Paradoxes, Incipient Species, and Radiations: An Evolutionary Perspective on Fish Biodiversity

Understanding the drivers of biodiversity is a key focus in biology. However, biodiversity is multifaceted. Studies in biodiversity must focus on not only the species themselves, but also the ecological, genetic, and functional diversity that they possess. Thus, the drivers of biodiversity must be investigated across various scales in a comparative evolutionary framework. Here, I highlight three different studies that investigate various aspects of biodiversity using ecological and morphological data in a phylogenetic comparative framework. First, I test Liem's paradox—the phenomenon that species with specialized morphologies do not always act as ecological specialists. By combining a large morphological and diet dataset covering most of cichlid fish diversity, I discuss why this paradox may occur and why morphological specialization may not constrain trophic evolution. Then, using cichlids as a system, I examine how hybridization and the incipient nature of species impact taxonomy, phylogenetic comparative analyses, and the drivers of species diversity. I also explore how incorporating spatial non-independence into models can facilitate analyses of the drivers of biodiversity. Finally, I investigate, at a continental scale, the drivers of fish species diversity in the Neotropics, the most species-rich region for freshwater fish diversity. By combining a large dataset of trophic levels with a well-sampled phylogeny, I examine the timing and rates of both lineage and trophic ecological diversification across the Neotropics. I discuss how rates of lineage diversification and ecological diversification are not correlated. I also highlight how ecological specialization early in the evolutionary history of functionally important Neotropical fish clades resulted in a pattern of phylogenetic conservatism. My work highlights how investigating various aspects of biodiversity in an evolutionary comparative framework increases our understanding of the patterns and processes of diverse clades and biotic assemblages in fishes.