Evolution and Ecological Associations in Herbivorous Theropods

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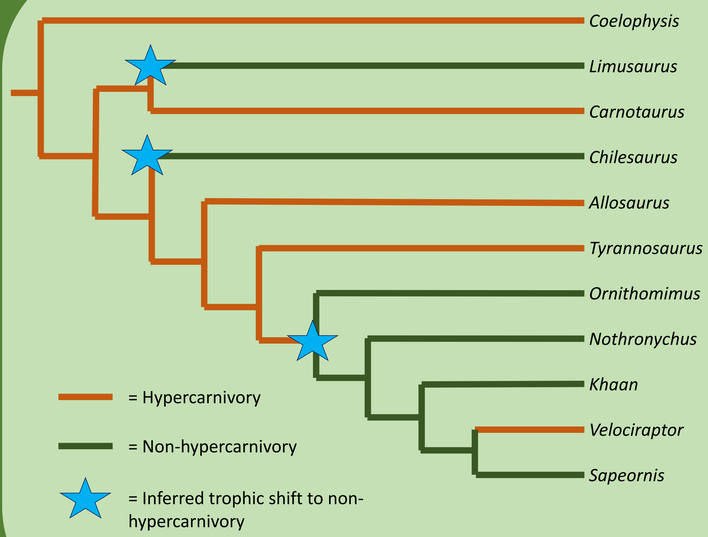
Introduction

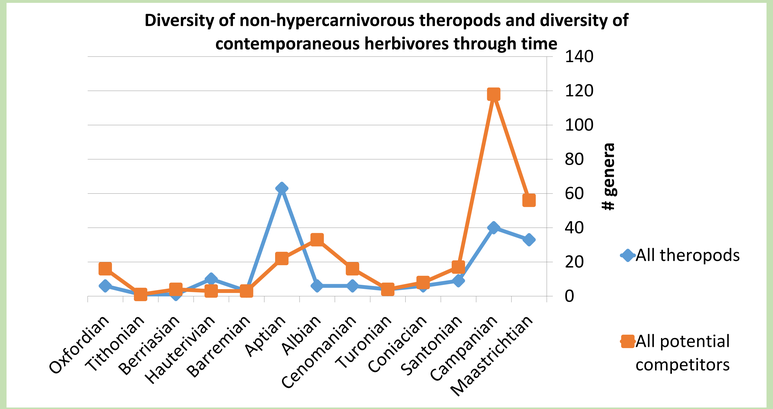
- Some Mesozoic theropod dinosaurs preserve fossil evidence of evolutionary trophic shifts from an ancestrally hypercarnivorous lifestyle
  - Plant material found as gut contents
  - Gastroliths (gizzard stones) suggestive of a gastric mill similar to modern herbivorous birds.
  - Zanno and Makovicky (2011) identified 21 morphological characters strongly correlated with herbivory in Mesozoic theropods
- To search for ecological and environmental factors that may have been associated with these trophic shifts, I tested for potential correlations between the diversity of herbivorous theropods, contemporaneous herbivores, and plants, as well as change in average global sea level



Phylogeny based on Novas et al. (2015)

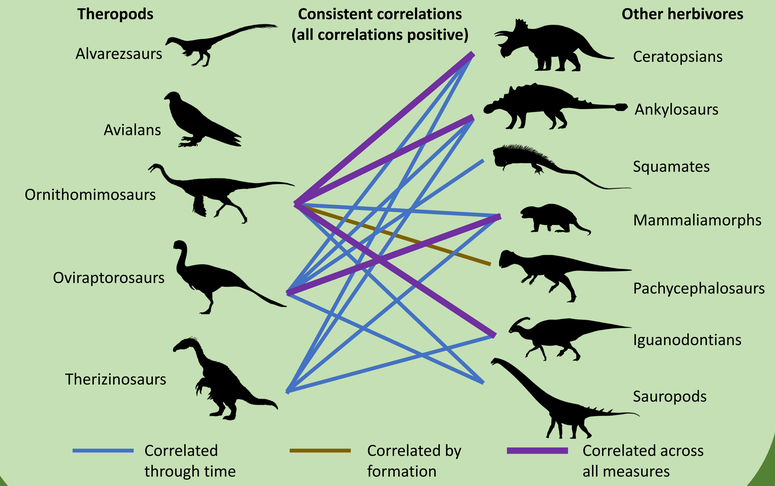
Methods

- Diversity of non-hypercarnivorous theropods was measured by genus count, tallied using the Paleobiology Database (PBDB) (https://paleobiodb.org/cgi-bin/bridge.pl)
- Diversity of contemporaneous potential competitors (other herbivorous vertebrates) and plants were also tallied using the PBDB
- Data were binned by location (formation) and by time (age)
- Average global sea levels through time were based on estimates by Miller et al. (2005)
- To account for preservational and sampling biases, residual diversity calculated based on number of dinosaur-bearing formations (DBFs) and dinosaur-bearing collections (DBCs)
  - Observed diversity in the Oxfordian and Campanian Ages were consistently strongly impacted by these biases; data points from these ages were removed
- Correlation coefficients Spearman's ρ and Kendall's τ were calculated in the software PAleontological STatistics (PAST) between theropod diversity and potential competitor diversity, plant diversity, and average global sea level



Results

- No statistically significant correlations were found between theropod diversity and plant diversity
- Only alvarezsaurian theropod diversity was consistently significantly correlated with sea level change through time (ρ = 0.78, p = 0.005; τ = 0.57, p = 0.012)
- Overall diversity of theropods was positively correlated with that of contemporaneous herbivores (ρ = 0.38, p = 0.024; τ = 0.29, p = 0.014 when binned by formation; ρ = 0.66, p = 0.028; τ = 0.56, p = 0.017 when binned by age)



Silhouettes by Raven Amos, Andrew A. Farke, "FunkMonk," Scott Hartman, Alyshia Hutchinson, T. Michael Keesey, Matt Martyniuk, and Nobu Tamura

Discussion and Conclusions

- Positive correlation supports association between diversity of non-hypercarnivorous theropods with that of contemporaneous herbivores
  - No evidence of direct competition
  - Non-hypercarnivorous theropods may have benefited from presence of other herbivores
  - Alternatively, extrinsic factors unidentified in present study may have favored herbivore diversity as a whole
- No correlation between theropod and plant diversity, but sample size limited
- Little correlation between theropod diversity and global sea level

References

- Miller et al. 2005. The Phanerozoic record of global sea-level change. *Science* **310**: 1293-1298.
- Novas et al. 2015. An enigmatic plant-eating theropod from the Late Jurassic period of Chile. *Nature* **522**: 331-334.
- Zanno, L.E. and P.J. Makovicky. 2011. Herbivorous ecomorphology and specialization patterns in theropod dinosaur evolution. *Proceedings of the National Academy of Sciences, U.S.A.* **108**: 232-237.

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