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**Anderson Luiz Silva Miranda**

**HOLOTHUROIDEA (ECHINODERMATA) DOS ECOSSISTEMAS RECIFAIS DO  
LITORAL CENTRAL DE ALAGOAS, BRASIL.**

**MACEIÓ**  
**2013**



**Anderson Luiz Silva Miranda**

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Dissertação apresentada ao Programa de Pós-Graduação em Diversidade Biológica e Conservação nos Trópicos, Instituto de Ciências Biológicas e da Saúde, Universidade Federal de Alagoas, como requisito para obtenção do título de Mestre em CIÊNCIAS BIOLÓGICAS, área de concentração em Conservação da Biodiversidade Tropical.

**Orientadora: Prof. Dra. Monica Dorigo Correia**

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*Dedico à minha família que me apoiou em todos os momentos dessa valiosa experiência.*

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*“O saber humano é limitado e até os olhares do gênio não são mais do que relâmpagos no domínio do infinito das ideias e das leis”.*

*Leon Denis*

## RESUMO

Os invertebrados pertencentes à classe Holothuroidea são organismos exclusivamente marinhos, conhecidos como pepinos-do-mar, sendo importantes componentes dos ecossistemas recifais, os quais realizam boa parte da reciclagem de nutrientes no sedimento destes e de outros ambientes costeiros. No entanto, os efeitos dos holoturóides nas comunidades marinhas são raramente documentados e sugerem a necessidade de mais estudos ecológicos. O conhecimento dos holoturóides na costa do Brasil, particularmente em ecossistemas recifais do litoral nordeste é bastante escasso. Este estudo descreve as espécies de Holothuroidea dos ecossistemas recifais de Alagoas, incluindo aspectos ecológicos e a distribuição espacial baseada nas características do sedimento. Foram estudados nove ecossistemas recifais localizados no litoral central de Alagoas, com coletadas efetuadas em zonas de entremares até 20m de profundidade. A identificação das espécies foi realizada segundo metodologia usual e bibliografia específica, assim como as análises de sedimento que incluíram granulometria, matéria orgânica e carbonatos. As relações entre a distribuição dos holoturóides e as características do sedimento foram caracterizadas através das analisadas dos Componentes Principais (PCA), Correspondência Canônica (ACC), análise de Cluster usando o método UPGMA e Ordenação Multidimensional Não Paramétrica (NMDS). Foram identificadas 17 espécies de Holothuroidea, sendo a maioria encontrada embaixo de rochas e em áreas protegidas. Duas espécies, *Epitomapta roseola* e *Psolus tuberculosus* são novos registros para a América do Sul. *Holothuria grisea* apresentou a maior número de ocorrência, além de *Synaptula hydriformis* no recife da Ponta Verde e *Trachythyone crassipeda* no recife de Riacho Doce que foram classificadas como frequentes. A análise da porcentagem de carbonatos apresentou a maior variação entre as características do sedimento. Constatou-se na análise de cluster a formação de três grupos com aproximadamente 45% de similaridade, sendo confirmado no NMDS e na Correspondência Canônica que demonstrou a influência das características do sedimento na distribuição dos holoturóides nos ecossistemas recifais do litoral central de Alagoas.

**Palavras chave:** Pepinos-do-mar. Carbonatos. Recife de coral. Recife de arenito. Distribuição.

## ABSTRACT

The invertebrates on the class Holothuroidea are exclusively marine, call as sea cucumbers, and they are important components on reef ecosystems, which have largely perform in the much recycling of nutrients in the sediment of these and other coastal environments. However, the effect of Holothuroidea in marine communities is rarely documented, and suggesting that need for ecological studies on this group. Knowledge of class Holothuroidea on the Brazilian coast, particularly in reef ecosystems on the northeast is scarce. The present study describes the Holothuroidea species present in shallow reef ecosystems from Alagoas, including ecological and spatial distribution based on sediment characteristics as carbonates, organic matter and particle size. This study was conducted in nine reef ecosystems located in the central coast of Alagoas, with samples from intertidal zones up to 20m deep. The species identification was performed according to standard methodology and specific bibliography, as well as the sediment samples that were analyzed on the texture, organic matter and carbonates. The relationships between the distribution of Holothuroidea species and sediment characteristics were characterized by analyzed of Principal Component (PCA), Canonical Correspondence (ACC), Cluster analysis using UPGMA and Multidimensional Non Parametric (NMDS). In total, 17 species were identified from Holothuroidea, mostly found under rocks and in protected areas. *Holothuria grisea* had the highest occurrence in all reefs studied. Two other species were classified as common *Synaptula hydriformis* on the Ponta Verde coral reef and *Trachythyone crassipeda* the Riacho Doce coral reef. The analysis of the percentage of carbonates showed the greatest variation between the characteristics of the sediment. The cluster analysis indicated the formation of three groups with approximately 45% similarity, which was confirmed by NMDS, as well as CCAs demonstrated the influence of the sediment characteristics in the distribution of Holothuroidea species along the coral reefs on the central coastal Alagoas.

**Keywords:** Sea cucumber. Carbonates. Coral reef. Sandstone reef. Distribution.

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## APRESENTAÇÃO

A formatação da presente dissertação foi realizada conforme orientação estabelecida na Instrução Normativa 02/2010 do Programa de Pós-Graduação em Diversidade Biológica e Conservação nos Trópicos da Universidade Federal de Alagoas (PPG-DIBICT/UFAL).

Optou-se como modelo organizacional a divisão em capítulos, correspondendo a três artigos que foram produzidos sobre tema “Holothuroidea (Echinodermata) dos Ecossistemas Recifais do Litoral Central de Alagoas, Brasil”. Entre esses, um artigo encontra-se publicado em periódico nacional e os outros dois artigos foram submetidos para periódicos internacionais, todos esses relacionados no Qualis CAPES.

O Capítulo I refere-se ao artigo intitulado “Inventário da Coleção de Echinodermata do Setor de Comunidades Bentônicas da Universidade Federal de Alagoas”, o qual serviu como base para o desenvolvimento dos capítulos posteriores dessa dissertação. Nesse artigo foram registradas 50 espécies distribuídas entre as cinco classes pertencentes ao Filo Echinodermata, incluindo exemplares da Classe Holothuroidea representada por 14 espécies. Todos os exemplares do Filo Echinodermata foram devidamente numerados e catalogados em um Livro Tombo informatizado, onde constam os locais de ocorrência de cada uma das espécies de holoturias existentes no litoral do Estado de Alagoas. Esse artigo encontra-se publicado no periódico *Biota Neotropica*, volume 12(2): 135-146, 2012, o qual foi apresentado como pré-requisito para a qualificação no Programa de Pós-graduação em Diversidade Biológica e Conservação nos Trópicos (PPG-DIBICT/UFAL).

No Capítulo II, com o artigo intitulado “Holothuroidea (Echinodermata) from reef ecosystems on the central coast of Alagoas, Brazil, with two new records to South America”, objetivou registrar as espécies da Classe Holothuroidea, Filo Echinodermata, presentes em nove ecossistemas recifais, sendo seis recifes de coral e outros três recifes de arenito, localizados ao longo do litoral central do estado de Alagoas, nordeste do Brasil. Nesse artigo foram incluídas descrições taxonômicas das espécies de holoturias, incluindo fotografias dos exemplares e seus respectivos corpúsculos calcários, além de informações sobre ecologia, preferência por habitat e distribuição zoogeográfica, tanto em relação aos ecossistemas recifais estudados

quanto globalmente, sendo também publicados dois novos registros para o Oceano Atlântico Sul que foram encontrados durante essa pesquisas.

O Capítulo III incluiu o artigo “Effects of the sediment composition on the distribution of Holothuroidea species (Echinodermata) on the central coast of Alagoas state, Northeast of Brazil.” Neste foram discutidas as relações entre composição do sedimento e a distribuição das espécies de holoturóides observadas nos nove ecossistemas recifais localizados no litoral central de Alagoas, Nordeste do Brasil. Optou-se por realizar análises multivariadas incluindo Análise dos Componentes Principais (PCA), Ordenação Multidimensional Não Paramétrica (NMDS) e Análise de Correspondentes Canônicos (ACC), além da análise de Agrupamento (Cluster), visando relacionar a distribuição das espécies com as características variáveis do sedimento, tais como porcentagem de matéria orgânica e carbonatos, assim como a análise granulométrica baseada na porcentagem de cascalho, areia e finos.

# CAPÍTULO 1

## INVENTORY OF THE ECHINODERMATA COLLECTION FROM THE UNIVERSIDADE FEDERAL DE ALAGOAS.

Anderson Luiz Silva Miranda<sup>1</sup>, Maria Lilian de Freitas Lima<sup>1</sup>, Hilda Helena Sovierzoski<sup>1</sup> and Monica Dorigo Correia<sup>1</sup>

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### ABSTRACT

Collections and inventories provide important and essential information for understanding the composition and distribution of biodiversity. This contribution presents an inventory of the species held in the Echinodermata collection in the Setor de Comunidades Bentônicas (LABMAR/ICBS), Universidade Federal de Alagoas. The collections were made over a period of more than 20 years, at several localities of coastal Alagoas. This collection now includes 16,201 catalogued individual specimens, with 50 species in the five extant classes Crinoidea, Asteroidea, Ophiuroidea, Echinoidea and Holothuroidea, based on 640 records and the class Ophiuroidea is best represented. The results of this inventory contribute significantly to knowledge of marine benthic diversity from the state of Alagoas, and the information presented here expands the data for Echinodermata from the northeastern coast of Brazil.

**Keywords:** Biodiversity, Echinoderm, Taxonomy, Benthic macroinvertebrate, Brazil.

## 1.1. Introduction

Zoological catalogues and collections on regional scales are important to understand the composition and distribution of national and global faunas (MIKKELSEN;CRACRAFT, 2001). Such data is the principal source of information on biodiversity distribution, providing knowledge of areas yet unexplored, and also reveals local extinctions and reductions in species distributions (NOGUEIRA *et al.*, 2009). Zoological scientific collections are important records of Brazilian biodiversity, because the increasing occupation and intensity of human impacts often result in species extinction (ZAHER;YOUNG, 2003).

In Brazil, knowledge of zoological collections is still sparse, especially for the North and Northeast regions. For example, information on collections of Echinodermata is mostly limited to the Southeast region, in institutions such as the Museu Nacional of the Universidade Federal do Rio de Janeiro, the Museu de Zoologia of the Universidade de São Paulo and the Museu de Zoologia of the Universidade de Campinas (AMARAL;JABLONSKI, 2005, VENTURA *et al.*, 2009). In the Brazilian Northeast, other specific collections with Brazilian specimens of Echinodermata have been established more recently in universities in the states of Bahia (MANSO *et al.*, 2008), Paraíba (GONDIM *et al.*, 2008), Pernambuco (LIMA;FERNANDES, 2009), and Sergipe (OLIVEIRA *et al.*, 2010).

The first reference to the phylum Echinodermata for the Brazilian coast was based on notes published by Verrill (1868), when this group was still called Radiata, based on samples collected in the Abrolhos area off southern Bahia. Later, Rathbun (1879) surveyed the distribution of species of Echinodermata. The species and distribution of Echinodermata according to salinity in Guanabara Bay, state of Rio de Janeiro (RJ) were characterized by Krau (1950). The first catalogue of echinoderms from the Brazilian coast was made available by Brito (1962). Several studies and remarks about the fauna of Echinodermata along the Brazilian coast have been contributed, especially by Tommasi (1985, 1999). The diversity of Echinodermata from the west coast of the Atlantic Ocean was described by Hendler *et al.*, (1995), who provided taxonomic and ecological information, with some citations for the Brazilian coast. Castro *et al.*, (1999) observed the occurrence of Echinodermata at different depths in Ilha Grande Bay (RJ). Netto, Hadel and Thiago (2005) published new records

from studies on the São Paulo coast. Xavier (2010) reviewed the literature and listed species of Echinodermata from the Santa Catarina coast.

On the Brazilian northeastern coast, Lima-Verde (1969) studied the Echinodermata from shallow waters from the mouth of the Parnaíba River in Piauí state, to the mouth of the São Francisco River in Alagoas state. Albuquerque (1986) investigated the fauna of Ophiuroidea from the northern and northeastern continental shelf. Echinodermata from the coast of Bahia were characterized for several reef and soft bottom substrates (ALVES; CERQUEIRA, 2000, MAGALHÃES *et al.*, 2005, MANSO *et al.*, 2008). The diversity of echinoderms from the Ceará coast was characterized by Martins and Queiroz (2006). In the intertidal zone of Cabo Branco, Paraíba state, the echinoderm fauna was analyzed according to habitat (GONDIM *et al.*, 2008). New records of Ophiuroidea were reported from shallow waters on the coast of Maceió, Alagoas (LIMA *et al.*, 2011).

Most of the catalogues of Echinodermata include mainly representatives of class Ophiuroidea, and some of these publications included descriptions of new species and records (TOMMASI, 1970; 1999; TOMMASI; ABREU, 1974). Other studies were based on specimens obtained from oceanographic research cruises that dredged along different parts on the Brazilian coast, and included descriptions, notes, ecological and biogeographical aspects of Ophiuroidea (MONTEIRO, 1987; MANSO, 1989; ABSALÃO; MANSO, 1990; MANSO, 1991; BORGES; MONTEIRO; AMARAL, 2002; BORGES; AMARAL, 2006; VENTURA *et al.*, 2007; BORGES; YOKOYAMA; AMARAL, 2011).

This contribution presents a catalogue and information on the collection of material of the phylum Echinodermata, held by the Setor de Comunidades Bentônicas (LABMAR/ICBS), Universidade Federal de Alagoas.

## **1.2. Material and Methods**

The present inventory is based on specimens from the intertidal zone and shallow waters, including coral reefs, sandstone reefs, beaches, soft bottoms, and the phytal, which is abundant along the coast of Alagoas (CORREIA; SOVIERZOSKI, 2009; CORREIA, 2011).

The specimens were collected from different sites on the coast of Alagoas (8°55'S-36°10'W / 10°30'S-36°23'W), including the following localities, from north to

south: Maragogi - Galés (9°01'07"S-35°12'13"W); São Miguel dos Milagres - Porto da Rua (9°15'11"S-35°20'31"W); Passo de Camaragibe – Camaragibe River bar (9°18'47"S-35°24'54"W); Paripueira – Natural Pool (9°28'25"S-35°32'40"W); Maceió - Ipioca (9°29'55"S-35°33'50"W), Ponta do Prego (9°31'48"S-35°35'30"W), Ponta do Meirim (9°32'37"S-35°36'52"W), Sereia (9°34'04"S-35°38'46"W), Riacho Doce (9°34'55"S- 35°39'25"W), Guaxuma (9°35'33"S-35°39'54"W), Jatiúca (9°39'12"S-35°41'46"W), Ponta Verde (9°39'57"S-35°41'32"W), Piscina dos Amores (9°40'39"S-35°42'10"W), Pajuçara (9°41'06"S-35°43'22"W), Sobral sewel outfall (9°40'45"S-35°45'00"W); Marechal Deodoro - channel of the Manguaba lagoon (9°43'13"S-35°48'23"W), Saco da Pedra (9°44'26"S-35°48'59"W) and Francês (9°46'03"S-35°50'13"W); Barra de São Miguel – São Miguel River bar (9°50'10"S-35°53'05"W); Jequiá da Praia - Lagoa Azeda (9°58'04"S - 35°58'32"W); Coruripe - Pontal do Coruripe (10°07'32"S-36°10'32"W); and Piaçabuçu - Pontal do Peba (10°21'25"S-36°17'40"W) (Figure 1).

The samples were transported to the Setor de Comunidades Bentônicas, where they were sorted, anesthetized with 10% MgCl<sub>2</sub>, and then fixed with 4% formaldehyde for 24 to 48 h. The specimens were conserved in 70% ethanol and assigned a catalogue number. The material was identified with specialized bibliography to the lowest possible taxonomic category, based on Clark and Downey (1992), Tommasi (1969, 1999), Hendler *et al.*, (1995) and Pawson, Pawson and King (2010), and when necessary was sent to a specialist for confirmation of the identification. All remarks on the species of Echinodermata in this collection were entered in a database, available from the Setor de Comunidades Bentônicas, Universidade Federal de Alagoas (UFAL/ECH).

Figure 1 – Map showing the sites studied on the coast of Alagoas state, northeastern Brazil.



Fonte: Autor dessa dissertação / Google Earth, 2013.

### 1.3. Results

The catalogue lists 16,201 individuals in the five extant classes Crinoidea, Asteroidea, Ophiuroidea, Echinoidea, and Holothuroidea. To date, the collection includes 640 records representing 50 species. The class Ophiuroidea is best represented, followed by the class Holothuroidea. Classes Asteroidea and Echinoidea include fewer families, with different numbers of genera and species. Only one family and a single species of the class Crinoidea are represented.

Most of the Echinodermata species were collected from reef ecosystems. The reefs provide different substrata composed by algae, corals, and sponges, and of these, macroalgae harbored most individuals of Ophiuroidea and Holothuroidea. Specimens of classes Asteroidea, Echinoidea, and Crinoidea were recorded on coral and sandstone reefs, and some species of Asteroidea and Echinoidea were also found on soft bottoms.

The class Ophiuroidea is the most abundant taxon recorded for the Alagoas coast, with 14,837 individuals, in seven families and 19 species (Table 1).

Table 1: Species of class Ophiuroidea catalogued in the Echinodermata collection of the Setor de Comunidades Bentônicas, Universidade Federal de Alagoas (UFAL/ECH).

Taxa	Nº Ind.	Records	Substrate
Family Ophirolepididae			
<i>Ophirolepis impressa</i>	1	1	Coral reef
<i>Ophirolepis paucispina</i>	9	6	Coral reef, algae
Family Ophiodermatidae			
<i>Ophioderma appressa</i>	21	15	Coral reef, sandstone reef, algae
<i>Ophioderma cinerea</i>	10	9	Coral reef, sandstone reef , algae
Family Ophiocomidae			
<i>Ophiocoma echinata</i>	7	4	Coral reef, sandstone reef
<i>Ophiocoma wendti</i>	1	1	Coral reef
<i>Ophiocomella ophiactoides</i>	263	37	Coral reef, algae, coral and hydrocoral
Family Ophionereidae			
<i>Ophionereis reticulata</i>	22	16	Coral reef, sandstone reef
<i>Ophionereis squamulosa</i>	1	1	Coral reef
Family Ophiactidae			
<i>Ophiactis brasiliensis</i>	125	10	Coral reef, sandstone reef, algae, coral



<i>Ophiactis lymani</i>	118	25	Coral reef, sandstone reef, algae, sponge, coral, polychaetes and fouling
<i>Ophiactis quinqueradia</i>	5	4	Sponge
<i>Ophiactis savignyi</i>	7,033	129	Coral reef, sandstone reef, algae, sponge, coral and soft bottom
Family Amphiuridae			
<i>Amphipholis januarii</i>	7	5	Recife de coral, soft bottom, algae
<i>Amphipholis squamata</i>	7,084	96	Coral reef, sandstone reef, algae, sponge, coral and fouling
<i>Amphiura kinbergi</i>	1	1	Fouling
<i>Ophiocnida loveni</i>	2	1	Coral reef
<i>Ophiocnida scabriuscula</i>	4	4	Coral reef
Family Ophiotrichidae			
<i>Ophiothrix (Ophiothrix) angulata</i>	123	60	Coral reef, sandstone reef, algae, sponge, coral and fouling
Total	14,837	425	

Fonte: Autor desta dissertação, 2013.

#### Class Ophiuroidea

Order Ophiurida Müller;Troschel, 1840

Family Ophiolepididae Ljungman, 1867

Genus *Ophiolepis* Müller;Troschel, 1840

*Ophiolepis impressa* Lütken, 1859: one record. Brazil, Alagoas, Paripueira - Natural Pool UFAL/ECH 0620.

*Ophiolepis paucispina* (Say, 1825): six records. Brazil, Alagoas, Maceió - Ponta do Prego reef UFAL/ECH 0478; Ponta Verde reef UFAL/ECH 0147, 0172, 0249, 0411, 0533.

Family Ophiodermatidae Ljungman, 1867

Genus *Ophioderma* Müller;Troschel, 1840

*Ophioderma appressa* (Say, 1825): 15 records. Brazil, Alagoas, Maceió - Ipioca reef UFAL/ECH 0541; Ponta do Prego reef UFAL/ECH 0537, 0549; Ponta do Meirim reef UFAL/ECH 0517, 0526, 0527; Sereia reef UFAL/ECH 0470, 0535; Jatiúca reef UFAL/ECH 0511; Ponta Verde reef UFAL/ECH 0210, 0376, 0412; Pajuçara reef UFAL/ECH 0025. Marechal Deodoro - Saco da Pedra reef UFAL/ECH 0331; Francês reef UFAL/ECH 0387 (Figure 2a).

*Ophioderma cinerea* Müller;Troschel, 1842: nine records. Brazil, Alagoas, Maceió - Ponta do Prego reef UFAL/ECH 0546; Ponta do Meirim reef UFAL/ECH 0528; Sereia reef UFAL/ECH 0497; Riacho Doce reef UFAL/ECH 0560; Ponta Verde reef

UFAL/ECH 0016, 0127, 0133, 0587. Marechal Deodoro – Francês reef UFAL/ECH 0615.

Family Ophiocomidae Ljungman, 1867

Genus *Ophiocoma* L. Agassiz, 1835

*Ophiocoma echinata* (Lamarck, 1816): four records. Brazil, Alagoas, Maceió - Riacho Doce reef UFAL/ECH 0389; Jatiúca reef UFAL/ECH 0624. Marechal Deodoro - Francês reef UFAL/ECH 0228. São Miguel dos Milagres - Porto da Rua reef UFAL/ECH 0175 (Figure 2b).

*Ophiocoma wendti* Müller;Troschel, 1842: one record. Brazil, Alagoas, Marechal Deodoro – Francês UFAL/ECH 0623.

Genus *Ophiocomella* A.H. Clark, 1939

*Ophiocomella ophiactoides* (H. L. Clark, 1901): 37 records. Brazil, Alagoas, Maceió - Ponta do Meirim reef UFAL/ECH 0529; Ponta Verde reef UFAL/ECH 0064, 0066, 0067, 0087, 0091, 0110, 0120, 0150, 0160, 0166, 0186, 0197, 0201, 0213, 0225, 0241, 0244, 0248, 0259, 0262, 0265, 0287, 0303, 0329, 0367, 0370, 0374, 0408, 0409, 0442, 0465, 0553, 0593. Maragogi - Galés reef UFAL/ECH 0107, 0109. Marechal Deodoro – Francês reef UFAL/ECH 0614.

Family Ophionereididae Ljungman, 1867

Genus *Ophionereis* Lütken, 1856

*Ophionereis reticulata* (Say, 1825): 16 records. Brazil, Alagoas, Maceió - Ipioca reef UFAL/ECH 0542; Ponta do Prego reef UFAL/ECH 0547; Ponta do Meirim reef UFAL/ECH 0516; Sereia reef UFAL/ECH 0534, 0563; Riacho Doce reef UFAL/ECH 0390; Jatiúca reef UFAL/ECH 0291, 0636; Ponta Verde reef UFAL/ECH 0142, 0157, 0267; Pajuçara reef UFAL/ECH 0381. Maragogi - Galés reef UFAL/ECH 0105. Marechal Deodoro - Saco da Pedra reef UFAL/ECH 0334, 0480; Francês reef UFAL/ECH 0475 (Figure 2c).

*Ophionereis squamulosa* Koehler, 1914: 1 record. Brazil, Alagoas, Maceió – Jatiúca UFAL/ECH 0625.

Family Ophiactidae Matsumoto, 1915

Genus *Ophiactis* Lütken, 1856

*Ophiactis brasiliensis* Manso, 1988: 10 records. Brazil, Alagoas, Maceió - Ponta do Meirim reef UFAL/ECH 0519; Ponta Verde reef UFAL/ECH 0037, 0068; Piscina dos Amores reef UFAL/ECH 0485; Pajuçara reef UFAL/ECH 0380, 0559, 0626. Maragogi - Galés reef UFAL/ECH 0108. Marechal Deodoro - Francês reef UFAL/ECH 0072, 0639.

*Ophiactis lymani* Ljungman, 1872: 25 records. Brazil, Alagoas, Maceió - Ponta do Meirim reef UFAL/ECH 0518; Ponta Verde reef UFAL/ECH 0089, 0102, 0118, 0164, 0270, 0301, 0325, 0372, 0403, 0404, 0460, 0461, 0552, 0603. Sobral sewel outfall UFAL/ECH 0114, 0585. Jequiá da Praia - Lagoa Azeda reef UFAL/ECH 0231. Maragogi – Galés reef UFAL/ECH 0106. Marechal Deodoro - Francês reef UFAL/ECH 0343, 0638; Saco da Pedra reef UFAL/ECH 0277, 0305, 0337, 0355.

*Ophiactis quinqueradía* Ljungman, 1872: four records. Brazil, Alagoas, Maceió - Ponta Verde reef UFAL/ECH 0136, 0255. Marechal Deodoro - Saco da Pedra reef UFAL/ECH 0338. Paripueira - Natural Pool UFAL/ECH 0622.

*Ophiactis savignyi* (Müller;Troschel, 1842): 129 records. Brazil, Alagoas, Maceió - Ponta do Meirim reef UFAL/ECH 0554, 0557, 0564; Sereia reef UFAL/ECH 0489, 0617, 0631; Riacho Doce reef UFAL/ECH 0447; Garça Torta reef UFAL/ECH 0055; Jatiúca reef UFAL/ECH 0309, 0349, 0430, 0443, 0628; Ponta Verde reef UFAL/ECH 0009, 0013, 0036, 0048, 0058, 0060, 0062, 0065, 0070, 0077, 0079, 0081, 0083, 0085, 0088, 0097, 0099, 0101, 0112, 0113, 0117, 0122, 0128, 0134, 0135, 0138, 0143, 0145, 0148, 0158, 0161, 0163, 0180, 0182, 0184, 0193, 0195, 0198, 0205, 0208, 0211, 0220, 0223, 0239, 0242, 0245, 0256, 0257, 0260, 0263, 0269, 0271, 0285, 0298, 0300, 0321, 0322, 0324, 0327, 0365, 0368, 0371, 0398, 0401, 0402, 0436, 0437, 0438, 0457, 0458, 0459, 0543, 0554, 0581, 0592, 0596, 0604, 0606; Piscina dos Amores reef UFAL/ECH 0486; Pajuçara reef UFAL/ECH 0352, 0382, 0627; Sobral sewel outfall UFAL/ECH 0187, 0413, 0424, 0583, 0584, 0599, 0608, 0634. Maragogi - Galés reef UFAL/ECH 0044, 0168. Marechal Deodoro - Saco da Pedra reef UFAL/ECH 0278, 0306, 0308, 0332, 0339, 0354, 0385, 0449, 0450, 0530; Francês reef UFAL/ECH 0023, 0075, 0227, 0272, 0292, 0304, 0342, 0345, 0377, 0616, 0640. Paripueira - Natural pool UFAL/ECH 0358. Passo de Camaragibe - Camaragibe River bar UFAL/ECH 0582. São Miguel dos Milagres - Porto da Rua reef UFAL/ECH 0177.

Genus *Amphipholis* Ljungman, 1866

*Amphipholis januarii* Ljungman, 1866: five records. Brazil, Alagoas, Maceió - Jatiúca reef UFAL/ECH 0429; Ponta Verde UFAL/ECH 0200, 0247. Jequiá da Praia - Lagoa Azeda reef UFAL/ECH 0230. Paripueira – Cabeço UFAL/ECH 0618.

*Amphipholis squamata* (Delle Chiaje, 1828): 96 records. Brazil, Alagoas, Maceió - Ponta do Prego reef UFAL/ECH 0550; Ponta do Meirim reef UFAL/ECH 0520, 0558; Sereia reef UFAL/ECH 0490, 0629; Riacho Doce reef UFAL/ECH 0104; Jatiúca reef UFAL/ECH 0347, 0513; Pajuçara reef UFAL/ECH 0032, 0076; Ponta Verde reef UFAL/ECH 0008, 0014, 0059, 0061, 0063, 0069, 0071, 0078, 0080, 0082, 0084, 0086, 0090, 0098, 0100, 0103, 0115, 0116, 0119, 0144, 0146, 0149, 0159, 0162, 0165, 0173, 0181, 0183, 0185, 0194, 0196, 0199, 0206, 0209, 0212, 0221, 0222, 0224, 0240, 0243, 0246, 0258, 0261, 0264, 0284, 0286, 0297, 0299, 0302, 0323, 0326, 0328, 0366, 0369, 0373, 0405, 0406, 0407, 0439, 0440, 0441, 0462, 0463, 0464, 0501, 0512, 0555, 0556, 0580, 0590, 0595, 0597, 0602, 0605; Sobral sewel outfall UFAL/ECH 0414, 0423, 0427, 0598, 0607, 0635. Maragogi - Galés reef UFAL/ECH 0169. Marechal Deodoro - Saco da Pedra reef UFAL/ECH 0336, 0357; Francês reef UFAL/ECH 0341, 0637. Paripueira – Natural Pool UFAL/ECH 0619.

Genus *Amphiura* Forbes, 1843

*Amphiura kinbergi* Ljungman, 1872: one record. Brazil, Alagoas, Maceió - Sobral sewel outfall UFAL/ECH 0576.

Genus *Ophiocnida* Lyman, 1865

*Ophiocnida loveni* (Ljungman, 1867): one record. Brazil, Alagoas, Maceió - Jatiúca reef UFAL/ECH 0275.

*Ophiocnida scabriuscula* (Lütken, 1859): four records. Brazil, Alagoas, Maceió - Ponta do Meirim reef UFAL/ECH 0514; Jatiúca reef UFAL/ECH 0252; Ponta Verde reef UFAL/ECH 0215, 0266.

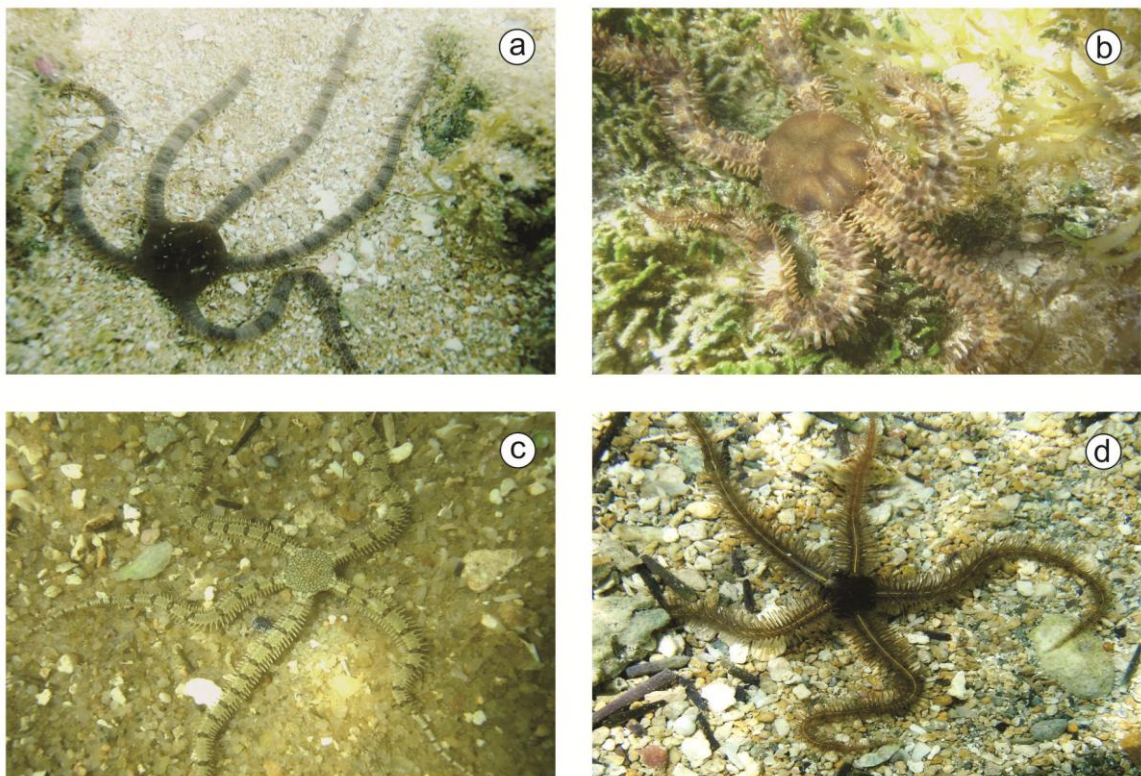
## Family Ophiotrichidae Ljungman, 1867

Genus *Ophiothrix* Müller;Troschel, 1840

*Ophiothrix angulata* (Say, 1825): 60 records. Brazil, Alagoas, Maceió - Ponta do Prego reef UFAL/ECH 0538, 0551; Sereia reef UFAL/ECH 0471, 0496, 0532, 0562, 0632; Riacho Doce reef UFAL/ECH 0561; Garça Torta reef UFAL/ECH 0052; Guaxuma reef

UFAL/ECH 0499; Jatiúca reef UFAL/ECH 0167, 0251, 0276, 0426; Ponta Verde reef UFAL/ECH 0001, 0002, 0017, 0035, 0188, 0207, 0214, 0226, 0288, 0320, 0330, 0375, 0410, 0466, 0600, 0601; Piscina dos Amores reef UFAL/ECH 0421; Pajuçara reef UFAL/ECH 0420, 0508; Sobral sewer outfall UFAL/ECH 0056, 0425, 0467. Barra de São Miguel - Barra de São Miguel reef UFAL/ECH 0033. Coruripe - Pontal de Coruripe reef UFAL/ECH 0525. Jequiá da Praia - Lagoa Azeda reef UFAL/ECH 0229. Marechal Deodoro – Manguaba lagoon channel UFAL/ECH 0004; Saco da Pedra reef UFAL/ECH 0279, 0307, 0333, 0335, 0353, 0356, 0384, 0388, 0448, 0481; Francês reef UFAL/ECH 0024, 0074, 0268, 0340, 0378, 0386, 0419, 0633. Paripueira – Natural Pool UFAL/ECH 0621. São Miguel dos Milagres - Porto da Rua reef UFAL/ECH 0178 (Figure 2d).

Figure 2 – Some species of the class Ophiuroidea recorded on the Echinodermata collection of the Sector of Benthic Communities, University Federal of Alagoas (UFAL/ECH): a) *Ophioderma appressa*, b) *Ophiocoma echinata*, c) *Ophionereis reticulata* and d) *Ophiothrix angulata*.



Fonte: Autor desta dissertação, 2013.

The class Holothuroidea has 1,214 individuals recorded, distributed in eight families and 14 species. *Synaptula hydriformis* is the most abundant species (Table 2).

Table 2: Species of class Holothuroidea catalogued in the Echinodermata collection of the Setor de Comunidades Bentônicas, Universidade Federal de Alagoas (UFAL/ECH).

Taxa	Ind.	Records	Substrate
Family Psolidae			
<i>Lissothuria braziliensis</i>	1	1	Coral reef
Family Phylloporidae			
<i>Phylloporus (Urodemella) occidentalis</i>	16	6	Coral reef
<i>Stolus cognatus</i>	6	4	Coral reef
Family Sclerodactylidae			
<i>Pseudothyone belli</i>	1	1	Algae
Family Cucumariidae			
<i>Aslia Pygmaea</i>	2	2	Coral reef and algae
<i>Duasmodyctyla seguroensis</i>	16	8	Coral reef
<i>Ocnus braziliensis</i>	62	20	Coral reef, sandstone reef
<i>Ocnus suspectus</i>	4	4	Coral reef, sandstone reef
Family Holothuriidae			
<i>Holothuria (Halodeima) grisea</i>	27	15	Coral reef, sandstone reef
<i>Holothuria (Platyperona) parvula</i>	2	2	Coral reef
<i>Holothuria (Thymiosycia) arenicola</i>	2	1	Coral reef, sandstone reef
Family Stichopodidae			
<i>Isostichopus badionotus</i>	2	2	Sandstone reef
Family Synaptidae			
<i>Synaptula hydriformis</i>	968	40	Algae
Family Chiridotidae			
<i>Chiridota rotifera</i>	105	35	Coral reef, algae
Total	1,214	141	

Fonte: Autor desta dissertação, 2013.

## Class Holothuroidea

Order Dendrochirotida Grube, 1840

Family Psolidae Perrier, 1902

Genus *Lissothuria* Verrill, 1867

*Lissothuria braziliensis* (Théel, 1886): one record. Brazil, Alagoas, Maceió - Ipioca reef UFAL/ECH 0575.

Family Phyllophoridae Oestergren, 1907

Genus *Phyllophorus* Grube, 1840

*Phyllophorus (Urodemella) occidentalis* Ludwig, 1875: six records. Brazil, Alagoas, Maceió - Ponta do Prego reef UFAL/ECH 0539; Riacho Doce reef UFAL/ECH 0394, 0507; Ponta Verde reef UFAL/ECH 0311; Pajuçara reef UFAL/ECH 0020, 0043.

Genus *Stolus* Selenka, 1867

*Stolus cognatus* (Lampert, 1885): four records: Brazil, Alagoas, Maceió - Riacho Doce reef UFAL/ECH 0393, 0612; Jatiúca reef UFAL/ECH 0250, 0274 (Figure 3a).

Family Sclerodactylidae Panning, 1949

Genus *Pseudothyone* Panning, 1949

*Pseudothyone belli* (Ludwig, 1887): one record: Brazil, Alagoas, Maceió – Ponta do Meirim reef UFAL/ECH 0589.

Family Cucumariidae Ludwig, 1894

Genus *Aslia* Rowe, 1970

*Aslia Pygmaea* (Théel, 1886a): two records. Brazil, Alagoas, Maceió – Sereia reef UFAL/ECH 0609, 0630.

Genus *Duasmodyctyla* Ayres, 1854

*Duasmodyctyla seguroensis* (Deichmann, 1930): eight records. Brazil, Alagoas, Maceió - Ponta do Prego reef UFAL/ECH 0446; Riacho Doce reef UFAL/ECH 0392, 0418, 0422, 0613; Jatiúca reef UFAL/ECH 0273; Ponta Verde reef UFAL/ECH 0040, 0232.

Genus *Ocnus* Forbes, 1841

*Ocnus braziliensis* (Verrill, 1868): 20 records. Brazil, Alagoas, Maceió - Sereia reef UFAL/ECH 0494, 0536; Riacho Doce reef UFAL/ECH 0141, 0415, 0504; Garça Torta reef UFAL/ECH 0050; Jatiúca reef UFAL/ECH 0510; Ponta Verde reef UFAL/ECH 0022, 0039, 0053, 0121, 0126, 0395; Pajuçara reef UFAL/ECH 0012, 0029, 0042, 0045, 0046. Marechal Deodoro - Saco da Pedra UFAL/ECH 0383. Passo de Camaragibe – Camaragibe river bar UFAL/ECH 0350 (Figure 3b).

*Ocnus suspectus* (Ludwig, 1874): four records. Brazil, Alagoas, Maceió - Sereia reef UFAL/ECH 0495; Riacho Doce reef UFAL/ECH 0506, 0611; Ponta Verde reef UFAL/ECH 0586.

## Order Aspichirotida Grube, 1840

## Family Holothuriidae Ludwig, 1894

Genus *Holothuria* Linnaeus, 1767

*Holothuria (Halodeima) grisea* Selenka, 1867: 15 records. Brazil, Alagoas, Maceió - Sereia reef UFAL/ECH 0469, 0493; Riacho Doce reef UFAL/ECH 0391, 0505; Garça Torta reef UFAL/ECH 0049; Jatiúca reef UFAL/ECH 0348; Ponta Verde reef UFAL/ECH 0038, 0041, 0140; Pajuçara reef UFAL/ECH 0011, 0018, 0019, 0021, 0359. Marechal Deodoro - Saco da Pedra reef UFAL/ECH 0479 (Figure 3c).

*Holothuria (Platyperona) parvula* (Selenka, 1867): two record. Brazil, Alagoas, Maceió – Riacho Doce reef UFAL/ECH 0610; Ponta Verde reef UFAL/ECH 0487.

*Holothuria (Thymiosycia) arenicola* Semper, 1868; one record. Brazil, Alagoas, Marechal Deodoro - Francês reef UFAL/ECH 0474.

## Family Stichopodidae Haeckel, 1896

Genus *Isostichopus* Deichmann, 1958

*Isostichopus badionotus* (Selenka, 1867): two records. Brazil Alagoas, Marechal Deodoro - Francês reef UFAL/ECH 0344, 0531.

## Order Apodida Brandt, 1835

## Family Synaptidae Burmeister, 1837

Genus *Synaptula* Oersted, 1849

*Synaptula hydriformis* (Lesueur, 1824): 40 records. Brazil, Alagoas, Maceió - Ponta do Meirim reef UFAL/ECH 0545; Riacho Doce reef UFAL/ECH 0073; Ponta Verde reef



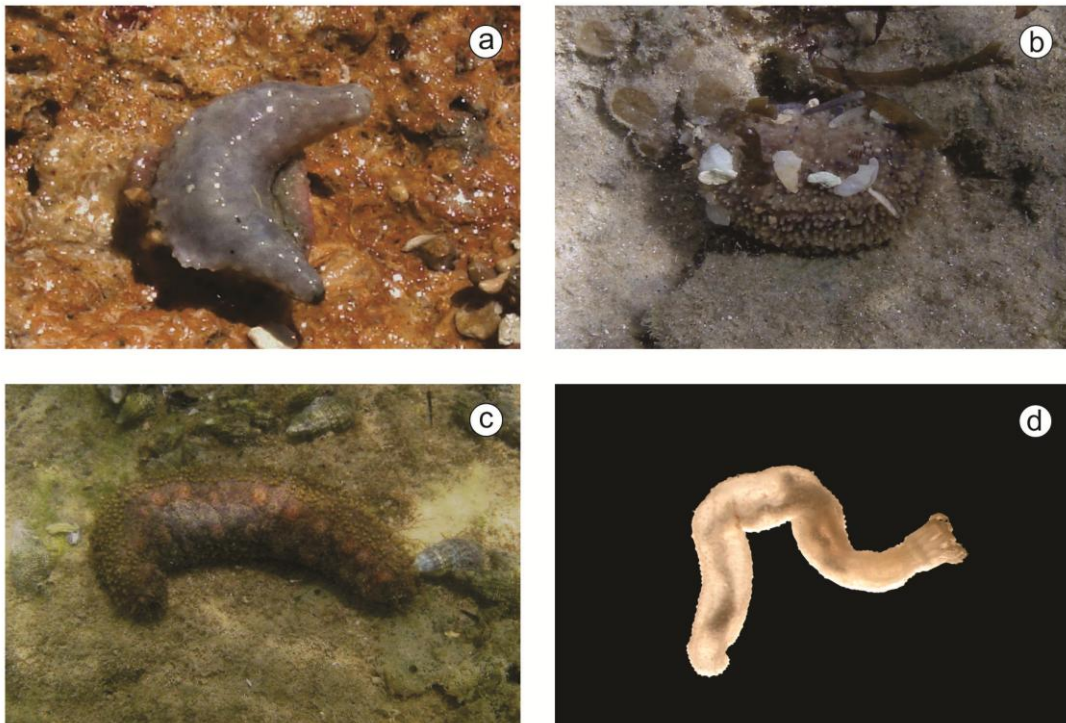
UFAL/ECH 0006, 0015, 0057, 0094, 0111, 0132, 0155, 0174, 0179, 0191, 0203, 0204, 0217, 0218, 0236, 0237, 0253, 0254, 0281, 0282, 0294, 0295, 0296, 0317, 0318, 0362, 0363, 0396, 0399, 0416, 0433, 0434, 0455, 0456, 0500, 0588, 0591, 0594 (Figure 3d).

Family Chiridotidae Oestergren, 1898

Genus *Chiridota* Eschscholtz, 1829

*Chiridota rotifera* (Pourtalès, 1851): 35 records. Brazil, Alagoas, Maceió - Ponta do Prego reef UFAL/ECH 0477; Garça Torta reef UFAL/ECH 0051; Ponta Verde reef UFAL/ECH 0007, 0095, 0154, 0156, 0171, 0176, 0189, 0190, 0192, 0202, 0216, 0219, 0234, 0235, 0238, 0280, 0283, 0293, 0315, 0316, 0319, 0361, 0364, 0397, 0400, 0417, 0431, 0432, 0435, 0454, 0476, 0502, 0503.

Figure 3 – Some species of the class Holothuroidea of the Echinodermata collection of the Sector of Benthic Communities, University Federal of Alagoas (UFAL/ECH): a) *Stolus cognatus*, b) *Ocnus braziliensis*, c) *Holothuria grisea* and d) *Synaptula hydriformis*.



Fonte: Autor desta dissertação, 2013.

The class Echinoidea is represented by 97 individuals, including five families and eight species. The most abundant Echinoidea species are *Echinometra lucunter*, *Eucidaris tribuloides* and *Lytechinus variegatus* (Table 3).

Table 3: Species of class Echinoidea catalogued in the Echinodermata collection of the Setor de Comunidades Bentônicas, Universidade Federal de Alagoas (UFAL/ECH).

Taxa	Ind.	Records	Substrate
Family Cidaridae			
<i>Eucidaris tribuloides</i>	33	5	Coral reef, sandstone reef
Family Diadematidae			
<i>Diadema antillarum</i>	1	1	Coral reef, sandstone reef
Family Echinometridae			
<i>Echinometra lucunter</i>	10	10	Coral reef, sandstone reef
Family Toxopneustidae			
<i>Lytechinus variegatus</i>	36	13	Coral reef, algae, mud
<i>Tripneustes ventricosus</i>	7	7	Coral reef, sandstone reef
Family Mellitidae			
<i>Encope emarginata</i>	6	2	Coral reef, soft bottom
<i>Leodia sexiesperforata</i>	1	1	Coral reef, soft bottom
<i>Mellita quinquesperforata</i>	3	2	Coral reef, soft bottom
Total	97	41	

Fonte: Autor desta dissertação, 2013.

Class Echinoidea

Order Cidaroida Claus, 1880

Family Cidaridae Gray, 1825

Genus *Eucidaris* Pomel, 1883

*Eucidaris tribuloides* (Lamarck, 1816): five records. Brazil, Alagoas, Maceió - Guaxuma reef UFAL/ECH 0498; Ponta Verde UFAL/ECH 0026. Barra de São Miguel - Barra de São Miguel reef UFAL/ECH 0030. Jequiá da Praia - Lagoa Azeda reef UFAL/ECH 0568, 0570 (Figure 4a).

Ordem Diadematoidea Duncan, 1889

Family Diadematidae Gray, 1855

Genus *Diadema* Gray, 1825

*Diadema antillarum* Philippi, 1845: one record. Brazil, Alagoas, Barra de São Miguel - Barra de São Miguel reef UFAL/ECH 0034 (Figure 4b).

Order Echinoida Claus, 1876

Family Echinometridae Gray, 1825

Genus *Echinometra* Gray, 1825

*Echinometra lucunter* (Linnaeus, 1758): 10 records. Brazil, Alagoas, Maceió - Sereia reef UFAL/ECH 0491; Ponta Verde reef UFAL/ECH 0123, 0137, 0151, 0170, 0312, 0451; Piscina dos Amores reef UFAL/ECH 0290, 0484. Marechal Deodoro - Saco da Pedra reef UFAL/ECH 0310 (Figure 4c).

Family Toxopneustidae Troschel, 1872

Genus *Lytechinus* A. Agassiz, 1863

*Lytechinus variegatus* (Lamarck, 1816): 13 records. Brazil, Alagoas, Maceió - Jatiúca reef UFAL/ECH 0129; Ponta Verde reef UFAL/ECH 0027, 0139, 0152, 0153, 0233, 0313, 0314, 0360, 0452; Piscina dos Amores reef UFAL/ECH 0289. Barra de São Miguel - Barra de São Miguel reef UFAL/ECH 0031. Jequiá da Praia - Lagoa Azeda reef UFAL/ECH 0569 (Figure 4d).

Genus *Tripneustes* L. Agassiz, 1841b

*Tripneustes ventricosus* (Lamarck, 1816): seven records. Brazil, Alagoas, Maceió - Ponta do Prego reef UFAL/ECH 0548; Sereia reef UFAL/ECH 0468, 0488, 0567; Jatiúca reef UFAL/ECH 0346, 0428, 0482 (Figure 4e).

Order Clypeasteroida L. Agassiz, 1835

Family Mellitidae Stefanini, 1912

Genus *Encope* L. Agassiz, 1840

*Encope emarginatus* (Leske, 1778): two records. Brazil, Alagoas, Maceió - Ponta do Prego reef UFAL/ECH 0444. Marechal Deodoro - Francês reef UFAL/ECH 0473 (Figure 4f).

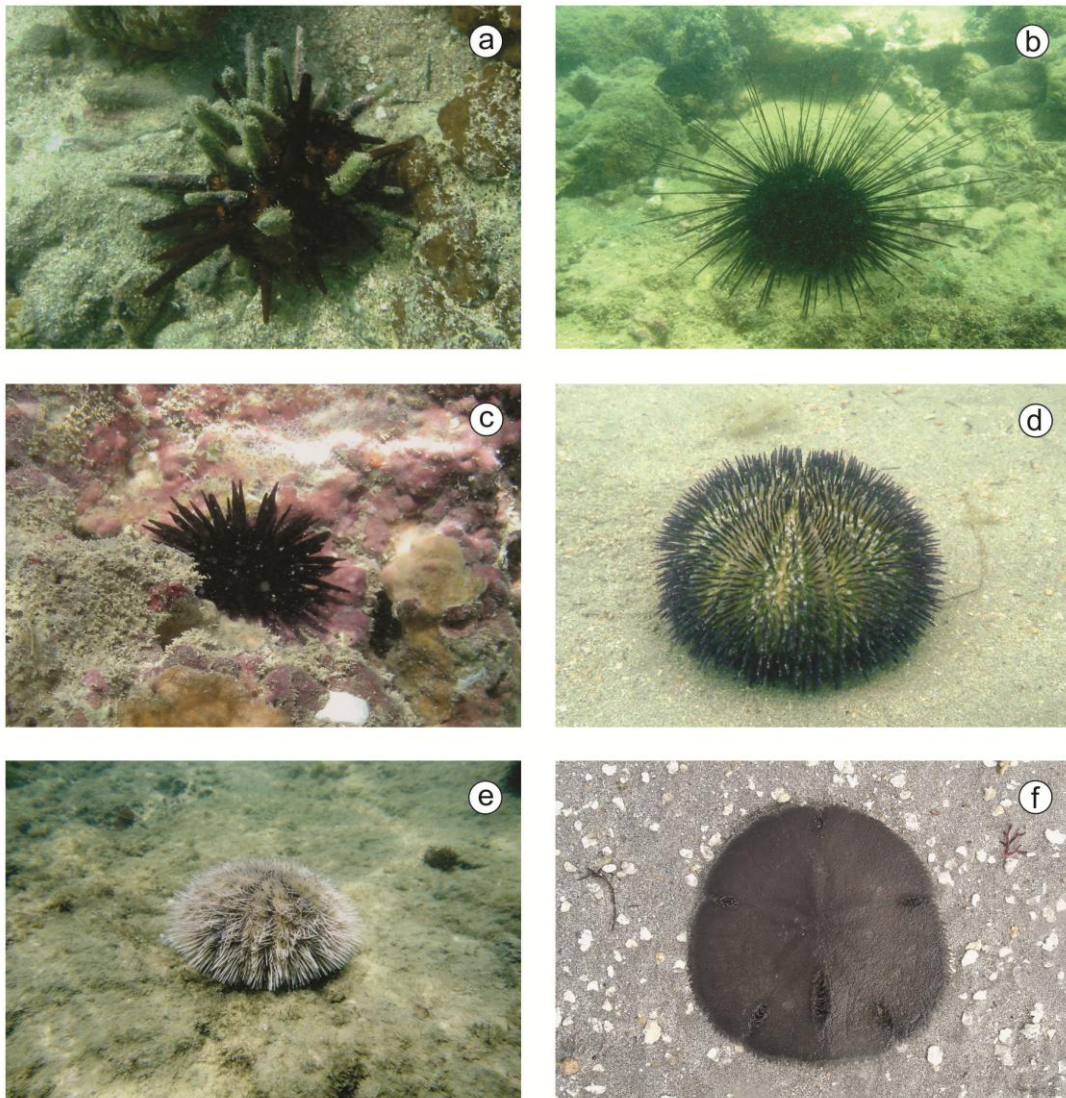
Genus *Leodia* Gray, 1851a

*Leodia sexiesperforata* (Leske, 1778): one record. Brazil, Alagoas, Marechal Deodoro - Francês reef UFAL/ECH 0565.

Genus *Mellita* L. Agassiz, 1841a

*Mellita quinquesperforata* (Leske, 1778): two records. Brazil, Alagoas, Maceió - Ponta do Meirim reef UFAL/ECH 0515. Coruripe - Lagoa do Pau UFAL/ECH 0524.

Figure 4 – Some species of the class Echinoidea on the Echinodermata collection of the Sector of Benthic Communities, University Federal of Alagoas (UFAL/ECH): a) *Eucidaris tribuloides*, b) *Diadema antillarum*, c) *Echinometra lucunter*, d) *Lytechinus variegatus*, e) *Tripneustes ventricosus* and f) *Encope emarginatus*.



Fonte: Autor desta dissertação, 2013.

The class Asteroidea is represented by 46 individuals, including five families and eight species. *Luidia senegalensis* and *Linckia guildingi* are the most abundant species (Table 4).

Table 4: Species of class Asteroidea catalogued in the Echinodermata collection of the Setor de Comunidades Bentônicas, Universidade Federal de Alagoas (UFAL/ECH).

Taxa	Ind.	Records	Substrate
Family Luidiidae			
<i>Luidia senegalensis</i>	16	3	soft bottom
<i>Luidia alternata</i>	1	1	soft bottom
Family Astropectinidae			
<i>Astropecten brasiliensis</i>	1	1	soft bottom
Family Oreasteridae			
<i>Oreaster reticulatus</i>	1	1	soft bottom
Family Ophidiasteridae			
<i>Linckia guildingi</i>	13	12	Recife de coral, sandstone reef
<i>Narcissia trigonaria</i>	2	1	soft bottom
Family Echinasteridae			
<i>Echinaster brasiliensis</i>	8	3	Coral reef, sandstone reef, soft bottom
<i>Echinaster echinophorus</i>	4	4	Coral reef, sandstone reef
Total	46	26	

Fonte: Autor desta dissertação, 2013.

#### Class Asteroidea

Order Paxillosida Perrier, 1884

Family Luidiidae Sladen, 1889

Genus *Luidia* Forbes, 1839

*Luidia senegalensis* (Lamarck, 1816): three records. Brazil, Alagoas, Jequiá da Praia - Lagoa Azeda reef UFAL/ECH 0572, 0573, 0578.

*Luidia alternata* (Say, 1825): one record. Brazil, Alagoas, Jequiá da Praia - Lagoa Azeda reef UFAL/ECH 0577.

Family Astropectinidae Gray, 1840

Genus *Astropecten* Gray, 1840

*Astropecten brasiliensis* Müller;Troschel, 1842: one record. Brazil, Alagoas, Jequiá da Praia - Lagoa Azeda reef UFAL/ECH 0571.

Order Valvatida Perrier, 1884

Family Oreasteridae Fisher, 1911

Genus *Oreaster* Müller;Troschel, 1842

*Oreaster reticulatus* (Linnaeus, 1758): one record. Brazil, Alagoas, Jequiá da Praia - Lagoa Azeda reef UFAL/ECH 0566.

Family Ophidiasteridae Verril, 1870

Genus *Linckia* Nardo, 1834

*Linckia guildingi* Gray, 1840: 12 records. Brazil, Alagoas, Maceió - Ponta do Prego reef UFAL/ECH 0445, 0523; Sereia reef UFAL/ECH 0492; Jatiúca reef UFAL/ECH 0130, 0509; Ponta Verde reef UFAL/ECH 0028, 0124, 0131; Piscina dos Amores reef UFAL/ECH 0125, 0522; Pajuçara reef UFAL/ECH 0010; Paripueira – Natural Pool UFAL/ECH 0047 (Figure 5a).

Genus *Narcissia* Gray, 1840

*Narcissia trigonaria* Sladen, 1889: one record. Brazil, Alagoas, Jequiá da Praia - Lagoa Azeda reef UFAL/ECH 0579.

Order Spinulosida Perrier, 1884

Family Echinasteridae Verril, 1870

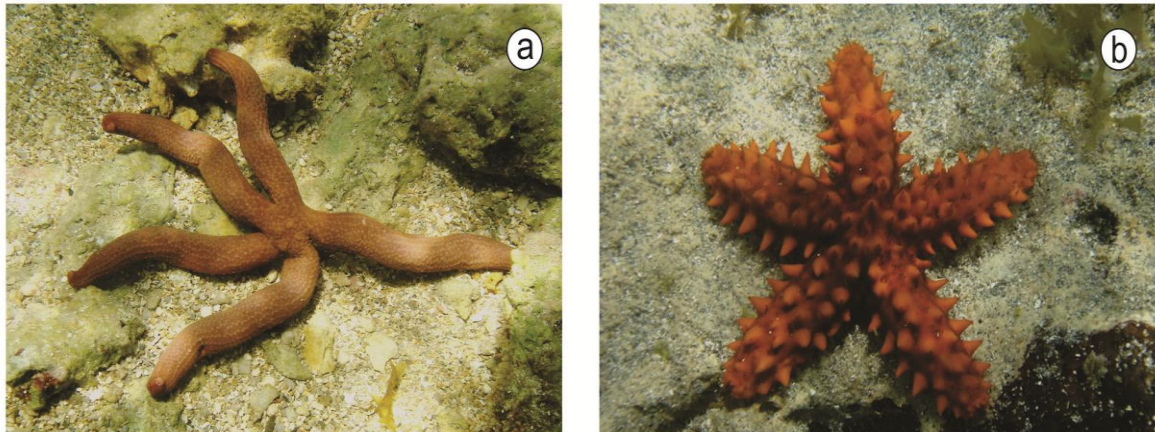
Genus *Echinaster* Müller;Troschel, 1840

*Echinaster brasiliensis* Müller;Troschel, 1842: three records. Brazil Alagoas, Maceió - Ponta Verde reef UFAL/ECH 0093, 0096. Jequiá da Praia - Lagoa Azeda reef UFAL/ECH 0574.

*Echinaster echinophorus* (Lamarck, 1816): four records. Brazil, Alagoas, Maceió - Jatiúca reef UFAL/ECH 0483; Ponta Verde reef UFAL/ECH 0092, 0453. Piaçabuçu - Pontal do Peba reef UFAL/ECH 0054 (Figure 5b).



Figure 5 – Some species of the class Asterozoa of the Echinodermata collection of the Sector of Benthic Communities, University Federal of Alagoas (UFAL/ECH): a) *Linckia guildingi* and b) *Echinaster brasiliensis*.



Fonte: Autor desta dissertação, 2013.

The class Crinoidea is represented by only seven individuals in this collection, all *Tropiometra carinata* (Table 5).

Table 5: Species of class Crinoidea catalogued in the Echinodermata collection of the Setor de Comunidades Bentônicas, Universidade Federal de Alagoas (UFAL/ECH).

Taxa	Ind.	Records	Substrate
Family Tropiometridae			
<i>Tropiometra carinata</i>	7	7	Coral reef, sandstone reef
Total	7	7	

#### Class Crinoidea

Order Isocrinida Sieverts-Doreck, 1952

Family Tropiometridae A.H. Clark, 1908

Genus *Tropiometra* A.H. Clark, 1907

*Tropiometra carinata* (Lamarck, 1816): seven records. Brazil, Alagoas, Maceió - Ponta do Meirim reef UFAL/ECH 0521; Guaxuma reef UFAL/ECH 0540; Pajuçara reef UFAL/ECH 0003, 0005. Marechal Deodoro - Saco da Pedra reef UFAL/ECH 0351; Francês reef UFAL/ECH 0379, 0472 (Figure 6).

Figure 6 – The crinoid *Tropiometra carinata*, representative of the class Crinoidea on the Echinodermata collection of the Sector of Benthic Communities, University Federal of Alagoas (UFAL/ECH).



Fonte: Autor desta dissertação, 2013.

#### 1.4. Discussion

In this collection, the class Ophiuroidea is the most abundant with 19 taxa, including *Ophiactis savignyi* and *Amphipholis squamata* with the most records. According to Borges, Yokoyama and Amaral (2011), the ophiuroids are the most diverse and frequently abundant group among the echinoderms, living associated with several types of substrata including sand, algae, mud and rubble, or associated with biological substrata such as corals, sponges and polychaete tubes. Numerical and taxa abundance of the class Ophiuroidea was also observed in the echinoderm fauna associated with several types of substrata from the Bahia coast (MAGALHÃES; MARTINS; ALVES, 2005, BORGES; AMARAL, 2006, MANSO; ALVES; MARTINS, 2008).

Holothuroidea is the second best-represented class in abundance and taxonomic richness. This group was considered the least studied class in the South Atlantic (HADEL *et al.*, 1999). *Holothuria grisea* is very common, and was reported as the most frequent and numerous holothuroid on the Brazilian coast (TOMMASI, 1969; 1999). The most numerous species of this class in the collection is *S. hydriformis*, principally from phytal communities. According to Clark (1908), this species is viviparous and occurs in association with several species of macroalgae.



Several species in the present collection, including the sea cucumber *Isostichopus badionotus*, the sea urchin *Eucidaris tribuloides*, and the sea stars *Astropecten brasiliensis*, *Echinaster brasiliensis*, *Luidia senegalensis*, *Echinaster echinophorus* and *Narcissia trigonaria*, are considered endangered in some localities on the southeastern Brazilian coast (HADEL *et al.*, 1999, VENTURA *et al.*, 2009).

Other catalogues report more specimens and taxa of the classes Echinoidea and Asteroidea than the classes Ophiuroidea and Holothuroidea (ALVES;CERQUEIRA, 2000. LIMA;FERNANDES, 2009; OLIVEIRA;OLIVEIRA;MANSO, 2010; XAVIER, 2010). However, the dominance of these groups is associated with the types of substrates where these species can be found (GONDIM *et al.*, 2008). Substrates composed of algae, marine grasses, sponges, and other sessile organisms also contribute to increasing the abundance and richness of the echinoderm fauna (HENDLER *et al.*, 1995). The variety of types of substrates where the specimens were collected contributed to increasing the abundance and richness of the species listed in this catalogue, mainly of the classes Ophiuroidea and Holothuroidea.

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## CAPÍTULO 2

### HOLOTHUROIDEA (ECHINODERMATA) FROM REEF ECOSYSTEMS ON THE CENTRAL COAST OF ALAGOAS, BRAZIL, WITH TWO NEW RECORDS FOR SOUTH ATLANTIC OCEAN.

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#### ABSTRACT

Knowledge of the Holothuroidea in the South Atlantic, particularly on the coral reefs from the Brazilian northeast coast, is still sparse. The present paper describes the distribution and ecological aspects of the species of Holothuroidea in the shallow reef ecosystems of Alagoas State. This study was carried out on nine reef ecosystems located on the central coast of Alagoas. Samples were collected in intertidal zones and shallow water to 20 m depth. In total, 17 species of holothuroids were recorded, most of them found on the undersurface of rocks in protected reef areas. Two species, *Epitomapta roseola* and *Psolus tuberculosus*, are new record for South American coast on the Atlantic Ocean. On coral and sandstone reefs from the Alagoas coast, *Holothuria grisea* and *Trachythyone crassipeda* were the most abundant species. Four species were rare and presented only one reef ecosystem *Aslia pygmaea* on the Sereia sandstone reef, *Isostichopus badionotus* on the Francês sandstone reef, *Lissothuria braziliensis* on the Ponta do Meirim coral reef and *Psolus tuberculosus* on the Saco da Pedra sandstone reef.

**Keyword:** sea cucumber, distribution, Brazilian reefs, biodiversity, South.

## 2.1. Introduction

Knowledge of the class Holothuroidea in the South Atlantic, particularly for the coral reefs in the Brazilian northeast coast, is still sparse. Most studies comprise general evaluations of the phylum Echinodermata, but few have included ecological data about Holothuroidea, and some were carried out on the south and southeastern coast (HADEL *et al.*, 1999).

The first study addressing the class Holothuroidea on the Brazilian coast was by Verrill (1868), who described coral and echinoderm species from the Abrolhos Archipelago in the northeast. On the Brazilian coast, taxonomic studies of Holothuroidea were initiated by Ancona-Lopez (1957) and Tommasi (1957; 1959), principally with the fauna from the south and southeast regions. The first checklist of recent sea cucumbers from Brazil, including other localities of South America, was published by Tommasi (1969). Studies on the Brazilian coast continued sporadically until the latest checklist published by Tiago and Ditadi (2001), who listed 32 species. However, this diversity is low compared to the global inventory of 1300 species (PAWSON;PAWSON;KING, 2010).

On the northeast coast of Brazil, studies including the class Holothuroidea during the past decade contain general wildlife surveys and inventories of Echinodermata in collections from some states, including Bahia (ALVES;CERQUEIRA, 2000; MAGALHÃES;MARTINS;ALVES, 2005), Paraíba (GONDIM *et al.*, 2008), Pernambuco (LIMA;FERNANDEZ, 2009) and Alagoas (MIRANDA *et al.*, 2012).

The class Holothuroidea is the least studied among echinoderms of the southwest Atlantic Ocean, where only a few species of shallow waters belonging to the orders Aspidochirotida and Apodida have been studied (HADEL *et al.*, 1999). Aspects of ecology such as the effect of sea cucumbers on marine communities are not well documented, suggesting that ecological information about the group is inadequate (PAWSON;PAWSON;KING, 2010).

The growing interest in sea cucumbers is mainly related to their economic importance for many communities around the world. The current high demand, principally in the Southeast Asian countries, has contributed to a decline in global stocks, which shows the importance of studies related to ecology and conservation (KALAEB *et al.*, 2008).

The present paper includes spatial distribution and ecological data for species of Holothuroidea on the shallow reef ecosystems on the central coast of Alagoas, northeast Brazil.

### 2.1.1. Study Area

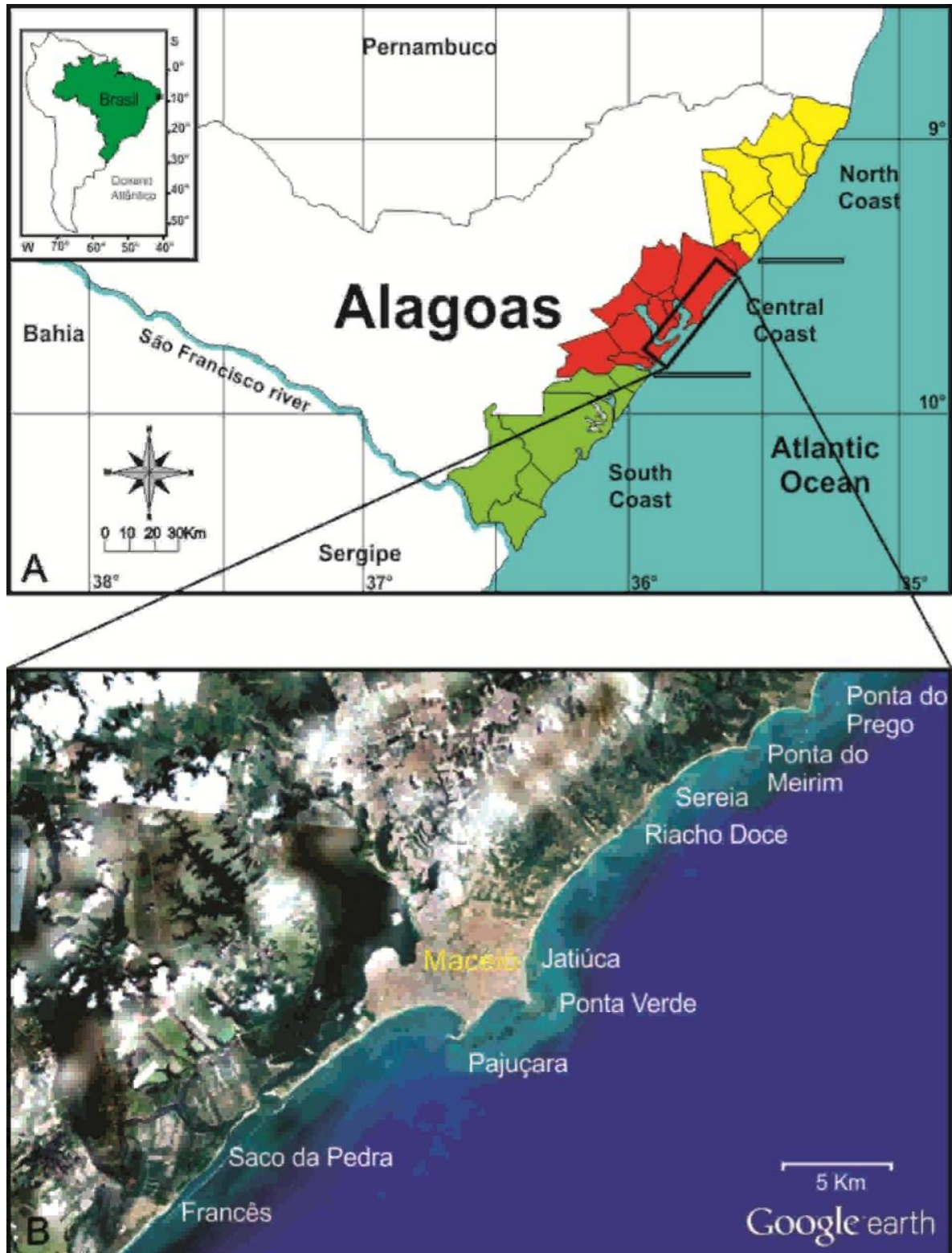
The coast of Alagoas is about 230 km long, and is located in northeast Brazil between 8°8'12"S and 10°29'12"S (CORREIA;SOVIERZOSKI, 2009). This state is bounded on the north by the Persinunga River and on the south by the São Francisco River, and has three administrative areas dividing the northern, central and southern coasts (Figure 1a).

Along the Alagoas coast are two different reef ecosystems with distinct geomorphological aspects. The coral reefs were formed mainly by scleractinian corals, hydrocorals, calcareous algae, and bryozoans. The sandstone reefs were formed through sedimentation of calcium carbonate or iron oxide on sand banks started with the chemical reaction of fresh water and silica from seawater. The central coast of Alagoas has predominantly coral reefs, and also four sandstone reefs situated close to the coastline. Many of these coral reefs near the coast line form fringing reefs with pools 1 to 5 m deep, protected from waves and other hydrodynamic effects (CORREIA, 2011).

This study was carried out on nine reef ecosystems situated on the central coast of Alagoas. The coral reefs are distributed in a NE - SW sequence, including Ponta do Prego (9°31'48"S-35°35'30"W), Ponta do Meirim (9°32'37"S-35°36'52"W), Riacho Doce (9°34'55"S- 35°39'25"W), Jatiúca (9°39'12"S-35°41'46"W), Ponta Verde (9°39'57"S-35°41'32"W) and Pajuçara (9°41'06"S-35°43'22"W). The sandstone reefs also studied are located at Sereia (9°34'04"S-35°38'46"W), Saco da Pedra (9°44'26"S-35°48'59"W) and Francês (9°46'03"S-35°50'13"W) (Figure 1b).



Figure 1. Map of the collection areas: (A) Alagoas State and (B) Reef Ecosystems.



Fonte: Autor dessa dissertação / Google Earth, 2013.

## 2.2. Material and Methods

ollections were made during low tide in intertidal zones and shallow waters to 20 m depth, by means of snorkeling and SCUBA. Holothurians were observed and photographed underwater, when possible, using a waterproof digital camera, and then were stored in bottles or plastic bags containing sea water. Based on field observations species has been added after comparison of data compiled on the reefs studies to classify on three categories and absent to relate the spatial distribution.

In the laboratory, the specimens were anesthetized with 10% MgCl<sub>2</sub>, and then sorted and fixed with 4% formaldehyde for 24 to 48 h. Holothurians were conserved in 70% ethanol and assigned a catalogue number. Taxonomic identification was performed using histological sections made in different areas of the animals' epidermis. The resulting tissue fragments were immersed in 2.5% sodium hypochlorite solution to dissolve organic matter and better show the body-wall ossicles, essential structures for species identification. The ossicles were mounted on slides with cover slips and evaluated under a binocular microscope, and also photographed with a digital camera. All specimens were identified based on specific references (DEICHMANN, 1930; HENDLER *et al.*, 1995; MILLER;PAWSON, 1984; PAWSON;PAWSON;KING, 2010; TOMMASI, 1969), and were deposited in the Echinodermata collection in the Sector of Benthic Communities, of the Federal University of Alagoas.

## 2.3. Results

A total of 17 species of Holothuroidea were recorded on the shallow reef ecosystems on the central coast of Alagoas. These species represented 15 genera and eight families, and two of the species are new records for the South American coast on the Atlantic Ocean.

### 2.3.1. Systematics

Family Psolidae Perrier, 1902  
Genus Lissothuria Verrill, 1867  
*Lissothuria braziliensis* (Théel, 1886)  
(Figure 2A and B)

*Material Examined:* 1 specimen - UFAL/ECH 0575.

*Diagnosis:* Ventral side has two rows of tube feet, and ten tentacles with two smaller. Ossicles are hourglass shaped table, smooth buttons and towerlike deposits.

*Remarks:* The single specimen was found in the intertidal zone at 2 m depth, attached to a reef fragment in a protected area with substrate formed by rubble and calcareous algae. The body structure forms a strong defense system, with numerous scales covering the dorsal region. The specie was considered rare for the Alagoas coast.

Genus *Psolus* Jaeger, 1833

*Psolus tuberculosus* Théel, 1886b

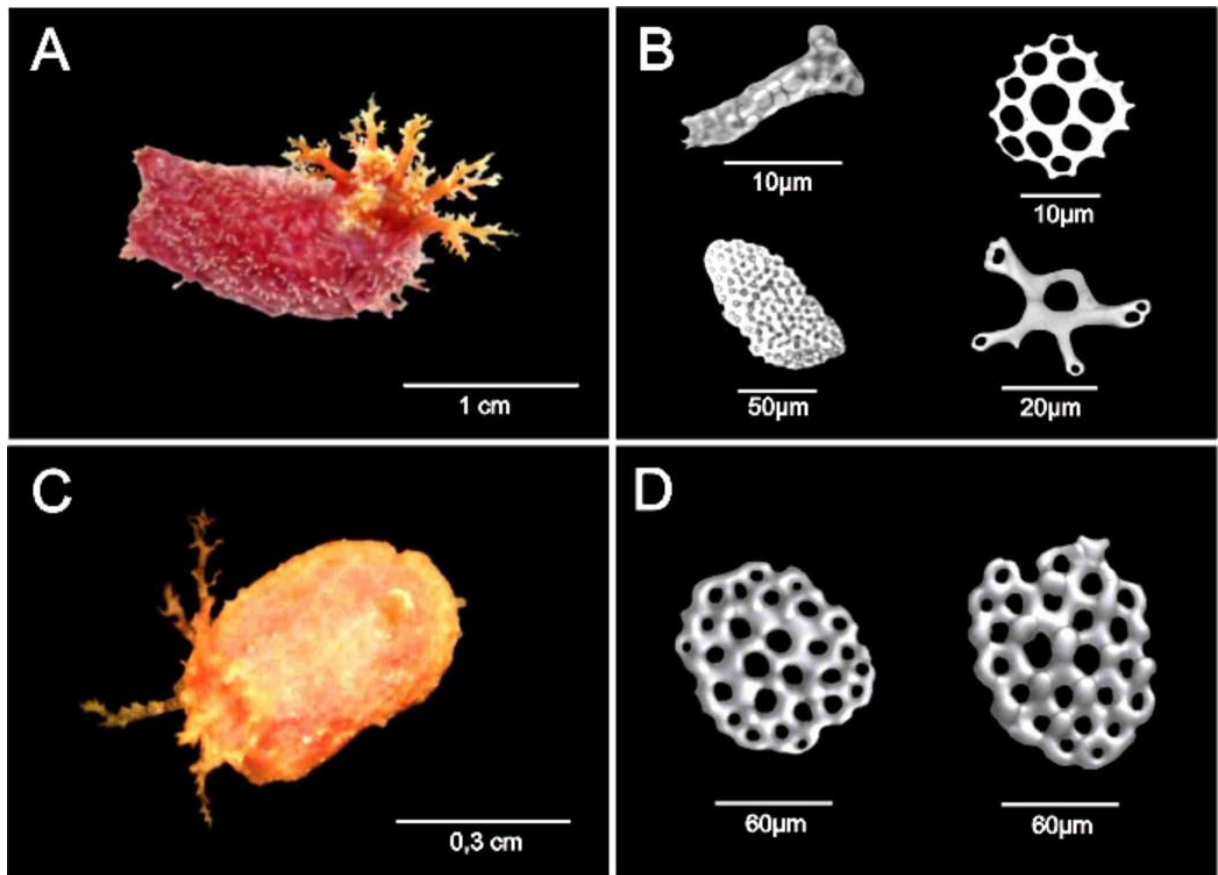
(Figure 2C and D)

*Material Examined:* 3 specimens – UFAL/ECH 0672.

*Diagnosis:* Dorsal region covered by numerous scales that are smoothly overlapping. Mouth dorsal surrounded by dendritic tentacles that when retracted the mouth is partially closed by five interradial oral valves. Anus dorsal. Tube feet only along the margin of the sole. Ossicles are large plates with numerous perforations.

*Remarks:* Species typical of hard substrates, living closely attached to the substrate, protected by numerous scales on the dorsal side. The body coloration is pink, with the sole grayish white; the tentacles are transparent with yellow extremities. These characteristics, together with its small size, less than 1 cm long, make it difficult to locate in the natural environment, which can also be aggravated by presence of other organisms with similar coloration such as ascidians and sponges. On the Alagoas coast, the species was recorded only on the Saco da Pedra coral reef where it was found at 20 m depth. However, this is the first record from less than 50 m depth; other reports of this species, from the southern United States, the Gulf of Mexico and the Dominican Republic, gave the depths as between 73 and 243 m (PAWSON;PAWSON;KING, 2010).

Figure 2. Species of the Family Psolidae and their ossicles: (A-B) *Lissothuria braziliensis* and (C-D) *Psolus tuberculosus*.



Fonte: Autor desta dissertação, 2013.

Family Phylloporidae Oestergren, 1907

Genus *Phylloporus* Grube 1840

*Phylloporus (Urodemella) occidentalis* Ludwig, 1875

(Figure 3 A and B)

*Material Examined:* 16 specimens - UFAL/ECH 0020, 0043, 0311, 0394, 0507 and 0539.

*Diagnosis:* 20 tentacles, alternating between large and small. Ossicles are tables with four to eight large perforations, occasionally with one to six smaller accessory perforations, and two short pillars

*Remarks:* Samples were collected in shallow water at depths to 2 m, living in reef crevices or attached under rocks near the edge of reef pools in sheltered areas,

providing good conditions for shelter and food. Some individuals were found buried in the substrate. Mostly young specimens were collected, with a mean diameter of 4cm.

Genus *Stolus* Selenka, 1867  
*Stolus cognatus* (Lampert, 1885)  
(Figure 3 C and D)

*Material Examined:* 6 specimens - UFAL/ECH 0250, 0274, 0393 and 0612.

*Diagnosis:* Body wall is thin, stiff and slightly gritty with small tube feet arranged in five bands on the radii and scattered on the interradii. The ossicles are irregular plates and curved rods

*Remarks:* Individuals living attached under rocks using small tube feet, and the numerous ossicles in the thin body wall give the skin a smooth appearance. Individuals occurred in shallow water to 2 m depth, and were sometimes found buried in the substrate with only the anterior and posterior regions exposed, showing their tentacles.

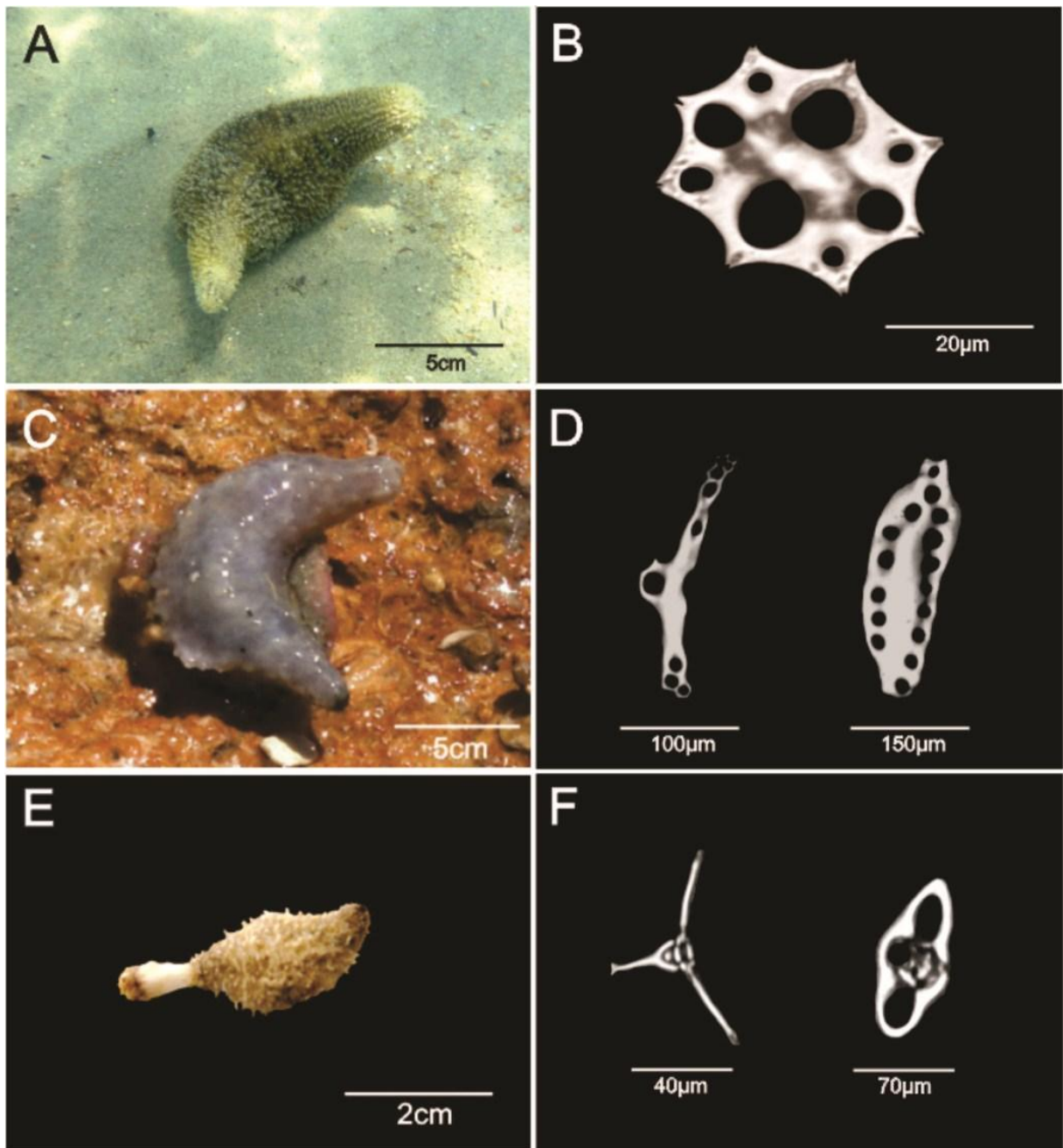
Genus *Thyone* Oken, 1815  
*Thyone pseudofusus* Deichmann, 1930  
(Figure 3E and F)

*Material Examined:* 1 specimen – UFAL/ECH 0661.

*Diagnosis:* Tube feet in double rows in the radial region and fewer scattered in the interradial region. Mouth surrounded by 10 tentacles with the two ventral smaller. Introvert when extended can reach one-third or one-half the length of the body.

*Remarks:* Only one individual was found, associated with algae in a protected tide pools at a depth of 1 m. In this area the sediment consisted of sand covered by a layer of coralline algae fragments, principally of the genus *Halimeda*. According to Hendler *et al.*, (1995), this species lives in areas with calcareous or quartz sand covered with the green alga *Caulerpa*, among coralline algae, or also beneath rubble on the reef ledges. In Alagoas this species was rare, recorded only for the Ponta Verde coral reef.

Figure 3. Species of the Family Phylloporidae and their ossicles: (A-B) *Phylloporus (Urodemella) occidentalis*, (C-D) *Stolus cognatus* and (E-F) *Thyone pseudofusus*.



Fonte: Autor desta dissertação, 2013.

Family Sclerodactylidae Panning, 1949

Genus *Pseudothyone* Panning, 1949

*Pseudothyone belli* (Ludwig, 1887)

(Figure 4 A and B)

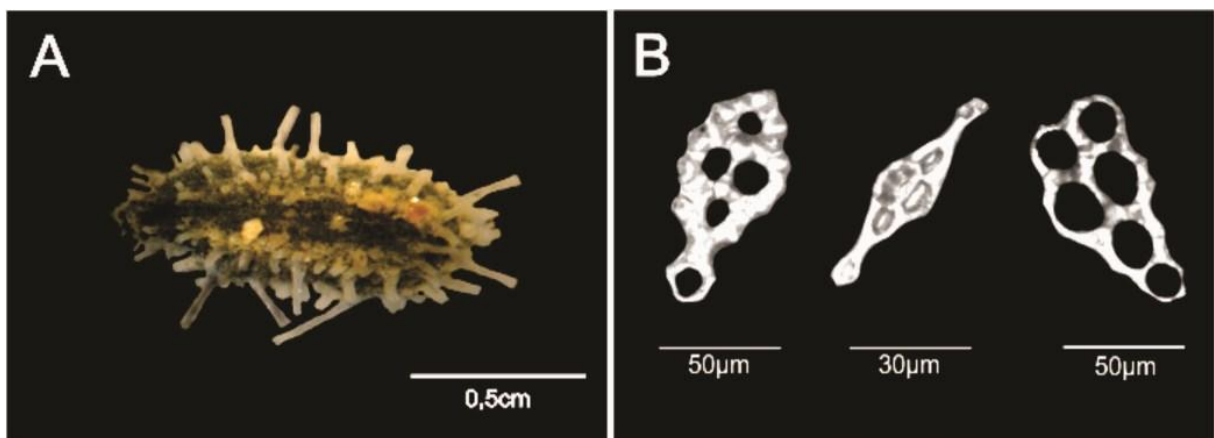


*Material Examined:* 6 specimens – UFAL/ECH 0589, 0644, 0648 and 0662.

*Diagnosis:* Body wall is rigid, with numerous tube feet scattered over the entire body. There are 10 tentacles, eight of them long and richly branched and two smaller tentacles are ventrally located. Ossicles are knobbed buttons with supporting tables.

*Remarks:* When adults this species lives in small crevices in coral reefs and can be observed when their tentacles are extended for feeding, but juveniles were found in association with various macroalgae. The adults are a characteristic dirty white color with flecks of brown or maroon, while juveniles about 0.5 cm long were gray dorsally and white on the ventral region. On the central coast of Alagoas, a few specimens were found on the Ponta do Meirim coral reef and Francês sandstone reef, where adults inhabit the edge of reef pools, strongly attached under reef fragments, or on the soft bottom formed by fragments of calcareous algae of the genus *Halimeda*.

Figure 4. Specie of the Family Sclerodactylidae and their ossicles: (A-B) *Pseudothyone belli*.



Fonte: Autor desta dissertação, 2013.

Family Cucumariidae Ludwig, 1894

Genus *Aslia* Rowe, 1970

*Aslia pygmaea* (Théel, 1886a)

(Figure 5A and B)

*Material Examined:* 2 specimens – UFAL/ECH 0609 and 0630.

*Diagnosis:* Body form characteristic, with conspicuous tube feet confined to five radii. Mouth has oral valves. Body wall is rigid because of the numerous ossicles that form irregular baskets, regular buttons and triradiate supporting rods

*Remarks:* Individuals approximately 5 cm long were found under sandstone fragments covered by different algae species, to a maximum depth of 1.5 m. Juveniles were about 1/3 as long as the adults, with inconspicuous tube feet, and were attached to algae of the genus *Padina*. In Alagoas, this species was recorded only on the Sereia sandstone reef.

Genus *Duasmodyctyla* Ayres, 1854  
*Duasmodyctyla seguroensis* (Deichmann, 1930)  
 (Figure 5C and D)

*Material Examined:* 16 specimens - UFAL/ECH 0040, 0232, 0273, 0392, 0418, 0422, 0446 and 0613.

*Diagnosis:* There are 20 dendritic tentacles with small pairs alternating with large pairs. The body wall is thin with tube feet scattered except on the introvert where they form five distinct rows. Ossicles are tables only.

*Remarks:* The species inhabits intertidal zones, living in relatively protected microhabitats under reef fragments, in crevices, or on the bottom of the reef pools. Some individuals were found buried several centimeters in the substrate, cohabiting with other species including *Trachythyone crassipeda* Cherbonnier, 1961 and *P. occidentalis*. This confirms the remarks of Hendler *et al.*, (1995), who reported these two species, *P. occidentalis* and *D. seguroensis* sharing the same habitat, requiring observation of the ossicles to distinguish them.

Genus *Trachythyone* Studer, 1876  
*Trachythyone crassipeda* Cherbonnier, 1961  
 (Figure 5E and F)

*Material Examined:* 5 specimens – UFAL/ECH 0667 and 0671.

*Diagnosis:* Body cylindrical, tapered toward the ends, particularly the posterior end. Ten tentacles of similar size richly branched surrounding the mouth. Tube feet scattered over the body but sometimes more numerous ventrally. Coloration is gray or



light brown with blue spots. Ossicles form baskets of different tips, plates with four holes arranged in cross and edges with rounded digitations, support rods, buttons and plates with irregular holes and edges.

*Remarks:* Individuals were found attached under rocks, using their numerous tube feet that are distributed throughout the body wall. Groups of three to five animals were often observed living under the same reef fragment, frequently masked by shell fragments, sea urchin spines, and other materials, firmly attached by tube feet. Many individuals were found buried several centimeters in the substrate, forming large concentrations. In some areas of the Riacho Doce coral reef covered by many species of algae and reef fragments, about 40 individuals were found in one square meter. This species was common on several reefs on the central Alagoas coast.

Genus *Ocnus* Forbes, 1841

*Ocnus braziliensis* (Verrill, 1868)

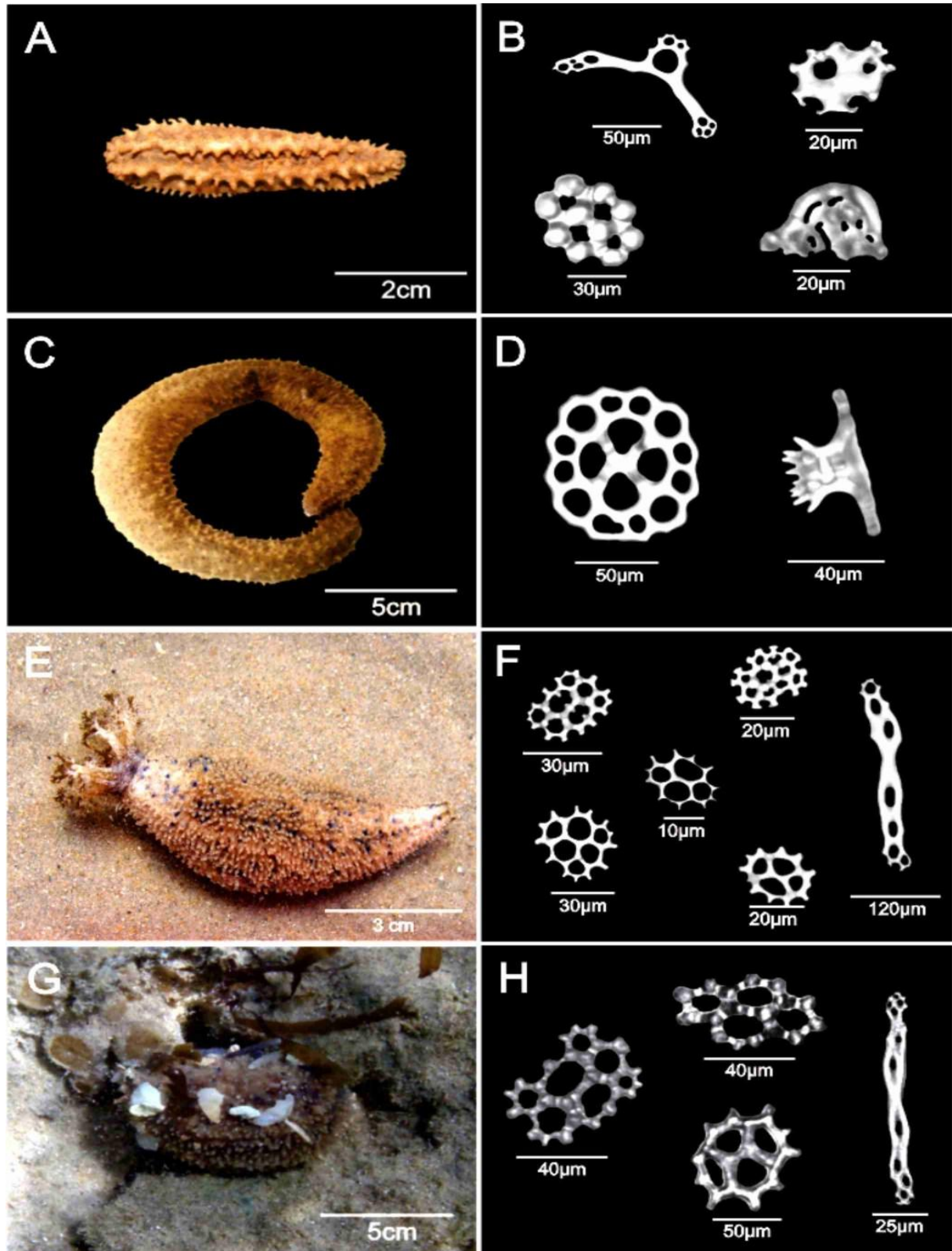
(Figure 5G and H)

*Material Examined:* 11 specimens – UFAL/ECH 0042, 0046 and 0510.

*Diagnosis:* 10 tentacles, two of which are smaller and located on the ventral surface. The body wall is thin with numerous scattered tube feet. Calcareous rings are formed by ten simple parts with posterior prolongations. Ossicles form baskets, support rods and buttons of different sizes.

*Remarks:* Individuals were typically found attached under rocks, using their numerous tube feet distributed throughout the body wall. Many small individuals, about 1 cm, were found associated with algae, principally of the genera *Padina* and *Sargassum*. *Ocnus braziliensis* has sometimes been confused with *Ocnus suspectus* (Ludwig, 1875), but was differentiated by Ancona-Lopez (1957) using the tentacles, the shape of the calcareous ring, and the concentration of ossicles.

Figure 5. Species of the Family Cucumariidae and their ossicles: (A-B) *Aslia pygmaea*, (C-D) *Duasmodyctyla seguroensis*, (E-F) *Trachythyone crassipeda* and (G-H) *Ocnus braziliensis*.



Family Holothuriidae Ludwig, 1894

Genus *Holothuria* Linnaeus, 1767

Subgenus *Holothuria* (*Halodeima*) Pearson, 1914

*Holothuria* (*Halodeima*) *grisea* Selenka, 1867

(Figure 6A and B)

*Material Examined:* 27 specimens - UFAL/ECH 0011, 0018, 0019, 0021, 0038, 0041, 0049, 0140, 0348, 0359, 0391, 0469, 0479, 0493 and 0505.

*Diagnosis:* Body characterized by a distinct ventral sole with numerous tube feet. The upper body surface carries six rows of papillae supported by very large warts, each wart surrounded by five to ten small tube feet. The mouth is directed slightly downward and possesses 20-25 peltate tentacles. The ossicles form tables, perforated plates and tube feet rods

*Remarks:* Specimens were found in shallow water to 5m depth, strongly attached on hard substrates, using numerous tube feet and resisting moderate hydrodynamics. When the individuals were in crevices on the reef substrate, they were often difficult to see because the dark skin coloration was similar to the substrate, but had accumulation of fecal pellets near the posterior ends. On the Alagoas coast, this species was present on eight reefs, and was observed in considerable numbers on the Sereia and Saco da Pedra sandstone reefs, where these areas have many crevices for refuge. A few individuals were also observed on the Riacho Doce, Jatiúca, Ponta Verde and Pajuçara coral reefs and Francês sandstone reef.

Subgenus *Holothuria* (*Platyperona*) Rowe, 1969

*Holothuria* (*Platyperona*) *parvula* (Selenka, 1867)

(Figure 6C and D)

*Material Examined:* 2 specimens - UFAL/ECH 0487 and 0610.

*Diagnosis:* body elongated with upper and lateral surfaces covered by conical warts each one with papilla. The mouth is ventral and surrounded by 18-20 peltate tentacles with a narrow collar of conical warts. Ossicles form tables and irregular buttons.

*Remarks:* Specimens 3cm long were observed in shallow water during low tide, on the reef substrate up to 1.5m deep. They were strongly attached on the undersurface of rocks using their powerful tube feet, in tide pools, or along the reef edges. Along the

central Alagoas coast, specimens were found on the Riacho Doce and Ponta Verde coral reefs and also Francês sandstone reef. The present record evidences the distribution of *H. parvula* on reef ecosystems of the northeast coast of Brazil.

Subgenus *Holothuria* (*Thymiosycia*) Pearson, 1914

*Holothuria* (*Thymiosycia*) *arenicola* Semper, 1868

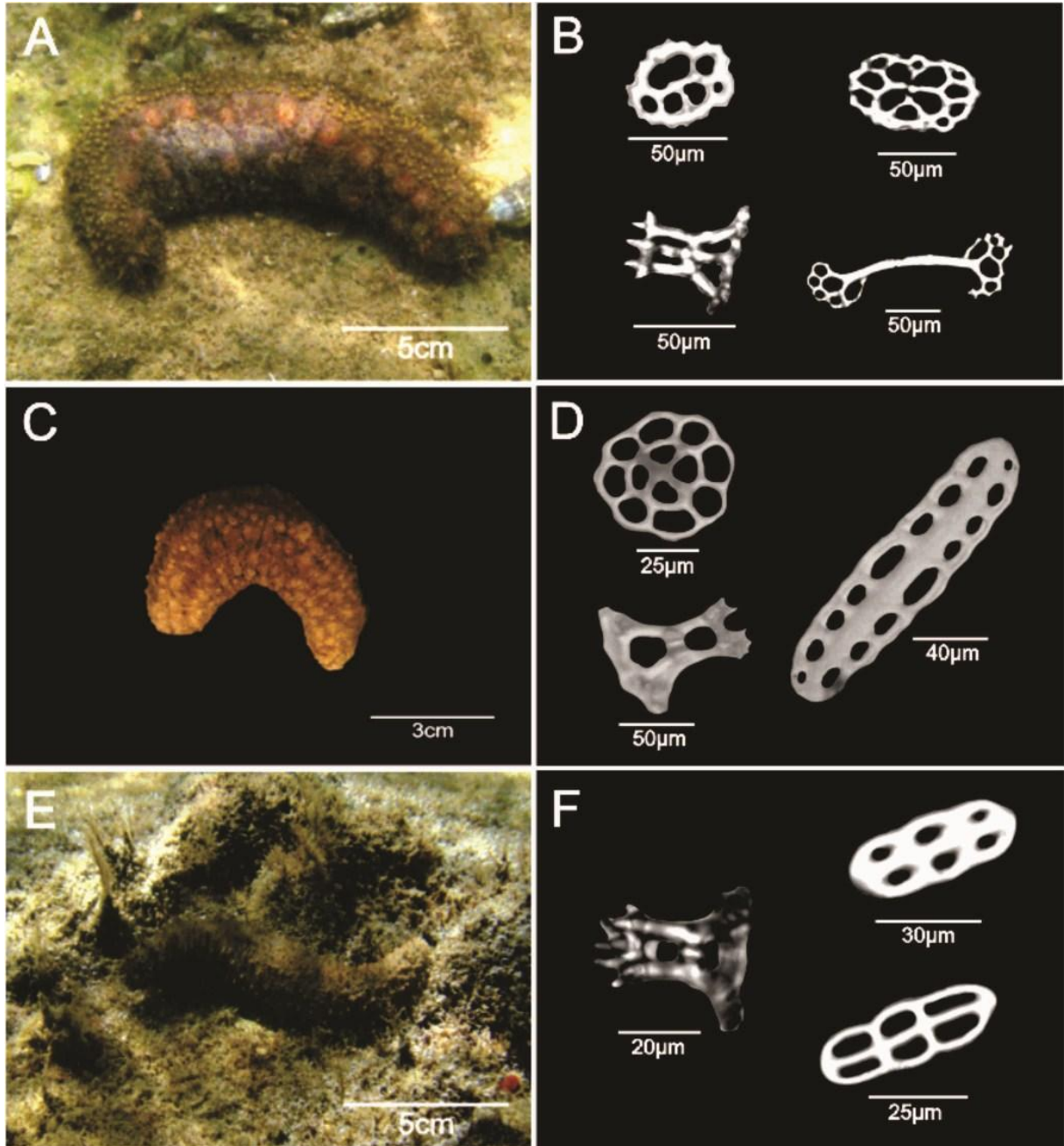
(Figure 6E and F)

*Material Examined:* 9 specimens – UFAL/ECH 0474, 0656, 0659, 0668 and 0669.

*Diagnosis:* Body is slender, elongate, swollen at the middle and tapered towards both ends. Body wall is thin with small, cylindrical tube feet scattered across dorsal and ventral surfaces. The mouth is surrounded by 20 very small tentacles. Ossicles form tables and buttons.

*Remarks:* The individuals collected were about 20cm long, living in relatively protected microhabitats on the undersurface of rocks or typically buried in soft sediment, where they produce conical mounds at the sediment surface and expose the crown of tentacles to capture food particles. Samples were collected on the Saco de Pedra and Francês sandstone reefs. On the Saco da Pedra reef, many individuals of *H. arenicola* were found buried in regions with muddy sediments and in some of these locations with 10 individuals per m<sup>2</sup>.

Figure 6. Species of the Family Holothuriidae and their ossicles: (A-B) *Holothuria* (*Halodeima*) *grisea*, (C-D) *Holothuria* (*Platyperona*) *parvula* and (E-F) *Holothuria* (*Thymiosycia*) *arenicola*.



Fonte: Autor desta dissertação, 2013.

Family Stichopodidae Haeckel, 1896  
 Genus *Isostichopus* Deichmann, 1958  
*Isostichopus badionotus* (Selenka, 1867)  
 (Figure 7A and B)

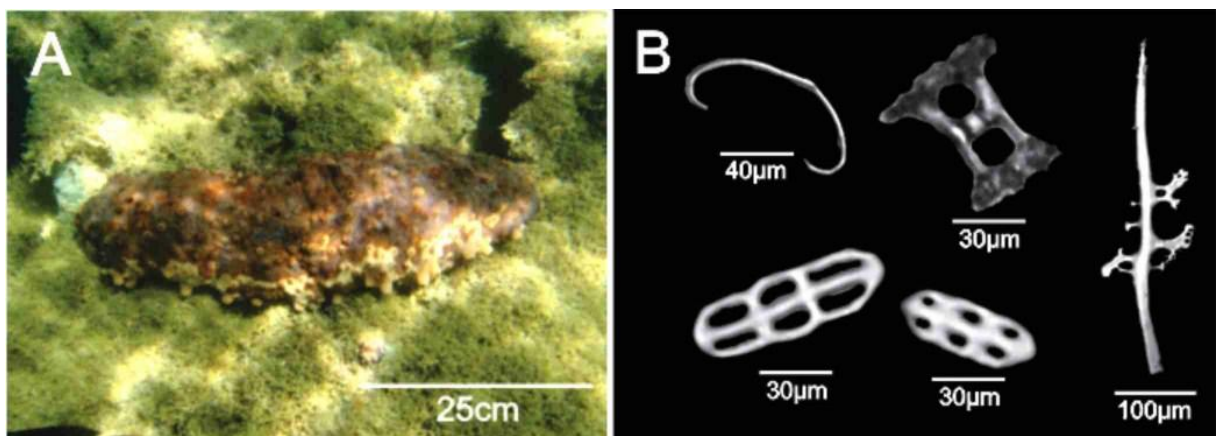


*Material Examined:* 2 specimens – UFAL/ECH 0344 and 0531

*Diagnosis:* Body wall extremely thick with distinctive low warts on the dorsal and lateral surfaces. The flat ventral surface is covered by three bands of numerous tube feet. Mouth ventrally located and surrounded by 20 shield-shaped tentacles. Ossicles form tables, supporting rods and C-shaped elements.

*Remarks:* Specimens were observed in sheltered microhabitats near reef edges on soft sediments. The individuals are robust, and in the study area was predominantly orange with darker warts. Generally, this holothurian is found by the presence and concentration of fecal pellets near the animal. In Brazil, *I. badionotus* has been negatively impacted by uncontrolled collection for human consumption, and by pollution and environmental degradation. Because of these pressures, the Brazilian population is estimated to be fewer than ten thousand individuals and is listed as endangered (AMARAL *et al.*, 2008). In Alagoas there have been no records of consumption of this species, possibly due to the weaker Asian culinary influence and the low population density in this part of Brazil.

Figure 7. Specie of the Family Stichopodidae and their ossicles: (A-B) *Isostichopus badionotus*.



Fonte: Autor desta dissertação, 2013.

Family Synaptidae Burmeister, 1837

Genus Epitomapta Heding, 1928

*Epitomapta roseola* (Verrill, 1874)

(Figure 8A and B)

*Material Examined:* 2 specimens – UFAL/ECH 0651 and 0664.

*Diagnosis:* The body wall is thin, transparent and has small circular spots on the surface. The ossicles are anchors, anchors plates and military granules.

*Remarks:* The species was typically attached to the undersurface of rocks or in crevices on the reef ledges, associated with substrate formed of calcareous algae, principally *H. opuntia*. It was found in the intertidal zone to a depth of 0.5 m, in protected areas formed by tide pools. The samples had a mean size of 4 cm and typical pink coloration, with small dark spots. The C- and O-shaped military granules distinguish this species from other members of the family Synaptidae (PAWSON;PAWSON;KING, 2010). In Alagoas, this species was recorded on the Ponta do Meirim and Ponta Verde coral reefs, on the Maceió coast.

Genus *Synaptula* Oersted, 1849

*Synaptula hydriformis* (Lesueur, 1824)

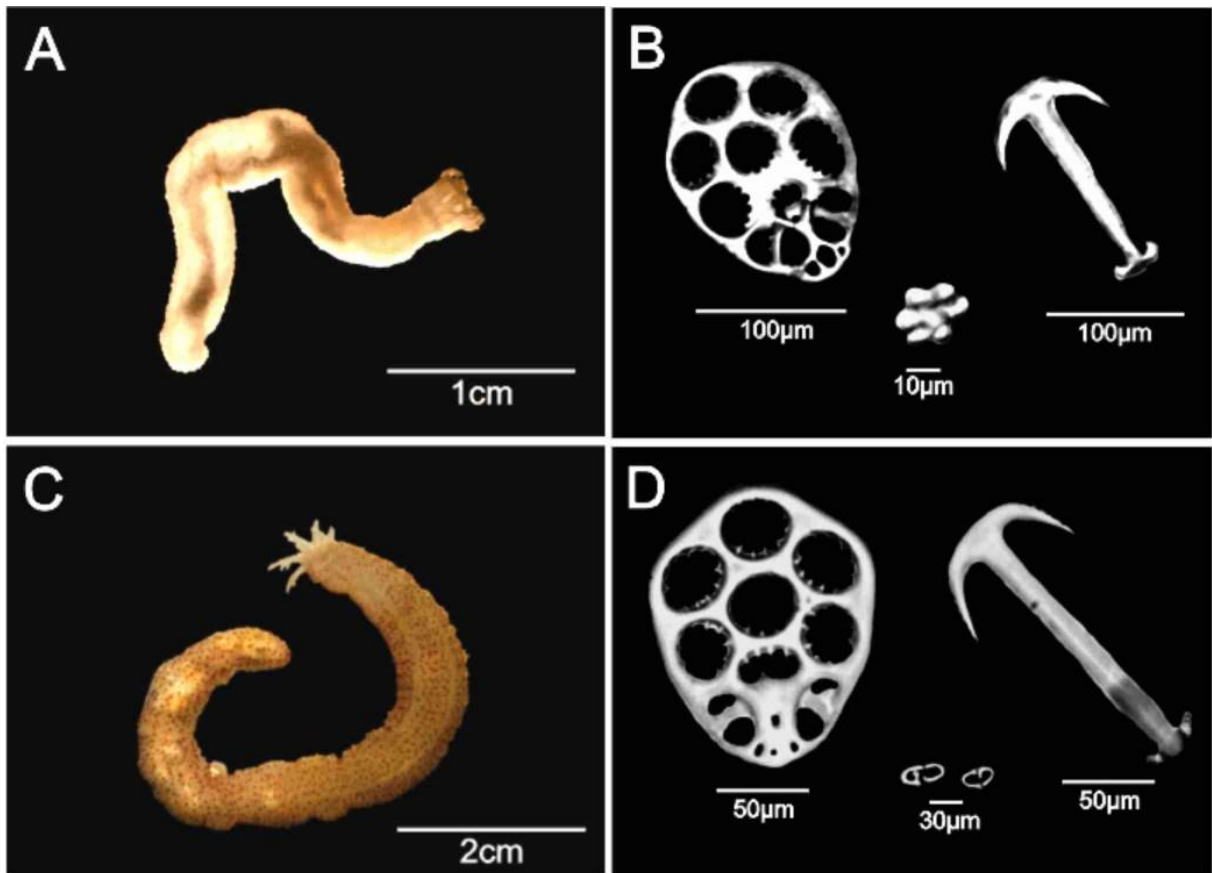
(Figure 8C and D)

*Material Examined:* 968 specimens - UFAL/ECH 0006, 0015, 0057, 0073, 0094, 0111, 0132, 0155, 0174, 0179, 0191, 0203, 0204, 0217, 0218, 0236, 0237, 0253, 0254, 0281, 0282, 0294, 0295, 0296, 0317, 0318, 0362, 0363, 0396, 0399, 0416, 0433, 0434, 0455, 0456, 0500, 0545, 0588, 0591, 0594

*Diagnosis:* Worm-like form with a semitransparent and elastic body wall. Mouth is surrounded by 12 pinnate tentacles and each tentacle has 20 pairs of lateral digits. Ossicles are anchors and a military granule like rosettes.

*Remarks:* Individuals were found in sheltered tidal pools on the undersurface of rocks, rubble, or in association with the algae *Amphiroa fragilissima* (Linnaeus) J.V. Lamouroux, *Caulerpa racemosa* (Forsskal) J. Agardh and *Dictyota cervicornis* Kützing, where this species was very abundant. The anchor-shaped ossicles and anchor plate hold the animal in the interior spaces of the algae, protecting it from predation. In some samples, individuals with juveniles in the coelomic cavity were observed. Juveniles had fewer tentacles and smaller body size, but had the ossicles completely formed. The anchors, together with the viviparous reproduction, lead these animals to live in close association with algae. On the Alagoas coast, this species occurred on the Ponta do Meirim, Riacho Doce and Ponta Verde coral reefs and Francês sandstone reef.

Figure 8. Species of the Family Synaptidae and their ossicles: (A-B) *Epitomapta roseola* and *Synaptula hydriformis*.



Fonte: Autor desta dissertação, 2013.

Family Chiridotidae Oestergren, 1898

Genus Chiridota Eschscholtz, 1829

*Chiridota rotifera* (Pourtalès, 1851)

(Figure 9A and B)

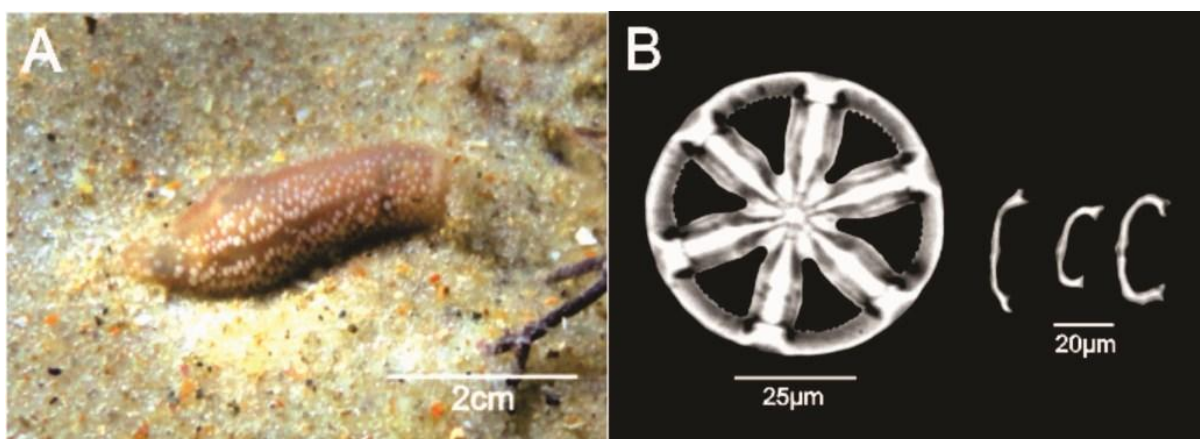
*Material Examined:* 105 specimens - UFAL/ECH 0007, 0051, 0095, 0154, 0156, 0171, 0176, 0189, 0190, 0192, 0202, 0216, 0219, 0234, 0235, 0238, 0280, 0283, 0293, 0315, 0316, 0319, 0361, 0364, 0397, 0400, 0417, 0431, 0432, 0435, 0454, 0476, 0477, 0502, 0503.

*Diagnosis:* Body wall with many warts like protuberances that contain aggregations of ossicles that are wheel or irregular C-shaped. Mouth surrounded by twelve digitate tentacles, each one with five pairs.



*Remarks:* Different habitats and variations in the animal lengths were observed, which suggests that the habitat preference of this species changes according to the stage of development. Small specimens averaging approximately 1.5cm long were associated with the algae *A. fragilissima*, *C. racemosa* and *D. cervicornis*. However, adults approximately 6 cm long were found on the undersurface of rocks, rubble or in tidal pools, in protected areas associated with mobile substrates and muddy sediments. Sometimes groups of five to ten attached individuals were found, in accordance with previous observations (HADEL *et al.*, 1999; GODIM *et al.*, 2008). On the central coast of Alagoas, specimens were observed on the Ponta do Prego, Riacho Doce and Ponta Verde coral reefs and the Saco da Pedra and Francês sandstone reefs, in the intertidal zone up to 1 m depth.

Figure 9. Specie of the Family Chiridotidae and their ossicles: (A-B) *Chiridota rotifera* (Pourtalès, 1851).



Fonte: Autor desta dissertação, 2013.

### 2.3.2. Distribution

In this study, 17 species of Holothuroidea were recorded on the central coast of Alagoas in the shallow reef ecosystems. The number of holothurian species was highest on the Ponta Verde and Riacho Doce coral reefs, with a total of nine species found at each site. The species *H. grisea* and *T. crassipeda* were relatively common on these reefs, and in some localities were present in considerable numbers. Five species presented only one local of occurrence including *A. pygmaea* on the Sereia sandstone reef, *I. badionotus* on the Francês sandstone reef, *P. tuberculosus* on the

Saco da Pedra sandstone reef and *T. pseudofusus* on the Ponta Verde coral reef (Table 1).

Table 1: Distribution of the Holothuroidea species on the central coast of Alagoas, Brazil. PP – Ponta do Prego; PM – Ponta do Meirim; SE – Sereia; RD – Riacho Doce; JA – Jatiúca; PV – Ponta Verde; PJ – Pajuçara; SP – Saco da Pedra and FR – Francês.

Species	Reef Ecosystems								
	PP	PM	SE	RD	JA	PV	PJ	SP	FR
<i>Aslia pygmaea</i>	-	-	X	-	-	-	-	-	-
<i>Chiridota rotifera</i>	-	-	-	XXX	-	XXX	-	X	XX
<i>Duasmodyctyla seguroensis</i>	X	-	-	XX	X	XX	-	-	-
<i>Epitomapta roseola</i>	X	-	-	-	-	X	-	-	-
<i>Holothuria grisea</i>	-	-	XXX	XX	X	X	XX	XXX	X
<i>Holothuria parvula</i>	-	-	-	X	-	X	-	-	X
<i>Holothuria arenicola</i>	-	-	-	-	-	-	-	XXX	XX
<i>Isostichopus badionotus</i>	-	-	-	-	-	-	-	-	X
<i>Lissothuria braziliensis</i>	X	-	-	-	-	-	-	-	-
<i>Ocnus braziliensis</i>	-	X	X	XX	X	XX	XX	-	-
<i>Phyllophorus occidentalis</i>	X	-	-	X	-	XX	XX	-	-
<i>Pseudothyone belli</i>	-	X	-	-	-	-	-	-	X
<i>Psolus tuberculosus</i>	-	-	-	-	-	-	-	X	-
<i>Stolus cognatus</i>	-	-	-	XX	X	-	-	-	-
<i>Synaptula hydriformis</i>	-	X	-	X	-	XXXX	-	-	XX
<i>Thyone pseudofusus</i>	-	-	-	-	-	X	-	-	-
<i>Trachytyone crassipeda</i>	-	X	XX	XXXX	-	-	X	X	-
Total of Species	4	4	4	9	4	9	4	5	7

- Absent, X Rare <10%, XX Occasional 15% < x > 45%,  
XXX Common 50% < x > 75% and XXXX Frequent >80%

Fonte: Autor desta dissertação, 2013.

The spatial distributions of the species on the Alagoas reefs showed some differences in their microhabitat preferences. Generally, small species of the families Synaptidae and Chiridotidae preferred protected zones with more sheltered areas and in association with marine algae such as *A. fragilissima*, *C. racemosa* and *D. cervicornis*. Other species, including *H. arenicola*, *S. cognatus* and *T. crassipeda*, were often partially or totally buried in soft substrate in tide pools or near the reef edges. However, most individuals of these species were found on the undersurface of rocks, at a maximum depth of 2m.

With respect to geographical distributions, 16 species also occur in the Caribbean; in contrast, *T. crassipeda* was previously mentioned only for the Abrolhos Archipelago, Brazilian coast. Two of these species, *P. tuberculosus* and *E. roseola*,

are newly recorded for Brazil and also the South American coast. With respect to the distributions along the Brazilian coast, six species have been found only in the northeastern ecoregion, and the others occur as far south as São Paulo and Santa Catarina in the southern ecoregion (Table 2).

Table 2: Holothuroidea species of Alagoas with their general geographical distribution and distribution in the Brazilian coast.

Species	Geographic Distribution	Distribution in Brazilian	Source
<i>Aslia Pygmaea</i>	South Carolina, Florida (USA), Mexico, Puerto Rico, Grenada, Venezuela, Trinidad and Brazil	Bahia	Tommasi 1969, Muller;Pawson 1984
<i>Chiridota rotifera</i>	Bermuda, Florida (USA), the Antilles and Brazil	São Paulo, Bahia, Paraíba and Alagoas	Tommasi 1969, Netto <i>et al.</i> , 2005, Magalhães <i>et al.</i> , 2008, Oliveira <i>et al.</i> , 2011
<i>Duasmodyctyla seguroensis</i>	Florida (USA), Antilles and on Brazilian coast	São Paulo, Bahia and Alagoas	Tommasi 1969, Netto <i>et al.</i> , 2005, Magalhães <i>et al.</i> , 2005, Oliveira <i>et al.</i> , 2011
<i>Epitomapta roseola</i>	Connecticut, Massachusetts to Florida (USA) and Bermuda	First Record	Hendler <i>et al.</i> , 1995
<i>Holothuria grisea</i>	Florida (USA), Puerto Rico, Gulf of Mexico, Bahamas, Jamaica, Lesser Antilles, Curacao, Panama, Colombia, West Africa and Brazil	São Paulo, Bahia, Paraíba, Rio de Janeiro, Santa Catarina and Alagoas	Hendler <i>et al.</i> , 1995, Netto <i>et al.</i> , 2005, Magalhães <i>et al.</i> , 2005, Mendes <i>et al.</i> , 2006, Gondim <i>et al.</i> , 2008, Krau 1950, Oliveira <i>et al.</i> , 2011
<i>Holothuria parvula</i>	Bermuda to Brazil	Rio de Janeiro	Hendler <i>et al.</i> , 1995, Oliveira <i>et al.</i> , 2011
<i>Holothuria arenicola</i>	Circumtropical	Until Rio de Janeiro (Ilha Grande), São Paulo	Mosher 1980
<i>Isostichopus badiotus</i>	Central America to West Africa and Brazil		Ancona-Lopez 1957, Sloan;von Bodungen 1980; Guzmán <i>et al.</i> , 2003, Netto <i>et al.</i> , 2005
<i>Lissothuria braziliensis</i>	From Antilles to Brazil	Sites of occurrence uncertain	Tommasi, 1969
<i>Ocnus braziliensis</i>	Colombia, Barbados and Brazil	Abrolhos Archipelago, Pernambuco, Rio de Janeiro, São Paulo and Alagoas	Ancona-Lopez 1957, Tommasi 1969, Netto <i>et al.</i> , 2005, Oliveira <i>et al.</i> , 2011
<i>Phyllophorus occidentalis</i>	Florida (USA) to Porto Seguro, northeast Brazil	Bahia and Paraíba	Tommasi 1969, Magalhães <i>et al.</i> , 2005, Gondim <i>et al.</i> , 2008
<i>Pseudothyone belli</i>	Bermuda, Florida and Puerto Rico (USA), Panama, Trinidad, Tobago and Brazil	Abrolhos Archipelago, Bahia.	Tommasi 1969, Muller;Pawson 1984
<i>Psolus tuberculatus</i>	North Carolina, Florida, Gulf of Mexico and Dominican Republic.	First record	Pawson <i>et al.</i> , 2010
<i>Stolus cognatus</i>	Florida (USA), Antilles and Brazil	Fernando de Noronha and Alagoas	Tommasi 1969, Oliveira <i>et al.</i> , 2011
<i>Synaptula hydriformis</i>	Bermuda to Brazil	São Paulo and Paraíba	Tommasi, 1969, Netto <i>et al.</i> , 2005, Gondim <i>et al.</i> , 2008
<i>Thyone pseudofusus</i>	North Carolina, Florida, Gulf of Mexico, West Indies, Tobago, Panama, Colombia and Brazil.	São Paulo	Tommasi, 1969
<i>Trachytyone crassipeda</i>	Brazil	Bahia	Cherbonnier 1961, Tommasi 1969

Fonte: Autor desta dissertação, 2013.

## 2.4. Discussion

The species recorded here on the coast of Alagoas comprise approximately 54% of the 32 species listed for the Brazilian coast by Tiago and Ditadi (2001). Oliveira, Oliveira and Manso (2010) added three new records of the class Holothuroidea, including *Molpadia parva* Théel, 1886, *Molpadia liska* Pawson, 1977 and *Holothuria (Thymiosycia) thomasi* (PAWSON;CAYCEDO, 1980). The present study added two more new records, *P. tuberculosus* and *E. roseola*, for the Brazilian northeast coast and also for the South Atlantic. However, even with these new records it is clear that the taxonomic diversity of holothurians in Brazil is still incompletely documented, especially compared with the global total of 1,300 species (PAWSON;PAWSON;KING, 2010). According to Tommasi (1969), this is the least studied class of Echinodermata in the southwest Atlantic Ocean, and the gap between these values suggests that more information is needed about Holothuroidea species on the Brazilian coast. Hadel *et al.*, (1999) mentioned the deeper waters as a potential area for further studies of the holothurian communities, because these echinoderms are relatively well represented in these environments.

The most abundant species recorded in the present study were *H. grisea*, *O. braziliensis* and *T. crassipeda*, which occurred on several reefs. *H. grisea* has been found in different localities throughout the Brazilian coast, including the south coast (ANCONA-LOPEZ, 1957), southeast (KRAU, 1950; TOMMASI, 1957; NETTO;HADEL;TIAGO, 2005), and northeast (MAGALHÃES;MARTINS;ALVES, 2005; GONDIM *et al.*, 2008; LIMA;FERNANDES, 2009). Studies of distribution patterns and density of holothuroideans by Mendes, Marenze and Domenico (2006) demonstrated the preference of *H. grisea* for hard substrates in tide pools and crevices, which provide good conditions for feeding and shelter from predators, wave action, and desiccation. These conditions were observed on the Alagoas reefs, and explain the presence and abundance of this species. The other most abundant specie, *T. crassipeda*, was recorded only by Cherbonnier (1961) to the Abrolhos Archipelago and this record constitutes the first out of this locality. Information about ecology and distribution patterns of *T. crassipeda* is scarce demonstrating the necessity of more studies in these areas.

The geographical distribution and occurrence of the holothurians in the Alagoas study area showed the influence of the Caribbean fauna (HENDLER *et al.*, 1995),

where 16 of the species also occur. According to Spalding *et al.*, (2007), the Tropical Atlantic province includes ecoregion on the Brazilian northeast coast, and the Warm Temperate Southwestern Atlantic province includes the ecoregion on the southern coastal states of Brazil. These two ecoregions differ in the influence of climate and water temperature. Probably, the distribution of some holothuroidean species on the Brazilian coast may evidence the environmental limits of the two different ecoregions.

Global stocks of sea cucumbers have declined in recent years, due to the high demand for exportation to Southeast Asian countries where they are considered a delicacy. The ease with which they can be collected and their high commercial value make them particularly vulnerable to overfishing (KALAEB *et al.*, 2008). In Brazil, commercial collection of *H. grisea* has been recorded in small quantities on the coast of São Paulo, and of *I. badionotus* in coastal regions of Rio de Janeiro (HADEL *et al.*, 1999; AMARAL *et al.*, 2008). In Alagoas state, until the present, no records of commercial exploitation of holothuroidean species exist, and the principal human impacts that threaten sea cucumbers are pollution and unregulated tourism activities, which cause considerable physical damage to many reef ecosystems (CORREIA;SOVIERZOSKI, 2010).

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## CAPÍTULO 3

### EFFECTS OF THE SEDIMENT COMPOSITION ON THE DISTRIBUTION OF HOLOTHUROIDEA SPECIES (ECHINODERMATA) ON THE CENTRAL COAST OF ALAGOAS STATE, NORTHEAST OF BRAZIL.

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#### ABSTRACT

The sea cucumbers are exclusively marine organisms and are important component of reef ecosystems performing recycling of nutrient on the soft sediment. However the effect of the sea cucumbers on the marine communities are which no well documented, suggesting the necessity of ecological studies about this group. The present study analyses the effects on spatial distribution of the Holothuroidea species based on the substrate composition recorded in reef ecosystems of the central coast of Alagoas state, northeast of Brazil. The animals and sediment samples were collected in nine reef ecosystems during low tide until 20m depth. The species identification was made by specific references, and the granulometry, organic matter and carbonates on the sediment samples were analyzed by standard methodology. The relations among the species distribution and sediment characteristics were analyzed by Principal Component, Canonical Correspondence and Cluster analysis using the UPGMA

method and Nonmetric Multidimensional Scaling (NMDS). Seventeen species were recorded to the reef ecosystems, and were found *Synaptula hydriformis* on the Ponta Verde coral reef and *Trachytyone crassipeda* on the Riacho Doce coral reef which were classified as frequent, and also *Holothuria grisea* obtained the highest occurrence. The analyses of carbonates percentage presented the highest variation among the sediment characteristics. The cluster analysis shows the formation of three groups with approximately 45% of similarity confirmed by NMDS. The Canonical Correspondence analysis demonstrated the influence of the sediment characteristics to the Holothuroidea species distribution on the reef ecosystems from Alagoas coast.

**Keyword:** sea cucumber, carbonate, granulometry, coral reef, sandstone reef.

### 3.1. Introduction

The sea cucumber are exclusively marine habiting from shallow water to abyssal regions, living under rocks, buried on the sediment or in association with algae and other organisms such as sponges (HADEL *et al.*, 1999).

They are important component on the reef ecosystems performing recycling of nutrient on the marine sediment, consuming and then depositing enriched material in the form of fecal pellets, presenting in areas with feeding activity and natural densities of sea cucumbers beneficial for the sediment microalgae community (UTHICKE;KAREZ, 1999). According Birkeland (1989) to understand the ecology of the Phylum Echinodermata, which belong the class Holothuroidea, allows knows largely the structure and behavior on the reef communities. However these ecological aspects are related principally with the effect of the sea cucumbers on the marine communities are which no well documented, suggesting the necessity of ecological studies about this group (PAWSON;PAWSON;KING, 2010).

The most of studies about Echinoderms realized in Brazilian coast were related with general aspects of benthic communities and generally not included the class Holothuroidea contributing, so that this class of the echinoderms is considered the least studied from South Atlantic Ocean (TOMMASI, 1969; HADEL *et al.*, 1999).

The growing interest related to the economic importance of the sea cucumbers for many countries around the world, principally in the Southeast Asian countries is worrying. Many species of holothuroids are utilized largely in the food and

pharmaceutical industries which were contributing to the decline of global stocks, demonstrating the importance of ecology studies and distribution of Holothuroidea species to adopt conservation policies (KALEB *et al.*, 2008; SHAKOURI *et al.*, 2009).

The present work analyses the spatial distribution of the Holothuroidea species based on the substrate composition recorded in reef ecosystems of the central coast of Alagoas state, northeast of Brazil.

## 3.2. Material and Methods

### 3.2.1. Study area

The Alagoas state is located in northeast Brazil between 8°8'12"S and 10°29'12"S and is bounded on the north by the Persinunga River and on the south by the São Francisco River.

The reefs ecosystems of Alagoas coast present predominantly two different geomorphological aspects. The coral reefs are formed basically by scleractinian corals, hydrocorals, calcareous algae, and bryozoans. The sandstone reefs were formed through sedimentation of calcium carbonate or iron oxide on sand banks started with the chemical reaction of fresh water and silica from seawater. The central coast of Alagoas has predominantly coral reefs and many of these coral reefs are located near of the coast line and form fringing reefs with have the reef platform expose during low tides and some pools on 1 to 5 m deep, protected from waves and other hydrodynamic effects (CORREIA, 2011).

The study area on the central coast of Alagoas, including two cities Maceió and Marechal Deodoro, which comprise nine reef ecosystems with six coral reefs including Ponta do Pregó (9°31'48"S-35°35'30"W), Ponta do Meirim (9°32'37"S-35°36'52"W), Riacho Doce (9°34'55"S- 35°39'25"W), Jatiúca (9°39'12"S-35°41'46"W), Ponta Verde (9°39'57"S-35°41'32"W) and Pajuçara (9°41'06"S-35°43'22"W), and also three sandstone reefs among Sereia (9°34'04"S-35°38'46"W), Saco da Pedra (9°44'26"S-35°48'59"W) and Francês (9°46'03"S-35°50'13"W) (Figure 1).

Figure 1: Map of the study area on the central coast of Alagoas, northeastern of Brazil.



Fonte: Autor dessa dissertação / Google Earth, 2013.

### 3.2.2. Collection and material processing

Invertebrate samples were collected by snorkeling during low tide and SCUBA until 20m depth. The specimens obtained were stored in plastic bags containing sea water. The samples of sediment were also collected, with approximately 1kg, in each site to characterize the sediment composition.

The specimens were anesthetized with 10%  $MgCl_2$ , and then fixed and conserved in 70% ethanol in the laboratory. All specimens were identified until specific level based on specific references (Hendler *et al.*, 1995; Pawson *et al.*, 2010; Tommasi, 1969), and then deposited in the Echinodermata collection at the Sector of Benthic Communities, of the Federal University of Alagoas. Based on field observations species has been added after comparison of data compiled on the reefs studies to classify on three categories and absent to relate the spatial distribution.

The characterization of the sediment samples with respect to granulometry, organic matter and carbonates were analyzed by standard methodology. These samples were dried in greenhouse with temperature of 80 °C until constant weight.

Each granulometry analysis was utilized 100g of sediment that were sieved to determine the percentages of rubble, sand and fine. The percentage of organic matter were estimated by separating three subsamples of homogenized and dried sediment with until 2g in crucible of porcelain that were transferred to muffle and burned at 500°C for 2 hours. After cooling in a desiccator, samples were reweighed and the difference of initial and final weight is the organic matter content. The same subsamples were separated to the carbonate percentages, weight in Becker to react in 50% HCl for 24h. The insoluble material was washed with distilled water and dried in greenhouse at 80°C for 24h and then was weighed and the difference between initial and final weight is the carbonate content.

### 3.2.3. Data analysis

The species distribution and sediment data were processed in Excel Microsoft Office® with the program PAST 2.0 was made A Principal Components Analysis (PCA) to understand how reef ecosystems are grouped, and also was realized the Canonical Correspondence Analysis (CCA) to explore the relationships among spatial distribution of the Holothuroidea species in the reef ecosystems studied and sediment factors.

Bray-Curtis similarity index was analyzed in  $\log(x+1)$  which was used to the Cluster Analysis using the UPGMA method and to the Nonmetric Multidimensional Scaling (NMDS). The both analyses was calculated with the program PRIMER 6® that were utilized to observe the similarity among the reef ecosystems in relation to species distribution.

## 3.3. Results

### 3.3.1. Species distribution

Seventeen species were recorded to the coast of Alagoas state, where two were classified as frequent including *Synaptula hydriformis* (Lesueur, 1924) on the Ponta Verde coral reef and *Trachytyone crassipeda* Cherbonnier, 1961 on the Riacho Doce coral reef. The specie with highest occurrence frequency was *Holothuria grisea* Selenka, 1867 that was found in seven of the nine localities studied. In relation with

the reef ecosystems, Ponta Verde and Riacho Doce coral reefs presents the highest quantity of species record with nine. Some species were presented only one reef ecosystem with *Aslia pygmaea* on the Sereia Sandstone Reef, *Isostichopus badionotus* on the Francês Sandstone reef, *Lissothuria braziliensis* on the Ponta do Meirim coral reef and *Psolus tuberculosus* on the Saco da Pedra Sandstone reef (Table 1).

Table 1: Distribution of the Holothuroidea species on the central coast of Alagoas, Brazil. PP – Ponta do Pregó; PM – Ponta do Meirim; SE – Sereia; RD – Riacho Doce; JA – Jatiúca; PV – Ponta Verde; PJ – Pajuçara; SP – Saco da Pedra and FR – Francês.

Species	Reef Ecosystems								
	PP	PM	SE	RD	JA	PV	PJ	SP	FR
<i>Aslia pygmaea</i>	-	-	X	-	-	-	-	-	-
<i>Chiridota rotifera</i>	-	-	-	XXX	-	XXX	-	X	XX
<i>Duasmodyctyla seguroensis</i>	X	-	-	XX	X	XX	-	-	-
<i>Epitomapta roseola</i>	X	-	-	-	-	X	-	-	-
<i>Holothuria grisea</i>	-	-	XXX	XX	X	X	XX	XXX	X
<i>Holothuria parvula</i>	-	-	-	X	-	X	-	-	X
<i>Holothuria arenicola</i>	-	-	-	-	-	-	-	XXX	XX
<i>Isostichopus badionotus</i>	-	-	-	-	-	-	-	-	X
<i>Lissothuria braziliensis</i>	X	-	-	-	-	-	-	-	-
<i>Ocnus braziliensis</i>	-	X	X	XX	X	XX	XX	-	-
<i>Phyllophorus occidentalis</i>	X	-	-	X	-	XX	XX	-	-
<i>Pseudothyone belli</i>	-	X	-	-	-	-	-	-	X
<i>Psolus tuberculosus</i>	-	-	-	-	-	-	-	X	-
<i>Stolus cognatus</i>	-	-	-	XX	X	-	-	-	-
<i>Synaptula hydriformis</i>	-	X	-	X	-	XXXX	-	-	XX
<i>Thyone pseudofusus</i>	-	-	-	-	-	X	-	-	-
<i>Trachytyone crassipeda</i>	-	X	XX	XXXX	-	-	X	X	-
Total of Species	4	4	4	9	4	9	4	5	7

- Absent, X Rare, XX Occasional, XXX Common, and XXXX Frequent

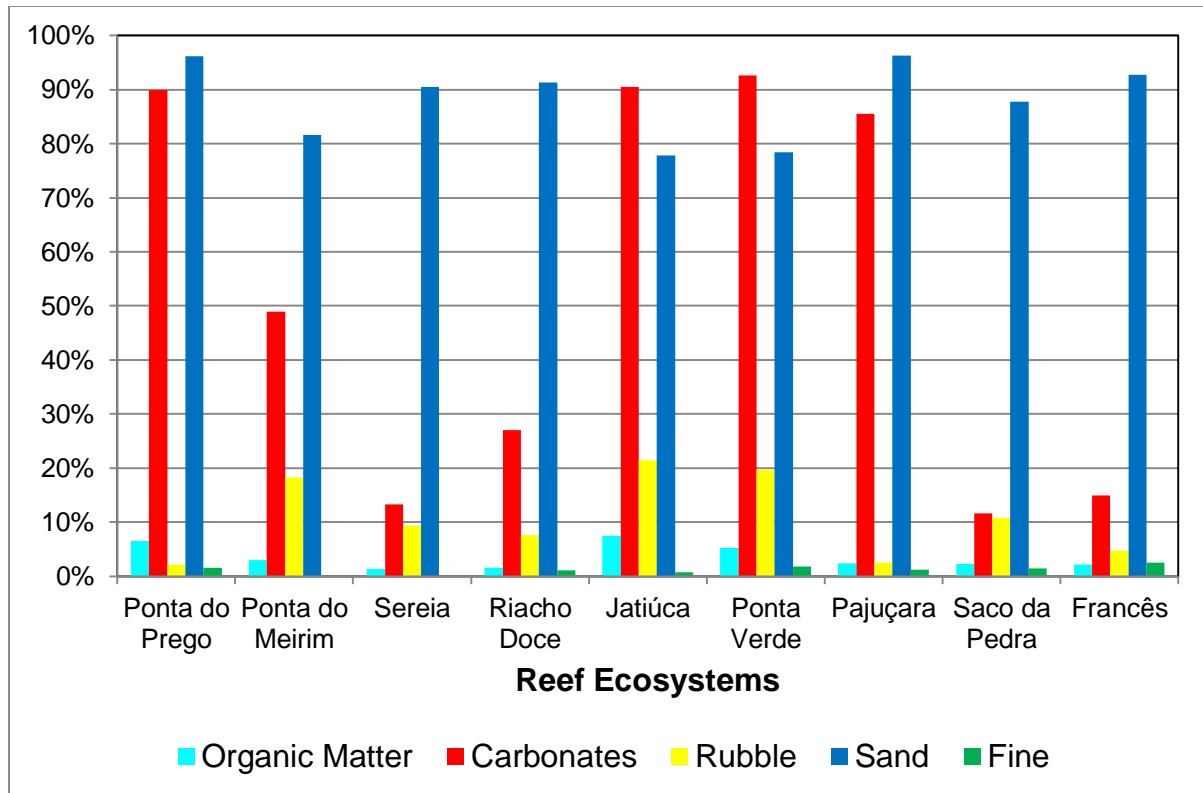
Fonte: Autor desta dissertação, 2013.

### 3.3.2. Sediment characterization

The sediment in the study areas presented significant difference among the reef ecosystems in some of the aspects analyzed relative to organic matter, carbonates, and granulometry on the percentage of sand, rubble and fine. The

carbonates percentage had the highest variation among the reef ecosystems varying of 92,61% to 11,68%. Organic matter varied from 7,54% to 1,33%. In relation to the granulometry the highest percentage was of sand that varied from 96,3% to 77,8%, followed by rubble from 21,5% to 2,2% and Fine from 2,5% to 0,1% (Figure 2).

Figure 2: Sediment compositions on the reefs ecosystems of the Alagoas central coast.

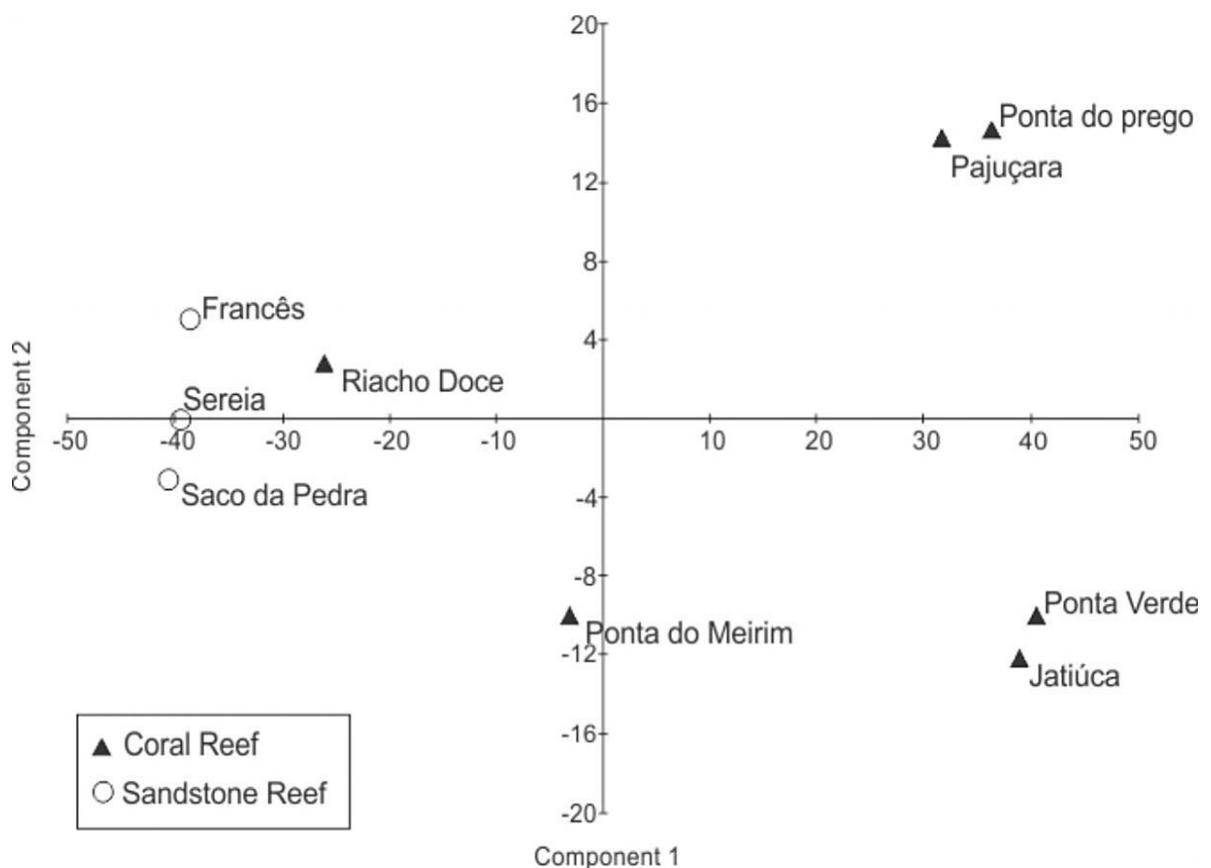


Fonte: Autor desta dissertação, 2013.

The characterization of sediment variables among reef ecosystems observed when analyzed by Principal Components Analysis (PCA) demonstrated the formation of three reef groups. The first group formed by Saco da Pedra, Sereia, Francês and Riacho Doce was influenced principally by lower levels of carbonates varying from 27,05% to 11,68%. The second group was formed by Ponta Verde, Jatiúca and Ponta do Meirim that were influenced by percentages of rubble the highest among reefs studied with variation from 21,5 % to 18,3%. Ponta do Meirim coral reef presented smaller similarity in the sediment composition with Ponta Verde and Jatiúca because had reduced level of carbonates with 48,93%. The lastly group compound by Ponta do Prego and Pajuçara was influenced by smaller values of rubble varying from 2,5% to 2,3% (Figure 3).

The PCA demonstrated that first axis responded 92,8% of the data variation and was strongest related with carbonates levels. The reef ecosystems with higher scores Ponta Verde and Jatiúca presented carbonates percentage larger than 90%. In the opposite extreme of the axis were Saco da Pedra, Francês and Sereia that presented less than 15% of carbonate. In relation to second axis it responded 6,8% of the data variation being related with rubble and sand levels. The Ponta do Prego and Pajuçara coral reefs obtained the highest scores and related with sand percentage of approximately 96%. In the other extreme of the axis, Ponta Verde and Jatiúca were related with rubble percentage.

Figure 3: Principal Components Analyses of the sediment variables among the reef ecosystem of the Alagoas central coast.



Fonte: Autor desta dissertação, 2013.

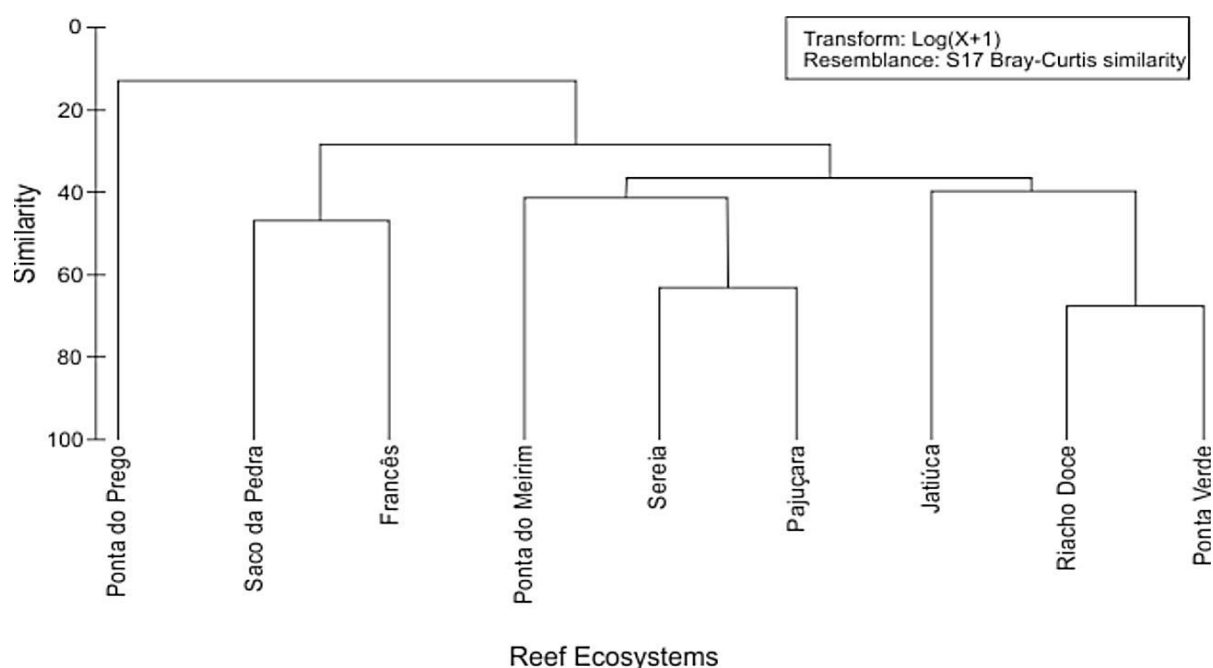


### 3.3.3. Ecological analysis

The cluster analysis realized among the reef ecosystems studied demonstrated the formation of three principal groups with approximately 45% of similarity. On the first group were found two reefs which including Francês and Saco da Pedra sandstone reefs. The second group had three reef ecosystems with Ponta do Meirim, Sereia and Pajuçara. The third group formed by Jatiúca, Riacho Doce and Ponta Verde coral reefs. The second and third groups presented among them similarity of 40%. Riacho Doce and Ponta Verde reefs had the larger similarity with approximately 70%. The Ponta do Prego coral reef remained isolated with similarities smaller than 20% in relation with the others groups (Figure 4).

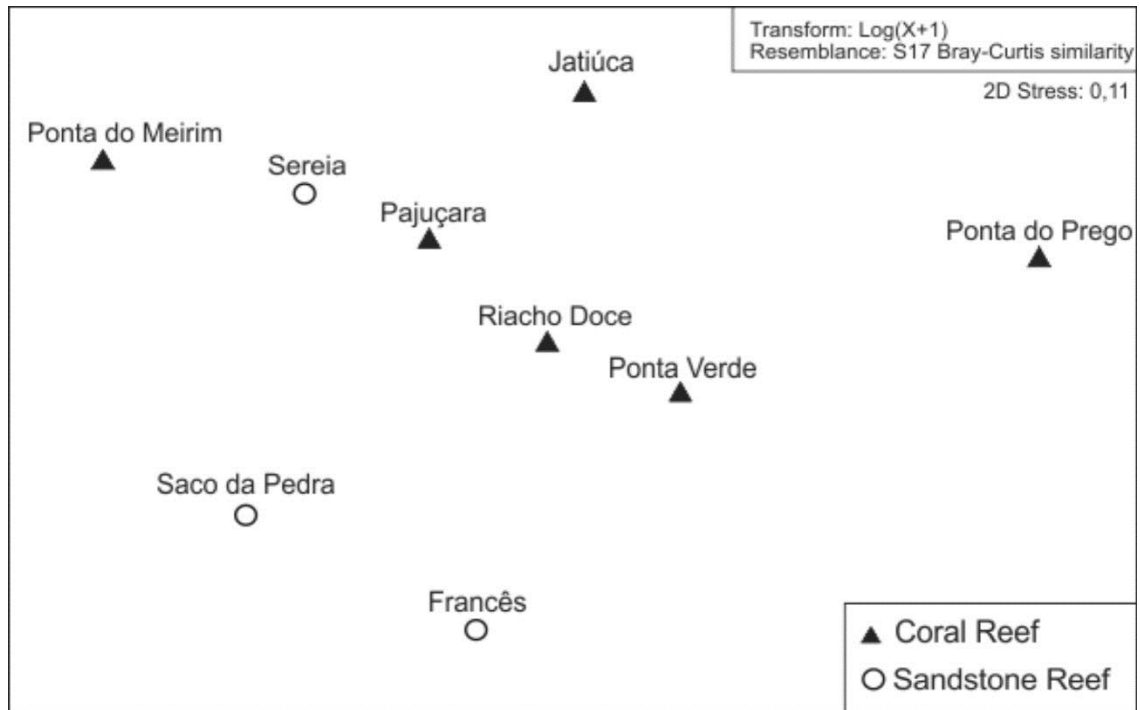
To confirm the cluster analysis, the Nonmetric Multidimensional Scaling analysis (NMDS) demonstrated the proximity of second and third groups formed in the cluster. Also this analysis confirmed the group formed by Francês and Saco da Pedra sandstone reefs, and also the smaller similarity of Ponta do Prego coral reef with the others (Figure 5).

Figure 4: Cluster Analysis of the reef ecosystems of the Alagoas central coast based on the species distribution using Bray-Curtis similarity index in  $\log(x+1)$ .



Fonte: Autor desta dissertação, 2013.

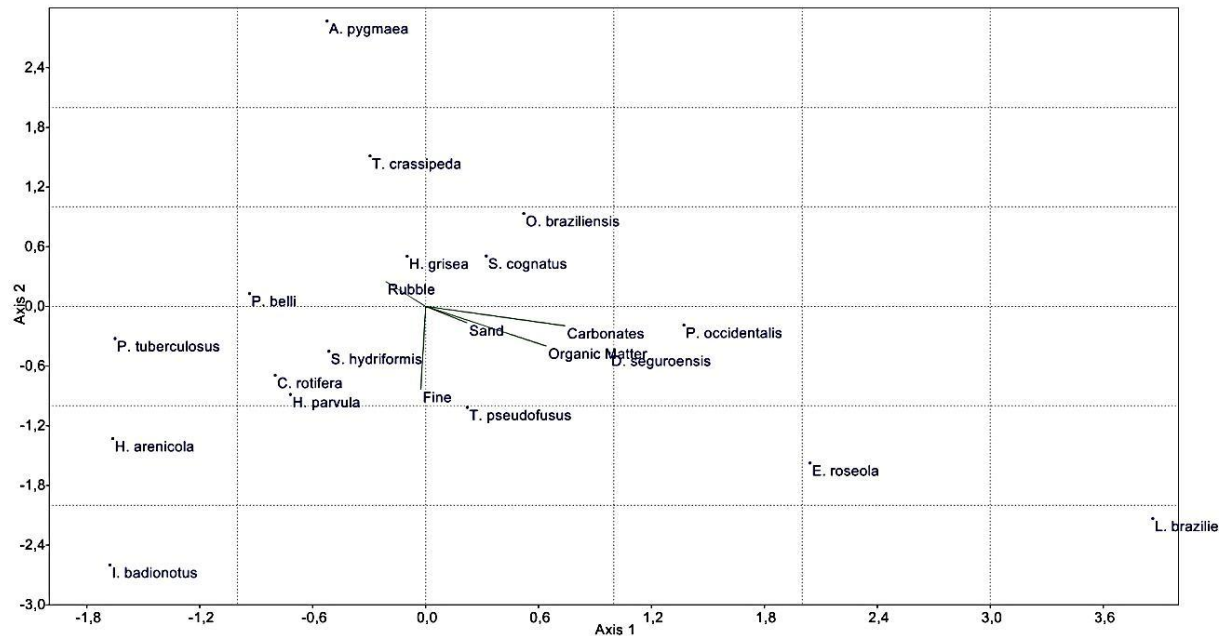
Figure 5: Nonmetric Multidimensional Scaling analysis of the reef ecosystem of the Alagoas central coast based on the species distribution using Bray-Curtis similarity index in log (x+1).



Fonte: Autor desta dissertação, 2013.

The correspondence canonical analysis (CCA) demonstrated the difference influence of the sediment characters on the Holothuroidea species distribution. The influence of the fines sediment were detected on the distribution of the *S. hydriformes*, *C. rotifera*, *H. parvula* and *T. pseudofusus*. Three sediment variables including carbonate, sand and organic matter influenced the occurrence of *P. occidentalis*, *D. seguroensis*, *E. roseola* and *L. braziliensis*. The rubble percentage influenced the distribution of *H. grisea*, *P. belli* and *T. crassipeda*. The first two axis explained 72,27% of the variation in the distribution and abundance of the Holothuroidea species observed on the reef ecosystems studied (Figure 6).

Figure 6: Correspondence Canonical Analysis (CCA) on the sediment characteristics and the Holothuroidea species on the reef ecosystems from Alagoas central coast.



Fonte: Autor desta dissertação, 2013.

### 3.4. Discussion

The seventeen species found on the reef ecosystems of the central coast of Alagoas State correspond to more than 50% of the Holothuroidea species recorded by Tiago and Ditadi (2001) to the Brazilian coast. Among these species, *S. hydriformes* and *T. crassipeda* were classified with frequent in the Ponta Verde and Riacho Doce coral reefs. The first specie was observed associated with algae, principally *Amphiroa fragilissima* (Linnaeus) Lamouroux that according Littler *et al.*, (1989) was formed by calcified branches with dichotomous aspect, thereby proving a rigid and matted structure. This alga were characterized in association with morphological and reproductive characters of *S. hydriformis*, and also including arrangement of the ossicles in the body wall and the viviparous reproduction explain the great quantity of animals living associated (CLARK, 1908). In relation to the other frequent species, *T. crassipeda* was recorded before by Cherbonnier (1961) only in the type locality in the Abrolhos Archipelago, northeast of the Brazil and Information about ecology and

habitat preference is scarce. In the Riacho Doce coral reef was observed in large aggregations buried on the substrate like other species as *D. seguroensis* and *P. occidentallis* that had this behavior registered by Hendler *et al.*, (1995). *H. grisea* was specie with highest occurrence, and also was considered the specie most frequent of the Brazillian coast by Tommasi (1969). According Mendes, Marenzi and Domenico, (2006) the abundance of *H. grisea* was related with the availability of hard substrate which provides good conditions of fixation to the animal.

The sediment characteristics observed on the reef ecosystems studied presented similar with reported by other studies to the northeast coast of Brazil. According Lacerda and Marins (2006) the predominance of sediment rich in carbonate is characteristic from northeast region. This carbonate is mostly generated in situ with the contribution of hermatypic coral, red and green algae, foraminifers, molluscs, bryozoans and echinoderms (SOARES; LEMOS; KIKUCHI, 2009). On the central coast of Alagoas the Ponta do Pregó, Jatiúca, Ponta Verde and Pajuçara coral reefs had presented greater percentage of carbonates than 85%, which showing the influence of coralline algae and other organisms abundant on the localities studied. Ponta do Meirim coral reef presents in the sediment 48,9% of carbonates that is influenced by concurrence of other algae without coralline structure. The lowest levels of carbonates were observed in the Riacho Doce coral reef also Sereia, Saco da Pedra and Francês sandstone reefs located near of the mouth of lagoons or small rivers that exert according Lacerda and Marins (2006) great influence reducing the carbonate percentage with increasing of sediment siliciclastic from the continent. These reefs groups were evidenced on the Principal Components Analysis (Figure 6) that were influenced by carbonate percentages principally.

The distribution of some species of the Holothuroidea were associated with the influenced by sediment characteristics. Small species among *S. hydriformes* and *C. rotifer* had their distribution influenced by fine sediments (Figure 6). This characteristic can be related with the habitat preference of these species in protected areas with fine sand and mud, and according Massin (1982) also in addition to the relation between tentacles morphology and capture of determined type of food ingested. Research about food activity and grain-size sediment selectivity like Hammond (1982) demonstrated the absence of particle size discrimination in some species of Holothuroidea including *I. badionotus* and *H. arenicola* that were recorded to Alagoas coast and the distribution of these species can be related with habitat

preferences since occurring according Sloan; von Bodungen (1980) in protected areas where usually occur deposition of fine sediment.

According Pawson (1966) the number of holothurians tends to be higher in areas with great concentration of organic aspects content that providing food. The low percentages of organic matter on some reef ecosystems of the central coast of Alagoas suggest the influence of other environmental factors in the distribution and abundance of the species. According Bakus (1973) the principal factor influencing the distribution of the most holothurian on tropical reefs is the shelter from wave actions. However, in this study the distribution of Holothuroidea species on reef ecosystems of the central coast of Alagoas were influenced by the differences on the sediment composition.

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