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Symposium on "Molluscan Biogeography: Perspectives from the Pacific Ocean" at the 76th Annual Meeting of the American Malacological Society, 2010

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This issue of the *American Malacological Bulletin* includes four papers from the symposium on "Molluscan Biogeography: Perspectives From the Pacific Ocean," held at the joint annual meeting of the American Malacological Society and the Western Society of Malacologists in San Diego, California, on June 29th 2010. We focused the symposium on the Pacific region due to the wide range of macro-oceanographic environments: long linear coastlines, one- and two-dimensional archipelagoes, remote islands, and vast areas of open ocean. Past contrasts between the distributions and diversity of molluscan faunas across these different types of habitats have provided numerous important insights into the factors that influence species ranges and patterns of species diversity (*e.g.,* Taylor 1971, Valentine and Jablonski 1983, Perron and Kohn 1985, Vermeij 1987).

The symposium included presentations on species discrimination, speciation, life history evolution, island biogeography, and phylogeography; the papers published in this volume provide a broad representation of recent research in these subdisciplines. Alan Kohn analyzed life history and geographic range data with comparative methods to re-evaluate the relationship between egg size, larval developmental mode, and geographic range in the gastropod genus *Conus*. Phylogenetically-controlled comparisons provided strong support for the hypothesis that species with smaller eggs (and longer planktonic developmental times) do in fact have larger geographic ranges, an interesting biogeographic relationship all on its own, but also a fundamental component in hypotheses about the relationships among larval mode of development, geographic range, and species longevity in the sea (Jablonski and Lutz 1983, Jablonski and Hunt 2006). In contrast, a second contribution by Tom Duda, Marielle Terbio, Gang Chen, Semoya Phillips, Amy M. Olenzek, Dan Chang, and David W. Morris synthesized phylogeographic patterns across the tropical Pacific among four species of *Conus*, emphasizing the importance of dispersal capability and recent gene flow as an explanation for an absence of obvious phylogeographic concordance among four widespread tropical Pacific species. Despite limited genetic differentiation across much of each of these species' ranges (presumably as a consequence of planktonic dispersal), the data also suggest that rare jump dispersal events and peripheral isolation have resulted in considerable genetic structure in geographically distant populations of some but not all species, and may represent an important route to speciation in the tropical Pacific.

Suzanne Williams, Andie Hall, and Piotr Kuklinski used a combination of DNA sequence data and shell shape data to investigate the power of Elliptic Fourier analysis to discriminate among living and fossil species of the turbinid gastropod genus *Lunella* from the tropical western Pacific and Indian oceans. They reported that morphological divergence is greatest between sympatric taxa.

Christine Parent's conceptually-related paper evaluated the contribution of within-island speciation to patterns of diversity among three lineages of terrestrial snails: the Galápagos Bulimulidae, the Hawaiian Succineidae, and the Hawaiian Achatinellinae. Parent showed that within-island speciation has contributed substantially to patterns of species diversity in each archipelago but that the historical factors associated with speciation within islands appear to differ among the taxa, with either island size or habitat heterogeneity having the greatest influence over rates of speciation within islands. The surprisingly large amount of within-island speciation inferred for each of these lineages emphasizes the need for models that incorporate speciation into formal quantitative theories of island biogeography (Rosindell and Phillimore 2011).

Despite the variety of ideas, hypotheses, and questions that each of the published papers addressed, together they demonstrate the importance of studying biogeographic processes on different spatial and taxonomic scales. In *Conus*, Duda *et al.*'s conclusions about the stochastic nature of long distance dispersal that undoubtedly characterize the biogeographic histories of many species in the tropical Pacific complements the more deterministic relationship between dispersal potential and range size that has emerged from Kohn's work (e.g. Vermeij 1987, Palumbi *et al.* 1997, Lessios and Robertson 2006). Parent's focus on within-island diversification processes and Williams *et al*.'s (2011) suggestions about sympatric divergence together indicate that even though most molluscan speciation is likely initiated in allopatry, the small-scale habitat heterogeneity and transient geographic isolation that initiates divergence probably results in many opportunities for ecological interactions between recently split species, which may cause strong divergent selection on morphological, ecological, and behavioral traits (e.g. Marko 2005, Parent and Crespi 2009, Pfennig and Pfennig 2010, Rundell 2011, Krug 2011). If this is how speciation often proceeds in marine organisms (perhaps most often for linearly distributed nearshore species, see Valentine and Jablonski 1983), the implications for interpreting patterns of morphological change in the fossil record are potentially profound.

In addition to the published papers, other symposium participants presented work on other topics relevant to molluscan biogeography in the Pacific. David Jacobs discussed interoceanic transport in the trematode *Parorchis* and the gastropods *Cerithidea* and *Nutricola*, presumably accomplished by birds. Cynthia Trowbridge discussed biogeographic patterns of diversity among north Pacific saccoglossans, Doug Eernisse evaluated the significance of parapatric distributions towards understand patterns of diversification in eastern Pacific chitons, and Peter Marko reviewed the biogeographic and evolutionary responses of eastern Pacific molluscs to Pleistocene climate change.

The symposium highlighted the need for additional spatio-temporal perspectives on biogeographic processes, particularly those leading to speciation and diversification. Too few studies have combined fine-scale sampling of diverging populations and species with complementary studies of the fossil record. Patterns of sudden morphological change in the fossil record could represent peripatric speciation as envisioned by Eldredge and Gould (1972), but could also reflect other processes such as colonization of more distantly related species (Glaubrecht 2011), secondary contact and character displacement (Marko 2005), and taxon cycles (Ricklefs and Bermingham 2002). Studying extinction rates over evolutionary timescales is impossible without examination of the fossil record (Quental and Marshall 2010, Rabosky 2010, Losos 2011), and the potential for extinction to complicate histories inferred strictly from neontological data is potentially high; incomplete taxon sampling of living species alone is a problem in many neontological studies (Marko and Jackson 2001, Alroy 2002, Agapow *et al*. 2004, Isaac and Purvis 2004, Moran 2004, Laurin 2010). This call for more integration between neontological and paleontological perspectives is easier said than done: the taxa with the very best fossil records are often those that live in habitats that are hard to access in the Recent (sediments and deep water). Nevertheless, malacologists are uniquely poised to address biogeographic questions from a wide range of perspectives.

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