The Influence of Oxygen, Temperature, and Salinity on Ostracod Body Size in the Gulf of California and the Pacific Coast of North America

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1. Introduction
The study of body size and its evolution is important to paleontological understanding of ecological niches that different organisms have occupied. Ostracods, with frequent occurrences throughout the geological record beginning in the Ordovician, are useful in analyzing how body size has changed. Therefore, understanding the impact of environmental variables is crucial to understanding patterns of body size evolution in extinct ostracods.

Both oxygen levels and temperature have been significant factors in the body size of various fauna over time, and body size evolution has been shown to be largely influenced by these two critical environmental factors. Several studies have examined the effect of these two factors as discrete variables, and our goal is to study the impact and trends, if any, of oxygen levels together with temperature and salinity on body size. Payne et al. (2009) has shown that two major increases in oxygen levels predate the two major increases in maximum body size. In addition, according to Hunt et al. (2006), the body size of ostracods follow both Cope’s rule and Bergmann’s rule. Another study of marine bivalves demonstrates the strikingly analogous size-frequency distributions across four different latitudinal regions in North America despite changes in temperature and other biotic factors (Roy et al. 2000). The Gulf of California and the Pacific Coast of North America have a rich diversity of ostracod species in addition to various habitats. In our research, we would like to study how ostracod body size is affected by three important environmental variables, temperature, oxygen levels, and salinity.

2. Methodology
In order to further investigate this question, ostracod populations in the Gulf of California and the Pacific Coast of North America were studied. By compiling data from Ostracoda from the Gulf of California (Swain, 1967), Marine Holocene Ostracoda from the Pacific Coast of North and Central America (Swain and Gilby, 1974), and the National Oceanographic Data Center, we compare different environmental factors in the Gulf of California and the Pacific Coast, including oxygen levels, temperature, salinity, and depth (Figure 1), with anteroposterior length measurements of about 180 recent ostracod species found in the corresponding locations in order to determine the impact of these variables, discretely and concurrently. We used the statistical programming language R to visualize and analyze the data.

3. Results
Using the statistical programming language R, we constructed three graphs of oxygen levels, temperature, and salinity versus average body size per station (Figure 2 a-c). Using Pearson’s product-moment correlation test, the correlation coefficient for oxygen is -0.193, temperature is -0.398, and salinity is -0.322, with the corresponding p-values of 0.067, 9.196 x 10^-5, and 0.002; only the latter two p-values are significant at the alpha = 0.05 level. The correlation test for depth was also calculated but showed no trends (Figure 2d). The statistically significant coefficient between temperature and body size suggests a strong negative correlation. Because several variables simultaneously impact body size, we sought out the best combination of variables that would fit the average body sizes by creating a coefficient path model (Figure 3). When comparing the temperature, salinity, oxygen, and depth variables concurrently, it was found that temperature alone is the best predictor of body size.

4. Discussion
Data from average ostracod size and temperature suggest that ostracod size increases with lower temperatures, which supports Hunt’s research on ostracod body size and Bergmann’s rule (2006). In addition, salinity also shows a negative correlation between body size. Because oxygen levels and salinity levels are, to some extent, dependent upon temperature, this may also explain the smaller, yet still statistically significant, correlation between body size and salinity. Although further research is needed, higher levels of dissolved oxygen can have significant impacts on lower temperatures could be the cause of increased body size. Relationships between ostracod body size and temperature may be relevant to our understanding of the impacts on ecological structure as the ocean temperatures fluctuate in the future.

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References

5. Data

- Figure 1: Maps of the Pacific Coast of North America and the Gulf of California
- Figure 2 a-d: Oxygen, temperature, salinity, and depth compared to average body size per location
- Figure 3: Oxygen, temperature, and salinity, and depth compared concurrently on the coefficient path model