DEEP TIME HISTORICAL BIOGEOGRAPHY OF MYTILID BIVALVES

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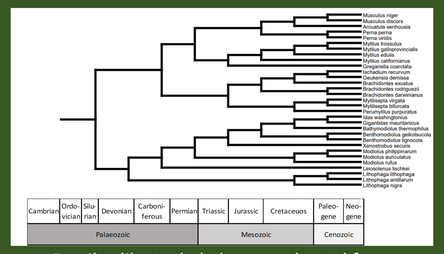
Background

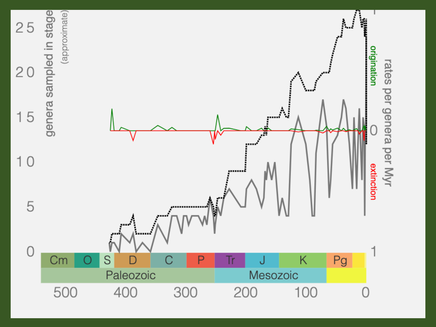
Present-day patterns of biogeography are heavily influenced by processes operating on million-year timescales, including climate change, evolution, extinction, and tectonics.

Mytilid bivalves (Family Mytilidae) are a globally distributed clade of sessile marine invertebrates which originated in the Silurian and have diversified to the present in part by adapting to new lifestyles and habitats

By quantifying and reconstructing geographic range parameters of extant and extinct Mytilid taxa I can understand how various processes have influenced the modern diversity and distribution of species.



Fossil calibrated phylogeny adapted from Audino et. al 2020.



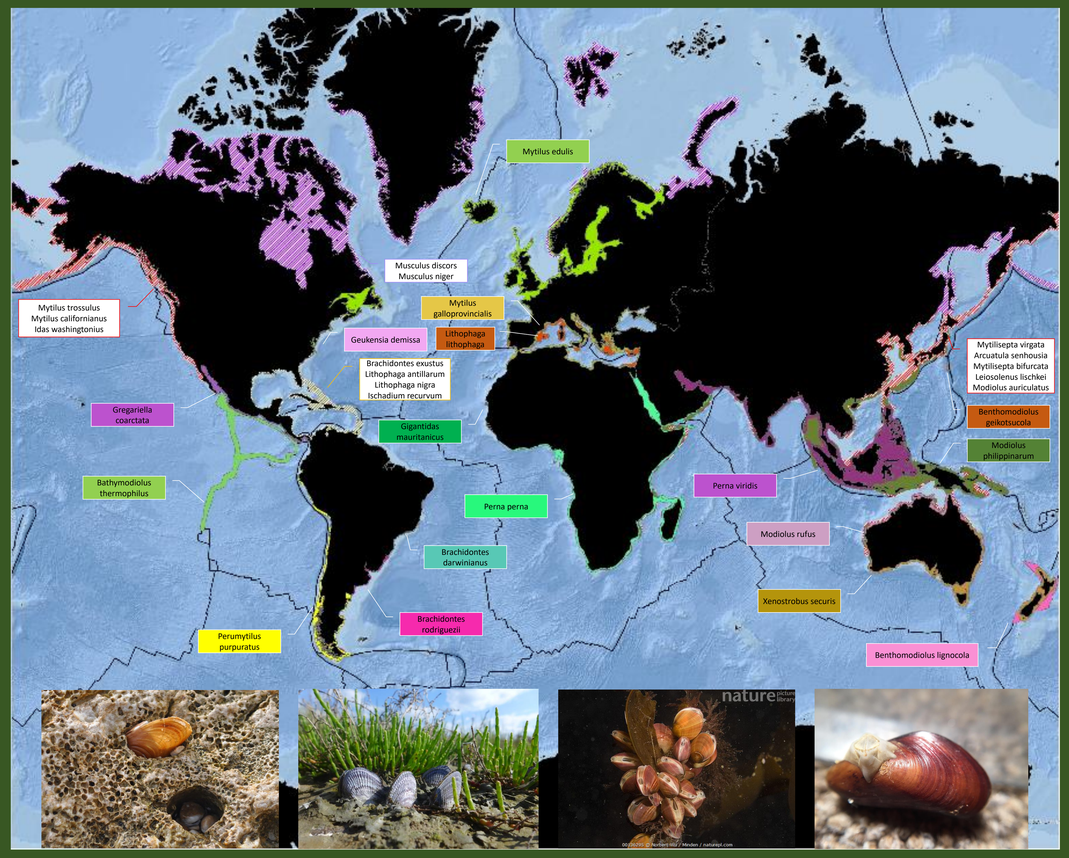
Sampled-in-bin diversity of Mytilidae showing the number of genera found in each time interval and range-through diversity (first occurrence to last occurrence of each taxa). From paleobiodb.org

Methods

Using GIS, I digitized the known native geographic ranges of 31 extant Mytilid species.

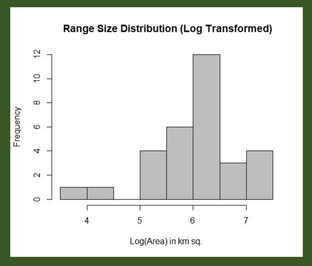
I then quantified key characters of these ranges, including: Range Area, Perimeter, lat./long. centroid, and max. lat./lat. range.

To answer Q1, I perform an ancestral character state reconstruction (using parsimony) in Mesquite v3.81, tracing these characters onto a recently published molecular phylogenetic tree from Audino et al., 2020.

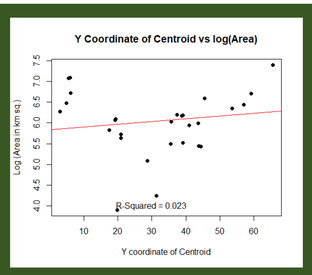


Mapped geographic ranges of 31 taxa within Mytilidae. Pictures representing a taxa of each lifestyle (left to right), *Lithophaga lithophaga* (borer), *Geukensia demissa* (semi-infaunal), *Musculus discors* (infaunal) and *Xenostrobus securis* (epifaunal).

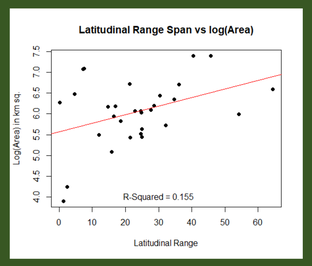
Modern Biogeographic Patterns



Extant mytilids include highly endemic and widely distributed species



Extant mytilids seem to disregard Rapoport's rule as their latitudinal location is not related to range size

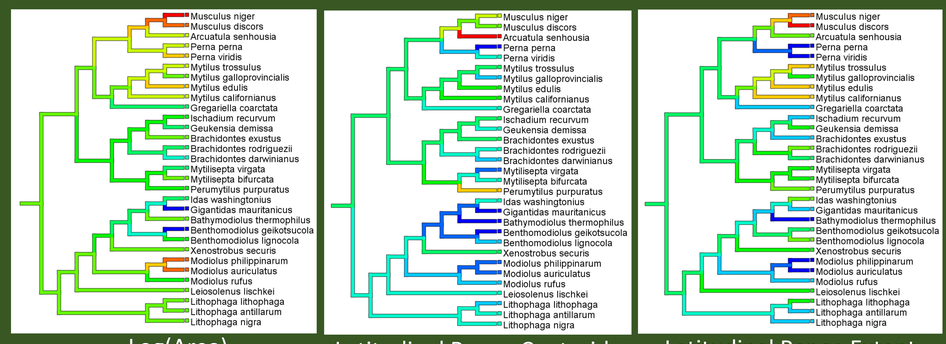


Variance in latitudinal range and size is likely due to available habitat space with increasing latitudes, with some ranges being very large/small

Key Questions

1. Where did the clade originate, and what are the characteristics of its ancestral range?
2. As the clade diversified, are there predictable biogeographic patterns for taxa prone to speciation or extinction?
3. Are specific lifestyles (e.g., epifaunal, semi-infaunal or boring) geographically constrained, and is this pattern consistent through evolutionary time?

Ancestral Range Reconstruction

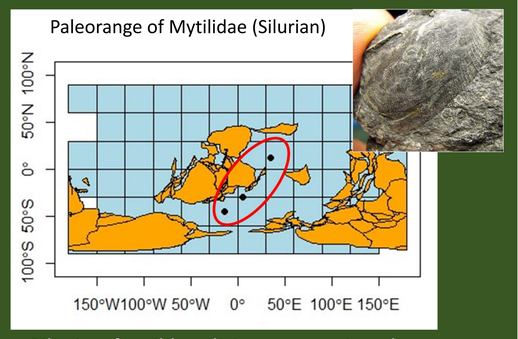


Log(Area) | Latitudinal Range Centroid | Latitudinal Range Extent

Ancestral Character Reconstruction (ACR) suggest the mytilid ancestor was of medium-high range with a Log(Area) of 6.04 km^2 (Min/Max of 3.90/7.74 km^2) and preferred lower latitudes ≤ 30° N/S with a medium latitudinal extent of ~26° N/S.

Low Medium High

Hypothesis Test



Silurian fossil localities preserving the oldest known mytilid species – *Phthonia regularis* – projected onto a paleogeographic map. This provides a preliminary test of the predictions levied by my ACR; localities suggest a low latitude and mid-sized range centered on the western margin of the Rheic Ocean.

Ongoing Work

Using fossil occurrence data, I will reconstruct the geographic ranges of Mytilid genera and species through time.

Paleo-range maps will be used to identify temporal trends in geographic range size and distributional patterns, paying particular attention to intervals characterized by bursts of origination and mass extinction, and/or intervals of major global change.

The results will help identify what, and how, processes operating on million-year timescales have influenced global patterns in diversity.

References

Jorge A Audino, Jeanne M Serb, José Eduardo A R Marian, Phylogeny and anatomy of marine mussels (Bivalvia: Mytilidae) reveal convergent evolution of siphon traits, Zoological Journal of the Linnean Society, Volume 190, Issue 2, October 2020, Pages 592–612.
Lithophaga lithophaga by Manu Romero Peñalver.
Geukensia demissa by https://manayunkia.wordpress.com/category/the-love-of-writing/.
Musculus discors by Norbert Wu.
Xenostrobus securis by Javier via iNaturalist.
Phthonia regularis by Jeffrey P. via FossilForum.