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?

# 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 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 their present-day distribution and the midpoint age from their assigned temporal bin with three Global Plate Models: PALEOMAP [3], GOLONKA [4], and MERDITH2021 [5]. Palaeorotations were implemented via the GPlates Web Service (<https://gwsdoc.gplates.org>) using the palaeorotate() function in palaeoverse ver. 1.1.1.900 [2]. Subsequently, fossil occurrences were binned into one of twelve equal-area latitudinal bins (assuming a spherical Earth with a mean radius of ~6,371 km) using the palaeolatitudes estimated by each Global Plate Model [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

# Acknowledgements

# References

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