THE BIOLOGICAL COMMUNITIES, SEDIMENTS, AND BIOGENIC PROCESSES OF A MODERN, CARBONATE TIDAL FLAT, PIGEON CREEK, SAN SALVADOR ISLAND, BAHAMAS

Megan C. Bresnehan
Department of Geology
Smith College
Northampton, MA 01063

INTRODUCTION

Pigeon Creek lagoon on San Salvador is a tropical, shallow-water, carbonate environment surrounded by and containing a diverse array of biological communities and sediment bottom types. It is an area where organism-substrate interactions along with fluctuating tides, contribute significantly to the reworking of the sediment.

There is a northern and southern extension from the point where Pigeon Creek is connected to the Atlantic Ocean by a channel. A large intertidal flat located approximately 1 km south from the main lagoon channel was chosen for study. The tidal flat is representative of the different flora and fauna and sedimentary features of this setting. The focus of this study is to identify and characterize the floral, faunal, and sediment zones across the flat.

TRANSECT LINE

A 280 m - long transect line was marked across the study area. The line began in the subtidal channel and extended across the intertidal zone (190 to 0 m). The line was then extended from 0 to 90 m along a mangrove channel (high intertidal). Characteristic subzones were identified according to their physical and biological characteristics, (Fig. 1); a subtidal zone (190 - 185 m), a scoured flat zone (185 - 150 m), a hummocky callianassid mound zone (150 - 0 m) overlapping with a *Schizothrix* algal crust zone (80 -0 m), and a wet, muddy zone extending into the mangrove channel (0 - 90 m).

FLORA

Bordering the tidal flat area are dense regions of red and black mangroves (*Rhizophora mangle* and *Avicennia germinans* respectively) creating the mangrove channel. Within the channel many characteristic flora were identified. *Dictyosphaeria ocellata,* a small, angular, green, lens-shaped alga that forms dense, firm crusts (Norris et al., 1989) was attached to red mangrove roots within the mangrove channel. *Batophora oerstedii*, a fuzzy, small, cylindrical green alga formed dense clusters around the roots of the mangroves (Norris et al., 1989). This species was also abundant in the *Schizothrix* algal crust zone. *Dasycladus vermicularis*, similar to *Batophora* in both appearance and habitat, was most abundant within the mangrove channel but ranged across the entire transect. *Thalassia testudinum* (turtle-grass) and *Halodule beadettei*, a green seagrass similar in appearance to *Thalassia*, were abundant across the tidal flat, characteristically surrounding callianassid mounds. Ejected sediment either reduces available light for photosynthesis or physically smothers *Thalassia*, thereby eliminating it from regions of abundant *Callianassa* (Suchanek, 1983). *Penicillus capitatus*, a faded green, well-defined, bristly, lightly calcified alga that sits atop a 5-10 cm stalk (Norris et al., 1989), was abundant from 190 - 0 m but was rarely seen in the mangrove channel. Within the *Schizothrix* crust zone, on the crests of mounds, a smooth, cohesive, rubbery *Schizothrix* (blue-green alga) mat develops. This alga binds sediment in thin laminae when flooded by sediment -laden water (Garrett, 1977), and it creates a pink tinge to the sediment within this zone.

FAUNA

The most abundant faunal element across the tidal flat is burrowing shrimps and crabs that continually rework the sediment and create a unique sedimentary environment. The characteristic species are: *Uca major* (large fiddler crab), *Uca pugnax rapax* (small fiddler crab), *Callianassa rathbunae* (large mound forming shrimp), and *Upogebia pusilla* (small, burrowing shrimp).

The large callianassids build volcano-shaped mounds of ejected sediment during feeding and burrowing (Suchanek, 1983). These mounds form distinct features across the tidal flat (Fig.1), and range in height from 15-18

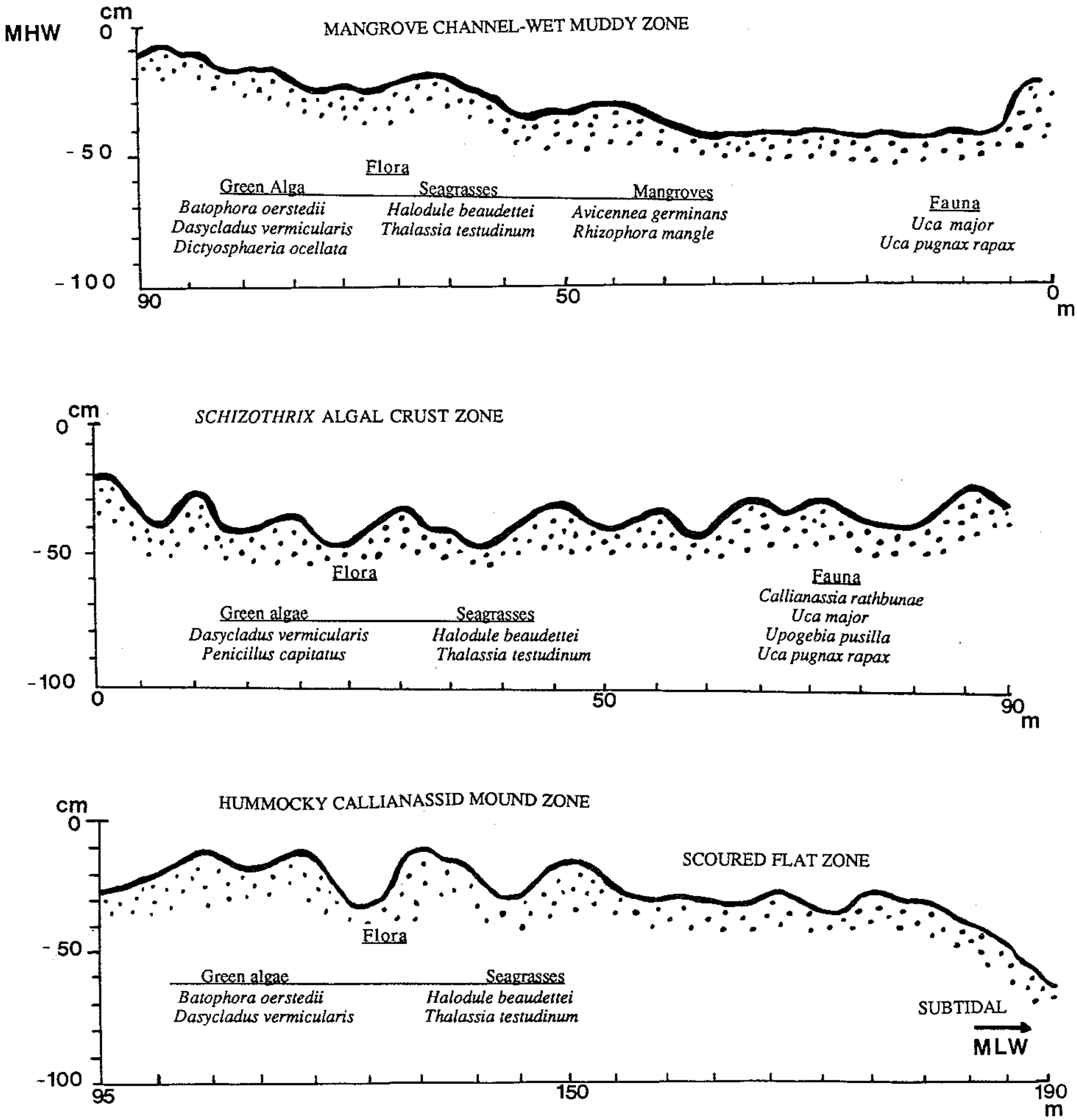

Figure 1. Topographic profile of the tidal flat, with characteristic zones, flora, and fauna.
VE = 25x; MHW = mean high water; MLW = mean low water.

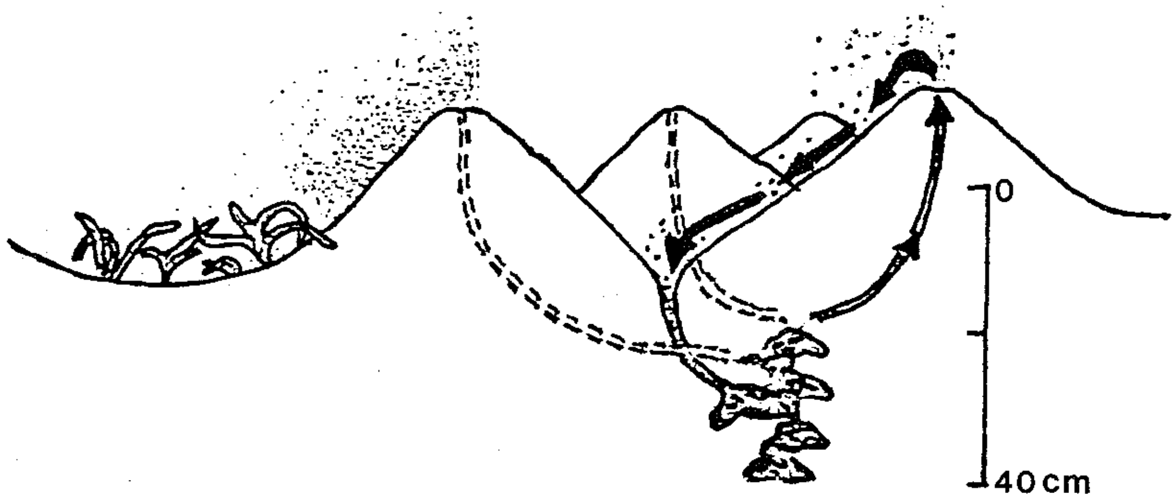

Figure 2. Cross sectional view of a callianassid mound and burrow complex, with surrounding turtle grass (*Thalassia testudinum*) (after Suchanek, 1983).

cm (Fig 2.). The smaller *Upogebia pusilla* leaves surface sedimentary features that can be recognized as four small holes found together on a mound. The large fiddler crab leaves a distinctive 2 -3 cm hole on top of a mound and is characteristically surrounded by fecal pellets. The small holes of the small fiddler crabs can be distinguished from the *Upogebia pusilla* burrows by the characteristic mounds of fecal pellets surrounding the crab burrows.

SEDIMENTS

Sediment analyses showed that the substrate is a calcareous, fine-medium grained, shelly, pelloidal sand. The main categories of the sand fraction were found to be: fecal pellets, foraminifera, gastropods, bivalves, ostracodes, and grain aggregates. Samples taken in the subtidal zone were found to be more fine-grained and better sorted than samples from the heavily bioturbated zone of the callianassids.

CONCLUSIONS

A thorough understanding of the characteristics of the modern carbonate tidal flat at Pigeon Creek should enhance the capability for recognition of similar settings preserved in the carbonate rock record. Several interrelationships between the substrate, burrowers, and vegetation exist that are important both ecologically and geologically. Specifically, the continual reworking of the sediment by the burrowing organisms of the tidal flat environment contributes significantly to the understanding of the distinct zonation of the flora and the sedimentary features of the flat.

REFERENCES CITED

Garrett, P., 1977, Biological communities and their sedimentary record, in Hardie, L. A., ed., Sedimentation on the modern carbonate tidal flats of Northwest Andros Island, Bahamas: The Johns Hopkins University Press, Baltimore, pp 58-62.

Norris, J., Bucher, E., Littler, M., Littler, D., 1989, Marine plants of the Carribean, Smithsonian Institution, Library of Congress, 180pp.

Suchanek, T. H., 1983, Control of seagrass communities and sediment distribution by *Callianassa* (Crustacea, Thalassinidea) bioturbation: Journal of Marine Research, v. 41, p. 281-298.

Modern and Ancient Carbonate Beach-Dune Systems on the Windward Side of San Salvador Island, the Bahamas

Andrew Lane Brill
Department of Geology
Williams College,
Williamstown, MA

INTRODUCTION

Despite its identification as one of the more thoroughly studied islands in the Bahamas, San Salvador Island's beaches have received relatively little attention from sedimentologists. Only the most general of surveys have been conducted; these have shown the beaches to be as varied as the island itself (Clark, Mylroie and Carew, 1988). Inattention to San Salvador's beaches is part of a larger pattern of ignorance concerning modern carbonate beach sediments worldwide. Because of this, there are relatively few identified examples of carbonate beach deposits in the rock record (Inden and Moore, 1983). These fossil strandlines are known to harbor oil and thus warrant detailed study.

In June, 1990, a one kilometer section of East Beach, near the United Estates settlement at the northeast corner of the island, was chosen as representative of windward beaches on San Salvador and elsewhere in the Bahamas. A baseline was surveyed, and data were collected along nine transects. Work at the nearby Hanna Bay Cliffs served to identify them as a Holocene analogue to the modern windward beaches. The beach was resurveyed on December 30, 1990 to assess changes over the preceding six months. Data indicate that East Beach is actively prograding, despite what is probably seasonal erosion of the foreshore and berm. Mean grain sizes and standard deviations follow a pattern decreasing from the dunes to the ocean. This interesting result could be the product of rapid lithification and the formation of micrite crusts and particle rims in backshore and dune areas. Eventually, if the present trend continues, the present East Beach system will lithify and be exposed as a progradational sequence, much as the Hanna Bay member of the Rice Bay Formation is today.

FIELD AREA AND METHODS

East Beach faces the open Atlantic over a shallow shelf and intermittent reefs, and is characterized by a shallowly dipping, broad expanse of fine to very fine biogenic sand. The beach lies seaward of a large field of vegetated ridges interpreted by Titus (1986) to represent progressive stages of accreting beach and dune sands. Steady trade winds from the east and southeast produce generally rough waters, which have shaped the beach into a series of large, curving bays and sandy headlands. The wavelength of this rhythmic topography is about 500 meters, but higher order harmonics also produce an intermittent smaller cusp and horn system. Gentle wind induced onshore and alongshore currents cause a rippled bottom and onshore transport of the sediments produced by flourishing patch reefs offshore (Marrack, 1989).

On June 12, a baseline was surveyed at the base of the primary dune along the kilometer section, and nine parallel transects were taken at 125-meter intervals along this baseline. Stake and horizon profiles were made along each transect from the slope of the secondary dune to 1.5 meters water depth. These were used to produce a topographic map of the beach (fig. 1). Six sediment samples were taken along each transect. Ten large trenches were dug in the foreshore and dune areas to investigate the erosive or depositional nature of the beach at each site. To assess sediment transport potential, nearshore currents were measured with a flowmeter at each transect and through a full tidal cycle. Burrows and other features of the beach thought likely to be preserved were photographed and sketched. On December 30, the transects were re-profiled and plotted. The data from the two trips were combined to produce a map of erosion and deposition over the six months between June and December (fig. 2).

To the north of East Beach lie the sea cliffs of Hanna Bay. These low bluffs compose the Hanna Bay Member of the Holocene Rice Bay formation. Structure revealed in the cliffs is mostly sweeping eolian crossbedding, but at the base of the cliffs lies a zone of fine, seaward dipping foreshore lamination. Burrows and other indicators of the beach environment also fill this zone. At this site, two detailed stratigraphic sections were drafted, and the rock was sampled in eight locations above a baseline.

In the lab, sand samples were sieved for ten minutes each using a Ro-Tap, and sediment grain-size analysis carried out with the help of the IBM PC programs PROBSPL.5 and SIEVE. Topographic maps of mean grain size and standard deviation can be seen in figures 3 and 4. Rock samples from the Hanna Bay Cliffs were thin sectioned, and are to be examined for composition and evidence of micrite crust or rim formation. This thin section work is continuing.