Dinosaur bonebeds and biogeography—what the tiniest fossils tell us about the largest patterns

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Alberta, Canada. Credit: Wikipedia, Qyd

Discovering new dinosaurs is very romantic, isn't it? A team of plucky explorers stumbles across a small bone sticking out of a cliff, and after a bit of digging around it reveals a complete dinosaur skeleton, and a totally new species to science! I mean, that's how it always happens, right?

Wrong. Discoveries of complete dinosaurs, or even partial skeletons, are actually incredible rare. They often get the most glory and attention because this is how our media machine functions. The majority of dinosaur discoveries are actually disarticulated, broken, disassociated and fragmentary remains, often comprising no more than a few bones that somehow managed to survive the Earth's never-ending ravages for tens of millions of years. This is the rule, and 'good' fossils, no matter how incredible, are the exception.

More commonly than complete skeletons, 'bonebeds' are incredibly fossil-rich deposits that occur in single layers, comprising numerous small fragments of bone, or 'microfossils'. They typically form as 'lag deposits' in coastal environments or river bends where changes in the flow energy of water that transports the fossils leads to their deposition and concentration in clusters. Most of the time, the fossils aren't identifiable to the species level due to their fragmented nature and small size, but they still give us a good idea about the faunal composition based on sheer numbers alone. This is because we can obtain fossils from them in bulk through methods like sieving, and accrue massive sample sizes. So an actual time where quantity over quality actually comes in useful!

We've had a post all about the value of bonebeds before on the network by Don Brinkman. Don described the kinds of patterns we could detect for dinosaur communities and their ecology from these bonebeds, such as trophic (feeding) structures. But what can bonebeds tell us about larger biological patterns too? Can they yield information about dinosaur biogeography, or how dinosaurs changed between different environments? This is what Thomas Cullen from the University of Toronto, Canada, set out to discover as part of his PhD focusing on the vertebrate faunas of North America during the Late Cretaceous.

The Belly River Group of southern Alberta is a renowned fossil hunters dream, containing numerous fossil deposits that have been well-sampled historically and represent a great diversity of dinosaurs and at a very high geological resolution. From this, Thomas helped to build and apply the largest Cretaceous vertebrate microsite dataset yet assembled to test different evolutionary and ecological associations between the faunal assemblages represented by the different microfossil sites.

What he found by applying a cadre of sophisticated statistical methods do this dataset is that changes in palaeoenvironment seem to have been most responsible for changes in the structure of the preserved faunal assemblages. In particular, where the rocks record a shift from a marine to a more inland (terrestrial) environment, major shifts in faunal composition are recorded, as we might expect. Personally, I kinda like this result as it supports some of my own research showing that sea level changes are important in controlling tetrapod diversity through time, but here on a much more localised scale and using different techniques and data.

What Thomas also found is that dinosaur faunas appear to be quite stable in terms of changes to latitude and altitude, distinct from numerous studies that have found this at larger scales within North America. For example, the existence of a dinosaur 'latitudinal diversity gradient' has been long debated, but evidence for the existence of this pattern on a more localised scale appears to be lacking. Furthermore, dinosaur faunas did not appear to differ substantially based on occupation of different terrestrial environments, for example coastal versus rivers. Again, this is contrary to some recent evidence that found a strong partitioning between sauropod dinosaurs and palaeoenvironment, but again at a different scale.

What this implies overall is that dinosaurs are perhaps less sensitive than previously thought to more subtle changes across terrestrial landscapes, and that additional parameters must therefore be responsible for their relatively high diversity at this time. Thomas suggests that additional ecological or evolutionary factors such as niche partitioning among species or high rates of evolution might be important here, but that's an avenue for future research!

More information: Thomas M. Cullen et al. Palaeoenvironmental drivers of vertebrate community composition in the Belly River Group

(Campanian) of Alberta, Canada, with implications for dinosaur biogeography, *BMC Ecology* (2016). DOI: 10.1186/s12898-016-0106-8

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