Reconstructing Parrotfish Tooth Size Distributions Across Millennia and Ocean Basins

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Background

- Up to 70% of Caribbean reefs are at risk of overfishing, and parrotfish biomass has decreased by up to 60% since 1970.[5]
- Overfishing in the Caribbean began before quantitative surveys were conducted in the 1970s.
- The fossil record can be used to help understand the role, abundance, and size of parrotfish in on coral reefs before humans.[3]

Juvenile stoplight parrotfish (Sparisoma viride)

Importance of Understanding Parrotfish

Corals and algae compete for nutrients and space; parrotfish regulate this competition through consuming algae, and are directly tied to the health of coral reefs.[2]

Queen parrotfish (Scarus vetula) on a relatively healthy coral reef

Algae-dominated coral reef

Driving Questions

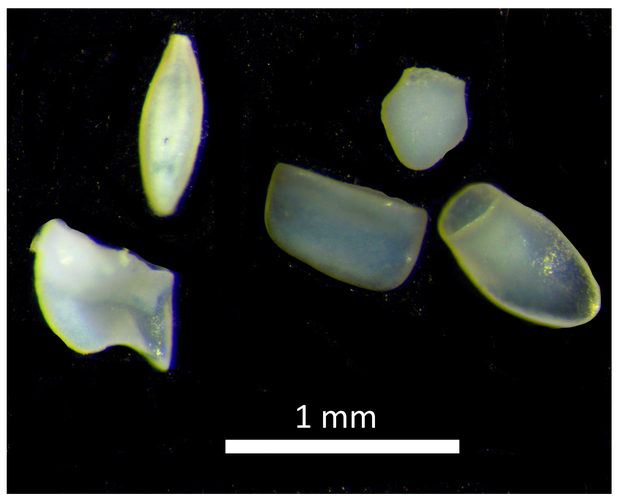
- Have parrotfish teeth, as a proxy for fish size, changed in size or abundance in the Dominican Republic over the last 9000 years?
- Is there a difference in parrotfish tooth size and abundance between modern reefs in Palmyra Atoll (Pacific) and the Dominican Republic (Caribbean)?

Hypotheses

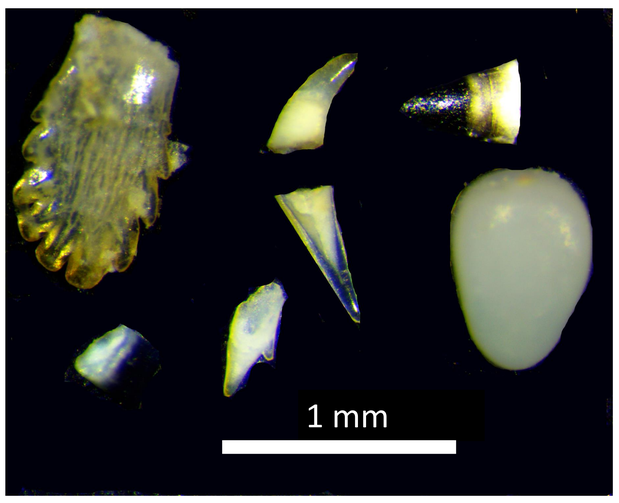
1. Parrotfish teeth will be smaller and less abundant on the modern Dominican reef relative to the fossil reef.
2. Parrotfish teeth will be larger and more abundant on modern reefs on Palmyra than the Dominican Republic.

Methods: Collecting, Processing, and Measuring

- Bulk sediment samples were collected from comparable fossil reefs in the Dominican Republic dating back 6000-9000 years[4] along with modern reefs in the Dominican Republic (Caribbean Sea) and modern reefs in Palmyra Atoll (Pacific Ocean).
- 10% acetic acid was used to eliminate calcium carbonate isolating the fish teeth; 5% hydrogen peroxide were used to dissolve organic material.[1]



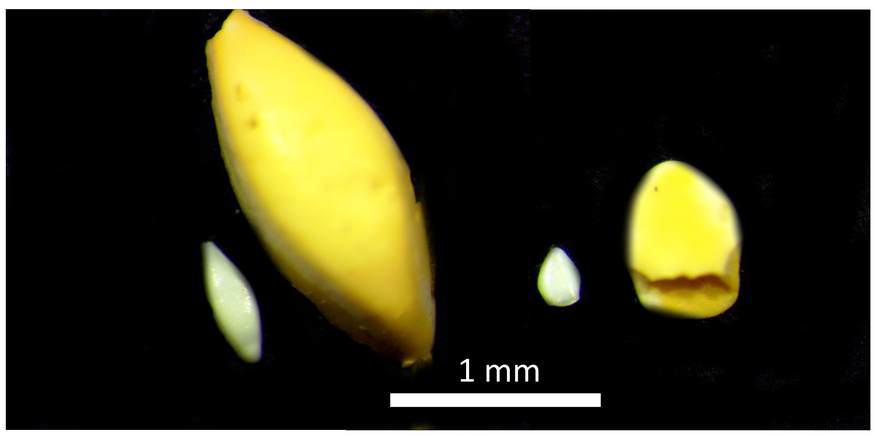
Parrotfish tooth morphotypes



Non-parrotfish tooth morphotypes

- Teeth between 106 and 2000 µm long were counted, classified, and measured in length and width across each tooth's centroid as per Sibert & Norris 2015.[1]
- Length was analyzed using the most abundant parrotfish tooth morphotype (second tooth and fourth tooth from left), while all parrotfish tooth morphotypes were used in analysis of abundance.

Abnormally Large Teeth in Modern Dominican Reef



Normal and abnormally large parrotfish teeth side by side for comparison

- Certain teeth from the modern Dominican Republic reefs were large, opaque, and yellow, rather than small, white, and translucent. As of now, we are still investigating their presence and preservation. This occurrence spanned all parrotfish morphotypes and several non-parrotfish morphotypes.

Data: Modern Reef has Larger Teeth than Fossil Reef

Parrotfish teeth found in the modern Dominican Republic reef were significantly larger than those found in the fossil Dominican Republic Reef, likely because the modern reef possessed the large yellow teeth.
No significant difference in tooth size was found between the modern Dominican Republic and Palmyra reefs.

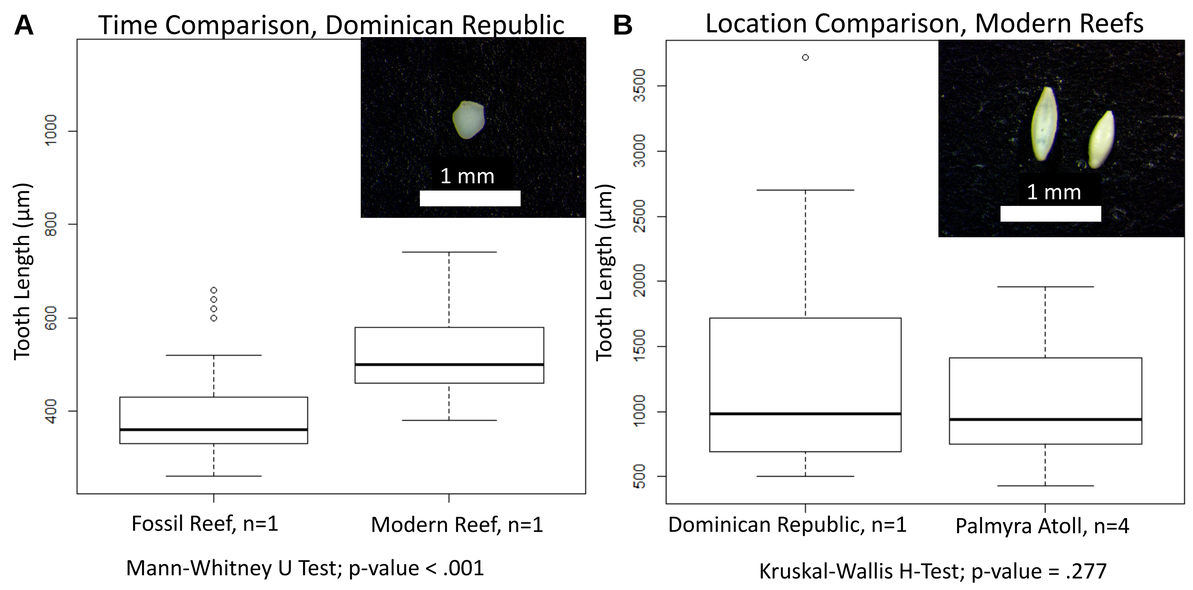


Figure 1: Comparison of parrotfish tooth length over time (A) and location (B). These graphs show the size distributions for the most common parrotfish tooth morphotype across the two sites being compared (tooth morphotype used for comparison is pictured in the correspond graph). The subaerially exposed fossil reef in the Dominican Republic dates back 6000-9000 years.

Data: Comparison of Relative Abundance across Sites

The relative abundance of parrotfish teeth was not significantly different across various samples within Palmyra. The Palmyra sites had a significantly larger relative abundance of parrotfish teeth than both of the Dominican Republic sites (p-value < .001), which may be due to environmental and geographic differences. There was not a significant difference in the relative abundance of parrotfish teeth between the modern and fossil Dominican Republic sites (p-value = .0591).

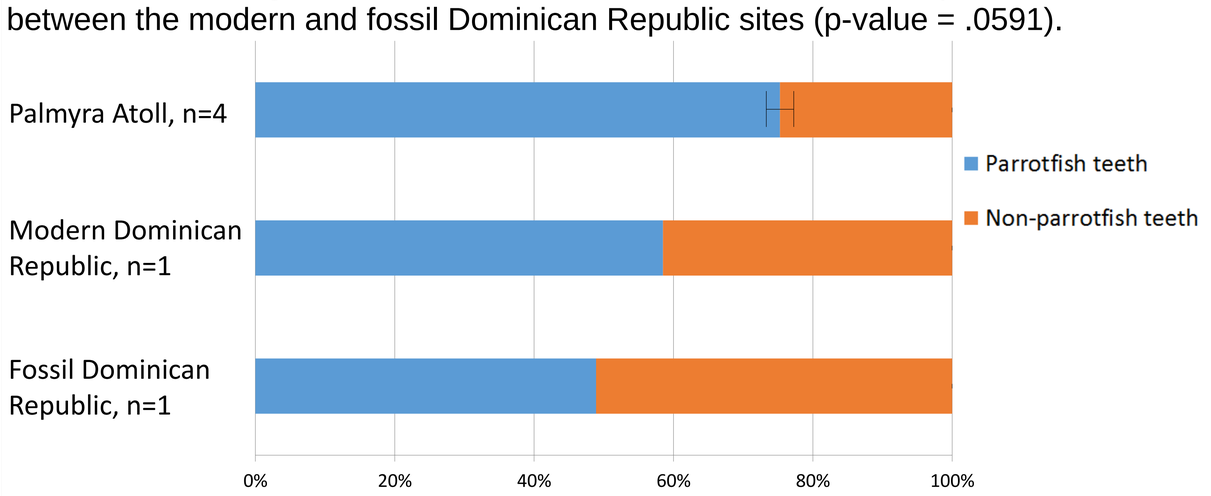


Figure 2: Relative abundance across all sites. This graph shows the ratio of parrotfish teeth to other morphotypes within a given sample. A chi-square test of independence was used for both comparisons.

Conclusions

- The study's results suggest that Palmyra Atoll has a greater relative abundance of parrotfish than the Dominican Republic, possible due to differences in geography or fishing activity. However, parrotfish teeth from Palmyra and the Dominican Republic were not significantly different in size.
- The modern Dominican reef possessed larger teeth than the fossil Dominican Republic reef due to the presence of the large and opaque yellow parrotfish teeth; moving forward, we will investigate the meaning of this occurrence. This data suggests a shift in parrotfish tooth size over time.
- Establishing pre-exploitation baselines of parrotfish size and relative abundance and understanding natural variation across spatial and temporal scales may help develop more accurate conservation targets. It is critical to give context to parrotfish population changes and establish baselines, as they are directly tied to the health of Caribbean coral reefs.

References and Acknowledgements

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