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SPEED, MOVEMENT, AND FEEDING PATTERNS OF THE COMMON CARIBBEAN CUSHION STAR, *OREASTER RETICULATUS*

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ABSTRACT

The primary goal of this project was to find and chart the speed, movement, and feeding patterns of *Oreaster reticulatus*. In addition to charting the speed, distance, and direction each sea star traveled, the radius and height measurements of each specimen were taken. Sea stars with faster than average speeds had a different method of moving. Rather than moving by tube feet, these stars would take their leading rays and elevate them, which seems to differentiate the function of the leading and trailing tube feet, respectively; the former pulls while the latter pushes. The slower stars kept each of their rays parallel to the ground. Measured rates of movement were as high as 20 m/hr in 2004, when sea stars were individually tagged by an invasive method. Observation of untagged individuals in 2005 resulted in reduced movement rates of 1-7 m/hr (N = 19). Overall direction traveled by *O. reticulatus* resulted in 40% traveling southwest, 33% northwest, 20% southeast, and 7% northeast, with no discernable pattern. Eighty-nine percent of the sea stars were observed eating during at least one of the six timed intervals. The eating behavior *O. reticulatus* utilized was substratum grazing, in which the cardiac stomach was everted and digestion was extraoral.

INTRODUCTION

Oreaster reticulatus (L.), the common cushion sea star, prefers the shallow, quiet waters of reef flats, lagoons, and mangrove channels and is the most widely known sea star in the Caribbean (Hendler, 1995). Islands like Saddleback, Calabash, and Pigeon Cays along the windward side of Andros Island, The Bahamas, are prime examples of cays near Forfar Field Station that fit the description of where *O. reticulatus* can be found in abundance. *Oreaster reticulatus* inhabits the intertidal and sublittoral (Scheibling, 1980a) zones in areas protected from wave and current action. Wave and current action around these cays were found to be minimal to nonexistent during low tide, which is when *O. reticulatus* was prevalent.

Adult *O. reticulatus* form assemblages called fronts in sandy turtle grass (*Thalassia testudinum*) beds and around mangroves where benthic organisms are rich (Guzman *et al.*, 2002). Cushion stars are usually large in size (Clark, 2001) and easily identified with their diagnostic color patterns. An average adult is about 20-30 cm in diameter and 7-10 cm tall. Some may even grow to be 60 cm across (Clark, 2001). Scheibling (1980b) stated that intraspecific competition limits the growth in a population of *O. reticulatus* and that size is inversely proportional to the density on sand bottoms.

A study on *O. reticulatus* similar to ours was conducted by students from Saint Mary's College of Maryland, under the supervision of Dr. Walter I. Hatch and published by Jennifer A. Barrett *et al.* (1998). Barrett and her team focused on feeding patterns and concurrently studied the speed at which *O. reticulatus* moved. Barrett *et al.* (1998) determined an approximate speed of 2 m in 2 hr. Dr. Hatch commented that their methods were anything but sophisticated. They were not studying speed, but instead feeding preferences. They released the animals at a marked location and recorded distance moved by continuous observation. For longer-term movements, they tagged the animals with a meter of surveyor's tape attached with a clothing tagging gun (Barrett *et al.*, 1998). This allowed easy location of the animals from surface grids covered in a small boat.

Oreaster reticulatus is considered an omnivorous, microphagous substratum grazer (Barrett *et al.*, 1998). In some cases, *O. reticulatus'* feeding and habitat preferences appear to restrict distributions of many Caribbean reef sponge species to habitats without *O. reticulatus* and may have exerted significant selective pressure on defenses of those sponges that live in *O. reticulatus* habitats (Wulff, 1995). A sea star may feed either intraorally or extraorally. Intraoral feeders take live prey into their stomachs and digestion may take up to a week. Extraoral feeders extend their stomach from their disk and apply it directly to their food. *Oreaster reticulatus* has been noted (Barrett *et al.*, 1998) to have two distinct feeding patterns: (1) substratum grazing, in which the sea star everts its cardiac stomach, and (2) predation and scavenging, by which the sea star envelops macrofaunal prey or carrion. Some species of sea stars attach themselves to a mollusk and proceed to persistently pull apart the shell of the animal with their tube feet (Hendler, 1995). Some mollusks manage to keep their shell closed for days, but eventually the sea star wins and devours the prey with their stomach (Fichter, 1993). Although no predation of macrofaunal prey was observed, *O. reticulatus* has been known to prey upon sessile or slow-moving animals, like urchins (Scheibling, 1982) and sponges (Wulff, 1995), and to exhibit cannibalism (Barrett *et al.*, 1998).

Sea stars that live in deeper water (>10 m) can evert their stomachs and digest food outside their bodies. They can also move along the ocean bottom on the tips of their arms at 30.5 m/hr. In contrast, their shallow-water (<10 m) relatives move along at a mere 4.6-9.1 m/hr (Collins, 1994). Deep-water sea stars have to be more efficient eaters because of underwater currents. Running along the bottom on the tips of their arms reduces the surface area that touches the ocean bottom.

Data collection in 2004 occurred at three locations: Saddleback, Calabash, and Pigeon Cays off Andros Island, Bahamas. The first method incorporated a monofilament tag via a tagging gun, and a release-recapture protocol. This protocol was discontinued and a new method was adopted without tags. The average speed exhibited by the sea stars at Pigeon Cay and Saddleback was 7.26 m/hr (N = 6) and 11.20 m/hr (N = 8), respectively. The average speed of the sea stars was 11.96 m/hr (N = 5) at Calabash.

The purpose of this study was to test the following hypotheses: (1) the direction of movement is random, disregarding proximity to the shoreline and presumed prey (detritus, micro/macroorganisms) location; and (2) observations prior to capture will result in behaviors that differ from the rapid (>10 m/hr), prolonged movements away from the shoreline that were exhibited in 2004 after individuals were captured and tagged using an invasive technique.

METHODS

The goal of this study was to chart the movement, speed and direction, of as many sea stars in similar environments as possible, record data such as wave and current action, survey the substratum, and observe mode of travel. Data were collected in 2005 at two locations: once at Saddleback and twice, on two separate days, at Calabash Cays near Andros Island, Bahamas.

Data collection began with locating several *O. reticulatus* specimens. Sea stars used were found on the leeward side of each of the cays. Locating sea stars began at the northernmost section of the beach, about 10 to 20 m offshore, and continued south as long as time permitted. Upon finding a new sea star, a flagged rod, which was light enough to allow backward movement, was placed between the individual's interradial arc and time was recorded. Movement was marked by subsequent flagged rods every 10 min.

Between the six 10-min intervals, abiotic factors were recorded. Wind speed and air temperature were determined with a Kestrel 2000 thermonanometer. Salinity was also recorded. Water depth at the farthest sea star from the beach was recorded as was the water flow rate. A standard flow meter was used. Flow was determined in counts per minute (C). Data were collected at low tide due to the fact that *O. reticulatus* was inaccessible at high tide.

RESULTS

The salinity of the water around both cays, Saddleback and Calabash, was 37.5 ppt. The average speed of *O. reticulates* at all three sample sites was 2.67 m/hr (N = 19). Eighty-nine percent of the sea stars were observed grazing during at least one 10-min interval. Overall direction traveled by *O. reticulatus* resulted in 40% traveling southwest, 33% northwest, 20% southeast, and 7% northeast. The direction that each sea star traveled appeared to be random. No one direction seemed more desirable than another in this study, as was observed in 2004. The majority of sea stars (79%) traveled away from shore. Eleven percent of the individuals moved with their leading rays elevated, whereas 89% moved with all of their rays equally distant from the sand.

The substrate in the vicinity of both cays was similar in texture and catered to the needs of similar species. The substratum used by the sea stars included: red mangroves (*Rhizophora mangle*; on the nearby beach); conch (*Strombus gigas*; dead/alive); detritus (leaf litter/twigs); *Thalassia testudinum*; *Porites porilis*; coral skeleton; sponges; sea urchins; sea stars (other than *O. reticulatus*); algae; bivalves (dead/alive); holothurians; juvenile lemon shark; small striped fish; various crustaceans; and anemones. Grazing occurred in the *Thalassia* beds directly offshore. The aforementioned animals sparsely populated the study area and never made contact with the sea stars used in this study.

DISCUSSION

Eighty-nine percent of the sea stars were observed eating during at least one of the six timed intervals. The eating behavior utilized by *O. reticulatus* was substratum grazing, in which the cardiac stomach was everted and digestion was extraoral. Grazing affected movement. Four (21%) of the 19 individuals remained stationary during the entire observation period.

The way in which each sea star was handled directly affected all data collected. Removing *O. reticulatus* from the water to collect size data, as was done in 2004, presumably creates stress for the animal. An excited period of response occurs after handled specimens of *O. reticulatus* are released. Figure 1 illustrates the increase in average speed of *O. reticulatus* as individuals rapidly fled from the site of release.

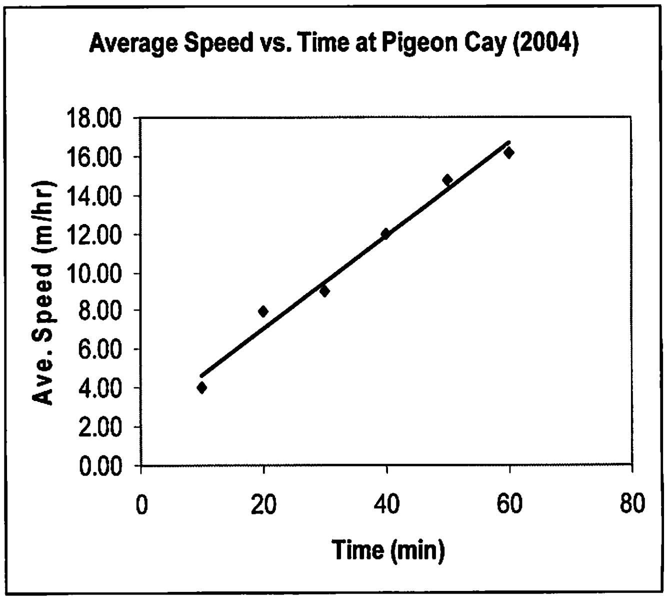

Figure 1. Average speed (m/hr) of Oreaster reticulatus *sea stars versus time following release, as measured in 10-min intervals (N = 6). As observation time increased, the average speed also increased with the equation* $y = 0.24x + 2.2$ *(*$R^2 = 0.98$*).*

Different methods were adopted for this study compared to 2004; *O. reticulatus* was not removed from its natural state and movement/feeding was observed prior to measurement. No stress was placed on these individuals; therefore, they had no reason to travel with haste. Wave and current action were dismissed as factors in movement, as there seemed to be no influence in the cases seen. When looking at the speed of *O. reticulatus* versus the flow rate, in respect to the wind speed, there was no apparent action created by wind that could influence waves or currents and adversely affect sea star speed. During this study, sea stars were witnessed using the typical shallow-water method of moving along the ocean bottom at a slow rate.

This study resulted in different data from 2004 due to methodological changes. In 2005, *O. reticulatus* moved about one-tenth as fast as the maximum speed observed in 2004, in which stress was applied prior to data collection. The contrasting results offer insight on maximum and normal speeds used during locomotion.

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