What Bores You? Predation Rates at Cape Cod and the Bahamas

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Introduction

Since the Cambrian explosion and the introduction of predation as a driver of evolution, predation rates have risen. Evidence for this trend in predation has been preserved in the fossil record, but this record is neither complete nor fully understood. To help decode apparent evolutionary patterns, modern day analogs are an invaluable tool, and research on present day drilling frequencies allows more confident interpretations of predation rates through time. Much work has been done to identify trends in modern mollusk predation patterns. For instance, recent research on predation in the Atlantic shows a gradation in predation pressures radiating into the north and south from the Chesapeake Bay area (Kelley,et al. 2007). Other studies have focused on specific mollusk behaviors to gastropod predation, and broader mollusk interactions (Pratt 1974, Dietl et al 2006, Kelley et al 1996, Quijon et al 2005). More work on modern systems is needed to provide a framework to understand the fossil record.

Methods and Materials

The Smith College Paleontology Class in the Fall of 2008 analyzed shell assemblages from three different Atlantic beaches, Cape Cod, Haitian Boat, and Sandy Point. Students and faculty collected the shells from 2 beaches on San Salvador Island, Bahamas, in January 2008 (figure 1). The Cape Cod shells were collected in the Spring 2008 (figure 2). Once in the laboratory, paper cups were used to scoop out shells to avoid introducing a bias based on shell size. Shells that were broken, that could not be confidently classified as bored or unbored, or were otherwise too taphonomically altered to properly identify were discarded. Shell diameters were determined to two decimal places in millimeters using a digital caliper. Identification was made to the genus level, and it was noted how many shells within each genus were bored. Bivalves make up majority of the Bahamian assemblages, but gastropods were included in the analyses of all beaches. Bore hole morphology was also briefly studied to determine likely predators. As a class, three hypotheses were developed to explain the patterns of predation.

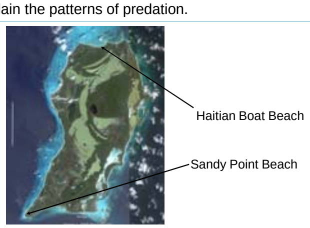


Figure 1 (left): Map of San Salvador Island, Bahamas. Shells were collected at both Haitian Boat and Sandy Point Beach.
Figure 2 (above): Map of Cape Cod, Massachusetts. Shells were collected at Duck Creek Beach at Jeremy Point (location outlined in yellow).

Results

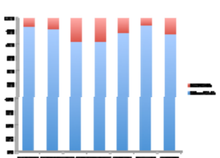


Figure 3 (above): Boring frequencies varied greatly between beaches. Haitian Boat had the highest percentage of bored shells, with each group showing about 80% boring rates.

- Boring rates varied drastically depending on the beach setting (see figure 3).
- The shells of the Haitian Boat assemblage showed the highest predation rates. *Chione* had the highest percent of the total population bored, and *Americardia* had the highest total amount of shells. *Lucina* had the highest percent of its total bored (see Figure 7).
- Unlike Haitian Boat, *Americardia* and *Chione* were not the dominant genera of the Sandy Point assemblage. Instead *Glycmeris* and *Trachycardium* were the most prominent. *Glycymeris* was also the most heavily bored, followed by *Cerithium* and *Chama* (see Figure 8).
- Examination of the Cape Cod shells led to the discovery that *Crepidula* made up over half the total shell assemblage, but *Anomia*, *Astarte* and *Pandora* had the highest percentage of the total bored (see Figure 5).

Discussion

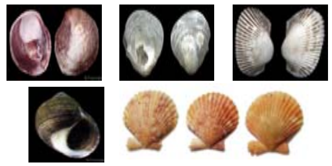


Figure 4 (above): Most common genera in Cape Cod assemblage. Top from left to right: *crepidula, anomia, anadara.* Bottom from left to right: *littorina* and *aequipecten.*

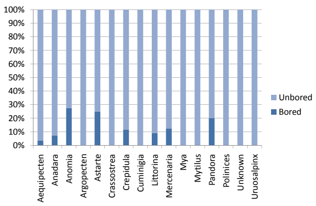


Figure 5 (above): Percentages of bored and unbored shells in Cape Cod assemblage.

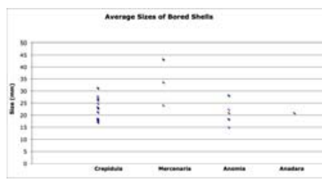


Figure 6 (above): Diameters of bored shells of Thornton-Montgomery shell group. Statistical analysis showed no relationship between diameter of bored shells and predation rates.

Hypothesis #1
Prey Size

After examination of Cape Cod assemblages, we propose that size of prey does not correlate with rates of predation. The Duck Creek Beach at Cape Cod was the collection site for shells that were measured and examined for predator drilling. All of our mollusks live in the subtidal or low rocky intertidal zone. The hypothesis was that predators would choose to bore into prey that would yield a net energy gain. Naticid and muricid bore holes, which are beveled or straight, respectively, were seen in the 600 examined. The size of the prey does not appear to influence a predator’s choice of prey, las a wide range of sizes of bored shells were examined in this study. These factors may vary with type of predator and environment (Leighton 2002), but in general size selectivity does not seem to influence the size of bored shells.

Hypothesis #2
Energy and Location of Beaches

In comparing Sandy Point to Haitian Boat Beach, Sandy Point has a very low rate of boring and is also exposed to the ocean. Exposure to waves and storms in a high-energy setting may have an effect on predators’ abilities to execute a successful boring, making it difficult for a gastropod to drill into a shell long enough to kill the animal inside. The Sandy Point shells are less likely to be bored than the shells from other assemblages, although there are no complete predator species present in the assemblages. The high energy level of Sandy Point may also break up shells after death, essentially removing evidence of predation. Haitian Boat Beach is in a somewhat more sheltered cove with lower energy levels and has the highest overall rates of boring. It is possible that quiet-water settings are more conducive to intense rates of predation. Further work on other localities is required to test this hypothesis.

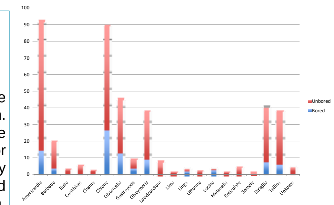


Figure 7 (above): Bored and unbored shells of Haitian Boat, San Salvador.

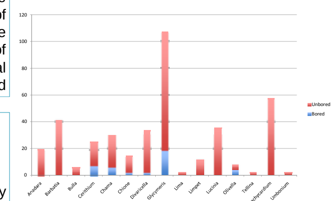


Figure 8 (above): Bored and unbored shells of Sandy Point, San Salvador.

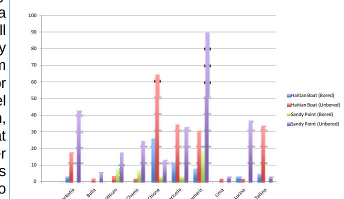


Figure 9 (above): Bored and unbored shells of genera common to both Haitian Boat and Sandy Point Beaches.

Hypothesis #3
The Predator Range

The types of organisms that are most frequently bored at Cape Cod are those that inhabit that same environment as *Polinices*, the dominant predator. When comparing type of shells that were bored, some genera were more frequently bored than others. The environmental living ranges of the genera were mapped on the tidal zone (see diagram). Genera that were less frequently bored either had a specific mode of living (specialists) or had a large environmental distribution (generalists). Specialists found in the Cape Cod assemblage were the *Aequipecten*, which lived at the base of eel grass beds, and the *Anadara*, which lived partially submerged in sediment under rocks. Some Cape Cod generalists included the *Mya* and the *Crassostrea*, which inhabited all environments from the intertidal zone to 100 feet offshore (Tucker, 1968). The habitats of the most frequently bored seemed to be centered on the *Polinices*’ “death zone,” or its predominant range of living.

The Generalists

The Particularlists

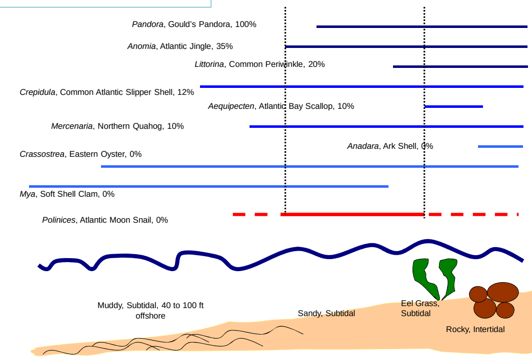
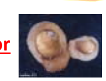


Figure 10 (above): Map of the living ranges of genera found in Cape Cod assemblage of King-Breus. *Polinices*, the predator, is indicated by red.

The Predator



Conclusions

- Hypothesis #1 suggests that size of a prey organism may not play a significant role in whether or not it is bored. We also suggest that different latitudinal settings (Cape Cod vs. the Bahamas) may be unhelpful for general comparisons as the habitats in temperate and tropical settings are too different to draw any firm conclusions. It may be better to look at local habitats to assess what effects the environment plays in predation pressures, as opposed to broad ranges along the Atlantic coast line. Further studies need to be completed to determine if predatory gastropods truly do not distinguish size when selecting their next meal.

- Hypothesis #2 proposes that predation is related to energy level of the beach; a more exposed beach with more wave energy will have lower predation rates than a more sheltered beach. There does not seem to be a correlation with predation and latitude, but instead with the setting of the beach itself.

- Hypothesis #3 proposes that drilling frequency patterns seemed to indicate that within the Cape Cod community, habitat and abundance? controlled rates of predation. Although this study produced significant work, much future work is needed. Bigger data sets from a wider geographic range, possibly outside the eastern Atlantic, are needed to confirm these apparent trends. It would also be interesting to further test the generalist-specialist hypothesis at other locations around Cape Cod.

Acknowledgements

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