Examining the Role of Substrate Preference in the Mesozoic Decline of Brachiopods

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Introduction

Brachiopods are a primary member of the Paleozoic evolutionary fauna, which dominated marine ecosystems between the early Ordovician and late Paleozoic. However, they are today restricted to various marginal habitats, having been displaced by bivalves.

Their decline can be traced to the Jurassic, occuring in spite of a promising recovery of their abundance and diversity following the Permian-Triassic extinction.

It is hypothesized that a driving cause of this shift was the reduced availability of carbonate substrates, prefered
by brachiopods, as opposed to softer, muddy substrates, due to changes in ocean chemistry and the disappearance of large carbonate platforms.

Analysis of lithological data from over 150,000 occurences of brachiopods and 160,000 occcurences of bivalves shows an increasing brachiopod preference for carbonate substrates over the Mesozoic, compared to a more balanced distribution during the Paleozoic.

Indeed, most living brachiopods occur on hard, usually carbonate, substrates, with the exception of a few minor groups. Likely ecological drivers of this shift include the susceptiblity of brachiopod larvae to grazing organisms in the abscence of cryptic habitats as well as fouling by burrowing organisms

Methods

The occurence data used to examine my hypothesis was obtained using the Paleobiology Database

n order to examine carbonate vs. siliciclastic trends, over 100,000 brachiopod and bivalve occurences were broadly re-classified as either carbonate (based on database lithology adjectives such as "carbonate" or rudstone) or siliciclastic

Carbonate occurences were assigned a value of 1 and siliciclastic occurences were assigned a value of 0

This data was then used to calculate a mean lithology at the stage level, from the Fortunian to the Holocene

A moving average was then used to display the trends in brachiopod and bivalve substrate preference as well as preferences in overall brachiopods vs. major orders

A Cretaceous specimen of Crania craniolairs

Permian productid

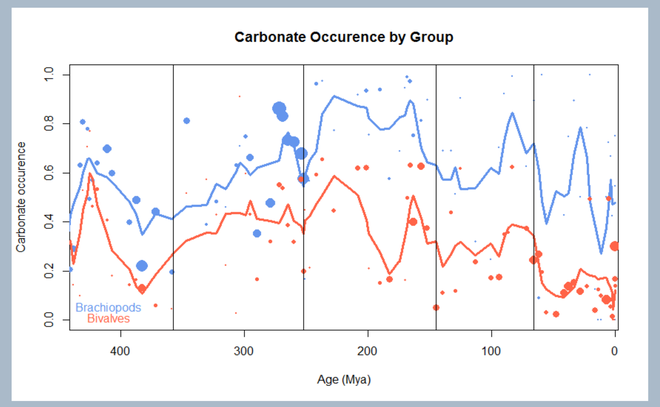


Figure 1: Mean carbonate occurence (1 carbonate, 0 non-carbonate) of bivalves and brachiopods plotted as a moving average. The size of the colored circles correspond to the number of occurences

This figure illustrates that brachiopods occur more frequently on carbonate substrates than bivalves, with the disparity intensifying since the Mesozoic

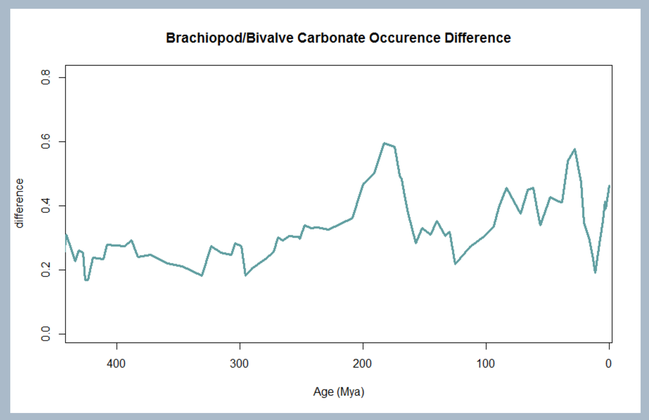


Figure 2: The difference between the proportion of bivalves and brachiopods occuring in carbonates plotted as a moving average

This figure shows a consistent difference between the proportion of carbonate occurence for the two groups, with some peaks introduced by the limited number of brachiopod occurences near the Recent

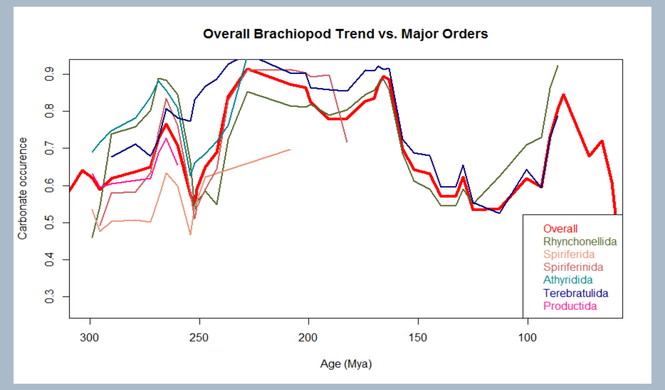


Figure 3: The overall carbonate occurence trend of brachiopod compared to the carbonate occurence of major brachiopod orders

This figure compares carbonate preference trends of silicia-favoring, soft-sediment adapted groups such as the Spiriferida and Productida, but also illustrating that the overall trend is not entirely dominated by their decline

Future Research

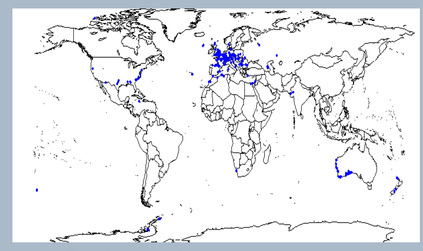
An important area of future analysis is the relationship between paleolatitude and carbonate preference

In addition to determining how paleolatitude factors into substrate preference, this is also important due to the records' bias towards European paleolatitudes

In order to increase the number of occurences, I have entered over 1000 new collections, focusing on two key periods the Jurassic and Cretaceous

I plan on concentrating on the non-European and Russian literature in order to add occurences in less well-represented areas, especially at higher paleolatitudes as well as improving the Cenozoic brachiopod record

Future analysis will also attempt to determine substrate preference relationships between nearby collections using a paleolatitude grid



Distribution of occurences I have entered into the Paleobiology Database