

# On present day islands and past distributions

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Southeast Asia, and especially the Philippines-Indonesia-Papua New Guinea Archipelago, harbours the world's highest marine diversity. This region also had a complex geological history. This raises the question whether these two attributes are related and, if so, how. To locally build high species richness in a region, the balance between speciation/immigration and extinction/extirpation should be positive over at least part of its geologic history.

Recently, a scenario was proposed in which extreme diversity is related to archipelago formation as the result of complex tectonic convergence. The origin of the present day biodiversity hotspot can be traced back to the western Tethyan Eocene, and its progressively eastern position can be linked to the final closure of the Tethys Ocean. Thus, at least at higher taxonomic levels, immigration is an important component. Here I explore examples using both fossil and recent distribution patterns of large benthic foraminifera to explore the question whether marine speciation was facilitated by islands.

Large benthic foraminifera are traditionally believed to have broad geographic ranges and are thus ideally suited for biostratigraphy. However, as shown by examples in the extant calcarinids and soritids, this need not be the case. Careful morphological analyses, sometimes supported and never contradicted by molecular analyses, show the presence of ten times as many species than previously expected. Distribution patterns seemingly are associated with ocean current patterns and there is a potential to reconstruct palaeogeography, especially current systems, when present day distribution is plotted on palaeogeographic maps. However, in most cases there is no obvious pattern, which raises the risk of cherry-picking in the previous examples.

Further examples from the fossil record provide evidence of the plasticity of geographic distribution patterns. For example, the genus *Cycloclypeus* shows over its entire duration variously homogeneous evolutionary ranges from Western Europe to Fiji. This is attenuated by periods in which morphological evolution is concentrated in one small part of its range.

Even further back in time, during the Eocene, *Lacazinella* was restricted to the Australian plate, but it is questionable whether this is due to vicariance or long distance migration. All this evidence together does not equivocally reject the hypothesis that islands directly affect biodiversity through increased opportunities for speciation or survival of marine species.

Indirectly, environmental parameters of island groups are characterised by a large range of habitats, both along onshore-offshore and depth gradients. The greatest chance for these to develop is in areas with a mix of oceanic islands and coastal settings, such as the present day biodiversity hotspot. Tracing backwards to past hotspots, similar

patterns can be seen in the western Tethyan Eocene and Paleogene Caribbean, but much less so in the Oligo-Miocene of the Middle East and the Mio-Pliocene Caribbean, demonstrating the idiosyncratic nature of the phenomena.