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LETTER

Species–energy relationship in the deep sea: a test using the Quaternary fossil record

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Abstract
Little is known about the processes regulating species richness in deep-sea communities. Here we take advantage of natural experiments involving climate change to test whether predictions of the species–energy hypothesis hold in the deep sea. In addition, we test for the relationship between temperature and species richness predicted by a recent model based on biochemical kinetics of metabolism. Using the deep-sea fossil record of benthic foraminifera and statistical meta-analyses of temperature-richness and productivity-richness relationships in 10 deep-sea cores, we show that temperature but not productivity is a significant predictor of species richness over the past *c.* 130 000 years. Our results not only show that the temperature-richness relationship in the deep-sea is remarkably similar to that found in terrestrial and shallow marine habitats, but also that species richness tracks temperature change over geological time, at least on scales of *c.* 100 000 years. Thus, predicting biotic response to global climate change in the deep sea would require better understanding of how temperature regulates the occurrences and geographical ranges of species.

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The Questions

Does the species-energy hypothesis hold in the deep sea?

- Is foram species richness a function of available energy in the deep sea?
- Is there a positive correlation between richness and temperature and/or richness and productivity?

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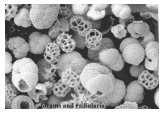
Study System

- 13 deep sea cores – foram species richness, temperature, productivity index
- 100,000 yrs in Quaternary
- series of multiple regression techniques to predict relationship between richness and temperature/productivity



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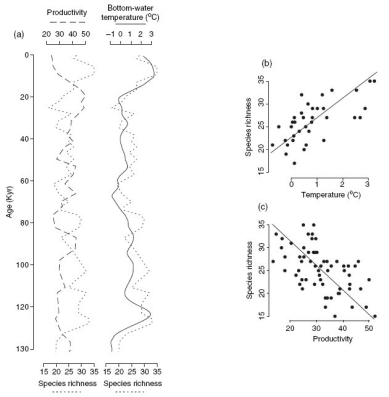

Hunt et al 2005 Fig 1

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Natural experiments

Macroecology ≠ manipulative nor experimental

Temporal fluctuations in climate and foram species richness:

- natural experiment manipulating richness
- spatially replicated (10 cores in 2 oceans)

Can we take advantage of current climate change in similar manner??

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Role of evolution ?

Positive correlation between richness & T°

Current climate determines richness

Regional speciation & extinction determines richness

Present-day richness patterns = snapshot

Major issue = how do we account for evolution?

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How to rule out evolution

Add temporal scale <<< species turnover rate

E.g. Spp turnover rate forams = 20 my

Cores timescale = 0.1 my

Rule out evolution as driver of richness patterns

Focus on how temperature affects species' distribution

Correlation vs. causation

Standard methodology used to explain richness patterns is correlation between number of species and variable X.

Is this GOOD evidence that the variable causes observed patterns?

Alternatives??

move beyond # of species

dynamics of geographic ranges

Hunt, G., T. M. Cronin, and K. Roy. 2005. Species-energy relationship in the deep sea: a test using the Quaternary fossil record. Ecology Letters **8**:739-747.