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GSA Proposal – Final

Extinction of marine invertebrates in the Phanerozoic with respect to mode of life and latitude.

Statement of the Problem

Marine invertebrates are widely studied because not only are many diverse species very well-preserved in the fossil record, but extinction and speciation patterns that are easily recognizable in the rock record making such organisms very useful tools for biostratigraphy (Hallam, 1989). Given the robustness of the marine macrofauna record, a large amount of research that has been dedicated to investigating diversity patterns of invertebrates. However, not many studies have focused on clade-specific questions relating an organism’s morphology or habitat preferences to its patterns of diversity (Mondal and Harries, 2015). In this study, my aim is to study the habitat preferences of bivalves through geologic time and to use data from the Paleobiology Database to model those preferences with respect to latitude. I hypothesize that, at increasingly lower latitudes, one mode of life for bivalves will be favored over the other.

Justification: Questions about ecosystems and the response of organisms to environmental perturbations are of special interest to researchers today who seek to understand how anthropogenic effects that have continued over the past 300 years will influence biological communities and what can be done to preserve at-risk communities. A useful way to study ecological relationships is by looking at the fossil record which preserves important information about faunal response to both biotic and abiotic factors over a long time. The marine molluscan record provides a particularly good way to do this since bivalves in particular are very sensitive to changes in sea-levels and ocean chemistry, which in turn reflect overall variations in climate and tectonics. This study will be important in contributing to insight behind the paleoecology and habitat preferences of past macrofauna.

Research Plan: 2302/2500

The selectivity patterns of molluscan fauna will be modeled from the Ordovician to the Holocene (including background extinction) to uncover trends in diversity and habitat preference with respect to mode of life and geographic range. Molluscan fossil occurrences will be downloaded using the Paleobiology Database (PBDB) and organisms will be separated based on their preferred mode of life or tiering, namely epifaunal or bivalves that grow at or above the sediment-water interface, and infaunal, or bivalves that grow within the sediment itself. Epifaunal bivalves will include erect epifaunal bivalves that grow vertically into the water column, as well as surficial epifaunals, which live in contact with sediment but do not extend high into the water column (Mondal et al., 2016). Infaunal bivalves will include shallow-burrowers (<6 cm) and deep-burrowers (>6cm) (Mondal et al., 2016). Semi-infaunal organisms will not be considered and the study will take place at the genera level in order to include as many organisms as possible. Data from the PBDB will be essential to this study and all fossil occurrences of bivalves will be downloaded spanning most of the Phanerozoic and beginning at the Ordovician when they first appeared (Stanley, 1968). The data will be cleaned and culled for outlier occurrences to exclude fossils with an occurrence of less than 2. Organisms will then be separated based on mode of life, age, and latitudinal region using R programming language. Shannon’s Entropy, a diversity index which is used to mathematically quantify species diversity in a particular region based on richness (number of species) and abundance (number of individuals per species), will be calculated for each region studied. Next, the PBDB data will be used to perform a logistic regression analysis which will model the relationship between bivalve paleoecology and latitude. This will essentially predict the tiering preferences (infaunal or epifaunal) of bivalves at different latitudes, and high or low probability values from the regression will reflect the probability of an infaunal or epifaunal species occurring at a particular latitude. Finally, for this comparison, four main latitudinal regions will be considered: tropical, sub-tropical, Antarctic, and sub-Antarctic islands.