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Edited by Joaquín Hortal

symposium summary

Marine biogeography

A contributed session at the 5th International Biogeography Society Conference – Heraklion, Greece, 7–11 January 2011

How does life in the sea compare or contrast with life in or above its land, lakes, rivers, and streams? By asking questions about geographic patterns of marine speciation (Renema, Tellier et al., Tyberghein et al.), how well landscape metrics describe saltwater systems (Wedding et al.), and how patterns of human use impact the marine biota (Davidson et al., Tittensor and Worm), one might begin to intuit some answers.

Willem Renema's study of the distinctive *Cycloclypeus*, the largest living benthic foraminifera (10–12 cm diameter), which occupies a very well characterized niche on tropical coral reefs, provides a well-constrained fossil series, of a quality rare in any realm, for examining patterns and rates of speciation. He found that long-distance dispersal events from the Indo-West Pacific culminate in extinction in the Mediterranean, and that morphological disparity increases regionally but not globally during the Middle Miocene following range contraction and re-expansion. The region of speciation may vary among taxa, even if speciation is contemporaneous. These results suggest patterns of marine species diversity can be influ-

enced by local 'species pumps' (that is, vacuum pumps drawing species in, rather than pressure pumps pushing species outward) causing regional dispersal and diversification, and that evolutionary ecological dynamics of at least some taxa may play out as a series of taxon cycles.

Florence Tellier and colleagues also found evidence of geographically variable evolutionary dynamics along the intertidal rocky shore of the southeastern Pacific. Their comparative phylogeographic study of two low-dispersal co-distributed species, an isopod (*Excirologa hirsuticauda*) and a kelp (*Lessonia nigrescens*), revealed genetic discontinuities in both taxa at 30°S, with sub-groups—possibly cryptic species—of one or the other species either side of this well-known biogeographic filter. Their inference is that concordant phylogeographic patterns may arise from significant environmental factors such as vicariance mediated by oceanography. Yet, secondary discontinuities that are geographically incongruent exist in these taxa: at 27°S for the kelp and 33°S for the isopod. Transplant and laboratory experiments with the kelp suggested at least some of

this genetic structure is due to local adaptation, with differences among kelp populations in their tolerance of desiccation and high heat. Differentiation of secondary sexual characteristics in the isopod suggest reproductive isolation and maybe sexual selection may contribute to, or result from, local adaptation in the isopod.

Lennert Tyberghein and colleagues (Tyberghein et al. 2011) described the new tool Bio-ORACLE (Ocean Rasters for Analysis of CLimate and Environment) that should help determine environmental factors to which populations may be locally or regionally adapted. Bio-ORACLE brings together 23 geophysical, biotic, and climatic rasters at ~9 km² resolution in a format intended to be easier to use than the existing detailed yet disparate datasets (such as those available for download from the National Oceanic and Atmospheric Administration [NOAA]). The dataset was illustrated by maximum entropy species distribution modeling of genetic variation in two seaweed genera: *Halimeda* and *Codium fragile*. The environmental correlates for *Halimeda* suggest origin in warm water and evolution of one clade into cooler waters. Their findings with *C. fragile* are reported in *Global Ecology and Biogeography* (Verbruggen et al. 2009). A major challenge remains gathering reliable empirical data for near-shore environments—where the organisms in the seminal marine studies of Joseph Connell, Paul Dayton, Robert Paine, Peter Sale, Terry Hughes and others live—which Bio-ORACLE currently interpolates.

Lisa Wedding and colleagues examined some of these coastal processes that may influence species diversity at a very fine scale. Particularly, they focused on understanding processes that lead to diversity in a particular place, for which the first task was to establish a method for gathering large datasets. Wedding et al. demonstrated that Light Detection and Ranging (LIDAR) is an effective and accurate way to increase geographic coverage with resolution comparable to traditional time-intensive underwater surveys. The rugosity of coral reefs, as measured by the finest resolution possible with LIDAR is proportional to rugosity measured by experienced divers. Moreover, these fine-resolution LIDAR estimates

of rugosity are significantly correlated with fish diversity at all scales. Thus, there is potential for these nearshore GIS-like tools to be integrated with the offshore data of Tyberghein and colleagues. When this level of integration becomes routine, and we can regularly work with marine datasets approaching the size and resolution of terrestrial datasets, we will be one step closer to understanding how marine systems compare and contrast with those in other realms.

Reaching the level of integration of information, including biological characteristics, that will enable prediction of the consequences of global change is a priority that unites aerial, freshwater, marine, and terrestrial research during a time of intense global change (Barnosky et al. 2011). The final two talks of the marine biogeography session both addressed anthropic challenges facing the natural environment. Ana Davidson and colleagues took on the challenge of developing a predictive and spatially explicit model for determinants of global extinction risk in marine mammals. Using random forest models, they were able to predict extinction risk with 90% accuracy. The four major predictors (of high risk) were, in order of descending importance, the speed of life-history (slow), group size (small), geographic range (small), and body mass (large). Including extrinsic environmental factors did not improve performance of the model greatly. Polar bears (*Ursus maritimus*), for example, have the slowest life-history for their body size of any mammal (marine or terrestrial) and so are predicted to be among the most endangered mammals with the least potential for recovery if threats are removed. In general, high productivity marine coastal regions, i.e. those about which we have most biological data and least environmental data, are where most marine mammals are at risk. Yet the large predatory fishes that roam the high oceans have not escaped unscathed. Intense fishing pressure has decreased the abundance and diversity of large marine animals. Derek Tittensor and Boris Worm asked whether these animals have also experienced changes in range. Their sampling data, derived from commercial fisheries data, are substantial: logbook data from Japanese fisheries alone since 1950, for example, provide billions of

sample points (hooks) and hundreds of millions of observations (fish caught). By stitching together several such datasets, and after correcting for variability in the data such as geographically unevenly distributed effort, Tittensor and Worm were able to detect changes in range. They found generally similar patterns across the Atlantic, Indian, and Pacific oceans, showing an apparent effect of life-history. Fishes that grew more slowly and to larger size and spawned in aggregations, such as the bluefin tuna (*Thunnus thynnus* and *T. orientalis*), showed decreases in range size; the range of *Thunnus thynnus* has contracted almost entirely from the South Atlantic, and populations are fractioning in the Pacific. In contrast, fishes that grow faster to smaller maximum size, such as the albacore tuna (*Thunnus alalunga*) generally have shown no change or an increase in range. Whether changing ocean climate or exploitation provide a more likely explanation is currently under investigation. Thus, we find consensus in the results of Davidson et al. and Tittensor and Worm in predicting, if human activities don't change, an ecological extinction of the marine megafauna that echoes the extinction of the terrestrial megafauna from the Americas thousands of years ago. While in many ways we are beginning to see

parallels between marine and terrestrial systems, it would be heartening to see a difference in this respect.

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symposium summary

Palaeoecology

A contributed session at the 5th International Biogeography Society Conference – Heraklion, Greece, 7–11 January 2011

The IBS meeting is rapidly emerging as a critical meeting for those interested in paleobiogeography, and in particular for those interested in how past and present biogeographic patterns are shaped by the intersection of past environmental changes with ecological and evolutionary processes. Paleoeecology was well represented at the Crete meeting, with 25 abstracts submitted, a packed oral session, and many cross-cutting talks. Several general themes emerged from the talks in the paleoecology session.

One running theme was species niches and their shifting manifestation over time in response to new species interactions and environmental conditions. Alycia Stigall (“Using ecological niche

modeling to evaluate niche stability in deep time”) applied GARP and Maxent analyses to Late Ordovician brachiopod species to show that niche conservatism decreased during and after a major invasion event (the Richmondian Invasion), suggesting that species responded to invasion pressure. Jack Williams and co-authors (“Apparent niche shifts and no-analogue climates in eastern North America during the Late Quaternary”) tackled the problem of reconstructing ‘truncated’ niches, i.e. species’ fundamental niches for portions of environmental space that do not exist at present, showing that different starting assumptions resulted in very different reconstructions of species fundamental niches, and hence very different pre-