Disentangling extinction risk in deep time

Primary supervisor:	Erin Saupe
Co supervisor(s):	• Ben Mills (Leeds) • Richard Stockey (Southampton)
Research theme(s):	• Palaeobiology and Evolution
Eligible courses for this project:	• DPhil in Earth Sciences • Environmental Research (NERC DTP) • Interdisciplinary Bioscience (BBSRC DTP)

Overview

Determining the species most vulnerable to extinction is key to understanding the drivers of macroevolutionary patterns, and to building accurate projections for biodiversity in the face of accelerated loss today. Past work on modern and fossil taxa have identified biological traits associated with enhanced risk of extinction, including body size and geographic range size. In addition to these intrinsic biological traits, external environmental stressors may also regulate patterns of extinction over geological timescales. In some recent work, work in my lab found that an external, environmental factor—the magnitude of temperature change experienced by a taxon—was as important as intrinsic, biological traits in predicting extinction risk.

Despite this important step forward, critical knowledge gaps remain in our understanding of the drivers of extinction on macroevolutionary timescales. Although temperature is a key physiological variable regulating responses to climate change, changes in other environmental stressors, such as dissolved oxygen (O_2), pH, and food supply, may be as—or even more—important in driving marine invertebrate extinctions on Phanerozoic timescales.

The student will utilise the rich fossil record of marine invertebrates to compare known determinants of extinction risk to potentially-significant but underexplored environmental stressors over millions of years, including changes in dissolved O_2, pH, and food supply.

Artistic reconstruction of a late-Triassic coral reef (left) before and (right) after a rise in ocean temperature led to extinction. Credit: Maija Karala

Methodology

The student will gather trait data for taxa using novel palaeoenvironmental simulations and input these into statistical models of extinction risk.

Timeline

Year 1: Reading the literature, training on spatial methods, collecting and cleaning occurrence data, and quantifying trait information.

Years 2 and 3: Model development, statistical analyses, and development of new trait data

Year 4: Data integration, thesis and paper completion, conference presentations

Training & Skills

Training in the R programming language

Training in GIS software

Training in use of palaeoclimatic and palaeoenvironmental data

Training in statistical methods

Skills developed will include quantitative reasoning, use of coding platforms and software, writing, and formulating logical arguments.

References & Further Reading

Malanoski, C. M., Farnsworth, A., Lunt, D. J., Valdes, P. J., & Saupe, E. E. (2024). Climate change is an important predictor of extinction risk on macroevolutionary timescales. *Science*, *383*(6687), 1130-1134.

McKinney, M. L. (1997). Extinction vulnerability and selectivity: combining ecological and paleontological views. *Annual review of ecology and systematics*, *28*(1), 495-516.

Payne, J. L., & Finnegan, S. (2007). The effect of geographic range on extinction risk during background and mass extinction. *Proceedings of the National Academy of Sciences*, *104*(25), 10506-10511.

Saupe, E. E., Qiao, H., Hendricks, J. R., Portell, R. W., Hunter, S. J., Soberón, J., & Lieberman, B. S. (2015). Niche breadth and geographic range size as determinants of species survival on geological time scales. *Global Ecology and Biogeography*, *24*(10), 1159-1169.

Further Information

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