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Sedimentary Environments and Paleoecology of Proterozoic and Cambrian "Avalonian" Strata in the United States
Mark McMenamin (Mount Holyoke College) and Jack Beuthin (U of Pittsburgh, Johnstown)
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Keck Geology Consortium: Projects 2007-2008
Short Contributions – St Croix

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TAPHONOMY OF MOLLUSC SPECIES FOUND IN LAGOONAL CORES OF SMUGGLER'S COVE, U.S.V.I.

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INTRODUCTION

Twelve sediment cores and associated samples of surface sediment were taken in varied lagoon environments on St. Croix, U.S. Virgin Islands (See Figures 1 & 3 in Hubbard et al., this volume). By studying the taphonomic characteristics of surface mollusc assemblages from different environments in the St. Croix reef/lagoon system one is able to determine a taphonomic signature for each area. This project involves utilizing the taphonomic signatures determined at the surface for each of four bottom types (seagrass, open backreef sand, nearshore grass, bioturbated sand) to compare down the cores to determine whether these signatures are reflected throughout the subsurface, or whether environmental conditions have changed over time. Should this signature prove to be traceable in the subsurface, a new tool for tracing environments of subfossil assemblages at the time of deposition will have been identified.

The objectives of this study are to:
1. Describe the taphonomic state of all molluscs taken from lagoon surface and downcore samples.
2. Assess taphonomic correlations between surface samples and downcore samples at each site.
3. Search for any taphonomic and facies correlations between cores.
4. Document lagoonal facies migration through time.

METHODS

Ocean Bottom Sampling

Before coring, a diver descended with a 50cm x 50cm quadrat made of PVC pipe, an airlifting device, and a thin rebar probe that was used to pre-determine the depth to bedrock. The airlifting device was constructed of PVC tubing with an elbow joint at the top where a mesh bag was attached. The mesh bag functioned as a sieve, allowing anything smaller than the holes in the bag to drop out, while catching everything larger. The PVC tube of the airlift was attached to an air tank, which created suction up the tube. Two airlift samples to ~10cm depth were taken at each coring site. These samples were sorted back at the lab, saving only molluscs and mollusc fragments.

Coring Methods

In total, thirteen 3-inch cores were extracted using a diver-operated vibrocore system that was powered by a hydraulic motor from the surface (See Figure 2d, Hubbard et al., this volume). Coring continued until the aluminum pipe stopped penetrating the

Figure 1. Moving the core from the boat to the core lab on shore required keeping the core vertical to avoid damaging the stratigraphy, especially toward the top of the core.

bottom, presumably at bedrock, or until the top of the core pipe approached the seabed (core pipes were 4.5m). The core was transported vertically to the lab (Fig. 1), cut open, and cleaned for analysis. Each core was logged, and stratigraphic columns were created. Specific 8cm intervals of the core were sampled in full; remaining, connecting 12cm intervals were sieved with a 2mm sieve, and this coarse fraction (mostly molluscs) was rinsed and bagged. This study focuses on a transect across the lagoon from a nearshore grassbed (SC10), over two mid-lagoon grassy areas (SC4 and SC3), a transition area between seagrass and open sand (SC6) and backreef open sand (SC12; see Fig. 3b, Hubbard et al., this volume).

Data Collection

Samples were grouped into bivalves and gastropods, identified (using Abbott, 1974 and Rehder, 1981), measured, and each shell or shell fragment given a number value of 0, 1, 2, or 3 for its corresponding taphonomic rating (method of Brandt and Elias, 1989). A score of 0 indicates no taphonomic alteration, 1 minor alteration, 2 moderate alteration, and 3 represents a total taphonomic alteration of the shell. Mean values for the taphonomic grade of bivalves, gastropods, and total molluscs were calculated for surface shells and by depth in each core.

RESULTS

Airlifted material from the surface at core sites provides the taphonomic signature of the present depositional environment. As a general rule, gastropods are more degraded than bivalves in airlift samples from all environments (Fig. 2). Mean taphonomic scores in order of decreasing taphonomic values (i.e, low to high preservation quality) are SC3 (lagoon seagrass), SC10 (nearshore seagrass), SC4 (lagoon seagrass), SC6 (bare sand), and SC12 (backreef bare sand). Therefore, shells at the surface in seagrass-covered areas are most degraded, especially the gastropods. In contrast, shells at the surface in bare sand (SC12 an SC6) were quite well preserved, and those samples tended to contain few gastropods. Although they had few gastropods, they showed the greatest difference between bivalve and gastropod taphonomy.

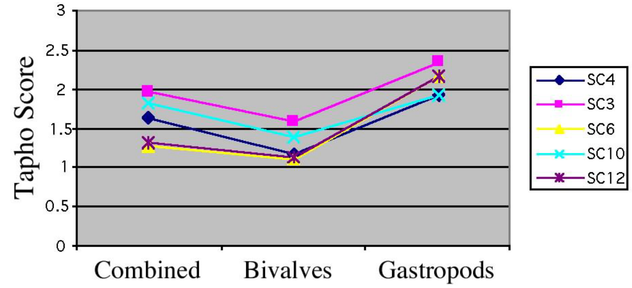

Figure 2. Data collected from the surface samples taken near each coring site. The grassbed environments include SC3, SC4, and SC10. SC6 and SC12 are the sandy bottom environments. The three data points represent mean taphonomic scores of total molluscs, bivalves, and gastropods at each site.

Most cores show high taphonomic damage near the surface (upper 50cm). In general, the condition of shells improves in the middle of the core, but mean shell condition worsens toward the bottom in cores with a definite shell-rich bottom lag.

Grassbeds

Figure 2 shows that surface shells in grassbed environments have the greatest taphonomic damage. The cores, however, reveal different characteristics. SC10 (nearshore grass; Fig. 3A) possesses a very high mean taphonomy score. In fact, this core shows much more taphonomically altered bivalves than gastropods, which is rare. Individual bivalve scores range from 2.6 to 1 and the gastropods range from 2.3 to 1.75. SC3 (Fig. 3B) shows the highest taphonomy for all molluscs, bivalves, and gastropods from all of the cores with the maximum taphonomic scores occurring at 8-40cm for the average of all molluscs and for gastropods, while bivalve damage peaks at 168-180cm. SC4 (Fig. 3C) displays fairly moderate taphonomy amongst bivalves and total molluscs, and higher taphonomy among gastropods and in select areas the absence of gastropods altogether. The taphonomic maxima for the combined mollusc sample, bivalves, and gastropods all occur at the 8-40cm interval with the minimum at 128-

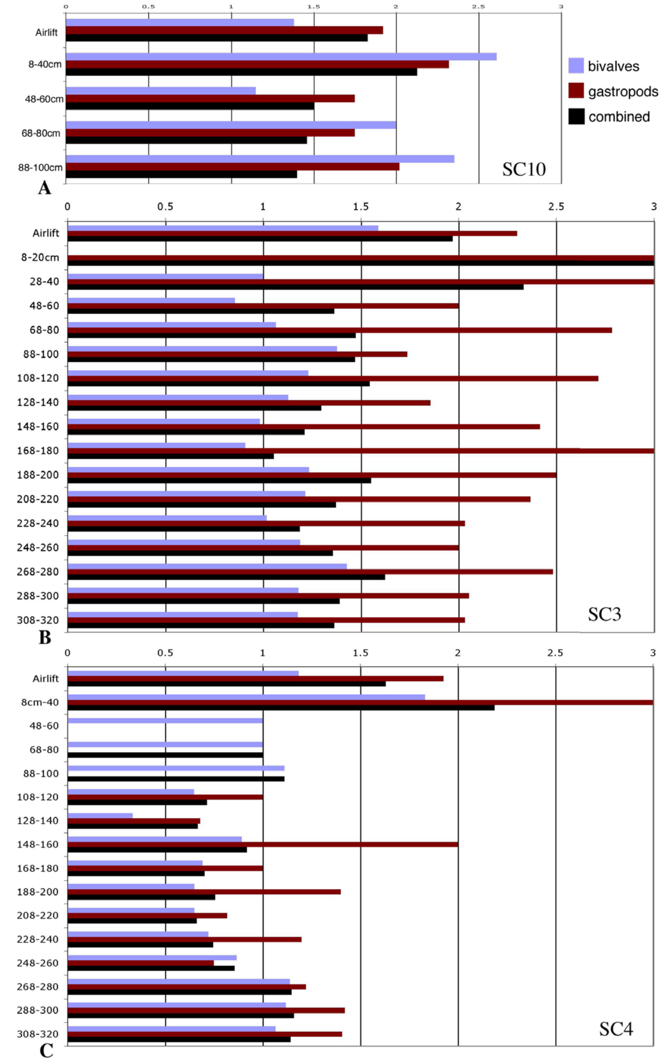

Figure 3. Mean taphonomic scores for shells from airlifts and from grassbed cores. A) SC10 is from the nearshore grassbed (for location, see Fig. 3, Hubbard et al., this volume). Mean scores for the total mollusk sample are in black; bivalves and gastropods are also plotted separately (blue and red, respectively). B) Core SC3 is a mid-lagoon grassbed site, which is one of the longest cores extracted from the lagoon, and C) Core SC4 another mid-lagoon grassbed site. Note that gastropods tend to have more taphonomic alteration than bivalves.

140cm.

Sandy Blowouts

SC12 and SC6 (Fig. 4) show an absence of gastropods in select areas of the cores, particularly toward the bottom of the core. SC6 (Figure 4A) illustrates the generally low taphonomic damage found in the bare sand areas; scores never rise above the 1-1.5 range. There is a gastropod taphonomic maximum at the 8-40cm interval with the bivalve taphonomic maximum occurring at 108-120cm. Figure 4B shows a more varied taphonomic signal down core for SC12. There is a gastropod taphonomic maximum of 3 at 108-120cm and scores are always high wherever gastropods are present. The bivalve taphonomic maximum occurs at 148-160cm and then the next core interval down shows a mean score of zero, but only two shells were sieved from that sample, which makes that result unreliable.
[Figure 3 near here]

DISCUSSION

Life habits of bivalves and gastropods are important factors in the resulting taphonomic signature (Parsons-Hubbard, 2005). Most species of bivalves in the lagoon are infaunal. This may account for lower taphonomic alteration and consistent appearance of bivalves in the cores. Conversely, gastropods are mostly epifaunal; therefore, one would expect higher taphonomic alteration among gastropods due to their increased exposure to biostratinomic and diagenetic conditions. However, within this data set this pattern is not always the case. A "taphonomic filter" may skew the data. If the taphonomic filter is very strong, then the rate of damage and total destruction of surface shells is very high. The presence of a strong taphonomic filter would have a greater effect on epifaunal species than infaunal. Consequently, because most gastropod species are epifaunal, they may be rare in the cores because they were broken down completely at the surface and were never buried.

Surface Characterization

Mean taphonomic damage scores of all airlifts show little variation; bivalves are generally less damaged than gastropods and all means fall under the category of moderate taphonomic damage. However, SC3 exhibits the highest mean taphonomic score for both total molluscs and bivalves. SC3 is located in a grassbed nearest the blowout area. The airlift's high taphonomic score is slightly unexpected based solely on the surface environment. The lagoon

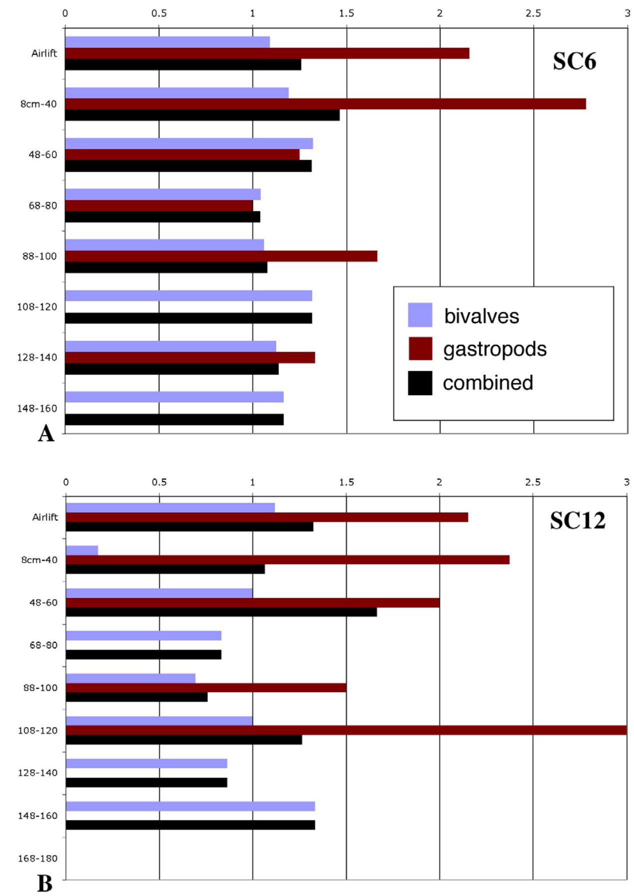

Figure 4. Mean taphonomic scores for shells from sandy blow-out areas. A) Core SC6 near middle of lagoon. Note preservation quality of shells improves down core. B) Core SC12 also shows general improvement of taphonomic grade down core, with the exception of the interval from 108-120cm where there were just two gastropods, both with high taphonomic scores, so this result is misleading at that interval.

cross-section (Figure 4, Hubbard et al., this volume) shows that the lagoonal bedrock at SC3 is the lowest topographic point in the lagoon along the transect used in this study. This makes it an ideal spot for reef materials as well as terrestrial materials to collect, especially during storm events that might have occurred during the early development of the reef-lagoon system. SC10 is located in a nearshore grassbed in an area of high wave energy and turbulence due to the low water depth (7ft) and proximity to shore. SC4 is from a grassbed area in the middle of the lagoon with a water depth of 13ft, which is the second deepest bathymetry along the transect (see Figure 4, Hubbard et al, this volume). SC12 and SC6 are located in sandy bottom blowout areas. These two areas share nearly the same surface sample taphonomic values. They exhibit the lowest bivalve taphonomic alteration score due to the taphonomic filter and infaunal protection discussed previously. They also share the highest gastropod taphonomic alteration values due also to the taphonomic filter as well as a possible change in the taxonomic mix of gastropods in these areas versus the grassbed environments. It is possible that some of this taxonomic change can be contributed to shells washed off the reef and deposited in this sandy blowout area. Reef shells have been shown to exhibit the greatest taphonomic damage of any of the environments in this reef/lagoon system (Parsons, 1989; Parsons-Hubbard, 2005) and would therefore raise the mean damage score if they were present in the sample.

Cores

SC10, taken from a nearshore grassbed environment, has an overall higher taphonomic score for bivalves than for gastropods. This may be due to high-energy conditions in which even the infaunal species are not able to escape taphonomic alteration. It may also be due to a taxonomic change in the gastropods. It is possible that gastropods present in this setting are species that do not remain when greatly altered, thereby creating a situation in which bivalves appear more taphonomically altered than gastropods. There are many similarities between SC3 and SC4, the mid-lagoon grassbed cores. The total mollusc taphonomic scores in both core samples resemble each other, with subtle fluctuations in bivalves and rapid changes in gastropods. The sloping topography of the lagoonal bedrock at SC4 resembles that at SC3, providing settings for similar physical processes. The location of core SC3 in the middle of lagoon as well as the fact that this core had the greatest depth to the bedrock, leads to the possibility that the sedimentation in that area is the result of more import of material from other environments over time. It was also determined that a probable cause of the spike in gastropod taphonomy in some cores would have been due to the introduction of very taphonomically altered shells into the area from another adjacent environment. SC6 and SC12, cores taken in the bare sand blowouts, also have similar taphonomic patterns down core. They both have low taphonomic scores for bivalves with highly fluctuating taphonomic scores for the gastropods. For example, in SC12 the apparent rapid changes in taphonomic scores may simply be a result of the small number of shells present in the core.

The absence of gastropods in select areas of the cores may be explained in one of two possible ways. First, gastropods may not have colonized the particular environment at the time. The surface airlift samples would suggest that bare sand "blowouts" lack indigenous gastropods, so this could be an indication of migration of environments in the past. A second possibility is that gastropods did live in the area, but the presence of a taphonomic filter prevented the preservation of the shells.

CONCLUSION

This study shows that surface airlifts show taphonomic signatures that are consistent within environment type. The surface airlifts are more degraded than cores in general and the shallow parts of the cores are more degraded than middle. The bottom of some cores sometimes return to more poorly preserved shells possibly due to the presence of shell lags at the end of the core. The most noteworthy shell lags occur at the end of the grassbed environment cores. These shell lags as well as the taxonomic mixing suggest that recent environments are very different from past environments. Another possible explanation revolves around the importance of the taphonomic filter. No matter the environment, should the taphonomic filter be present there will be an effect seen in both core and airlift samples.

However, ultimately results that prove a correlation between surface environments and exact levels down core as of yet remain inconclusive.

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REFERENCES

Abbot, R.T., & Morris, P. 1995, A Field Guide to Shells of the Atlantic and Gulf Coasts and the West Indies. New York. 350 pp.

Brandt, D., and R.J., Elias, 1989, Taphonomic grades as a classification for fossiliferous assemblages and implications for paleoecology. Palaios v. 4, p. 303-309.

Miller, A. 1988, Spatial Resolution in Subfossil Molluscan Remains: Implications for Paleobiological Analyses. Paleobiology, v. 14(1), p. 91-103.

Parsons, K., 1989, Taphonomy as an Indicator of Environment: Smuggler's Cove, U.S.V.I., Terrestrial and Marine Geology of St. Croix, U.S. Virgin Islands. Teague Bay St. Croix, U.S.V.I.: Special Publication Number 8 West Indies Laboratory, p. 135-144.

Parsons-Hubbard, Karla. 2005, Molluscan Taphofacies in Recent Carbonate Reef/Lagoon Systems and their Application to Sub-fossil Samples from Reef Cores. Palaios, 20: 175-191.

Rehder, Harald. 1981, National Audubon Society Field Guide to North American Seashells. New York: Alfred A. Knopf.