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Multi-proxy, multi-taxic approaches to reconstructing community structure and trophic ecology in non-analogue Mesozoic contexts

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The Late Cretaceous floodplain palaeocommunities of North America preserve a rich record of biodiversity, although various biotic and abiotic parameters also make this system at least partially non-analogous to any specific modern ecosystem. Consequently, a range of hypotheses have been proposed concerning the habitat preferences, food web structure, and niche partitioning among terrestrial and aquatic taxa in these systems. Increasingly, a combination of multiple geochemical proxies, alongside the incorporation of more novel approaches and applications, play a critical role in investigations testing these hypotheses.

To illustrate this, I provide a case-study based on data field-sampled from spatiotemporally-constrained sites in the Upper Cretaceous (Campanian) Belly River Group of Alberta, Canada, and analyzed for a suite of proxies, including $\delta^{13}C$, $\delta^{18}O$,$^{87}Sr/^{86}Sr$, element ratios (e.g. Sr/Ca, Ba/Ca), and a variety of preservational indicators, from a diverse range of terrestrial and aquatic taxa, in order to test several hypotheses of vertebrate palaeocommunity structure and niche partitioning, and to reconstruct aspects of the associated palaeoenvironmental conditions. In the terrestrial system, we find evidence for niche partitioning, as well as habitat breadth and movement differences among co-occurring herbivorous ornithischian dinosaurs. As well, log Sr/Ca – log Ba/Ca distributions for taxa are consistent with expected food web positions from other sources, and are similar in relative patterns to those observed in modern ecosystems, suggesting this proxy can provide a reliable indicator of trophic structure in Cretaceous systems. Notable among these, the troodontid theropods, which have been variably hypothesized as carnivores, omnivores, or herbivores in prior studies, plot most closely to herbivorous ornithischians. The application of Bayesian mixing model approaches to these taxa, including possible diet sources, recovers troodontids as omnivores, and are best fit as plant-dominant omnivores. In the aquatic system, we find differences in isotopic/elemental distributions between the alligatoroid crocodylians and the superficially gharial-like choristoderes, likely related to dietary specializations for mixed-feeding vs. piscivorous specialization.

Taken together, these multi-proxy studies provide novel data for reconstructing community ecology and environmental conditions in these ancient systems, while underscoring the importance of intensive studies on spatiotemporally-constrained sites, alongside broader-scale and model-based analyses, to the advancement of macroecology and palaeoecology.