Correlation Between Echinoidea Dimensions and Threat Level

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Abstract

Echinoidea (or sea urchins), are small, spiny, globular, animals that populate the seafloors of nearly the entire planet. Echinoidea have existed on Earth since the Ordovician period, and from their archaic origin there is much to be learned about the relationship between Echinoidea body size and how it affects the survivability of the individual. The goal of this project is to determine how Echinoidea dimensions such as body volume, area, and length compare across extinct and extant species by plotting Echinoidea data in R. We will use stratigraphic data (Heim *et al.* 2015) as a source to find which species of sea urchin from our data are extinct. We will then create three sets of three histograms of the size data for each type of measurement. One set will include histograms for sea urchin length, area, and volume. The other set will include histograms for extinct sea urchin length, area, and volume. The last set will include histograms for extant sea urchin length, area, and volume. Our data showed that extant sea urchins had a larger size, and extinct sea urchins were smaller. Our length data showed that the average length of all sea urchins were 54.95791 mm, the average length of extinct sea urchins were 51.0337 mm, and the average length of extant sea urchins were 66.12774 mm. There is a generally increasing trend of size over time, except for a small outlier about 350 million years ago, where echinoid extinction selected towards larger species and biovolume was abnormally high. Our data also showed that over the past 200 million years, echinoid extinction selectivity drove slightly smaller sea urchins towards extinction, further supporting the idea that a larger size was and still is advantageous for echinoids.

Figure 1

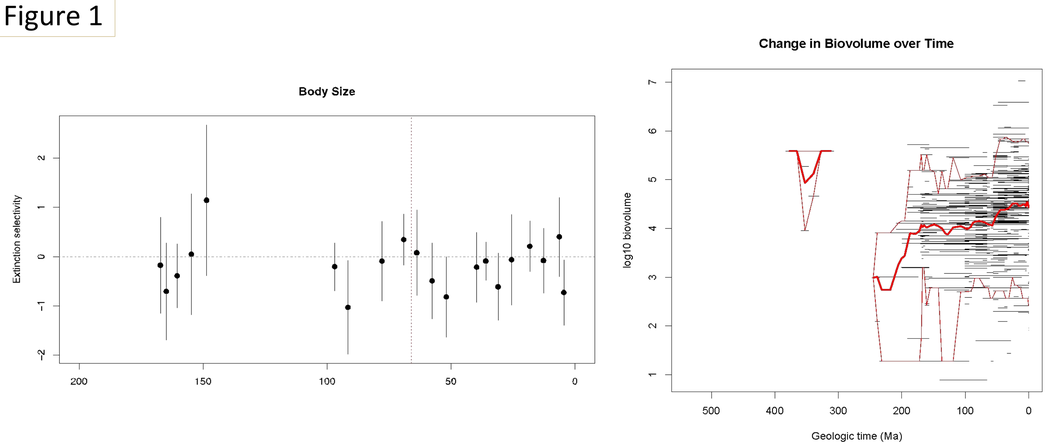

Figure 1. The graph on the left shows extinction selectivity for the body size of echinoids over time, in millions of years. The dots' heights show how size matters when sea urchin are going extinct. For example, a dot below 0 and into the negatives would mean that smaller sizes of echinoid selected towards extinction at a point in time as indicated by the x-axis. The bars going through the dots show the range of selectivity with a 95% certainty. The red line marks the Cretaceous–Paleogene extinction from 66 million years ago. The graph on the right shows individual biovolumes of echinoids, plotted with time. The dark red line shows the average biovolume of the echinoid data, with lighter red lines showing 5th and 95th percentiles. The black lines show individual data with the height showing volume for one specimen and the length of the line showing how long that species stayed alive. Data came from Heim, *et al.* (2015).

Figure 2

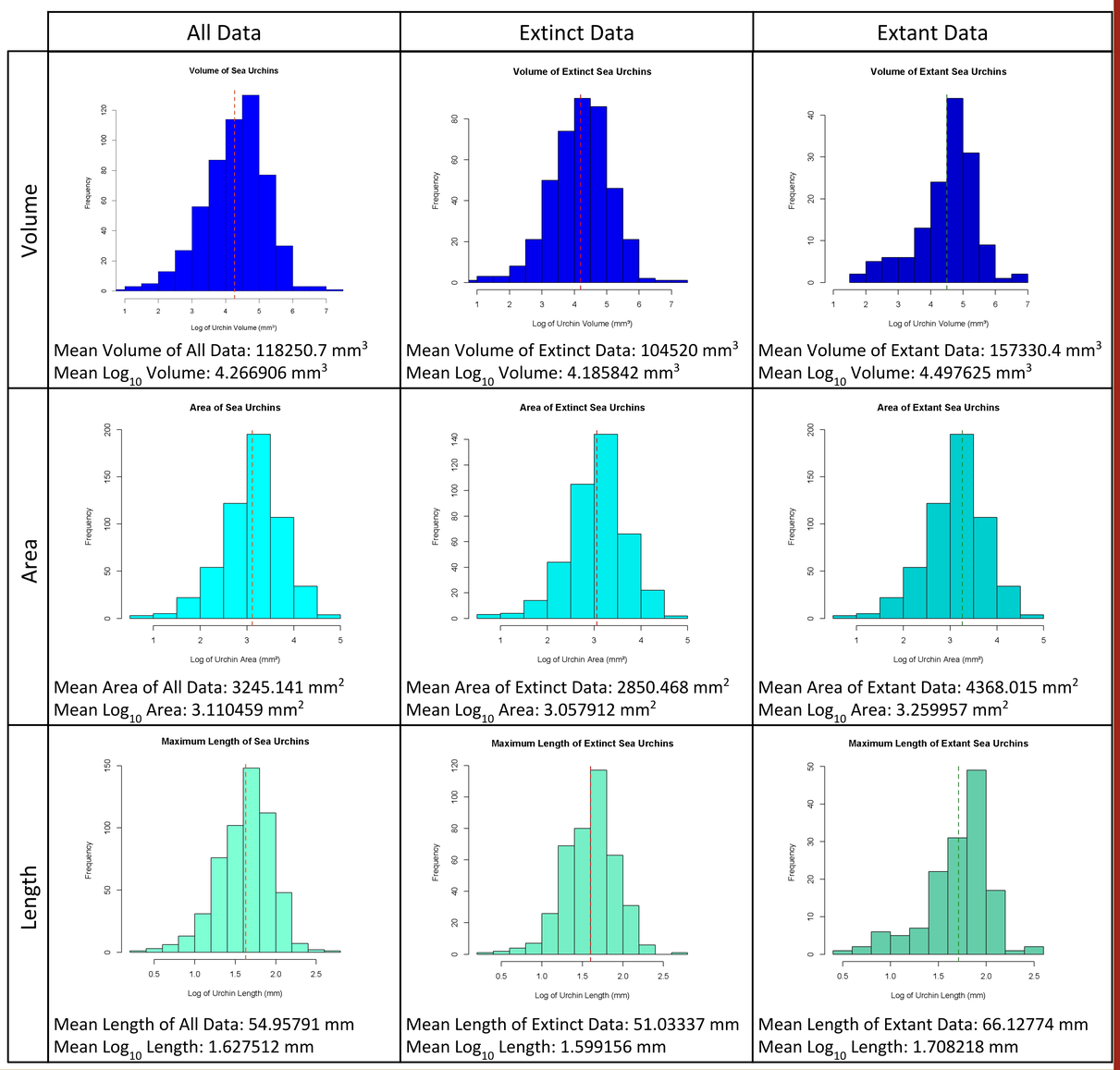

Figure 2. These graphs show size distribution of sea urchin data for length (mm), area (mm^2), and volume (mm^3). All the measurements are shown as logarithmic numbers to show differences in magnitude of size. The dotted lines on the graphs represent mean values for the specified data sets. Data came from Heim, *et al* (2015).

Conclusions

Our data showed that echinoid have been steadily growing over the past 250 million years. Since then, species of echinoid selected towards extinction have been generally smaller. In addition, the maximum biovolume size has grown, indicating an overall increase in biovolume and dimensions. However, the minimum biolvolume size has shown a steady plateau in growth, indicating that although echinoids are growing, the smaller species aren't necessarily severely threatened (Figure 1). The maximum lengths, two dimensional areas, and volumes of the echinoid also show similar results (Figure 2). The dimensions for extant species of the present are seen to be larger than the extinct species of the past. This is seen with dimensions such as the maximum length. The extant species have an average maximum length of 66.12774 mm. This is considerable greater than the average maximum length of the extinct species, which have an average length of 51.0337 mm. The growth in size of sea urchin is relevant to the ecosystem of marine communities. Even though the size provides greater amounts of food to local predators, they also consume greater amounts of algae and could contribute to an ecological imbalance because of their greater presence (Pearse 2006).

Citations

Heim, N. A., Knope, M. L., Schaal, E. K., Wang, S. C. & Payne, J. L. 2015. Cope's rule in the evolution of marine animals. *Science* 347:867–870.

Pearse, J. S. 2006. Ecological Role of Purple Sea Urchins. *Science* 314:940-941.

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