# THE LATE TRIASSIC LATITUDINAL BIODIVERSITY GRADIENT

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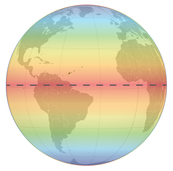
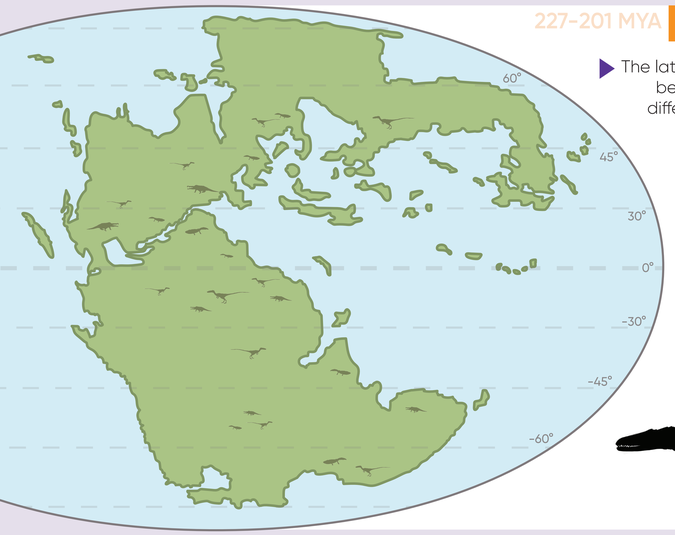
## THE MODERN LBG

- The latitudinal biodiversity gradient (LBG) is the most widely recognised pattern in macroecology. The LBG has been extensively documented in modern faunas, yet the evolution and drivers of this gradient through time remain uncertain
- Today, species diversity increases markedly from the poles towards the tropics. This pattern can be seen in vertebrates, invertebrates, plants and fungi - not only on land, but also in the open ocean and even the deep sea

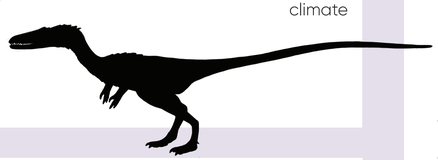


## THE LATE TRIASSIC

227–201 MYA

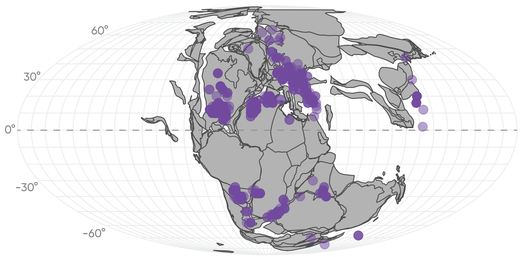



- The late Triassic tetrapod fossil record has been well-sampled across a range of different latitudes, presenting a unique opportunity to examine the LBG in deep time
- Many of the first dinosaurs appeared in the Late Triassic (such as Coelophysis, below). Other tetrapods living at this time include temnospondyls, phytosaurs, and early mammals
- Previous studies suggest that the distribution of Late Triassic groups (e.g. dinosaurs) is closely linked to palaeolatitude & climate

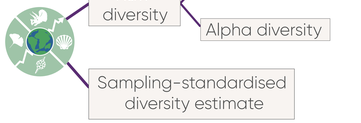


## DATA & METHODS

Occurrences for all Late Triassic terrestrial tetrapods were compiled within the Paleobiology Database (paleobiodb.org)



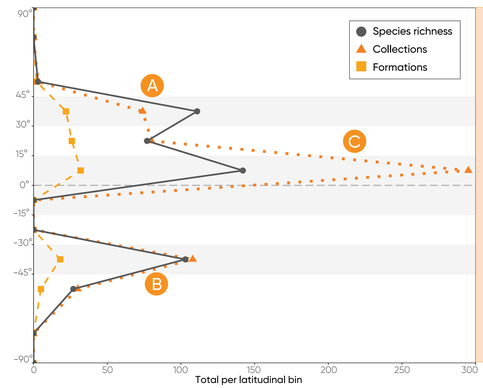

### DIVERSITY




### BIOGEOGRAPHY


## RESULTS

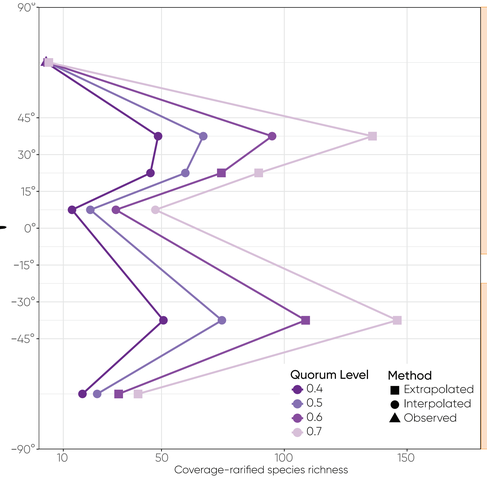
### DIVERSITY & SAMPLING




A Global sampling in the Late Triassic varies between latitudes, with the northern hemisphere markedly better sampled

B Species richness tracks proxies for sampling, most closely in the southern hemisphere

C However, there are deviations from this general pattern, most noticably at 0-15° North




To mitigate the effects of sampling biases, we used the R package iNEXT [1] to implement Shareholder Quroum Subsampling (SQS), a widely-used method of sampling standardis -ation, and obtain an estimate of coverage-rarified species richness

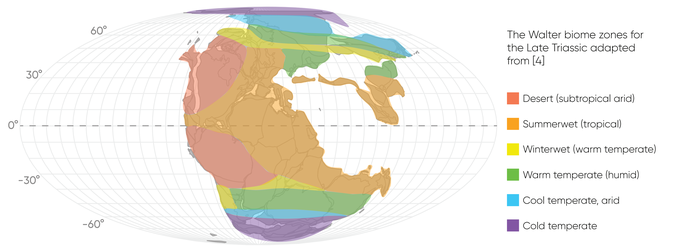
Initial subsampled diversity estimates suggest that during the Late Triassic there was a reversed LBG where diversity is highest at mid latitudes (30-45°)

### ALPHA DIVERSITY


'Local richness' may be less strongly affected by biases in sampling that confound global diversity compilations

### BIOGEOGRAPHY

We optimised palaeolatitude as a continuous character on a tetrapod supertree [2] and calculated fir using the consistency index and a randomisation process [3]. We found evidence of significant ($p<0.001$) latitudinal structuring. This may indicate that climate in part controlled tetrapod distribution




## SUMMARY & FUTURE WORK

- Global sampling patterns in the Late Triassic make it particularly well-suited to studying the evolution and drivers of the LBG through time
- Both alpha diversity ('local richness') and subsampled diversity estimates suggest that tetrapod **richness was highest at mid latitudes** (30°–45°) in the late Triassic
- Preliminary analyses suggest that tetrapod fauna were **latitudinally structured.** However, further comparisons at finer temporal scales and to other adjacent time intervals are required
- Future analyses will examine tetrapod subgroups (e.g. archosauromorphs, amphibians, etc) and incorporate palaeoclimate data to further assess the drivers of the LBG through time

REFERENCES:
1. Hsieh, Ma, & Chao (2016) iNEXT: an R package for rarefaction and extrapolation of species diversity (Hill numbers). Methods Ecol. Evol. 7: 1451–1456
2. Button, Lloyd, Ezcurra, & Butler (2017) Mass extinctions drove increased global faunal cosmopolitanism on the supercontinent Pangaea. Nat. Comms 8:733
3. Ezcurra & Agnolin (2012) A new global palaeobiogeographical model for the late Mesozoic and early Tertiary. Syst. Biol. 61: 553–566
4. Sellwood & Valdes (2006) Mesozoic climate: General circulation models and the rock record. Sedimentary Geol. 190: 269–287

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