Global plate model choice impacts reconstructions of the latitudinal biodiversity gradient

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¶ Abstract

# Keywords

Latitudinal biodiversity gradient, marine invertebrates, macroecology, global plate model, palaeogeographic uncertainty

# Introduction (700 words)

* Could flat, unimodal and bimodal type gradients be observed depending on model choice?
* Is there a temporal relationship?
* P1: Introduction about the LBG
* P2: Introduce Global Plate Models

Here, we test whether Global Plate Model choice influences the recognition of ‘unimodal-type’ latitudinal biodiversity gradients through out the Phanerozoic (the last 540 million years). To do so, we reconstruct the palaeogeographic distribution of fossil occurrences for five major marine invertebrate groups using data from the Palaeobiology Database and three Global Plate Models. Subsequently, we reconstruct the latitudinal biodiversity gradient using coverage-based rarefaction–a common sampling-standardisation approach–and quantify the strength of the gradient through time and the variability between Global Plate Models. We hypothesis that reconstructions of the latitudinal biodiversity gradient are more sensitive to plate rotation model choice with age of rotation.

# Materials and Methods (600 words)

## Occurrence data

We downloaded Fortunian–Piacenzian (541–0 Ma) fossil occurrence data from the Paleobiology Database (PBDB; <https://paleobiodb.org/>) for five major marine invertebrate groups (Bivalvia, Brachiopoda, Cephalopoda, Gastropoda, Trilobita) on March 02 2023. Fossil occurrence data were downloaded using the PBDB API service and were restricted to marine environments, valid taxa and regular preservation (i.e. excluding form taxa and ichnotaxa). Occurrence data were subsequently binned into stratigraphic time bins following the Geological Timescale 2020 [1]. To do so, we used the bin\_time() function from the palaeoverse R package ver. 1.1.1.900 using the ‘majority’ approach [2]. Subsequently, we removed all occurrences with less than 95% of their age range covered by their assigned temporal bin. After data preparation, the occurrence dataset contained 347,193 occurrences from 56,283 collections.

## Palaeogeographic reconstruction and binning

To reconstruct the palaeogeographic distribution of fossil occurrences, we used occurrences’ present-day coordinates and midpoint age from assigned temporal bins with three Global Plate Models: PALEOMAP [3], GOLONKA [4], and MERDITH2021 [5]. Palaeogeographic reconstructions were generated using the GPlates Web Service (<https://gwsdoc.gplates.org>) via the palaeorotate() function in palaeoverse ver. 1.1.1.900 [2]. Subsequently, for each Global Plate Model, fossil occurrences were binned into one of twelve equal-area latitudinal bins (assuming a regular spheroid Earth model with a radius of ~6,371 km), using the estimated palaeolatitudes ([Table 1](#tbl-bins)).

Table 1: Equal-area latitudinal bins used in this study. Bins are generated assumming a regular spheroid Earth model with a mean radius of ~6,371 km.

| Bin | Maximum | Midpoint | Minimum | Area (m2) | Proportion of Area |
| --- | --- | --- | --- | --- | --- |
| 1 | 90.00 | 73.235 | 56.47 | 4.24e+13 | 0.083 |
| 2 | 56.47 | 49.150 | 41.83 | 4.25e+13 | 0.083 |
| 3 | 41.83 | 35.920 | 30.01 | 4.25e+13 | 0.083 |
| 4 | 30.01 | 24.745 | 19.48 | 4.25e+13 | 0.083 |
| 5 | 19.48 | 14.540 | 9.60 | 4.25e+13 | 0.083 |
| 6 | 9.60 | 4.800 | 0.00 | 4.25e+13 | 0.083 |
| 7 | 0.00 | -4.800 | -9.60 | 4.25e+13 | 0.083 |
| 8 | -9.60 | -14.540 | -19.48 | 4.25e+13 | 0.083 |
| 9 | -19.48 | -24.745 | -30.01 | 4.25e+13 | 0.083 |
| 10 | -30.01 | -35.920 | -41.83 | 4.25e+13 | 0.083 |
| 11 | -41.83 | -49.150 | -56.47 | 4.25e+13 | 0.083 |
| 12 | -56.47 | -73.235 | -90.00 | 4.24e+13 | 0.083 |

## Quantifying the latitudinal biodiveristy gradient

* Metrics used to quantify the gradient

# Results (500 words)

* Summary of reconstructions (could all points be reconstructed for each model?)
* Summary of results from metrics, do different gradients emerge?

# Discussion (700 words)

* Recap on importance of GPMs for deep time macroecology?
* What have we shown?
* Are some times or areas more problematic than others?
* Importance for other fields beyond palaeobiology?
* Consider importance of GPM choice in future work… or not?

# Data accessibility

# Authors’ contributions

# Funding

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# References

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