABSTRACT

This work presents the most complete and updated taxonomic list of the shallow water (0-100m) Echinodermata (Crinoidea, Asteroidea, Ophiuroidea, Echinoidea, and Holothuroidea) from Puerto Rico. The species list is a review based on the collection of echinoderms of the National Museum of Natural History (NMNH) at Washington, D.C., the Marine Invertebrate collection of the Department of Marine Science (MSC), University of Puerto Rico, Mayaguez Campus, and from simultaneous collections in 8 coral reefs stations (Buoy, Weimberg, San Cristobal, Enrique, Media Luna, Turrumote, Pelotas and Romero) and 6 sampling stations in sea grass beds (Caballo Blanco, Enrique, San Cristobal, Laurel, La Corona del Medio de Laurel and Media Luna) at La Parguera, Puerto Rico, during 2005 and 2006. A total of 108 species were revised (6 crinoids, 14 asteroids, 44 ophiuroids, 15 echinoids, and 29 holothuroids) representing 5 classes, 15 orders, 1 suborder, 33 families, 3 subfamilies and 68 genera. Nine species, *Davidaster discoidea*, *Poraniella echinulata*, *Ophioderma squamosissimum*, *Ophioderma phoenium*, *Ophionephthys limicola*, *Plagiobrissus grandis*, *Actinopyga agassizi*, *Holothuria (Halodeima) floridana*, and *Synaptula hydriformis* are new records for Puerto Rico. The exact locations of 52 species are stated for the first time. Of the species found (108), 74 were preserved at the MSC, 61 at the NMNH, while 39 were recently collected from the coral reefs and sea grass beds at La Parguera. In the sea grass beds, the total mean abundance of echinoderm species was 18.46 ind.m<sup>-2</sup>; ophiuroids and echinoids had the highest abundance (0.31-3.99 ind.m<sup>-2</sup> and 0.22-5.89 ind.m<sup>-2</sup>, respectively). The spatial patterns of total echinoderm abundance in these communities were characterized by a significant difference between sampling stations, being San Cristobal the main station introducing these differences.

## RESUMEN

Este trabajo presenta la lista taxonómica más completa y actualizada del Filo Echinodermata (Crinoidea, Asteroidea, Ophiuroidea, Echinoidea y Holothuroidea) de aguas someras (0-100 m) de Puerto Rico. La lista de especies es una revisión basada en la colección de equinodermos del National Museum of Natural History (NMNH), Washington, D.C., la colección de Invertebrados Marinos del Departamento de Ciencias Marinas (MSC), Universidad de Puerto Rico, Recinto Universitario de Mayagüez y de una colecta simultánea realizada en 8 estaciones en arrecifes coralinos (Buoy, Weimberg, San Cristobal, Enrique, Media Luna, Turrumote, Pelotas y Romero) y 6 estaciones en praderas de pastos marinos (Caballo Blanco, Enrique, San Cristobal, Laurel, La Corona del Medio de Laurel y Media Luna) en la Parguera, Puerto Rico, durante el 2005 y el 2006. Se registraron un total de 108 especies (6 crinoideos, 14 asteroideos, 44 ofiuroideos, 15 equinoideos y 29 holothuroideos) representando 5 clases, 15 órdenes, 1 suborden, 33 familias y 68 géneros. Nueve especies, *Davidaster discoidea*, *Poraniella echinulata*, *Ophioderma squamosissimum*, *Ophioderma phoenium*, *Ophionephthys limicola*, *Plagiobrissus grandis*, *Actinopyga agassizi*, *Holothuria (Halodeima) floridana*, and *Synaptula hydriformis* son nuevos registros para Puerto Rico. La localidad exacta de 52 especies se registra por primera vez. De las 108 especies encontradas, 74 están depositadas en la MSC, 61 en el NMNH y 39 fueron colectadas de los arrecifes de coral y las praderas de pastos marinos de las estaciones escogidas en La Parguera. En las praderas de pastos marinos, la abundancia total promedio de equinodermos fue de 18.46 ind.m<sup>-2</sup>; ofiuroideos y equinoideos tuvieron la abundancia más alta (0.31-3.99 ind.m<sup>-2</sup> y 0.22-5.89 ind.m<sup>-2</sup>, respectivamente). El patrón espacial de la abundancia total de equinodermos en estas comunidades se caracterizó por presentar diferencias significativas entre estaciones, siendo San Cristóbal la estación principal que introdujo estas diferencias.

To God,  
my parents and my sister Mónica and brother Oscar Mauricio, for  
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## INTRODUCTION

The echinoderms comprise an important group of marine animals that include feather stars, sea stars, brittle stars, sea urchins and sea cucumbers. They are simple animals, lacking a brain and complex sense organs, and are characterized by their radial symmetry as adults and a central mouth. Many of the sea urchins have developed extremely sharp spines as a means of protection. They move around with the use of thousands of tiny tube feet, many of which have suction cups at the ends. They display a stunning variety of shapes and colors decorating reefs and other habitats around the world and populating the submerged roots of the mangrove's forests. They are found in all oceans and at all depths, from the littoral zone, to 6000 m deep. With the exception of some pelagic holothuroids (*Rynkatropa pawsoni*) all echinoderms are benthic. In deep seas they constitute more than 90% of the benthic biomass (Brusca and Brusca, 1990). The echinoderms have different feeding strategies: some are carnivorous, other feed on corals or survive on scavenging the ocean floor. Certain species of starfish even extend their stomachs into their victims in order to digest them. The feather stars and sea cucumbers are mainly filter feeders, catching whatever they can find in the ocean currents. Many species are considered to be keystone species, regulating the community structure and balance, allowing the survival of other organism and nutrient recycling (Caso, 1978).

The Phylum Echinodermata is a very ancient group, not very distant from the Phylum Chordata. The group had its origins in the Precambrian. Echinoderms were very common and diverse in the early Cambrian, more than 600 million years ago. Approximately 16 classes of echinoderms are extinct, with more than 13,000 described fossil species, many of which are highly different from the extant forms. Even the most primitive forms had a well-developed exo-skeleton and diverse body patterns (Hendler *et al.*, 1995).

Around 6,500 echinoderm species are known at the present time and they are grouped into 5 classes: Class Crinoidea (approximately 700 species), Class Asteroidea (with

1,800 species), Class Ophiuroidea (approximately 2,000 species), Class Echinoidea (with 900 species) and Class Holothuroidea (approximately 1,200 species) (Hendler *et al.*, 1995).

The majorities of echinoderms are stenohaline and are adapted to a normal salinity (30-36 ppm.); however, their tolerance to salinities ranges between 20 and 40 ppm. They are highly diverse; but there is a gradual reduction of the diversity and abundance towards higher latitudes in shallow waters of tropical and subtropical regions.

The knowledge of echinoderms has a long history, which started with the conceptions of the anatomists of the XVIII Century, who were mostly interested in aspects related to the function of organs and their parts. Since then, important biologists and taxonomists, such as Linnaeus, Brugiere, Lamarck, Cuvier, Miller and Leuckart, with the aid of expeditions, and the recent studies of taxonomy, the actual knowledge of the phylum Echinodermata have expanded greatly. Many echinoderm taxonomic studies (Clark, 1901a; 1901b; 1919; 1933; Engel, 1939; Cherbonier, 1959; Hendler *et al.*, 1995) have been centered on the Atlantic Ocean and the Caribbean, but studies of the Phylum Echinodermata for Puerto Rico are scarce, not only for shallow waters but for deep waters as well. The last taxonomic revision of this group was made in the early 1930's, and many organisms collected over the years have been preserved and stored in collections without any revision. Also, the lack of knowledge of ecological and population biology aspects place this group in a priority situation for further studies.

In the actual context of global warming and the development of management strategies for marine ecosystems, studies on biodiversity play an important role. Mikkelsen and Cracraft (2001) stated that despite universal recognition of coral reefs as the "ocean's rainforest", the focus of conservation has been largely restricted to cnidarians, fish, larger sponges, and macroalgae. Like in the rainforest, the overwhelming majority of species and clades in the reef are cryptic, where worms, mollusks, echinoderms, and crustaceans are numerically dominant, but have been underestimated. On the other hand, the actual lack of trained taxonomists is as ongoing concern, in the face of the extensive specimen collections



at museums waiting for revision. Systematic inventories provide a permanent scientific record for documenting patterns of diversity and endemism across habitats and ecosystems. Such information is essential for identifying and establishing conservations priorities.

The main objective of this study was to review and update the shallow water echinoderm collections (0-100m) of Puerto Rico, stored at the echinoderm collection of the National Museum of Natural History (NMNH), Washington D.C., and the Marine Invertebrate Collection of the Department of Marine Science (MSC), University of Puerto Rico and to characterize the echinoderm fauna in two major communities in La Parguera, Puerto Rico: Sea grass beds and coral reefs.

# 1. LITERATURE REVIEW

The study of echinoderm's started with the anatomists of the XVIII century. Their contributions were mostly based on aspects related to organs and system functions. Linnaeus had the intuition of a relationship between *Asterias* and *Echinus*, but not with the sea cucumbers (Holothurians). Cuvier in 1817, placed the echinoderms as superior taxa in the Radiata, with different groups. Four years later, Miller formally separated the crinoids, which since the beginning of the systematic history were included in the Stelleroidea (Caso, 1948). For the first time the echinoderms were formed by five classes: Crinoidea, Asterioidea, Ophiuroidea, Echinoidea and Holothuroidea.

The most recent work that appreciably enriched the taxonomy of the Phylum Echinodermata was wrote by Paul and Smith (1984), who established a new phylogenetic classification based on an integral analysis of the evolution of diverse fundamental characters of the group, such as the anus displacement, mouth position in relation with anus, and madreporite displacement, among others.

The study of echinoderms in the Caribbean was initiated in the XVIII and XIX centuries, as part of the expeditions of the *H.M.S. Challenger*, *Blake* and *Albatross*, where many marine organisms from shallow and deep waters were collected in some Caribbean places, such as Puerto Rico, Jamaica, Cuba, Bermuda, Tobago, Cayman Island, Virg in Islands, Curaçao, Aruba, Bonaire, Venezuela, and the coast of French Guyana. The main contributions have been the works of Clark (1898, 1901a, 1901b, 1919, 1933, 1941, 1942), Engel (1939), Cherbonier (1959) and Engel and Aberson (1960), some of which studied not only the taxonomic characteristics, but the morphological and ecological aspects of echinoderms. The most recent work is the one by Hendler *et al.* (1995), who produced an identification guide and life history of 150 echinoderm species from the shallow waters (0 to 33 m deep) of the Florida Keys, Bahama Islands and the Caribbean.

An extensive monograph collection exists on the Class Crinoidea, especially of the Order Comatulida, commonly known as sea feathers, written by Clark (1915, 1921, 1931, 1941, 1947 and 1950) and *The Challenger* expedition records included the stalked crinoids or sea lilies. In the last 30 years, special works on the systematic, distribution, and ecology have been published (Meyer, 1972; Meyer, 1973a; Meyer, 1973b; Meyer, *et al.*, 1978; Messing and Dearborn, 1990).

Clark and Downey (1992) did one of the most substantial contributions to the knowledge of Class Asteroidea in the Atlantic Ocean. They revised every asteroids species collected in the Atlantic, included taxonomic keys, morphological descriptions and the bathymetric distribution of 374 species. Perrier (1884) did another contribution for the asteroids from Western-Atlantic region, who recorded a highly representative species number for the West Indies. Sladen (1889) increased the knowledge of tropical and subtropical asteroids in the region with the report called Challenger. On the other hand, Verrill (1915) described new species and new records from the shallow and deep waters of Florida, West Indies and Brazil.

The taxonomic identification of ophiuroids or brittle stars (Class Ophiuroidea) is extremely difficult, mainly due to the absence of complete and unified studies. Among the works that are essential for the taxonomic study of the Antilles, the Caribbean and Gulf of Mexico, are the Catalog published by Clark (1915), which includes all the known ophiuroid species for the area up to 1915, and a taxonomic key for families and genera identification by Fell (1960). Some other works dedicated to the study of the internal anatomy contributed greatly to the taxonomic knowledge of this group. Among these studies, the classification proposed by Matsumoto (1915) and Spencer and Wright (1966) have been valuable material. Also, Lyman (1865, 1869, 1871, 1874, 1875, 1878a, 1878b, 1879, 1882a, 1882b and 1883) is considered one of the authors who have contributed the most to the original echinoderms descriptions in the Caribbean.

The knowledge on the taxonomy of Class Echinoidea has been based on the ample monographs wrote by Mortensen (1928, 1935, 1940, 1943a, 1943b, 1948a, 1948b, 1950 and 1951). Some of these publications summarized all the existing information on sea urchins up to the middle XX century, including taxonomic revisions, descriptions and taxonomic keys. For the Caribbean, the major contributions were made by Farfante (1959), who published a compilation of the irregular sea urchin species from Cuba, followed by Chesher (1968) who described some species of the order Spatangoida from the Caribbean Sea, and the one by Serafy (1979) who worked with the echinoids of the Gulf of Mexico and adjacent waters.

The taxonomic knowledge of sea cucumbers (Class Holothuroidea) from the Caribbean Sea is mainly attributed to Deichmann. She considered the Atlantic species (1930), Antilles (1940) and Gulf of Mexico (1954). Miller and Pawson (1984) identified and made descriptions of some species from the Gulf of Mexico and adjacent waters, including taxonomic keys, photographs and ecological notes. Cutress (1996) studied the changes of dermal ossicles during holothurian's growth, an important trait for the identification of juvenile individuals of the *Holothuria* genera.

The first major survey of marine biodiversity of Puerto Rico was done during the expedition of The *Sea Hawk* in the late 1800's. This survey provided the first systematic lists of marine invertebrates and fish for the island. Other smaller expeditions, sponsored by the New York Academy of Sciences in the early 1900's, reported new taxonomic groups and brought about a revision of some of the *Sea Hawk* collections. The first list of all echinoderms collected in Puerto Rico was done by Clark (1901a). A total of 87 species were identified and this list was completed and reviewed three decades later by the same author (Clark, 1933).

Several other studies on echinoderms have been done in Puerto Rico. For example, Carrera (1974) studied the Class Ophiuroidea (particularly the Amphiuridae family) at La Parguera, and found 17 new records for the island. Wolf (1978) studied aspects of the biology of *Astrophiton muricatum* at Enrique, La Parguera; González-Liboy (1971) who

emphasized the echinoderms in his study of the macro-invertebrates at the Maní Beach (Mayagüez). Rivera and Vicente (1977) focused on the role played by the sea urchin *Diadema antillarum* on the composition of corals and sea grass beds at Jobos Bay. Rivera (1979) evaluated the mass mortality of three sea urchin species at Jobos Bay: *Lytechinus variegatus*, *Tripneustes esculentus* and *Diadema antillarum*. Yoshioka (1996) studied the role of *Diadema antillarum* in the coral reef communities. He observed the influence of this sea urchin in the gorgonians recruitment at the south-eastern coast of Puerto Rico.

Williams *et al.*, (1986) recorded the die-off of *Astropyga magnifica* and *Eucidaris tribuloides* that occurred on the northwest coast of Puerto Rico in the winter of 1984-1985. Engstrom (1982) studied immigration as a factor in maintaining populations of the sea urchin *Lytechinus variegatus* in sea grass beds on the southwest coast of Puerto Rico. He suggested that settlement of *L. variegatus* may be highly localized and that populations of this important grazer in sea grass beds can be dependent on immigration. Cameron (1986) worked with the reproduction, larvae occurrences and recruitment patterns of four sea urchin species (*Lytechinus variegatus*, *Tripneustes ventricosus*, *Echinometra lucunter* and *Echinometra viridis*) at the southeast coast of Puerto Rico. Griffin *et al.*, (2003) studied the ecological role that the sea urchin *Echinometra viridis* plays in coral reef's bio-erosion processes, an important degrading factor in these communities.

The most recent work on the sea urchin *D. antillarum*, was done by Weil *et al.*, (2005) who described the population characteristics of La Parguera 17 years after their mass mortality event. They concluded that *Diadema* seems to be making a slow come back at La Parguera.

## **2. MATERIAL AND METHODS**

### **2.1. REVISION OF THE COLLECTIONS**

#### **2.1.1. National Museum of Natural History (NMNH, Smithsonian Ins titute)**

The echinoderm collection at The National Museum of Natural History (NMNH, at Washington D.C.) was studied during July and August of 2005. This collection is one of the most complete and oldest of the Caribbean. Thanks to the collaboration of Curators David Pawson and Cynthia Ahearn, the complete echinoderm collection from shallow waters (0-100 m deep) of Puerto Rico was reviewed. Some of the specimens of NMNH were sent to the Department of Biology of the University of Puerto Rico at Mayagüez in order to complete this revision. The species identification was reviewed and all specimens were measured. Some of the species and identification details were photographed and are included in the taxonomic cards.

#### **2.1.2. Department of Marine Sciences (UPR, Mayagüez)**

The echinoderm collection of Marine Invertebrates of the Marine Science Department (MSC, Mayagüez Campus, University of Puerto Rico) was reviewed during 2005 and 2006. This collection is located at Isla Magueyes (La Parguera), and is considered the most complete and important of Puerto Rico. The invertebrates collection has approximately 4000 specimens (Weil, 2005) belonging to different taxonomic groups, including the Phyla Porifera, Cnidaria, Mollusca, Nemertea, Echinodermata, Arthropoda and Annelida (Class Polychaeta). All the shallow water echinoderm species were identified, and the specimens were measured (Addendum 1) by Bertha and Charles Cutress, who concentrated especially on Class Holothuroidea, and by Carlos Carrera, who worked with all echinoderms, previously studied most of the echinoderms found in this collection.

## **2.2 COLLECTIONS OF SPECIMENS AT LA PARGUERA**

### **2.2.1. Site description**

The insular shelf of La Parguera, on the southwest coast of Puerto Rico, is characterized by an extensive development of coral reefs, sea grass beds, and mangrove forests. The dry, warm, and relatively stable climate, low wave energy, high water transparency, relatively wide shelf and oligotrophic offshore waters, are some of the factors that contribute to the conditions of the marine ecosystem of La Parguera. Interactions among coral reef, sea grass beds, and mangrove communities provide for a highly productive, structurally complex, and biologically diverse ecosystem. Mean surface salinity is 35.2, but it varies from 34 to 37. Mean temperature is 28.4°C, changing from 25°C to 31°C (García et al. 1998). Coral reefs are distributed in three parallel lines: (1) Inshore, (2) Mid-shelf and (3) Outer shelf (Almy and Carrión-Torres 1963, Acevedo and Morelock, 1988). The length and the wide range of the reef's depths produce physical, chemical and biological gradients providing a highly productive, structurally complex, and biologically diverse ecosystem (Morelock *et al.*, 1977, Acevedo and Morelock 1988). The most common mangrove species is *Rizophora mangle*, and *Laguncularia racemosa* to a lesser degree. Extensive sea grass beds are well established in La Parguera, and *Thalassia testudinum* and *Syringodium filiforme* are the most common and widely distributed species. Also, most extensive sea grass beds are found at the two meter depth and surrounding mangrove islands (García et al. 2003) (Figure 1).

### **2.2.2. Coral reefs communities**

Samples were collected by SCUBA diving during several field trips (February, 2005 through January, 2006) at eight different reefs localities: two reefs at the outer-shelf (Weimberg and the Buoy), three reefs on the mid-shelf (Turrumote, Media Luna and San Cristobal), and three at the inner-shelf (Romero, Enrique and Pelotas). At each reef, four

transects (40 m<sup>2</sup>) were placed at different depths, with the exception of the outer shelves reefs where only one depth was used. These transects followed the same position used by the Coral Reef Ecosystem Studies (CRES) “Integrating science and Management in The Caribbean” project (Figure 1, Table 1). Echinoderms were identified or collected by hand along a 1 m band at both sides of each transect in a continuous way (40 m<sup>2</sup>). All organisms collected were placed individually in ziploc bags with sea water and were kept in a closed containers to avoid heat and light, exposure that give further stress to the organisms. Organisms were transported to the laboratory for preservation and analyses.



**Figure 1.** Aerial photograph of La Parguera, Puerto Rico, showing the sampling stations: coral reefs communities: inner-shelf (Enrique, Pelotas and Romero), mid-shelf (San Cristobal, Media Luna and Turrumote) and outer-shelf reefs (The Buoy and Weinberg). Sea grass beds communities: inner-shelf (Caballo Blanco and Enrique) and mid-shelf (San Cristobal, La Corona del Medio de Laurel, Media Luna and Laurel) (picture from USNOAA-NOS-NCCOSBP 2001).

### 2.2.3. Sea grass beds communities

Specimens were collected during several field trips (November, 2005 through March, 2006) at six different localities: two at the inner shelf (Enrique and Caballo Blanco) and four located at the mid shelf (San Cristobal, La Corona del Medio de Laurel, Media Luna



and Laurel) (Figure 1). The number of transects sampled at each site, the transect length, depth and geographical position are shown in Table 2. Samples were collected by hand sorting from 1m at both sides of the transect in a continuous way (40 m<sup>2</sup>). Organisms that were not identified *in situ*, were placed in ziploc bags for further preservation and identification in the laboratory.

**Table 1.** Sampling stations along the inshore-offshore insular platform at La Parguera. Transects Coral Reef Ecosystem Studies (CRES) project.

Position	Locality	Transects (CRES)	Depth (M)	Transects length (M)	Geographical position
Outer-shelf	The Buoy	143	18	20 x 2	17°53.38 N-66°59.09 W
		142	18	20 x 2	
		125	18	20 x 2	
		136	21	20 x 2	
	Weimberg	46	21	20 x 2	17°53.429 N-66°59.320 W
		47	21	20 x 2	
		55	21	20 x 2	
		60	23	20 x 2	
Mid-shelf	Turrumote	10	4	20 x 2	17°56.097 N-67°01.130 W
		3	9	20 x 2	
		5	3	20 x 2	
		16	14	20 x 2	
	Media Luna	26	6	20 x 2	17°56.093 N-67°02.931 W
		25	5	20 x 2	
		31	10	20 x 2	
		28	16	20 x 2	
	San Cristobal	42	9	20 x 2	17°56.501 N-67°04.509 W
		43	13	20 x 2	
		44	2	20 x 2	
		41	5	20 x 2	
Inner-shelf	Pelotas	99	7	20 x 2	17°57.442 N-67°04.176 W
		103	7	20 x 2	
		93	12	20 x 2	
		108	2	20 x 2	
	Romero	71	8	20 x 2	17°56.249 N-66°59.433 W
		69	12	20 x 2	
		70	2	20 x 2	
		72	5	20 x 2	
	Enrique	79	6	20 x 2	17°56.658 N-67°02.213 W
		80	9	20 x 2	
		78	4	20 x 2	
		77	2	20 x 2	

**Table 2.** Sampling stations in sea grass beds communities at inner-shelf and mid-shelf.

Position	Key	Number of transects	Depth	Transects length	Geographical position
Inner-Shelf	Caballo Blanco	8	4 to < 1m , 4 to > 1m	20 x 2m	17°57.984'N -67°02.979' W
	Enrique	4	< 1m	10 x 2m	17°57.262'N -67°02.797' W
Mid-Shelf	Media Luna	4	< 1m	20 x 2m	17°56.407'N -67°02.554'W
	Laurel	4	< 1m	10 x 2m	17°56.626'N -67°03.408'W
	San Cristobal	4	< 1m	10 x 2m	17°56.556'N -67°04.633' W
	La Corona del Medio de Laurel	4	< 1m	10 x 2m	17°56.503'N -67°03.615'W

## 2.3. PRESERVATION OF ORGANISMS

The taxonomic protocol by Solís-Marín and Pérez (1999) and Hendler *et al.*, (1995) were used for the preserving of all organisms at coral reefs and sea grass beds. This methodology included the following steps:

### 2.3.1. Relaxation

This step keeps specimens from breaking or contorting when they are preserved. The echinoderms are commonly anesthetized with magnesium chloride or magnesium sulfate solutions. However, it is more convenient to use magnesium sulfate (Epsom salts) because it is found at any pharmacy and does not need to be weighed before use. This method is the preferred treatment for specimens that will be come reference material at museums.

Once the sampling work was completed, all organisms were removed from the ziploc bags and transferred to a plastic container. The relaxation was done at the Department of Marine Sciences facilities at La Parguera. Depending of the kind of echinoderm different protocols were followed:

- Class Crinoidea and Ophiuroidea: The relaxation procedure was accomplished within 15 minutes for each specimen. Once the organisms were collected, they were

transferred to a plastic container with sea water and covered with aluminum paper. One to three tablespoons (15-45 gr) of magnesium sulfate (Epsom salts) were added at a corner of the container (avoiding direct contact with the specimens); the amount of salts required was proportional to the volume of water in the tray and the organism's size. The specimens were placed with the disk facing down, leaving the animal completely covered with sea water and with enough space to allow for arm extension. Containers were sealed and transferred to the laboratory.

- Class Asteroidea and Echinoidea: These classes are less fragile than the classes previously mentioned. The relaxation procedure was accomplished within 15 minutes for each specimen. As described above for ophiuroids. The specimens were placed with the disk facing down, and in containers big enough to allow arm extension in the case of the sea stars, or the extension of the ambulacral feet and pedicellaria for the sea urchins.
- Class Holothuroidea: Generally, holothuroids need a faster relaxation procedure to avoid evisceration. The relaxation procedure was accomplished within 15 minutes for each specimen. They were placed in a plastic container and covered with aluminum paper. One to three tablespoons (15-45 gr) of magnesium sulfate (Epsom salts) were added at a corner of the container (not directly on the specimens).

### **2.3.2. Fixation**

Relaxation was considered to be complete when the tube feet, arms, or tentacles of an individual did not react to prodding.

After relaxation, the specimens (with the exception of holothuroids and small echinoderms) were fixed in an 8% formalin solution. It is important the use of formaldehyde at this concentration to avoid the deterioration of soft tissues in big organisms. A good

fixation will allow future histological analysis and scanning electron microscopy studies, and preserve reference material of museums; it is a dangerous chemical solution, and properly trained scientists should use it.

In the laboratory, the organisms were transferred to containers with formalin solution for only two hours, in order to avoid the destruction of calcareous structures, followed by a half an hour in a running fresh water bath. On the other hand, the holothuroids were fixed with a 70% alcohol solution; the formalol destroys the spicules, which are needed for identification. To improve the fixation of internal organs, 70% ethylic alcohol was injected through the mouth and anus. Small echinoderms were directly submerged in a 70% ethyl alcohol.

### **2.3.3. Preservation**

Two different protocols were used to preserve organisms:

- Wet preservation: In general, the best preservative for echinoderms specimens is 70% ethanol. This type of preservation was used for most of the echinoderms collected. Each specimen was placed in a translucent glass container, with 70% alcohol solution, hermetically sealed and labeled with all pertinent data.
- Dry preservation: Some asteroids, ophiuroids and echinoids were dried out over paper towels at room temperature, away from the light and with good ventilation for 24 hours, then, specimens were placed in glass containers or in labeled plastic bags.

## **2.4. SPECIES REVISION AND IDENTIFICATION**

All organisms were classified in the different classes following Paul and Smith (1984). Identifications to order, family and species were based in the following taxonomic guides:

- Class Crinoidea: A. H. Clark (1915, 1921, 1931, 1941, 1947, 1950), Messing and Dearborn (1990), Meyer et al. (1978).
- Class Asteroidea: Clark and Downey (1992), Hendler et al. (1995).
- Class Ophiuroidea: Fell (1960), Spencer and Wright (1966), Hendler et al. (1995).
- Class Echinoidea: Mortensen (1928, 1935, 1940, 1943a, 1943b, 1948a, 1948b, 1950, 1951), Serafy (1979), Hendler et al. (1995).
- Class Holothuroidea: Deichmann (1930), Miller and Pawson (1984), Hendler et al. (1995).

The information provided for each species follow the taxonomic identification, and includes identification references, examined material, measurements, diagnosis, description, geographical distribution, depth range, and some comments when needed. In each taxonomic list the distribution is presented as: \*First record for Puerto Rico, \*\*First record for La Parguera, \*\*\* First record for Puerto Rico and La Parguera and + first record for specific locations different to La Parguera. The abbreviations used in this investigation are presented in annex 1.

All echinoderms collected at Parguera will be deposited at the Marine Invertebrate collection (MSC) of the Department of Marine Sciences, University of Puerto Rico, La Parguera and at the National Museum of Natural History.

## **2.5. DATA COLLECTION AND ANALYSES**

### **2.5.1. Sea grass beds data - abundance**

Sampling information from coral reefs was analyzed qualitatively, while the sea grass beds data analyses were quantitative (ind.m<sup>-2</sup>).

Due to the lack in normality and in the homogeneity of variances for the data obtained at the sea grass beds communities, the results were analyzed using the nonparametric analysis of variance Kruskal-Wallis to test for differences in the abundance of total echinoderms and other specific groups, between stations. Significant differences ( $P < 0.05$ ) between stations were further compared using Contrasts Analysis. All data was analyzed using the statistical package from INFO-Stat software version 3.0.2. (2003).

### 3. RESULTS

#### 3.1. IDENTIFIED SPECIES

The numeric taxonomic composition of the collections from NMNH and MSC and from La Parguera sampling were: 5 classes, 15 orders, 1 suborder, 33 families, 3 subfamilies, 68 genera and 108 species. Of these 74 are located at the MSC, 61 at the NMNH, while 39 were collected from the coral reefs and sea grass beds at La Parguera.

##### 3.1.1. Class Crinoidea Miller, 1821

Order Comatulida A. H. Clark, 1908

Family Comasteridae A. H. Clark, 1908

\*\*\**Davidaster discoidea* (Carpenter, 1888)

\*\**Davidaster rubiginosa* (Pourtalès, 1869)

+*Leptonemaster venustus* Clark, 1909

+*Comactinia echinoptera* (Müller, 1840)

*Comactinia meridionalis* (Agassiz, 1865)

Family Colobometridae

+*Analcidometra armata* (Pourtalès, 1869)

**Class CRINOIDEA Miller, 1821**  
**Order COMATULIDA A. H. Clark 1908**  
**Family COMASTERIDAE A. H. Clark 1908**  
***Davidaster discoidea* (Carpenter, 1888)**

**References used for identification:** A. H. Clark 1931: 232-240; Meyer et al. 1978: 415-416; Hendler et al. 1995: 51-52.

**Material examined:** USNM 5243 (1); USNM 5242 (1); USNM E43043 (1); MSC E-184 (2) (1: al.: 55 mm, dcd.: 2 mm, 2: al.: 55 mm, dd.: 3 mm).

**Previous Puerto Rican records:** None.

**Diagnostic features:** This is a slender and delicate species, and is at once distinguishable from all the others in the genus by the striking coloration of the pinnules which have a large black, blackish, or at least very dark, spot in the middle of each segment, so that the much lighter white, yellow, or reddish ends stand out prominently and the pinnules as a whole appear like strings of minute alternately dark and light beads. The cirri are XV-XXI, 10-12, long and slender; the arms are 11-20, long, delicate, with rather long brachials which have the ends less oblique than usual (A. H. Clark 1931).

**Description:** From A. H. Clark 1931 (233-235). "The centrodorsal is dicoidal, broad, rather thin, the broad flat polar area, sometimes with a slight shallow median pit. The cirrus sockets are closely crowded, arranged in one and a more or less complete second alternating marginal rows. The cirri are XV-XXI, 10-12. The first segment is very short, the second is about as long as broad or slightly longer than broad, the third is from half again to nearly twice as long as its proximal width, and the fourth is the longest, twice as long as its proximal width or even somewhat longer. The fifth is as long as the third, and the following gradually decrease in length to the antepenultimate, which is about as long as broad. The penultimate



segment is somewhat longer ventrally than dorsally, from one-third to one-half again as broad as its ventral length. The opposing spine is small, erect, arising from the whole dorsal latter. The terminal claw is long and slender, about three-quarters as long as the penultimate segment, with its apex slightly beyond the center of the penultimate and antepenultimate segments together, moderately curved. As viewed dorsally the second and following segments as far as the terminal 3 or 4 are very strongly constricted centrally, with much expanded ends; but this feature is only slightly marked in lateral view, being due to the lateral expansion of the articulations over the ends of the articular ridges as a center. Most of the segments are smooth dorsally, but the antepenultimate always, the preceding one often, and the one preceding that sometimes has a small subterminal tubercle or small spine which, though often but slightly marked, is always present. Its position on the antepenultimate segment is but little in advance of the center, on the preceding more distal, and on the third from the last it is situated near the distal edge. The radials are concealed by the centrodorsal in the radial line, but show slightly in the interradial angles. The  $IBr_1$  are oblong, with the proximal border often convex, about two and one-half times as broad as the median length, rounded laterally and entirely separated, even at the base. The  $IBr_2$  (axillaries) are most triangular, between one and one-half times and twice as broad as long, the distal angle sharp, the lateral sides short, and forming an obtuse angle with those of the  $IBr_1$ , or parallel in the proximal half but diverging in the distal. The  $IIBr$  series are 4 (3+4). The division series are comparatively narrow and widely separated. The first ossicles following each axillary are united interiorly for about the proximal two-third, those following the  $IBr$  axillary the diverging at an acute angle, those following the  $IIBr$  axillary remaining in apposition, though not united. Arms 16-20, very slender. The first brachials are wedge-shaped, about twice as broad as the exterior length. The second are similar in shape and size. On arms arising from a  $IIBr$  axillary the first brachials are much larger, being not greatly broader than the exterior length. The first syzygial pair (on arms arising from the  $IIBr$  axillaries composed of brachials 2+3, and on those arising from the  $IBr$  axillaries composed of brachials 3+4) is oblong, about half again as broad as long, or slightly longer. The following three brachials (the following 1 or 2 on arms arising from a  $IIBr$  axillary) are oblong, about twice as broad as

long, those succeeding becoming very obliquely wedge-shaped, about as long as broad, in the distal part of the arm less obliquely wedge-shaped, almost oblong, about as long as broad, and in the attenuated terminal portion longer than broad. After the first 2 or 3 the brachials develop overlapping and finely spinous distal edges which become prominent after the sixth or eighth, though their development is never very great; they are plainly evident even in the attenuated terminal portion of the arm. Syzygies occur between brachials 3+4, again between brachials 6+7 to 9+10.  $P_D$  is long, stout basally but tapering rather rapidly and slender. It is composed of nearly 40 segments. The comb consists of 13 teeth, the terminal 2 or 3 more or less obsolete. The teeth are slightly longer than broad basally, about as long as the width of the segment which bears them, rounded, well separated, and beset with small marginal spines. Except for the first 2 or 3, all the teeth are double, the segments bearing another similar, but smaller, tooth on the opposite side.  $P_1$  is long, much more slender than  $P_D$  though similar to it, and with a similar comb.  $P_3$  is small, slender, and weak, long, with about 15 segments, and bears a more or less imperfect comb distally.  $P_4$  and the following pinnules resemble  $P_3$ ,  $P_D$  as described,  $P_2$  resembles  $P_1$ , etc. The distal pinnules are long, very slender, with about 20 segments, of which the first is short, the second is half again as long as broad, and those following become rapidly elongated and about three times as long as broad. The segments all have very strongly overlapping and spinous distal ends, as do the segments of all the pinnules except in the distal portion of the first 1 or 2. The color in alcohol is white, yellowish white, or violet, the cirri and pinnules dark purple with the ends of the segments white, in sharp contrast”.

**Distribution:** Gulf of Mexico, southeastern Florida from Boca Raton to the Dry Tortugas, Bahamas Islands, Turks and Caicos islands, Antillean Arc from the north coast of Cuba to Barbados and the Grenadines including Grand Cayman and Jamaica; Caribbean coast of Central and South America from the Yucatan to Colombia, Curaçao and Bonaire (Meyer et al. 1978, Durán-González et al. 2005, Valle-García et al. 2005). In Puerto Rico waters from Salinas and Puerto Nuevo Point and Mayagüez according with reference material examined

in the echinoderms collection at NMNH and MSC. In this study it has been observed and collected at La Parguera (The Buoy).

**Depth Range:** 0.6-355 m, but most common at 20-40 m (Macurda and Meyer 1977).

**Remarks:** Although catalogued specimens from Puerto Rico are deposited in NMNH, and in the MSC, there is no record of such in any publication. Therefore it is considered a first record for the island and for La Parguera (The Buoy Key).

***Davidaster rubiginosa* (Pourtales, 1869)**

**References used for identification:** A. H. Clark 1931: 225-232; Meyer et al. 1978: 415; Hendler et al. 1995: 53-54.

**Material examined:** USNM E28324 (2) (as *N. iowensis*); MSC (1) (al.: 120 mm, dcd.: 7 mm); MSC (1) (al.: 60 mm, dcd.: 5 mm); MSC (1) (al.: 45 mm, dcd.: 6 mm); MSC (arms only); MSC (1) (al.: 80 mm, dd.: 4 mm); BIOL (1).

**Previous Puerto Rican records:** As *Nemaster iowensis* (A. H. Clark 1931), Meyer 1973a.

**Diagnostic features:** The cirri are XX-XXX, 11-17 (usually not more than 14); the arms are 18-34 in number. Slender form, in all its parts and always shows a conspicuous black stripe down the middle of the dorsal surface of each arm, which in some cases may be more or less broken up into a series of dashes or dots. Except for this black line the color appears to be



**Figure 2.** *Davidaster rubiginosa*. General Image.

almost uniform, yellow to red or brownish red. The shorter cirri with fewer segments and the dorsal arm stripe separate this species from *N. grandis*, while the presence of the arm stripe, the absence of the dark spots on the pinnule segments, the stouter build, and the shorter brachials, which have more oblique ends, separate it from *N. discoidea* (A. H. Clark 1931).

**Description:** From A. H. Clark 1931 (226-228). “The centrodorsal is discoidal, with the bare polar area rather broad and slightly concave. The cirrus sockets are arranged in 2 closely crowded alternating marginal rows. The cirri are XX-XXX, 11-17 (usually 13-14). The first segment is very short, the second is nearly or quite as long as broad, the third is somewhat longer, and fourth and fifth are the longest, half again as long as broad. The segments following decrease in length so that the terminal 4 are about as long as broad. Beginning with the sixth segment, the distal dorsal edge is somewhat thickened, this becoming, on the last 2 segments before the penultimate, a small sub-terminal dorsal spine. The opposing spine is sub-median or sub-terminal, slender, erect, short and sharp. The terminal claw is considerably longer than the penultimate segment, stout and strongly curved basally, becoming more centrally constricted with expanded ends, this being especially marked in dorsal view. The segments distal to these have straighter edges and are laterally compressed. The ends of the basal rays form rather prominent tubercles in the interradial angles of the calyx. The radials are entirely concealed by the centrodorsal, or are just visible in the interradial angles over the ends of the basal rays. The  $IBr_1$  are very short, oblong, not in contact laterally. The  $IBr_2$  (axillaries) are broadly pentagonal to almost triangular, from two to two and one-half times as broad as long; the lateral edges are not so long as those of the  $IBr_1$  with which they form an obtuse angle. The adjacent the  $IIIBr$  series are 3 (2+3), rarely 4 (3+4); the  $IVBr$  series are 3 (2+3), but are not often present. The division series are well separated and are rounded dorsally. The arms are 18-34 in number. The first brachials are obliquely wedge-shaped, about twice as broad as the median length, interiorly united. The first syzygial pair (brachials 2+3) varies from about as long as broad to about twice as broad as long, being usually about half again as broad, as long, this proportion being maintained almost to the tip, the terminal segments being rather longer and with less oblique ends. The

brachials beyond the third have prominent and overlapping distal ends which are armed with fine spines. Syzygies occur between brachials 2+3, again from between brachials 10+11 to between brachials 13+14. The disk is naked, or bears a few scattered granules which are usually finely papillose. The lateral interbrachial areas between the division series are usually covered with a calcareous deposit which may or may not be broken up into distinct interrachial plates.  $P_D$  is stout basally, but rapidly tapering and slender in the distal half, and is composed of 40 segments, of which the first 5 are broader than long and the remainder are about as long as broad. The terminal comb consists of 12 teeth which are triangular, small, slender, and well separated basally, and not quite so high as the width of the segments that bear them; on the inner side of each of the pinnule segments involved in the comb there is a similar, but smaller, tooth.  $P_P$  is similar to  $P_D$ .  $P_1$  is similar to  $P_P$ , but slightly shorter and more slender.  $P_2$  and the following pinnules are slightly stouter than  $P_1$ , composed of 20 segments, all but the first 2 or 3 of which are about as long as broad. They are without terminal combs, and carry gonads on the first-ninth segments. Distally the pinnules become gradually longer and more slender. In the distal pinnules the first 2 segments are short, the third and fourth are about as long as broad, and those following segments of all but the oral pinnules have projecting and spinous distal edges. The color in alcohol is reddish or yellowish brown, with a dark purple medio-dorsal line in the arms”.

**Distribution:** Western Gulf of Mexico, southwestern Florida from the Dry Tortugas to Key Largo, Bahamas Islands, Turks and Caicos Islands, Antillean Arc from Hispaniola to Barbados and the Grenadines including Grand Cayman, Jamaica, Cuba, Puerto Rico, Dominica and St. Vincent; Caribbean coast of Central and South America from Belize to Bahia, Brazil (Meyer 1973a, Meyer et al. 1978, Durán-González et al. 2005, Laguarda-Figueras et al. 2005b, Valle-García et al. 2005). At Puerto Rico from La Parguera (The Buoy) and off mouth of Añasco according with reference material examined in the echinoderms collection at MSC.

**Depth Range:** 1-334 m, but most common at 6-15 m (Meyer 1973).

**Remarks:** *Nemaster iowensis* (Springer) was synonymized with *D. rubiginosa* (Meyer 1973). H. L. Clark (1933) corrected identifications of *Comactinia echinoptera* from this species previously reported on in his 1901 account of echinoderms collected by the *Fish Hawk* in Puerto Rico. It is considered a first record for La Parguera (The Buoy).

***Leptonemaster venustus* Clark, 1909**

**References used for identification:** A. H. Clark 1931: 81, 275-284.

**Material examined:** USNM 5245 (9) (1: al.: 18,3 mm, dcd.: 2.5 mm, 2: al.: 21 mm, dcd.: 1 mm, 3: al.: 32 mm, dcd.: 1 mm); USNM E3909 (1); USNM E5241 (6) (1: al.: 25 mm); USNM E5244 (1); USNM E5246 (1); USNM E5238 (1); MSC (1).

**Previous Puerto Rican records:** Possibly: H. L. Clark 1933. Confirmed: Meyer et al. 1978.

**Diagnostic features:** There are never more than 10 arms; the cirri are rather long and slender with 12-15 (usually 13-14) segments. The first 2 segments of  $P_2$  and  $P_3$  are produced dorsally into high and conspicuous carinate processes, which have the crest, at least in the second segment, parallel with the longitudinal axis of the pinnule. The animal is rather slender; the arms are from 70 mm to 90 mm long, and the cirri are 10 mm long (A. H. Clark 1931).



**Figure 3.** *Leptonemaster venustus*. General Image.

**Description:** From A. H. Clark 1931 (277-278). “The centrodorsal is a thin flat disk. The small cirrus sockets are arranged in a single crowded marginal row, usually 5 to each radial

division. The cirri are XV-XX, 12-15 (most commonly 13 or 14), 10 mm long. The ends of the basal rays are visible as rather prominent tubercles in the angles of the calyx. The radials are entirely concealed, or just visible over the ends of the basal rays; they are separated distally. The  $IBr_1$  are short, nearly four times as broad as long, the proximal edge convex, not in contact basally, rounded and widely free laterally. The  $IBr_2$  (axillaries) are triangular, the anterior angle somewhat produced, about one and one-half times as broad as long, the very short lateral edges making an obtuse angle with those of the  $IBr_1$ . Arms 10, 70 mm to 90 mm long. The first brachial is short, slightly wedge-shaped, about three times as broad as the exterior length, entirely separated from its fellow by the anterior apex of the  $IBr_2$ . The second brachial is irregularly quadrate, slightly larger than the first. The first syzygal pair (third and fourth brachials) is oblong, about twice as broad as long, the following becoming obliquely wedge-shape and after the tenth triangular, about as long as broad, and in the terminal portion longer than broad. After about the sixth the brachials develop strongly produced and overlapping distal ends. Syzygies occur between brachials 3 + 4, again between brachials 10 + 11 to 12 + 13, and distally at intervals of 3 muscular articulations.  $P_1$  is moderately stout basally and evenly tapering, composed of about 35 segments. The terminal comb has 13 to 15 teeth, preceded by 2 or 3 more or less rudimentary. The teeth are spade-shaped or triangular, higher than broad. The basal segments of the pinnule are broader than long, the proportionate length gradually increasing so that the segments from the middle onward are approximately squarish. The segments have prominent dorsal projections, with the apex at the distal end, and strongly produced distal edges, these characters dying gradually away after about the middle of the pinnule. The  $P_2$  is much more slender than  $P_1$ , with the segments after the fifth squarish. The first two segments have strong dorsal processes or broad carinations, that of the second the stronger. The following segments have rounded dorsal processes and prominent distal edges. The terminal comb is rather long, with 16 fully developed and 5 or 6 smaller and more rounded teeth.  $P_3$  slender and delicate, with the first 2 segments disproportionately large, about half again as broad as long, the second with a much produced distal dorsal angle or even distal half of the dorsal side; the third segment is squarish, and the following segments as far as the comb, as in  $P_2$ , have strongly produced and

coarsely thorny distal ends.  $P_4$  is slightly more delicate than  $P_3$ , with no enlargement of the 2 basal segments, and no comb.  $P_5$  is similar to  $P_4$  but slightly stouter. The following pinnules are similar to  $P_5$  increasing very gradually in length”.

**Distribution:** Bahamas Islands, southwestern Gulf of Mexico, Lesser and Greater Antilles, including Cuba and Puerto Rico, Caribbean coast of Central and South America, from Honduras east to Trinidad (A. H. Clark 1931, Meyer et al. 1978, Valle-García et al. 2005). In Puerto Rico waters from Jiguero, Salinas and Boca Juana Point, Aguadilla and Vieques Island according with reference material examined in the echinoderms collection at NMNH and MSC.

**Depth Range:** 24-236 m (Meyer et al. 1978).

**Remarks:** Material examined in the collections of the NMNH confirms the newly reported specific localities from Puerto Rico herein.

*Comactinia echinoptera* (Müller, 1840)

**References used for identification:** A. H. Clark 1931: 375-400; Messing 1978: 49-80; Hendler et al. 1995: 48-49.

**Material examined:** USNM E5234 (1); USNM E5247 (1); USNM E5248 (1); USNM E5250 (2); USNM 21466 (1); USNM E5240 (1); USNM E5239 (1); USNM 21464 (3); USNM E26020 (6); USNM 21465 (1); USNM E5232 (3); USNM E5249 (2); USNM E5233 (1); MSC (5); MSC E-180 (1) (al.: 31 mm).



**Figure 4.** *Comactinia echinoptera*. General Image.



**Previous Puerto Rican records:** H. L. Clark 1933.

**Diagnostic features:** Comb usually present on  $P_{1-4}$ ; middle comb teeth usually quadrate and often terminally notched, rounded keel usually present on basal segments of proximal pinnules; aboral distal margin of brachials lacks spines; color in life reddish flecked with yellow, with yellow pinnules; centrodorsal pale (Messing and Dearborn 1990).

**Description:** From Messing 1978 (53-57). “Centrodorsal small, flat, thin and discoidal or pentagonal. Cirrus sockets arranged in single, rarely partly double, irregular, marginal row. Polar area usually flat and smooth, sometimes with small, weak central convexity or weak, radiating interradiar ridges developed only near polar area margin. Cirri XV-XXII, usually 10-12, slender and cylindrical proximally, broader and laterally compressed distally; fourth and/or fifth cirral longest; subsequent cirrals decreasing in length; distal cirrals squarish; penultimate cirral squarish or longer than broad; opposing spine short, conical, erect and subterminal; terminal claw curved, as long as or longer than penultimate cirral. Basal rays hidden. Radials always visible. Division series usually dorsally rounded, infrequently flattened, rarely closely on opposed; arm bases and division series often with weak synarthrial swellings.  $IBr_1$  short, united at least proximally, oblong, usually broader distally than proximally and often slightly inflated laterally.  $IBr_2$  triangular, laterally free. Arms slightly broader in the middle than at base; greatest width reached proximally by about  $Br_{15}$ . Distal dorsal rim of all brachials lacking spines, and concave.  $Br_1$  oblong, united interiorly, sometimes slightly longer exteriorly.  $Br_2$  oblong to almost triangular, laterally free.  $Br_{3+4}$  oblong, sometimes slightly longer interiorly.  $Br_5$  oblong or wedge-shaped. Next few brachials increasingly wedge-shaped. Subsequent brachials in proximal half of posterior arms and proximal third of anterior arms short, triangular and of uniform width, appearing wider than arm bases often only because of their thickened distal edges. Sysygies at  $Br_{3+4}$ ,  $Br_{11+12}$ . Subsequent intersyzygial interval usually four.  $P_1$  have the proximal pinnulars short; middle pinnulars squarish; distal pinnulars longer than broad but appearing short due to presence of high comb teeth. Dorsal side of second to third, fourth or fifth pinnulars

produced as high rounded carinae which are often similar to but more variable than those of *Leptonemaster venustus*. Comb of four to nine teeth short and strong; first and last teeth narrow (and sometimes shorter).  $P_2$  one-third to little more than one-half length of  $P_1$ , with nine to 28 pinnulars and comb of three to eight teeth; carinae sometimes present on second and third, sometimes to fourth or fifth pinnulars.  $P_3$  of nine to 18 pinnulars, only rarely carinate; comb higher than on  $P_1$  or  $P_2$ , of two to eight teeth; middle teeth broader and more deeply notched.  $P_4$  the last comb bearing pinnule with 20 pinnulars and five comb teeth; comb similar to that on  $P_3$ . Subsequent pinnules increasing with over 20 pinnulars. Gonads first appearing on  $P_2$ ,  $P_3$  or  $P_4$  and continuing to between  $P_{11}$  and  $P_{20}$ . More pinnules bearing gonads on posterior arms than on anterior arms. Disk inflated, with small, conical, elongate or irregular nodules quite evenly spaced, projecting from tissue and appearing as papillae. Mouth marginal, interradial; anal cone central”.

**Distribution:** Gulf of Mexico, Southeastern Florida; Bahamas Islands; Turks and Caicos Islands; Arrowsmith Bank off Yucatan; throughout the Caribbean, including Cuba, Puerto Rico and south to Cape Frio, Brazil and perhaps to Isla de los Alcatraces off Sao Paulo, Brazil. One specimen is reported from waters off South Carolina (Messing 1978, Durán-González et al. 2005, Laguarda-Figueras et al. 2005b, Valle-García et al. 2005). In Puerto Rico waters, it has been found at Salinas, Jiguero and Puerto Point and Culebra Island according with reference material examined in the echinoderms collection at NMNH and MSC.

**Depth Range:** 2-92 m (Hendler et al. 1995).

**Remarks:** H. L. Clark (1933) corrected his identifications of *C. echinoptera* which he had confused with *Actinometra meridionalis* and *Actinometra rubiginosa* in an earlier report. Messing (1978) gave a careful and detailed description of *C. echinoptera*, and he distinguished it from *C. meridionalis*, with which it has frequently been confused (Hendler et al. 1995). Specific localities within Puerto Rico are reported.

*Comactinia meridionalis* (Agassiz, 1865)

**References used for identification:** Messing 1978: 49-80; Messing and Dearborn 1990: 23-24.

**Material examined:** USNM E31664 (3).

**Previous Puerto Rican records:** Messing 1978.

**Diagnostic features:** Comb on P<sub>1-2</sub> (sometimes P<sub>3</sub> and P<sub>4</sub>); teeth rounded or triangular, weak or strong, basal keels absent; middle segments of proximal pinnules with spiny rims that may develop into strong, spiny flanges; aboral distal margin of brachials finely spiny; color yellow, red, purple, brown or a combination (Messing and Dearborn 1990).

**Description:** From Messing 1978 (62-

65). “Centrodorsal discoidal or pentagonal, comparatively larger than in individuals of *Comactinia echinoptera* (Müller, 1840). Cirri arranged in single or, rarely, partly double, irregular marginal row. Polar area usually smooth and flat. Cirri X-XXX, 817 (usually 912), 5 to 11 mm, of constant width or,

rarely, slightly broader distally; third and/or fourth (rarely, fifth) cirral longest; penultimate cirral usually broader than long; opposing spine short, erect, conical and subterminal; low dorsal subterminal tubercle often present on antepenultimate cirral; terminal claw longer than preceding cirral. Basal rays hidden, barely visible or appearing as prominent tubercles in interradian angles. Radials just visible in interradian angles or well exposed, rarely hidden. Division series smoothly rounded dorsally and infrequently closely opposed; synarthrial tubercles absent. IBr<sub>1</sub> short, united



**Figure 5.** *Comactinia meridionalis*. General Image.

laterally, usually broader distally than proximally, sometimes slightly inflated laterally. IBr<sub>2</sub> triangular, usually separated laterally, infrequently pentagonal with short lateral edges. Arms 20 to 95 mm long, usually slightly broader in middle than at base; greatest width reached proximally between Br<sub>10</sub> and Br<sub>20</sub>. Br<sub>1</sub> short, oblong or slightly longer exteriorly, united interiorly (at least proximally). Br<sub>2</sub> oblong to strongly wedge-shaped, laterally free. Br<sub>3+4</sub> oblong, slightly longer than Br<sub>2</sub>. Br<sub>5</sub> and Br<sub>6</sub> oblong, less often wedge-shaped. Next several brachials increasingly wedge-shaped, becoming triangular between Br<sub>8</sub> and Br<sub>11</sub> and wedge-shaped again anywhere between Br<sub>17</sub> and Br<sub>50</sub>. Triangular brachials extending almost to arm tip in some large specimens, absent in some small specimens; distal brachials less strongly wedge-shaped, usually elongate near arm tip. Syzygies at Br<sub>3+4</sub> and Br<sub>11+12</sub> (infrequently from Br<sub>8+9</sub> to Br<sub>13+14</sub>). P<sub>1</sub> slender, composed of 23 to 40 pinnulars; proximal pinnulars squarish; distal pinnulars longer than broad; comb of three to 11 rounded or triangular, weak or strong, well separated teeth. P<sub>2</sub> from less than half to 4/5 as long as P<sub>1</sub>, composed of 11 to 28 pinnulars with three to 12 comb teeth similar to those of P<sub>1</sub>. P<sub>b</sub> sometimes lacking a comb. P<sub>3</sub> with up to 17 pinnulars; proximal and middle pinnulars squarish or triangular, distal pinnulars longer than broad; when present, comb of 3 to 10 teeth. Either P<sub>2</sub> or P<sub>3</sub> shortest pinnule. Gonads on P<sub>3</sub> to between P<sub>7</sub> and P<sub>16</sub>. Disk naked, sometimes with sparse, small nodules and rarely crowded with large, irregular nodules. Mouth marginal”.

**Distribution:** Gulf of Mexico; southeastern United States from Cape Lookout, North Carolina to the Florida Keys; Bahamas Islands; throughout the Caribbean from Yucatan and Cuba to Surinam, including Cuba and Puerto Rico (Messing 1978, Laguarda-Figueras et al. 2005b, Durán-González et al. 2005, Valle-García et al. 2005).

**Depth Range:** Possible: 3-508 m (Messing 1978).

**Remarks:** Messing (1978) detailed the differences between the two sub-species of *C. meridionalis*: *C. meridionalis meridionalis* and *C. meridionalis hartlaubi*, where the first occurs in shallow water, and the other from deep water. *C. meridionalis hartlaubi* is much

larger and more robust, with longer and irregular intersyzygial intervals. The cirri are longer, heavier, with more, but shorter cirrals than the *C. meridionalis meridionalis*. The proximal pinnules differ considerably from those of the previous forms and P<sub>1</sub> through P<sub>3</sub> or P<sub>4</sub> bear weak combs.

**Family COLOBOMETRIDAE**  
***Analcidometra armata* (Pourtales, 1869)**

**References used for identification:** A. H. Clark 1947: 79-83; Meyer et al. 1978: 417-418; Hendler et al. 1995: 54-55.

**Material examined:** MSC (3).

**Previous Puerto Rican records:** Puerto Rico, as *Analcidometra caribbea* (A. H. Clark 1947).

**Diagnostic features:** P<sub>1</sub> is very stout in the basal portion, so much so as to cause the second brachial to appear as an axillary, and is very much stouter than P<sub>2</sub>. The short stout cirri composed of segments most of which are about as long as broad, and of which the proximal bear conspicuous transverse ridges, combined with the curiously enlarged P<sub>1</sub>, make this little species an easy one to recognize (A. H. Clark 1947).

**Description:** From A. H. Clark 1947 (80-81). "The centrodorsal is approximately discoidal, thin, and slightly convex. The cirri are arranged in a single marginal row. The cirri are XIII-XV, 20 (or somewhat more), from 8 to 10 mm long in two larger specimens, short and more or less stout. The short cylindrical segments are of approximately equal length, and of approximately the same form; they are mostly about as long as broad, but may be slightly longer than broad, or slightly broader than long. From the second to the fifth the segments following have a single median spine. The opposing spine is especially stout. The radial are

visible and are united laterally. The  $IBr_1$  are laterally entirely free, rectangular, always markedly broader than long, in one of the two larger specimens with the distal border concave. The  $IBr_2$  (axillaries) are more rhombic than hexagonal. The two proximal angles of the radials, which are often rounded off, come together in a more or less blunted angle, while the distal border is concave and runs out into acutely pointed anterolateral angles. In the smallest specimen the proximal border of the axillaries is thickened, uneven, and irregularly and sharply dentate. The 10 arms are in the largest specimen about 45 mm long. The first brachials are short and rather small; they are in contact only at the proximal angles. The second brachials, which are somewhat longer than the first, are often strongly axillary in shape, as a result of having on the outer side and oblique base for the very stout  $P_1$ . The first syzygal pair (composed of brachials 3+4) is markedly longer than broad. The four following brachials are approximately oblong with sharp processes on the proximal border. The brachials of the middle arm region are longer than broad. In the middle and distal arm region small sharp processes on the distal borders of the brachials overlap the bases of the brachials succeeding. The lateral profiles of the arm as seen in dorsal view are, as a result of the humplike swelling of the brachials at the insertions of the pinnules, uneven. This is specially noticeable in the middle of the arm, so that the arms at the base often appear more slender than in the middle. The first syzygal is between brachials 3 + 4. The position of the second syzygy is variable. Especially characteristic is  $P_1$ , which is stiff and so stout as to influence the form of the second brachial. Long as is composed of 12 segments of which the first is short, the second is longer than broad, the third, fourth, and fifth are strikingly long, and those succeeding are again shorter, but still elongated.  $P_2$  is of about the same length as  $P_1$  and is composed of about the same number of segments, but lacks the strong broadening of the base.  $P_3$  is sometimes markedly shorter than  $P_2$ , but sometimes of equal length.  $P_4$  is generally shorter than  $P_3$ , is composed of two short basal segments which are followed by about 5 elongated segments”.

**Distribution:** Dry Tortugas ; Bahamas Islands; Turks and Caicos Islands; Antille an Arc from Hispaniola to Barbados and Grenada, including Jamaica, Grand Cayman and Puerto Rico

Island; Caribbean coast of Central and South America from Honduras to Guyana (A. H. Clark 1947, Meyer et al. 1978). In Puerto Rico waters from Rincon, according with reference material examined in the echinoderms collection at MSC.

**Depth Range:** 3-148 m (Hendler et al. 1995).

**Remarks:** Although A. H. Clark (1947) cited this species for Puerto Rico, he provided no specific locality. Specific localities within Puerto Rico are reported.

### 3.1.2. Class Asteroidea De Blainville, 1830

Order Paxillosida Perrier, 1884

Family Luidiidae Salden, 1889

+*Luidia alternata alternata* (Say, 1825)

+*Luidia clathrata* (Say, 1825)

+*Luidia senegalensis* (Lamarck, 1816)

Family Astropectinidae Gray, 1840

\*\**Astropecten articulatus* (Say, 1825)

\*\**Astropecten duplicatus* Gray, 1840

+*Astropecten marginatus* Gray, 1840

Order Valvatida Perrier, 1884

Family Asterinidae Gray, 1840

\*\**Asterinides folium* (Lütken, 1859)

+*Asterina hartmeyeri* Döderlein, 1910

Family Ophidiasteridae Verrill, 1870

+*Linckia guildingii* Gray, 1840

\*\**Ophidiaster guildingii* Gray, 1840

Family Asteropseidae Hotchkiss and Clark, 1976

\**Poraniella echinulata* (Perrier, 1881)

Family Oreasteridae Fisher, 1911

+*Oreaster reticulatus* (Linnaeus, 1758)

Order Spinulosida Perrier, 1884

Family Echinasteridae Verrill, 1870

+\*\**Echinaster (Othilia) echinophorus* (Lamarck, 1816)

*Echinaster (Othilia) sentus* (Say, 1825)

**Class ASTEROIDEA De Blainville, 1830**

**Order PAXILLOSIDA Perrier, 1884**

**Family LUIDIIDAE Salden, 1889**

*Luidia alternata alternata* (Say, 1825)



**Figure 6.** *Luidia alternata alternata*. General Image. A. Oral and B. Aboral.

**References used for identification:** H. L. Clark 1933: 14-15, 20; Downey 1973: 22, 23-24, Pl. 2, Figs. A, B; Clark and Downey 1992: 6, 8-9, Figs. 4b, c, 5d, 6f, 7a-g, q, 8a, b, Pl.1B; Hendler et al. 1995: 66-67, Fig. 13.

**Material examined:** USNM E12687 (1) (R: 56 mm, r: 10 mm, R/r: 5,6); USNM 21441 (1) (R: 29 mm, r: 5 mm, R/r: 5,8).



**Previous Puerto Rican records:** H. L. Clark 1933.

**Diagnostic features:** Five arms, with paxillae rounded, skeleton loose or fragile. Arms banded or blotched with black. The paxillar armament consists of one central spine abruptly enlarged on some isolated (mostly lateral) paxillae (Downey 1973, Clark and Downey 1992).

**Description:** From Hendler et al. 1995 (66). “The species has five flat, straplike arms bordered by a fringe slender, sharp, marginal spines. The rows of paxillae on the upper arm surface are irregularly arranged, giving the body a fragile appearance. The paxillae near the arm margins are larger than those along the midline of the arms. Several of the paxillae in the marginal rows bear a single long, erect spine surrounded by small spinelets. The distinctively colored living individuals have a white or cream-colored dorsal surface, with mottling or bands of dark green, purple, brown or black. The ventral surface is yellow, and the tube feet bright orange”.

**Distribution:** Discontinuous between Cape Hatteras, North Carolina, and Buenos Aires, Argentina; known from several Caribbean Islands including Cuba and Puerto Rico, and from the coasts of Mississippi, Texas and Mexico and the Gulf of Mexico, but not reported from the Bahama Islands or from south of the Yucatan Peninsula to Colombia. Off Florida, it occurs from Jacksonville to the Dry Tortugas and northward on the west coast to St. Petersburg. (H. L. Clark 1933, Hendler et al. 1995, Abreu-Pérez et al. 2005, Benavides-Serrato et al. 2005, Durán-González et al. 2005, Laguarda-Figueras et al. 2005b). In Puerto Rico waters from Puerto Real and Humacao according with reference material examined in the echinoderms collection at NMNH.

**Depth Range:** Generally 3-50 m, but reported from low -tide mark to 200 m (Hendler et al. 1995).

**Remarks:** Specific localities within Puerto Rico are reported.

*Luidia clathrata* (Say, 1825)

**References used for identification:** Downey 1973: 22-23; Clark and Downey 1992: 6, 13-14, Figs. 4d, 5e-g, 6g, i, 8g, Pl.4B; Hendler et al. 1995: 68-69, Fig. 14.

**Material examined:** USNM E3753 (1) (R: 61 mm, r: 8 mm, R/r: 7,625); USNM E5478 (1 arm); USNM 31940 (1) (R: 100 mm, r: 14 mm, R/r: 25); USNM 38231 (4) (1: R: 105,6 mm, r: 8 mm, R/r: 13,2, 2: R: 88,8 mm, r: 15 mm, R/r: 5,92, 3: R: 88,8 mm, r: 13 mm, R/r: 6,83, 4: R: 120 mm, r: 14 mm, R/r: 8,57).

**Previous Puerto Rican records:** H. L. Clark 1933.

**Diagnostic features:** Five arms, not boldly patterned but uniform, sometimes darker midradially, or lighter along superomarginals or adjoining lateral paxillae. The paxillar armament consists of central spinelets distinctly coarser than peripheral ones (Clark and Downey 1992).

**Description:** From Clark and Downey 1992 (13). “Arms five, basally fairly broad tapering; abactinal paxillae laterally distinctly enlarged and rectangular, about three each side forming regular longitudinal series, of which the two outer (the lateral paxillae in the restricted sense) match transversely with each other and with the slightly broader rectangular superomarginal paxillae, paxillar armament fairly uniform in height though the numerous central spinelets are coarser; superomarginal paxillae very closely appressed to the inferomarginal plates with no slender peripheral spinelets along their common boundary; inferomarginal plates mainly ventral in position, bearing 2-3 blunted spines of moderate length at the ambitus, the lowest one longest, on the ventral side 4-5 abruptly shorter, markedly flattened and blunt-tipped spines; adambulacral plates with four large spines, the two abradial ones in line parallel to the furrow; pedicellariae absent. The color is usually bluish-grey, often with a darker midradial stripe, graduated or sharply defined, sometimes pinkish or light brown rather than gray”.

**Distribution:** New Jersey to southern Brazil including Bermuda, Mexico, the Gulf of Mexico and most Caribbean islands including Cuba and Puerto Rico, Panama, Colombia and Venezuela. (H. L. Clark 1933, Hendler et al. 1995, Abreu-Pérez et al. 2005, Benavides-Serrato et al. 2005, Durán-González et al. 2005, Laguarda-Figueras et al. 2005b). In Puerto Rico waters from Puntilla Point and San Juan Harbor according with reference material examined in the echinoderms collection at NMNH.

**Depth Range:** 0-100 m, but most common less than 40 m (Hendler et al. 1995).

**Remarks:** Specific localities within Puerto Rico are reported.

*Luidia senegalensis* (Lamarck, 1816)

**References used for identification:** Downey 1973: 22-23, Pl. 1, Figs. A, B; Clark and Downey 1992: 6, 21-22, Pl.4A; Hendler et al. 1995: 69-71, Fig. 15.

**Material examined:** USNM E5582 (2) (1: R: 57,16 mm, r: 10 mm, R/r: 5,716); USNM 21440 (1); USNM 31522 (2).

**Previous Puerto Rican records:** H. L. Clark 1933.

**Diagnostic features:** Arms nine, sometimes eight (Clark and Downey 1992).

**Description:** From Clark and Downey 1992 (21-22). “Arms almost invariably nine, very rarely fewer, relatively narrow and attenuate; abactinal paxillae laterally enlarged and rectangular, the two outermost series matching each other and the similar adjacent superomarginal paxillae, paxillar spinelets all similar in height though the central ones are coarser; inferomarginal plates mainly ventral in alignment, bearing usually two

inconspicuous spines at the ambitus, the upper one often smaller, ventrally with blunt squamiform spinelets; actinal interradiar areas much larger than in the other species of *Luidia* represented, with numerous series of plates, though only one series extends on the arm; adambulacral plates with four large spines, the two abradial in line parallel to the furrow; pedicellariae lacking”.

**Distribution:** Sporadically in southern Florida, Jamaica and from Cuba eastwards along the Greater and Lesser Antilles, also from Belize and Nicaragua and the coast of South America to southern Brazil (Clark and Downey 1992, Hendler et al. 1995, Abreu-Pérez et al. 2005, Benavides-Serrato et al. 2005). In Puerto Rico waters from Mayagüez, Puerto Real, Cataño (H. L. Clark 1933) and Puntilla Point according with reference material examined in the echinoderms collection at NMNH.

**Depth Range:** Low-tide mark to 46 m (Hendler et al. 1995).

**Remarks:** Specific localities within Puerto Rico are reported.

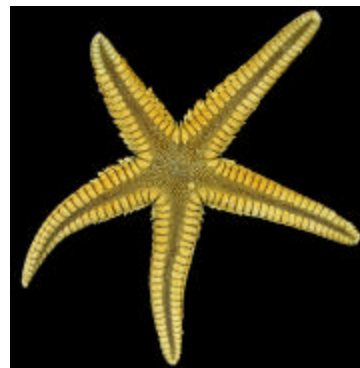
#### **Family ASTROPECTINIDAE Gray, 1840**

##### ***Astropecten articulatus* (Say, 1825)**

**References used for identification:** H. L. Clark 1933: 14-15, 16-17; Downey 1973: 28, Pl.4C,D; Clark and Downey 1992:31-32, 40, Fig. 9a, Pl.5A, B; Hendler et al. 1995: 71-72, Fig. 16.

**Material examined:** BIOL (2) (1: R: 53 mm, r: 10 mm, R/r: 5,3, 2: R: 50,6 mm, r: 8 mm, R/r: 6,32).

**Previous Puerto Rican records:** Hendler et al. 1995.



**Figure 7.** *Astropecten articulatus*.  
General Image.

**Diagnostic features:** Marginals granulose, superomarginals convex. No spine or tubercles on proximal superomarginals. Single spine on distal superomarginals (Downey 1973, Hendler et al. 1995).

**Description:** From Hendler et al. 1995 (71-72). “The smooth appearance of this sea star is a consequence of the closely set, granulose paxillae covering the disk and arms. The arms are moderately long and gradually tapering. They are bordered by prominent, compact superomarginal plates, which protrude above a level of the paxillae. In many individuals, some of the marginal plates carry a short, erect, acute spine on their outer margin. These spines are generally lacking on marginals near the disk and are never found on the pair of basal marginals at the junction of adjacent arms. Surrounding each arm is a fringe of flat, acute spines arranged two to a plate. They are set at right angles to the long axis of the arm, and their length nearly equals the width of the marginal plates. Five elongate jaws, covered with tiny spines, can seal the stellate mouth opening. This species can usually be recognized by its coloration. Dorsally the deep blue or purple paxillar region is framed by conspicuous white to orange marginal plates; ventrally the sea star is white or beige”.

**Distribution:** Chesapeake Bay, Virginia to Colombia, including Gulf of Mexico, Bahama Islands, the Yucatan, Cuba, Jamaica, Dominica, Puerto Rico, St. Thomas, Martinique, and the Lesser Antilles. In Florida, from Jacksonville to Tampa Bay, the Florida Keys, and the Dry Tortugas (Clark and Downey 1992, Hendler et al. 1995, Abreu-Pérez et al. 2005, Durán-González 2005). In Puerto Rico waters from La Parguera (Enrique).

**Depth Range:** 0-200 m (Clark and Downey 1992).

**Remarks:** Two specimens were collected for this study. Specific localities within Puerto Rico are reported.

***Astropecten duplicatus* Gray, 1840**

**References used for identification:** H. L. Clark 1933: 14-15, 17-19; Downey 1973: 27, 29, Pl.6A, B; Clark and Downey 1992:34-35, 40, Fig. 10d, Pl.8F,G; Hendler et al. 1995: 72-75, Fig. 17.

**Material examined:** USNM E10263 (2) (1: R: 56 mm, r: 7 mm, R/r: 8; 2: R: 59 mm, r: 10, R/r: 5,9); USNM 27723 (1) (R: 10 mm, r: 3 mm, R/r: 3,33); USNM 21427 (1) (R: 63 mm, r: 12 mm, R/r: 5,25); USNM 21428 (1) (R: 51,5 mm, r: 10, R/r: 5,15); USNM 31941 (2) (1: R: 64,75 mm, r: 8 mm, R/r: 8,09, 2: R: 67,75 mm, r: 10 mm, R/r: 6,78); USNM 33485 (2) (1: incomplete arms, 2: R: 31 mm, r: 7 mm, R/r: 4,43); MSC (1) (R: 20,66 mm, r: 5 mm, R/r: 4,132); MSC (1) (R: 30,8 mm, r: 7,4 mm, R/r: 4,16).

**Previous Puerto Rican records:** Hendler et al. 1995.

**Diagnostic features:** Marginals granulose, superomarginals convex. Two basal superomarginals (sometimes up to five) carry a single (occasionally two or more) small, erect spine on their inner edge (Downey 1973, Hendler et al. 1995).

**Description:** From Hendler et al. 1995 (72-73). “The five flat, narrow, and slightly tapering arms are two to three times greater in length than the disk diameter. The edge of each arm is bordered by large, smooth, rectangular superomarginals that are set above the level of the paxillae covering the disk and most of the arm. Starting with the third, superomarginals plates along the length of the arm may be armed with a similar, but smaller, spine on their outer edge. Below these plates lies marginal fringe of flat, erect, slightly curved spines with acute tips. The spines are arranged two to a plate. Ventrally, the five triangular jaws, covered with numerous spines, are prominent and distinct. Within the ambulacral groove are two rows of tube feet with pointed tips; suckers are lacking. In life, *A. duplicatus* is quite variable in coloration and color pattern; some individuals are simply a drab gray or light brown.

Others have light brown on the central portion of the arms and the disk, and marginal plates mottled with light pink to dark reddish brown. The small erect spines on the superomarginals and the fringe on marginal spines are often white, with an orange at their base. The ventral surface is white to tan, with pale orange tube feet”.

**Distribution:** North Carolina to Brazil, including the Bahama Islands, Jamaica, Cuba, Tobago, Trinidad, Puerto Rico, Dominica, St. Vincent and St. Thomas. In the Gulf of Mexico, off Louisiana, Mississippi, Texas and Mexico. Around Florida, it ranges from Jacksonville on the east coast to Tampa Bay on the west coast and the Florida Keys and the Dry Tortugas (Clark and Downey 1992, Abreu-Pérez et al. 2005, Durán-González et al. 2005, Laguarda-Figueras et al. 2005b). In Puerto Rican waters from La Parguera (Enrique), Vieques Island, Luquillo beach, Molines Point and Boqueron Bay according with reference material examined in the echinoderms collection at NMNH.

**Depth Range:** 0-550 m (Clark and Downey 1992).

**Remarks:** Specific localities within Puerto Rico are reported.

*Astropecten marginatus* Gray, 1840

**References used for identification:** Downey 1973: 27, 29-30, Pl. 6C, D; Clark and Downey 1992: 40, 41-42, Fig. 10e, Pl. 11A, B.

**Material Examined:** USNM 21429 (1); USNM 21430 (1); USNM E26352 (1); USNM 27724 (1) (R: 38 mm, r: 13 mm, R/r: 2,92); USNM 33477 (1) (R: 103 mm, r: 7 mm, R/r: 15).



**Figure 8.** *Astropecten marginatus*. General Image.

**Previous Puerto Rican records:** Clark and Downey 1992.

**Diagnostic features:** Marginals granulose, superomarginals convex, no spines or tubercles on any superomarginals. Body extremely flat, arms broad-based, inferomarginals projecting far beyond superomarginals (Downey 1973).

**Description:** From Clark and Downey 1992 (41-42). “Disc broad, flat, very thin; arms broadly triangular, slightly indented at base (petaloid); paxillae small, uniform, compact, in regular transverse rows, bearing 3-6 central and 10-12 peripheral granules; superomarginal plates narrow, mainly on upper surface, becoming tiny distally, covered with uniform rounded granules; inferomarginal plates projecting laterally beyond superomarginals, bearing two large, heavy, blunt slightly flattened, erect fringe spines and, behind them, four much smaller flattened aciculate spines; inferomarginals notably bare below, except for a few small flat spines; adambulacral furrow spines three, moderate, acicular, divergent; one large truncate subambulacral spine and 4-5 small acicular subambulacrals; mouth plates large, with four large oral spines, four similar suboral spines, and rows of small spines; a double row of three groups of four curved spines along sides of mouth plates; pedicellariae not usually present, but simple ones may occur on actinal plates. In life, the color of this species is blue with white marginals”.

**Distribution:** Puerto Rico, northern South America to Brazil (Clark and Downey 1992, Benavides-Serrato et al. 2005). In Puerto Rican waters from Mayagüez, Luquillo and Arroyo according with reference material examined in the echinoderms collection at NMNH.

**Depth Range:** 6-130 m (Clark and Downey 1992).

**Remarks:** Specific localities within Puerto Rico are reported.



**Order VALVATIDA Perrier, 1884**

**Family ASTERINIDAE Gray, 1840**

***Asterinides folium* (Lütken, 1859)**

**References used for identification:** Clark and Downey 1992: 177-181, 182-184, Figs 31c, d, e, 32f, k, Pl. 42I, J (as *Asterina folium*); Hendler et al. 1995: 74-75, Fig 18 (as *Asterina folium*); O'Loughlin and Waters 2004: 16-17, Figs 2d, 8f-I (as *Asterinides folium*).

**Material examined:** USNM 21442 (1) (R: 7 mm, r: 5 mm, R/r: 1,4); USNM E28573 (1) (R: 20 mm, r: 14 mm, R/r: 1,43); USNM E09097 (2) (1: R: 13 mm, r: 9 mm, R/r: 1,44, 2: R: 6 mm, r: 5 mm, R/r: 1,2); USNM E49050 (3) (1: R: 5 mm, r: 3 mm, R/r: 1,66); MSC ¿?¿? (1) (R: 8 mm, r: 6 mm, R/r: 1,33); MSC (5) (1: R: 10 mm, r: 8 mm, R/r: 1,25, 2: R: 7,5 mm, r: 5 mm, R/r: 1,5, 3: R: 11 mm, r: 7 mm, R/r: 1,57, 4: R: 12 mm, r: 9 mm, R/r: 1,33, 5: R: 8 mm, r: 6 mm, R/r: 1,33); MSC (1) (R: 7 mm, r: 6 mm, R/r: 1,17) as *A. foliate*; MSC (1) (R: 9 mm, r: 7,5 mm, R/r: 1,2).

**Previous Puerto Rican records:** H. L. Clark 1933.

**Diagnostic features:** 2-4 actinal spines per plate; 2 (1) suboral spines (Clark and Downey 1992).

**Description:** From Clark and Downey 1992 (183). Body form low, thin marginally, almost pentagonal but each ray slightly petaloid, sometimes four- or six-rayed; abactinal plates fairly regularly arranged but without a distinct pentagon on the disc, the primary plates of the pore areas mostly heart-shaped, with two alternating longitudinal series midradially in specimens with R <10 mm but some median proximally trilobed plates in the largest specimens, the median lobe no longer than the lateral ones, secondaries few but one or two corresponding to some proximal primaries in the holotype (R14 mm), plates densely embedded with coarse crystal bodies and armed with fine spinelets having a narrow core of one series of cavities

and several hyaline points the distal half, spinelets very easily lost, their full extent in life uncertain, some preserved specimens having them all along the proximal or adradial edge while at least the more lateral plates seem to have a compact cluster of 15 set back from concavity opposite the pore; papular pores large, arranged in six main longitudinal series on each ray at R7-10 mm; superomarginals similarly armed with fine, easily lost, spinelets but the projecting inferomarginals with a more tenacious fringe of 15-20 slightly larger spinelets; actinal plates each armed with a webbed comb of 2-5, usually three or four, slender pointed spines, at least the proximal ones long enough to just overlap the adjacent spines peripheral to them; adambulacral plates with up to five, usually three or four, webbed furrow spines backed by an oblique comb of 2-4 subambulacral spines; each oral plate armed with four or five (six) furrow spines and usually two suboral ones, the webbing of the furrow spines continuous across the apex of the jaw; pedicellariae absent; gonopores not detected. The smallest specimens nearly white, becoming cream to yellow to reddish-yellow or more often greenish, the largest olive- or bluish-green to blue.

**Distribution:** Gulf of Mexico, Mexico, Bermuda, the Florida Keys, the Dry Tortugas, the Bahama Islands, and most Caribbean islands including Puerto Rico, and the northern coast of South America, southward to Brazil (H. L. Clark 1933, Hendler et al. 1995, Durán-González 2005, Laguarda-Figueras et al. 2005b). In Puerto Rico waters from Guanica Harbor, Ponce (H. L. Clark 1933) and La Parguera (Patch Reef, Enrique Reef, Margarita Cay and Mario Reef) collected in this study.

**Depth Range:** Low -tide mark to 15 m (Hendler et al. 1995).

**Remarks:** There is some confusion between *A. folium* and *A. hartmeyeri*. Clark and Downey (1992) revised this species and established some morphological differences between the two. O'Loughlin and Waters (2004) provided an extensive revision of the genera of Asterinidae family including *Asterinides* genus. Specific localities within Puerto Rico are reported.

*Asterina hartmeyeri* Döderlein, 1910

**References used for identification:** Clark and Downey 1992: 181, 185-186, Fig 31g, Pl. 42E-H.

**Material examined:** USNM E4950 (1) (Trinidad and Tobago) (R: 5 mm, r: 3 mm, R/r: 1,66).

**Previous Puerto Rican records:** H. L. Clark 1933, Clark and Downey 1992.

**Diagnostic features:** Abactinal plates are small, crescentic, triangular or rod-like; 18-30 pores per papula area and are large and many (about same size as the numerous small abactinal plates) (Clark and Downey 1992).

**Description:** From Clark and Downey 1992 (186). “Disc small, arms five (4-6), long, slender, cylindrical, usually showing signs of autotomy and regeneration; abactinal plates small (ten per cm along mid-arm), forming more or less irregular reticulate pattern, sometimes imbricate, covered with small, slightly flattened granules; papular areas large, numerous, with 18-30 pores per area, none below inferomarginals; actinal plates in two (three) series, extending nearly or quite to end of arm, covered with granules coarser than those of abactinal surface; adambulacral furrow spines truncate, granuliform in external view, one large and one small, slightly flattened parallel to furrow; two quite large, round, granuliform subambulacral spines, plus 4-5 small granules, usually two madreporites on adjacent interradial, sometimes only one, large, flat; terminal plate small, oval usually covered with granules”.

**Distribution:** This species is circumtropical. In the western Atlantic occurring off Bermuda, from Florida to Brazil, from the Bahama Islands to Mexico, at numerous Caribbean islands, including Jamaica, Cuba, Puerto Rico, Barbados, Tobago, Aruba and Bonaire (H. L. Clark 1933, Hendler et al. 1995, Abreu-Pérez et al. 2005, Laguarda-Figueras et al. 2005b). In

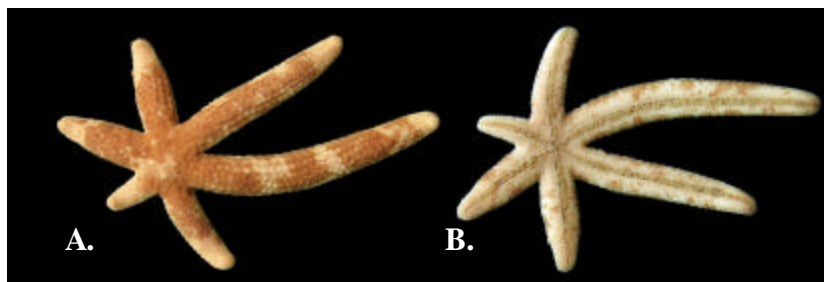
Puerto Rico waters from La Parguera (Mangrove Island), Guayanilla Harbor (Cayo Maria Langa), Ensenada Honda (Culebra), Ponce and San Juan (H. L. Clark 1933); from La Parguera (La Gata Reef, Majimo Reef, Isla de la Cueva, Mario Reef) and Playa Sucia (Cabo Rojo) according with reference material examined in the echinoderms collection at NMNH.

**Depth Range:** 0-298 m (Clark and Downey 1992).

**Remarks:** Specific localities within Puerto Rico are reported.

**Family OPHIDIASTERIDAE Verrill, 1870**

***Linckia guildingii* Gray, 1840**



**Figure 9.** *Linckia guildingii*. General Image: A. Aboral region and B. Oral region.

**References used for identification:** Downey 1973: 66-67, Pl. 27: Figs A, B; Clark and Downey 1992: 274, 275-276, Fig 42c, d, Pl. 67C, D; Hendler et al. 1995: 76, Fig 20, 21.

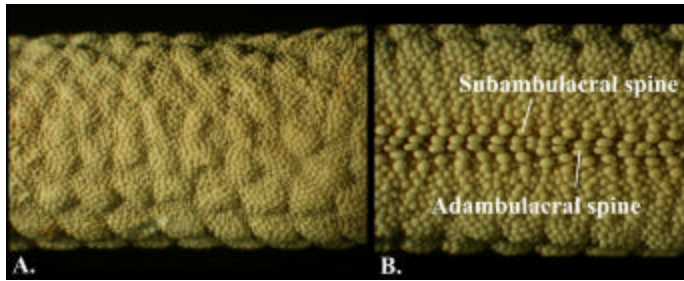
**Material examined:** USNM E24654 (1); USNM 21434 (2) (1: R: 19,5 mm, r: 3 mm, R/r: 6,5, 2: R: 15,5 mm, r: 3 mm, R/r: 5,17); USNM 21435 (3) (1: R: 13,16 mm, r: 2 mm, R/r: 6,58, 2: R: 10,2 mm, r: 2 mm, R/r: 5,1, 3: R: 20,6 mm, r: 4 mm, R/r: 5,16); USNM 21436 (4) (1: R: 35,2 mm, r: 6 mm, R/r: 5,9, 2: R: 8,1 mm, r: 0,5 mm, R/r: 16,2, 3: R: 11 mm, r: 2 mm, R/r: 5,5, 4: R: 55 mm, r: 1 mm, R/r: 55); USNM 21437 (1 arm); USNM 27718 (3) (1: R: 13,8 mm, r: 3 mm, R/r: 4,6, 2: R: 15,8 mm, r: 2 mm, R/r: 7,9, 3: R: 6,33 mm, r: 1,5 mm, R/r: 4,2); USNM 27719 (2) (1: R: 14,83 mm, r: 3 mm, R/r: 4,94, 2: R: 19,33 mm, r: 4 mm, R/r: 4,83);

MSC (2) (1: R: 25,33 mm, r: 5 mm, R/r: 5,06, 2: R: 13 mm, r: 3 mm, R/r: 4,33); MSC (2) (1: R: 25,6 mm, r: 4 mm, R/r:

6,4, 2: R: 20,08 mm, r: 3 mm, R/r: 6,69); MSC (4) (1: R: 10,8 mm, r: 3 mm, R/r: 3,6, 2: R: 13,6 mm, r: 4 mm, R/r: 3,4, 3: R: 16,5 mm, r:

3,5 mm, R/r: 4,71, 4: R: 8,58 mm, r: 2 mm, R/r:

4,29); MSC (3) (1: R: 14 mm, r: 4 mm, R/r: 3,5, 2: R: 13,8 mm, r: 3 mm, R/r: 4,6, 3: R: 20,66 mm, r: 5 mm, R/r: 4,132); MSC (2) (1: R: 10,8 mm, r: 2 mm, R/r: 5,4, 2: R: 5,33 mm, r: 2 mm, R/r: 2,66); MSC E 17 (1) (R: 41,4 mm, r: 5 mm, R/r: 8,28); MSC E 188 (1) (R: 22 mm, r: 3 mm, R/r: 7,33); MSC (2); MSC (3); MSC (4); MSC (1 arm); BIOL (1) (lb: 25,17 mm); BIOL (1) (lb: 12 mm); BIOL (1) (lb: 20,33 mm); BIOL (1) (lb: 15,16 mm).



**Figure 10.** *Linckia guildingii*. Arms Details: A. Aboral region and B. Oral region.

**Previous Puerto Rican records:** H. L. Clark 1933.

**Diagnostic features:** Abactinal plates are small, crescent, triangular or rod-like; 18-30 pores per papular area and are large and many (about same size as the numerous small abactinal plates) (Clark and Downey 1992).

**Description:** From Clark and Downey 1992 (275-276). “Disc small, arms five (4-6), long, slender, cylindrical, usually showing signs of autotomy and regeneration; abactinal plates small (ten per cm along mid-arm), forming more or less irregular reticulate pattern, sometimes imbricate, covered with small, slightly flattened granules; papular areas large, numerous, with 18-30 pores per area, none below inferomarginals; actinal plates in two (three) series, extending nearly or quite to end of arm, covered with granules coarser than those of abactinal surface; adambulacral furrow spines truncate, granuliform in external view,

one large and one small, slightly flattened parallel to furrow; two quite large, round, granuliform subambulacral spines, plus 4-5 small granules; usually two madreporites on adjacent interradii, sometimes only one, large, flat; terminal plate small, oval usually covered with granules”.

**Distribution:** This species is circumtropical. In the western Atlantic it occurs off Bermuda, Gulf of Mexico, from Florida to Brazil, from the Bahama Islands to Mexico, at numerous Caribbean islands, including Cuba and Puerto Rico (H. L. Clark 1933, Hendler et al. 1995, Abreu-Pérez 2005, Durán-González et al. 2005, Laguarda-Figueras et al. 2005b). In Puerto Rico waters from La Parguera (Mangrove Island), Guayanilla Harbor (Cayo Maria Langa), Ensenada Honda (Culebra), Ponce and San Juan (H. L. Clark 1933); La Parguera (La Gata Reef, Majimo Reef, Isla de la Cueva, Mario Reef) and Playa Sucia (Cabo Rojo) according with reference material examined in the echinoderms collection at MSC. In this study, from Pelotas, Media Luna, Laurel and Enrique (La Parguera).

**Depth Range:** 0-298 m (Clark and Downey 1992).

**Remarks:** Specific localities within Puerto Rico are reported.

### ***Ophidiaster guildingii* Gray, 1840**

**References used for identification:** Downey 1973: 68-69, Pl. 28: Figs C, D; Clark and Downey 1992: 279, 281, Fig 44c, d, Pl. 69A, B; Hendler et al. 1995: 79, Fig 22.

**Material examined:** USNM E24649 (1); USNM 21433 (2) (1: R: 30,8 mm, r: 4 mm, R/r: 7,7, 2: R: 30,8 mm, r: 4 mm, R/r: 7,7); USNM 27722 (1) (R: 33 mm, r: 5 mm, R/r: 6,6); MSC (1) (R: 28,6 mm, r: 3 mm, R/r: 9,53); MSC (1) (R: 42,8 mm, r: 7 mm, R/r: 6,11).

**Previous Puerto Rican records:** H. L. Clark 1933.

**Diagnostic features:** Arm shape cylindrical, 5-15 pores per papular area, granulation (approximate number of granules covering one median abactinal plate near arm base) are moderately coarse (200-400), actinal plates corresponding in number to inferomarginal plates, one row of actinal plates, one series of subambulacral spines (Clark and Downey 1992).

**Description:** From Clark and Downey 1992 (281), Hendler et al. 1995 (79). “Disc small, arms five, blunt, cylindrical, 5-15 pores per papular area; body covered with coarse granules, 200 covering one median abactinal plate near arm base, with several central granules slightly enlarged; abactinal plates cruciform; one row of small actinal plates adjoining adambulacral plates reaching nearly to end of arm; actinals connected to inferomarginal plates by rod-like plates which correspond with inferomarginals, but only half as many as actinals; adambulacral furrow spines two, short, broad, blunt, subequal; one subambulacral spine per plate, tapering, flattened, appressed; pedicellaria rare (only in occasional specimens,  $R > 50$  mm). The coloration is variable and can change as an individual grows. According to H. L. Clark (1933), young individuals are dull purplish red variegated with a lighter shade. Mature specimens range from pale yellow to orange and scarlet to brownish red, more or less blotched with blue, purple, maroon or brown”.

**Distribution:** Gulf of Mexico, the Florida Keys, the Dry Tortugas, many of the islands of the Greater and Lesser Antilles including Mexico, Cuba and Puerto Rico, Belize and off Brazil (Hendler et al. 1995, Abreu-Pérez 2005, Durán-González et al. 2005, Laguarda-Figueras et al. 2005b). In Puerto Rico from Guayanilla Harbor (Cayo Maria Langa), Ponce (H. L. Clark 1933) and La Parguera (Margarita Reef, Cayo Turrumote) according with reference material examined in the echinoderms collection at MSC.

**Depth Range:** 0-329 m (Clark and Downey 1992).

**Remarks:** Specific localities within Puerto Rico are reported.

**Family ASTEROPSEIDAE Hotchkiss and Clark, 1976**

***Poraniella echinulata* (Perrier, 1881)**

**References used for identification:** Downey 1973: 81, Pl. 36: Figs C, D; Clark and Downey 1992: 143, 289, Pl. 46A, B; Hendler et al. 1995: 81, Fig 24.

**Material examined:** USNM E3756 (1) (R: 5,1 mm, r: 3 mm, R/r: 1,7); MSC (1) (R: 8 mm, r: 5 mm, R/r: 1,6).

**Previous Puerto Rican records:** None.

**Diagnostic features:** Disc form inflated, abactinal plates reticulate and flat, armament of abactinals covered with thick skin and granules, ambulacral grooves narrow, without suboral spines (Clark and Downey 1992).

**Description:** From Clark and Downey 1992 (289-290), Hendler et al. 1995 (81-82). “Sea star with a short-rayed stellate form, rays low but distinctly carinate above, flat below, apparently of small size,  $R < 20\text{mm}$ ; body and spines covered in slightly thickened skin; the five primary radial plates enlarged and shield-shaped, the spines along their straight or concave proximal sides together forming a pentagonal pattern around the anal area, other abactinal plates mostly hexagonal with very short lobes, tending to imbricate, plates armed sparsely with fine, acute, divergent spines; papulae single and interstitial between the lobes of the plates in about six longitudinal rows on each radial area, pores absent from a triangular area in each interradius; marginal plates conspicuous, relatively few, flattened, the superomarginals inset from the edge and with oblique sutures, armed with a double row of acute spines, inferomarginals projecting to form a blunt flange along the edge of which the spines are coarser and tend to form a divergent flattened group or fan, bare ventrally where embedded crystal bodies are especially evident; actinal plates arranged in regular chevrons in each interradial area, all but the first (adradial) one with an odd interradial plate, plate armed



sparsely with small spines similar to the abactinal ones; adambulacral plates more numerous and armed with a few furrow spines in longitudinal series backed by subambulacral spines arranged obliquely; no pedicellariae. The upper surface is a bright orange-red to blood red, variegated with white. In some individuals, the white pigment forms a pentagon at the center of the disk and a distinct stripe along the midline of each arm. The distal tips of the arms are mottled black and white, the fleshy papulae are pigmented pale orange, and the madreporite is light tan, The lower surface is uniformly orange-red except for the white tips of the spines at the jaws tips”.

**Distribution:** Gulf of Mexico, Florida, the Bahama Islands, Cuba, Yucatan, Mexico, Panama, Belize, and Barbados. Specimens from Carrie Bow Cay provide the shallowest depths reported to date (Hendler et al. 1995, Abreu-Pérez et al. 2005, Durán-González et al. 2005) and now at Puerto Rico.

**Depth Range:** 3-309 m (Hendler et al. 1995).

**Remarks:** Although neither Clark and Downey 1992 nor Hendler et al. 1995 record this species from Puerto Rico, material in the NMNH as well as MSC confirms its presence. Herein is the first record from Puerto Rico.

#### **Family OREASTERIDAE Fisher, 1911**

##### ***Oreaster reticulatus* (Linnaeus, 1758)**

**References used for identification:** Downey 1973: 60, Pl. 24: Figs A, B; Clark and Downey 1992: 292-293, Pl. 72C, D; Hendler et al. 1995: 82-84, Fig 25, 26.

**Material examined:** USNM E3965 (1); USNM E12617 (1); USNM 21438 (3) (1: R: 70 mm, r: 27 mm, R/r: 2,59, 2: R: 50 mm, r: 18 mm, R/r: 2,78, 3: R: 65 mm, r: 24 mm, R/r: 2,71);

USNM 21439 (1) (R: 32 mm, r: 16 mm, R/r: 2); MSC E-175 (1) (R: 60 mm, r: 22 mm, R/r: 2,72).

**Previous Puerto Rican records:** H. L. Clark 1933.

**Diagnostic features:** Disc highly inflated; abactinal plates with tubercle or spine; subambulacral spine large and heavy and actinal pedicellariae not in alveoli (Clark and Downey 1992).



**Figure 11.** *Oreaster reticulatus*. General Image.

**Description:** From Clark and Downey 1992 (293), Hendler et al. 1995 (82-83). “Form large, heavy, stellate, with highly inflated disc and short arms; principal abactinal plate convex, bearing low, heavy, conical spines or tubercles; plates connected by narrow elongate secondary plates, forming reticulum, the open meshes with many pores; superomarginal plates bearing larger, heavier spine or tubercle; plates of actinal interradial areas in regular chevrons, bearing one or more low central tubercles or enlarged granules; inferomarginal plates similar to actinals; entire surface, except for naked tips of spines, covered with close granules, larger and coarser on actinal surface; adambulacral furrow spines five, small, flattened; subambulacral spine single, large, heavy, somewhat flattened; tiny bivalved pedicellariae present on both surfaces, never sunken in alveoli on plates; madreporite relatively small. The color patterns of *O. reticulatus* are extremely variable, even among individuals in the same population. The upper surface of juveniles is usually mottled green (often olive green), brown, tan, and gray. In contrast, the upper surface of adults is yellow, brown, or orange, with the large erect tubercles distinctly lighter or darker than the disk and arms. The lower surface of both juvenile and adult specimens is beige or cream”.

**Distribution:** Amphiatlantic. In the tropical western Atlantic ranging from North Carolina (Cape Hatteras) and Bermuda (occasional) south to Florida, the Bahama Islands, Gulf of Mexico although to Caribbean including South América to Brazil; also from the Cape Verde Islands off Western Africa (Hendler et al. 1995, Abreu-Pérez et al. 2005, Benavides-Serrato et al. 2005, Durán-González 2005, Laguarda-Figueras et al. 2005b). In Puerto Rico waters, from Ponce, Mayagüez, San Juan (H. L. Clark 1933), Boqueron Bay and Aguadilla according with reference material examined in the echinoderms collection at NMNH.

**Depth Range:** 1-37 m (Hendler et al. 1995).

**Remarks:** Specific localities within Puerto Rico are reported.

**Order SPINULOSIDA Perrier, 1884**

**Family ECHINASTERIDAE Verrill, 1870**

***Echinaster (Othilia) echinophorus* (Lamarck, 1816)**

**References used for identification:** Downey 1973: 86, 87 Pl. 39: Figs C, D; Clark and Downey 1992: 354-355, 367-371, Pls. 89A, B, F, 90F-H; Hendler et al. 1995: 84-85, Fig 27.

**Material examined:** USNM E13180 (1) (R: 24,2 mm, r: 6 mm, R/r: 4,04); USNM 21424 (1) (R: 43,6 mm, r: 4 mm, R/r: 11); USNM 21425 (1) (R: 46,6 mm, r: 5 mm, R/r: 9,32); USNM 21426 (1) (R: 45 mm, r: 11 mm, R/r: 4,09); USNM 21431 (1) (R: 24 mm, r: 8 mm, R/r: 3); USNM 21432 (1) (R: 18 mm, r: 5 mm, R/r: 3,6); USNM 27720 (3) (1: R: 19,6 mm, r: 4 mm, R/r: 4,9, 2: R: 19,4 mm, r: 4 mm, R/r: 4,85); USNM 27721 (1) (R: 19 mm, r: 4 mm, R/r: 4,8); USNM 33483 (1) (R: 50,5 mm r: 7,21 mm, R/r: 7,004); BIOL (1) (R: 20 mm, r: 6 mm, R/r: 3,33); MSC (2) (1: R: 2,8 mm, r: 0,6 mm, R/r: 4,66, 2: R: 4,8 mm, r: 1,2 mm, R/r: 4).

**Previous Puerto Rican records:** Clark and Downey 1992, Hendler et al. 1995.

**Diagnostic features:** Arm thick and blunt; adambulacral plates with one spine within furrow and one on margin (Downey 1973).

**Description:** From Hendler et al. 1995 (84-85). “This species has a small disk and five arms that taper little, except near their tips. They are subcylindrical, flattened ventrally, and composed of widely spaced plates covered by a relatively thin skin. The upper surface of each arm bears one to two irregular rows of conspicuous, erect, thornlike spines. There are six to nine spines per row, each spine measuring 2-3 mm in length. Along the



**Figure 12.** *Echinaster (Othilia) echinophorus*. General Image.

side of the arm there is a straight row of spines similar to those on the upper surface. On the lower surface, the ambulacral grooves are bordered on both sides by three series of spines: the spines in the middle and outer rows are twice and four times as large, respectively, as those in the inner row. The ventral margin of each arm carries another series of spines, more numerous and slightly smaller than those on the upper surface. The uniform bright red or crimson color is fairly consistent”.

**Distribution:** Florida Keys, Puerto Rico, Jamaica, Cuba and Nicaragua, Belize and Bahama Islands (Hendler et al. 1995, Abreu-Pérez et al. 2005), in Puerto Rico waters, from Cabo Rojo Lighthouse (Salinas Bay), Puerto Real, San Juan, Vieques, Mayagüez (Punta Guanaibo) and Point Molines according with reference material examined in the echinoderms collection at NMNH and MSC. In this study was collected in La Parguera (Magueyes and Caballo Blanco).

**Depth Range:** Usually in shallow water, although it has been reported to 55 m (Hendler et al. 1995).

**Remarks:** Specific localities within Puerto Rico are reported.

*Echinaster (Othilia) sentus* (Say, 1825)

**References used for identification:** Downey 1973: 86, 87 Pl. 40: Figs A, B; Clark and Downey 1992: 349-357, 362-363, 377-380, Figs 56a, 58a, Pl. 91A, B; Hendler et al. 1995: 85-87, Fig 28, 29.

**Material examined:** USNM E37835 (1) Colombia (R: 47 mm, r: 11 mm, R/r: 4,27) ; USNM E08121 (1) Jamaica (R: 18,4 mm, r: 5,5 mm, R/r: 3,34); MSC (1) (R: 4,9 mm, r: 1 mm, R/r: 4,9).

**Previous Puerto Rican records:** H. L. Clark 1933.

**Diagnostic features:** Arm thick and blunt, broad throughout but slightly tapering, tips still fairly broad; adambulacral plates with 3 or 4 spines, 1 or 2 in furrow and 1 or 2 on margin (Downey 1973).

**Description:** From Clark and Downey 1992, Hendler et al. 1995. Arm coarse and stout, sometimes almost cylindrical but usually tapering to broad rounded tips, sometimes narrower distally, especially in very large specimens, R>60mm, skin thick, completely obscuring the plating; skeleton coarse, primary pentagon on disc and the three primary abactinal plate series on arms only revealed by their spines which are often somewhat irregular in position, carinals and adradials linked directly by their lobes or by plates themselves, carinals sometimes in very zigzag series so as to make two rows for part of their extent, adradial plates linked to the superomarginals by adradial plating which becomes irregular in specimens larger than R:40mm, up to that size including some proximal elongated secondary abradials superimposed on the transverse plates but the elongated plates apparently becoming transformed into polygonal ones and even developing patches of crystal bodies (glassy

tubercles) while similar plates indistinguishable from the adradial primaries continue the abradial series in the distal part of the arm, abradial spines single and arising from longitudinal plates when present or from polygonal ones, spinose primaries of the three main abactinal series more or less convex, numbering usually 13-19 but up to 24 in the largest specimens in each adradial row, spines relatively conspicuous, up to 2mm long, more often 1,3-1,6 mm, conical or tapering to a point at the distal end, sometimes blunted, arising from the summit of a convexity on the plate which is usually inset but may be towards the distal end, most plates with a compact and sometimes slightly sunken rounded patch of crystal bodies on the proximal slope, some spineless plates also with similar patches; adradial skeletal meshes often appearing more or less confluent, the larger ones with up to 15 papulae and 6-10 glands; superomarginal plates beyond the base of the arm aligned just below or sometimes at half the height of the arm, most four lobed, 50-60%, rarely up to 80%, of the plates with an upper, or in the distal third a median distal spine, the other, usually alternate, plates either spineless or with a lower spine, intermarginal plating fairly well developed, usually extending for more than half the arm length and some proximal plates in larger specimens with a spine forming a partial series, or occasionally two in large specimens, but usually a total of 11 longitudinal series of spinose plates, inferomarginals tending to alternate spinose and spineless, the spinose plates polygonal and often convex with the spine median and the patch of crystal bodies reduced or absent, unlike the intervening plates which are flatter and usually quadrangular; adambulacrals with three, sometimes four spines on the proximal half of the arm, rarely sporadic plates with two or even five, the first two spines usually reduced in size and inset into the furrow but the second may arise on or just within the furrow margin and appear superficial, spines joined by a more or less distinct transverse web in a fairly straight line, or the third spine may appear slightly offset distally, abradial ends of plates usually bare of "subambulacral" spines, the distal plates often with spine number enhanced; madreporite flat, usually distinctly longer in the interradian plate than wide, with fairly distinct radial ridges on which are mounted small blunt spaced spinules, sometimes extending nearly to the center, the peripheral ones sometimes slightly coarser.

This specie is reported to be deep red, reddish brown, dark purple, pale violet, yellow brown or purple.

**Distribution:** The geographic range is problematic because the reports of western Atlantic Echinaster species have so often been based on misidentified specimens. However, its occurrence is confirmed from the Bahama Islands and Florida (Hendler et al. 1995). According with Durán-González et al. (2005) now is a record from Gulf of Mexico. In Puerto Rico waters, it was taken at a mangrove island at La Parguera, Ensenada, at the west end of the reef between Pargas Bay and Harbor entrance, Ensenada, east end of San Antonio (San Juan) and Puerto Real (H. L. Clark 1933).

**Depth Range:** Shallow intertidal to 13 m (Hendler et al. 1995).

### 3.1.3. Class Ophiuroidea (Gray, 1840)

Order Phrynophiurida Matsumoto, 1915

Family Ophiomyxidae Ljungman, 1866

+*Ophiomyxa flaccida* (Say, 1825)

+*Ophioblenna antillensis* Lütken, 1859

Family Gorgonocephalidae Ljungman, 1867

*Asteroporpa annulata* Örsted & Lütken, 1859

*Astrophyton muricatum* (Lamarck, 1816)

*Schizostella bifurcata* A. H. Clark, 1952

Order Ophiurida Mueller & Troschel, 1840

Family Ophiuridae Lyman, 1865

Subfamily Ophiolepidinae Matsumoto, 1915

\*\**Ophiolepis paucispina* (Say, 1825)

+*Ophiolepis elegans* Lütken, 1859

\*\**Ophiolepis impressa* Lütken, 1859

Family Ophiocomidae Ljungman, 1867

Subfamily Ophiocominae Ljungman, 1867

+\*\**Ophiocoma echinata* (Lamarck, 1816)

+\*\**Ophiocoma pumila* Lütken, 1859

+\*\**Ophiocoma wendtii* Müller & Troschel, 1842

*Ophiocomella ophiactoides* (H. L. Clark, 1901)

Subfamily Ophiopsilinae Matsumoto, 1915

*Ophiopsila riisei* Lütken, 1859

Family Ophionereidae Ljungman, 1867

*Ophionereis olivacea* H. L. Clark, 1901

+\*\**Ophionereis reticulata* (Say, 1825)

*Ophionereis squamulosa* Koehler, 1913

Family Ophi Dermatidae (Ljungman, 1867)

+\*\**Ophioderma appressum* (Say, 1825)

+\*\**Ophioderma brevicaudum* Lütken, 1856

+*Ophioderma brevispinum* (Say, 1825)

\*\**Ophioderma cinereum* Müller & Troschel, 1842

\*\*\**Ophioderma phoenium* H. L. Clark, 1918

+*Ophioderma rubicundum* Lütken, 1856

\*\*\**Ophioderma squamosissimum* Lütken, 1856

Family Ophiactidae Matsumoto, 1915

+*Hemipholis elongata* (Say, 1825)

*Ophiactis quinquerradia* Ljungman, 1871

+*Ophiactis savignyi* (Müller & Troschel, 1842)

Family Amphiuridae Ljungman, 1867

*Amphiodia planispina* (Martens, 1867)

*Amphiodia pulchella* (Lyman, 1869)

+*Amphiodia trychna* Clark, 1918

*Amphipholis gracilima* (Stimpson, 1852)



*Amphipholis januarii* Ljungman, 1867  
*Amphipholis squamata* (Delle Chiaje, 1828)  
 \*\**Amphiura palmeri* Lyman, 1882  
 +*Amphiura stimpsonii* Lütken, 1859  
*Ophiocnida scrabriuscula* (Lütken, 1859)  
 \**Ophionephthys limicola* Lütken, 1869  
*Ophiophragmus pulcher* H. L. Clark, 1918  
*Ophiophragmus septus* (Lütken, 1859)  
*Ophiostigma isocanthum* (Say, 1825)  
*Ophiostigma siva* Hendler, 1995

Family Ophiotrichidae Ljungman, 1867

+\*\**Ophiothrix angulata* (Say, 1825)  
*Ophiothrix brachyactis* H. L. Clark, 1915  
 +\*\**Ophiothrix orstedii* Lütken, 1856  
 +\*\**Ophiothrix suensonii* Lütken, 1856

Class OPHIUROIDEA (Gray, 1840)  
Order PHRYNOPHIURIDA Matsumoto, 1915  
Family OPHIOMYXIDAE Ljungman, 1866  
*Ophiomyxa flaccida* (Say, 1825)

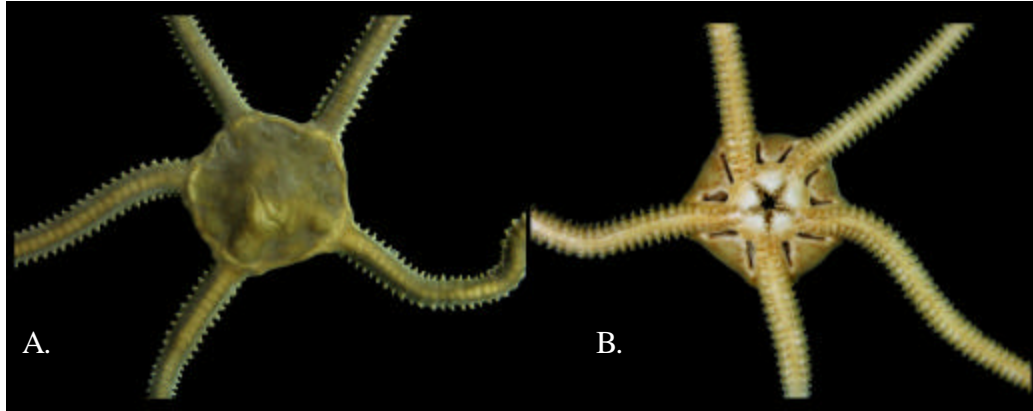


Figure 13. *Ophiomyxa flaccida*. General Image. A. Aboral and B. Oral.

**References used for identification:** Lyman 1865: 178, pl. 2, figs. 6, 18, 19; Hendler et al. 1995: 99-100, Fig. 34.

**Material examined:** USNM E10295 (5) (1: dd: 20 mm, al: 80 mm, 2: dd: 20 mm, al: 90 mm, 3: 20 mm, al: 110 mm, 4: dd: 18 mm, al: 73 mm, 5: dd: 6 mm, al: 18 mm) ; USNM 21356 (1) (dd: 24 mm, al: 115 mm); BIOL (1) (dd: 20 mm, al: 90 mm); MSC (1) (dd: 18 mm, al: 68 mm).

**Previous Puerto Rican records:** H. L. Clark 1933, Hendler et al. 1995.

**Diagnostic features:** The disk and arms are both covered by soft, smooth, slick skin, hence its scientific name, loosely translated as “soft mucus-snake”. Dorsal arm-plates fragmented; radial shields conspicuous: arm-spines not hooked, save a tip of arm; disc plates around the

margin, disc otherwise covered by skin; teeth and oral papillae broadly expanded with denticulate free margins; second oral tentacle opening entirely within the mouth-angles (Fell 1960, Hendler et al. 1995).

**Description:** From Hendler et al. 1995 (99). “Minute serrations on the arm spines give the arms a rough texture and provide another tactile clue for identification. The teeth and oral papillae of this species have a transparent, serrated edge, visible under the microscope. There is a thick collar of connective tissue reinforced with microscopic scales, rather than discrete tentacle scales, at the base of the tube feet. The color is green, yellow, orange, red or brown. The disk is often flecked or mottled, and the arms usually are banded with lighter and darker shades of the ground color or cream color. At a given locality, individuals may all be a single color, or a variety of colors may be represented”.

**Distribution:** Gulf of Mexico, Bermuda, the Florida Keys, the Dry Tortugas, the Bahama Islands, Cuba, Jamaica, Haiti, Puerto Rico, Virgin Islands, the Leeward and Windward Islands, Barbados, Trinidad, Tobago, Curaçao, Belize, Isla de Providencia and the mainland of Central and South America from Belize to Brazil (Hendler et al. 1995, Durán-González et al. 2005). In Puerto Rico waters it is known from Mangrove Island (La Parguera), Ensenada, Ensenada Honda (Culebra Island) and San Juan (H. L. Clark 1933); also from La Parguera (Enrique).

**Depth Range:** Less than 100 m (Hendler et al. 1995).

**Remarks:** Specific localities within Puerto Rico are reported.

***Ophioblenna antillensis* Lütken, 1859**

**References used for identification:** H. L. Clark 1901a: 249, pl 15, figs. 1-4 (as *Ophialcaea glabra*), H. L. Clark 1933: 43, 44.

**Material examined:** None.

**Previous Puerto Rican records:** H. L. Clark 1933, Hendler et al. 1995.

**Diagnostic features:** Paired, ovoid tentacle scales. Smooth-edged teeth and oral papillae (Hendler et al. 1995).

**Description:** From Hendler et al. 1995 (98). “The soft, smooth disk integument of the species is the basis of its scientific name, which translates as “slimy snake of the Antilles.” The arms have a thin skin through which the broad, unfragmented dorsal arm plates and slender thorny arm spines are evident even with the naked eye. Additional characteristics that distinguish this species from *Ophiomyxa flaccida* are paired, ovoid tentacle scales and smooth-edged teeth and oral papillae. Embedded in the flesh of the disk are microscopic, pointed ossicles that can be seen on dried specimens. The disk of *O. antillensis* is usually brown or reddish brown dorsally, sometimes sported or otherwise variegated; the ventral surface of the disk always is marbled with a contrasting cream color and very dark brown or black. The arms are banded with light and dark brown and sometimes also purple; those of small individuals are purplish, as are the regenerating arms tips of adults. The disk of juveniles has a radiating purple pattern on a cream-colored background”.

**Distribution:** Bahama Islands, Puerto Rico, St. Thomas, Belize and Panama (Hendler et al. 1995). In Puerto Rico as *Ophiomitrella glabra* in Ponce and as *Ophialcaea glabra* in San Juan.

**Depth Range:** 1-24 m. A specimen of *Ophialcaea glabra* collected from a depth of 166 m at San Juan is from NMNH.

**Remarks:** Specific localities within Puerto Rico are reported.

*Astrophyton muricatum* (Lamarck, 1816)



**Figure 14.** *Astrophyton muricatum* General Image.

**References used for identification:** H. L. Clark 1933: 42; Hendler et al. 1995: 101-102, figs. 30C-7, 30D-9, 36.

**Material examined:** BIOL (1) (dd: 10 mm); BIOL (2) (1: dd: 4 mm, 2: dd: 10 mm).

**Previous Puerto Rican records:** H. L. Clark 1933, Hendler et al. 1995.

**Diagnostic features:** Arms dichotomously branched; radial shields with a longitudinal series of tubercles or spines; hooklets without any secondary teeth; Only one madreporite (H. L. Clark 1933, Hendler et al. 1995).

**Description:** Hendler et al. 1995 (102). “The meshlike complexity of the arms is the basis of the common name “basket star” for this and related species. The disk and arms are covered with flattened, closely crowded granules. Microscopic hooks occur in small groups near the base of the arm, and a hook-bearing ridge straddles the dorsal surface of each distal arm segment. There are two to three arm spines on arm joints beyond the second bifurcation. Prominent, granule-free tubercles are irregularly distributed on the radial shields and on the dorsal surface of the proximal part of the arm. Each of the five arms gives rise to two thick, stubby locomotory branches and two long, slender feeding branches. Outer branches are unequal, with thick central forks and thin later forks and thin lateral forks arising on alternate sides of the arm. The complexity has inspired some impressive calculations. Specimens reportedly may have 35 series of arm bifurcations more than 81000 arm joints and over 10000 terminal arm branches. Juveniles with relatively few arm branches are pink. Small basket stars have banded arms and have yellow and white tubercles set in reddish and brown regions on the disk. Large individuals are a homogeneous black, brown, light-chocolate brown, yellowish brown, bright orange-yellow, tan, gray, green, or dirty white”.

**Distribution:** North Carolina to the Florida Keys and the Gulf of Mexico, the Bahama Islands, Cuba, Jamaica, Puerto Rico, The Virgin Islands, the Windward and Leeward Islands, Barbados, Curaçao, and the mainland coasts of Central and South America to Brazil (Hendler et al. 1995, Abreu-Pérez et al. 2005, Durán-González et al. 2005, Laguarda-Figueras et al. 2005b). In Puerto Rico, in this study it was collected and observed in La Parguera (Weinberg, Turrumote, Media Luna, Pelotas, San Cristobal, Romero, Enrique).

**Depth Range:** 2-70 m (Hendler et al. 1995); a record from 508 m (H. L. Clark 1915).

**Remarks:** Specific localities within Puerto Rico are reported.

*Schizostella bifurcata* A. H. Clark, 1952

**References used for identification:** Hendler et al. 1995: 104-105, fig. 37.

**Material examined:** None.

**Previous Puerto Rican records:** Hendler et al. 1995.

**Diagnostic features:** Seven short arms that branch near the middle and sometimes again near the tip. Has multiple madreporites (Hendler et al. 1995).

**Description:** From Hendler et al. 1995 (104). “This diminutive reddish brown or pinkish brown basket star is typically 4 mm in disk diameter, with seven short arms that branch near the middle and sometimes again near the tip. The arm bases are swollen and poorly differentiated from the disk; proximal rows of arm hooks occur on the top of the disk. Rings of elevated white granules border both sides of each darkly pigmented hook-bearing annulus on the dorsal surface of the arm. Two hook-shaped, ventrally placed arm spines are present on most arm segments. Scattered scales are embedded in the integument covering the ventral surface on the disk and arms”.

**Distribution:** Elliot Key and Key Biscayne, Florida; the Cayman Islands, Cozumel, Puerto Rico, Barbados, Belize and Colombia (Hendler et al. 1995).

**Depth Range:** 12-46 m (Hendler et al. 1995).

**Order OPHIURIDA Mueller & Troschel, 1840**  
**Family OPHIURIDAE Lyman, 1865**  
**Subfamily OPHIOLEPIDINAE Matsumoto, 1915**  
***Ophiolepis paucispina* (Say, 1825)**

**References used for identification:** Hendler et al. 1995: 109-110, fig. 41.

**Material examined:** BIOL (1) (dd: 3 mm, al: 8,5 mm); BIOL (1) (dd: 3 mm, al: 10 mm).

**Previous Puerto Rican records:**  
Hendler et al. 1995.

**Diagnostic features:** Disk convex; rough; arm-spines minute (H. L. Clark 1933).

**Description:** From H. L. Clark 1933, Hendler et al. 1005 (109). “*O. paucispina* is a “pygmy” species. It is best identified under magnification,

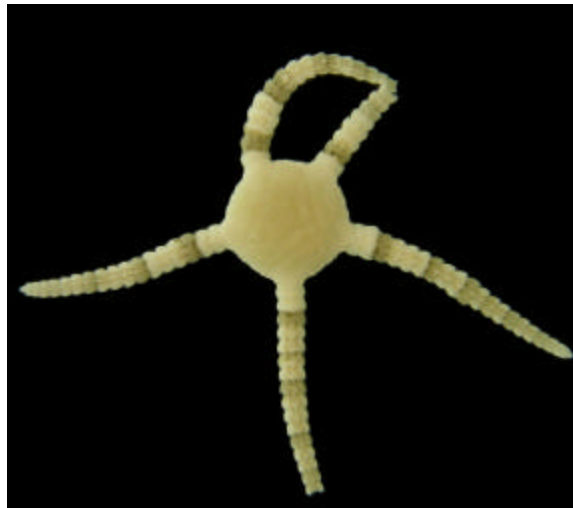


Figure 15. *Ophiolepis paucispina* . General Image.

because it resembles the juveniles of larger *Ophiolepis* species and the adults of *O. gemma*. From the center of the disk, columns of large, regularly arranged scales radiate outward. These thick-edged major scales are separated from each other by continuous rows of small, close-set scales, imparting a symmetrical, faceted appearance to the disk. There is a trio of scales, in a moustache-shaped array, at the outer ends of the pairs of radial shields, as in other *Ophiolepis* species. The arm joints are swollen distally. The two conical arm spines are much shorter than an arm joint. The sides of dorsal arm spine length, fills the gap between the dorsal and lateral arm plates on most arm joints. The small, smooth tube feet can be retracted into the tentacle pores and completely covered by paired, opercular tentacle scales. The color



“harmonize well with the sand”. The white, brownish, or bluish gray disk may have a few gray, greenish, or brown spots, and the pale arms often have several brown or gray bands”.

**Distribution:** Bermuda, the Bahama Islands, the Florida Keys and the Dry Tortugas, Texas, Mexico, Gulf of México, Cuba, Jamaica, Haiti, Puerto Rico, St. Thomas, St. Barthélemy, Antigua, Barbados, Tobago (Trinidad?), Curaçao, Aruba, Mexico, Belize, Panama, Colombia, and Brazil, including Isla de Trinidad (Hendler et al. 1995, Abreu-Pérez et al. 2005, Durán-González et al. 2005, Laguarda-Figueras et al. 2005b). Off Africa, it is reported from the Canary Islands to south of the Equator, but there are no reliable records from Ascension Island (Pawson 1978) and other mid-Atlantic islands. In Puerto Rico waters, it known from coral reefs and lagoons, four miles east of Talleboa (Peñuelas) (H. L. Clark 1933). In this study it was collected and observed in La Parguera (Enrique and Laurel).

**Depth Range:** 1-37 m (Hendler et al. 1995).

**Remarks:** Specific localities within Puerto Rico are reported.

*Ophiolepis elegans* Lütken, 1859

**References used for identification:** Hendler et al. 1995: 105-106, figs. 30C-4, 30D-14, 32-5, 38.

**Material examined:** USNM 21365 (1) (dd: 7 mm, al: 11 mm).

**Previous Puerto Rican records:** H. L. Clark 1933, Hendler et al. 1995.

**Diagnostic features:** Upper arm-plates with a small supplementary piece on each side; disk flat and smooth; arm-spines 4-6 (H. L. Clark 1933).

**Description:** From Hendler et al. 1995 (105-106). “This moderate-sized species has short arms; two to three times the disk diameter. The disk is flat and smooth, and in large individuals the tile like dorsal scales of the disk are visible to the naked eye. One column of scales lies between each pair of arms, and each major disk scale is framed by a row of microscopic scales. There are usually swollen scales at the edge of the disk, and at the outer tip of each of the paired radial shields a trio of scales is arranged in a moustache shape. The accessory dorsal arm plates are conspicuous. There are four to six arm spines. The tube feet are small, smooth and can completely retract into the tentacle pores, where they are covered by paired, opercular tentacle scales. The disk is colored, and the arms are banded, with contrasting shades of cream color, gray, dusky green and brown”.

**Distribution:** The Bahama Islands, North Carolina to the Dry Tortugas and the Gulf of Mexico, Texas offshores reefs, Cuba, Jamaica, Puerto Rico, St. Thomas, St. Martin, Barthélemy, Antigua, Martinique, Barbados, Trinidad, Mosquito Bank, and the coast of Central and South America from Mexico to French Guiana (Hendler et al. 1995, Abreu-Pérez et al. 2005, Durán-González et al. 2005, Laguarda-Figueras et al. 2005b). In Puerto Rico waters it is known from Condado Bay, San Juan and San Juan harbor (H. L. Clark 1933); a specimen from Culebra Island, according with reference material examined in the echinoderms collection at NMNH.

**Depth Range:** 1-92 m (Hendler et al. 1995).

**Remarks:** Specific localities within Puerto Rico are reported.

*Ophiolepis impressa* Lütken, 1859

**References used for identification:** Hendler et al. 1995: 107-109, fig. 40.

**Material Examined:** USNM E3726 (1) (dd: 8 mm, al: 29 mm); USNM E3727 (3) (1: dd: 11 mm, 2: dd: 6 mm, 3: dd: 6 mm); USNM 21286 (2) (1: dd: 12 mm, 2: dd: 10 mm); BIOL (1) (dd: 11 mm, al: 44 mm); BIOL (1) (dd: 14 mm, al: 51,2 mm); BIOL (3) (1: dd: 15 mm, al: 52 mm, 2: dd: 11 mm, al: 44 mm, 3: dd: 13 mm, al: 61 mm); MSC (4) (1: dd: 11 mm, al: 36 mm, 2: dd: 13 mm, al: 35 mm, 3: dd: 13 mm, al: 51 mm, 4: dd: 11 mm, al: 32 mm); MSC (4) (1: dd: 11 mm, al: 36 mm, 2: dd: 13 mm, al: 59 mm, 3: dd: 13 mm, al: 51 mm, 4: dd: 11 mm, al: 32 mm).

**Previous Puerto Rican records:** H. L. Clark 1933, Hendler et al. 1995.



**Figure 16.** *Ophiolepis impressa* . General Image.

**Diagnostic features:** Upper arm-plates with no supplementary pieces; disk convex, rough with slightly swollen plates (H. L. Clark 1933).

**Description:** From Hendler et al. 1995 (107-108). “On the dorsal side of the disk, rows of large, thick scales are bordered by small, irregularly shaped and arranged scales. Distal to the pairs of radial shields there are three scales arranged in a moustache shape. The four or five small arm spines, about the length of an arm joint, project from the side of the arm; the topmost is distinctly shorter and thinner than the ventral spines. The lateral edges of the dorsal arm plates are straight and diverging. The accessory dorsal arm plates, distal to the outer corners of the dorsal arm plate, are nearly microscopic and no larger than the topmost arm spine. The small, smooth tube feet are whitish. They can completely retract into the tentacle pores, which are protected by paired, opercular tentacle scales. *O. impressa* is reddish, yellowish, or greenish brown, the disk variegated with cream color and patches of brown, and the arms banded with gray and white”.

**Distribution:** The Bahama Islands, Mexico, Gulf of Mexico, the Florida Keys, the Dry Tortugas, Texas, Cuba, Jamaica, Puerto Rico, St. Thomas, St. Croix, Guadeloupe, Barbados, Curaçao, Belize, Panama, Colombia, Venezuela and Brazil (Hendler et al. 1995, Abreu-Pérez et al. 2005, Durán-González et al. 2005, Laguarda-Figueras et al. 2005b). In Puerto Rico waters it is known from Guanica Harbor, Guayanilla Harbor and Ponce (H. L. Clark 1933); in La Parguera according with reference material examined in the echinoderms collection at NMNH and this study.

**Depth Range:** 1-92 m (Hendler et al. 1995).

**Remarks:** Specific localities within Puerto Rico are reported.

**Family OPHIOCOMIDAE Ljungman, 1867**  
**Subfamily OPHIOCOMINAE Ljungman, 1867**  
***Ophiocoma echinata* (Lamarck, 1816)**



Figure 17. *Ophiocoma echinata* . General Image.

**References used for identification:** Hendler et al. 1995: 111-113, figs. 30C-1, 32-6, 42, 43.

**Material Examined:** USNM E05487 (1) (dd: 12 mm, al: 75 mm); USNM E05486 (1) (dd: 27 mm, al: 105 mm); USNM E05489 (1) (dd: 11 mm, al: 45 mm); E5484 (1) (dd: 20 mm, al: 8 mm); USNM E05488 (1) (dd: 8 mm); USNM E5490 (1) (dd: 5 mm, al: 22 mm); USNM 26656 (3) (previously identified as *O. pumila*) (1: dd: 9 mm, al: 32 mm, 2: dd: 8 mm, al: 35 mm, 3: dd: 8 mm, al: 28 mm); BIOL (3) (1: dd: 17 mm, al: 47 mm, 2: dd: 18 mm, al: 42 mm, 3: dd: 13 mm, al: 47 mm); BIOL (1) (dd: 28 mm, al: 90 mm); BIOL (1) (dd: 7 mm, al: 34 mm); BIOL (1) (dd: 13 mm, al: 55 mm); BIOL (1) (dd: 13 mm, al: 60 mm).

**Previous Puerto Rican records:** H. L. Clark 1933, Hendler et al. 1995.

**Diagnostic features:** Tentacle scales 2, (single oftentimes on individual pores or near tip of arm); black or blackish, unicolor or variegated with cream-color or whitish; no red (H. L. Clark 1933); white tube feet and thickened or bulbous dorsal arms spines (Hendler et al. 1995).

**Description:** From Hendler et al. 1995 (111). “Like other *Ophiocoma* and *Ophiocomella* species, it has a granule-covered disk, and the jaws bear a cluster of dental papillae and series of oral papillae. The dorsal arm spines may be longer or shorter than adjacent spines near the disk, and they are the longest spine near the arm tip. There are two tentacle scales on arm joints beyond the disk, three arms spines on the first and second arm joints, and different numbers of arm spines on opposite sides of arm joints beyond the disk. The disk is usually irregularly, and sometimes boldly, patterned, with the combination of black, brown, and gray; the arms are variegated or banded with the same hues. Juveniles are almost entirely black, with white-tipped radial shields and several white bands on the arms; they first develop disk granules at 2.3 mm (0.1 in) disk diameter”.

**Distribution:** Gulf of Mexico, Mexico, Bermuda, the Bahama Islands, Florida, Cuba, the Cayman Islands, Jamaica, Haiti, Puerto Rico, the Virgin Islands, the Leeward and Windward Islands, Barbados, Tobago, Isla La Tortuga, the Netherlands Antilles (Curaçao, Bonaire, Saba, St. Martin and St. Eustatius) and the coast of Central and South America to Brazil (Hendler et al. 1995, Abreu-Peréz et al. 2005, Durán-González et al. 2005, Laguarda-Figueras et al. 2005b). According to H. L. Clark (1933), this species is abundant throughout the Puerto Rican waters and it is well represented in the NMNH with reference material from San Juan Island, La Parguera, Vieques Island, Playa Ponce (Lighthouse reef), Ponce, Fajardo, Culebra Island. For this study, also collected from La Parguera (Turrumote, Pelotas, Enrique, San Cristobal, Caballo Blanco, Media Luna, Laurel).

**Depth Range:** Intertidal-24 m (Hendler et al. 1995).

**Remarks:** Although H. L. Clark (1933) noted the abundance of this species in Puerto Rican waters, he did not provide specific localities. Specific localities within Puerto Rico are reported.

***Ophiocoma pumila* Lütken, 1859**



Figure 18. *Ophiocoma pumila*. General Image.

**References used for identification:** Hendler et al. 1995: 114-116, fig. 45.

**Material Examined:** USNM 21327 (1) (dd: 10 mm); USNM E05560 (1) (dd: 11 mm, al: 45 mm); USNM E03713 (2) (1: dd: 9 mm, 2: dd: 9 mm); USNM E05304 (2) (1: dd: 10 mm, 2: dd: 4 mm); USNM E26658 (1) (dd: 10 mm); BIOL (1).

**Previous Puerto Rican records:** H. L. Clark 1933, Hendler et al. 1995.

**Diagnostic features:** Disk granules, some or all, at least near disk margin, higher than thick, tending to be spiniform; not very dark colored (H. L. Clark 1933, Hendler et al. 1995).

**Description:** From Hendler et al. 1995 (114). “This species is the smallest, most delicate, and most pallid Caribbean *Ophiocoma*. Like its congeners, it has jaws bearing both dental oral papillae, and its disk is granule-covered. In this species the largest, longest arm spine is one of the middle arm spines. The species is further distinguished by elongate granules along the edge of the disk, single tentacle scales (except on a few proximal arm joints), and three arms spines on the first and second arm joints. Some individuals have club-shaped, integument-covered ventral arm spines on one or a few proximal arm joints; these are not, however, a consistent and reliable taxonomic characteristic. The tube feet are nearly transparent. The disk of *O. pumila* is variegated with a combination of brown, tan, yellow, green, gray, or white; its arms are banded. Small individuals often are boldly colored with green and reddish pigmentation, and the arm tips and regenerating arms of adults are frequently green”.

**Distribution:** Gulf of Mexico, Mexico, Bermuda, the Bahama Islands, Florida, the Dry Tortugas, Cuba, Jamaica, Pedro Bank, Haiti, Puerto Rico, the Virgin Islands, the Leeward and Windward Islands, Barbados, Tobago, Isla La Tortuga, the Netherlands Antilles and the coasts of Central and South America to Brazil. Also known from the Azores, the Cape Verde Islands, Gold Coast and São Tomé (Gulf of Guinea) in Africa (Hendler et al. 1995, Abreu-Pérez et al. 2005, Durán-González et al. 2005, Laguarda-Figueras et al. 2005b). In Puerto Rico waters it is known from Guanica Harbor (H. L. Clark 1933), San Juan, Gallardo Bank, Humacao, Culebra Island and Vieques Island, according with reference material examined in the echinoderms collection at NMNH. In this study it was collected at La Parguera (Turrumote).

**Depth Range:** Usually intertidal to 24 m, but reported from 368 m (Hendler et al. 1995).

**Remarks:** Specific localities within Puerto Rico are reported.



*Ophiocoma wendtii* Müller & Troschel, 1842



**Figure 19.** *Ophiocoma wendtii*. General Image.

**References used for identification:** H. L. Clark 1933: like *Ophiocoma riisei*: 33-39, 66; Hendler et al. 1995: 116-117, figs. 30D-12, 46.

**Material Examined:** USNM 26649 (2) (1: dd: 23 mm, 2: dd: 24 mm); BIOL (1) (dd: 17 mm, al: 76 mm).

**Previous Puerto Rican records:** Hendler et al. 1995.

**Diagnostic features:** Like *O. riisei*: The tentacle scale single (2 often on basal pores); black or deep-brown, orally tinged with rust red; no white or whitish (H. L. Clark 1933). The most dorsal arm spines are the longest, usually equal in length to four to five arm joints (Hendler et al. 1995).

**Description:** From Hendler et al. 1995 (116-117). “The species grows to 35 mm in disk diameter and has arms longer than 176 mm. The most dorsal arm spines are thin, irregularly cylindrical. The disk has a relatively dense cover of granules. It has a single tentacle scale on the joints beyond the disk, two arm spines on the first and three on the second arm joints, and alternating numbers of spines on successive arm joints in some has three, in others has four. The species has a characteristic black to reddish brown coloration and banded arm tips. Its red tube feet impart a reddish hue to the ventral surface of the arms. A radiating black pattern on the disk. Juveniles are so unlike the adults that may be mistaken for amphiuroids or ophiacanthids. They have only a pair of papillae, resembling amphiuroid infradental papillae, at the tip of the jaw. As the individual grows, these are incorporated into a cluster of dental papillae, and flanked by oral papillae. The very smallest specimens have scattered, short spines on the disk; at 1-4 mm disk diameter they have a homogeneous black disk and uniformly orange or salmon-colored arms; those 2-7 mm have only scales on the disk; disk granules and arm banding appear in larger individuals”.

**Distribution:** Gulf of Mexico, Bermuda, the Bahama Islands, the Florida Keys, the Dry Tortugas, Texas, Cuba, Jamaica, Haiti, Puerto Rico, the Virgin Islands, the Leeward and Windward Islands, Barbados, Tobago, the Netherlands Antilles, Mexico, and coasts of Central and South America to Brazil (Hendler et al. 1995, Abreu-Pérez et al. 2005, Durán-González et al. 2005, Laguarda-Figueras et al. 2005b). As *O. rissei*, in Puerto Rico waters it is known from Pargas Bay and Harbor Entrance and Ensenada (H. L. Clark 1933); in San Juan Island, Fajardo and Ponce according with reference material examined in the echinoderms collection at NMNH. For this study, it was collected in La Parguera (Turumote and San Cristobal).

**Depth Range:** Usually less than 1-27 m; also reported from 384 m (Hendler et al. 1995).

**Remarks:** May be, when are juveniles, is easily confused with others *Ophiocoma* species, like *O. echinata*. Specific localities within Puerto Rico are reported.

***Ophiocomella ophiactoides* (H. L. Clark, 1901)**

**References used for identification:** H. L. Clark 1933: 33-34, 43 (as *Ophiacantha ophiactoides*); Hendler et al. 1995: 118-119, figs. 47.

**Material Examined:** USNM E27030 (3) (1: dd: 5 mm, al: 20 mm, 2: dd: 5 mm, al: 26 mm, 3: dd: 5 mm); BIOL (1) (dd: 4 mm, al: 21 mm).

**Previous Puerto Rican records:** H. L. Clark 1901a, H. L. Clark 1933, Hendler et al. 1995.

**Diagnostic features:** Six arms and small size (Hendler et al. 1995).

**Description:** From H. L. Clark 1901a, Hendler et al. 1995 (118). “This is a small six-armed species, usually no more than 5 mm in disk diameter, with arms 19 mm long. It has a granule-covered and hexagonal disk, and the combination of dental and oral papillae typical of *Ophiocoma* species. Arm spines 4, approximately equal and smooth to the eye, but very spine under a lens, about equaling a joint. 1 small tentacle-scale. Individuals are a cream color or yellowish brown, variegated with reddish brown and green; the arms are banded with dark and pale green and reddish brown”.

**Distribution:** Bermuda, the Dry Tortugas, the Florida Keys, the Bahama Islands, Jamaica, Cuba, Puerto Rico, St. Martin, St. Barthélemy, Barbados, Tobago, Bonaire, Curaçao, Belize, Mexico and Venezuela (Hendler et al. 1995, Abreu-Pérez et al. 2005, Laguarda-Figueras et al. 2005b). In Puerto Rico waters was taken in Gallardo Bank (H. L. Clark 1901a), mangrove island (La Parguera), Montalva Bay and Ensenada (H. L. Clark 1933). For this study was collected in La Parguera (Laurel).

**Depth Range:** Usually less than 1-27 m; also reported from 384 m (Hendler et al. 1995).

**Subfamily OPHIOPSILINAE Matsumoto, 1915**

***Ophiopsila riisei* Lütken, 1859**

**References used for identification:** H. L. Clark 1933: 33-39, 67; Hendler et al. 1995: 118-119, figs. 47.

**Material Examined:** MSC (1) (dd: 7 mm, al: 35 mm).

**Previous Puerto Rican records:** H. L. Clark 1933, Hendler et al. 1995.

**Diagnostic features:** Tentacle-scales 2, the inner long, flat and spine-like, lying diagonally across lower surface of arm; disk and basal part of arms, above and below, more or less freely sprinkling of black dots (H. L. Clark 1933).

**Description:** From Hendler et al. 1995 (121). “A large specimen can measure 12 mm in disk diameter and has arms 165 mm long. This species, like other ophiocomids, has both dental papillae and oral papillae. *O. rissei* differs from its congeners in having up to seven thick, flattened arm spines. The two most dorsal spines are almost ellipsoidal, short and broad, with a very blunt tip. The more ventral spines are relative slender; the most ventral spine is longest. Thick integument obscures the disk scales, except for the radial shields and a group of small scales proximal to them. The disk is blotched and the arms are irregularly banded with cream color and shades of gray, reddish, yellowish, maroon, or purplish brown. The arm band may be considerably more pronounced than in the individual depicted here. There are black spots on the dorsal and ventral sides of the disk and arms, and generally there is a small black spot on the lateral arm plate near the base of each arm spine”.

**Distribution:** Gulf of Mexico, Mexico, the Bahama Islands, Florida, the Dry Tortugas, Cuba, Haiti, Puerto Rico, St. Thomas, St. Barthélemy, Tortola, Barbados and the coast of Central

and South America to Brazil (Hendler et al. 1995, Abreu-Pérez et al. 2005, Durán-González et al. 2005, Laguarda-Figueras et al. 2005b). In Puerto Rico waters it is known from Guanica and Brea Point (H. L. Clark 1933).

**Depth Range:** 1-366 m (Hendler et al. 1995).

**Remarks:** In the MSC, there is a specimen; unfortunately does not have a specific locality.

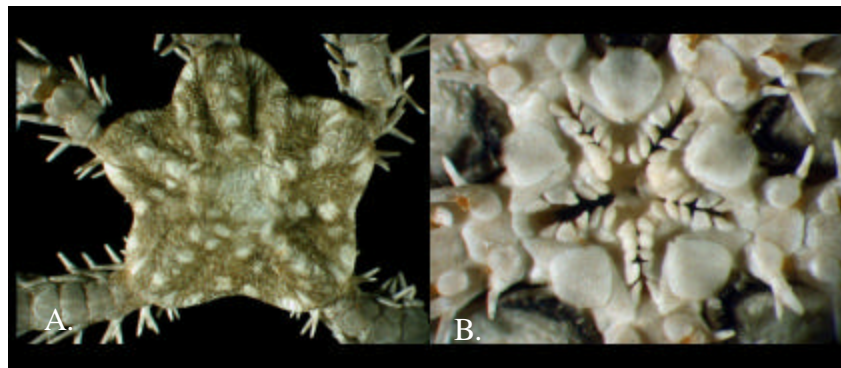
**Family OPHIONEREIDAE Ljungman, 1867**

***Ophionereis olivacea* H. L. Clark, 1901**

**References used for identification:** H. L. Clark 1933: 33-39, 64; Hendler et al. 1995: 123-125, fig. 51.

**Material Examined:** USNM E3669 (2) (1: dd: 4 mm, 2: dd: 5 mm).

**Previous Puerto Rican records:** H. L. Clark 1901a, H. L. Clark 1933, Hendler et al. 1995.



**Figure 20.** *Ophionereis olivacea*. Disc Image. A. Aboral Disc B. Oral Disc.

**Diagnostic features:** General coloration more or less green; middle arm-spine much longer than the others, more or less club-shaped; disk scaling relatively coarse (H. L. Clark 1933).

**Description:** From Hendler et al. 1995 (123-124). “This is the smallest *Ophionereis* in the Caribbean region, with a disk diameter of only 6 mm, and arms approximately 33mm long; on the basis of size alone it could mistaken for the young of another *Ophionereis* species. Like other members of the genus, it has a finely scaled disk with small radial shields. The disk is usually pentagonal, instead of round as in *O. reticulata* and *O. squamulosa*. The dorsal arm plates are longer than wide, roughly hexagonal, and widest near the center. The accessory dorsal arm plates adjoin the distal half of the dorsal arm plate; minute overlapping scales may be associated with the accessory dorsal arm plates of large individuals. There are three erect, smooth arm spines. Near the edge of the disk of large individuals, at the widest part of the arm, there are several may be nearly twice the length of the dorsal and ventral spines. They are shaped like a wooden match, nearly cylindrical with a thick tip. The tentacle scales are large; each one completely covers a tentacle pore. The disk is gray, with gray-green blotches and an irregular dense or netlike pattern of the same color. The arms are banded”.

**Distribution:** Mexico, The Florida Keys, Puerto Rico, Cuba, Colombia and Belize; questionable records include St. John, Curaçao and Panama (Hendler et al. 1995, Abreu-Pérez et al. 2005, Laguarda-Figueras et al. 2005b).

**Depth Range:** 1-366 m (Hendler et al. 1995).

**Remarks:** This species differs markedly from *O. reticulata*, not only in the color (and in this respect *O. reticulata* is very constant) but in the coarser scaling of the disk, the shape of the upper-arm plates, and in the size and shape of the second arm-spines (H. L. Clark 1901a).

*Ophionereis reticulata* (Say, 1825)



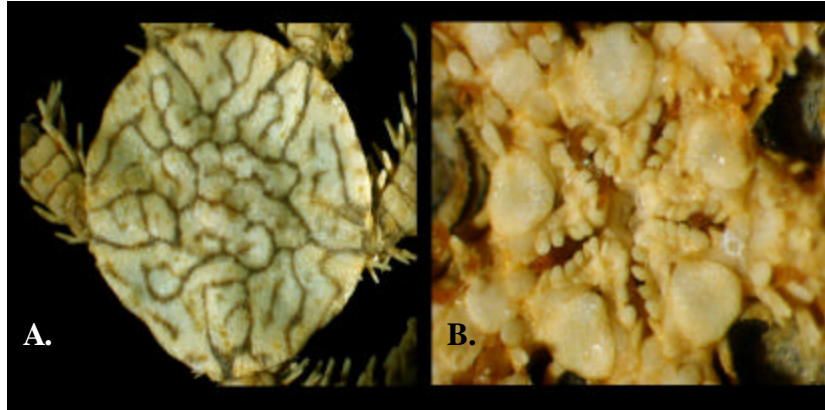
**Figure 21.** *Ophionereis reticulata*. General Image.

**References used for identification:** H. L. Clark 1933: 33-39, 64; Hendler et al. 1995: 125-127, figs. 30C-3, 52, 53.

**Material Examined:** USNM E21337 (1) (1: dd: 6 mm, al: 35 mm); USNM E26675 (2) (1: dd: 6 mm, al: 4 mm, 2: dd: 6 mm, al: 4 mm); USNM 26684 (3) (1: dd: 7 mm, al: 32 mm, 2: dd: 5 mm, al: 26 mm, 3: dd: 7 mm); BIOL (1) (dd: 5 mm, al: 26 mm); BIOL (1) (dd: 1,5 mm, al: 9 mm); MSC (1).

**Previous Puerto Rican records:** H. L. Clark 1901a, H. L. Clark 1933, Hendler et al. 1995.

**Diagnostic features:** Arm-spines moderately long, greatly exceeding an arm-segment; disk pearl gray, generally marked with a net-work of dark lines; arm sharply banded with dark brown, the bands usually about one segment wide (H. L. Clark 1933).



**Figure 22.** *Ophionereis reticulata*. Disc Image. A. Aboral disc B. Oral Disc.

**Description:** From Hendler et al. 1995 (125-126). “Individuals can grow to 15 mm disk diameter with arms over 120 mm long. The disk is finely scaled and the radial shields are small; the primary plates are rarely discernible in adults. The proximal dorsal arm plates are approximately twice as wide as long; the accessory dorsal arm plates are as long as the adjacent dorsal arm plate. The three arm spines are smooth, compressed, blunt-tipped, and generally longer than an arm joint. The middle arm spine is the largest and is longest on joints at a distance from the disk edge equivalent to about one disk diameter. A single, large tentacle scale completely covers each tentacle pore, and the tube feet are white. Has a well-defined, brown or reddish brown network pattern on the pale gray disk, but it is sometimes less distinct than the pattern on the disk of *O. olivacea* and *O. squamulosa*. Typically, arms are banded with blackish or purplish brown about every fourth joint, and there is a dark thin band between the intervening pale arm joints”.

**Distribution:** Gulf of Mexico, Mexico, Bermuda, the Bahamas Islands, South Carolina, Florida, Florida Keys, the Dry Tortugas, Texas, Cuba, Jamaica, Haiti, Puerto Rico, the Virgin Islands, the Leeward Islands, Barbados, Tobago, the Netherlands Antilles, Belize, Panama, Colombia, Venezuela and Brazil (Hendler et al. 1995, Abreu-Pérez et al. 2005, Durán-González et al. 2005, Laguarda-Figueras et al. 2005b). In Puerto Rico waters it is known



from Culebra Island (Ensenada Honda), Puerto Real, Guanica Bay (H. L. Clark 1901a), Vieques Island and La Parguera (according with reference material of echinoderms collections at NMNH). In study was collected and observed in La Parguera (Enrique, Caballo Blanco, Laurel, Turrumote).

**Depth Range:** Less than 1-221 m (Hendler et al. 1995).

**Remarks:** Specific localities within Puerto Rico are reported.

***Ophionereis squamulosa* Koehler, 1913**

**References used for identification:** H. L. Clark 1933: 33-39, 65; Hendler et al. 1995: 127-128, fig. 54.

**Material Examined:** None.

**Previous Puerto Rican records:** Hendler et al. 1995.

**Diagnostic features:** Arm-spines short little exceeding a segment; disk reddish-white in life, gray or yellowish in preserved material, variegated with several shades of brown; arms banded but distal boundary of bands indistinct and 2 or 3 segments are thus included in each band (H. L. Clark 1933).

**Description:** From Hendler et al. 1995 (127). "This species is decidedly smaller than similar-looking *O. reticulata*; a large individual is 6 mm in disk diameter with arms 45 mm. It has conspicuous primary plates, unlike some large *Ophionereis* species. The accessory dorsal arm plates are almost as long as its dorsal arm plates; the latter are somewhat wider than long. The three arm spines exceed the length of an arm joint; they are less markedly compressed than the spines of *O. reticulata*. The gray background color of the disk has brown or

brownish green spots and blotches, scattered about an irregular network of reddish or greenish brown pigmentation”.

**Distribution:** Mexico, the Bahama Islands, the Florida Keys, the Dry Tortugas, Haiti, Cuba, Puerto Rico, St. Thomas, Tobago, Belize and Brazil (Hendler et al. 1995, Abreu-Pérez et al. 2005, Laguarda-Figueras et al. 2005b).

**Depth Range:** 1-40 m (Hendler et al. 1995).

**Remarks:** Although Hendler et al. 1995 mention Puerto Rico like locality of this species, no reference material was found in the museums reviews.

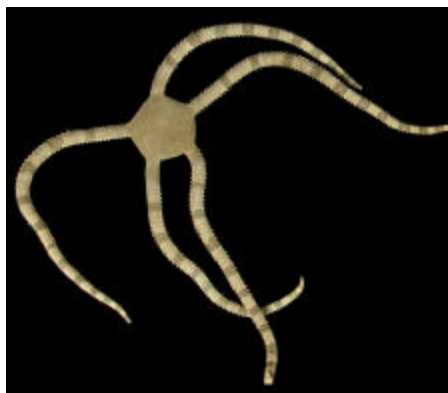
#### **FAMILY OPHIODERMATIDAE (Ljungman, 1867)**

##### ***Ophioderma appressum* (Say, 1825)**

**References used for identification:** H. L. Clark 1933: 33-40, 68; Hendler et al. 1995: 129-131, fig. 56.

**Material Examined:** USNM E3683 (1) (dd: 11 mm, al: 62 mm); USNM E5418 (1) (dd: 14 mm, al: 67 mm); USNM 21312 (1) (dd: 11 mm); USNM 21313 (5) (1: dd: 14 mm, 2: dd: 13 mm, 3: dd: 18 mm, 4: dd: 12 mm, 5: dd: 12 mm); USNM 21316 (1); USNM 21318 (1) (dd: 12 mm); USNM 26652 (1) (dd: 11 mm, al: 45 mm); USNM 26654 (1) (dd: 5 mm, al: 25 mm); MSC (4) (1: dd: 12 mm, al: 61 mm, 2: dd: 13 mm, al: 58 mm, 3: dd: 11 mm, al: 60 mm, 4: dd: 15 mm, al: 50 mm);

MSC (6) (1: dd: 20 mm, al: 97 mm, 2: dd: 20 mm, al: 87 mm, 3: dd: 74 mm, al: 12 mm, 4: dd: 12 mm, al: 57 mm, 5: dd: 13 mm, al: 44 mm, 6: dd: 9 mm, al: 31 mm); MSC (3) (1: dd: 10



**Figure 23.** *Ophioderma appressum*. General Image.

mm, al: 31 mm, 2: dd: 14 mm, al: 66 mm, 3: dd: 13 mm, al: 59 mm); BIOL (1) (1: dd: 17 mm, al: 76 mm); BIOL (2) (1: dd: 13 mm, al: 59 mm, 2: dd: 11 mm, al: 40 mm); BIOL (2) (1: dd: 16 mm, al: 62 mm, 2: 13 mm); BIOL (1) (dd: 14 mm, al: 52 mm); BIOL (1) (dd: 4 mm, al: 25 mm); BIOL (2) (1: dd: 5 mm, 2: dd: 12 mm, al: 55 mm).

**Previous Puerto Rican records:** H. L. Clark 1901a, H. L. Clark 1933, Hendler et al. 1995.

**Diagnostic features:** Dorsal arm plate smooth not keeled; they are widest beyond the edge of the disk and remain a constant width for some distance, instead of gradually tapering from the disk edge to the arm tip. The most ventral arm spine is tapered and is markedly larger than the dorsal spines (Hendler et al. 1995).

**Description:** From Hendler et al. 1995 (129-130). “Individuals can attain 25 mm disk diameter with arms 125 mm long, but seldom exceed 18 mm in disk diameter. The specie has tiny adpressed arm spines like others members of the genus. Its disk is covered by small, rounded granules, and it has four bursal slits beside each arm. The color pattern of some individuals resembles that of *O. rubicundum*. Unlike the latter species, however, it is rarely reddish, and its radial shields are covered with granules. Its arms differ in overall shape from those of *O. rubicundum*; the arm tips taper gradually; their terminal joints are not longer than wide. The posterior edge of the oral shield is straight or slightly concave and touches the bursal slit. The coloration is extremely variable, but falls into two patterns: “uniform” and “harlequin”, one or another of which predominates at a given locality. The disk of “uniform” individuals is gray, green, or brown, usually with tiny clusters of salt and pepper flecks. The disk of “harlequin” individuals is almost entirely white or has irregularly shaped patches of contrasting color. The arms are banded with the ground color and with a lighter shade or white”.

**Distribution:** Mexico, Gulf of Mexico, Bermuda, the Bahama Islands, South Carolina, Florida, the Florida Keys, the Dry Tortugas, Texas offshore reefs, Cuba, Jamaica, Haiti,

Puerto Rico, The Virgin Islands, the Leeward Islands, Barbados, Tobago, Trinidad, Curaçao, Aruba, Belize, Swan Island, Isla Providencia, Panama, Colombia, Venezuela and Brazil (Hendler et al. 1995, Abreu-Pérez et al. 2005, Durán-González et al. 2005, Laguarda-Figueras et al. 1005b). In Puerto Rico waters it is known from San Juan, Ponce, Ensenada Honda (Culebra Island), Caballo Blanco, Guanica (H. L. Clark 1901a), La Parguera and Vieques Island (according with material reference examined at NMNH). In this study and at MSC was observed and collected in La Parguera (Enrique, San Cristobal, Laurel, Media Luna, The Buoy).

**Depth Range:** Usually less than 1-18 m; reportedly a deep as 64 m (Hendler et al. 1995).

**Remarks:** Specific localities within Puerto Rico are reported.

***Ophioderma brevicaudum* Lütken, 1856**

**References used for identification:** H. L. Clark 1933: 33-40, 69; Hendler et al. 1995: 131-132, fig. 57.

**Material Examined:** USNM E5441 (3) (1: dd: 17 mm, al: 50 mm, 2: dd: 18 mm, al: 58 mm, 3: dd: 15 mm, al: 42 mm); USNM 5445 (2) (1: dd: 7 mm, al: 22 mm, 2: dd: 9 mm al: 26 mm); USNM 26681 (1) (dd: 15 mm); USNM 21306 (1) (dd: 14 mm); USNM

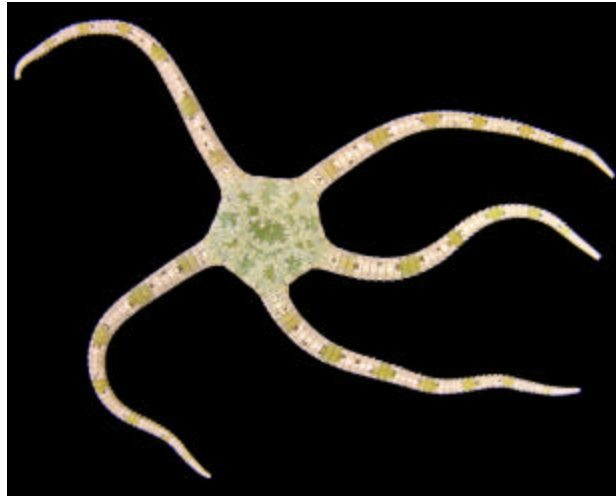


Figure 24. *Ophioderma brevicaudum* . General Image.

21310 (4) (1: dd: 12 mm, al: 46 mm, 2: dd: 18 mm, al: 63 mm, 3: dd: 10 mm, al: 23 mm, 4: dd: 16 mm, al: 48 mm); MSC (3) (1: dd: 17 mm, al: 47 mm, 2: dd: 17 mm, al: 47 mm, 3: dd: 15 mm, al: 45 mm); MSC (1) (dd: 17 mm, al: 61 mm); BIOL (1) (dd: 10 mm, al: 26 mm).

**Previous Puerto Rican records:** H. L. Clark 1901a, H. L. Clark 1933, Hendler et al. 1995.

**Diagnostic features:** Arms short, 3-4 times disk diameter; arm-spines 7-9, subequal, about 2/3 as long as joint (Hendler et al. 1995).

**Description:** From Hendler et al. 1995 131). “The arms are short in relation to the disk. It grows to 22 mm in disk diameter with arms 77 mm long. Like its congeners, has four bursal slits beside each arm, one pair near the oral shield and the other near the disk margin. The granules at the center of the top of the disk are small and rounded, those at the edge of the disk are larger and often polygonal, and on the ventral surface the granules are appreciably separated from one another. The adoral shields are sparsely granulated. The small, adpressed arm spines are flat and almost triangular in outline and nearly touch each other at the base. The most ventral spine is not appreciably larger than adjacent spines; it is in contact, or nearly so, with the tentacle scale of the next distal joint. The dorsal arm plates are sometimes fragmented. The disk is mottled, and the arms are banded with various combinations of green, blue-green, gray, and white. Often, patches of rust red or reddish brown decorate the ventral interradii or the top of the disk”.

**Distribution:** South Carolina, the Florida keys, Mexico, the Dry Tortugas, the Bahama Islands, Cuba, Jamaica, Haiti, Puerto Rico, the Virgin Islands, Leeward and Windward Islands, Barbados, Tobago, Isla La Tortuga, the Netherlands Antilles, Belize, Panama, Colombia, Venezuela, French Guyana, also Ascension Island (Hendler et al. 1995, Abreu-Pérez et al. 2005, Laguarda-Figueras et al. 2005b). In Puerto Rico waters it is known from Ponce, Ensenada Honda (Culebra), Caballo Blanco, Puerto Real, San Juan (H. L. Clark 1901a, H. L. Clark 1933), La Parguera and Boca Prieta (according with the reference

material in the echinoderms collection at NMNH and MSC). In this study was observed and collected at La Parguera (San Cristobal and Media Luna).

**Depth Range:** 1-18 m (Hendler et al. 1995).

**Remarks:** Specific localities within Puerto Rico are reported.

***Ophioderma brevispinum* (Say, 1825)**

**References used for identification:** H. L. Clark 1933: 33-40, 70; Hendler et al. 1995: 133-134, fig. 58.

**Material Examined:** USNM 21296 (1)

(dd: 10 mm, al: 36 mm); USNM 21298

(1) (dd: 12 mm, al: 48 mm); USNM

26682 (10) (1: dd: 12 mm, 2: dd: 11

mm, 3: dd: 13 mm, 4: dd: 14 mm, al:

55 mm, 5: dd: 12 mm, al: 67 mm, 6: dd:

12 mm, al: 44 mm, 7: dd: 11 mm, al:

45 mm, 8: dd: 12 mm, al: 45 mm, 9:

dd: 12 mm, al: 45 mm, 10: dd: 12 mm,

al: 41 mm); USNM 26672 (1) (dd: 3

mm, al: 13 mm); MSC (1) (dd: 21 mm,

al: 95 mm); MSC (1) (dd: 14 mm, al: 65 mm); MSC (8) (1: dd: 15 mm, al: 65 mm, 2: dd: 7

mm, al: 34 mm, 3: dd: 6 mm, al: 30 mm, 4: dd: 9 mm, al: 39 mm, 5: dd: 5 mm, al: 22 mm, 6:

dd: 6 mm, al: 25 mm, 7: dd: 8 mm, al: 33 mm, 8: dd: 9 mm, al: 42 mm); BIOL (2) ( 1: dd: 11

mm, al: 44 mm, 2: dd: 11 mm, al: 47 mm); BIOL (8) (1: dd: 7 mm, al: 30 mm, 2: dd: 6 mm,

al: 25 mm, 3: dd: 7 mm, al: 23 mm, 4: dd: 9 mm, al: 40 mm, 5: dd: 9 mm, al: 31 mm, 6: dd:

10 mm, al: 39 mm, 7: dd: 9 mm, al: 34 mm, 8: dd: 4 mm, al: 14 mm); BIOL (1) (dd: 13 mm,



**Figure 25.** *Ophioderma brevispinum* . General Image.

al: 57 mm); BIOL (1) (dd:8 mm, al: 37 mm); BIOL (4) (1: dd: 9 mm, al: 45 mm, 2: dd: 11 mm, al: 60 mm, 3: dd: 11 mm, al: 45 mm, 4: dd: 7 mm, al: 35 mm); BIOL (2) (1: dd: 15 mm, al: 50 mm, 2: dd: 10 mm, al: 50 mm).

**Previous Puerto Rican records:** H. L. Clark 1901a, H. L. Clark 1933, Hendler et al. 1995.

**Diagnostic features:** Disk pentagonal and its arms gradually taper from the edge of the disk to the arm tip. Its ventral arm spine is similar in length to the adjacent spine (Hendler et al. 1995).

**Description:** From Hendler et al. 1995 (133). “Individuals grow to 15 mm in disk diameter with arms 70 mm long. Its coloration is variable, resembling that of several congeners that also have small, rounded disk granules and four bursal slits beside each arm. Its granule-covered radial shields distinguish it from *O. rubicundum*. In contrast with most specimens of *O. appressum*, its disk is pentagonal and its arms gradually taper from the edge of the disk to the arm tip. Its ventral arm spine is similar in length to the adjacent spine; however, it does not touch the tentacle scale of the next distal joint, and the arm spines are thin, straight-side (peglike), and blunt-tipped. The disk is uniformly colored or variegated with combinations of gray, green, brown, yellow, orange, pink, red, white, and black; the arms usually are banded”.

**Distribution:** Gulf of Mexico, Bermuda, the Bahama Island, Massachussets to Florida and the Gulf coast, Cuba, Jamaica, Haiti, Puerto Rico, Virgin Islands, the Leeward and Windward Islands, Barbados, Aruba, Belize, Colombia, Venezuela, French Guyana and Brazil. Also Ascension Island (Hendler et al. 1995, Durán-González et al. 2005). In Puerto Rico waters it is known from Ensenada Honda (Culebra Island), Arroyo Puerto Real (H. L. Clark 1901a), Don Luis Cayo, Salinas Cove, Guanica Harbor, La Parguera (Mangrove Island) (H. L. Clark 1933), Humacao and Vieques Island, according to echinoderms collection from NMNH. In this study and the MSC was observed and collected at La Parguera (San Cristobal, Laurel, Caballo Blanco and Enrique).

**Depth Range:** 1-223 m (Hendler et al. 1995).

***Ophioderma cinereum* Muller & Troschel, 1842**

**References used for identification:** H. L. Clark 1933: 33-40, 71; Hendler et al. 1995: 134-136, figs. 30C-6, 59.

**Material Examined:** USNM E5427 (1) (dd: 10 mm, al: 24 mm); USNM 21319 (28) (dd: 8-20 mm, al: 40-70 mm); USNM 21320 (2) (1: dd: 11 mm, 2: dd: 18 mm); USNM 26683 (14) (1: dd: 19 mm, al: 74 mm, 2: dd: 12 mm, al: 43 mm, 3: dd: 12 mm, al: 46 mm, 4: dd: 12 mm, al: 59 mm, 5: dd: 17 mm, al: 50 mm, 6: dd: 13 mm, al: 51 mm, 7: dd: 16 mm, al: 48 mm, 8: dd: 13 mm, al: 41 mm, 9: dd: 11 mm, al: 30 mm, 10: dd: 18 mm, al: 49 mm, 11: dd: 11 mm, al: 42 mm, 12: dd: 15 mm, al: 46 mm, 13: dd: 15 mm, al: 55 mm, 14: dd: 16 mm, al: 54 mm); MSC (1) (dd: 12 mm, al: 117 mm); MSC (1) (dd: 20 mm, al: 90 mm); MSC (1) (dd: 20 mm, al: 90 mm); MSC (1) ind (dd: 20 mm, al: 121 mm); BIOL (2) (1: dd: 31 mm, al: 115 mm, 2: dd: 20 mm, al: 90 mm).

**Previous Puerto Rican records:** H. L. Clark 1901a, H. L. Clark 1933, Hendler et al. 1995.

**Diagnostic features:** Radial shields bare. Granules surround the bursal slits and oral shields, with often just a single row of granules along the distal edge of the shield. Individuals larger than about 10 mm in disk diameter have arms fragmented in numerous dorsal arm plates on joints near the disk (Hendler et al. 1995).

**Description:** From Hendler et al. 1995 (134-135). "This robust species often grows to 29 mm in disk diameter, with arms 148 mm long; and exceptionally large individual of 37 mm disk diameter with arms 210 mm long has been reported. The top of the disk, except for the conspicuous radial shields, is covered with microscopic, rounded granules. The oral shield is



rounded-triangular; the distal edge is not strongly convex. There are four bursal slits beside each arm, as in other *Ophioderma* species. The plates of arms fragmented are irregularly dissected by fissures running from the proximal to the distal edge. The arm spines are small, adpressed, bluntly pointed, and gradually increase in size toward the ventral surface. The ground color ranges from light to dark gray or brown; most individuals, except the darkest, have a conspicuous, dark border that demarcates the edge of the radial shields. Usually, tiny clusters of black and white specks are scattered on the disk. The arms are conspicuously banded, and the dorsal arm plates have an irregular reticulate pattern”.

**Distribution:** Gulf of Mexico, the Bahama Islands, the Florida keys, the Dry Tortugas, Cuba, Jamaica, Haiti, Puerto Rico, The Virgin Islands, The Leeward and Windward Islands, Barbados, Tobago, Curaçao, Aruba, and the coast of Central and South America to Brazil (Hendler et al. 1995, Abreu-Pérez et al. 2005, Durán-González et al. 2005, Laguarda-Figueras et al. 2005b). In Puerto Rico waters it is known from Ensenada Honda (Culebra), Puerto Real, San Juan (H. L. Clark 1901a), Ballena Point and Ensenada (H. L. Clark 1933); in this study was collected and observed in La Parguera (Enrique and San Cr istobal).

**Depth Range:** Intertidal to 24 m (Hendler et al. 1995).

**Remarks:** In this study it was found especially in mangrove roots *Rhizophora mangle* in Enrique.

### *Ophioderma phoenium* Clark, 1918

**References used for identification:** H. L. Clark 1933: 33-40, 71; Hendler et al. 1995: 138-140, fig. 62.

**Material Examined:** MSC (1) (dd: 19 mm, al: 81 mm).

**Previous Puerto Rican records:** None.

**Diagnostic features:** Radial shields bare, or in certain individuals, 1 or more may be covered; colors brighter, red of some shade, or green, or both, being evident; disk brick-red, arms green, or disk and arms either red or green; arms not banded or only faintly so (H. L. Clark 1933).

**Description:** From Hendler et al. 1995 (138). “Individuals grow to 23 mm in disk diameter, with arms 90 mm long. Granules usually, but do not always, cover the radial shields; they completely cover the adoral shields and surround the oral shield and the bursal slits. The oral shield does not have a strongly convex distal edge. There are four bursal slits beside each arm, as is characteristic for all *Ophioderma* species. The arms are thick, tapering near the distal end, and terminating in a blunt, flattened tip. The arm spines are adpressed, the dorsal arm spines short and pointed; ventrally, they become gradually longer, larger, and more blunt-tipped. The dissimilar coloration of the disk and arms, although sometimes subtle, is a valuable guide for field identification. The disk is usually red or brown (the specific name derives from the Greek for “blood red”); the arms are contrasting coloration. However, pure red and purely green individuals have been reported. *O. rubicundum* is also red, but it lacks the tiny scattered clusters of white or white and black flecks found on the disk of *O. phoenium*. Furthermore, in *O. phoenium* the entire dorsal and ventral surfaces of the disk are the same color, but the ventral interradii are “two-toned” in *O. rubicundum*”.

**Distribution:** The Florida Keys, Mexico, the Bahama Islands, Cuba, Tobago, Barbados, Belize and Panama (Hendler et al. 1995, Abreu-Pérez et al. 2005, Laguarda-Figueras et al. 2005b). In Puerto Rico waters it is known from La Parguera (Mario reefs, seaward side) according to reference material examined in the echinoderms collection at MSC.

**Depth Range :** 1-14 m (Hendler et al. 1995).

**Remarks:** The specimen that are in the MSC initially was identified like *Ophioderma rubicundum*, but Hendler re-identified the specimen as *O. phoenium* because of the granules that covered the adradial shields and the form of the oral shields. It is a first record for Puerto Rico.

***Ophioderma rubicundum* Lütken, 1856**

**References used for identification:** H. L. Clark 1933: 33-40, 71; Hendler et al. 1995: 139-140, fig. 63.

**Material Examined:** USNM E3690 (1) (dd: 7 mm, al: 48 mm); USNM 26648 (1) (dd: 22 mm); USNM 26668 (1) (dd: 7 mm, al: 34 mm); MSC (1) (dd: 16 mm, al: 81 mm); MSC (1) (dd: 14 mm, al: 83 mm); MSC (3) (1: dd: 17 mm, al: 105 mm, 2: dd: 15 mm, al: 73 mm, 3: dd: 18 mm, 123 mm); MSC (1) (dd: 16 mm, al: 80 mm); MSC (1) (dd: 17 mm, al: 100 mm); BIOL (1) (dd: 20 mm, al: 85 mm); BIOL (1) (dd: 12 mm, al: 74 mm).



**Previous Puerto Rican** Figure 26. *Ophioderma rubicundum* . General Image.

**records:** H. L. Clark 1901a, H. L. Clark 1933, Hendler et al. 1995.

**Diagnostic features:** Radial shields bare. The lowest arm spine, especially near the disk, is considerably broader and longer than the dorsal spines (Hendler et al. 1995).

**Description:** From Hendler et al. 1995 (139-140). “Adult attains a disk diameter of 23 mm, with arms 135 mm long. The radial shields are bare of the rounded granules covering the rest of the disk. Flanking each arm there are four bursal slits. The oral shield has a convex distal edge that touches the edge of the proximal bursal slits. The dorsal arm plates are arched near the disk. The arm tip is very thin and tapered, nearly as high as broad. The arm spines are small and adpressed. The lowest arm spine is considerably broader and longer than the dorsal spines. *O. rubicundum* is reddish. The brownish to purplish red ground color, retained for a considerable time in alcohol-preserved specimens, is usually variegated with black, gray and brown”.

**Distribution:** The Bahama Islands, Mexico, the Florida Keys, the Dry Tortugas, Texas, Cuba, Jamaica, Puerto Rico, St. Thomas, St. John, Guadeloupe, Barbados, Tobago, Curaçao, Panama, Colombia and Venezuela (Hendler et al. 1995, Abreu-Pérez et al. 2005, Durán-González et al. 2005, Laguarda-Figueras et al. 2005b). In Puerto Rico waters it is known from Guanica Harbor, Mangrove Island (La Parguera), Ensenada, Ensenada Honda (Culebra Island), Ponce (H. L. Clark 1933) and Humacao (according to reference material examined in the echinoderms collection at NMNH). For this study, it was collected and observed in La Parguera (San Cristobal and Enrique).

**Depth Range:** 1-31 m (Hendler et al. 1995).

*Ophioderma squamosissimum* Lütken, 1856

**References used for identification:** H. L. Clark 1933: 33-41, 72; Hendler et al. 1995: 141-142, figs. 30C-5, 30D-13, 64.

**Material Examined:** MSC (1) (dd: 40 mm, al: 150 mm), MSC (1) (dd: 42 mm, al: 240 mm)

**Previous Puerto Rican records:** None.

**Diagnostic features:** Each upper arm-plate divided into a single transverse series of 7 or 9 plates; color in life brilliant vermilion-red, wholly lost on preservation; museum specimens are buff or cream-color (H. L. Clark 1933).

**Description:** From Hendler et al. 1995 (141). “It is remarkable for its large size, with a disk diameter of 42 mm and arms 200 mm long. Its disk granules are flattened and polygonal, creating a mosaic surface that is conspicuous under the microscope. Each dorsal arm plate appears to be divided into a transverse series of plates, such that each arm joint is covered by a small, central (roughly diamond-shaped) scale and several symmetrically placed pairs of lateral scales. The scales on adjacent joints overlap, giving the arm the appearance of snakeskin. Lateral arm plates near the arm tip have a granular texture because of the presence of expanded peripheral trabeculae. Like its congeners, has smooth arms with small adpressed arm spines and four bursal slits at the base of each arm. Large living individuals are entirely scarlet red or orange-hued vermilion; the brilliant pigment quickly and completely bleaches in alcohol-preserved specimens. Small individuals have pale orange patches on the disk”.

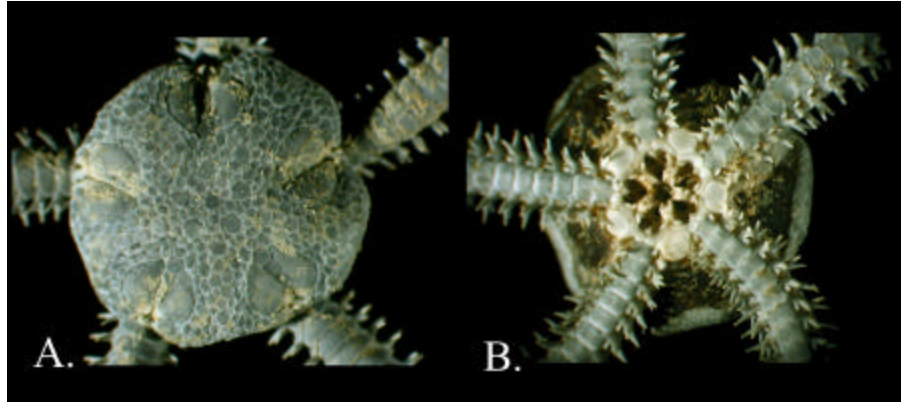
**Distribution:** The Bahama Islands, the Florida Keys, Texas, Cuba, St. Barthélemy, and Belize (Hendler et al. 1995, Abreu-Pérez et al. 2005). In Puerto Rico waters it is known from Desecheo Island and La Parguera (Mario reefs) (according to reference material examined in the echinoderms collection at MSC).

**Depth Range:** 3-85 m (Hendler et al. 1995).

**Remarks:** It is a first record for Puerto Rico.

**FAMILY OPHIACTIDAE Matsumoto, 1915**

***Hemipholis elongata* (Say, 1825)**



**Figure 27.** *Hemipholis elongata*. Disc detail: A. Aboral and B. Oral disc.

**References used for identification:** H. L. Clark 1933: 33-35, 46; Hendler et al. 1995: 143-145, fig. 66.

**Material Examined:** USNM E5593 (3) (1: dd: 6 mm, 2: 6 mm, 3: 5 mm).

**Previous Puerto Rican records:** H. L. Clark 1933, Carrera 1974, Hendler et al. 1995.

**Diagnostic features:** Disk without scales on the interbrachial areas orally; upper surface of disk fully covered with scales (H. L. Clark 1933). The dark brown color of the stomach shows through the thin ventral body wall (Hendler et al. 1995).

**Description:** From Hendler et al. 1995 (143). “A large specimen of 10 mm disk diameter has arms approximately 90 mm long, but individuals seldom grow to even half size. The species has five arms and a single oral papilla. It lacks evident scales on the ventral surface of the disk. The dorsal surface of the disk is covered by large scales. The conspicuous radial shields have been described aptly as “pear-seed shaped”, and a few papillae at the outer edge of the radial shields are the only spines on the disk. There are three arm spines and a single tentacle scale. Individuals are usually brown, tan, or gray, sometimes with touches of blue or green, and the arms are banded light and dark. The papillose tube feet are red”.

**Distribution:** South Carolina, Georgia; Florida; the Florida Gulf coast, Gulf of Mexico, Cuba, Puerto Rico, Trinidad, Panama and Brazil (Hendler et al. 1995, Abreu-Pérez et al. 2005, Durán-González et al. 2005). In Puerto Rico waters it is known from the mouth of Añasco River, Guanica and Ponce Bays (Carrera 1974). According to reference material examined in the echinoderms collection at NMNH it is in Puntilla Point and San Juan.

**Depth Range:** 2-35 m (Hendler et al. 1995).

**Remarks:** Although H. L. Clark (1933) mentioned this species to Puerto Rico waters, he said that it had no record to its exact locality or depth. Specific localities within Puerto Rico are reported.

### ***Ophiactis quinquerradia* Ljungman, 1871**

**References used for identification:** H. L. Clark 1901a: 246, Pl. 14, figs. 1-5; H. L. Clark 1933: 58, Hendler et al. 1995: 146-147, figs. 68.

**Material Examined:** As *Ophiactis longibrachia*: USNM 21362 holotype (1) (dd: 13 mm).

**Previous Puerto Rican records:** H. L. Clark 1901a: as *Ophiactis longibrachia*, Carrera 1974 and Hendler et al. 1995: as *Ophiactis quinqueradia*.

**Diagnostic features:** This is the largest Caribbean *Ophiactis* species and is exclusively five-armed (Hendler et al. 1995).

**Description:** From H. L. Clark 1901a, Hendler et al. 1995 (146-147). “Ray 5, long and slender. Disk 13 mm in diameter; arms 100 mm long. Disk mostly circular, hiding the bases of the arms, covered with small but thickish scales. Over the whole surface of the disk are scattered numerous very small, almost smooth, blunt spines, and these also cover the interbrachial spaces below; those spines on the dorsal surface are usually granulelike; often there is a relatively large spine below the outer end of the radial shield. Radial shields long and rather narrow, separated at the inner ends, but touching at the outer extremities, smooth and naked. Upper arm plates granular, wide and short, 3 or 4 times as wide as long, rounded at the sides. Has two (some times three) oral papillae; the most proximal one on the side of the jaw is long and slender; there are one or two rounded scales on the jaw or adoral shield. The dorsal arm plates are subellipsoidal, wider than long. There are usually 6 arm spines; the middle spines are longest, flattened, with a broad, spinulose tip; the dorsal spines are shorter, rounded, and more pointed; and the most ventral spine is smallest and nearly circular in outline. The disk is dark reddish brown, or black, variegated with gray and white; the radial shields usually have pale outer tips. The arms are banded with gray, black, tan, or brown; band often are more evident in small or pale specimens than in darkly pigmented larger ones”.

**Distribution:** The Bahama Islands, the Florida Keys and the Dry Tortugas, Mexico, Gulf of Mexico, Cuba, Puerto Rico, Virgin Islands, the Leeward and Winward Islands, Barbados, Curaçao, Belize, Panama and Brazil (Hendler et al. 1995, Abreu-Pérez et al. 2005, Durán-González et al. 2005, Laguarda-Figueras et al. 2005b). In Puerto Rico waters it is known



from Vieques Island, as the holotype, under *Ophiactis longibrachia* (H. L. Clark 1901a) and Jobos Bay (Carrera 1974).

**Depth Range:** 2-618 m, but most records are for depths less than 73 m (Hendler et al. 1995).

**Remarks:** *O. quinqueradialia* is species with taxonomic problems. A carefully revise the specimens from the Caribbean islands, because, may be, possibly is an adult of the others species of the genus, like is suggested (H. L. Clark 1901a, H. L. Clark 1933). On the other hand, the abundance of individuals of this species is low, difficult for the possible revisers. The big specimens of *O. muelleri* are some time confused with *O. quinqueradialia*.

***Ophiactis savignyi* (Müller & Troschel, 1842)**

**References used for identification:**

H. L. Clark 1933: 33-38, 59; Hendler et al. 1995: 148-151, figs. 32-4, 70.

**Material Examined:** USNM E5451

(5) (1: dd: 2 mm, 2: dd: 3 mm, 3: dd: 1 mm, al: 6 mm, 4: dd: 2 mm, 5: dd: 2 mm); USNM 21358 (1) (dd: 3 mm); BIOL (1) (dd: 3 mm, al: 18 mm); BIOL (1) (dd: 1,6 mm al: 7,83 mm); BIOL (1) (1: dd: 2 mm, al: 1 mm); BIOL (5) (1: dd: 3 mm, al: 16 mm, 2: dd: 3 mm, al: 17 mm, 3: dd: 2 mm, al: 7 mm, 4: dd: 1 mm, al: 4 mm, 5: dd: 1,5 mm, al: 7 mm); BIOL (1) (dd: 4 mm, al: 13 mm).



**Figure 28.** *Ophiactis savignyi*. General Image.

**Previous Puerto Rican records:** H. L. Clark 1933, Carrera 1974.

**Diagnostic features:** Upper arm-plates swollen, the distal margin notched or with a dark spot on each side but occasionally 1 or none; colors green and white, no blue (H. L. Clark 1933).

**Description:** From Hendler et al. 1995 (148-149). “A typical specimen of this six-armed species is 3.8 mm in disk diameter with arms 16.3 mm long; individuals as large as 5mm in disk are relatively rare. The length of the radial shield typically exceeds half the radius of the disk. Small rough-tipped spines, scattered over the disk, are evident on larger specimens. The two (some times one or three) oral papillae of *O. savignyi* are flattened and scalelike. The five to six arm spines are of roughly similar size, except for the relatively small ventral spine, are almost as wide at the tip as at the base. The spine tip is distinctly spinulose, frequently with minute “teeth” at opposite corners. Individuals are various combinations of greenish, greenish brown, brown, and cream; there is usually a white patch at the outer tip of the darkly pigmented radial shield. The dorsal arm plates typically have pairs of dark marks on the distal edge, which sometimes demarcate a small median distal lobe on the plate”.

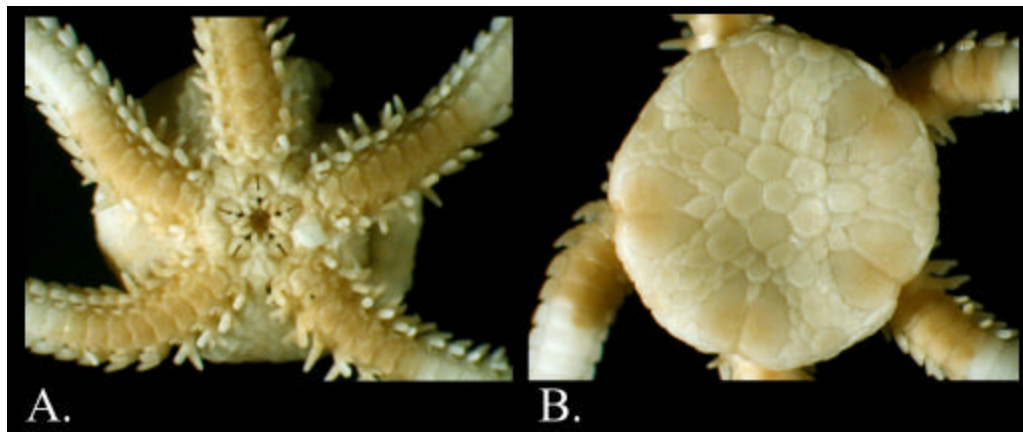
**Distribution:** Next to *Amphipholis squamata*, this is probably the most ubiquitous of brittle stars, as it is tropicopolitan in its distribution (H. L. Clark 1933). It lives in warm waters throughout the Indo-Pacific, eastern Pacific, and on both sides of the Atlantic. Off the east coast of the Americas it is reported from South Carolina and Bermuda, throughout the Caribbean and Gulf of Mexico, southward to Brazil (Hendler et al. 1995, Abreu-Pérez et al. 2005, Durán-González et al. 2005, Laguarda-Figueras et al. 2005b). “There is no doubt *savignyi* is to be found anywhere around Puerto Rico, where there are sponges and coral rock” (H. L. Clark 1933); off the mouth of Guanica harbor, bell-buoy, Guayanilla, Ensenada, Enrique Key (La Parguera) and Jobos Bay (H. L. Clark 1933, Carrera 1974). According to reference material examined in the echinoderms collection at NMNH there is in San Juan, Mayagüez and Puntilla Point. In this study, was collected and observed in La Parguera (San Cristobal, Laurel, Media Luna and Enrique).

**Depth Range:** Commonly shallow water, but reportedly to 518 m (Hendler et al. 1995).

**Remarks:** Several fissiparous *Ophiactis* species reported from the Caribbean region are superficially similar to, and could be confused with, *O. savignyi* (Hendler et al. 1995). *O. muelleri* is reported for the other localities of Caribbean and is very similar to *O. savignyi*; the diagnosis and description are in H. L. Clark (1933) and a few characters in Hendler et al (1995). Specific localities within Puerto Rico are reported.

**FAMILY AMPHIURIDAE Ljungman, 1867**

***Amphiodia planispina* (Martens, 1867)**



**Figure 29.** *Amphiodia planispina*. Disc detail: A. Oral and B. Aboral disc.

**References used for identification:** H. L. Clark 1901a: 247, H. L. Clark 1933: 33-37; Hendler et al. 1995: 152-153, figs. 71, 100A, B, C.

**Material Examined:** USNM 21340 (1); MSC (1) (dd: 9 mm, al: > 100 mm); MSC (1) (dd: 7 mm, al: > 100 mm).

**Previous Puerto Rican records:** H. L. Clark 1901a (as possible), H. L. Clark 1933 (as possible), Hendler et al. 1995, Carrera 1974.

**Diagnostic features:** Disk scales 10 –25 per square millimeter; radial shields less than twice as long as wide; upper arm-plates square cut on lateral margins; arms 7-8 times disk-diameter; adoral plates do not meet proximal to oral shields; arm-spines short and blunt or even truncate; tentacle-scales 2 (H. L. Clark 1933).

**Description:** From Hendler et al. 1995 (152-153). “This species is moderately large for an amphiuroid; a specimen of 10 mm disk diameter has arms over 100 mm long. The disk is inflated and covered by opaque, imbricating scales. The pairs of radial shields are almost circular in outline, and they flank a notch at the edge of the disk. There is a characteristic pit at center of each jaw of preserved specimens. *A. planispina* has three laterally compressed arm spines that are widest below the tip and very blunt. The dorsal spine is longest on joints near the disk; the ventral spine is longest near the arm tip. There two tentacle scales. Tube feet at the tips of the arms have annuli studded with minute papillae. The disk is bluish gray. The radial shields are brown or dark gray, with white tips; they are surrounded by whitish scales. In some individuals the arms are whitish or pale gray, irregularly banded with sparse patches of reddish brown and brown”.

**Distribution:** Florida, the Dry Tortugas, Cuba, Panama, Brazil and Argentina. There are less reliable records from Puerto Rico, Grenada and Barbados (Hendler et al. 1995, Abreu -Pérez et al. 2005). “ A single specimen of amphiuroid from Mayagüez, may represent this species, but as the disk is wanting, it is impossible to identify it positively. It is clearly an *Amphiodia*, and has 3 very broad and blunt arm-spines; the color is reddish, while the tentacles are dark brown, making them very conspicuous” (H. L. Clark 1901a). Found among material dredged at the mouth of the Añasco River from an unknown depth (Carrera 1974).

**Depth Range:** 1-49 m (Hendler et al. 1995).

**Remarks:** In MSC, there two lots examined for Gordon Hendler that confirm the presence of this species in the island. One specimen there was identified as *Amphipholis planispina* ?. Now, after a careful revision it is confirmed. The characteristics are constant with the description, except in the form of the dorsal disk plates.

***Amphiodia pulchella* (Lyman, 1869)**

**References used for identification:** H. L. Clark 1901a: 248, H. L. Clark 1933: 33-37; Hendler et al. 1995: 153-154, figs. 72, 100J, K.

**Material Examined:** USNM 21342 (1) (damage specimen).

**Previous Puerto Rican records:** H. L. Clark 1901a, H. L. Clark 1933, Carrera 1974, Hendler et al. 1995.

**Diagnostic features:** Disk covered with fine scales among which the primary plates are distinguishable and often conspicuous; tentacle-scale single (H. L. Clark 1933).

**Description:** From Hendler et al. 1995 (153-154). "Individuals seldom exceed 5 mm in disk diameter with slender arms 40-50 mm long. The disk is covered with fine scales, and the pairs of radial shields are closely joined. The primary plates are prominent on the disk of smaller individuals, but generally absent in larger ones. The presence on only a single tentacle scale makes this brittle star unique between shallow-water Caribbean *Amphiodia* and *Amphipholis* species. The middle arm spine is dorsoventrally flattened, with truncate, echinulate tip; the other two spines are bluntly rounded. Also distinctive are the elongate, blunt-tipped shape of the two distal pairs of oral papillae. The tube feet have a bulbous tip. The disk is gray to brownish gray; often the primary plates and other large scales are reddish or purplish gray; the radial shields are dark proximally and have a pale distal tip. Reddish brown pigmentation

of the stomach may be visible through the thin body wall. The arms are pale gray, blotched or banded with dark gray, brown, or reddish brown. The arm spines usually have a dusky internal spot”.

**Distribution:** Gulf of Mexico, Mexico, Bermuda, the Bahama Islands, the Florida Keys and the Dry Tortugas, the Gulf of coast, Cuba, Jamaica, Puerto Rico, the Windward and Leeward Islands, Tobago, Mexico, Belize, Brazil and Argentina (Carrera 1974, Hendler et al. 1995, Abreu-Pérez et al. 2005, Durán-González et al. 2005, Laguarda-Figueras et al. 2005b). In Puerto Rico waters it is known from San Antonio Bridge, San Juan (H. L. Clark 1901a, H. L. Clark 1933), Atravesado Key (La Parguera) and Guanica Bay (Carrera 1974).

**Depth Range:** Less than 1-71 m (Hendler et al. 1995).

**Remarks:** In this study, no specimens were collected.

*Amphiodia trychna* Clark, 1918

**References used for identification:** H. L. Clark 1933: 33-37; Hendler et al. 1995: 155-156, figs. 73, 100D, E, F, G.

**Material Examined:** USNM E41105 (2) (1: dd: 5 mm, 2: dd: 5 mm), MSC (1) (dd: 9 mm, al: 190 mm).

**Previous Puerto Rican records:** H. L. Clark 1933, Carrera 1974, Hendler et al. 1995.

**Diagnostic features:** Disk scales and radial shields rugose; arm very slender; arm spines small and blunt (H. L. Clark 1933).

**Description:** From Hendler et al. 1995 (155). “This is a big amphiuroid, with arms ranging in length from 13 to over 24 times the disk diameter; a large specimen of 10 mm disk diameter has arms 250 mm long. *A. trychna* has closely joined radial shields about twice as long as wide and thick, irregular disk scales. The dorsal arm plates are over twice as wide as long. Its tentacle scales and arm spines are similar in number and shape to those of *A. planispina*; however, the middle arm spine is compressed dorsoventrally, rather than laterally as in *A. planispina*. The adoral shields of *A. trychna* usually are broadly joined proximal to the oral shield; those of *A. planispina* are separated. The body is mostly tan. The disk is mottled with tan and brown scales. Each dorsal arm plate has a band of dark tan abutting a white line on the plate's distal edge; series of darker and lighter joints confer a banded pattern on the arm”.

**Distribution:** Gulf of Mexico, México, Florida, the Dry Tortugas, Cuba, Puerto Rico, Tobago, Belize, Panama, Venezuela and Brazil (?) (Hendler et al. 1995, Abreu-Pérez et al. 2005, Durán-González et al. 2005, Laguarda-Figueras et al. 2005b). In Puerto Rico waters it is known from La Parguera (Carrera 1974). In the echinoderms collection of NMNH there are two specimens taken from Puerto Rico waters, but no localities are reported.

**Depth Range:** 1-160 m (Hendler et al. 1995).

**Remarks:** The reference material of NMNH possible isn't the specie, for this reason is necessary review this material.

*Amphipholis gracilima* (Stimpson, 1852)

**References used for identification:** H. L. Clark 1933: 33-36; Hendler et al. 1995: 159-160, figs. 77, 102A, B.

**Material Examined:** None.

**Previous Puerto Rican records:** H. L. Clark 1933, Carrera 1974, Hendler et al. 1995.

**Diagnostic features:** Disk scales very small; middle arm-spine pointed; arms very slender (H. L. Clark 1933).

**Description:** From Hendler et al. 1995 (159-160). “An individual of 4.6 mm disk diameter has arms 52 mm long, but the disk may grow to 8 mm with the arm length reaching an estimated 20 times the disk diameter. This delicate amphiuroid has a round, inflated disk and long, almost threadlike arms. The disk is covered with extremely fine scales of uniform size. The thin radial shields, four to six times longer than wide, are set in notches at the disk edge. The distal oral papilla is shaped like a long isosceles triangle, with the narrow base proximal and the long sides tapering to a point at the distal end. *A. gracillima* has as many as five arm spines near the base of the arm, but there are three slender, pointed spines on most arm joints. The middle spine is slightly flattened and longer than the others. There are two narrow tentacle scales. The tube feet are smooth, with a rounded terminal bulb. The disk is tan or gray, and the radial shields are often a dark contrasting hue and have a white distal tip. The brown stomach may show through the thin disk wall. The arms are irregularly banded with tan and gray or black and sometimes have a thin, whitish, middorsal stripe”.

**Distribution:** Bermuda, the Bahama Islands, South Carolina, Virginia, the Florida Keys, Cuba, Puerto Rico, the Virgin Islands, Tobago, Curaçao and Belize (Hendler et al. 1995, Abreu-Pérez et al. 2005). In Puerto Rico waters it is known from Guanica Bay, Ponce and Yabucoa Bay (Carrera 1974).

**Depth Range:** Shallow water to 26 m (Hendler et al. 1995).



*Amphipholis januarii* Ljungman, 1867

**References used for identification:** Hendler et al. 1995: 161-162, figs. 78, 102 C, D, E.

**Material Examined:** BIOL (1) (dd: 3 mm, arms broken).

**Previous Puerto Rican records:** Carrera 1974, Hendler et al. 1995.

**Diagnostic features:** Disk scales very small; middle arm-spine pointed; arms very slender (H. L. Clark 1933).

**Description:** From Hendler et al. 1995 (161). “*A. januarii* is a moderate-sized amphiuroid; a specimen of 4 mm disk diameter has arms 40-50 mm long. Its toothed arm spines set the species apart from other *Amphipholis* and *Amphiodia* from the Caribbean. On joints with three arm spines, the middle spine is longest, flattened, and has a prominent, flesh-covered, subterminal tooth (sometimes several teeth) on each edge. On joints with four arm spines, the second from the bottom is similarly modified. The other spines are rounded, terminating in a blunt point. The tentacle scale on the ventral arm plate is distinctly broader than associated scale on the lateral arm plate. The proximal tube feet have a bulbous tip, and those at the outer end of the arm bear several small, ventrally directed papillae. The disk and the arms are light brown, tan, light greenish yellow, or gray, and there are usually incomplete bands of dusky gray, gray-green, or brown on the arms. The center and edge of the disk scales may be different hues; the radial shields, with whitish distal tips, are usually darker than the rest of the disk. Sometimes a pale, thin, middorsal stripe on the arm is produced by the vertebrae showing through the thin dorsal plates. Within the arm spines there is often a spot of brown pigment. The oral frame and proximal arm plates may be darker brown than the remainder of the ventral surface of the arm”.

**Distribution:** South Carolina, Florida and the Florida Keys, Texas, Cuba, Puerto Rico, the Virgin islands, Tobago, Brazil, and an uncertain record from Barbados (Hendler et al. 1995, Abreu-Pérez et al. 2005, Durán-González et al. 2005). In Puerto Rico waters it is known from Enrique, Atravesado, Media Luna and Caracoles Keys (La Parguera) and Jobos Bay (Carrera 1974); in this study it was collected on sea grass beds at Caballo Blanco (La Parguera).

**Depth Range:** 1-55 m (Hendler et al. 1995).

*Amphipholis squamata* (Delle Chiaje, 1828)

**References used for identification:** H. L. Clark 1933: 33-38, 50; Hendler et al. 1995: 162-164, figs. 79, 102 F, G.

**Material Examined:** USNM E26477 (1), USNM E26478 (1).

**Previous Puerto Rican records:** H. L. Clark 1933, Carrera 1974.

**Diagnostic features:** Arms short, only 3 or 4 times disk-diameter; disk smoothly covered with scales (H. L. Clark 1933). Coarse scales on top of the disk, primary plates usually lacking, and pairs of radial shields that touch one another and are nearly circular in outline (Hendler et al. 1995).

**Description:** From Hendler et al. 1995 (162). “The largest individuals from the Caribbean region are only 3 mm disk diameter with arms 11 mm long, but the species grows to at last 5 mm in disk diameter in temperate waters. Its middle oral papilla is rounded and markedly smaller than the infradental papilla and the elongate, opercular distal oral papilla. The dorsal and ventral arm plates of successive joints are separated by the lateral arm plates, and the projecting rodges of the lateral arm plates give the arm a “beaded” appearance. Each ridge bears three erect arm spines (sometimes four near the disk) that have a bulbous base. There

are two tentacle scales. The adoral shields are broadly in contact proximal to the oral shield . The disk is white, yellow, orange, pale, brown to reedish, or gray (dark pigmentation of the stomach sometimes shows through the body wall), and the radial shields commonly have a white distal tip; the arms are pale brown, yellowish, or white, sometimes with thin dusky, green, or brown bands”.

**Distribution:** Cosmopolitan, occurring in all except the extreme polar regions, though not reported from every Caribbean island (Hendler et al. 1995, Abreu-Pérez et al. 2005, Laguarda-Figueras et al. 2005b). In Puerto Rico waters it is known in the mouth of Guanica Harbor, La Parguera (Enrique Key, Guayacan Chanel, Mata La Gata, Atravesado Key, Mangrove Island) and Ensenada (H. L. Clark 1933, Carrera 1974).

**Depth Range:** Intertidal to 1130 m (Hendler et al. 1995).

*Amphiura palmeri* Lyman, 1882

**References used for identification:** H. L. Clark 1933: 33-34, 44-45; Hendler et al. 1995: 166-167, figs. 82, 103 E, F, G.

**Material Examined:** BIOL (1) (dd: 4 mm, al: 25 mm).

**Previous Puerto Rican records:** Hendler et al. 1995.

**Diagnostic features:** Disk covered above and below with a coarse coat of scales, often very fine; tentacle-scales 2; disk-scaling fine; arm-spines 6 (H. L. Clark 1933).

**Description:** From Hendler et al. 1995 (167). “*A. palmeri* is a moderate-sized amphiurid, reaching 8 mm disk diameter; a specimen of 5.3 mm disk diameter has arms 60 mm long. Similarly to *A. fibulata*, it has proximal dorsal arm plates that are nearly circular and

completely scale-covered disk. The radial shields area at least three times longer than wide, with an acute proximal angle. Unlike *A. fibulata*, it has two tentacle scales at each tentacle pore; the scale on the lateral arm plate is larger than and overlaps, the one on the ventral arm plate. *A. palmeri* is further distinguished by the shape of its six to seven flattened arm spines, which gradually, but markedly, increase in length from the dorsal to ventral side of the arm. All spines except the very upper and lowermost have spinulose tip and a distally directed subterminal tooth. The beaklike apex of these spines is covered with transparent flesh. Individuals have the disk gray, light tan, or yellowish, accented with some larger brown scales and white-tipped radial shields. The arms are tan to orange, banded with light brown and gray, often with a dark middorsal stripe near the tip of the arm; there may be a dark brown pigment spot within the arm spines”.

**Distribution:** Georgia, Mexico, the Florida Keys and the Dry Tortugas, Puerto Rico, the Virgin Islands, Barbados and possibly Venezuela (Hendler et al. 1995, Laguarda-Figueras et al. 2005b). In this study were collected and observed in La Parguera (The Buoy).

**Depth Range:** Less than 6 m; but elsewhere reported from 183 to 479 m (Hendler et al. 1995).

**Remarks:** In the echinoderms collection of the NMNH there is reference material of Puerto Rico waters, to 256 m, but no locality was established. The specimen collected in this study, has a feature different with the description done by Hendler et al. 1995: the specimen it has four to five arm spines and the difference between the long of the dorsal and ventral arm spine is not evident. Specific localities within Puerto Rico are reported.

*Amphiura stimpsonii* Lütken, 1859

**References used for identification:** H. L. Clark 1933: 33-35, 45-46; Hendler et al. 1995: 167-168, figs. 83, 103 H, I, J.

**Material Examined:** USNM E6756 (1), USNM 21294 (1).

**Previous Puerto Rican records:** H. L. Clark 1933, Carrera 1974, Hendler et al. 1995.

**Diagnostic features:** Tentacle scales single; oral shields as wide as long or wider; arm spines 5 or 4; upper arm-plates, rounded triangular with proximal angle truncated; a dusky spot on upper arm-spines (H. L. Clark 1933).

**Description:** From Hendler et al. 1995 (167-168). “This is the smallest shallow-water *Amphiura* species from the Caribbean region, rarely larger than 4 mm disk diameter, with arms 15-20 mm long. It is distinguished by having three to five arm spines; its thorny-tipped middle spines often have diminutive distally and proximally directed thorns. It lacks the exaggerated subterminal teeth characteristic of *A. fibulata* and *A. palmeri* arm spines. The ventral arm plates of *A. stimpsonii* are markedly longer than wide, and the dorsal arm plates have straight lateral edges that converge proximally and a convex distal edge. The disk is grayish or reddish, and the large scales, primary plates, and radial shields are darkly pigmented; outer tips of the radial shields usually are pale. The arms usually are more pale than the disk, light yellow or white, sometimes irregularly banded with brown or gray”.

**Distribution:** The Florida Keys and the Bahama Islands, the Dry Tortugas, Texas offshore reefs, Jamaica, Haiti, Puerto Rico, the Virgin Islands, the Leeward Islands, Barbados, Tobago, the Netherlands Antilles, Belize and Brazil (Hendler et al. 1995, Abreu-Pérez et al. 2005, Laguarda-Figueras et al. 2005b). H. L. Clark (1933) reported a single small specimen at Mayagüez, “on the reefs”; La Parguera (Enrique and Atravesado Keys and Pajaros Island)

(Carrera 1974). According to reference material examined in the echinoderms collection at NMNH there are material of Mona Island.

**Depth Range:** 1-126 m (Hendler et al. 1995).

**Remarks:** Specific localities within Puerto Rico are reported.

***Ophiocnida scrabriuscula* (Lütken, 1859)**

**References used for identification:** H. L. Clark 1933: 33-37, 55; Hendler et al. 1995: 168-169, figs. 84, 104 A, B.

**Material Examined:** None.

**Previous Puerto Rican records:** Carrera 1974, Hendler et al. 1995.

**Diagnostic features:** Disk covered with scales bearing more or less numerous spinelets; tentacle-scales 2; radial shields narrow, 2-3 times as long as wide (H. L. Clark 1933).

**Description:** From Carrera 1974, Hendler et al. 1995 (168-169). "A moderate-sized amphiurid; the disk can attain 9 mm in diameter, but the arms are relatively short. An individual of 6.6 mm disk diameter has arms 62 mm long. This species is unique among shallow-water Caribbean amphiurids because most of its disk is covered with scattered, short, pointed spinules. The proximally diverging pairs of radial shields are bare of spinules and flanked by overlapping scales that are distinctly larger than those at the center of the disk. Three tick arm spines with truncate tips give the arm a robust appearance. The dorsal and ventral spines are laterally compressed. The middle spine is dorsoventrally flattened, and near the middle of the arm it is longer than the other spines. The dorsal and ventral arm plates are wider than long. The dorsal arm plates of adjacent arm joints overlap, but ventral arm

plates do not. There are two flattened tentacle scales. The disk is light yellow to yellowish brown, with contrasting areas of gray, yellow, or pink; the outer tips of the radial shields are white. The arms are yellowish brown, the distal portion sometimes with thin purplish brown bands between joints, and purple spots and yellow patches on the dorsal arm plates. The arm spines may be brownish. The dorsal arm plates of individuals from Puerto Rico have a pale or white distal border”.

**Distribution:** Gulf of Mexico, Mexico, Bermuda, Florida, the Florida Keys, the Dry Tortugas, Jamaica, Cuba, Puerto Rico, the Virgin Islands, the Leeward Islands, Tobago, Venezuela and Brazil (Hendler et al. 1995, Abreu-Pérez et al. 2005, Durán-González et al. 2005, Laguarda-Figueras et al. 2005b). At Puerto Rico it is known from La Parguera and Jobos Bay (Carrera 1974).

**Depth Range:** Less than 2 m (Hendler et al. 1995).

*Ophionephthys limicola* Lütken, 1869

**References used for identification:** H. L. Clark 1933: 33-35, 46; Hendler et al. 1995: 169-171, figs. 85, 101 H, I.

**Material Examined:** MSC (1) (dd: 2,5 mm, broken arms).

**Previous Puerto Rican records:** None.

**Diagnostic features:** Disk without scales on the interbrachial areas orally and even dorsally also; oral shields longer than wide; a single small tentacle-scale present; arms moderately long and slender (H. L. Clark 1933).

**Description:** From Hendler et al. 1995 (169). This brittle star attains an impressive size for an amphiurid, 13 mm disk diameter with arms over 250 mm long. The disk appears dark green-brown or yellow-green, because the color of the stomach shows through the body wall. The few scales on the disk that are visible to the naked eye are clustered at the proximal ends of the radial shields and in a series linking the distal ends of the shields. Has four to five oral papillae, arranged as in *Amphioplus* species. The ventral arm plates are slightly longer than wide, usually with an indented distal end. There are up to five acute, slender, slightly flattened arm spines and a single, minute tentacle scale. Some individuals have pale tan arms with a thin, black, middorsal stripe that is crossed at irregular intervals by dark hatch-marks.

**Distribution:** The Florida Keys, the Dry Tortugas, the Florida Gulf coast, Cuba, the Virgin Islands, Belize and Panama (Hendler et al. 1995, Abreu-Pérez et al. 2005). In Puerto Rico it is known from Tres Hermanos Beach (Añasco), like results of Exploration R/V Medusa.

**Depth Range:** 1-12 m (Hendler et al. 1995).

**Remarks:** It is a first record for Puerto Rico.

***Ophiophragmus pulcher* H. L. Clark, 1918**

**References used for identification:** H. L. Clark 1933: 33-35, 48; Hendler et al. 1995: 174-175, figs. 30 D-8, 32-2, 89, 106 A, B.

**Material Examined:** None.

**Previous Puerto Rican records:** Carrera 1974, Hendler et al. 1995.

**Diagnostic features:** Radial shields broad; a conspicuous longitudinal stripe on upper side of arm (H. L. Clark 1933).



**Description:** From Hendler et al. 1995 (175). “An individual of 7 mm disk diameter has arms about 80 mm long. The blunt fence papillae at the edge of the disk usually number 6-12 between each pair of arms, but sometimes fewer. The dorsal and ventral arm spines are vertically compressed and shorter than the horizontally flattened middle spine. All the spines have blunt tips; the tip of the middle spine is usually broadened. Tube feet at the arm tip have papillose annuli. The pale gray to reddish disk may have areas of lavender or pinkish hue and greenish or red-brown spots; the fence papillae are white, and the radial shields usually tipped with white. A thin middorsal stripe of red, blue, or green and narrow greenish brown bands adorn the drab tan to yellowish arms. There may be a similarly colored, discontinuous stripe on the ventral surface of the arm”.

**Distribution:** Gulf of Mexico, Mexico, the Bahama Islands, the Florida Keys and the Dry Tortugas, Cuba, Puerto Rico, Aruba; also in Belize and Brazil (Hendler et al. 1995, Abreu-Pérez et al. 2005, Durán-González et al. 2005, Laguarda-Figueras et al. 2005b). In Puerto Rico waters it is known from La Parguera (Carrera 1974).

**Depth Range:** 1-13 m (Hendler et al. 1995).

*Ophiophragmus septus* (Lütken, 1859)

**References used for identification:** H. L. Clark 1933: 33-35, 48; Hendler et al. 1995: 176-177, figs. 91, 92, 106 F, G.

**Material Examined:** None.

**Previous Puerto Rican records:** Carrera 1974, Hendler et al. 1995.

**Diagnostic features:** Radial shields narrow, length two or three times the width; a conspicuous longitudinal stripe on lower surface of arm (H. L. Clark 1933).

**Description:** From Hendler et al. 1995 (176-177). “A large individual is 9.3 mm in disk diameter with arms 190 mm long. The species has slender, sharply pointed fence papillae on the disk, about 20 between adjacent arms. The shape of the middle arm spine sets this species apart; its curved distal edge and slightly concave proximal edge make the spine appear to bend toward the disk. The disk is gray and brown, with some scales and the radial shields usually much darker than the rest. The arms are mottled with black, brown, or yellow-brown, darker near the disk than at tip. A dark middorsal arm stripe is typical in populations from Fort Pierce, Florida, and Puerto Rico”.

**Distribution:** North Carolina and the east coast of Florida, but not Florida Keys. Gulf of Mexico, Puerto Rico, St. Thomas, Tortola, Tobago, Colombia, as far south as Brazil (Hendler et al. 1995, Abreu-Pérez et al. 2005, Durán-González et al. 2005). In Puerto Rico waters it is known from Jobos Bay (Carrera 1974).

**Depth Range:** 1-100 m (Hendler et al. 1995).

*Ophiostigma isocanthum* (Say, 1825)

**References used for identification:** H. L. Clark 1933: 33-36, 50; Hendler et al. 1995: 178-179, figs. 93, 104 C, D.

**Material Examined:** None.

**Previous Puerto Rican records:** Carrera 1974, Hendler et al. 1995.

**Diagnostic features:** Disk covered with scattered blunt spinelets of unequal size concealing the scales (H. L. Clark 1933).

**Description:** From Hendler et al. 1995 (178-179). “A typical specimen of 4.2 mm in disk diameter has five arms that reach 14.2 mm in length, and individuals with disk diameters up to 7 mm are known. The disk is covered by numerous short, blunt tubercles that obscure the scales and may cover the radial shields. Usually several of the tubercles near the radial shields are markedly larger than the rest. The distalmost of oral papillae, which set it apart from the latter species, are long, opercular, and close the gaps between the jaws. The three arm spines are blunt and somewhat flattened. There are two small, slender tentacle scales. Dorsal arm plates near the disk are subovoidal; they touch or overlap one another. The adoral shields overgrow the first ventral arm plates, both series thereby forming a nearly continuous circle of plates around the mouth. The grain texture of the lateral arm plates contrasts with the smooth dorsal and ventral arm plates. Particles of fine sediment and debris, caught in mucus, usually adhere to the dorsal surface of the disk and arms. The animal self is “sandy colored”, gray to brown with reddish brown, gray-brown, orange or black markings. The outer ends of the radial shields are usually white. Tips of the arm spines are reddish or orange. The tops of the arms often have a complex, dusky, chainlike pattern, and appear banded”.

**Distribution:** Bermuda, the Bahama Islands, North Carolina to Florida, the Florida Keys, the Dry Tortugas, Texas, Cuba, Jamaica, Puerto Rico, the Virgin Islands, the Leeward Islands, Barbados Tobago, Curaçao, Aruba, Costa Rica, Panama, Colombia, Venezuela and Brazil (Hendler et al. 1995, Abreu-Pérez et al. 2005, Durán-González et al. 2005, Laguarda-Figueras et al. 2005b). In Puerto Rico waters it is known from Point Brea, Condado Bay, inside Dos Hermanos bridge (San Juan) and La Parguera (Caracoles Key, Pajaros Island, Atravesado Key and Media Luna Key) (H. L. Clark 1933, Carrera 1974).

**Depth Range:** 1-223 m (Hendler et al. 1995).

***Ophiostigma siva* Hendler, 1995**

**References used for identification:** Hendler et al. 1995: 179-180, figs. 94, 104 E, F.

**Material Examined:** None.

**Previous Puerto Rican records:** Hendler et al. 1995.

**Diagnostic features:** Disk covered with scattered blunt spinelets of unequal size concealing the scales (H. L. Clark 1933).

**Description:** From Hendler et al. 1995 (179-180). “Individuals have six arms, generally three longer arms and three shorter regenerating arms. The arms of *O. siva* are relatively longer in relation to the disk diameter than those of *O. isocanthum*. A specimen of 2.5 mm disk diameter has arms up to 16.4 mm long. The disk tubercles are longer than wide, especially at the edge of the disk. There are three erect, bluntly pointed arm spines. They appear to curve toward the disk, because of their concave proximal and convex distal edges. Dorsal arm plates near the disk are subtriangular and are separated by the lateral arm plates. The distal edge of the adoral shield touches the first ventral arm plate, but does not overgrow it. Is similar in coloration to *O. isocanthum*, but generally a lighter hue. The arms are less darkly pigmented than the disk, with a faint, dusky, chainlike pattern, and they may be faintly banded”.

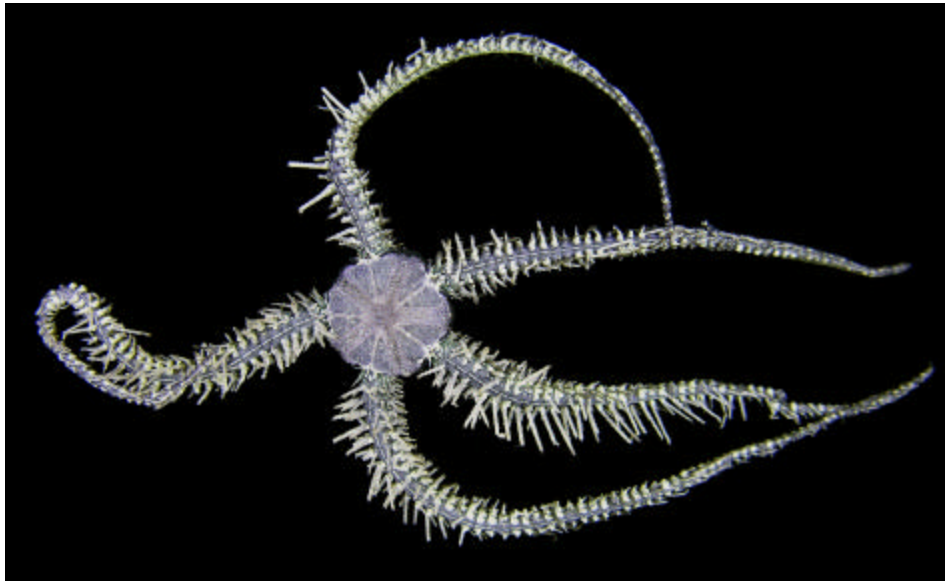
**Distribution:** Bermuda, the Florida Keys and the Dry Tortugas, Jamaica, Puerto Rico, St. Thomas and Belize (Hendler et al. 1995).

**Depth Range:** 1-42 m (Hendler et al. 1995).

**Remarks:** Although this species has been reported by Hendler et al (1995), don't were collected in this study and don't found in the echinoderms collection of NMNH or in the MCS.

**FAMILY OPHIOTHRICHIDAE Ljungman, 1867**

***Ophiothrix angulata* (Say, 1825)**



**Figure 30.** *Ophiothrix angulata* . General Image.

**References used for identification:** H. L. Clark 1901a: 244; H. L. Clark 1933: 33-38, 60-61; Hendler et al. 1995: 180-181, figs. 30D-11, 95.

**Material Examined:** USNM E3733 (1) (dd: 4 mm); USNM E5395 (3) (1: dd: 4 mm, 2: dd: 4 mm, al: 30 mm, 3: dd: 6 mm); USNM E5396 (4) (1: dd: 6 mm, 2: dd: 6 mm, al: 25 mm, 3: dd: 6 mm, al: 21 mm, 4: dd: 5 mm, al: 22 mm); USNM E5397 (4) (1: dd: 10 mm, al: 57 mm, 2: dd: 9 mm, al: 50 mm, 3: dd: 9 mm, al: 50 mm, 4: dd: 9 mm, al: 50 mm); USNM 21380 (2) (1: dd: 5 mm, 2: 3,5 mm); USNM 21389 (1) (dd: 2 mm, al: 10 mm); USNM 21391 (3) (1: dd: 7 mm, 2: dd: 7 mm, 3: dd: 8 mm); USNM 21394 (4) (1: dd: 7 mm, 2: dd: 7 mm, 3: 5 mm, 4: 8

mm), USNM 26673 (1) (dd: 3,5 mm, al: 15 mm), USNM 26680 (1) (dd: 4 mm); USNM E8689 (3) as *O. pallida* (1: dd: 3 mm, 2: dd: 3 mm, 3: 1 mm); BIOL (1) (dd: 4 mm); BIOL (10) (1: dd: 6 mm, al: 24 mm, 2: dd: 6 mm, al: 25 mm, 3: dd: 6 mm, al: 20 mm, 4: dd: 6 mm, al: 22 mm, 5: dd: 4 mm, al: 12 mm, 6: dd: 5 mm, al: 26 mm, 7: dd: 4 mm, al: 17 mm, 8: dd: 5 mm, al: 21 mm, 9: dd: 4 mm, 10: dd: 4 mm, al: 18 mm); BIOL (1) (dd: 8 mm, al: 40 mm); BIOL (2) (1: dd: 11 mm, al: 50 mm, 2: dd: 8 mm, al: 52 mm); BIOL (2) (1: dd: 8 mm, al: 40 mm, 2: dd: 8 mm, al: 35 mm); BIOL (2) (1: dd: 4 mm, al: 16 mm, 2: dd: 5 mm, al: 20 mm); BIOL (2) (dd: 4 mm, al: 20 mm); BIOL (2) (dd: 8 mm, al: 60 mm), BIOL (4) (1: dd: 7 mm, al: 45 mm, 2: dd: 7 mm, al: 45 mm, 3: dd: 7 mm, al: 25 mm, 4: dd: 6 mm, al: 31 mm), BIOL (5) (1: dd: 10 mm, al: 40 mm, 2: dd: 6 mm, al: 34 mm, 3: dd: 5mm, 4: dd: 7 mm, al: 46 mm, 5: dd: 9 mm, al: 45 mm).

**Previous Puerto Rican records:** H. L. Clark 1901a, H. L. Clark 1933, Hendler et al. 1995.

**Diagnostic features:** A median line, white, black or colored, on upper surface of arm, at least on distal portion; radial shields small, at least the inner ends, like disk, covered with minute spinelets (H. L. Clark 1933); disk covered by numerous short, delicate, bifid and trifid spines (Hendler et al. 1995).

**Description:** From Hendler et al. 1995 (180). “This moderately small species grows to 10 mm in disk diameter with arms 80 mm long. The spine arrangements and colors on the disk seem as intricate and varied among different individuals as the designs of Persian carpets. It has numerous short, delicate, bifid and trifid spines, sometimes interspersed among long thin spines, sometimes interspersed among long thin spines on the disk are the flattened, toothed, middle spines; the longest spines near the tip of the arm are the smooth, slender topmost spines. As in other *Ophiothrix* species, the jaws bear a terminal clump of dental papillae and lack oral papillae. The tube feet are papillose. The ground color on the dorsal surface may be pink, rose, violet, blue, purplish, orange-red, crimson, brown, gray or green. The arms generally have a median stripe or a lacy pattern of black, white, or a contrasting color; the

ventral surface of the arms is usually white. The overall color pattern frequently resembles one typical of other *Ophiothrix* species”.

**Distribution:** This is one of the most common brittle stars on the Caribbean; it has been observed in Bermuda, the Bahama Islands, North Carolina to the Dry Tortugas and the Florida Gulf coast, the Texas coast, the Greater and Lesser Antillas and Central and South America to Uruguay (Hendler et al. 1995, Abreu-Pérez et al. 2005, Durán-González et al. 2005, Laguarda-Figueras et al. 2005b). *O. angulata* may be found everywhere on the Puerto Rican coast when the conditions are at all suitable (H. L. Clark 1933); taken at Ponce, Boqueron Bay, Ensenada Honda (Culebra Island), San Juan, Mayagüez, Puerto Real, Guanica and others places of the island (H. L. Clark 1901a); additionally, in the echinoderms collection of the NMNH there is reference material of Puntilla Point, La Parguera, Point Molines, Boca Prieta, Humacao, and Vieques Island. In this study, it was collected and observed in La Parguera (Turrumote, Enrique, Laurel, Caballo Blanco, San Cristobal and Media Luna).

**Depth Range:** 1-540 m (Hendler et al. 1995).

**Remarks:** Specific localities within Puerto Rico are reported.

***Ophiothrix brachyactis* H. L. Clark, 1915**

**References used for identification:** H. L. Clark 1933: 33-39, 63-64; Hendler et al. 1995: 182-183, fig. 96.

**Material Examined:** None.

**Previous Puerto Rican records:** H. L. Clark 1933, Hendler et al. 1995.

**Diagnostic features:** Arms without band; disk covered with large, bare shields and relatively few distinct scales each of which carry a single, low, thorny stump; arms short (H. L. Clark 1933).

**Description:** From Hendler et al. 1995 (182-183). “This is a small and distinctly flattened brittle star, with a disk diameter less than 5 mm and relatively short arms less than 18 mm in length. Covering the disk are large, convex radial shields and conspicuous coarse scales that each bear a short stump crowned with sharp points. This species lacks the trifold stumps that characterize *O. angulata*. The oral shield is much wider than long, with rounded lateral edges; the adoral shields are broadly in contact proximal to the oral shield. Successive arm plates are squarish, with angular corners and a slightly concave distal margin. The dorsal arm plates are triangular with a broad, tickened, and slightly concave outer edge. The arm spines are echinulate; the longest spines are borne on joints well beyond the edge of the disk. Near the disk, the upper base than near the tip; the lower arm spines are slender and rounded. The jaws, typical for *Ophiothrix* species, have an apical cluster of dental papillae and lack oral papillae. A dried, preserved specimen is bluish gray; the radial shields have whitish margins; the radial shields have whitish outer tips, and the ventral surface of the body is nearly white”.

**Distribution:** Florida: Biscayne Bay, the Dry Tortugas. Mexico, Cuba, Puerto Rico, St. Barthélemy, Grenada, Barbados and Tobago (Hendler et al. 1995, Abreu-Pérez et al. 2005, Laguarda-Figueras et al. 2005b). One specimen from Puerto Rico was taken off Guanica Harbor (H. L. Clark 1933).

**Depth Range:** 1-6 m (Hendler et al. 1995).

**Remarks:** In this study, no specimens were collected and observed.



*Ophiothrix orstedii* Lütken, 1856

**References used for identification:** H. L. Clark 1901a: 244, H. L. Clark 1933: 33-38, 63; Hendler et al. 1995: 185-187, fig. 98.

**Material Examined:** USNM E3734 (1) (dd: 5 mm, al: 24 mm); USNM E5412 (1) (dd: 8 mm, al: 52 mm); USNM 21367 (2) (1: dd: 5 mm, al: 38 mm, 2: dd: 6 mm); USNM 21368 (3) (1: dd: 8 mm, 2: dd: 9 mm, 3: 4 mm); USNM 21370 (1) (dd: 6 mm); USNM 21371 (1) (dd: 9 mm, al: 26 mm); USNM 21372 (1) (dd: 4 mm); USNM 21373 (1) (dd: 6 mm); USNM 26650 (1) (dd: 9 mm); USNM 26674 (1) (dd: 4 mm, al: 16 mm); BIOL (1) (dd: 3 mm); BIOL (1) (dd: 7 mm); BIOL (1) (dd: 7 mm, al: 30 mm); BIOL (2) (1: dd: 10 mm, al: 47 mm, 2: dd: 7 mm); BIOL (5) (1: dd: 7,5 mm, al: 55 mm, 2: dd: 5 mm, al: 25 mm, 3: dd: 6 mm, al: 20 mm, 4: 3 mm, 5: 3 mm); BIOL (5) (1: dd: 4 mm, 2: dd: 3 mm, 3: dd: 5 mm, al: 30 mm, 4: dd: 5 mm, 5: dd: 6 mm, al: 40 mm); BIOL (1) (dd: 3 mm); BIOL (2) (1: dd: 8 mm, al: 45 mm, 2: dd: 8 mm); BIOL (1) (dd: 4,5 mm, al: 30 mm)

**Previous Puerto Rican records:** H. L. Clark 1901a, H. L. Clark 1933, Hendler et al. 1995.

**Diagnostic features:** Arms beautifully and regularly cross-banded with narrow lines of white or yellow (H. L. Clark 1933). No median line on arm, rough granules; even at tip; arms beautifully and regularly cross-banded with narrow lines of white or yellow (Hendler et al. 1995).

**Description:** From Hendler et al. 1995 (185). “A brittle star of modest size; a large specimen is 12 mm in disk diameter with arms long. The numerous long, thin spines on dorsal interradial sectors of the disk have sharp tips terminating in two or three microscopic spinelets. There are similar but many fewer spines on the radial shields. The squat spines on the edge and ventral surface of the disk may have bifid or trifid tips. The topmost arm spine is thin, rounded, nearly smooth, and sharply pointed; lower spines are distinctly flattened and

have a jagged, toothed edge and broadened, spinulose tip. Characteristically for an *Ophiothrix* species, the jaws lack oral papillae but bear a proximal cluster of dental papillae. The tube feet are papillose. The ground color of *O. orstedii* is green, brown, red-brown, blue, purple, or gray. Bands of the ground color on the arms are interrupted by thin yellow (or whitish) lines that are bordered on each side by a thin black line. The distinctive and striking black and yellow pattern may continue over the radial shields and onto the disk. Preservation in alcohol turns specimens blue and white, but the characteristic banded pattern remains evident”.

**Distribution:** The Bahamas Islands, Mexico, the Florida Keys and the Dry Tortugas, Texas, Cuba, Jamaica, Haiti, Puerto Rico, the Leeward and Windward Islands, Barbados, Tobago, Isla la Tortuga, the Netherlands Antilles, Belize, Isla de Providencia, Panama, Colombia and Venezuela; absent from Brazil (Hendler et al. 1995, Abreu-Pérez et al. 2005, Durán-González et al. 2005, Laguarda-Figueras et al. 2005b). In Puerto Rico waters it is known from Ponce, Arroyo, Ensenada Honda (Culebra), Caballo Blanco, Mayagüez and Puerto Real (H. L. Clark 1901a); this species is from all sides of Puerto Rico and no doubt is present wherever conditions are suitable (H. L. Clark 1933); additionally, in the echinoderms collection of NMNH there are specimens from San Juan, La Parguera and Vieques Island. In this study, were collected or observed in La Parguera (Enrique, Turrumote, Pelotas, Media Luna, Laurel, San Cristobal and Caballo Blanco).

**Depth Range:** Shallow water to 31 m (Hendler et al. 1995).

**Remarks:** Specific localities within Puerto Rico are reported.

***Ophiothrix suensonii* Lütken, 1856**

**References used for identification:** H. L. Clark 1901a: 244, H. L. Clark 1933: 33-38, 62; Hendler et al. 1995: 187-188, figs. 30D-10, 32-7, 99.

**Material Examined:** USNM E3686 (2) (1: dd: 8 mm, 2: dd: 5 mm); USNM E3687 (1) (dd: 9 mm); USNM E3718 (1) (dd: 3 mm); USNM 26679 (1) (dd: 7 mm); USNM E41019 (3) (1: dd: 3 mm, 2: dd: 6 mm, 3: dd: 5 mm); BIOL (1) (dd: 13 mm, al: 88 mm), BIOL (1) (dd: 1,5 mm, al: 20 mm).

**Previous Puerto Rican records:** H. L. Clark 1901a, H. L. Clark 1933, Hendler et al. 1995.

**Diagnostic features:** A dark median line on upper surface of arm; radial shields large and bare, the narrow interrational areas between with a few acicular spines (H. L. Clark 1933).

**Description:** From Hendler et al. 1995 (187). "This fairly large brittle star has a small disk, strikingly long, needlelike arm spines, and slender, boldly striped arms. A specimen of 10 mm disk diameter has arms 101 mm long. Only a few long, slender spines project from the smooth integument of the disk. The radial shields are nearly bare of spines; paired shields are in contact. A row of scales, contrasting in color with the surrounding surface of the disk, is arrayed at the outer edge of each radial shield; parallel rows of smaller scales and minutes scattered spines near the disk are several times longer than the width of the arm, very slender, glassy, finely toothed and sharply pointed. Integument obscures the dorsal arm plates. The lateral sides of the ventral arm plates are clearly defined; those nearest the disk are square, but succeeding plates are distinctly longer than wide. Dental papillae are present at the apex of each jaw, and oral papillae are lacking, as in other *Ophiothrix* species. The tube feet are papillose. A dark, dorsal stripe, particularly dramatic on pale-colored individuals, runs the length of the arm. It is usually black, purple, or crimson. There is often a dark stripe on the

bottom of the arm. The ground color of the disk and arms is gray, tawny, lavender, pink, orange, red, or dark purple (appearing almost black)".

**Distribution:** Bermuda, the Bahama Islands, the Florida Keys and Gulf coast, Texas, Mexico, the Greater and Lesser Antilles, and the coast of Central and South America to Brazil (Hendler et al. 1995, Abreu-Pérez et al. 2005, Durán-González et al. 2005, Laguarda-Figueras et al. 2005b). In Puerto Rico waters it is known from Caño Gordo Island, near Guanica (H. L. Clark 1933); additionally, according to reference material examined in the echinoderms at NMNH there are specimens from La Parguera, Mayagüez and Boqueron. In this study, it was collected or observed in La Parguera (Turrumote, San Cristobal, Pelotas, Romero and Enrique).

**Depth Range:** Probably to several hundred feet; reported depths to 479 m (Hendler et al. 1995).

**Remarks:** Specific localities within Puerto Rico are reported.

#### 3.1.4. Class Echinoidea Leske, 1878

Order Cidaroidea Claus, 1880

Family Cidaridae Gray, 1825

+\*\**Eucidaris tribuloides tribuloides* (Lamarck, 1816)

Order Didadematoida Duncan, 1889

Family Diadematidae Gray, 1855

*Diadema antillarum* (Philippi, 1845)

+*Astropyga magnifica* A. H. Clark, 1934

Order Temnopleuroida Mortensen, 1942

Family Toxopneustidae Troshel, 1872

*Lytechinus variegatus variegatus* (Lamarck, 1816)

+\*\**Tripneustes ventricosus* (Lamarck, 1816)

Order Echinoidea Claus, 1876

Family Echinometridae Gray, 1825

*Echinometra lucunter lucunter* (Agassiz, 1863)

*Echinometra viridis* Agassiz, 1863

Order Clypeasteroida A. Agassiz, 1872

Family Clypeasteridae L. Agassiz, 1835

*Clypeaster rosaceus* (Linné, 1758)

Family Mellitidae Stefanini, 1911

+*Leodia sexiesperforata* (Leske, 1778)

+*Mellita quinquiesperforata* Leske, 1778

Order Spatangoida Claus, 1876

Family Schizasteridae Lambert, 1905

*Moiria atropos* (Lamarck, 1816)

Family Brissidae Gray, 1855

*Brissus unicolor* (Leske, 1778)

+\*\**Brissopsis elongata elongata* Mortensen, 1907

*Meoma ventricosa ventricosa* (Lamarck, 1816)

\**Plagiobrissus grandis* (Gmelin, 1788)

**Class ECHINOIDEA Leske, 1778**

**Family CIDARIDAE Claus, 1880**

***Eucidaris tribuloides tribuloides* (Lamarck, 1816)**

**References used for identification:** H. L. Clark 1933: 75; Serafy 1979: 13-19; Hendler et al. 1995: 206-208, Figs. 110, 134A.

**Material examined:** BIOL (1) (DT: 20 mm).

**Previous Puerto Rican records:** H. L. Clark 1933, William et al. 1986, Hendler et al. 1995.

**Diagnostic features:** Primary spines, not more than one to each plate, arranged in 10 vertical series, solid and stout ending in crown-like tips, abruptly much bigger than all other spines; tubercle non-crenulate; globiferous pedicellariae without large single end tooth; test flattened adapically; scrobicular spines with broad, blunt tips and no median stripes (H. L. Clark 1933, Serafy 1979, Hendler et al. 1995).

**Description:** From Hendler et al. 1995 (206-207). “This urchin is easily recognized because of its small number of solid, thick, brown, cylindrical spines arranged in 10 vertical series. The spines are attached to a thick, globular test. Over all diameter, including spines, of this species can reach 130 mm. Ground color of the test is light brown to red-brown. The muscle bases of the primary spines are variegated brown, and the shafts of the spines are variously colored because of epizoic animals and plants; naked primary spines often have broad, dirty white and pinkish brown bands. The oral most primary spines are often banded dirty white and light pinkish. The tube feet are light brown; aboral feet are very broad at the base, more or less pointed, and very extensile; the oral feet are well-developed, and more conspicuous. The spines lack a covering of living tissue and consequently are frequently adorned with algae and other epizoans”.

**Distribution:** Cape Hatteras, North Carolina, Gulf of Mexico, south throughout the Caribbean to Rio de Janeiro, Brazil. *Eucidaris t. africana* Mortensen, 1909, is known from the Gulf of Guinea and the Cape Verde Islands (Serafy 1979, Borrero-Pérez et al. 2002, Durán-González et al. 2005, Laguarda-Figueras et al. 2005b, Valle-García et al. 2005). In Puerto Rican waters, it has been found inside Cayo Maria Langa, near mouth of Guayanilla Harbor, Guanica Harbor, Fort San Geronimo (San Juan) and Condado rocks (H. L. Clark 1933); additionally, there is reference material from Vieques Island, Mayagüez and Palmas Altas in the echinoderms collection at NMNH. Was observed and collected at La Parguera (Turrumote, Media Luna, Pelotas, San Cristobal and Enrique) as part of this study.

**Depth Range:** It occurs in depths from 0 to 800 m, but is most common in less than 50 m (Serafy 1979).

**Remarks:** Specific localities within Puerto Rico are reported.

**Order DIADEMATOIDA Duncan, 1889**

**Family DIADEMATIDAE Gray, 1855**

***Diadema antillarum* (Philippi, 1845)**

**References used for identification:** Serafy 1979: 13, 23-26; Hendler et al. 1995: 210-213, Figs. 112, 136A.

**Material examined:** None.

**Previous Puerto Rican records:** Rivera and Vicente 1974, Rivera 1979, Serafy 1979, Hendler et al. 1995, Yoshioka 1996, Weil et al. 2005.

**Diagnostic features:** Test low, flexible; tubercles perforate, crenulate; ambulacral plates compound; primary spines banded, filled with meshwork; interambulacra purplish-red, ambulacra yellowish-white (Serafy 1979).

**Description:** From Hendler et al. 1995 (210-211). “This urchin has extremely long, fragile, slender, hollow, black spines equipped with numerous whorls of spinelets. Overall diameter of fully grown individuals can exceed 500 mm. The spines can be 300-400 mm long, up to four times the diameter of the test. The test is low and flattened, with the height usually less than 50% of the width. The apical system and central areas of the broad interambulacra are depressed, and the narrow ambulacra are slightly inflated, with the pore pairs in two fairly straight series in each area. The tubercles are perforate and crenulate. The test is so thin and fragile that it remains intact for only a short time after the death of the urchin. The typical

color of the test and spines is black, but individuals may have few to many lighter-colored white or gray spines, and some are almost entirely white. Juveniles always have spines with black and white bands and may be mistaken for a different species. In general, darker animals live in bright light and clear water, and lighter individuals live in darker, more turbid conditions, in crevices or deep water”.

**Distribution:** In the western Atlantic, from Gulf of Mexico, Bermuda, and from southeastern Florida to Rio de Janeiro, Brazil; in the eastern Atlantic at the Azores, Madeira, The Canaries, the Capes Verdes, Annobón Island, and the Gulf of Guinea (Serafy 1979, Hendler et al. 1995, Borrero-Pérez et al. 2002, Durán-González et al. 2005, Laguarda-Figueras et al. 2005b, Valle-García et al. 2005). According to reference material in the echinoderms collection at the NMNH, it is found at Palominos, Arroyo and Mayagüez. In this study, it has been found at La Parguera (Turrumote, Media Luna, Pelotas and Enrique), but is widely distributed in all waters of Puerto Rico.

**Depth Range:** 0-400 m, but usually less than 50 m (Hendler et al. 1995).

**Remarks:** Specific localities within Puerto Rico are reported.

***Astropyga magnifica* Clark, 1934**

**References used for identification:** Serafy 1979: 13, 23-24, 27-28; Hendler et al. 1995: 208-209, Fig. 111.

**Material examined:** None.

**Previous Puerto Rican records:** Serafy 1979, Williams et al. 1986, Hendler et al. 1995.



**Diagnostic features:** Test low, flexible; tubercles perforate, crenulate; ambulacral plates compound; primary spines banded, filled with meshwork; interambulacra purplish-red, ambulacra yellowish-white (Serafy 1979).

**Description:** From Hendler et al. 1995 (208). “This beautiful, brilliantly colored urchin shares many morphological characters with *Diadema antillarum*; both species have somewhat flattened test with conspicuous perforate and crenulate tubercles, and long fragile spines. Unlike *D. antillarum*, *A. magnifica* has a fairly flexible test, with extensive naked interambulacral areas on the upper surface. The test can reach 20 cm in horizontal diameter. Also, the spines of *A. magnifica* are not hollow, but are filled with a calcite meshwork. The spines are banded in reddish brown and yellowish white. The naked areas of the test are golden yellow, and the brown ambulacra are bordered by single rows of brilliant iridescent blue spots. The inflated anal cone is bluish white, with a brown peripheral ring and a dark brown anus. When viewed from above, the anal cone resembles a bull’s-eye”.

**Distribution:** This species occurs from South Carolina and the southeastern Gulf of Mexico through the Greater and Lesser Antilles to Colombia, Venezuela and Surinam (Serafy 1979, Borrero-Pérez et al. 2002, Durán-González et al. 2005, Laguarda-Figueras et al. 2005b, Valle-García et al. 2005). In Puerto Rico it has been found on the northwestern coast (William et al. 1986) and at Aguadilla, according to reference material in the echinoderms collection of the NMNH; there are few published records of this species occurring around the island; however, in this study, it was observed at many localities.

**Depth Range:** 11-88 m (Serafy 1979).

**Remarks:** In this study, no specimens were collected. Specific localities within Puerto Rico are reported.

**Order TEMNOPLEUROIDA Mortensen, 1942**

**Family TOXOPNEUSTIDAE**

***Lytechinus variegatus* (Lamarck, 1816)**

**References used for identification:** H. L. Clark 1933: 75, 80-81; Serafy 1979: 13, 40-41; Hendler et al. 1995: 216-218, Figs. 114, 134D.

**Material examined:** BIOL (2) (1: DT: 30 mm, 2: DT: 30 mm).

**Previous Puerto Rican records:** H. L. Clark 1933, Engstrom 1982, Cameron 1986, Hendler et al. 1995.

**Diagnostic features:** Buccal membrane heavily plated; pore-pairs in regular arcs of 3 (H. L. Clark 1933); Primary IA spines from above ambitus with less than 16 wedges in cross-section; pedicellariae generally lighter colored (Serafy 1979).



**Figure 31.** *Lytechinus variegatus*. General Image.

**Description:** From Hendler et al. 1995 (216). “This urchin has short spines, and it reaches a total diameter of about 110 mm; diameter of the test reaches about 85 mm. The test is hemispherical with smoothly curving sides and carries many small tubercles. Tuberculation is poorly developed in aboral portions of ambulacra and interambulacra, where conspicuous naked areas occur. The globiferous pedicellariae, visible to the naked eye, are very numerous on living specimens, appearing as stalked, almost spherical, white or pink structures. Color of test and spines may vary and has been used as a basis for distinguishing subspecies (Serafy 1973 *in*: Hendler et al. 1995). In the Florida Keys, two so-called subspecies occur: *L. variegatus variegatus* (Lamarck, 1816) usually has a greenish test and green spines, and *L. variegatus carolinus* Agassiz, 1863 usually has a light red test and spines. However, color may be highly variable within a population”.

**Distribution:** Beaufort, North Carolina, southward throughout the Caribbean to Santos, Brazil. Also occurs in Bermuda and Gulf of Mexico (Hendler et al. 1995, Borrero -Pérez et al. 2002, Durán-González et al. 2005, Laguarda-Figueras et al. 2005b, Valle-García et al. 2005). *L. variegatus variegatus* seems to be abundant in Puerto Rico: Ponce, Arroyo, Boqueron Bay, San Juan, Cataño, Hucares, Maria Langa Cayo, (Guayanilla Harbor). Other specimens from La Parguera, Ensenada, Ballena Point, Ensenada and Guanica approach *carolinus* in coloration (H. L. Clark 1933). In this study, *variegatus* was observed from La Parguera (Pelotas, Caballo Blanco, San Cristobal, Enrique and Laurel).

**Depth Range:** 0-250 m, but the species is most common in less than 50 m (Serafy 1979).

***Tripneustes ventricosus* (Lamarck, 1816)**

**References used for identification:** Serafy 1979: 13, 40-41; Hendler et al. 1995: 220-222, Figs. 116, 134E.

**Material examined:** USNM E36783 (3) (1: DT: 77 mm, 2: DT: 40 mm, 3: DT: 50 mm); USNM E36800 (1) (DT: 28 mm); BIOL (1) (DT: 28 mm).

**Previous Puerto Rican records:** Cameron 1986, Hendler et al. 1995.

**Diagnostic features:** Ambulacral pores arranged in three vertical series; primary tubercle present on every third or fourth ambulacral plate; peristome naked except for buccal plates (Serafy 1979).

**Description:** From Hendler et al. 1995 (220). “This is a large urchin that reaches a diameter of up to 150 mm. The test is hemispherical, with ambulacra pores in three vertical series, and with numerous small tubercles, tending to form horizontal series of five or six on each interambulacral plate. In living individuals, the test appears uniform dark brown, including the basal muscles of primary spines. The short primary and secondary spines are a showy and contrasting white to dirty white. Aboral tube feet are uniformly brown, including the terminal disks; near the disk is a conspicuous white nerve ganglion visible as a double bump. In midradial and interradial, and around the periproct, are bands of hundreds of globiferous pedicellariae with calcareous stalks. They are covered with a thick layer of dark brown tissue, with the valves darker brown than the stalk; points of the valves are conspicuously white. The oral side of the test is lighter brown; the spines and feet are as on the aboral side. The peristome is light brown with scattered olive green patches marking the presence of small clusters of spinelets and pedicellariae. The tissue around the jaws is dark brown”.

**Distribution:** Florida and Bermuda south to Brazil; also off West Africa, Ascension, Fernando de Noronha, and Trinidad islands (Hendler et al. 1995, Borrero-Pérez et al. 2002, Durán-González et al. 2005, Laguarda-Figueras et al. 2005b, Valle-García et al. 2005). In Puerto Rico it has been occurs in Guanica Bay, Arroyo, Ponce, Aguadilla, San Juan and Palmas Altas, according to echinoderms collection at NMNH. In this study, it was observed at La Parguera (San Cristobal).

**Depth Range:** 0-55 m (Hendler et al. 1995).

**Remarks:** Specific localities within Puerto Rico are reported.

**Order ECHINOIDEA Claus, 1876**

**Family ECHINOMETRIDAE Gray, 1825**

***Echinometra lucunter lucunter* (Agassiz, 1863)**

**References used for identification:** H. L. Clark 1933: 75, 83-84; Serafy 1979: 13, 56-57; Hendler et al. 1995: 222-224, Figs. 117, 134F.

**Material examined:** USNM E05393 (4) (1: T: 5 mm, 2: DT: 7 mm, 3: DT, 15 mm, 4: DT: 9 mm); USNM E05394 (1) (DT: 10 mm); USNM E05392 (1) (DT: 20 mm); USNM E36129 (5) (1: DT: 18 mm, 2: DT: 30 mm, 3: DT: 30 mm, 4: DT: 30 mm, 5: DT: 30 mm); BIOL (1) (DTW: 18 mm, DTL: 23 mm).

**Previous Puerto Rican records:** H. L. Clark 1933, Cameron 1986.

**Diagnostic features:** Ambitus elliptical; pore-pairs in arcs of 6, or even 7; many spines on abactinal system; colors not as in *E. viridis* (H. L. Clark 1933). Apical system generally with five or more secondary tubercles on each genital and ocular plate; no white ring at base of primary spines (Serafy 1979).

**Description:** From Hendler et al. 1995 (222). "This urchin reaches a maximum diameter of 150 mm, but most individuals are half that size. It has an elongate oval test with two rows of large tubercles along the ambulacra and interambulacra, pore pairs in arcs of six, and a large peristome. The spines are long (although shorter than those of *E. viridis*), thick at the base, slender elsewhere, and sharply pointed. Aborally, the primary and secondary spines are very

dark olive green, greenish violet to purple at the tips; superficially, the general color of the spines is blackish, although some specimens are reddish dorsally. Test and muscle bases of the spines are light to dark red-brown. Aboral tube feet are light brown, and the terminal disks dark brown to blackish. Oral spines are lighter colored than aboral spines, light olive green, changing to violet distally. The test and peristome are variegated creamy brown. Near the mouth the tube feet are translucent, almost colorless, their terminal disks about twice as large as disks on the aboral feet, creamy white, the edge of the disk with a very narrow, dark brown band”.

**Distribution:** Beaufort, North Carolina, and Bermuda, Gulf of Mexico, southward throughout the Caribbean and eastern Central America to Desterra, Brazil; also West Africa (Hendler et al. 1995, Borrero-Pérez et al. 2002, Durán-González et al. 2005, Laguarda-Figueras et al. 2005b, Valle-García et al. 2005). The distribution of *E. lucunter* is even wider than that of the West Indian *Lytechinus* and *Tripneustes*. In Puerto Rico it occurs in San Juan, Ensenada, Guayanilla, Montalva Bay, La Parguera, between Pargas Bay and Ensenada, Guanica, Ponce, the beach at Playa opposite Talleboa, Caja de Muertos Island, Arroyo, Boqueron Bay, Fajardo (H. L. Clark 1933) and Hucars according to reference material in the echinoderms collection at NMNH. In this study, it was observed at La Parguera (Turumote, Enrique, Caballo Blanco, San Cristobal, Media Luna, Laurel).

**Depth Range:** 0-45 m (Serafy 1979).

### *Echinometra viridis* Agassiz, 1863

**References used for identification:** H. L. Clark 1933: 75, 84-85; Serafy 1979: 13, 56-57; Hendler et al. 1995: 225-226, Figs. 118, 134G.

**Material examined:** USNM 21210 (2) (1: DT: 60 mm, 2: DT: 32 mm); BIOL (1) (DT: 25 mm); BIOL (1) (DTW: 28 mm, DTL: 30 mm); BIOL (1) (DTW: 18 mm, DTL: 20 mm).

**Previous Puerto Rican records:** H. L. Clark 1933, Griffin et al. 2003.

**Diagnostic features:** Ambitus elliptical; pore-pairs in arcs of 5; few spines on abactinal system; primary spines light brownish, more or less green distally, and with purple tips (H. L. Clark 1933). Apical system with only one or two secondary tubercles on each genital and ocular plate; conspicuous white ring at base of each primary spine; pore-pairs in arcs of five (occasionally six) (Serafy 1979).

**Description:** From Hendler et al. 1995 (225). “This species is similar in general shape and size to *E. lucunter lucunter*, although the test is more nearly circular in outline. There are two rows of large tubercles in each ambulacrum, pore pairs in arcs of five, and spine strong and sharply pointed. In living specimens, the general test color is reddish brown. The conspicuous milled rings of the spines are white. The spines are brownish green, with the distal 10% uniformly olive green, but tipped with purple. The aboral feet are as long as primary spines, light brown overall, including disks. Color of the oral surface is lighter than the aboral surface; the test is light brown, the peristome dark red-brown. All spines on the oral surface are lighter colored, but otherwise not conspicuously different from aboral spines. Feet of the oral surface are similar in color to aboral feet, but the disks are larger”.

**Distribution:** Gulf of Mexico, southern Florida and throughout the West Indies to Venezuela (Hendler et al. 1995, Borrero-Pérez et al. 2002, Durán-González et al. 2005, Laguarda-Figueras et al. 2005b, Valle-García et al. 2005). In Puerto Rico it occurs at Playa Ponce (H. L. Clark 1933). In this study, it was observed at La Parguera (Turrumote, Pelotas, Media Luna, Enrique).

**Depth Range:** 0–45 m (Serafy 1979).

**Remarks:** Specific localities for the island are provided. This species occurred in greater numbers at Pelotas (La Parguera) compared with other Puerto Rican localities.

**Order CLYPEASTEROIDA A. Agassiz, 1872**

**Family CLYPEASTERIDAE L. Agassiz, 1835**

***Clypeaster rosaceus* (Linné, 1758)**

**References used for identification:** H. L. Clark 1933: 75, 85-86; Serafy 1979: 13, 57-58; Hendler et al. 1995: 229-230, Figs. 121, 134I.

**Material examined:** USNM E00585 (1) (Bahamas) (DTW: 47 mm, DTL: 53 mm, DTH: 15 mm).

**Previous Puerto Rican records:** H. L. Clark 1933.

**Diagnostic features:** Test well arched, with lower surface deeply concave, its margin thick, at least 25% of test length (H. L. Clark 1933). Test high, without distinct flattened margin; aboral surface rising uniformly from ambitus to apex; oral side markedly concave (Serafy 1979).

**Description:** From Hendler et al. 1995 (229). “This sea biscuit is elongate, up 200 mm long, dark brown, and inflated, with a strongly convex upper surface and concave lower (oral) surface. The five subequal ambulacral petals are inflated. The naked test is white, and, because it is thick and strong, complete dead tests are encountered frequently. In life, the test is covered with a carpet of short spines”.

**Distribution:** From South Carolina to Barbados (Serafy 1979); also known from Venezuela, Colombia, Panama, Belize and Texas (Hendler et al. 1995, Borrero-Pérez et al. 2002, Durán-González et al. 2005, Laguarda-Figueras et al. 2005b, Valle-García et al. 2005). In Puerto Rico has been found at San Juan and Fajardo (H. L. Clark 1933). In this study, it was not observed.



**Depth Range:** 0-285 m, but most common at shallow depths (Hendler et al. 1995).

**Family MELLITIDAE Stefanini, 1911**

***Leodia sexiesperforata* (Leske, 1778)**

**References used for identification:** H. L. Clark 1933: 75-76, 88; Serafy 1979: 13, 57-58, 74-75; Hendler et al. 1995: 234-235, Figs. 125, 135B.

**Material examined:** USNM 19656 (1) (broken); USNM 19657 (3) (1: DTW: 39 mm, DTL: 42 mm, 2: DTW: 68 mm, DTL: 74 mm, 3: DTW: 64 mm, DTL: 64 mm).

**Previous Puerto Rican records:** H. L. Clark 1933 (As *Mellita sexiesperforata*).

**Diagnostic features:** Genital pores 4; test fragile; lunules 6 (H. L. Clark 1933); Six lunules present; a line connecting tips of petals I and V marking adapical limit of posterior interambulacral lunule (Serafy 1979).

**Description:** From Hendler et al. 1995 (234). “This is a yellow to light brown subcircular sand dollar, up to 100 mm long, with a very flat, thin test and thin margin. The test has six slotlike holes (lunules) and five short, equal petals”.

**Distribution:** From Cape Hatteras, North Carolina and Bermuda, southward around the tip of Florida into the southeastern Gulf as far north as Sanibel Island, Florida. Also the Greater and Lesser Antilles, and from the Yucatan Peninsula along the coast of northern South America to Uruguay (Serafy 1979, Borrero-Pérez et al. 2002, Laguarda-Figueras et al. 2005b, Valle-García et al. 2005). At Puerto Rico has been found at Arroyo (H. L. Clark 1933) and Vieques, according to reference material in the echinoderms collection at NMNH. In this study, it was not observed.

**Depth Range:** 0-60 m, but most common in less than 25 m (Hendler et al. 1995).

**Remarks:** Specific localities within Puerto Rico are reported.

***Mellita quinquiesperforata* Leske, 1778**

**References used for identification:** H. L. Clark 1933: 75-76, 87-88; Serafy 1979: 13, 57-58, 68-74.

**Material examined:** USNM E6608 (4) (1: DTW: 48 mm, DTH: 43 mm, 2: DTW: 35 mm, DTH: 31 mm, 3: DTW: 54 mm, DTH: 44 mm, 4: DTW: 58 mm, DTH: 52 mm); USNM 19659 (1) (DTW: 76 mm, DTH: 70 mm); USNM 19658 (1) (DTW: 77 mm, DTH: 65 mm); USNM E6609 (2) (as *Mellita quinquiesperforata*: 1: DTW: 60 mm, DTH: 50 mm, 2: DTW: 71 mm, DTH: 62 mm).

**Previous Puerto Rican records:** H. L. Clark 1933.

**Diagnostic features:** Genital pores 4; test more fragile. Lunules 5 (H. L. Clark 1933); Five lunules present; a line connecting tips of petals I and V passing through middle of posterior interambulacral lunule (Serafy 1979).

**Description:** From Hendler et al. 1995 (236). “This is a frequently depicted sand dollar, with a thin, flattened test more or less pentagonal (five-sided) in outline, only very slightly wider than long, covered with a dense fur of short spines. The length or diameter of the test seldom exceeds 100 mm. There are five slotlike holes (lunules) in the test and five short, equal sized petals on the upper surface. When the animal is viewed from the side, the highest part of the test is slightly forward of the point where the petals meet”.

**Distribution:** From Cape Cod, Massachusetts southward along the Atlantic and Gulf coasts, throughout the Greater and Lesser Antilles, Gulf of Mexico and along the Central and South American coasts to São Paulo, Brazil (Serafy 1979, Borrero-Pérez et al. 2002, Durán-González et al. 2005, Valle-García et al. 2005). At Puerto Rico has been found at Ponce, Arroyo, Mayagüez, Puerto Real and near San Juan (H. L. Clark 1933); from Aguadilla, Luquillo and Humacao according to reference material in the echinoderm collection at NMNH.

**Depth Range:** It occurs in depths from 0 to 180 m but is most commonly found in less than 30 m (Serafy 1979).

**Remarks:** There are three species of *Mellita* represented for western Atlantic: *Mellita isometra* from the east coast of the United States and the Bahama Islands, *M. tenuis* (with circular outline and highest point posterior to the point where the petals meet) from the eastern Gulf of Mexico, and *M. quinquesperforata* (with test much wider than long) from the Caribbean, Central America and Brazil (Harold and Telford (1990) *In*: Hendler et al. 1995). Specific localities within Puerto Rico are reported. In this study, it was not observed.

**Order SPATANGOIDA Claus, 1876**

**Family SCHIZASTERIDAE Lambert, 1905**

***Moira atropos* (Lamarck, 1816)**

**References used for identification:** H. L. Clark 1933: 75-76, 89-90; Serafy 1979: 13-14, 86-88, 91-93; Hendler et al. 1995: 238-239, figs 127, 135C.

**Material examined:** USNM E36577 (1) (Florida) (DTW: 28 mm, DTL: 35 mm); USNM E13030 (Dominican Republic) (1) (DTW: 13 mm, DTL: 15 mm).

**Previous Puerto Rican records:** H. L. Clark 1933.

**Diagnostic features:** Test high, apex posterior; frontal ambulacrum (III) deeply sunken, narrow; paired petals deeply sunken, nearly closed at top, particularly adapically; posterior portion of test truncate; lateroanal fasciole distinct; peripetalous fasciole indented sharply on interambulacra to follow margins of paired petals; two genital pores (Serafy 1979).

**Description:** From Hendler et al. 1995 (238). “This is small, light brown or yellowish to white burrowing heart urchin, subspherical, usually less than 50 mm long, with distinctive narrow; deeply sunken petals and a well-developed frontal notch. The test is covered with short spines that become longer on the anterolateral margins. On many individuals a horseshoe-shaped stripe of dark red-brown pigment partially encircles the apical system”.

**Distribution:** From Cape Hatteras and Bermuda, Gulf of Mexico, southward throughout the Caribbean to São Paulo, Brazil (Serafy 1979, Borrero-Pérez et al. 2002, Durán-González et al. 2005, Valle-García et al. 2005). At Puerto Rico it occurs at Guanica Playa (H. L. Clark 1933).

**Depth Range:** It occurs in depths from 0 to 445 m but is more commonly found in less than 50 m (Serafy 1979).

#### **Family BRISSIDAE Gray, 1855**

##### ***Brissus unicolor* (Leske, 1778)**

**References used for identification:** H. L. Clark 1933: 75-76, 91-92 (as *Brissus brissus*); Hendler et al. 1995: 242-243, figs 131, 135E.

**Material examined:** USNM E36949 (2) (1: DTL: 19 mm, DTW: 13 mm, 2: DTL: 35 mm, DTW: 28 mm).

**Previous Puerto Rican records:** H. L. Clark 1933: probably.

**Diagnostic features:** Subanal plastron distinct with subanal fasciole complete (H. L. Clark 1933).

**Description:** From Hendler et al. 1995 (242). “This heart urchin seldom exceeds 50 mm in length, but can reach a length of more than 127 mm. It is elongated, inflated posteriorly, with a blunt anterior end and a bluntly pointed posterior end. The test and its covering of short spines are light tan to whitish, and there are some conspicuous black pedicellariae. There are four petals; the anterior pair is shorter than posterior pair. The anterior petals lie at an angle of 180° to one another, and the posterior petals lie at an acute angle of less than 45°”.

**Distribution:** Gulf of Mexico, Bermuda and Florida through then Caribbean to Brazil. In the eastern Atlantic, in the Mediterranean as far east as the Adriatic Sea, also the Cape Verde Islands and the Azores (Hendler et al. 1995, Borrero-Pérez et al. 2002, Durán-González et al. 2005, Laguarda-Figueras et al. 2005b, Valle-García et al. 2005). There is reference material from Puerto Rico in the echinoderms collection at NMNH but no specific localities were reported.

**Depth Range:** 0-240 m (Hendler et al. 1995).

**Remarks:** In this study, no specimens were observed.

***Brissopsis elongata elongata* Mortensen, 1907**

**References used for identification:** H. L. Clark 1933: 75-76, 90-91; Serafy 1979: 13-14, 86-87; Hendler et al. 1995: 241-242, figs 130, 135G.

**Material examined:** USNM E14380 (5) (1: DTL: 25 mm, 2: DTL: 17 mm, 3: DTL: 17 mm, 4: DTL: 17 mm, 5: DTL: 18 mm).

**Previous Puerto Rican records:** H. L. Clark 1933.

**Diagnostic features:** Small forms, generally less than 100 mm DTL; subanal fasciole complete in adults; ambulacra I and V wide on oral surface, greatest width greater than 40 percent greatest width of plastron; labrum extending posteriorly to second adjoining ambulacral plates (Serafy 1979).

**Description:** From Hendler et al. 1995 (241). “This small urchin, less than 10 mm long, elongate with rounded ends. There are four petals of more or less equal length, the posterior pair almost contiguous for much of their length, diverging distally. The test is whitish, with a covering of small tan spines”.

**Distribution:** Belize, Panama, Colombia to Venezuela, Florida Keys, the Dominican Republic, Puerto Rico and Dominica (Hendler et al. 1995, Borrero-Pérez et al. 2002). In Puerto Rican waters, it occurs at Mayagüez, according to reference material in the echinoderms collection at NMNH and is widely distributed. In this study, it was observed at La Parguera (Turrumote).

**Depth Range:** 13-72 m (Hendler et al. 1995).

**Remarks:** In this study, no specimens were collected. Specific localities within Puerto Rico are reported.

***Meoma ventricosa ventricosa* (Lamarck, 1816)**

**References used for identification:** H. L. Clark 1933: 75-76, 92; Hendler et al. 1995: 243-245, figs 132, 135H.

**Material examined:** USNM E10287 (1) (1: DTL: 170 mm, DTW: 140 mm).

**Previous Puerto Rican records:** H. L. Clark 1933: Probably.

**Diagnostic features:** Subanal plastron indistinct with subanal fasciole incomplete (H. L. Clark 1933).

**Description:** From Hendler et al. 1995 (243-244). “The test is high and covered with short spines. All spines are red-brown; the ground color of the test and of the muscle bases of spines is darker red-brown than the spines. On the oral surface, the overall color is generally lighter, the spines often tending toward olive green. The cleaned, naked test white, as it is in other burrowing urchins, with four conspicuous sunken petals of more or less equal size”.

**Distribution:** Fort Lauderdale, Florida, and the Bahama Islands, southward through the Greater and Lesser Antilles; in the Gulf of Mexico, from southern Florida westward to Central America; its southern limit is the Orinoco River (Hendler et al. 1995, Borrero-Pérez et al. 2002, Durán-González et al. 2005, Laguarda-Figueras et al. 2005b, Valle-García et al. 2005). According to reference material in the echinoderms collection at NMNH, it occurs at La Parguera.

**Depth Range:** 0-220 m (Hendler et al. 1995).

**Remarks:** In this study, no specimens were observed.

*Plagiobrissus grandis* (Gmelin, 1788)

**References used for identification:** H. L. Clark 1933: 75-76, 90-91; Hendler et al. 1995: 245-247, figs 133, 135I.

**Material examined:** MSC (1).

**Previous Puerto Rican records:** None.

**Diagnostic features:** Anal fasciole, arising from subanal on each side of periproct, well marked; primary tubercles and spines in interambulacra 1 and 4, within peripetalous fasciole, very conspicuous (H. L. Clark 1933). Large primary tubercles within peripetalous fasciole giving rise to very long primary spines (Serafy 1979).

**Description:** From Hendler et al. 1995 (245). “This is a large, elongate oval, irregular urchin, with a fragile, tan test, reaching a length of 220 mm. Its spines are short, except on the upper surface where conspicuous long, needlelike spines are directed posteriorly. Visible on the bare test are four petals and a slight anterior notch; conspicuous larger tubercles for carrying large spines are restricted to the area between petals”.

**Distribution:** Cape Canaveral, Florida, Gulf of Mexico, southward through the Caribbean and the Central and South American coasts to São Paulo, Brazil (Hendler et al. 1995, Durán-González et al. 2005, Laguarda-Figueras et al. 2005b, Valle-García et al. 2005).

**Depth Range:** 1-210 m (Hendler et al. 1995).

**Remarks:** In this study, no specimens were observed. First record for Puerto Rico Island.



### 3.1.5. Class Holothuroidea De Blainville, 1834

Order Dendrochirotida Grube, 1840

Family Cucumariidae Ludwig, 1894

*Duasmodyctyla seguroensis* (Deichmann, 1930)

+\*\**Ocnus surinamensis* (Semper, 1868)

+*Ocnus pygmaeus* (Théel, 1886)

+*Ocnus suspectus* (Ludwig, 1875)

Family Sclerodactylidae Panning, 1949

*Euthyonidiella destichada* (Deichmann, 1930)

+*Euthyonidiella trita* (Sluiter, 1910)

+*Pseudothyone belli* (Ludwig, 1886)

Family Phyllophoridae Östergren, 1907

+*Neothyonidium parvum* (Ludwig, 1881)

*Phyllophorus (Urodemella) occidentalis* (Ludwig, 1875)

Order Aspidochirotida Grube, 1840

Family Stichopodidae Haeckel, 1896

*Eostichopus arnesoni* Cutress and Miller, 1982

+*Astichopus multifidus* (Sluiter, 1910)

+\*\**Isostichopus badionotus* (Selenka, 1867)

Family Holothuroiidae Ludwig, 1894

\**Actinopyga agassizi* (Selenka, 1867)

*Holothuria densipedes* Clark, 1901

\*\**Holothuria (Cystipus) cubana* Ludwig, 1875

\*\*\**Holothuria (Halodeima) floridana* Pourtalès, 1851

+\*\**Holothuria (Halodeima) grisea* Selenka, 1867

\*\**Holothuria (Halodeima) mexicana* Ludwig, 1875

\*\**Holothuria (Platyperona) parvula* (Selenka, 1867)

*Holothuria (Selenkothuria) glaberrima* Selenka, 1867

*Holothuria (Semperothuria) surinamensis* Ludwig, 1875

**\*\**Holothuria (Theelothuria) princeps* Selenka, 1867**

**\*\**Holothuria (Thymiosycia) arenicola* Semper, 1868**

*Holothuria (Thymiosycia) impatiens* (Forskål, 1775)

**\*\**Holothuria (Thymiosycia) thomasi* Pawson and Caycedo, 1980**

Order Apodida Brandt, 1835

Family Sinaptidae Östergren, 1898

**\*\**Eupta lappa* (Müller, 1850)**

*Protankyra ramiurna* Heding 1928

**\*\*\**Synaptula hydriformis* (Lesueur, 1824)**

Family Chiridotidae Östergren, 1898

*Chiridota rotifera* (Pourtalès, 1851)

**Class HOLOTHUROIDEA de Blaville, 1834**

**Order DENDROCHIROTIDA Grube, 1840**

**FAMILY CUCUMARIIDAE Ludwig, 1894**

***Duasmodyla seguroensis* (Deichmann, 1930)**

**References used for identification:** Deichmann 1930: 140-142, Pl. 17, figs. 10-13; H. L. Clark 1933: 96-97 (as *Phyllophorus seguroensis*); Miller and Pawson 1984: 13-14; Hendler et al. 1995: 259-260, figs. 140, 178A, B (as *Duasmodyla seguroensis*).

**Material Examined:** CCM (1).

**Previous Puerto Rican records:** Hendler et al. 1995.

**Diagnostic features:** Deposits: tables or plates derived from tables; tables with squarish disk with about 12 holes in the margin. In introvert tables of more irregular form and small

rosettes (Deichmann 1930). Calcareous ring lacking posterior projections (Miller and Pawson 1984).

**Description:** From Deichmann 1930 (141-142), Hendler et al. 1995 (259). “5-6 cm in length or 10 cm. Tentacles 20 in alternating pairs. Skins soft but finely rough to the touch; color brownish with paler appendages, the general effect of the animal is mottled. Regular tables with 4 central holes and about 12 marginal ones; margin often undulated to blunt dentate; spire built up of 4 rods with one cross beam and ends in numerous teeth. End plate large; only the bases of the feet covered with tables; the terminal part is devoid of ossicles other than the end plate and therefore collapsible. In introvert tables of more irregular form and small rosettes”.

**Distribution:** Florida, and the Dry Tortugas, Mexico, Jamaica, Puerto Rico, Venezuela and Brazil (Hendler et al. 1995, Laguarda-Figueras et al. 2005b).

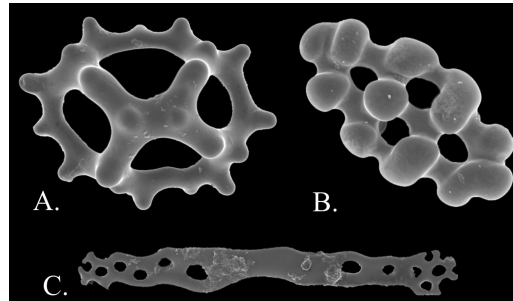
**Depth Range:** Less than 1-5,5 m (Hendler et al. 1995).

**Remarks:** In this study, no specimens were observed.

*Ocnus surinamensis* (Semper, 1868)

**References used for identification:**

Deichmann 1930: 163-164, 173-175 (as *Thyone surinamensis*); H. L. Clark 1933: 96-98, 116 (as *Thyone surinamensis*); Hendler et al. 1995: 259-260, 140, 178A, B (as



**Figure 32.** Ossicles of *Ocnus surinamensis*: A. Baskets. B. Regular Buttons and C. Roods of the tube feet.

*Ocnus surinamensis*).

**Material Examined:** BIOL (1) (L: 35 mm).

**Previous Puerto Rican records:** H. L. Clark 1933, Hendler et al. 1995.

**Diagnostic features:** Ossicles numerous; partly large-holed, regularly knobbed and partly swollen, small-holed; baskets large, well developed; supporting rods with small holes; skin relatively stiff (Deichmann 1930).

**Description:** From Deichmann 1930 (173-175). “The maximum length which this species seems to attain is about 10 cm. The shape of the body in well-extended specimens is cylindrical, tapering toward both ends which are bent slightly upward. The tentacles are of equal size, large and richly branched. The feet distributed in double rows along the ambulacra, seem to be more abundant in the ventral interambulacra than in the dorsal and lateral areas. The feet are conical with distinct end plates and, as a rule, expanded. The skin is thick, flexible, and contains an abundance of calcareous matter, which in contracted specimens may give some firmness to the integument. The color is brownish; tentacles dark, feet usually whitish sprinkled with brown, and provided with brown or yellowish sucking disks. The ossicles are composed by regular buttons and baskets. The buttons are of two kinds: a heavier, small-holed type, with large, slightly elevated knobs, and a more delicate type with large holes and small globular knobs, widely separated; the former type predominates; a few completely flat buttons with large holes may be present. The baskets are large, only slightly smaller than the buttons are long”.

**Distribution:** Bermuda to Colombia, Venezuela and Surinam, including Florida, Cuba, Puerto Rico, Jamaica and several islands of the Lesser Antilles (Hendler et al. 1995). According to H. L. Clark (1933), two specimens were collected from waters opposite Fort San Geronimo, San Juan. For this study was collected at La Parguera (San Cristobal).

**Depth Range:** Less than 1 m (Hendler et al. 1995).

**Remarks:** Specific localities within Puerto Rico are reported.

***Ocnus pygmaeus* (Théel, 1886)**

**References used for identification:** Deichmann 1930: 180-181, Pl. 21, figs. 10-16 (as *Pentacta pygmaea*); Miller and Pawson 1984: 17-20, figs. 10,11 (as *Ocnus pygmaeus*).

**Material Examined:** USNM E05571 (1).

**Previous Puerto Rican records:** Miller and Pawson 1984.

**Diagnostic features:** Small species, 30-70 mm. Body form characteristic, with heavy, conspicuous tube feet confined to 5 radii. Mouth concealed by prominent oral valves. Body wall rigid, with numerous ossicles consisting of buttons and baskets. Coloration in life light to chocolate brown (Miller and Pawson 1984).

**Description:** From Deichmann 1930 (180-181), Miller and Pawson 1984 (19). “Maximum length seems to be about 7 cm. The smallest, easily recognized specimens examined were about 3 cm. in length. It is a characteristic form, of very constant outer shape; short, rectangular, with flattened ventral side with closely packed cylindrical feet in 3 rows, and toward the ends, thick, blunt cylindrical papillae; dorsally 2 double rows of similar papillae, which in very old specimens also may spread into the interambulacra. The introvert is thin walled, the tentacles, which in most cases are retracted, filled with spicules. Skin thick, filled with ossicles; color brown, the pigment often worn off at the ends of the papillae. The body wall ossicles are composed by outer layer of deep, irregular baskets, with conspicuous

knobbed margin; inner layer of regular buttons with 10 knobs and 4 perforations. Podia large supporting rods, often triradiate; end plates present but not common”.

**Distribution:** South Carolina, Florida, Campeche, Mexico, Gulf of Mexico, Puerto Rico, Grenada, Venezuela, Trinidad, Brazil, Cape Lookout, North Carolina (Miller and Pawson 1984, Durán-González et al. 2005, Laguarda-Figueras et al. 2005b, Valle-García et al. 2005). It has been found in Puerto Rican waters off Puntilla, according to reference material in the echinoderm collection at NMNH.

**Depth Range:** 0-37 m (Miller and Pawson 1984).

**Remarks:** In this study, no specimens were observed. A specific locality within Puerto Rico are reported.

***Ocnus suspectus* (Ludwig, 1875)**

**References used for identification:** Deichmann 1930: 163-164, 175 (as *Thyone suspecta*); H. L. Clark 1933: 96-98, 115 (as *Thyone suspecta*); Hendler et al. 1995: 262-263, figs. 142, 178E, F, G, H, I, J (as *Ocnus suspectus*).

**Material Examined:** MSC (1).

**Previous Puerto Rican records:** Hendler et al. 1995.

**Diagnostic features:** Deposits few, large-holed buttons; few, often incomplete baskets; large holes in the supporting rods; skin soft (Deichmann 1930).

**Description:** From Deichmann 1930 (175). “In size and other external features resembling *O. surinamensis*, except that the skin is extremely soft, almost devoid of calcareous ossicles, and the color is more dirty, with a streak of brown along the middle of each ambulacrum. The spicules consist of a very scattered layer of large-holed buttons with 4 holes and small hemispherical knobs on the margin, and a small layer of baskets of the same type as those found in *O. surinamensis* but much smaller and often incomplete, partly flat. In the feet a large end plate composed of several smaller plates and a number of supporting rods with large holes and undulated margin. In the introvert rosettes and in the tentacles a variable number of perforated rods”.

**Distribution:** Jamaica, St. Martin, St. Kitts, Barbados and Colombia. Recently found in Florida and Puerto Rico (Hendler et al. 1995, Laguarda-Figueras et al. 2005b, Valle-García et al. 2005). In Puerto Rico waters it is known from La Parguera, according to material reference examined in echinoderms collection at MSC.

**Depth Range:** Less than 1 m (Hendler et al. 1995).

**Remarks:** In this study, no specimens were observed. A specific locality within Puerto Rico are reported.

**Family SCLERODACTYLIDAE Panning, 1949**

***Euthyonidiella destichada* (Deichmann, 1930)**

**References used for identification:** Deichmann 1930: 140, 146-147, Pl. 18, fig. 3 (as *Phyllophorus destichadus*); H. L. Clark 1933: 96-97, 112 (as *Phyllophorus destichadus*); Hendler et al. 1995: 266-267, figs. 145, 181D, E, F (as *Euthyonidiella destichada*).

**Material Examined:** MSC (1).

**Previous Puerto Rican records:** Hendler et al. 1995.

**Diagnostic features:** Margin of tables smooth; long well-developed tails on calcareous ring; usually 2 large and 6 slightly smaller holes in disk of tables (Deichmann 1930). Disc of tables oval, usually with 8 perforations; spire low, with few teeth (Miller and Pawson 1984).

**Description:** From Deichmann 1930 (146-147), Hendler et al. 1995 (266). “This is a small species, reaching a maximum length of 10 cm; individuals of less than half that size are usually collected. Body slightly curved; a robust form with numerous strong feet almost uniformly scattered over the entire surface; there are 15-20 tentacles arranged without order, small and large together. Skin solid, thick, soft to the touch; color brownish to violet; oral and anal ends paler. Tables with oblong smooth disk with 2 large central holes and 3 slightly smaller in each end; spire composed of two rods, ending in 8-12 teeth. End plate well developed; no supporting rods, the tables covering the feet almost to the end plate; in introvert tables of almost the same type, and rosettes; in tentacles small rods”.

**Distribution:** Previously known from Florida, Cuba, Puerto Rico (La Parguera), Venezuela, the southern tip of Martinique, Belize and Panama (Hendler et al. 1995, Valle-García et al. 2005).

**Depth Range:** Low-tide mark to about 4 m (Hendler et al. 1995).

**Remarks:** In this study, no specimens were observed.

***Euthyonidiella trita* (Sluiter, 1910)**

**References used for identification:** Deichmann 1930: 140-141, 147-148, Pl. 18, figs. 48 (as *Phyllophorus tritus*); Hendler et al. 1995: 267-268, figs. 146, 181G, H (as *Euthyonidiella trita*).



**Material Examined:** MSC (1).

**Previous Puerto Rican records:** Hendler et al. 1995.

**Diagnostic features:** Undulated outline of disk; 4 holes. Rudimentary spire (Deichmann 1930). Disc of tables oval to rectangular; the spire often reduced to form 2 knobs (Miller and Pawson 1984)

**Description:** From Deichmann 1930 (147-148), Hendler et al. 1995 (267). “This tiny species only grows to a length of 3 cm. Typically, the slender, cylindrical body is slightly tapered and turned upward near the posterior end, but when the tentacles are retracted, the anterior end is truncated; they are very soft and very difficult to count. Feet numerous, not retracted, uniformly distributed over the entire surface; color grayish brown, skin soft to the touch. Ossicles, in spite of the soft skin, rather numerous, developed as oval, four -holed tables with smooth to scalloped margin, often with 4 small accessory holes; spire two-pillared, very low, practically absent and with a few long teeth at the end of each of its 2 short pillars. In the feet a large end plate, no supporting rods at all, only a few typical tables. In the introvert, tables with smooth outline and usually 4 large and 4 small holes; spire somewhat higher and better developed; in tentacles rosettes and a few small delicate rods with a few perforations or a single hole in each end”.

**Distribution:** Previously reported from Dry Tortugas, Puerto Rico, the Virgin Islands, St. Martin, Antigua and Venezuela. Also known from Jamaica and Stuart, Florida (Hendler et al. 1995). In Puerto Rico waters it is known from La Parguera, according to material reference examined in echinoderms collection at MSC.

**Depth Range:** Low -tide mark to 3.6 m (Hendler et al. 1995).

**Remarks:** In this study, no specimens were observed. Specific localities within Puerto Rico are reported.

***Pseudothyone belli* (Ludwig, 1886)**

**References used for identification:** Deichmann 1930: 163-164, 176-177, Pl. 14, figs. 10-13 (as *Thyone belli*); Hendler et al. 1995: 268-269, figs. 147, 180A, B, C (as *Pseudothyone belli*).

**Material Examined:** MSC (1).

**Previous Puerto Rican records:** Hendler et al. 1995.

**Diagnostic features:** Buttons with thick smooth handle, strongly knobbed and short. Tables and rosettes in introvert; in tentacles rosette-like plates (Deichmann 1930). Small, burrowing form, up to 50 mm. Body cylindrical, curved. Podia numerous, scattered over entire body. Integument rigid. Feet with supporting tables. Coloration in preserved specimens grayish (Miller and Pawson 1984).

**Description:** From Hendler et al. 1995 (268). “This is a small sea cucumber, and although there are reports of specimens 5 cm in length, most individuals are considerably less than half that size. The body is usually curved, somewhat swollen at the middle, and slightly tapered at the ends. The thin body wall is very stiff, because of a profusion of skeletal ossicles. Numerous long, cylindrical tube feet are scattered over the body wall, and there is some tendency for the tube feet to be aligned in rows near the mouth and anus. On the ventral surface of the body they are most numerous, longest, and hairlike. They appear incapable of full retraction, probably because of the dense layer of ossicles in the tube foot wall. The mouth is surrounded by eight long, slender, abundantly branched tentacles and two shorter ventral ones about one-third the length of their neighbors”.

**Distribution:** Bermuda, Florida, the Dry Tortugas, Mexico, Panama, Puerto Rico, Trinidad, Tobago and Brazil (Hendler et al. 1995, Laguarda-Figueras et al. 2005b). In Puerto Rico waters it is known from La Parguera, according to material reference examined in echinoderms collection at MSC.

**Depth Range:** Low-tide mark to 37 m (Hendler et al. 1995).

**Remarks:** In this study, no specimens were observed. Specific localities within Puerto Rico are reported.

**Family PHYLLOPHORIDAE Östergren, 1907**

***Neothyonidium parvum* (Ludwig, 1881)**

**References used for identification:** Deichmann 1930: 140-141, 149-150, Pl. 14, figs. 10-13 (as *Phyllophorus parvus*); Hendler et al. 1995: 272-273, figs. 149, 179I,J (as *Neothyonidium parvum*).

**Material Examined:** MSC (1).

**Previous Puerto Rican records:** Hendler et al. 1995.

**Diagnostic features:** Smooth, oval outline of disk; 8 large holes and 2 small ones. Spire well developed (Deichmann 1930).

**Description:** From Deichmann 1930 (149-150), Hendler et al. 1995 (272). “This fairly small species reaches a length approximately 8 cm. The feet are scattered over the entire surface, being still more numerous in the radii where they form distinct double rows. Color pale reddish; 18 tentacles, 9 pairs alternating with 9 smaller. The calcareous ossicles are closely packed in the entire outer layer of the integument, being all of the same type; they consist of

an oblong disk, which most commonly is perforated by 8 larger and 2 smaller holes, and near the middle 2 rods vertical to the disk and united by a bridge parallel with the disk and ending in about 8 short spines. Quite similar ossicles are also placed in the feet, but never reaching the large end plate which is composed of 5 pieces”.

**Distribution:** Puerto Rico, Florida, Antigua and Brazil (Hendler et al. 1995). In Puerto Rico waters it is known from La Parguera, according to material reference examined in echinoderms collection at MSC.

**Depth Range:** Less than 2-3 m (Hendler et al. 1995).

**Remarks:** In this study, no specimens were observed. Specific localities within Puerto Rico are reported.

***Phyllophorus (Urodemella) occidentalis* (Ludwig, 1875)**

**References used for identification:** Deichmann, 1930: 140, 148-149, Pl. 18, figs 1, 2 (as *Phyllophorus occidentalis*); Miller and Pawson 1984: 13-14, 36-37, Figs. 27, 28 (as *Phyllophorus (Urodemella) occidentalis*); Hendler et al. 1995: 274-275, Figs. 151, 181A, B, C.

**Material Examined:** MSC (1).

**Previous Puerto Rican records:** Miller and Pawson 1984, Hendler et al. 1995.

**Diagnostic features:** Medium-size, burrowing form, up to 100 mm. Body cylindrical, U-shaped, slightly tapering toward blunt, rounded ends. Tentacles 20, alternating large and small. Podia arranged along radii and uniformly scattered over entire body. Ossicles

consisting of uniform tables. Coloration in life yellow, orange or dark brown. (Miller and Pawson 1984).

**Description:** From Deichmann 1930 (148-149). “The specimen is about 4 cm. long. A serial arrangement of the feet is indicated along the radii, and they are also spread uniformly over the entire body. The tentacles are arranged in a characteristic manner, namely 5 larger pairs 8-10 mm long, alternating with 5 smaller pairs, smaller, only 1.5-3 mm long. In the skin, which is rather soft to the touch, there are numerous ossicles which are all of the same type; they are in the form of tables; the disk is well developed with scalloped margin, whereas the spire is reduced to 4 low spines, united at their bases”.

**Distribution:** Florida, Mexico, Puerto Rico, Antigua, Barbados, Grenada, Aruba, Trinidad, Surinam and Brazil (Hendler et al. 1995, Laguarda-Figueras et al. 2005b). In Puerto Rico waters it is known from La Parguera, according to material reference examined in echinoderms collection at MSC.

**Depth Range:** 1-2 m (Hendler et al. 1995).

**Remarks:** In this study, no specimens were observed. Specific localities within Puerto Rico are reported.

**Order ASPIDOCHIROTIDA Grube, 1840**

**Family STICHOPODIDAE Haeckel, 1896**

***Eostichopus arnesoni* Cutress and Miller, 1982**

**References used for identification:** Cutress and Miller 1982: 715-722, figs. 1-3.

**Material Examined:** MSC (1).

**Previous Puerto Rican records:** Cutress and Miller 1982.

**Diagnostic features:** Length to 45 cm. Pedicels of ventral surface without distinct linear order. Some large papillae either bifurcate or trifurcate. Tables and C-shaped ossicles included in body wall ossicles. Disk of tables with up to 100 perforations. Spire composed of 4-9 (commonly 6) pillars and up to 10 crossbeams with spinose projections at every junction of crossbeam with pillar. Unique reticulate rods included in ossicles of tentacles, one portion of each rod resembling a tall, tapered, spinose spire, the other portion a very irregular three-dimensional meshwork (Miller and Pawson 1984).

**Description:** From Cutress and Miller 1982 (716-720). “Tentacles 20, peltate, light brown. Mouth directed ventrally, encircled by collar of small papillae. Lateral and dorsal surface convex, covered with large conical papillae in a double row along each flank and in about 8 indistinct, longitudinal rows dorsally. Some papillae at margin of ventral sole bifurcate or trifurcate. Ivory-white ring at base of each papilla: tips of papillae light brown. Body wall between papillae light chocolate brown. Ventrum flat, densely covered with pedicels without distinct linear arrangement: bright crimson in life, faded to cream color in alcohol. The ossicles of tentacles are composed of spiny rods, unique reticulate rods, one half or more of length of each rod in form of tall, tapered, spinose spire, the other portion an irregular mesh; rare spiny rosettes; on the body wall, papillae and pedicels are composed by numerous C-shaped ossicles, a few irregular C ossicles in shape of X, S, Y or irregular rosette, numerous tables high and across disk: spire comprising 4-9 pillars, 2-10 crossbeams connecting adjacent pillars and 2-3 smooth or dentate spines at each juncture of crossbeam with pillar; disks having 4-9 central perforations and up to 100 small peripheral perforations and margins varying from smooth and wide to scalloped and narrow. In anterior papillae only, a few perforated plates and, in pedicels only, spinose, slightly curved rods, some with irregular, occasionally elaborate, perforated central expansions”.

**Distribution:** Puerto Rico Island, specifically Punta Aguila (Cutress and Miller 1982).

**Depth Range:** 36 m, according with echinoderms collection at NMNH.

**Remarks:** In this study, no specimens were observed.

*Astichopus multifidus* (Sluiter, 1910)

**References used for identification:** Deichmann 1930: 84-85, Pl. 5, figs 44-47; Miller and Pawson 1984: 49, 51-54, Figs. 41, 42; Hendler et al. 1995: 279-280, Figs. 155, 187D, E, F.

**Material Examined:** MSC (1).

**Previous Puerto Rican records:** Miller and Pawson 1984, Hendler et al. 1995.

**Diagnostic features:** Large, cylindrical species, up to 450 mm in life, much contracted in preserved condition. Ventral surface flattened, covered with dense layer of cylindrical podia. Dorsally, podia papillate, numerous, scattered. Body wall soft, thick. Ossicles small, scattered, consisting of C-, O- or S-shaped bodies. Coloration in life is variable, dorsally variegated brownish yellow, ventrally white and pale pink podia and scattered black flecking (Miller and Pawson 1984).

**Description:** From Deichmann 1930 (84-85). “Outer aspect holothurian-like, with numerous, cylindrical, soft ventral feet and numerous smaller dorsal appendages, either papillae or papilliform pedicels. Twenty-one tentacles rounded, knob-like disk are present, ventrally directed, surrounded by a very narrow tentacle collar; anus subdorsal. Color mottled brownish, with pale ventral side and tentacles. Spicules are only spherical grains, collected in heaps and small C, S or O-shaped bodies. In pedicels and end plate, composed of several smaller plates, and numerous C-shaped bodies. In tentacles a few, straight, spinous rods, beside the C-shaped bodies”.

**Distribution:** The Bahama Islands, Florida, Florida Keys, the Dry Tortugas, Mexico, Cuba, Jamaica, Puerto Rico, Colombia and Venezuela (Miller and Pawson 1984, Hendler et al. 1995, Laguarda-Figueras et al. 2005b, Valle-García et al. 2005). At Puerto Rico waters has been found at Aguadilla and Boqueron, according with to echinoderms collection at NMNH.

**Depth Range:** 1-37 m (Miller and Pawson 1984, Hendler et al. 1995).

**Remarks:** In this study, no specimens were observed. Specific localities within Puerto Rico are reported.

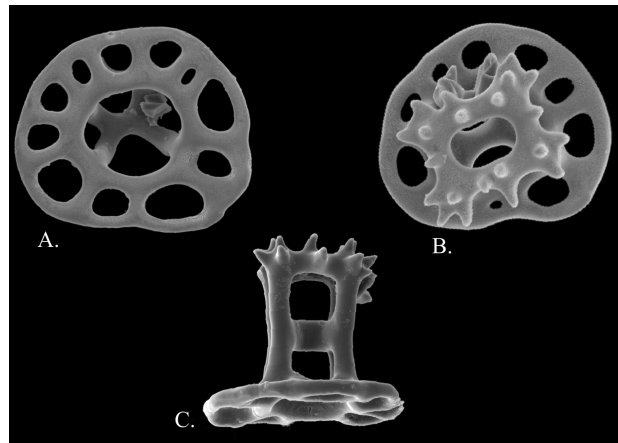
***Isostichopus badionotus* (Selenka, 1867)**

**References used for identification:** Deichmann 1930: 80-82, Pl. 5, figs 30-36; Miller and Pawson 1984: 49, 54-57, Figs. 44, 45; Hendler et al. 1995: 280-282, Figs. 156, 187G, H, I.

**Material Examined:** BIOL (3) (1: L: 245 mm, 2: 210 mm, 3: L: 200 mm); BIOL (2) (1: L: 100 mm, 2: L: 90 mm); BIOL (1) (L: 200 mm); MSC (1).

**Previous Puerto Rican records:** Miller and Pawson 1984.

**Diagnostic features:** Large form, up to 450 mm. Body wall extremely distinct, low warts dorsally and laterally. Dorsal and ventral surface sharply defined by lateral rim of conspicuous papillae.



**Figure 33.** *Isostichopus badionotus*. Details Ossicles: A. Dorsal Disc Table, B. Ventral Disc Table and C. Lateral Table.



Ventral surface flat, covered with numerous, cylindrical tube feet crowded into three rows. Ossicles include tables and C-shaped bodies. Color in life variable, usually a hue of tan or brown with darker warts and lighter ventral side (Miller and Pawson 1984).

**Description:** From H. L. Clark 1933 (109), Deichmann 1930 (80-81), Miller and Pawson (55-56). “Maximum size about 20 cm., in life up to about 30 cm. A broad flattened form, with 3 rows of crowded cylindrical appendages on ventral side; the middle row being twice as broad as the lateral rows. Dorsally low warts. Mouth ventrally directed, with about 20 broad tentacles, and a large tentacle collar. Skin thick, especially laterally. Color is extraordinarily varied. Unicolor individuals ranging from almost cream color to almost black, including buff, brown, deep redbrown and purple, are seen, but it even more common to find spotted, blotched and variegated individuals, whose ground color may be any of the shaded mentioned, while the dots, spots, and blotches are of one of the other shades. The ossicles in the body wall are numerous small, regular tables; margin of disc with complete circle of 10-12 perforations; spire composed of 4 pillars terminating in several teeth surrounding large central perforation; scattered C-shaped bodies of variable size (Miller and Pawson 1984). In pedicels is common to find a large end plate and numerous almost straight rods which in smaller specimens are simple, but in older become broadened out at the middle, with numerous perforations, so that they are ultimately transformed into broad, perforated plates. In tentacles is frequent to find large, curved rods with pointed ends and spines on their outer side”.

**Distribution:** Bermuda, South Carolina, Florida, the Bahama Islands, Puerto Rico, Cuba, Texas, Mexico, Belize, Panama, Colombia, Venezuela and many Caribbean Islands, as far south as Brazil. Also in the Gulf of Guinea off western Africa (Miller and Pawson 1984, Hendler et al. 1995, Durán-González et al. 2005, Laguarda-Figueras et al. 2005b, Valle-García et al. 2005); in Puerto Rico waters it is known from Boqueron, San Juan, Mayaguez and La Parguera, according to reference material examined in the echinoderms collection at

NMNH. For this study it was collected and observed at La Parguera (Pelotas, Enrique and was especially abundant at Caballo Blanco).

**Depth Range:** Low -tide mark to 65 m (Hendler et al. 1995).

**Remarks:** The specimens collected for this study from (La Parguera: Enrique) possess tables with 9 marginal holes agreeing with Miller and Pawson (1984). There were no tables with 4 central holes contradicting the descriptions of Deichmann (1930) and Hendler et al (1995). Specific localities within Puerto Rico are provided based on specimens collected for this study as well as reference material examined at the NMNH.

**Family HOLOTHURIIDAE Ludwig, 1894**

***Actinopyga agassizi* (Selenka, 1867)**

**References used for identification:** Deichmann 1930: 78-79, Pl. 5, figs 21-29; Hendler et al. 1995: 282-284, Figs. 157, 180G, H, I.

**Material Examined:** E17160 (1); CCM (1).

**Previous Puerto Rican records:** None.

**Diagnostic features:** Anus surrounded by 5 large conspicuous calcified anal teeth; mesentery with secondary attachments to the body wall; ossicles as grains or rosettes or short rods, at least in full grown specimens (Deichmann 1930).

**Description:** From Hendler et al. 1995 (282). “Among the largest species of the sea cucumbers in the Florida Keys, adult specimens reach 35 cm in length (Hendler et al. 1995). A very robust form with thick leathery skin and numerous cylindrical appendages, arranged in 3 bands on ventral side, and small papillae or papilliform pedicels on dorsal side. Mouth

ventrally directed with 25-29 broad tentacles; anus terminal with a round opening wherein are 5 large, white calcareous teeth, radial in position; the area around anus is devoid of other appendages. Skin very thick and firm. Color variable, from almost uniform brown to mottled yellow and different shades of brown in very diverse patterns. The pedicels seem invariably and the tentacles mostly be yellow (Deichmann 1930). The body wall ossicles are rosettelike elements, which vary from simple “dog biscuit” shapes to complex rods with dichotomously branched ends”.

**Distribution:** Bermuda, Florida, the Florida Keys and the Dry Tortugas, Mexico, the Bahama Islands, Cuba, Belize, Hispaniola, Jamaica and Barbados (Hendler et al. 1995, Laguarda-Figueras et al. 2005b, Valle-García et al. 2005); according to reference material examined of echinoderms collection at NMNH, this species has been collected at La Parguera.

**Depth Range:** To 7 m (Hendler et al. 1995).

**Remarks:** In this study, no specimens were collected. Specific localities within Puerto Rico are reported.

***Holothuria densipedes* Clark, 1901**

**References used for identification:** H. L. Clark 1901a: 257, Pl. 17, fig. 1. Deichmann 1930: 68-69.

**Material Examined:** E 21401 (1); MSC (1).

**Previous Puerto Rican records:** H. L. Clark 1901a, Deichmann 1930, H. L. Clark 1933.

**Diagnostic features:** Pedicels large and abundant. Numerous papillae also on dorsal surface (H. L. Clark 1933).

**Description:** From Deichmann 1930 (68-69). “Only a very small specimen, about 8.5 cm. in length, has ever been found of this peculiar form, which probably is an abnormal *H. arenicola*. It suggests that species strongly, except for the feet which are more conical soft, as if they were swollen and apparently more numerous but to estimate about the number of appendages in a very contracted holothurian is a difficult thing. The spicules cannot separated from those found in *H. arenicola*”.

**Distribution:** Lighthouse Reef, Puerto Rico (H. L. Clark 1901a).

### ***Holothuria (Cystipus) cubana* Ludwig, 1875**

**References used for identification:** Deichmann 1930: 52-57, Pl. 1, figs 1-8; Hendler et al. 1995: 284-285, Figs. 158, 183A, B, C, D.

**Material Examined:** BIOL (1) (L: 75 mm); BIOL (1) (L: 55 mm); BIOL (1) (L: 58 mm); BIOL (2) (1: L: 85 mm, 2: L: 45 mm); MSC (1).

**Previous Puerto Rican records:** H. L. Clark 1933, Hendler et al. 1995.

**Diagnostic features:** Tables very complicated, developed as reticulated spheres; buttons strongly knobbed, middle bar of buttons not projecting beyond end of deposit (Deichmann 1930).

**Description:** From Deichmann 1930 (52-57). “Twenty very small tentacles; the dirty white body of the single specimen is sausage-shaped; the entire surface is covered by appendages;

anus is round; skin rough to touch on account of the numerous ossicles; these are represented by a crowded layer of knobbed buttons which, as a rule, are perforated by 10 holes; beside these we find others which are irregular in their outline, smooth and perforated only by a few small holes, thus being transformed into plates. The tables are very complicated; the spire is low and with many teeth; the disk is provided with knobbed thickenings as are the buttons (Ludwig 1875 *In*: Deichmann 1930). A very characteristic form, flattened, with thin and rigid skin; mouth ventral with 20 very small tentacles; anus terminal. Appendages small, slightly tapering pedicels ventrally, rather scattered and completely retracted, visible only as small pits; dorsally they are small wart-like papillae, usually distinct along the sides and in scattered rows along the dorsal ambulacra. Color gray to whitish, dorsally often with 6 pairs of indistinct spots; ventral side lighter and often with a rusty stain at the bases of the appendages”.

**Distribution:** Gulf of Mexico, Mexico, Bahama Islands, the Dry Tortugas, Florida, Bermuda, Cuba, Puerto Rico, Antigua, Barbados, Curaçao and Venezuela (Hendler et al. 1995, Durán-González et al. 2005, Laguarda-Figueras et al. 2005b, Valle-García et al. 2005); in Puerto Rico waters, it was first collected at Condado Bay, San Juan, and are the first known from Puerto Rico (H. L. Clark 1933); according with a echinoderms collection of NMNH, this species has been collected at La Parguera. For this study, specimens were collected at La Parguera, specifically at Caballo Blanco, Media Luna and Laurel.

**Depth Range:** To 7 m (Hendler et al. 1995).

**Remarks:** Specific localities within Puerto Rico are reported.

*Holothuria (Halodeima) floridana* Pourtalès, 1851

**References used for identification:** Deichmann 1930: 52-54, 72-74, Pl. 5, figs 15-20; Miller and Pawson 1984: 49-50, Hendler et al. 1995: 285-287, Figs. 159, 183E, F, G.

**Material Examined:** None.

**Previous Puerto Rican records:** None.

**Diagnostic features:** Ossicles tables lacking spines on disc margin; perforated plates biscuit-shaped with minute perforations (Miller and Pawson 1984); rosettes dominating in skin, distinctly in heaps; color variable, often with large dark spots, and colored or dark reddish brown; maximum size about 25 cm, usually 15 cm.; skin not remarkably thick (Deichmann 1930).

**Description:** From Deichmann 1930 (52-57), H. L. Clark 1933 (107). “Maximum length of specimens examined, about 15 cm. A relatively slender form, especially when young. Mouth slightly ventrally bent; anus terminal. Ventral side with numerous cylindrical pedicels which are rarely retracted; somewhat more numerous than dorsal appendages; in very young specimens they may be arranged in series; dorsally papillae on low conical warts arranged without any definite order, and besides, cylindrical feet, somewhat smaller than ventral; the warts only conspicuous in young specimens. Tentacles 20, yellowish, not particular large. Skin of medium thickness, except in some young and contracted specimens, where it is thick and more gelatinous. Color very variable, from almost white, with darker tips of pedicels, to very dark brown. Specimens from certain localities very irregularly spotted. It is a characteristic feature that the ossicles of the inner layer of integument are arranged in heaps around the bases of the appendages and these heaps are visible to the unaided eye. An outer layer of tables, somewhat variable in height and form of spire, which may be composed of either almost parallel or converging pillars; very rarely holes are incomplete; spire ends in 12

long teeth, 4 of which are vertical and 8 horizontal. Inner layer of ossicles small rosettes, arranged in heaps; a few developed as perforated buttons, or as plates with large holes; rosettes are retained as such during the animal's entire life. Pedicels contain a well-developed end plate and a few slender supporting rods with branched ends; in papillae a small vestige of an end plate may be present and numerous supporting rods; in tentacles no ossicles seem to be present".

**Distribution:** Gulf of Mexico, Yucatan Peninsula (including Mexico) southward along the coast of Central America to Colombia, also the northern Bahama Islands, Cuba, Jamaica, and Aruba. Around Florida to Florida Bay; especially common in Biscayne Bay, the Dry Tortugas, and along the Gulf side of the Florida Keys (Hendler et al. 1995, Durán-González et al. 2005, Laguarda-Figueras et al. 2005b, Valle-García et al. 2005); in Puerto Rico waters, according to reference material examined in the echinoderms collection at NMNH, it has been collected at La Parguera.

**Depth Range:** Less than 1-1.5 m (Hendler et al. 1995).

**Remarks:** In this study, no specimens were observed. Specific localities with Puerto Rico are reported.

***Holothuria (Halodeima) grisea* Selenka, 1867**

**References used for identification:** Deichmann 1930: 52-54, 76-77, Pl. 5, figs 1-4; Miller and Pawson 1984: 49-50, Hendler et al. 1995: 287-288, Figs. 160, 184A, B, C, D, E, F, G, H.

**Material Examined:** BIOL (1) (L: 70 mm).

**Previous Puerto Rican records:** Deichmann 1930, H. L. Clark 1933, Hendler et al. 1995.

**Diagnostic features:** Ossicles scattered tables often with 2 or more distinct spines on disc margin; perforated rectangular plates with dentate margin and 2-4 large, central perforations surrounded by several smaller perforations at each end (Miller and Pawson 1984).

**Description:** From Deichmann 1930 (52-54), Hendler et al. 1995 (287-288). “Individuals of this species can reach a length of 25 cm. The body is subcylindrical, with a distinctly flattened sole covered with numerous cylindrical tube feet. The upper body surface carries six rows of papillae, borne upon very large warts, each wart surrounded by 5-10 small tube feet. The mouth is directed slightly downward, with 20-25 bushy peltate tentacles. The striking, harlequin colors of this species are a helpful distinguishing feature. The ground color of living animals, red or yellowish red, contrasts with brown mottling and with white papillae with yellow tips on the upper body. The feet on the sole are yellow-tipped, and the tentacles are yellow. The deposits are composed of scattered tables, as a rule with about 12 spines on the margin of the small disk; the spire ends in 12 teeth generally short. The inner spicules, are regularly shaped plates with two or four central holes and sometimes smaller holes arranged at the ends and with a series of blunt teeth around the margin; a few plates are larger, more like rods, and some may be incomplete and thus resemble rosettes. In the pedicels few, almost straight, supporting rods with a few holes in the spinous ends and a well-developed end plate; in papillae slightly curved, almost unbranched but spinous rods; in tentacles short, cylindrical rods, with unbranched or slightly branched ends and with spines along their sides”.

**Distribution:** Gulf of Mexico, Mexico, Florida, the Bahama Islands, Puerto Rico, Cuba, Jamaica, the Lesser Antilles to Curaçao, Panama, Colombia, southern Brazil, and West Africa (Hendler et al. 1995, Durán-González et al. 2005, Laguarda-Figueras et al. 2005b, Valle-García et al. 2005); in Puerto Rico waters, according to H. L. Clark (1933), it has been seen at Arroyo and Hucares. Additionally, there are specimens from La Parguera in the echinoderms collection at NMNH. In this study it has been observed at La Parguera (Laurel).



**Depth Range:** Less than 5 m (Hendler et al. 1995).

**Remarks:** Specific localities within Puerto Rico are reported.

***Holothuria (Halodeima) mexicana* Ludwig, 1875**

**References used for identification:** Deichmann 1930: 52-54, 74-76, Pl. 5, figs 15-20; Miller and Pawson 1984: 49-50, Hendler et al. 1995: 288-290, Figs. 161, 162, 183H, I, J, K.

**Material Examined:** BIOL (1) (Enrique L: 60 mm); BIOL (1) (L: 65 mm).

**Previous Puerto Rican records:** Deichmann 1930, H. L. Clark 1933, Hendler et al. 1995.

**Diagnostic features:** Ossicle tables lacking spines on disc margin; perforated plates biscuit-shaped with minute perforations (Miller and Pawson 1984).

**Description:** From Deichmann 1930 (52-54), Hendler et al. 1995 (288). "This is a large species, reaching a length of 30-50 cm. A subcylindrical form with blunt ends; mouth ventrally directed, anus terminal; skin very thick and smooth; ventrally numerous, soft, cylindrical feet, often completely retracted and hidden in the thick integument. Dorsally, smaller and more scattered cylindrical feet and a few papillae, which in preserved specimens seem to be placed on warts, except when very young. Tentacles 20 broad and peltate. The typical coloration of preserved specimens is very dark, almost black on dorsal side and a dirty yellowish on ventral side and flanks; the ventral feet are often bluish or brownish, as is the area around their bases; now and then a spotted form is found, usually with the ventral side provided with large dark patches, whereas the dorsal side is pale. The young specimens are sand-colored, with small dark spots on dorsal side, and with distinct warts, but the skin is tougher and no accumulation of spicules in heaps is visible. The deposits are composed of an outer layer of scattered tables with small disk, with 4 small marginal holes, rarely 8; spire

strong with 4 vertical and 8 horizontal spines; there is a inner layer of innumerable small buttons or plates of two kinds: a small elongate four-holed button with 2 lateral and 2 smaller terminal holes and also biscuit-shaped plates, slightly larger, with very small holes. In the pedicels are a well-developed end plate and practically no supporting rods; in the dorsal papillae a mere vestige of an end plate and some curved stout rods with a perforated ends and a few spines along the sides. The dorsal surface is usually dark gray, brown, or black in adults and brownish yellow in young individuals. The ventral surface is usually reddish pink, yellowish orange, or white; often there is a bright pink or red pigment stripe running along the midline and bordered on either side by white stripes. The tube feet are brown with darker brown or black tips”.

**Distribution:** The Florida Keys, the Bahama Islands, Gulf of Mexico, Mexico, Cuba, Jamaica, Puerto Rico, St. Martin, Antigua, Barbados, Tobago, Curaçao, Aruba, Bonaire, Venezuela and islands off Colombia, Belize and the Yucatan (Hendler et al. 1995, Durán-González et al. 2005, Laguarda-Figueras et al. 2005b, Valle-García et al. 2005); the specimens from Puerto Rico examined by H. L. Clark (1933) showed the usual diversity color. They were collected at or near San Juan, Guanica, and Ballena Point; on the other hand, this author reported specimens from Culebra Island, Fajardo, Boqueron Bay, Puerto Real and Mayagüez. Additionally, there are specimens from La Parguera (Enrique) and other localities in the echinoderms collection at NMNH. In this study it has been observed and collected at La Parguera (Enrique and Caballo Blanco). Although this species has not been registered at other localities of the island, it's presence is common throughout the waters surrounding Puerto Rico.

**Depth Range:** 0,5-20 m, but usually between 2 and 10 m (Hendler et al. 1995).

**Remarks:** Specific localities within Puerto Rico are reported.

*Holothuria (Platyperona) parvula* (Selenka, 1867)

**References used for identification:** Deichmann 1930: 52-54, 70-72, Pl. 4, figs 14-22; Miller and Pawson 1984: 49-50, Hendler et al. 1995: 291-293, Figs. 163, 185A, B, C.

**Material Examined:** BIOL (3) (1: L: 25 mm, 2: L: 26 mm, L: 18 mm); BIOL (1) (L: 32 mm); BIOL (1) (L: 16 mm).

**Previous Puerto Rican records:** H. L. Clark 1933, Hendler et al. 1995.

**Diagnostic features:** Numerous tables with a variable number of marginal holes; disk squarish; numerous teeth on top of spire; numerous elliptic buttons, often obviously curved; small yellowish brown form; contains a green pigment, which is extracted in alcohol (Deichmann 1930). Flattened form; ossicles, tables, buttons with paired perforations (Miller and Pawson 1984).

**Description:** Deichmann 1930 (70-72). “The largest specimens of this small species are 7-10 cm long. The body is elongate and of uniform diameter throughout in length (Hendler et al. 1995), flattened, with cylindrical pedicels on the ventral side, forming a kind of sole; dorsally papillae or papilliform pedicels, situated on low warts. Mouth ventrally directed with 20 large yellow tentacles and a broad collar of papillae. Color yellowish brown, paler below, without any pattern. The ossicles are composed of tables and smooth buttons. Tables with 8 marginal holes, often many accessories holes, and a well-developed spire with 2 cross beams and numerous small teeth crowded on the top. In the pedicels the spire may be somewhat higher and more tapering. Button elliptical, smooth, often distinctly curved and with 6 or more holes, of variable size and never placed exactly in pairs but always alternating. In pedicels a large end plate and numerous bilateral perforated plates in company with very large buttons, with the number of holes greater than 6. In papillae, slightly curved rods with pointed or branched ends and spines on the outer side of the curvature”.

**Distribution:** From Florida to Brazil, including Gulf of Mexico, the Florida Keys, the Dry Tortugas, the Bahama Islands, Jamaica, Puerto Rico, the Virgin Islands, Anguilla, St. Martin, Antigua, Barbados, Tobago, Aruba, Curaçao, Venezuela, and Colombia (Hendler et al. 1995, Durán-González et al. 2005); at Puerto Rico specimens was taken at Hucares (H. L. Clark 1933); additionally, according to the echinoderms collection at NMNH, it was taken at La Parguera (Enrique). In this study, it was observed at La Parguera (San Cristobal and Enrique)

**Depth Range:** Low -tide mark to 4 m (Hendler et al. 1995).

**Remarks:** Specific localities within Puerto Rico are reported.

*Holothuria (Selenkothuria) glaberrima* Selenka, 1867

**References used for identification:** Deichmann 1930: 52-53, 69-70, Pl. 4, figs 10-13; Miller and Pawson 1984: 49; Hendler et al. 1995: 293-294, Figs. 165, 184I, J, K.

**Material Examined:** MSC (1).

**Previous Puerto Rican records:** H. L. Clark 1933.

**Diagnostic features:** No tables (except possibly in very young specimens); ossicles branched rods often with curved ends, few and scattered; dark brown with dendritic almost black tentacles; integument soft, smooth (Deichmann 1930).

**Description:** From Deichmann 1930 (69-70), Hendler et al. 1995 (293). “This is small *Holothuria*, reaching a maximum length of about 15 cm. The body is cylindrical and soft-skinned, and the ventral surface has a distinct sole covered with numerous cylindrical tube feet, dorsally only small conical papillae or papilliform pedicels, not so numerous as the

ventral appendages; with a crown of large dendritic, black tentacles, which usually are ventrally directed in preserved specimens. Color varying from almost black to faded brown; a single almost white specimen has been found among several typical ones; never any patches or patterns on the dorsal side. The ossicles are straight or curved rods with branched ends; the branches unite often and thus series of holes along the edge; a few very small knobs may be found on the surface of the spicules near the end, but they are visible only with very high magnification. In pedicels a well-developed end plate, large in the ventral and small in the dorsal appendages. No supporting rods except the rods of the body wall which are found also in the tentacles”.

**Distribution:** Gulf of Mexico, the Bahama Islands southward, throughout the West Indian islands, including Cuba, to Trinidad, and from Panama and Mexico (Hendler et al. 1995, Durán-González et al. 2005, Valle-García et al. 2005); In Puerto Rico, *glaberrima* seems to be common. It was taken near San Juan, Guanica, La Parguera and Hucares (H. L. Clark 1933).

**Depth Range:** Low-tide mark to 42 m (Hendler et al. 1995).

***Holothuria (Semperothuria) surinamensis* Ludwig, 1875**

**References used for identification:** Deichmann 1930: 52-53, 63-64, Pl. 3, figs 12-15, 19; Miller and Pawson 1984: 49-50, 57-60, Figs. 46, 47; Hendler et al. 1995: 294-296, Figs. 166, 185D, E, F.

**Material Examined:** BIOL (1) (L: 87 mm); BIOL (1) (L: 110 mm); BIOL (1) (L: 50 mm); BIOL (1) (L: 25 mm); BIOL (1) (L: 60 mm).

**Previous Puerto Rican records:** H. L. Clark 1933, Miller and Pawson 1984, Hendler et al. 1995.

**Diagnostic features:** Large, burrowing form, up to 200 mm. Body cylindrical. Podia few, scattered, papillate dorsally, cylindrical ventrally. Ossicles consisting of tables and rods, no buttons. Coloration in life light yellow to dark brown (Miller and Pawson 1984).

**Description:** From Deichmann 1930 (63-64), Hendler et al. 1995 (294). “This is a medium-sized species, reaching a length of approximately 20 cm. The body tapers gradually toward the anterior end but not toward the bluntly rounded posterior end. The body wall is thin and flexible, and it has a slightly roughened texture. Body cylindrical, with terminal mouth and anus; tentacles 20, medium sized; no pronounced difference between dorsal and ventral sides; appendages on ventral side, and as smaller, more conical appendages which form transitional stages to papillae; the dorsal appendages are often on low warts. Color, all shades from faded brown to dark purplish, with darker patches on the dorsal side and with tip of appendages paler; the ventral side is often paler. Skin thin, flexible, often rough to touch. There are tables and large flat rods with dentate edge. Except very young specimens, where the disk is large and the spire high with several cross beams, the typical form of the tables is absolutely devoid of disk; the inner end of the table is almost conical; the outer end provided with 4 vertical teeth and 8 horizontal double teeth. The outer end of the tables is larger than the inner, and sometimes the top has been mistaken for the disk. Long flattened rods, with dentate margin are found in variable number; they are most numerous in the appendages where they are more or less curved and obviously function as supporting rods. End plate developed in accordance with the form of the appendage; in tentacles larger and smaller curved rods, usually with some spines”.

**Distribution:** Mexico, Bermuda, Jamaica, Cuba, Puerto Rico, some of the Lesser Antilles, the eastern and western Gulf of Mexico, Colombia, Venezuela, Surinam and southward to Brazil (Hendler et al. 1995, Durán-González et al. 2005, Laguarda-Figueras et al. 2005b, Valle-García et al. 2005); in Puerto Rico, it has been collected at Mangrove Island (La Parguera), near San Juan, Ponce, Boqueron Bay, Puerto Real and Guanica (H. L. Clark 1933).

Additionally, there are specimens from Puerto Real and La Parguera in echinoderms collection at NMNH. In this study it was collected and observed at La Parguera (Caballo Blanco and San Cristobal).

**Depth Range:** Low -tide mark to 42 m (Hendler et al. 1995).

**Remarks:** Specific localities within Puerto Rico are reported.

***Holothuria (Theelothuria) princeps* Selenka, 1867**

**References used for identification:** Deichmann 1930: 52-53, 58-60, Pl. 2, figs 1-8; Miller and Pawson 1984: 49-51, 60-63, Figs. 49, 50; Hendler et al. 1995: 296-297, Figs. 167, 185G, H, I, J.

**Material Examined:** MSC (1).

**Previous Puerto Rican records:** Hendler et al. 1995.

**Diagnostic features:** Large, cylindrical form, up to 300 mm. Body wall thick, strongly contracted in preserved specimens. Podia numerous, scattered over entire body, dorsally as papillae, ventrally as cylindrical tube feet. Ossicles abundant, consisting of tables and knobbed buttons. Coloration in life brown and white, with light ring around base of most dorsal papillae (Miller and Pawson 1984).

**Description:** From Deichmann 1930 (58-59). "Adults of this species are medium-sized, reaching a length of 30 cm. The body is subcylindrical, arched above, flattened below, and distinctly tapered, more so at the posterior end than toward the mouth. The body wall is relatively thin, yet rigid because of the quantity of embedded skeletal ossicles (Hendler et al. 1995). Mouth subterminal with very small tentacles, 20 in number; anus terminal. The body

is covered with conical appendages, which in some cases end in a distinctly cylindrical pedicel with a large end plate; in others they are distinctly conical to their end with only a small vestige of an end plate. The integument is thin, flexible in spite of the numerous ossicles, except when contracted. Color yellow with darker patches dorsally; often the pigment is rubbed off. The appendages are usually somewhat paler in color; their bases are, however, often provided with a darker ring. The ossicles are tables and buttons. The tables are of two types: in the body wall small ones with irregular disk, large central hole and variable number of marginal holes which may be entirely wanting, and dentate to undulated margin; spire low and on its way to becoming reduced; often one of the four rods is lacking; the top ends in few blunt teeth or none. In the terminal part of the appendages very large tables are present; they may be observed even with the unaided eye and the spire is simply gigantic, solid and ends in a smooth cone. The buttons are irregular, incomplete, of the six-holed type, variable in size and with low knobs on the middle bar and sometimes also in the margin. In the appendages numerous supporting rods short, with large holes near the expanded middle and at the ends, sometimes curved. In the pedicels a large end plate, in the papillae a mere vestige”.

**Distribution:** Gulf of Mexico, Florida, the Florida Keys, the Bahama Islands, the Dominican Republic, Puerto Rico, Mexico, Colombia and Venezuela (Hendler et al. 1995, Durán-González et al. 2005, Laguarda-Figueras et al. 2005b)

**Depth Range:** Low-tide mark to 229 m (Hendler et al. 1995).

**Remarks:** Although this species is mentioned by Hendler et al. 1995 to inhabit the waters surrounding Puerto Rico, I couldn't find specimens for this study and there are none present in the echinoderms collection at NMNH.



*Holothuria (Thymiosycia) arenicola* Semper, 1868

**References used for identification:** Deichmann 1930: 52-53, 66-68, Pl. 4, figs 1-9; Miller and Pawson 1984: 49-50; Hendler et al. 1995: 297-299, Figs. 168, 186A, B, C, D, E.

**Material Examined:** BIOL (2); BIOL (1) (L: 46 mm); BIOL (1) (L: 14 mm); BIOL (1) (L: 45 mm); BIOL (1) (L: 165 mm); BIOL (1) (L: 46 mm); BIOL (1) (L: 55 mm).

**Previous Puerto Rican records:** H. L. Clark 1933.

**Diagnostic features:** Tables small with from 4 to a complete ring of small holes around the large central hole; delicate in structure; buttons with small to almost obliterated holes; normally 3 pairs; appendages cylindrical, scattered and not on distinct warts; very few seem to be developed as papillae; color grayish, generally more or less rust color, at least anteriorly, and either small stains of black irregularly spread or two rows of large dark patches along the dorsal side (Deichmann 1930).

**Description:** From Deichmann 1930 (67-68), Hendler et al. 1995 (297-298). "This is a medium-sized species that reaches a maximum length of 25 cm. Cylindrical, slender form, tapering, with almost terminal mouth and 20 very small tentacles; anus terminal. Appendages, exclusively pedicels, cylindrical and of almost the same size both dorsally and ventrally; arranged in five broad bands, with narrow naked stripes between, corresponding to the radii; they are not crowded and often strongly contracted. Color very variable, and some time depend on the locality in which the animal lives; it varies from gray, sand colored, with large dark patches in two series along the dorsal side, to gray with numerous small stains irregularly scattered over the entire surface. The ossicles are composed of tables and buttons. The tables with relatively small delicately disk, with large central holes and, generally, 4 marginal holes, or a complete series of about 8. Spire low, tapering, with one or two cross beams, and ending in a variable number small teeth. In young specimens the disk is complete

and the spire is higher with more cross beams; in old specimens some of these tables are retained in the terminal portion of the oral and anal appendages, but the holes on the disk are reduced and the spire is shorter. The buttons, which are missing in the smallest specimens, are regular, smooth, with 6 holes of variable size. In the pedicels are large end plate, composed of several small pieces, and also numerous straight supporting rods, with a few holes near the ends and along the middle; some of them developed as buttons with a regular row of holes on each side”.

**Distribution:** Reportedly circumtropical. In the western Atlantic, known from Bermuda to Brazil, including Gulf of Mexico (Hendler et al. 1995, Durán-González et al. 2005, Laguarda-Figueras et al. 2005b, Valle-García et al. 2005). In the West Indian region this tropicopolitan holothurian is found from Bermuda, and the Tortugas, to Brazil. It is common in Jamaica and at Tobago. In Puerto Rico waters it has been found at Culebra (H. L. Clark 1933). Additionally, there are specimens from La Parguera (Pelotas) in echinoderms collection at NMNH; in this study, it was observed and collected at La Parguera (San Cristobal, Caballo Blanco, Laurel and Media Luna).

**Depth Range:** In the Florida-Caribbean region, the shoreline to at least 13 m (Hendler et al. 1995).

**Remarks:** Specific localities within Puerto Rico are reported.

***Holothuria (Thymiosycia) impatiens* (Forskål, 1775)**

**References used for identification:** Deichmann 1930: 52-53, 64-66, Pl. 3, figs 17-18; Hendler et al. 1995: 299-300, Figs. 169, 186F, G, H, I, J, K.

**Material Examined:** BIOL (2) (1: L:110 mm, 2: L: 125 mm).

**Previous Puerto Rican records:** H. L. Clark 1933.

**Diagnostic features:** Tables large with 8 marginal holes, almost as large as the central hole; disk large, squarish; spire with many spine on top; buttons with large holes; tentacles small; no difference between dorsal and ventral sides; appendages usually on warts; cylindrical on ventral side, more papilliform on dorsal; skin very rough to touch; color variable, mottled brown and gray (Deichmann 1933).

**Description:** From Deichmann 1930 (65), Hendler et al. 1995 (299). “This medium-sized species grows as large as 15-20 cm in length. Form cylindrical with the anterior end sometimes extended as a long slender “neck”; mouth almost terminal with 20 medium-sized tentacles; anus terminal. Appendages few, uniformly scattered and, placed on distinct warts, except in abnormally expanded specimens; ventrally they are developed as cylindrical pedicels; Skin thin, flexible, very rough to the touch. Color variable, different shades of gray mottled with larger and smaller patches of brown; sometimes small white spots are visible due the ossicles which may be collected in heaps The ossicles are composed by tables and smooth regular, six-holed buttons. Tables with 8 marginal holes and one central about equal in size; accessory small outer holes may be found. Strong, robust spire ending in numerous small teeth, usually two cross beams, excepting in very young specimens, where the spire is higher and more tapering, and in the appendages where the tables may show some irregularity. They have an inner layer of numerous, large, regular, very smooth buttons, provided with 6 large holes. Additionally, there are well-developed end plates in the pedicels, small in the papilliform appendages. Supporting rods, straight in the former and curved in the latter, with few holes in the ends, and strongly widened at the middle with some large perforations”.

**Distribution:** Reported from most tropical regions of the world; in the western Atlantic, throughout the Greater and Lesser Antilles, and from Florida, the Florida Keys, the Dry Tortugas, the Bahama Islands, Cuba, Mexico, Belize, Panama, Colombia and Venezuela

(Hendler et al. 1995, Laguarda-Figueras et al. 2005b, Valle-García et al. 2005). In Puerto Rico waters it has been found at Mangrove Island (La Parguera), Culebra and Ponce (H. L. Clark 1933); in this study it was collected at La Parguera (San Cristobal).

**Depth Range:** 0.5-27 m (Hendler et al. 1995).

***Holothuria (Thymiosycia) thomasi* Pawson and Caycedo, 1980**

**References used for identification:** Miller and Pawson 1984: 49-50, 63-65; Hendler et al. 1995: 300-301, Figs. 170, 187A, B, C.

**Material Examined:** MSC (1).

**Previous Puerto Rican records:** Miller and Pawson 1984, Hendler et al. 1995.

**Diagnostic features:** Large, reef-dwelling form, up to 2 m. Body cylindrical, elongate. Dorsal surface with scattered papillate podia; more numerous podia of cylindrical form ventrally. Tentacles surrounded by conspicuous collar of papillae. Ossicles consisting of tables and smooth buttons. Coloration in life yellowish-brown to maroon with mottling (Miller and Pawson 1984).

**Description:** From Hendler et al. 1995 (300-301). “This is by far the largest sea cucumber species in the western Atlantic, with adults reaching a length of 2 m. However, entire animals are rarely seen because the individuals, anchored in coral reef crevices, usually extend only the anterior portion of the body to feed. The body is cylindrical, elongate, and expanded at the oral end when the animal is feeding. The skin is soft. The upper surface carries distinct rows of conical papillae, placed on warts that are most prominent along the lateral margins and around the mouth. On the lower surface, cylindrical tube feet are scattered and not particularly abundant. Twenty conspicuous, shield-shaped tentacles extend from the ventrally

positioned mouth. The body wall ossicles are tables and buttons. The table margins are irregular to square in outline and generally perforated by a ring of 12 marginal holes and four central holes. The spires are short, composed of four pillars, and terminate in 18-20 short spines surrounding a large perforation. The buttons are usually swollen in the middle and perforated by two longitudinal rows of elongate holes, three holes per row. The color is generally a mottled yellowish to golden brown; the dorsal papillae have white and golden brown. Tentacles are light pink to yellow or chocolate brown”.

**Distribution:** The Bahama Islands, the Florida Keys, Cuba, Puerto Rico, St. Croix, St. Vincent, Mexico, Isla Cozumel, Panama, Colombia and Carrie Bow Cay, Belize (Hendler et al. 1995, Laguarda-Figueras et al. 2005b, Valle-García et al. 2005).

**Depth Range:** 3-30 m (Hendler et al. 1995).

**Order APODIDA Brandt, 1835**

**Family SINAPTIDAE Östergren, 1898**

***Euapta lappa* (Müller, 1850)**

**References used for identification:** Deichmann 1930: 204-205; H. L. Clark 1933: 96-99, 118-119; Miller and Pawson 1984: 69; Hendler et al. 1995: 304-306, Figs. 173, 188K, L, M, N.

**Material Examined:** MSC (1).

**Previous Puerto Rican records:** H. L. Clark 1933.

**Diagnostic features:** Large form, up to 100 cm; stock of anchors unbranched (Miller and Pawson 1984) or deeply cleft (H. L. Clark 1933).

**Description:** From Hendler et al. 1995 (pp. 304-305). “This species is unique in appearance among sea cucumbers of the Florida Keys and the Bahama Islands. It is a moderately large, skinny animal, reaching a maximum length if 1 m or more. The body wall is extremely thin and flexible, and active individuals can rapidly alter their length. The general shape is cylindrical and vermiform, and a segmented appearance is produced by alternate widened (pouchlike) and constricted rings at regular intervals along the body. The mouth is surrounded by 15 large, pinnate tentacles, each with 20-35 pairs of lateral digits. The tentacles of living animals are usually extended and very active; preserved specimens become contracted and flaccid”.

**Distribution:** Widespread throughout the Caribbean region, including the southwestern Gulf of Mexico (Henkel 1982 *In*: Hendler et al. 1995). Off Florida, it occurs in the Keys and the Dry Tortugas (Hendler et al. 1995, Durán-González et al. 2005, Laguarda-Figueras et al. 2005b, Valle-García et al. 2005); in Puerto Rico waters it has been taken on the reef outside Cayo Maria Langa, entrance of Guayanilla Harbor, Guanica Harbor (H. L. Clark 1933). Additionally there is a specimen that was collected at La Parguera. In the echinoderms collection at NMNH.

**Depth Range:** Low -tide mark to 24 m (Hendler et al. 1995).

**Remarks:** In this study, no specimens were observed. Specific localities within Puerto Rico are reported.

*Protankyra ramiurna* Heding 1928

**References used for identification:** Hendler et al. 1995: 310, Figs. 175, 190A, B, C, D, E.

**Material Examined:** MSC (1).

**Previous Puerto Rican records:** Hendler et al. 1995.

**Diagnostic features:** Anchors, anchors plates, and miliary granules (Hendler et al. 1995).

**Description:** From Hendler et al. 1995 (310). “This medium-sized species can reach a length of 15 cm. The body is worm-shaped and circular in cross section. Five distinctly wide bands of muscle run the length of the body. The body wall, between the longitudinal muscles, is so thin and transparent that the internal organs are visible within the body cavity. The mouth is surrounded by 12 equal, stout, digitate tentacles, each of which carries two pairs of pointed, elongate projections and a much smaller, rounded digit near the tip. The body wall ossicles are anchors, anchors plates and miliary granules. The anterior anchors and plates are significantly smaller than those at the posterior end of the body. The anchor arms have four to seven prominent teeth, and the anchor bases are covered with minute spines. The anchor plates have more numerous large holes than those of other synaptids from the Florida Keys, and they have a distinct bridge to which the anchor articulates. The miliary granules are small, plump rods, slightly constricted at the middle. The body wall is light pink, but so thin and transparent that the ossicles are visible to the naked eye as small white spots; the longitudinal muscle bands show through as white bands. In some individuals, minuscule flecks of brown pigment are scattered over the body and on the stalks of the otherwise transparent tentacles”.

**Distribution:** Known only from the southwestern coast of Puerto Rico near La Parguera and from the mouth of Biscayne Bay, off Miami, Florida (Hendler et al. 1995).

**Depth Range:** Less than 1 m (Hendler et al. 1995).

**Remarks:** In this study, no specimens were observed.

*Synaptula hydriformis* (Lesueur, 1824)

**References used for identification:** H. L. Clark 1933: 96-99; Miller and Pawson 1974: 69; Hendler et al. 1995: 311-313, Figs. 176, 190F, G, H, I.

**Material Examined:** MSC (1).

**Previous Puerto Rican records:** None.

**Diagnostic features:** Small form, less than 10 cm; stock of anchors unbranched (Miller and Pawson 1974); the large holes in anchor plates dentate and regularly arranged (Deichmann 1930).

**Description:** From Hendler et al. 1995 (311). “The vermiform body of this holothuroid is reported to reach a maximum length of 10 cm. Most specimens are less than half that size, and juveniles less than 1 cm are not common. The body wall is thin, semitransparent and very elastic. Around the mouth, full-grown specimens have 12 pinnate tentacles with a webbed base. Each tentacle stalk carries up to 20 pairs of lateral digits; each has a pair of dark pigment spots on the inner surface, near the mouth. The body wall ossicles are anchors, anchors plates, and miliary granules. The anchors flukes are smooth, with a series of prominent knobs at their apex. Near the base of the anchor plates there is a distinct bridge, the point of articulation for the anchor. The minuscule miliary granules look like flower-shaped rosettes. The color of living *S. hydriformis* is useful for identification. It varies from grayish green to reddish brown, with contrasting white patches of miliary granules clumped just beneath the epidermis. Young individuals are usually more pale transparent than adults”.



**Distribution:** Bermuda, Mexico, Florida, the Florida Keys, the Dry Tortugas, many islands of the Greater and Lesser Antilles including Cuba, Belize and Brazil; Bahama Islands, Texas and Panama (Hendler et al. 1995, Durán-González et al. 2005, Laguarda-Figueras et al. 2005b, Valle-García et al. 2005)

**Depth Range:** Less than 1-7 m (Hendler et al. 1995).

**Remarks:** In this study, no specimens were observed. Specific localities within Puerto Rico are reported.

**Family CHIRIDOTIDAE Östergren, 1898**

***Chiridota rotifera* (Pourtalès, 1851)**

**References used for identification:** Deichmann 1930: 210-211; H. L. Clark 1933: 96-100, 122-123; Miller and Pawson 1984: 69; Hendler et al. 1995: 311-313, Figs. 176, 190F, G, H, I.

**Material Examined:** MSC (1).

**Previous Puerto Rican records:** H. L. Clark 1933, Hendler et al. 1995.

**Diagnostic features:** A thin, scattered layer of curved rods; wheel-papillae abundant; wheels of very variable size, up to 0.2 mm. wide (Deichmann 1930). Ossicles wheels with six spokes (Miller and Pawson 1984)

**Description:** From Hendler et al. 1995 (pp. 313). “This small to moderate-sized holothurian is reported to reach a length of 10 cm. Most individuals are less than 5 cm long, with a diameter of approximately 5 mm. The body wall is quite smooth and slimy. However, it appears rough and bumpy because of numerous hemispherical, wartlike protuberances that

contain aggregations of wheel ossicles. The skin between the warts is semitransparent, and the longitudinal muscle bands and other internal structures are visible in living individuals. Twelve digitate tentacles surround the mouth; each has five pairs of digits, four lateral pairs and one terminal pair. The body wall ossicles are wheels and tiny, irregular C-shapes. The wheels have a serrate inner margin and six spokes that converge around a small hole in the central hub. Aggregations of these wheels form warts or “wheel papillae”. The wheels of young individuals have more spokes than those found in adults. Though this species is small, individuals are easily recognized in the field by their striking coloration. The pink or red ground color of the body wall contrasts sharply with the conspicuous, white wheel warts”.

**Distribution:** Bermuda, Florida, the Dry Tortugas, the Berry Islands of the Bahamas, Mexico, Gulf of Mexico, Belize, Jamaica, Puerto Rico, Cuba, the Virgin Islands, Antigua, Barbados, Tobago, Trinidad, Aruba, Bonaire, Panama, Venezuela and Brazil (H. L. Clark 1933, Hendler et al. 1995, Durán-González et al. 2005, Laguarda-Figueras et al. 2005b, Valle-García et al. 2005); in Puerto Rico waters it has been taken at Mangrove Island (La Parguera) and Turrumote, in La Parguera.

**Depth Range:** Low-tide mark to 10 m, though most individuals are found at depths less than 1 m (Hendler et al. 1995).

**Remarks:** In this study, no specimens were collected.

### 3.2. NEW FINDINGS

Nine new records of echinoderm species were added to the collections. These were found for the first time for the insular shelf in Puerto Rico.

For the Class Crinoidea, the new record is the species *Davidaster discoidea*, found at the Buoy reef and specimens were also found at Salinas Point and Puerto Nuevo (MSC and NMNH).

For the Class Asteroidea, the new record is *Poraniella echinulata*. This species was found at both collections (NMNH and MSC).

Three new records for the Class Ophiuroidea were found at the MSC: *Ophioderma squamosissimum*, collected near Desecheo Island and identified by Charles Cutress and Gordon Hendler in 1984; *Ophioderma phoenium*, collected at Mario Reef, Parguera in 1984 and identified by Charles Cutress was found at the MSC and *Ophionephthys limicola*, found at the MSC, collected at Tres Hermanos beach (Añasco) as part of the Medusa Exploration (R/V).

Two new records represented the Class Echinoidea: *Pagliobrisus grandis* and *Meoma ventricosa*, which were found at the MSC.

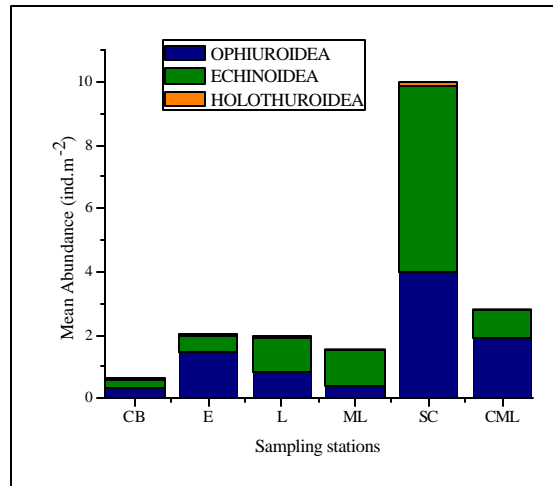
*Actinopyga agassizi* and *Synaptula hydriformis* represented the new records for the Class Holothuroidea. The first species is part of the reference material found at the NMNH and MSC. It was collected at La Parguera, according with the two collections. *Synaptula hydriformis* was part of the reference material of the MSC, but no site of collection was stated.

The specific location of collection for fifty-nine (59) species previously reported to be found in the insular shelf of Puerto Rico are registered in this work, from these, 32 species are recorded for the first time from La Parguera. The exact locations of these species appear in each of the taxonomic card distribution and in the annex 2.

### **3.3. TAXONOMIC COMPOSITION IN SEA GRASS BEDS**

A total of thirty-one echinoderm species were identified at sampling stations from the sea grass beds in La Parguera. The echinoderm species distribution in classes was: Asteroidea (3), Ophiuroidea (16), Echinoidea (3) and Holothuroidea (9).

The Class Asteroidea was represented by a low density ( $0.01$  to  $0.02 \text{ ind.m}^{-2}$ ) and organisms of this class were only found at Media Luna and Caballo Blanco (Table 3). Class Ophiuroidea was found at all stations. Ophiuroids mean abundance varied from  $0.31 \text{ ind.m}^{-2}$  at Caballo Blanco to  $3.99 \text{ ind.m}^{-2}$  at San Cristobal (Figure 34). Echinoid mean abundance varied from  $0.22 \text{ ind.m}^{-2}$  at Caballo Blanco to  $5.89 \text{ ind.m}^{-2}$  at San Cristobal, and, as well as ophiuroids, they were found at all stations. Holothuroids were found at all stations but with relatively low numbers (Figure 34). Class Echinoidea was the numerically dominant assemblage of the total echinoderms, with a relative abundance of 51.3%, followed by Class Ophiuroidea with 46.8%, asteroids and holothuroids represented less than 2%.



**Figure 34.** Mean abundance (ind.m<sup>-2</sup>) of classes of echinoderms distributed at the sampling stations in sea grass beds communities: Caballo Blanco (CB), Enrique (E), Laurel (L), Media Luna (ML), San Cristobal (SC) and La Corona del Medio de Laurel (CML).

### 3.3.1. Spatial variations of abundance at sampling stations

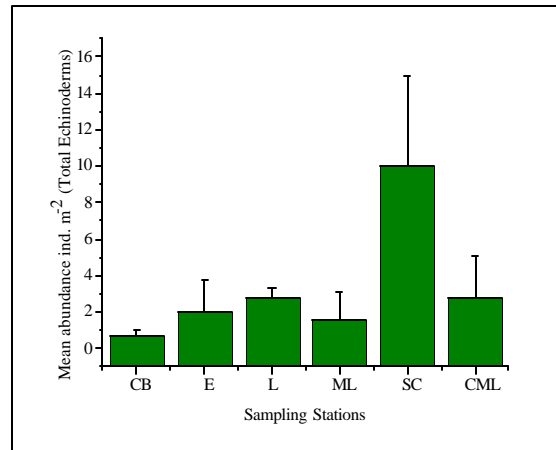
The spatial patterns of total echinoderms abundance were characterized by significant differences between sampling stations ( $p < 0.0090$ ) (Table 4). Significant differences were found between San Cristobal with the other stations ( $p < 0.0057$ ), as well as between Caballo Blanco compared with the rest of the stations ( $p < 0.0029$ ), as indicated by contrast analysis. San Cristobal station was characterized by having the highest abundance of total echinoderms (10 ind.m<sup>-2</sup>) (Figure 35) and also the highest species number (19). This pattern was repeated in the analysis of class echinoidea. Significant differences were found between Caballo Blanco and San Cristobal stations compared with the rest of the stations ( $p < 0.0051$  and  $p < 0.0068$ , respectively) (Figure 36). Class Holothuroidea showed a different pattern, significant differences were only found for San Cristóbal with the rest of the stations ( $p < 0.0107$ ) (Figure 37). Total abundance of individuals representing the Asteroidea and Ophiuroidea classes didn't show significant differences between stations (Table 4).

**Table 3.** Relative abundance and mean densities of species of the phylum Echinodermata for each sampling stations in sea grass beds communities at La Parguera, Puerto Rico. CB: Caballo Blanco, E: Enrique, SC: San Cristobal, CML: La Corona del Medio de Laurel. M: Mean for ind.m<sup>-2</sup>, R. A: Relative abundance for ind.m<sup>-2</sup>.

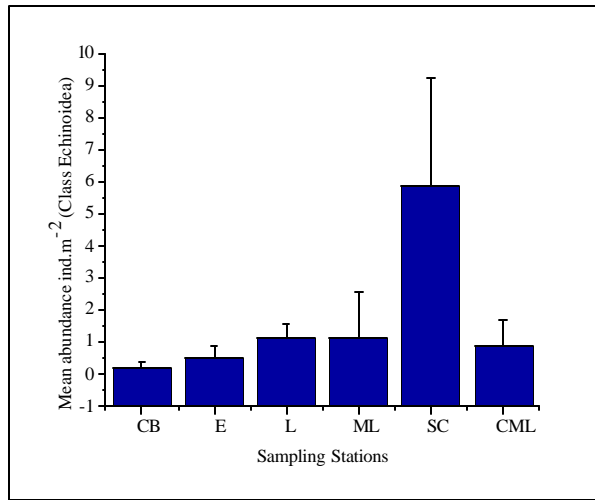
CLASS	SPECIES	CB		E		SC		CML		L		ML	
		M	R. A.	M	R. A.	M	R. A.	M	R. A.	M	R.A.	M	R.A.
ASTEROIDEA	<i>Linckia guildingii</i>	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,01	0,01
ASTEROIDEA	<i>Oreaster reticulatus</i>	0,02	0,03	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
ASTEROIDEA	<i>Echinaster (Otilia) echinoporus</i>	0,01	0,01	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
OPHIUROIDEA	<i>Ophiolepis elegans</i>	0,00	0,00	0,00	0,00	0,14	0,01	0,00	0,00	0,00	0,00	0,00	0,00
OPHIUROIDEA	<i>Ophiolepis impressa</i>	0,00	0,01	0,01	0,01	0,23	0,02	0,03	0,01	0,00	0,00	0,01	0,01
OPHIUROIDEA	<i>Ophiolepis paucispina</i>	0,00	0,00	0,01	0,01	0,00	0,00	0,00	0,00	0,03	0,01	0,00	0,00
OPHIUROIDEA	<i>Ophiocoma echinata</i>	0,05	0,09	0,14	0,07	1,44	0,14	0,96	0,34	0,35	0,18	0,26	0,25
OPHIUROIDEA	<i>Ophiocoma wendtii</i>	0,00	0,00	0,00	0,00	0,01	0,00	0,00	0,00	0,00	0,00	0,00	0,00
OPHIUROIDEA	<i>Ophiocomella ophiactoides</i>	0,00	0,00	0,00	0,00	0,00	0,00	0,01	0,00	0,00	0,00	0,00	0,00
OPHIUROIDEA	<i>Ophionereis reticulata</i>	0,00	0,01	0,01	0,01	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
OPHIUROIDEA	<i>Ophioderma appressum</i>	0,00	0,00	0,30	0,15	0,35	0,04	0,10	0,04	0,04	0,02	0,01	0,01
OPHIUROIDEA	<i>Ophioderma brevicaudum</i>	0,00	0,00	0,00	0,00	0,44	0,04	0,09	0,03	0,00	0,00	0,03	0,02
OPHIUROIDEA	<i>Ophioderma brevispinum</i>	0,04	0,05	0,26	0,13	0,14	0,01	0,03	0,01	0,15	0,08	0,00	0,00
OPHIUROIDEA	<i>Ophioderma cinereum</i>	0,00	0,00	0,24	0,12	0,01	0,00	0,00	0,00	0,00	0,00	0,00	0,00
OPHIUROIDEA	<i>Ophioderma rubicundum</i>	0,00	0,00	0,00	0,00	0,19	0,02	0,01	0,00	0,00	0,00	0,00	0,00
OPHIUROIDEA	<i>Ophiactis savignyi</i>	0,00	0,00	0,00	0,00	0,40	0,04	0,41	0,15	0,01	0,01	0,03	0,03
OPHIUROIDEA	<i>Amphipholis januari</i>	0,00	0,01	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
OPHIUROIDEA	<i>Ophiothrix angulata</i>	0,20	0,27	0,49	0,24	0,39	0,04	0,11	0,04	0,11	0,06	0,04	0,04
OPHIUROIDEA	<i>Ophiothrix orstedii</i>	0,02	0,04	0,04	0,02	0,26	0,03	0,14	0,05	0,13	0,06	0,02	0,02
ECHINOIDEA	<i>Lytechinus variegatus</i>	0,20	0,35	0,05	0,02	0,09	0,01	0,00	0,00	0,03	0,01	0,27	0,00
ECHINOIDEA	<i>Echinometra lucunter lucunter</i>	0,02	0,03	0,38	0,18	5,80	0,58	0,89	0,32	1,10	0,56	0,59	0,58
ECHINOIDEA	<i>Echinometra viridis</i>	0,00	0,00	0,08	0,04	0,00	0,00	0,00	0,00	0,00	0,00	0,27	0,00
HOLOTHUROIDEA	<i>Ocnus surinamensis</i>	0,00	0,00	0,00	0,00	0,01	0,00	0,00	0,00	0,00	0,00	0,00	0,00
HOLOTHUROIDEA	<i>Isostichopus badiionotus</i>	0,01	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
HOLOTHUROIDEA	<i>Holothuria (Cystipus) cubana</i>	0,00	0,01	0,00	0,00	0,00	0,00	0,01	0,00	0,00	0,00	0,01	0,01
HOLOTHUROIDEA	<i>Holothuria (Halodeima) grisea</i>	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,01	0,01	0,00	0,00
HOLOTHUROIDEA	<i>Holothuria (Halodeima) mexicana</i>	0,06	0,09	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
HOLOTHUROIDEA	<i>Holothuria (Platyperona) parvula</i>	0,00	0,00	0,04	0,02	0,04	0,00	0,00	0,00	0,00	0,00	0,00	0,00
HOLOTHUROIDEA	<i>Holothuria (Semperothuria) surinamensis</i>	0,00	0,00	0,00	0,00	0,01	0,00	0,00	0,00	0,00	0,00	0,00	0,00
HOLOTHUROIDEA	<i>Holothuria (Thymiosycia) arenicola</i>	0,00	0,01	0,00	0,00	0,04	0,00	0,03	0,01	0,00	0,00	0,02	0,02
HOLOTHUROIDEA	<i>Holothuria (Thymiosycia) impatiens</i>	0,00	0,00	0,00	0,00	0,03	0,00	0,00	0,00	0,00	0,00	0,00	0,00

**Table 4.** Results of Kruskal Wallis test ( $p < 0.05$ ) for differences in abundance of total echinoderms, classes and more abundant species across sampling stations in sea grass beds communities .

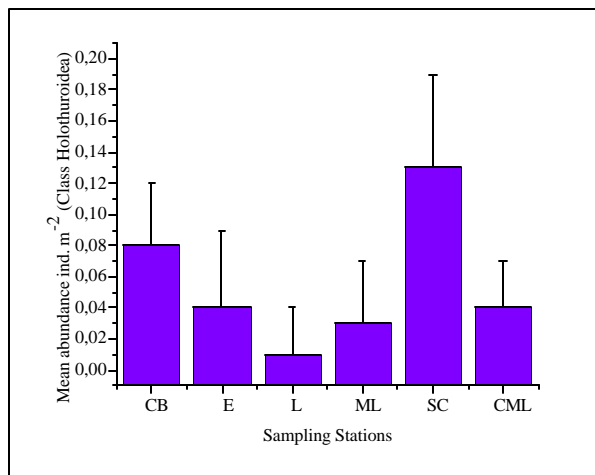
	p-value	Analysis-type
<b>Total Echinoderms</b>	0.0090	Kruskal Wallis
<b>ASTEROIDEA</b>	0.1014 (ns)	Kruskal Wallis
<b>OPHIUROIDEA</b>	0.0065 (ns)	Kruskal Wallis
<b>ECHINOIDEA</b>	0.0115	Kruskal Wallis
<b>HOLOTHUROIDEA</b>	0.0290	Kruskal Wallis
<i>Ophiocoma echinata</i>	0.0021	Kruskal Wallis
<i>Ophiothrix angulata</i>	0.3406 (ns)	Kruskal Wallis
<i>Ophiactis savignyi</i>	0.0568 (ns)	Kruskal Wallis
<i>Echinometra lucunter</i>	0.0010	Kruskal Wallis



**Figure 35.** Mean abundance (ind.m<sup>-2</sup>) of echinoderms distributed at the sampling stations in sea grass beds communities: Caballo Blanco (CB), Enrique (E), Laurel (L), Media Luna (ML), San Cristobal (SC) and La Corona del Medio de Laurel (CML).



**Figure 36.** Mean abundance (ind.m<sup>-2</sup>) of organisms of Class Echinoidea distributed at the sampling stations in sea grass beds communities: Caballo Blanco (CB), Enrique (E), Laurel (L), Media Luna (ML), San Cristobal (SC) and La Corona del Medio de Laurel (CML).



**Figure 37.** Mean abundance (ind.m<sup>-2</sup>) of organisms of Class Holothuroidea distributed at the sampling stations in sea grass beds communities: Caballo Blanco (CB), Enrique (E), Laurel (L), Media Luna (ML), San Cristobal (SC) and La Corona del Medio de Laurel (CML).



### 3.3.2. Spatial patterns of echinoderms species abundance at sampling stations

A total of 19 echinoderms species were identified in San Cristobal, followed by Enrique (13) and La Corona del Medio de Laurel (13). Media Luna had 11 species and Laurel and Caballo Blanco had 10 species each. Means and relative abundance of the echinoderms species found at each station are listed in Table 3.

Echinoids numerically dominated at San Cristobal. Significant differences among stations were found for the most abundant sea urchin *Echinometra lucunter lucunter* ( $p < 0.0010$ ) (Table 4), which differed significantly among Caballo Blanco with Corona del Medio de Laurel ( $p < 0.01246$ ), Caballo Blanco with Laurel ( $p < 0.0021$ ), Caballo Blanco with Media Luna ( $p < 0.00379$ ), Caballo Blanco with San Cristobal ( $p < 0.0001$ ), Enrique with Media Luna ( $p < 0.0040$ ) and Enrique with San Cristobal ( $p < 0.0193$ ) (Table 6). On the other hand, ophiuroidea, the most diverse class, showed to have significant differences between stations. The main species responsible for this distribution was *Ophiocoma echinata*, which differed significantly between stations ( $p < 0.0021$ ) (Table 4). The main differences were found between Caballo Blanco and Corona del Medio de Laurel ( $p < 0.011$ ), Caballo Blanco and San Cristobal ( $p < 0.0013$ ), Enrique and Corona del Medio de Laurel ( $p < 0.0075$ ) and Enrique and San Cristobal ( $p < 0.0085$ ) (Table 5).

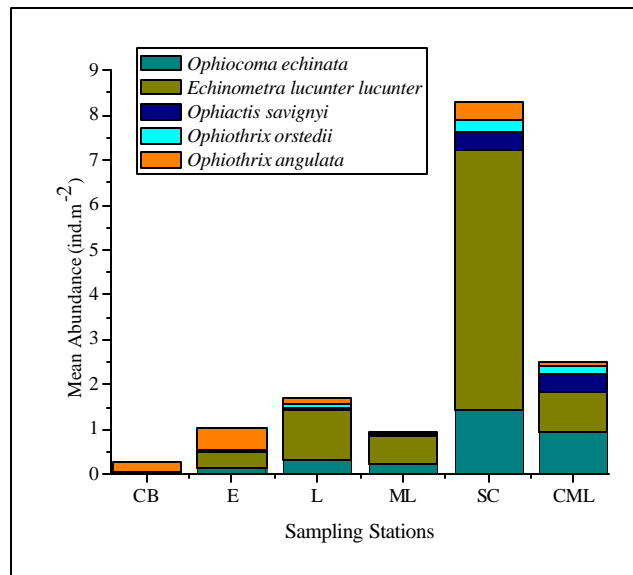
**Table 5.** Contrast analysis of *Ophiocoma echinata* between Caballo Blanco (CB), La Corona del Medio de Laurel (CML), San Cristobal (SC) and Enrique (E) in sampling stations in sea grass beds communities.

Contrasts	Sampling Stations	p-value
1	CB-CML	0.0011
2	CB-SC	0.0013
3	E-CML	0.0075
4	E-SC	0.0085

**Table 6.** Contrast analysis of *Echinometra lucunter lucunter* between Caballo Blanco (CB), Enrique (E), La Corona del Medio de Laurel (CML), Laurel (L), Media Luna (ML) and San Cristobal (SC) in sampling stations in sea grass beds communities.

Contrast	Sampling Stations	p-value
1	CB-CML	0.01246
2	CB-L	0.0021
3	CB-ML	0.0379
4	CB-SC	0.0001
5	E-ML	0.0040
6	E-SC	0.0193

The presence of other species were basically restricted to one or two samples stations, and were characterized by very low abundances (Figure 38).

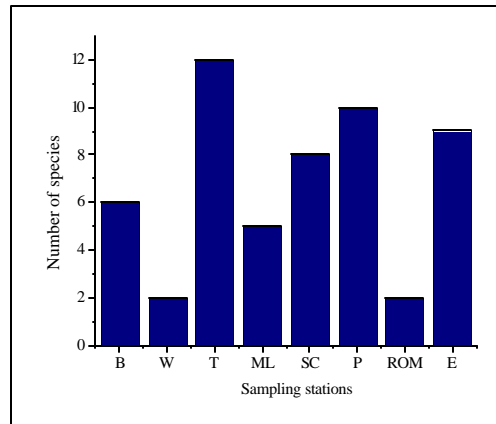


**Figure 38.** Mean abundance (ind.m<sup>-2</sup>) distribution of the most abundant echinoderms species at sampling stations in sea grass beds communities: Media Luna (ML), San Cristobal (SC), Laurel (L), Caballo Blanco (CB), Enrique (E) and La Corona del Medio de Laurel (CML).

### 3.4. ECHINODERMS COMPOSITION IN THE CORAL REEFS

A total of 24 species of echinoderms were identified from the Coral reef stations in La Parguera: Crinoidea (2), Asteroidea (1), Ophiuroidea (14), Echinoidea (5) and Holothuroidea (2).

The highest species number was found at Turrumote (12) followed by Pelotas (10), Enrique (9) and San Cristobal (8). Medium values of species number were found at Buoy (6) and Media Luna (5), and Weimberg and Romero were characterized for having only 2 species each one (Figure 39). The species found at all stations are shown in Table 7 and Table 8.



**Figure 39.** Number of species of echinoderms distributed through the sampling stations from the offshore to inshore stations in coral reefs communities: The Buoy (B), Weimberg (W), Turrumote (T), Media Luna (ML), San Cristobal (SC), Pelotas (P), Romero (ROM) and Enrique (E).

The highest species number was found at a depth between 11 to 20 m and in shallow habitats (Figure 40). Only 4 species were observed between 20 to 30 m deep.

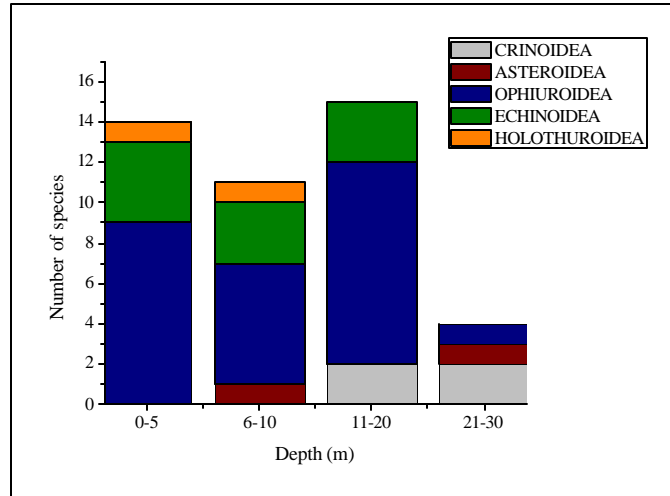
**Table 7.** Abundance (ind.m<sup>-2</sup>) of species of the phylum Echinodermata for each sampling station in coral reef communities. B: The Buoy, W: Weimberg, T: Turrumote, ML: Media Luna, P: Pelotas, SC: San Cristobal, E: Enrique, R: Romero. Each sampling station has transect number and the corresponding depth (m). \* In some stations there were more individuals of here expressed.

CLASS	SPECIES	B143 18m	B142 18m	B125 18m	B136 21m	W46 21m	W47 21m	W55 21m	W60 23m	T10 4m	T16 9m	T3 3m	T5 14m	ML26 6m	ML25 5m	ML31 10m	ML28 16m
CRINOIDEA	<i>Davidaster discoidea</i>	0.00	0.00	0.25	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CRINOIDEA	<i>Davidaster rubiginosa</i>	0.55	0.20	0.10	0.00	0.50	0.15	0.05	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ASTEROIDEA	<i>Linckia guildingii</i>	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OPHIUROIDEA	<i>Astrophyton muricatum</i>	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.10	0.00	0.00
OPHIUROIDEA	<i>Ophiolepis impressa</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00
OPHIUROIDEA	<i>Ophiocoma pumila</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00
OPHIUROIDEA	<i>Ophiocoma echinata</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.50	0.00	0.00	0.00	0.00
OPHIUROIDEA	<i>Ophiocoma wendtii</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00
OPHIUROIDEA	<i>Ophionereis reticulata</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00
OPHIUROIDEA	<i>Ophiactis savignyi</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OPHIUROIDEA	<i>Ophioderma appressum</i>	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OPHIUROIDEA	<i>Ophioderma brevispinum</i>	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OPHIUROIDEA	<i>Ophioderma rubicundum</i>	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OPHIUROIDEA	<i>Amphiura palmeri</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OPHIUROIDEA	<i>Ophiothrix orstedii</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.05	0.00	0.00	0.00	0.00	0.05	0.00
OPHIUROIDEA	<i>Ophiothrix angulata</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.05	0.50	0.00	0.00	0.00	0.00
OPHIUROIDEA	<i>Ophiothrix suensonii</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00
ECHINOIDEA	<i>Eucidaris tribuloides</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.00	0.00
ECHINOIDEA	<i>Diadema antillarum</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.50	0.15	0.05	0.00
ECHINOIDEA	<i>Lytechinus variegatus</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ECHINOIDEA	<i>Echinometra lucunter lucunter</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.00	0.05	0.00	0.00
ECHINOIDEA	<i>Echinometra viridis</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.05	0.00	0.00
HOLOTHUROIDEA	<i>Holothuria (Thymiosycia) arenicola</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HOLOTHUROIDEA	<i>Isostichopus badionotus</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

**Table 8.** Continued. Abundance (ind.m<sup>-2</sup>) of species of the phylum Echinodermata for each sampling station in coral reef communities. B: The Buoy, W: Weimberg, T: Turrumote, ML: Media Luna, P: Pelotas, SC: San Cristobal, E: Enrique, R: Romero. Each sampling station has transect number and the corresponding depth (m). \* In some stations there were more individuals of here expressed.

CLASS	SPECIES	P103 7m	P99 7m	P108 12m	P93 2m	SC43 9m	SC44 13m	SC41 2m	SC42 5m	E79 6m	E80 9m	E78 4m	E77 2m	R71 8m	R72 12m	R69 2m	R70 5m
CRINOIDEA	<i>Davidaster discoidea</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CRINOIDEA	<i>Davidaster rubiginosa</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ASTEROIDEA	<i>Linckia guildingii</i>	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.05	0.00	0.00	0.00	0.00	0.00	0.00
OPHIUROIDEA	<i>Astrophyton muricatum</i>	0.05	0.15	1.00	0.00	0.25	0.30	0.00	0.00	0.00	0.00	0.05	0.00	0.10	1.85	0.00	0.00
OPHIUROIDEA	<i>Ophiolepis impressa</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OPHIUROIDEA	<i>Ophiocoma pumila</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.05	0.25	0.00	0.00	0.00	0.00	0.00
OPHIUROIDEA	<i>Ophiocoma echinata</i>	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OPHIUROIDEA	<i>Ophiocoma wendtii</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00
OPHIUROIDEA	<i>Ophionereis reticulata</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OPHIUROIDEA	<i>Ophiactis savignyi</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	3.00	0.00	0.00	0.00	0.00
OPHIUROIDEA	<i>Ophioderma appressum</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OPHIUROIDEA	<i>Ophioderma brevispinum</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OPHIUROIDEA	<i>Ophioderma rubicundum</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OPHIUROIDEA	<i>Amphiura palmeri</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OPHIUROIDEA	<i>Ophiothrix orstedii</i>	0.00	0.00	0.00	0.25	0.00	0.00	0.00	0.00	0.10	0.05	0.25	0.00	0.00	0.00	0.00	0.00
OPHIUROIDEA	<i>Ophiothrix angulata</i>	0.00	0.00	0.00	0.00	0.00	0.65	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OPHIUROIDEA	<i>Ophiothrix suensonii</i>	0.00	0.10	0.00	0.00	0.45	0.20	0.05	0.00	0.00	0.00	0.00	0.00	0.10	0.20	0.00	0.00
ECHINOIDEA	<i>Eucidaris tribuloides</i>	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ECHINOIDEA	<i>Diadema antillarum</i>	0.00	0.00	0.00	0.15	0.00	0.20	0.10	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00
ECHINOIDEA	<i>Lytechinus variegatus</i>	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.10	0.00	0.00	0.00	0.00	0.00
ECHINOIDEA	<i>Echinometra lucunter</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ECHINOIDEA	<i>Echinometra viridis</i>	*6.55	*0.5	0.00	3.10	0.15	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HOLOTHUROIDEA	<i>Holothuria (Thymiosycia) arenicola</i>	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
HOLOTHUROIDEA	<i>Stichopus badionotus</i>	0.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

The composition of classes at different depths showed that ophiuroid and echinoid species were widely distributed from 0 to 20m deep. Crinoids only appeared at depths greater than the 10m. On the other hand, asteroids were absent from the shallow habitats (0-5m). The crinoids *Davidaster discoidea* and *D. rubiginosa* were only found at The Buoy in this study, 20-30m deep. No crinoids were found at the sea grass beds communities.



**Figure 40.** Number of species of echinoderms distributed at each depth (m) interval in coral reefs.

## 4.

## 5. DISCUSSION

### 4.1 GEOGRAPHICAL DISTRIBUTION

The tropical western Atlantic is defined as a region with a very homogeneous fauna, with multiple organisms (marine invertebrates and vertebrates) of the same species found in many areas along this biogeographic region (Briggs 1974). This region has been subdivided into a series of zoogeographic provinces, where the different species number and geographical barriers are still in debate among specialist of different taxonomic groups. The fauna differences among regions are mostly based on a high or low species endemism that are exclusive to them (Díaz and Puyana 1994).

Even though zoogeographic studies of shallow water echinoderms are scarce, the revised literature for this study and the findings at the collections, showed that the taxonomic composition of these organism in Puerto Rico, is similar to the composition found along the tropical western Atlantic, which extent from Bermuda, towards southeastern Florida, southward along the Antillean Arc to Trinidad, and along the Brazilian coast , as far south as Rio de Janeiro. This distribution includes the Caribbean Sea, southern Gulf of Mexico and the Bahama Islands (Meyer et al. 1978, Clark and Downey 1992, Hendler et al. 1995).

The six biogeographic zones (Isla Ascensión, Gulf of Mexico, Eastern-Atlantic, Northwestern-Atlantic, Southwestern-Atlantic and Caribbean) proposed by Clark and Downey (1992) were used in this study (Table 11 and Table 12). The species studied and collected for this research showed 13 different patterns of biogeographic distribution (Table 10) within the biogeographic regions proposed by Clark and Downey (1992): 22% of the species had a Great Caribbean-south western Atlantic distribution, 16.5% species where exclusive to the Caribbean region, 15.6% belong to the Great Caribbean and 12.8% have a

more western Atlantic distribution (Tabla 10, 11 and 12). The rest of the species had similar distribution patterns, but some species are missing in certain areas, and some have a mixed pattern. On the other hand, very few species are cosmopolitan (0.9%) and circumtropical (4.6%) distributions (Table 10). Many echinoderm studies done in the Caribbean region reveal a similar pattern; where there is a high degree of endemism for the Caribbean and Great Caribbean regions (H. L. Clark 1901a, Deichmann 1930, H. L. Clark 1933, H. L. Clark 1941, Meyer et al. 1978, Serafy 1979, Miller and Pawson 1984, Clark and Downey 1992, Hendler et al. 1995, Abreu-Pérez et al. 2005, Valle-García et al. 2005, Durán-González et al. 2005, Laguarda-Figueras et al. 2005a, 2005b). Table 10, gives a general idea of the affinity of echinoderm species from the shallow waters of Puerto Rico. A modification of Clark and Downey (1992) biogeographic regions classification was done in order to differentiate the distributions types of shallow water echinoderm of Puerto Rico. As observed in Table 10, the Caribbean and Great Caribbean have a high degree of endemism for shallow water echinoderms.



**Table 9.** Distribution Type, Biogeographic regions and Percentage of species found in this study.

Distribution Type	Regions	Species Percentage (%)
Great Caribbean-South Western Atlantic	Species found in Gulf of Mexico, Caribbean region and the South Western Atlantic, including Argentina.	22.0 %
Caribbean	Species found in Caribbean, including Bermuda Island, the south of Florida, Great and Lesser Antilles and costs of America Central to Colombia and Venezuela in South America.	16.5 %
Great Caribbean	Species found in the Gulf of Mexico and in the Caribbean.	15.6 %
tropical western Atlantic	Species found from Hatteras Cape to south America, including Caribbean.	12.8 %
Caribbean - South Western Atlantic	Species found in the Caribbean and the South Western Atlantic, including Argentina.	7.3 %
Amphiatlantic	Species found in the Western Atlantic and Eastern Atlantic.	7.3 %
Great Caribbean-North Western Atlantic	Species found in the Gulf of Mexico, Caribbean and the North-Western-Atlantic to Hatteras Cape.	6.4 %
Circumtropical	Species found in the Tropical Pacific and Atlantic.	4.6 %
North Western Atlantic-Caribbean-Atlantic	Species found in the North Western Atlantic, en the Caribbean and in the middle of Atlantic ocean.	1.8 %
Caribbean - North Western Atlantic – South Western Atlantic	Species found in the Caribbean, North Western Atlantic and South Western Atlantic.	0.9 %
Cosmopolitan	Species found in all biogeographic regions.	0.9 %
Western Atlantic-Atlantic	Species found in the Western Atlantic and in the middle of Atlantic ocean.	0.9 %
Caribbean - North Western Atlantic	Species found in the Caribbean North Western Atlantic.	1 %

**Table 10.** Geographic distribution of Puerto Rican shallow waters species. As. Isl: Isla Ascención. E. A: Eastern Atlantic. Nw. A: North Western Atlantic. So. A.: South-western Atlantic. GM: Gulf of Mexico. C: Caribbean. TWA: tropical western Atlantic. Ccumtr: Circumtropical. Cos: Cosmopolitan. Amph: Amphiatlantic. Atl: Atlantic. Atlw: Western Atlantic Tropical without Gulf of Mexico.

**Table 11.** Continued. Geographic distribution of Puerto Rican shallow waters species. As. Isl: Isla Ascención. E. A: Eastern Atlantic. Nw. A: North Western Atlantic. So. A.: South-western Atlantic. GM: Gulf of Mexico. C: Caribbean. TWA: tropical western Atlantic. Ccumtr: Circumtropical. Cos: Cosmopolita. Amph: Amphiatlantic. Atl: Atlantic. Atlw: Western Atlantic Tropical without Gulf of Mexico.

## 4.2 CURRENT STATUS OF THE KNOWLEDGE OF THE SHALLOW WATERS ECHINODERMS OF PUERTO RICO

Up to 1995, ninety-nine species of echinoderms were known for the shallow waters of Puerto Rican insular shelf (Deichmann 1930, H. L. Clark 1933, Carrera 1974, Hendler et al. 1995, Miller and Pawson 1984, Clark and Downey 1992, Meyer *et al.*, 1978, Meyer 1973a, Serafy 1979, Weil 2005). An increment of 8.3% of echinoderm species was added with this work. Nine (9) new records for Puerto Rico increased the number to 108 species. This finding shows the necessity of continuing supporting studies toward the revision of collections of different taxonomic groups, information that will enhance the understanding of the ecosystems trophic organization, and will give a better idea of the biodiversity of this region. On the other hand, these new records for the insular shelf of Puerto Rico show that the Caribbean waters are characterized by a high stability in species number, a feature already mentioned in several studies (Briggs 1974 and Ekman 1953). Nevertheless, a more intensive studies need to be addressed to fully study the taxonomic composition of shallow water echinoderms in these insular shelves. Special selective sampling methods need to be used in order to collect the organisms buried in the sediments or the ones hidden inside the intricate topographic structures of the coral reefs. At the same time, an effort to collect at night time need to be addressed, it is well known that echinoderms are very active at night, a highest diversity and abundance of these organisms have been observed during these hours (Solís-Marín and Pérez 1999).

The taxonomic composition found at both collections (NMNH and MSC) is consistent with all the records that exist for Puerto Rico and the Caribbean region. Small differences between both collections were found and between the collections and the sampling at la Parguera keys. The most noticeable difference was found among the crinoid's species. Six crinoid's species have been reported for the shallow waters of Puerto Rico (H. L. Clark 1933, A. H. Clark 1931, A. H. Clark 1947, Meyer 1973a, Meyer *et al.*, 1978, Messing 1978), all endemic to the Great Caribbean and tropical western Atlantic with the exception of

*Comactinia echinoptera* and *Comactinia meridionalis* (Meyer et al. 1978). Nevertheless, the total number of crinoids species observed at The Buoy (two) is low compared with other areas of the Caribbean. Higher numbers of species have been found elsewhere in the Caribbean where the shallow-water crinoids have been studied. Seven species were found in Panama, six in Santa Marta (Colombia) and five in Curaçao (Meyer 1973a). The distribution and relative abundance of crinoids in the shallow waters of the Western-Atlantic is not uniform, and has been associated to food availability, which is highly dependent of particular regimes of water movement (Meyer et al. 1978). Crinoids feed on suspended particles in the water column, and depending on the species, their arms extend like a fan in order to capture plankton, their main alimentary resource. In Colombia and Panama, where the continental influence is high and where the water movement is lower compared with the Caribbean Islands, there is a higher species number of stalked crinoids, finding the ideal conditions for their survival. Meyer (1973a), mentioned that crinoids inhabit places of high plankton productivity, which enhance a larger crinoids populations, higher diversity and a more homogeneous geographic distribution, like the coasts of Central and South America. Where productivity is low, crinoids populations are restricted to areas where local variation depends on food availability of the water currents, as in the Greater and Lesser Antilles. Coastal waters around Puerto Rico are considered nutrient depleted, but rainfall periods, land runoff of limiting nutrients, tidal pumping, breaking of internal waves, predation, and pollution have been pointed out as significant regulators of temporal variations in zooplankton (Alfaro 2002). These events may introduce temporal variations on crinoid's taxonomic composition and abundance. On the other hand, one of the most general biogeographic patterns in biogeography is that insular communities tend to be species-poor in comparison to mainland communities. Islands are not only isolated, but also small, and thus contain a limited diversity of habitats and resources; in this case limited nutrients in the water will be less compared to continental shelves.

In Puerto Rico, the Class Asteroidea was represented by 13 shallow water species and with the new record, *Poraniella echinulata*: the number is now to 14 species. Two species

are endemic to the Caribbean, *Echinaster (Othilia) echinoporus* and *Echinaster (Othilia) sentus*; three species are endemic to the tropical western Atlantic, *Luidia alternata alternata*, *Luidia clathrata* and *Astropecten duplicatus*. The other species have a wider geographic distribution.

Before this study, the Class Ophiuroidea was represented by 41 shallow waters species (Clark, 1933; Carrera, 1974; Hendler *et al.*, 1995). With the addition of three new records from this study, 44 species are known up to this date. This is not only the class with the highest species number, but also the most studied group in the Caribbean (Hendler *et al.*, 1995). With the exception of *Ophiocoma pumila*, *Ophiactis savignyi* and *Amphipholis squamata* which have a wider distribution (6.81%), the ophiuroids are more restricted to the Great Caribbean (9.1%), Caribbean (18.18%) and in the tropical western Atlantic (11.4%) regions. On the other hand, the ophiuroids compared with the other echinoderm classes showed a wider distribution. 47% of all species have distributions thought the Great Caribbean or the Caribbean with some regions of the tropical western Atlantic, at its northern or southern parts.

In Puerto Rico, 14 species of shallow water of Class Echinoidea have been reported (Clark, 1933; Serafy, 1979; Hendler *et al.*, 1995); the new record *Plagiobrissus grandis* increased the total to 15 species. This group is known to have a wide geographical distribution: 26.7% are amphiatlantic species, 20% are distributed along the tropical western Atlantic and 26% live in the Great Caribbean close the north or south of it. Only one species (6.7%) *Brissopsis elongata elongata* is endemic to the Caribbean.

The Class Holothuroidea was represented in Puerto Rico by 26 shallow water species (Deichmann, 1930; Clark, 1933; Miller and Pawson, 1984; Hendler *et al.*, 1995). Two new records are presented in this study, increasing the number up 29. Similarly to other echinoderm groups, this class is characterized by having endemic species in the Caribbean (27.58%), followed by other species with a larger distribution towards the Great Caribbean

region and part of the north or south of the tropical western Atlantic (24.13%). Other species have wider distributions; some of these are amphiatlantic or circumtropical.

The taxonomic composition of shallow water echinoderms in Puerto Rico is similar when compared to other regions in the tropical western Atlantic. In Cuba, 8 crinoids, 20 asteroids, 55 ophiuroids, 22 echinoids and 23 holothuroids were reported (Valle -García *et al.*, 2005, Abreu-Pérez *et al.*, 2005). In the Gulf of Mexico, 5 crinoids, 32 asteroids, 32 ophiuroids, 33 echinoids and 20 holothuroids are known (Duran-González *et al.*, 2005). Also, in the Caribbean region of Mexico, 4 crinoids, 21 asteroids, 44 ophiuroids, 29 echinoids and 29 holothuroids (Laguarda-Figueras *et al.*, 2005b). In the Colombian Caribbean a total of 35 species of Class Asteroidea were collected; however, this study included not only the fauna of the continental shelf but the upper slope (Benavides *et al.*, 2005). There is a great affinity in the taxonomic composition of echinoderms in the island of Puerto Rico with many other Caribbean sectors. This taxonomic update confirmed the similarity among Puerto Rico and other areas of the Caribbean and Gulf of Mexico, which supports the idea about a uniformity of the Caribbean and Great Caribbean for the shallow water echinoderms.

Of the six crinoids species reported for Puerto Rico, five are shared with Cuba (Valle -García *et al.*, 2005); four with the Gulf of Mexico (Durán-González *et al.*, 2005) and three with the Caribbean Mexican waters (Laguarda-Figueras *et al.*, 2005b). In a similar way, from the 14 asteroid species registered for Puerto Rico, 12 are found in Cuba (Abreu-Pérez *et al.*, 2005), 11 in the Gulf of Mexico (Durán-González *et al.*, 2005) and 9 species are shared with the Mexican-Caribbean (Laguarda-Figueras *et al.*, 2005b). In the case of the ophiuroids, 44 species that inhabit the shallow waters of Puerto Rico, are common to Cuba (Abreu-Pérez *et al.*, 2005), 28 to the Gulf of Mexico (Durán-González *et al.*, 2005) and 35 to the Mexican-Caribbean (Laguarda-Figueras *et al.*, 2005b). For the Class Echinoidea, of the 15 species reported to Puerto Rico, 14 are also found in Cuba (García *et al.*, 2005), 13 in the Gulf of Mexico (Durán-González *et al.*, 2005) and 11 in the Caribbean region of Mexico (Laguarda-Figueras *et al.*, 2005b). 29 species of the Class Holothuroidea have been collected in Puerto

Rico. This is the highest diversity of holothurians for rest of the Caribbean: 23 species reported in Cuba (19 common with Puerto Rico) (Valle-García *et al.*, 2005), 20 for the Gulf of Mexico (12 common with Puerto Rico) (Durán-González *et al.*, 2005) and 29 for the Caribbean region of Mexico (all common with Puerto Rico) (Laguarda-Figueras *et al.*, 2005b). This group has received a lot of attention, and many collections have been done at La Parguera. Also, the revision of the collections identified two species, *Eostichopus arnesoni* and *Holothuria densipedes*, that are endemic to the island.

#### **4.3 TAXONOMIC COMPOSITION OF THE ECHINODERMS OF LA PARGUERA**

Each key showed unique characteristics that can be related to key size and location at La Parguera shelf and were characterized by an accommodation of certain species. An evident low number of species representing asteroids and holothurians was found, however, the quantitative results from the sea grass beds are difficult to compare.

There is a lack of echinoderm population studies on specific species; only certain species have received some attention. Griffin *et al.* (2003) studied the bioerosion by the sea urchin *Echinometra viridis* in coral reef communities and found higher average densities (0.77-62.0 ind. m<sup>-2</sup>) in several patch reefs and fringing coral reefs in La Parguera, Puerto Rico. They mentioned that high densities of *E. viridis* might account for the degradation of corals and reef structure on Palmas, Mario and several other patch reefs in La Parguera and in high mortality of recruits of coral and other sessile invertebrates.

The abundance of and spatial disposition pattern of *Echinometra lucunter* was studied in a shallow locality of Turpialito, Golfo de Cariaco, Venezuela. The average density was 10.80 ind. m<sup>-2</sup> and showed temporal significant differences, with higher densities during December, 1980, January and May, 1981; and the lowest (7.3 ind.m<sup>-2</sup>) in March, 1981 (Pompa *et al.*, 1989). The numbers, biomass, and caloric content of the echinoderm fauna of



the rocky shores of Barbados were studied. Numerical densities of *E. lucunter* were high in all localities; the highest levels of 144 ind. m<sup>-2</sup> was found at Six Men's Bay; numerical densities of *H. glaberrima* were high at both Oistens and River Bay, the highest level of 36 ind. m<sup>-2</sup> being reported at River Bay (Lawrence and Kafri, 1979). On the other hand, no individuals of the sea urchin *Diadema antillarum* were sampled at the sea grass beds in La Parguera. However, organisms of this species were observed in the windward zone of Caballo Blanco key and in the coral reefs studied. Densities ranging from 0.56-1.88 ind/m<sup>-2</sup> were reported by Weil *et al.* (2005) in a population study done 17 years after the mass mortality event they went through.

## CONCLUSIONS

A significant input to the marine biodiversity of Puerto Rico was provided with this work, where 9 new species are reported for the first time. With these new records the echinoderm inventory increased 8.3%. It is important to remark that these specimens were found at the NMNH and/or MSC.

In general terms, the shallow water echinoderm taxonomic composition of Puerto Rico is similar to the one found in the great Caribbean and in the tropical western Atlantic biogeographic regions. A similarity of 82% was found between these regions. Most species showed restricted distribution in the Atlantic Ocean and in some localities of the tropical western Atlantic Species while 13 % have a wider distribution.

Shallow water Ophiroidea are well represented in this region, a pattern observed along the Caribbean as well. The success of these organisms may be due to their different sizes, ability to move and fold their body, and diverse feeding strategies that allow them to explore habitats that are out of reach for other echinoderms.

The internal lagoon of the San Cristobal key seems to provide multiple small-scale environmental variations to account for its high echinoderm abundance. The protected horseshoe-shaped lagoon in the leeward zone with the accumulation of *Porites porites* fragments and the growth *Thalassia testidum* provides higher spatial heterogeneity to support higher densities of echinoderms when compared to other keys.

More selective sampling methods and other strategies need to be used in order to explore the echinoderm diversity in a more inclusive approach. On the other hand, the shallow water echinoderm taxonomic update has been done, but mayor efforts for the continuation towards the revision of collections and their publication needs to be addressed.

Information regarding mode of development, life histories, population ecology and evolution for the echinoderms of Puerto Rico is also needed.

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## ANNEX 1

MSC: Collection at the Department of Marine Sciences, UPR Mayagüez.

USNM: Catalog Number Collection National Museum Natural History, Smithsonian.

NMNH: National Museum of Natural History, Smithsonian, Washington, D. C.

CRES: Coral Reef Ecosystem Studies Project.

BIOL: Collection Biology Department, Puerto Rico University (Mayagüez Campus).

- **Class Crinoidea:**

dd: diameter disc.

dcd: diameter center dorsal.

- **Class Asteroidea:**

R: major Radii.

r: minor Radii.

R/r: major Radii/ minor Radii.

- **Class Ophiuroidea:**

dd: disc diameter.

al: arm lenght.

- **Class Echinoidea:**

DT: Test Diameter.

DTW: Test Diameter Wide.

DTL: Test Diameter Large.



DTH: Test Diameter High.

• **Class Holothuroidea:**

L:

Body

Large.

## ANNEX 2

PHYLUM ECHINODERMATA	Jiguero	Jobos	Yabucoa	Brea	Salinas	Molines	Aguila	Juanas	Puerto	Pto Nuevo	Ballena	Puntilla	Gallardo	Desecheo
<i>Davidaster discoidea</i>					X					X				
<i>Davidaster rubiginosa</i>														
<i>Leptonemaster venustus</i>	X				X			X						
<i>Comactinia echinoptera</i>	X				X				X					
<i>Comactinia meridionalis</i>														
<i>Analcidometra armata</i>														
<i>Luidia alternata alternata</i>														
<i>Luidia clathrata</i>												X		
<i>Luidia senegalensis</i>												X		
<i>Astropecten articulatus</i>														
<i>Astropecten duplicatus</i>						X								
<i>Astropecten marginatus</i>														
<i>Asterinides folium</i>														
<i>Asterina hartmeyeri</i>														
<i>Linckia guildingii</i>														
<i>Ophidiaster guildingii</i>														
<i>Poraniella echinulata</i>														
<i>Oreaster reticulatus</i>														
<i>Echinaster (Othilia) sentus</i>														
<i>Echinaster (Othilia) echinoporus</i>						X								
<i>Ophyomyxa flaccida</i>														
<i>Ophioblenna antillensis</i>														
<i>Asteroporpa annulata</i>														
<i>Astrophyton muricatum</i>														
<i>Schizostella bifurcata</i>														
<i>Ophiolepis paucispina</i>														
<i>Ophiolepis elegans</i>														
<i>Ophiolepis impressa</i>														
<i>Ophiocoma echinata</i>														
<i>Ophiocoma pumila</i>													X	
<i>Ophiocoma wendtii</i>														
<i>Ophiocomella ophiactoides</i>													X	

PHYLUM ECHINODERMATA	Jiguero	Jobos	Yabucoa	Brea	Salinas	Molines	Aguila	Juanas	Puerto	Pto Nuevo	Ballena	Puntilla	Gallardo	Desecheo
<i>Ophiopsila riisei</i>				X										
<i>Ophionereis olivacea</i>														
<i>Ophionereis reticulata</i>														
<i>Ophionereis squamulosa</i>														
<i>Ophioderma appressum</i>														
<i>Ophioderma brevicaudum</i>														
<i>Ophioderma brevispinum</i>														
<i>Ophioderma cinereum</i>											X			
<i>Ophioderma phoenium</i>														
<i>Ophioderma rubicundum</i>														
<i>Ophioderma squamosissimum</i>														X
<i>Hemipholis elongata</i>												X		
<i>Ophiactis quinqueradia</i>		X												
<i>Ophiactis savignyi</i>												X		
<i>Amphiodia planispina</i>														
<i>Amphiodia pulchella</i>														
<i>Amphiodia trychna</i>														
<i>Amphipholis gracilima</i>			X											
<i>Amphipholis januarii</i>		X												
<i>Amphipholis squamata</i>														
<i>Amphiura palmeri</i>														
<i>Amphiura stimpsoni</i>														
<i>Ophiocnida scrabriuscula</i>		X												
<i>Ophionephthys limicola</i>														
<i>Ophiophragmus pulcher</i>														
<i>Ophiophragmus septus</i>		X												
<i>Ophiostigma isocanthum</i>				X										
<i>Ophiostigma siva</i>				X										
<i>Ophiothrix angulata</i>						X						X		
<i>Ophiothrix brachyactis</i>														
<i>Ophiothrix orstedii</i>														
<i>Ophiothrix suensonii</i>														
<i>Eucidaris tribuloides tribuloides</i>														
<i>Diadema antillarum</i>														
<i>Astropyga magnifica</i>														
<i>Lytechinus variegatus</i>											X			

PHYLUM ECHINODERMATA	Jiguero	Jobos	Yabucoa	Brea	Salinas	Molines	Aguila	Juanas	Puerto	Pto Nuevo	Ballena	Puntilla	Gallardo	Desecheo
<i>Tripneustes ventricosus</i>														
<i>Echinometra lucunter lucunter</i>														
<i>Echinometra viridis</i>														
<i>Clypeaster rosaceus</i>														
<i>Leodia sexiesperforata</i>														
<i>Mellita quinquiesperforata</i>														
<i>Moiria atropos</i>														
<i>Brissus unicolor</i>														
<i>Brissopsis elongata elongata</i>														
<i>Meoma ventricosa ventricosa</i>														
<i>Plagiobrissus grandis</i>														
<i>Ocnus pygmaeus</i>												X		
<i>Duasmodyctyla seguroensis</i>														
<i>Ocnus surinamensis</i>														
<i>Ocnus suspectus</i>														
<i>Euthyonidiella destichada</i>														
<i>Euthyonidiella trita</i>														
<i>Pseudothyone belli</i>														
<i>Neothyonidium parvum</i>														
<i>Phyllophorus (Urodemella) occidentalis</i>														
<i>Eostichopus arnesoni</i>							X							
<i>Astichopus multifidus</i>														
<i>Isostichopus badionotus</i>														
<i>Actinopyga agassizi</i>														
<i>Holothuria densipedes</i>														
<i>Holothuria (Cystipus) cubana</i>														
<i>Holothuria (Halodeima) floridana</i>														
<i>Holothuria (Halodeima) grisea</i>											X			
<i>Holothuria (Halodeima) mexicana</i>							X							
<i>Holothuria (Platyperona) parvula</i>														
<i>Holothuria (Selenkothuria) glaberrima</i>														
<i>Holothuria (Semperothuria) surinamensis</i>														
<i>Holothuria (Theelothuria) princeps</i>														
<i>Holothuria (Thymiosycia) arenicola</i>														
<i>Holothuria (Thymiosycia) impatiens</i>														
<i>Holothuria (Thymiosycia) thomasi</i>														

PHYLUM ECHINODERMATA	Jiguero	Jobos	Yabucoa	Brea	Salinas	Molines	Aguila	Juanas	Puerto	Pto Nuevo	Ballena	Puntilla	Gallardo	Desecheo
<i>Euapta lappa</i>														
<i>Protankyra ramiurna</i>														
<i>Synaptula hydriformis</i>														
<i>Chiridota rotifera</i>														

**ANNEX 2 (Continued)**

PHYLUM ECHINODERMATA	Boca Prieta	Guayanilla	Ponce	Guanica	Cataño	San Juan	Puerto Real	Humacao	Playa Sucia	Salinas Bay	Montalva Bay	Boqueron	Condado	Pardas
<i>Davidaster discoidea</i>														
<i>Davidaster rubiginosa</i>														
<i>Leptonemaster venustus</i>														
<i>Comactinia echinoptera</i>														
<i>Comactinia meridionalis</i>														
<i>Analcidometra armata</i>														
<i>Luidia alternata alternata</i>							X	X						
<i>Luidia clathrata</i>						X								
<i>Luidia senegalensis</i>					X		X							
<i>Astropecten articulatus</i>														
<i>Astropecten duplicatus</i>												X		
<i>Astropecten marginatus</i>														
<i>Asterinides folium</i>			X	X										
<i>Asterina hartmeyer</i>		X	X			X			X					
<i>Linckia guildingii</i>		X	X			X			X					
<i>Ophidiaster guildingii</i>		X	X											
<i>Poraniella echinulata</i>														
<i>Oreaster reticulatus</i>			X			X						X		X
<i>Echinaster (Othilia) sentus</i>						X	X							
<i>Echinaster (Othilia) echinoporus</i>						X	X			X				
<i>Ophyomyxa flaccida</i>						X								
<i>Ophioblenna antillensis</i>			X			X								
<i>Asteroporpa annulata</i>														
<i>Astrophyton muricatum</i>														
<i>Schizostella bifurcata</i>														
<i>Ophiolepis paucispina</i>														
<i>Ophiolepis elegans</i>						X							X	
<i>Ophiolepis impressa</i>		X	X	X										
<i>Ophiocoma echinata</i>			X			X								
<i>Ophiocoma pumila</i>				X		X		X						
<i>Ophiocoma wendtii</i>			X			X								X
<i>Ophiocomella ophiactoides</i>											X			
<i>Ophiopsila riisei</i>				X										
<i>Ophionereis olivacea</i>														

PHYLUM ECHINODERMATA	Boca Prieta	Guayanilla	Ponce	Guanica	Cataño	San Juan	Puerto Real	Humacao	Playa Sucia	Salinas Bay	Montalva Bay	Boqueron	Condado	Pardos
<i>Ophioneis reticulata</i>				X			X							
<i>Ophioneis squamulosa</i>														
<i>Ophioderma appressum</i>			X	X		X								
<i>Ophioderma brevicaudum</i>	X		X			X	X							
<i>Ophioderma brevispinum</i>				X			X	X						
<i>Ophioderma cinereum</i>						X	X							
<i>Ophioderma phoenium</i>														
<i>Ophioderma rubicundum</i>			X	X				X						
<i>Ophioderma squamosissimum</i>														
<i>Hemipholis elongata</i>			X	X		X								
<i>Ophiactis quinqueradial</i>														
<i>Ophiactis savignyi</i>														
<i>Amphiodia planispina</i>														
<i>Amphiodia pulchella</i>				X		X								
<i>Amphiodia trychna</i>														
<i>Amphipholis gracilima</i>			X	X										
<i>Amphipholis januarii</i>														
<i>Amphipholis squamata</i>				X										
<i>Amphiura palmeri</i>														
<i>Amphiura stimpsoni</i>														
<i>Ophiocnida scrabriuscula</i>														
<i>Ophionephthys limicola</i>														
<i>Ophiophragmus pulcher</i>														
<i>Ophiophragmus septus</i>														
<i>Ophiostigma isocanthum</i>						X							X	
<i>Ophiostigma siva</i>														
<i>Ophiothrix angulata</i>	X		X	X		X	X	X				X		
<i>Ophiothrix brachyactis</i>				X										
<i>Ophiothrix orstedii</i>			X			X	X							
<i>Ophiothrix suensonii</i>				X								X		
<i>Eucidaris tribuloides tribuloides</i>		X		X		X							X	
<i>Diadema antillarum</i>														
<i>Astropyga magnifica</i>														
<i>Lytechinus variegatus</i>		X	X	X	X	X						X		
<i>Tripneustes ventricosus</i>			X	X		X								

PHYLUM ECHINODERMATA	Boca Prieta	Guayanilla	Ponce	Guánica	Cataño	San Juan	Puerto Real	Humacao	Playa Sucia	Salinas Bay	Montalva Bay	Boqueron	Condado	Pardos
<i>Echinometra lucunter lucunter</i>		X	X	X		X					X	X		X
<i>Echinometra viridis</i>			X											
<i>Clypeaster rosaceus</i>						X								
<i>Leodia sexiesperforata</i>														
<i>Mellita quinquiesperforata</i>			X			X	X	X						
<i>Moira atropos</i>														
<i>Brissus unicolor</i>														
<i>Brissopsis elongata elongata</i>														
<i>Meoma ventricosa ventricosa</i>														
<i>Plagiobrissus grandis</i>														
<i>Ocnus pygmaeus</i>														
<i>Duasmodyctyla seguroensis</i>														
<i>Ocnus surinamensis</i>						X								
<i>Ocnus suspectus</i>														
<i>Euthyonidiella destichada</i>														
<i>Euthyonidiella trita</i>														
<i>Pseudothyone belli</i>														
<i>Neothyonidium parvum</i>														
<i>Phyllophorus (Urodemella) occidentalis</i>														
<i>Eostichopus arnesoni</i>														
<i>Astichopus multifidus</i>												X		
<i>Isostichopus badiotus</i>						X						X		
<i>Actinopyga agassizi</i>														
<i>Holothuria densipedes</i>														
<i>Holothuria (Cystipus) cubana</i>						X						X		
<i>Holothuria (Halodeima) floridana</i>														
<i>Holothuria (Halodeima) grisea</i>														
<i>Holothuria (Halodeima) mexicana</i>				X		X	X					X		
<i>Holothuria (Platyperona) parvula</i>														
<i>Holothuria (Selenothuria) glaberrima</i>				X		X								
<i>Holothuria (Semperothuria) surinamensis</i>			X	X		X	X					X		
<i>Holothuria (Theelothuria) princeps</i>														
<i>Holothuria (Thymiosycia) arenicola</i>			X											
<i>Holothuria (Thymiosycia) impatiens</i>			X											
<i>Holothuria (Thymiosycia) thomasi</i>		X												



PHYLUM ECHINODERMATA	Boca Prieta	Guayanilla	Ponce	Guanica	Cataño	San Juan	Puerto Real	Humacao	Playa Sucia	Salinas Bay	Montalva Bay	Boqueron	Condado	Pardas
<i>Euapta lappa</i>				X										
<i>Protankyra ramiurna</i>														
<i>Synaptula hydriformis</i>														
<i>Chiridota rotifera</i>														

**ANNEX 2 (Continued)**

PHYLUM ECHINODERMATA	Tallebo a	Caja de Muertos	Viequ es	Culebr a	Isla Mona	Fajard o	Rinco n	La Parguera	Hucare s	Añasc o	Palmas altas	Aguadill a	Mayague z	Luquill o
<i>Davidaster discoidea</i>								X					X	
<i>Davidaster ubiginosa</i>								X		X				
<i>Leptonemaster venustus</i>			X									X		
<i>Comactinia echinoptera</i>				X										
<i>Comactinia meridionalis</i>														
<i>Analcidometra armata</i>							X							
<i>Luidia alternata alternata</i>														
<i>Luidia clathrata</i>														
<i>Luidia senegalensis</i>													X	
<i>Astropecten articulatus</i>								X						
<i>Astropecten duplicatus</i>			X					X						X
<i>Astropecten marginatus</i>													X	X
<i>Asterinides folium</i>								X						
<i>Asterina hartmeyer</i>				X				X						
<i>Linckia guildingii</i>				X				X						
<i>Ophidiaster guildingii</i>								X						
<i>Poraniella echinulata</i>					X									
<i>Oreaster reticulatus</i>												X	X	
<i>Echinaster (Othilia) sentus</i>								X						
<i>Echinaster (Othilia) echinoporus</i>			X					X					X	
<i>Ophyomyxa flaccida</i>				X				X						
<i>Ophioblenna antillensis</i>														
<i>Asteroporpa annulata</i>														
<i>Astrophyton muricatum</i>								X						
<i>Schizostella bifurcata</i>														
<i>Ophiolepis paucispina</i>	X							X						
<i>Ophiolepis elegans</i>				X										
<i>Ophiolepis impressa</i>								X						
<i>Ophiocoma echinata</i>			X	X		X		X						
<i>Ophiocoma pumila</i>			X	X				X						
<i>Ophiocoma wendtii</i>						X		X						
<i>Ophiocomella ophiactoides</i>								X						

PHYLUM ECHINODERMATA	Tallebo a	Caja de Muertos	Viequ es	Culebr a	Isla Mona	Fajard o	Rinco n	La Parguera	Hucare s	Añasc o	Palmas altas	Aguadill a	Mayague z	Luquill o
<i>Ophiopsila riisei</i>														
<i>Ophionereis olivacea</i>														
<i>Ophionereis reticulata</i>			X	X				X						
<i>Ophionereis squamulosa</i>														
<i>Ophioderma appressum</i>			X	X				X						
<i>Ophioderma brevicaudum</i>				X				X						
<i>Ophioderma brevispinum</i>			X	X				X						
<i>Ophioderma cinereum</i>				X				X						
<i>Ophioderma phoenium</i>								X						
<i>Ophioderma rubicundum</i>				X				X						
<i>Ophioderma squamosissimum</i>								X						
<i>Hemipholis elongata</i>										X				
<i>Ophiactis quinqueradia</i>			X											
<i>Ophiactis savignyi</i>								X					X	
<i>Amphiodia planispina</i>													X	
<i>Amphiodia pulchella</i>								X						
<i>Amphiodia trychna</i>														
<i>Amphipholis gracilima</i>														
<i>Amphipholis januarii</i>								X						
<i>Amphipholis squamata</i>								X						
<i>Amphiura palmeri</i>								X						
<i>Amphiura stimpsoni</i>					X			X					X	
<i>Ophiocnida scrabriuscula</i>					X			X						
<i>Ophionephthys limicola</i>										X				
<i>Ophiophragmus pulcher</i>								X						
<i>Ophiophragmus septus</i>														
<i>Ophiostigma isocanthum</i>								X						
<i>Ophiostigma siva</i>														
<i>Ophiothrix angulata</i>			X	X				X					X	
<i>Ophiothrix brachyactis</i>														
<i>Ophiothrix orstedii</i>			X	X				X					X	
<i>Ophiothrix suensonii</i>								X		X			X	
<i>Eucidaris tribuloides tribuloides</i>			X					X			X		X	
<i>Diadema antillarum</i>													X	
<i>Astropyga magnifica</i>								X				X		

PHYLUM ECHINODERMATA	Tallebo a	Caja de Muertos	Viequ es	Culebr a	Isla Mona	Fajard o	Rinco n	La Parguera	Hucare s	Añasc o	Palmas altas	Aguadill a	Mayague z	Luquill o
<i>Lytechinus variegatus</i>								X	X					
<i>Tripneustes ventricosus</i>								X			X	X		
<i>Echinometra lucunter lucunter</i>	X	X	X			X		X						
<i>Echinometra viridis</i>								X						
<i>Clypeaster rosaceus</i>						X								
<i>Leodia sexiesperforata</i>			X											
<i>Mellita quinquiesperforata</i>												X	X	X
<i>Moira atropos</i>														
<i>Brissus unicolor</i>														
<i>Brissopsis elongata elongata</i>								X					X	
<i>Meoma ventricosa ventricosa</i>								X						
<i>Plagiobrissus grandis</i>														
<i>Ocnus pygmaeus</i>														
<i>Duasmodyctyla seguroensis</i>								X						
<i>Ocnus surinamensis</i>								X						
<i>Ocnus suspectus</i>								X						
<i>Euthyonidiella destichada</i>								X						
<i>Euthyonidiella trita</i>								X						
<i>Pseudothyone belli</i>								X						
<i>Neothyonidium parvum</i>								X						
<i>Phyllophorus (Urodemella) occidentalis</i>								X						
<i>Eostichopus arnesoni</i>														
<i>Astichopus multifidus</i>												X		
<i>Isostichopus badionotus</i>								X					X	
<i>Actinopyga agassizi</i>								X						
<i>Holothuria densipedes</i>														
<i>Holothuria (Cystipus) cubana</i>								X						
<i>Holothuria (Halodeima) floridana</i>								X						
<i>Holothuria (Halodeima) grisea</i>								X	X					
<i>Holothuria (Halodeima) mexicana</i>				X		X		X	X				X	
<i>Holothuria (Platyperona) parvula</i>								X	X					
<i>Holothuria (Selenothuria) glaberrima</i>								X	X					
<i>Holothuria (Semperothuria) surinamensis</i>								X						
<i>Holothuria (Theelothuria) princeps</i>														
<i>Holothuria (Thymiosyca) arenicola</i>				X				X						

PHYLUM ECHINODERMATA	Tallebo a	Caja de Muertos	Viequ es	Culebr a	Isla Mona	Fajard o	Rinco n	La Parguera	Hucare s	Añasc o	Palmas altas	Aguadill a	Mayague z	Luquill o
<i>Holothuria (Thymiosycia) impatiens</i>				X				X						
<i>Holothuria (Thymiosycia) thomasi</i>								X						
<i>Euapta lappa</i>								X						
<i>Protankyra ramiurna</i>								X						
<i>Synaptula hydr iformis</i>								X						
<i>Chiridota rotifera</i>								X						

**ANNEX 2 (Continued)**

PHYLUM ECHINODERMATA	Palomino	Arroyo	New Localities PR	New PR	MS C	NMN H	La Parguera					
<i>Davidaster discoidea</i>				X	X	X	X					
<i>Davidaster rubiginosa</i>			X		X		X					
<i>Leptonemaster venustus</i>			X		X	X						
<i>Comactinia echinoptera</i>			X		X	X						
<i>Comactinia meridionalis</i>						X						
<i>Analcidometra armata</i>			X		X							
<i>Luidia alternata alternata</i>			X			X						
<i>Luidia clathrata</i>			X			X						
<i>Luidia senegalensis</i>			X			X						
<i>Astropecten articulatus</i>			X				X					
<i>Astropecten duplicatus</i>			X		X	X						
<i>Astropecten marginatus</i>		X	X			X						
<i>Asterinides folium</i>			X		X	X						
<i>Asterina hartmeyer</i>			X			X						
<i>Linckia guildingii</i>			X		X	X	X					
<i>Ophidiaster guildingii</i>			X		X	X						
<i>Poraniella echinulata</i>				X	X	X						
<i>Oreaster reticulatus</i>			X		X	X	X					
<i>Echinaster (Othilia) sentus</i>					X	X						
<i>Echinaster (Othilia) echinoporus</i>			X		X	X	X					
<i>Ophyomyxa flaccida</i>						X	X					
<i>Ophioblenna antillensis</i>												
<i>Asteroporpa annulata</i>												
<i>Astrophyton muricatum</i>			X		X		X					
<i>Schizostella bifurcata</i>												
<i>Ophiolepis paucispina</i>			X		X		X					
<i>Ophiolepis elegans</i>			X		X	X						
<i>Ophiolepis impressa</i>			X		X	X	X					
<i>Ophiocoma echinata</i>			X		X	X	X					
<i>Ophiocoma pumila</i>			X			X	X					
<i>Ophiocoma wendtii</i>			X		X	X	X					
<i>Ophiocomella ophiactoides</i>						X	X					

PHYLUM ECHINODERMATA	Palomino	Arroyo	New Localities PR	New PR	MS C	NMN H	La Parguera					
<i>Ophiopsila riisei</i>					X							
<i>Ophionereis olivacea</i>					X	X						
<i>Ophionereis reticulata</i>			X		X	X	X					
<i>Ophionereis squamulosa</i>												
<i>Ophioderma appressum</i>			X		X	X	X					
<i>Ophioderma brevicaudum</i>			X		X	X	X					
<i>Ophioderma brevispinum</i>		X	X		X	X	X					
<i>Ophioderma cinereum</i>			X		X	X	X					
<i>Ophioderma phoenium</i>				X	X							
<i>Ophioderma rubicundum</i>					X	X	X					
<i>Ophioderma squamosissimum</i>				X	X							
<i>Hemipholis elongata</i>			X			X						
<i>Ophiactis quinqueradia</i>						X						
<i>Ophiactis savignyi</i>			X			X	X					
<i>Amphiodia planispina</i>		X			X	X						
<i>Amphiodia pulchella</i>						X						
<i>Amphiodia trychna</i>						X						
<i>Amphipholis gracilima</i>												
<i>Amphipholis januarii</i>							X					
<i>Amphipholis squamata</i>							X					
<i>Amphiura palmeri</i>			X			X						
<i>Amphiura stimpsoni</i>			X		X	X						
<i>Ophiocnida scrabriuscula</i>					X							
<i>Ophionephthys limicola</i>				X	X							
<i>Ophiophragmus pulcher</i>												
<i>Ophiophragmus septus</i>												
<i>Ophiostigma isocanthum</i>												
<i>Ophiostigma siva</i>												
<i>Ophiothrix angulata</i>			X			X	X					
<i>Ophiothrix brachyactis</i>												
<i>Ophiothrix orstedii</i>		X	X		X	X	X					
<i>Ophiothrix suensonii</i>			X			X	X					
<i>Eucidaris tribuloides tribuloides</i>			X			X	X					
<i>Diadema antillarum</i>	X	X	X			X	X					
<i>Astropyga magnifica</i>			X			X						

PHYLUM ECHINODERMATA	Palomino	Arroyo	New Localities PR	New PR	MS C	NMN H	La Parguera					
<i>Lytechinus variegatus</i>		X	X				X					
<i>Tripneustes ventricosus</i>		X				X	X					
<i>Echinometra lucunter lucunter</i>		X	X			X	X					
<i>Echinometra viridis</i>						X	X					
<i>Clypeaster rosaceus</i>						X						
<i>Leodia sexiesperforata</i>		X	X			X						
<i>Mellita quinquiesperforata</i>	X					X						
<i>Moira atropos</i>						X						
<i>Brissus unicolor</i>						X						
<i>Brissopsis elongata elongata</i>			X			X	X					
<i>Meoma ventricosa ventricosa</i>				X	X	X						
<i>Plagiobrissus grandis</i>				X	X	X						
<i>Ocnus pygmaeus</i>			X			X						
<i>Duasmodyctyla seguroensis</i>												
<i>Ocnus surinamensis</i>			X		X							
<i>Ocnus suspectus</i>			X		X							
<i>Euthyonidiella destichada</i>					X							
<i>Euthyonidiella trita</i>			X		X							
<i>Pseudothyone belli</i>			X		X							
<i>Neothyonidium parvum</i>			X		X							
<i>Phyllophorus (Urodemella) occidentalis</i>			X		X							
<i>Eostichopus arnesoni</i>			X		X	X						
<i>Astichopus multifidus</i>			X			X						
<i>Isostichopus badionotus</i>			X		X	X	X					
<i>Actinopyga agassizi</i>				X	X	X						
<i>Holothuria densipedes</i>					X	X						
<i>Holothuria (Cystipus) cubana</i>			X		X	X	X					
<i>Holothuria (Halodeima) floridana</i>			X			X	X					
<i>Holothuria (Halodeima) grisea</i>		X	X		X	X	X					
<i>Holothuria (Halodeima) mexicana</i>		X	X		X	X	X					
<i>Holothuria (Platyperona) parvula</i>			X		X	X						
<i>Holothuria (Selenothuria) glaberrima</i>					X		X					
<i>Holothuria (Semperothuria) surinamensis</i>					X	X						
<i>Holothuria (Theelothuria) princeps</i>			X		X		X					
<i>Holothuria (Thymiosycia) arenicola</i>					X		X					



PHYLUM ECHINODERMATA	Palomino	Arroyo	New Localities PR	New PR	MS C	NMN H	La Parguera					
<i>Holothuria (Thymiosycia) impatiens</i>					X							
<i>Holothuria (Thymiosycia) thomasi</i>					X							
<i>Euapta lappa</i>			X		X							
<i>Protankyra ramiurna</i>					X							
<i>Synaptula hydriformis</i>				X	X							
<i>Chiridota rotifera</i>					X							