A predator-prey arms race in Mesozoic oceans

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Background

The diversity of modern marine animals has increased dramatically over the past 230 million years, beginning with an event called the Mesozoic Marine Revolution (MMR). Over this period, marine fauna has gradually developed from sessile, epifaunal benthic assemblages in the Palaeozoic and early Mesozoic to more motile and structured/tiered communities we see today through the Late Triassic, Jurassic and Cretaceous.

Is there evidence of changes in trophic structure and trait evolution that indicate evolutionary escalation in Mesozoic oceans?

The escalation hypothesis was proposed by Vermeij (2008) and refers to an evolutionary pattern captured by measurement of a physiological response to predation pressure. The escalation hypothesis is a fundamental Red Queen (van Valen 1973) pattern and characterises predator-prey arms races.

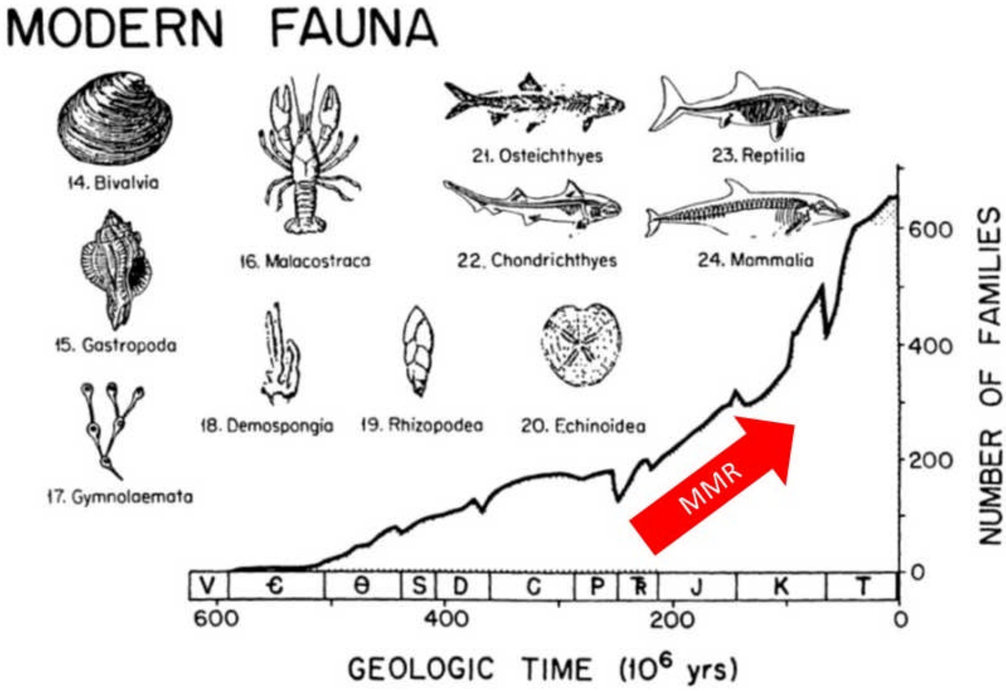

Figure 1. The evolution and diversification of the “modern fauna” and the supposed timing of the MMR (Sepkoski 1984)

The core hypothesis about this radiation, and particularly the transition to a tiered community is a predator - prey arms race. The hypothesis suggests that newly evolved and diversified predators (i.e. durophagous fish, malacostracan crustaceans, extraoral asteroids, drilling gastropods etc.) stimulated the evolutionary response of benthic marine organisms to develop flight (i.e. increased motility and/or infaunality) and defence (i.e. spikier and thicker shells) mechanisms to avoid being predated.

Hypothesis testing

The student will build a number of datasets from well preserved fossil assemblages from the Late Triassic to Early Cretaceous of the Tethys Ocean. Trophic interactions between fossil species will be deduced via a combination of inference based on a number of morphological, stratigraphic and ancestral lines of evidence and models based on the ecological theory of optimal foraging (Beckerman *et al.* 2006). The student will test the following hypotheses relating to escalation at the MMR:

1. Marine ecosystems increased in trophic complexity (i.e. more trophic species, higher connectance) throughout the Mesozoic in response to increased predation pressure and prey responses (i.e. escalation).
2. Increased predation led to increased trait evolution in prey species (i.e. increased motility and increased levels of infaunal tiering within ecosystems).
3. Red Queen processes drove the evolution and diversification of the modern oceanic biota during the Mesozoic.

Impact and publications

This project will pioneer the use of well-developed ecological modelling techniques to address a long standing controversy in the evolution of life in the oceans – did Red Queen processes drive the evolution of the modern oceanic biota during the Mesozoic? The work is divisible into publications that form consecutive chapters of the PhD thesis.

An excellent training and research environment: This interdisciplinary project will provide the successful PhD candidate with highly valued and sought-after tools for investigating macroecological and macroevolutionary processes. The student will gain experience and expertise in database construction, fossil specimen taxonomy, ecological modelling, and macroevolutionary modelling. This will equip the student with the necessary expertise to become the next generation of palaeontological and ecological scientist, ready to carry out their own programme of innovative scientific research. The student will benefit from working within and collaborating with dynamic scientists within the multidisciplinary Palaeo@Leeds group (*Aze, Little, Lloyd, Wignall)* as well as the quantitative evolutionary ecology group at Sheffield (*Childs, Thomas, Warren, Webb*). There will be opportunities to present results at major, international conferences, e.g. BES, GSA, PalAss, and attend residential summer-schools (e.g. in Australia, USA, UK) and in-house workshops and courses. CASE partner the Santa Fe Institute will provide funding for the student to travel to Santa Fe to attend the summer-school in complexity science and for residential trips to work with supervisor *Jennifer Dunne*.

Student profile: A good first degree (1 or high 2i), or a good Master's degree in physical or biological sciences or mathematics with a focus towards palaeobiology, ecology, or evolutionary biology, experience in programming (e.g. *R*) is an advantage but not essential.

References

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