Study IV: Distribution and abundance of Echinodermata in shallow near shore environments in Dominica, Lesser Antilles

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Abstract Twenty three sites were evaluated to determine the presence and abundance of echinoderms using a twenty minute roaming survey. The objective was to create a species inventory of all echinoderms present and as assess their abundance across a variety of habitats in depths of 0-5 meters. Seventeen species were identified along the west coast, *Diadema antillarum* being the most dominant at each site.

Keywords Dominica · Echinodermata · Abundance · *Diadema antillarum*

Introduction

Echinoderms are found in all zones of the ocean in a wide array of habitats. The five classes that have been described are Crinoidea (feather stars), Asteroidea (sea stars), Ophiuroidea (brittle and basket stars), Echinoidea (urchins, sand dollars, and sea biscuits), and Holothuroidea (sea cucumbers). All are benthic organisms, have a calcareous endoskeleton and exhibit radial symmetry sometime during their individual lifecycles (Humann and Deloach 2002).

Echinoderms are efficient scavengers within their respective marine ecosystems (Pawson and Miller 2008). Some are carnivorous predators or scavengers including sea stars and brittle stars (Brusca and Brusca 1990). Others are suspension or deposit feeders such as basket stars and feather stars. A select few are detritus, particulate feeders like sand dollars. Lastly, some are herbivorous grazers like sea urchins. A relevant example is the long spine sea urchin, *Diadema antillarum*, which is abundant in Dominica compared to the other islands in the Caribbean basin (Williams 2001). The abundance of this important grazer was inversely related to the percent cover algae (Macfarlane 2007). *D. antillarum* frees up the substrate for other organisms to flourish (Szmant 2001). In 2006 it was shown that *D. antillarum* controlled turf algae in Dominica which influenced the health of the reef (Steiner and Williams 2006). Removal of sea urchins would result in overgrowth of algae and the devastation of habitats (Pawson and Miller 2008).

Another threat to echinoderms in Dominica is the illegal extraction and merchandising of organisms. Sea stars are popular souvenirs but it is illegal to extract and sell them, however, this does not stop the trade. In Dominica on days where cruise ship visit, vendors can be seen selling dried and preserved *Oreaster reticulatus* on the street sides. The anthropogenic extraction of this species may have a negative impact on their population. Surveys on abundance are important as they can serve as reference points for future studies on the status of *O. reticulatus* in Dominica.

A study of the presence and abundance of echinoderms has not been executed in Dominica since Porter (1966); however he only focused on echinoids in Dominica. A broad echinoderm survey has never been executed in Dominica. This survey examined species richness, abundance of echinoderms and their distribution across different depth ranges and habitat types.

Materials and Methods

The survey was carried out at twenty-three different sites with a maximum depth of five meters (Figure A). During each survey, the presence and abundance of Echinoderms was determined. The survey was a twenty minute roaming surveying where swimming in a zigzag pattern at a slow pace allowed for the examination of the area. These areas ranged from 22 m² to 3500 m² (Table 1).

The quantification of the presence was done using a nominal ranking system. A ‘5’ was the first five minutes of survey (0-5 min), a ‘4’ was from 5-10 min, ‘3’ was the next five minute interval (10-15 min), ‘2’ was the last interval (15-20min) and a ranking of ‘1’ was given to those species seen outside the survey time. These organisms identified outside of the twenty minute survey were noted but not quantified within the data. An additional ranking system was used to quantify the abundance of the species. Rare species were species seen only once within the survey time and were given a ranking of ‘1’, occasional species were those seen two to ten times within the survey and were given a rank of ‘2’, and common species were those that are seen more than ten times throughout the survey and were given a rank of ‘3’. Using these values along with the area an index for each species at each site was calculated using the following formula: (presence) (abundance) / (area/100). This index provides a reference point for comparing the abundances of the species. Depth and microhabitat where species were found were also recorded. The depth was considered in three intervals: 0-1 meter, 1-3 meters and 3-5 meters. The microhabitat of the species were separated into five categories: rock hole – a hole created by another species within a rock habitat, rock crevice – a small space between rocks, rock surface – exposed on the top of a rock face, sponge – on or in a sponge, and other which includes sea plumes and sandy substrates. The identification of the species was done in the field but was derived from the pictures and descriptions by Humann and Deloach (2002).The area that was surveyed was estimated upon completion of the survey and then verified using the satellite imagery of Google Earth (Google).

Results

Species presence

Seventeen species of echinoderms were found at twenty three sites in Dominica. Seven of those belonged to the class Echinoidea, five were Ophiuroidea, two were Asteroidea, two belonged to Holothuroidea and one was a crinoid (Table 2).

Abundance

E. lucunter and *D. antillarum* were the most abundance species with the highest mean abundance index of all species (Fig. 1). The species with the lowest abundance index were *O. appressum* and *Ophiocoma* sp. The species seen at the most sites were *D. antillarum* and *E. lucunter*. The species seen at the fewest number of sites were *O. appressum* and *Ophiocoma sp.* (Table 3).

Depth

The speices that was had the widest depth range was *D. antillarum*. Some echinoids including *E. lucunter, E, viridis, E. tribuloides* and *T. ventricosus* were only distributed within the first three meters of depth. The species that were found from three to five meters were *D. rubignosa, H. mexicana, A. multifidus* and *C. subdepressus* (Fig 2).

Microhabitat

Species that were most frequently found on the surface of rocks were *D. antillarum, T. ventricosus* and *L. guildingii.* Rock holes house species such as *E. lucunter, E. viridis, O. echinata, E. tribuloides* and *O. suensonii.* Species seen in rock crevices were urchins such as *E. tribuloides* and sea stars like *L. guildingii.* Species commonly seen on sponges were *A. muricatum, O. suensonii* and *O. appressum.* Lastly*, A. muricatum* was occasionally seen on soft corals and the species *C. subdepressus, H. mexicana* and *A. multifidus* were found on sand.

Discussion

Species presence and abundance

During the survey, seventeen species were observed, and these were mostly sea urchins (Echinoidea). All of these species have been previously recorded in Dominica.

The survey provides evidence that certain abundant echinoids such as *D. antillarum* and *E. lucunter* tend to aggregate in large groups. This is shown by their high mean abundances (Fig 1). The high abundance of *D. antillarum* is consistent with data retrieved from 2001 – 2005 of *D. antillarum* presence and density in Dominica (Steiner and Williams 2006). *E. lucunter* was predominantly seen within the first depth range (0-1m) at most sites (Fig 2) but were still the most abundant within 0-1 meter, suggesting that aggregations occurred. This conclusion corresponds with shallow fossil beds dating back to the lower Cambrian period. Species that were seen less frequently and in smaller aggregations such as the brittle star species' *Ophiocoma sp.* and *O. appressum* do not aggregate in large groups according to Pawson and Miller (2008).

Abundance in certain echinoids is important to the benthic ecosystem in the fact that they keep the reef healthy by keeping the algal growth under control (Macfarlene 2007). A downside, however, is those aggregations of rock boring urchins such as *E. lucunter*, which is the most abundant echinoderm in Dominica, can actually accelerate the erosion of shore lines. They burrow into the rock causing it to weaken and eventually erode away. Erosion adds to the retrograding of shorelines eventually resulting in sedimentation (Erosion 2008). Sedimentation and the disappearance of the rocky shoreline results in the loss of habitat and therefore a decrease in the abundance of organisms present. Other organisms like holothurians, when abundant, actually aid in the health of the ecosystem by overturning sediment and extracting organic matter (Pawson and Miller 2008). Whether good or bad, the abundance of organisms like echinoderms is a key element in structural changes of many marine ecosystems.

Depth

The results provide evidence that the presence of some echinoderms vary with depth. The Echinoids seen here were predominantly found in the first three meters of depth. This result is consistent with the idea that the habitat of echinoderms is regulated by light and aggregation is a direct response to the availability of food (Pawson and Miller 2008). Since light penetration and intensity decreases with depth, it can be said that echinoderms primarily found within the first three meters such as *D. antillarum, E. lucunter, E. viridis,* and *E. tribuloides* depend on light to produce their food source which is algae (Brusca and Brusca 1990). Organisms that were mostly found within three to five meters are less dependant on light to produce their food and therefore can survive in deeper habitats. Such species include *C. subdepressus (*living in sediment), *D.*

rubignosa (inhabit cryptic environments), *A. multifidus* and *H. Mexicana* (both live on sediment). The depth range of three to five meters includes suspension feeders and particulate feeders (Brusca and Brusca 1990).

Although echinoderm's feeding habits range from suspension feeders, grazers and particulate feeders to predators they have an equal impact on the ecosystem and depth in which they inhabit. In lesser depths they help regulate the numbers of smaller organisms such as molluscs, and free up space on coral reefs by grazing on algae. Echinoderms at greater depths feed on decaying matter on the sea floor and are predators of smaller organisms. Also, the larvae of echinoderms serve as food for many other planktonic organisms (Pawson and Miller 2008). The removal of such efficient scavengers would disrupt the food chain and ultimately end in overgrowth of algae and a surplus of small organisms.

Microhabitat

Many of the echinoids were found in rocky, turbulent areas because it is where their food source is located. Because of this turbulence, they need to burrow into the rock or hide in rock holes and crevices in order to survive. These sea urchins have an adaption to their skeleton that makes it harder than other echinoderms as a response to the surf pounding against the rocks (Pawson and Miller 2008). Others which are found on or in sponges. They use the sponge as protection during the daytime while at night they come out and feed (Brusca and Brusca 1990). Organisms found in sand such as *C. subdepressus* usually burrow themselves into the sediment to hide from predators. Since a survey was never executed on sand or sea grass, the organisms that were found within these micro habitats were seen outside the survey time. Species such as *Meoma ventricosa* and *Oreaster reticulates* were never seen in survey time, but are known to be present in sea grass beds deeper than five meters through personal observation along with the help of other surveyors.

Since the microhabitats of some echinoids are self-made, they also provide a habitat for other small creatures. Within survey it was noted that certain crabs and brittle stars were found within the same holes that *D. antillarum* have created within rock substrates. *D. antillarum* provide protection for the smaller creatures without affecting itself. These relationships provide a habitat for species requiring protection while the other species remains unaffected. These results show a form of commensalism within micro habitats.

Acknowledgements I would like to thank Sascha Steiner, Keira Macfarlene and Lori Price for guiding the dives and lectures. I would also like to thank Lindsay Chapman, Jimmy Ritzmann, Robert Brewer, and Alex Clermont for aiding in the surveys.

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Table 1: Site number, name, habitat type, depth and area

Site #	Site Name	Habitat	Depth	Area (m^2)
1	Scott's Head	Cliff	0-5 m	800
2	Lauro Shallows	Cliff	0-2 m	1400
3	Douglas Bay	Rock	3-4 m	750
4	Cabrit's Pier	Rock	1-3 m	1200
5	Espagnole Bay	Rock	0-3 m	2700
7	Fond Cole	Rock	0-3 m	300
8	Champagne	Rock	0-5 m	2100
9	Dou Dou	Reef	0-5 m	1500
11	Anse Mulatre 1	Cliff	0-2 m	75
12	Anse Mulatre 2	Rock	0-7 m	600
13	Anse Mulatre 3	Cliff	0-2 m	300
17	Mero - East Carib Dive 1	Rock	3-5 m	1200
18	Mero East Carib Dive 2	Rock	0-2 m	60
19	Mero - East Carib Dive 3	Rock	0-2 m	22
22	South Mero 1	Rock	3-5 m	1200
23	South Mero 2	Rock	0-2 m	80
25	Anse à Liane 1	Rock	0-5 m	400
26	Anse à Liane 2	Rock	2-5 m	600
27	Anse à Liane 3	Cliff	0-3 m	3500
28	Colihaut	Rock	.5 - 5 m	1500
31	Grand Savanne - East Carib Dive 1	Rock	.5 - 2 m	60
32	Grand Savanne - East Carib Dive 2	Rock	1-5 m	2400
33	Grand Savanne - East Carib Dive 3	Cliff	0-3 m	300

Table 2: Species list and class distribution of seventeen echinoderms

Species	Class
Diadema antillarum	Echinoidea
Tripneustes ventricosus	Echinoidea
Meoma ventricosa	Echinoidea
Eucidaris tribuloides	Echinoidea
Echinometra lucunter	Echinoidea
Echinometra viridis	Echinoidea
Clypeaster subdepressus	Echinoidea
Astrophyton muricatum	Ophiuroidea
Ophiocoma sp.	Ophiuroidea
Ophiocoma echinata	Ophiuroidea
Ophioderma appressum	Ophiuroidea
Opiothrix suensonii	Ophiuroidea
Holothuria mexicana	Holothuroidea
Astichopus multifidus	Holothuroidea
Oreaster reticulatus	Asteroidea
Linckia guildingii	Asteroidea
Davidaster rubignosa	Crinoidea

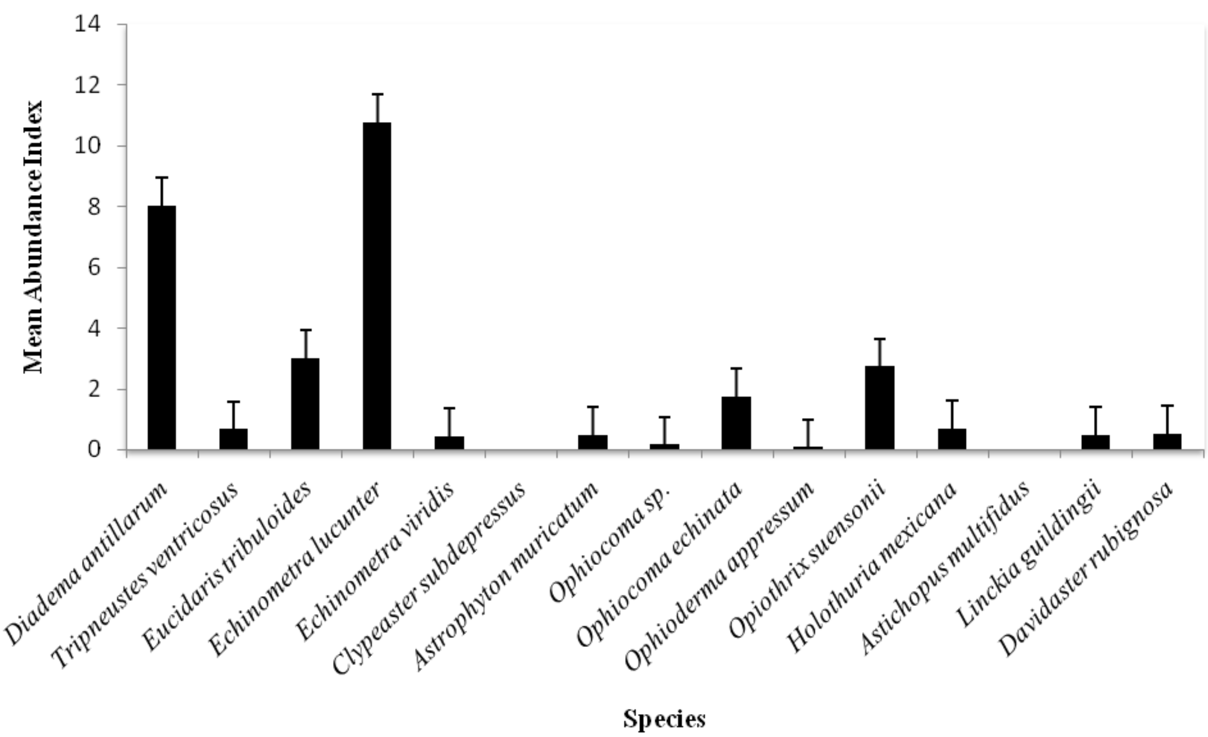

Figure 1: The mean abundance index ± S.E. of species across twenty three sites

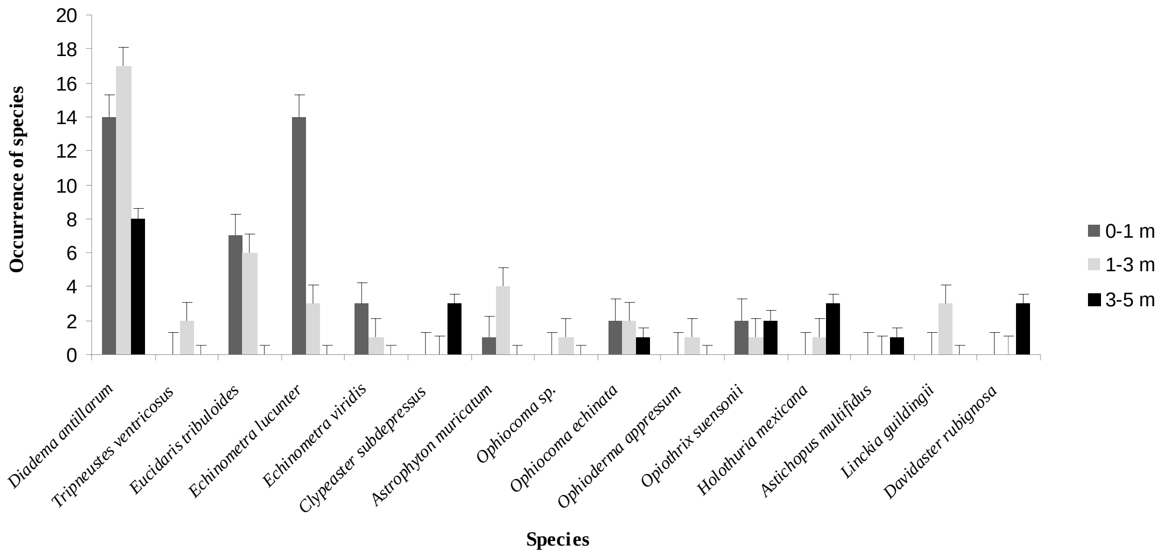

Figure 2: The occurrence of each species across a depth range of 0-5m for 23 surveyed sites ± S.E.

Table 3: The presence and abundance of each species at the twenty three sites surveyed.

	Sites																						
Species	1	2	3	4	5	7	8	9	11	12	13	17	18	19	22	23	25	26	27	28	31	32	33
Diadema antillarum	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●
Tripneustes ventricosus	◑							○															
Meoma ventricosa																							
Eucidaris tribuloides	◑			○		○		○	◑		◑		○				○	○	●	◑	◑		○
Echinometra lucunter	●	●				◑	◑		●		●		●	●		●	●		●	◑	◑	●	●
Echinometra viridis				○							○								○				
Clypeaster subdepressus					○			○		○													
Astrophyton muricatum							◑					○						○		○		○	
Ophiocoma sp.					○																		
Ophiocoma echinata				○					○		○		○		○								
Ophioderma appressum					○																		
Opiothrix suensonii	○		○	◑					◑		◑												
Holothuria mexicana				◑				◑		○												○	
Astichopus multifidus								○															
Oreaster reticulatus																							
Linckia guildingii		○											○					○					
Davidaster rubignosa	○			○						○													

Common: ●
Occasional: ◑
Rare: ○

Note: *Meoma ventricosa* and *Oreaster reticulatus* were seen at some sites but were not assigned an abundance rank as they were not found within the survey parameters (depth and time).