Elucidating Diversity Dynamics in Cenozoic Marine Tropical Hotspots: Caribbean

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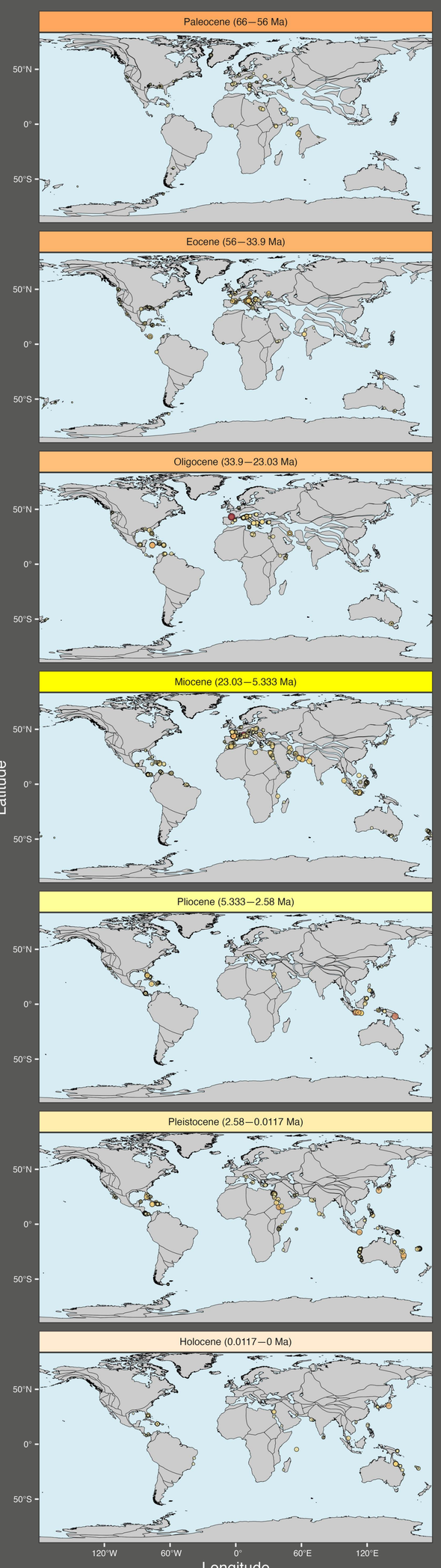
EDiTH

Life on Earth is extraordinarily diverse with more than eight million species recognised today. This richness is unevenly distributed across the Earth's surface with biodiversity hotspots a macroecological phenomenon of the biosphere. Within the marine realm, biodiversity is concentrated in the Indo-Australian Archipelago (IAA), where corals and other reef groups achieve their greatest species richness. But was it always so?

The fossil record suggests at least four marine biodiversity hotspots existed throughout the Cenozoic, located in the Caribbean (~30–2 Ma), Western Tethys (~56–19 Ma), Arabia (~40–15 Ma), and the IAA (~23–0 Ma).

The EDiTH project aims to understand the evolutionary history of these biodiversity hotspots, and test whether there are any general rules governing their emergence, maintenance, and ultimate decline. To do so, we are integrating the rich fossil record of scleractinian corals with ecological and Earth System modelling.

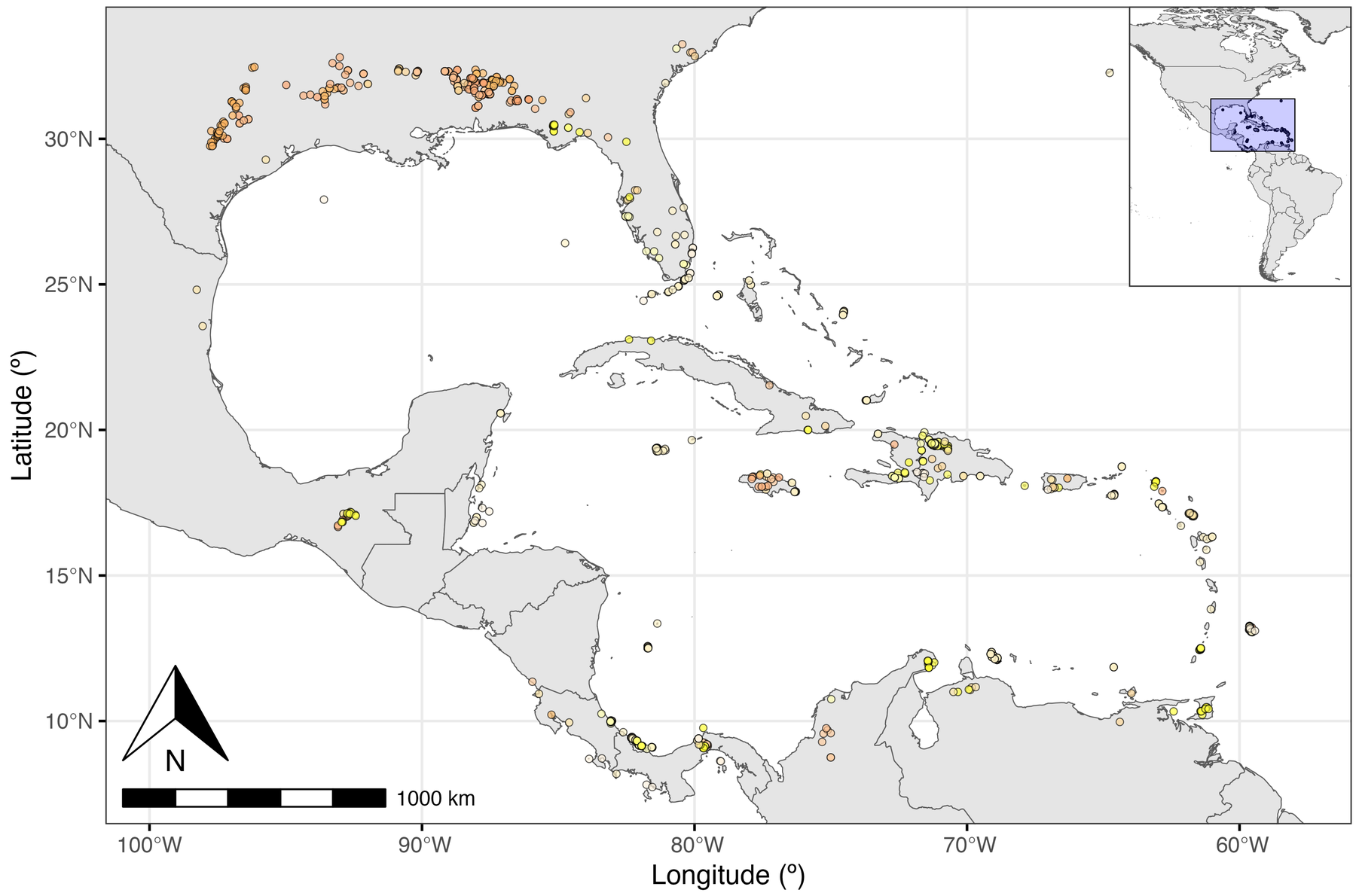


Palaeogeographic distribution of Cenozoic scleractinian coral collections. Data from the Paleobiology Database. Palaeogeographic reconstructions were generated using the MERDITH2021 Global Plate Model. Collections (points) are coloured and sized by their respective genus richness.

Acknowledgements

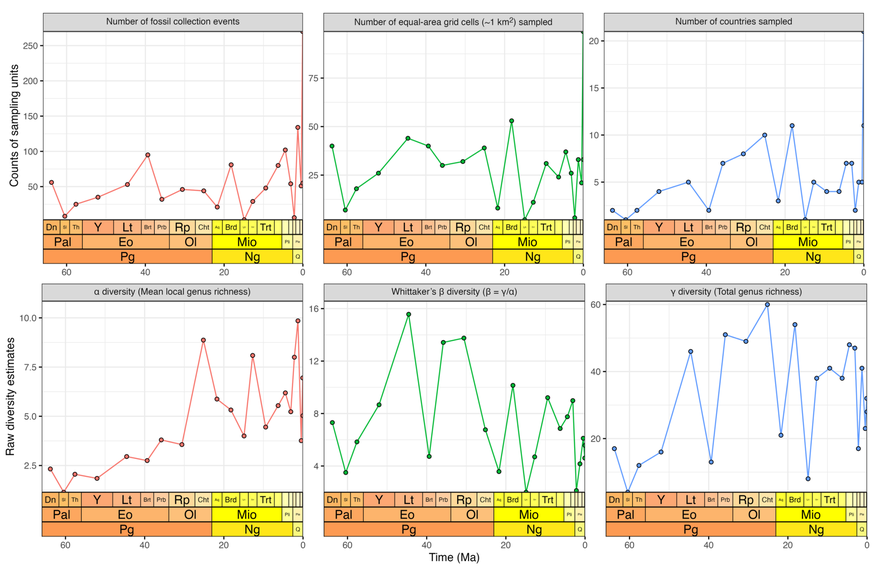
We are grateful for the efforts of all those who have collected and entered fossil coral data into the Paleobiology Database. This research is funded by the UKRI's Natural Environmental Research Council through an Independent Research Fellowship (UKRI185; 'Elucidating Diversity Dynamics in Marine Tropical Hotspots') awarded to L. A. Jones.

Study Region: The Caribbean Marine Biodiversity Hotspot

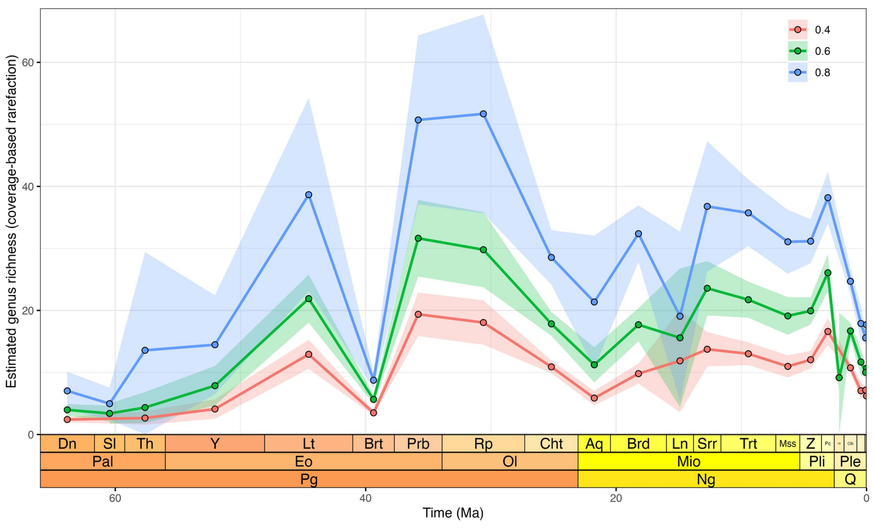


Cenozoic Caribbean scleractinian collections. Data from the Paleobiology Database. Collections are coloured by their respective age following the International Chronostratigraphic Chart. Geographic map indicates a limited and heterogenous spatiotemporal distribution of sampling across the region (e.g. for Jamaica* vs. Cuba).

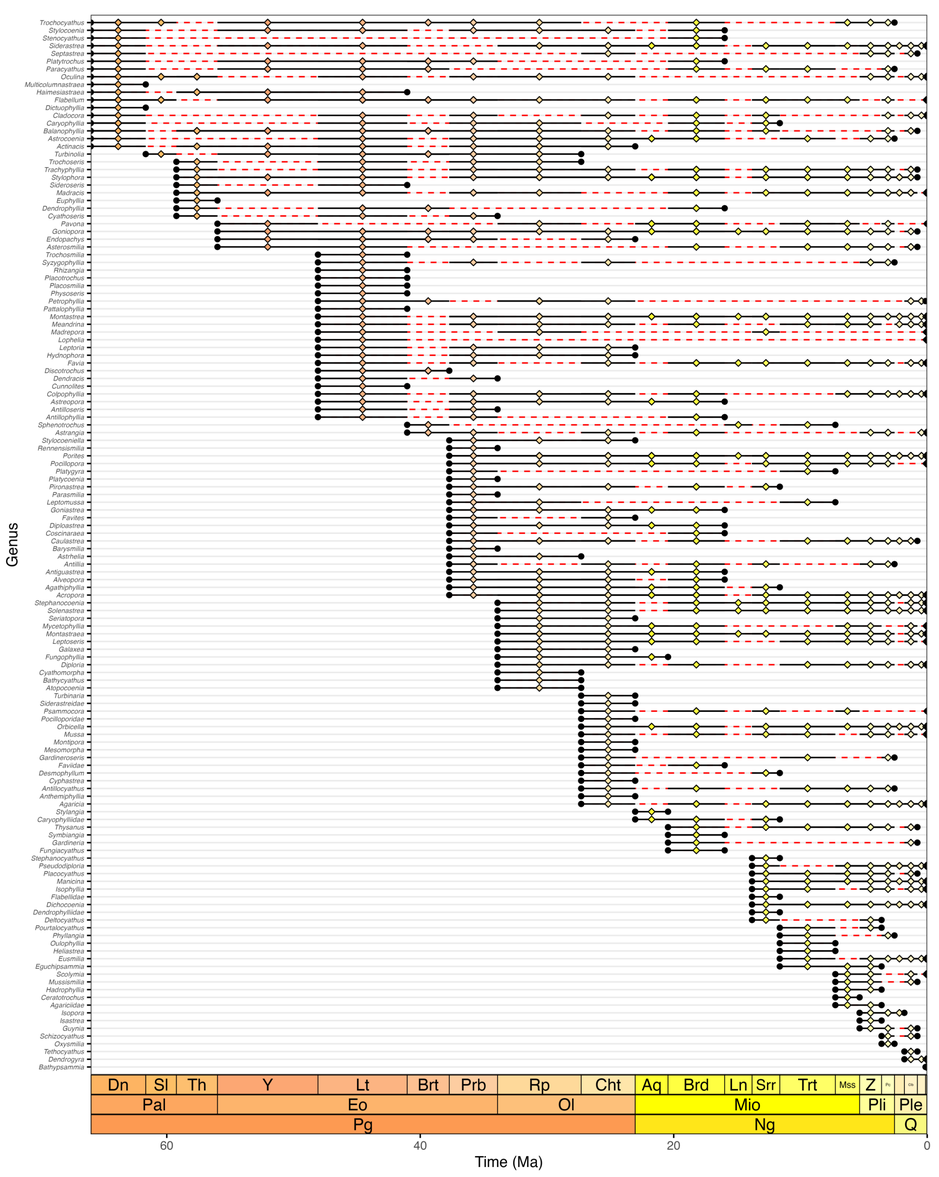
Sampling effort, diversity estimates, and temporal ranges of taxa



Raw counts of sampling and diversity for Cenozoic Caribbean scleractinian corals. Estimates are based on data from the Paleobiology Database.



Sampling-standardised (coverage-based rarefaction) estimates of genus richness for Cenozoic Caribbean scleractinian corals. Estimates are based on data from the Paleobiology Database using the iNEXT R package, and are computed at a coverage level of 0.4, 0.6, and 0.8 with equal-area grid cells treated as the reference sampling unit.



Temporal ranges of Cenozoic Caribbean scleractinian corals. Estimates are based on data available within the Paleobiology Database. Black points represent the maximum and minimum age of genera. Diamonds denote stage-level bins which an occurrence has been observed in. Red dashed lines highlight discontinuities in temporal range data (i.e. no occurrence observed).

Highlights

Data

- An extensive Cenozoic dataset of scleractinian corals is readily available for the Caribbean due to the past efforts of many in collecting and compiling this data.
- While extensive, this dataset is heterogenous in spatial (e.g. Jamaica* vs. Cuba) and temporal (e.g. Bartonian vs. Priabonian) coverage.

Results

- Based on raw counts, current analyses suggest diversity (alpha, gamma) increased up to the Chattian before an overall decline towards the Modern. However, these estimates closely track shifts in sampling proxies.
- Discontinuities in the temporal range of taxa suggest further sampling is needed.
- Sampling-standardised estimates of gamma diversity suggest a nuanced story, with diversity peaking in the Priabonian–Rupelian, declining substantially from the Chattian.

Future work

Data

- Update and expand taxonomic, stratigraphic, sampling, and geographic data.
- Integrate and homogenise published and unpublished data (e.g. museum 'dark data').
- Map data to biodiversity data standards (Darwin Core).
- Targeted fieldwork within under-sampled areas (Cuba).

Analyses

- Estimate evolutionary rates: Are biodiversity hotspots centres of origin, survival, or both?
- Larval dispersal modelling: Are biodiversity hotspots centres of accumulation?
- Palaeoclimatic Modelling: Are biodiversity hotspots of centres of refuge?

Long-term goal

- Examine each Cenozoic marine biodiversity hotspot and evaluate whether there are any general drivers of their origin, maintenance, and ultimate decline.

***Dr Thomas Stemann (8th October 1962–25th September 2024), University of West Indies contributed significantly to our understanding of the evolutionary history of corals within the Caribbean, particularly from his efforts in Jamaica. He sadly passed away late last year but is remembered fondly by colleagues.**