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Benthic-pelagic coupling determining intertidal community structure in Atlantic Canada

Coastal intertidal habitats host a unique biodiversity owing to the daily alternation of high and low tides, which has resulted in the evolution of many species not found anywhere else. Thus, such habitats have often been targeted for conservation due to their biological value. In addition, intertidal habitats can be accessed on foot during low tides, exposing a wide variety of marine organisms to the general public. However, field studies have been largely restricted to coastal locations near institutions such as Dalhousie University (Halifax) or St. Francis Xavier University (Antigonish). Thus, there is a good understanding of intertidal ecology at local spatial scales, but knowledge at regional scales is very limited. Such knowledge has been accumulated for the US Pacific coast over the last 30 years (Menge & Menge 2013, Menge et al. 2015), but extrapolation to other coasts has limits. For instance, while the northeast Pacific coast is dominated by upwelling, the northwest Atlantic coast is dominated by downwelling. In theory, such differences should influence intertidal species distribution and abundance, but real-world data are largely lacking. In fact, Menge and Menge (2013) concluded their large review by explicitly calling for studies on coasts dominated by downwelling.

Upwelling is the upstreaming of colder and nutrient-loaded water from subjacent water layers to the surface. In general, it occurs on shores with dominant offshore winds, as found along the west coast of North America (Menge & Menge 2013, Menge et al. 2015). Typically, upwelling regions have a high planktonic productivity with positive effects on food chains. In contrast, downwelling is characterized by predominant onshore winds, which press surface water on the coast down to deeper layers. Commonly the water is warmer and nutrient-poor, so the productivity of these coasts is lower.

Benthic-pelagic coupling is the relationship between coastal water-column processes and intertidal processes. Benthic-pelagic coupling has been well studied for upwelling-dominated coasts, but knowledge for downwelling-dominated coasts remains limited (Menge & Menge 2013). Data collected during a pilot study along the Atlantic coast of Nova Scotia, Canada (a downwelling system) in 2014 indicated that intertidal invertebrate recruitment may be driven by changes in pelagic productivity (planktonic food supply to benthic filter-feeders) along the coast, with positive bottom-up effects on intertidal predators (Petzold & Scrosati 2014, Scrosati & Petzold 2015). This suggests that pelagic food supply on downwelling coasts could drive intertidal community dynamics, a regulation recently proposed to occur mostly only on upwelling coasts. To understand benthic-pelagic coupling in downwelling-dominated system, I will monitor pelagic food supply, air and seawater temperature, and intertidal species recruitment and abundance along the Atlantic coast of Nova Scotia, Canada. Univariate and multivariate data analyses will identify how food supply and temperature may influence intertidal species recruitment and how intertidal species may interact. Based on these results, I will perform manipulative field experiments to test how the intensity of interspecific interactions and their impact on intertidal community structure may change in relation to food supply and temperature changes along the coast.

Therefore, the main objective of my PhD research is to understand how benthic-pelagic coupling drives the distribution and abundance of intertidal species along the Atlantic coast of Nova Scotia. My findings will thus provide a detailed understanding on how benthic-pelagic coupling operates on downwelling-dominated coasts, contributing to develop the ecological theory on intertidal ecosystems.