**Week 1: Spatial and Temporal Scale of Environmental Variation**

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| **13 Groups** | **84+ Participants** |

**Summary:** Groups discussed spatial and temporal variation between marine and terrestrial biomes based on papers by Steele et al. 2018 (*ICES Journal of Marine Science*) and Richardson et al. 2014 (*TREE*).

**Three main themes emerged from the discussions of the Steele paper:**

1. The thesis and evidence within the Steele et al. paper was oversimplified and over-generalized.
   * Temporal and spatial scale play a key role in differences among terrestrial and marine biomes as differences in variability between biomes likely become smaller at larger spatial and temporal scales.
   * Several marine ecosystems including coastal, intertidal, and estuarine systems were overlooked yet are likely as variable as many terrestrial systems.
   * Currents, gyres, tides, upwelling, offshore advection, pathogens, latitude, temperature, light attenuation, nutrient availability, salinity, pH, dissolved oxygen, season, and substrate stability were all listed as important sources of variation prevalent in marine systems.
   * There is more overlap between evolved differences between marine and terrestrial species (i.e., colonial vs. social systems, life longevity, reproductive mode) than was alluded to in the text. Broadcast spawning and planktonic larvae evolved in response to lower variability, as these life stages are also subject to strong environmental variability and stochasticity.
   * Evolutionary differences between land and sea species may be more likely to be due to differences in the physical and chemical properties of the two environments and the unique challenges posed by each rather than differences in variability.
2. Predictability of a system will have different impact on evolutionary dynamics.
   * Intertidal systems are highly variable systems, but a large component of the variation due to tides is predictable, which likely alters the set of adaptations necessary to persist. Only one group provided an empirical example of an organismal response correlated to environmental predictability which may mean that the impact of environmental stochasticity on adaptation is an area ripe for further research.
3. The organism itself (e.g., size, mobility, and number of stressors encountered) will strongly impact how environmental variability will affects evolution.
   * Ecological factors such as pathogens or predators further contextualizes environmental variability. Marine organisms may be exposed to pathogens more often since pathogens are suspended in the water column, and marine larval dispersal may have evolved to exploit lower predator abundance.

**Two main themes emerged from the discussions of the Richardson paper:**

1. Many discussions (9/11 posts) defined various requirements for adaptation applicable on a microgeographic scale and may be key to understand the potential for microgeographic adaptation.
   * Environmental variability across scales affects microgeographic adaptation. If dispersal kernels exceed the scale of environmental variability, greater environmental variation may be encountered thus increasing likelihoods of microgeographic adaptation. Variability across temporal or organizational levels, genetic variation, population size, mutation rate, sexual reproduction, and dispersal rates may also affect these likelihoods.
   * Dispersal and gene flow remain critical but may be more complicated than discussed in the paper. The influence of dispersal is likely affected if mortality is experienced within certain microhabitats (e.g., high mortality in intertidal systems or high post-settlement mortality). Potential dispersal is not the same as realized dispersal as certain taxa can exert some control over dispersal range.
   * In some scenarios, phenotypic plasticity may be a better strategy than microgeographic adaptation. For organisms with limited mobility, plasticity may be a better response to temporal variation, while microgeographic adaptation may be favored greater spatial variation is encountered.
2. Various factors obfuscate our ability to study or characterize microgeographic adaptation.
   * Data collection practices can be patchy, disjointed, or across coarse scales and therefore may not capture important environmental or evolutionary variability at relevant scales.
   * Researchers may not know the level that selection is acting, mistake microgeographic variation as phenotypic plasticity, or neglect maternal effects. Common garden approaches across multiple generations is a suggested solution for these issues.
   * Better efforts should be taken to define scale explicitly in evolutionary studies in terms of population, dispersal, symmetry, time, traits, and genomic basis.