Assembling the ammonite fauna of the Western Interior Seaway using a biogeographical framework

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The establishment of biota in epeiric seas provides a unique opportunity to observe long-term community assembly and evolution in physically novel and vacant environments.

Figure 1. Reconstruction of North American paleogeography during the Albian. (Ron Blakey, Colorado Plateau Geosystems, Inc.)

In the early development of the Western Interior Seaway (WIS) of North America, only two genera are known to have invaded: *Neogastroplites* (family: Hoplitidae) from the north before the seaway was complete, followed by *Metengonoceras* (family: Engonoceratidae) from the south. ***Why were these the only taxa present? Why not others? What can we learn from them and their closest relatives about traits that affect invasion potential? How do these taxa differ from each other?***

Here, I present two approaches to explore factors that may influence the ability of organisms to invade novel environments like the WIS.

The Data

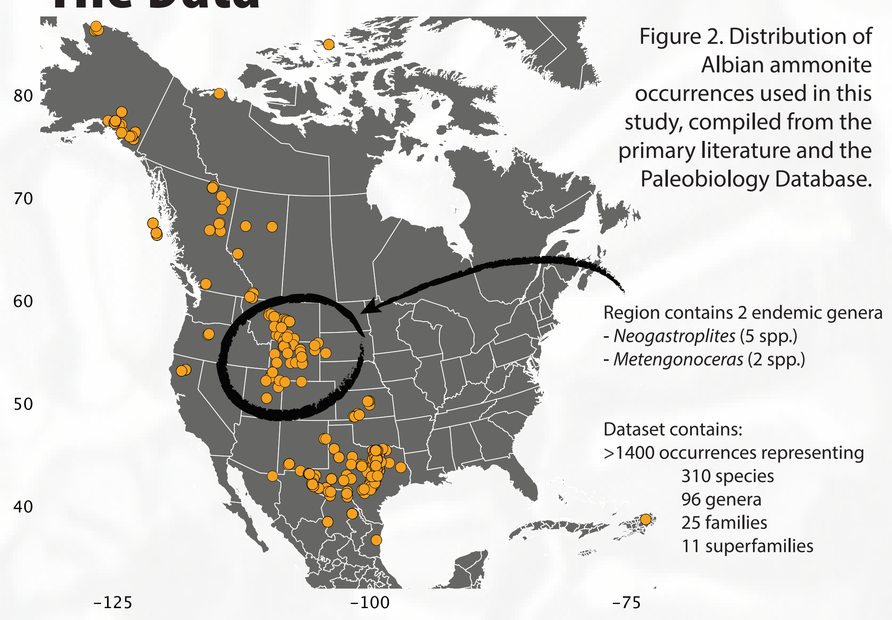

Figure 2. Distribution of Albian ammonite occurrences used in this study, compiled from the primary literature and the Paleobiology Database.

Environmental Breadth

Are members of the two invading families found in particularly broad ranges of environments?

A higher number of lithologies suggest the ability to live in a greater number of habitats, which may have aided invasion into the WIS.

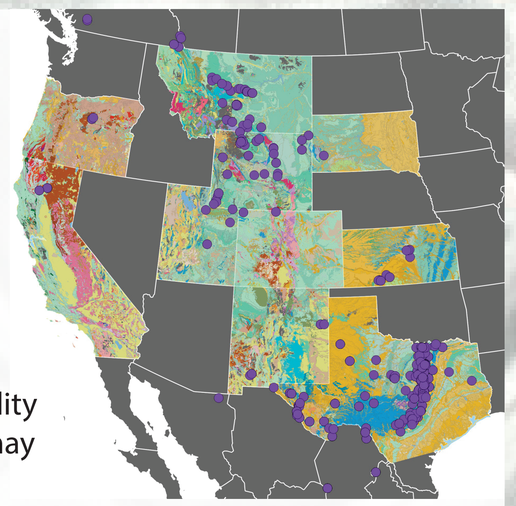

Figure 3. Map showing USGS data used to extract lithological associations for the occurrences (purple dots).

Each occurrence in the combined dataset was assigned a lithological association. Lithologies not reported with the original occurrence records were extracted according to location and formation using Quantum GIS from geologic maps provided by the United States Geological Survey (Fig. 3) or using formation descriptions from the published literature.

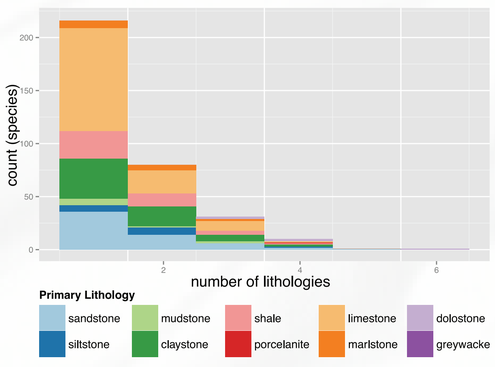

Figure 4. The distribution of the number of lithologies associated with each species. Colors indicate the species' most commonly associated lithology.

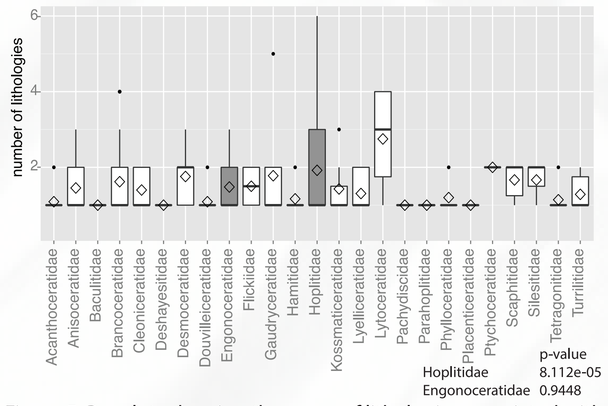

Figure 5. Boxplots showing the range of lithologies associated with members of each ammonite family in the dataset. Diamonds indicate means, ranges are interquartile ranges. The two families with WIS representatives are highlighted in gray. The p-values are from chi-squared tests comparing the families of interest to the rest.

Conclusions

- Most Albian ammonite species are found in only one lithology, most frequently in limestone. (Fig. 4)
- Species within the family Hoplitidae - the first invaders - are found in significantly more lithologies than expected. However, species from Engonoceratidae - the second invaders - were not. (Fig. 5)

Geographic Range

Do members of the two invading families show particularly large geographic ranges?

Small geographic ranges indicate endemism, which can have one or more impacts on the ecology of invasion.

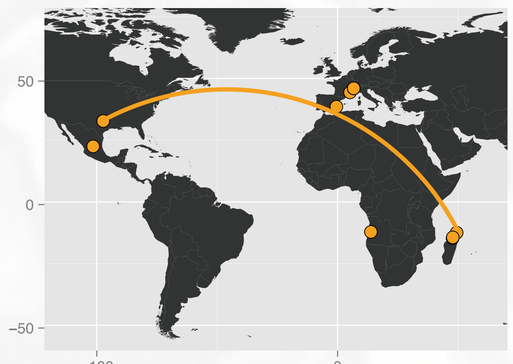

Figure 6. Example range of *Anisoceras armatum* in the Albian with great circle distance drawn.

These impacts are dependent on the reasons for endemism: the family may be geologically young, relictual, or geographically specialized.

Maximum great circle distances of global occurrences were calculated for the taxa known to be in or near the seaway (Fig. 1), but only occurrences from the Paleobiology Database were used. Species must have had at last three occurrences - 95 species met these criteria.

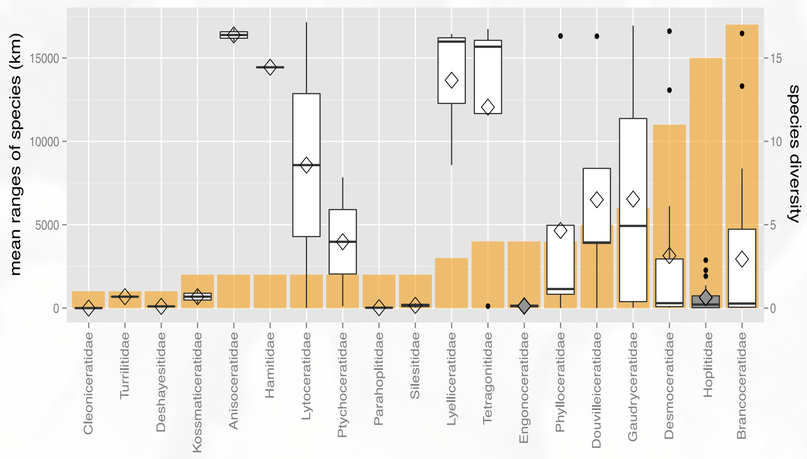

Figure 7. Boxplots showing the average maximum great circle distances for members of each ammonite family in the dataset. Diamonds indicate means, ranges are interquartile ranges. X-axis is arranged by species diversity, shown in orange. The two families with WIS representatives are highlighted in gray.

Conclusions

- Species in Hoplitidae and Metengonoceras show not only small average ranges, but small variance in those ranges – surprising, given their relatively high species diversity. (Fig. 7)
  - This suggests that the species within these families are more localized than other species.
- Further work must be done to interpret what the endemism means.

Future Work

- Using morphometric approaches to characterize the geographic distribution of specific aperture shapes, given that aperture shape should reflect some aspects of their ecology (Fig. 8)
- Expansion of dataset into the Cenomanian, when many more taxa occupied the seaway
- Application to analogous systems (e.g. Sundance Sea)

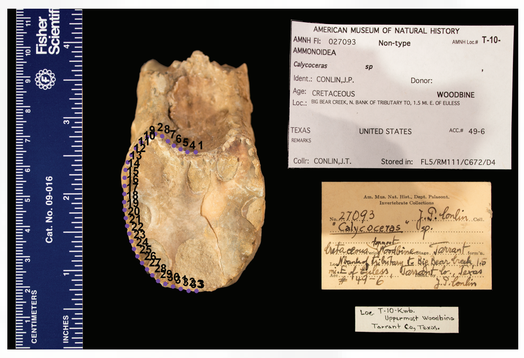

Figure 8. Photograph of *Calycoceras sp.* (AMNH 027093) with example landmarks and semilandmarks placed.

Acknowledgements

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Background image:
Ernst Haeckel, *Douvilleiceras mammillatum*, 1899