Predator Nonconsumptive Effects on Biodiversity: The Interplay of Green Crab Chemical Cues and Habitat Complexity in Intertidal Mussel Bed Community Assembly

Dr. Julius A. Ellrich, Postdoctoral Fellow

Marine Ecology Lab, Saint Francis Xavier University
2320 Notre Dame Avenue, Antigonish, B2G 2W5, Nova Scotia, Canada

Predators control prey populations by consuming prey, but they also have nonconsumptive effects (NCEs) on prey. In aquatic systems, NCEs are often triggered by waterborne chemical cues released by predators, which prey can detect from a distance before encountering the predator. Immediate prey behavioural responses include moving away from the predator or decreasing feeding activity to minimize predation risk. As predator cues can affect many prey individuals simultaneously, NCEs can have larger consequences for prey populations than consumptive effects, as indicated by theoretical and empirical studies.

Most marine invertebrates have a complex life cycle that includes a benthic adult phase and the pelagic dispersal of larvae. Studies on invertebrate predator-prey systems have found that waterborne predator chemical cues can limit prey larval settlement, as many settling larvae move away when predator cues are detected to reduce future predation risk. Such behavioural responses to predator cues can limit prey recruitment, the appearance of new benthic individuals that have metamorphosed after larval settlement, an essential demographic process in the replenishment of invertebrate populations.

Based on the detailed knowledge of predator NCEs on prey behavioural responses, recent research gained insight into predator NCEs on prey demography and the assembly of communities. Information on factors modulating the impact of predator NCEs on prey demography is available, but such information is missing for community assembly. However, the identification of the factors that determine the impact of predator NCEs on community assembly is highly relevant, as the knowledge of these factors would enable to predict their influences on community assembly under different scenarios. For example, habitat complexity is a key factor structuring communities, as predator consumption rates of prey decrease with habitat complexity, thereby enhancing local biodiversity. Furthermore, complex habitats may not only shelter prey from predators, but also reduce the detection of predator cues by prey, thereby dampening predator NCEs on community assembly.

Intertidal mussel beds are ideal habitats to examine the impact of predator NCEs on community assembly in relation to habitat complexity. For instance, layered mussel beds, formed by individual mussels attaching to conspecifics with byssal threads, provide complex habitats to a manifold of species. Therefore, mussels are considered important ecosystem engineers, organisms that modify entire habitats through their presence or activity, thereby affecting local biodiversity. In mussel beds, omnivorous crabs are common predators. Chemical cues by such crabs induce avoidance behaviour in adult and larval prey, suggesting that these cues may limit community assembly in mussel beds by limiting the immigration of mobile prey species and the recruitment of prey. Finally, mussel bed complexity reduces water motion through the mussel bed. Thereby, mussel bed complexity may limit the transport of waterborne predator chemical cues in mussel beds, suggesting that prey in more complex mussel beds may be exposed to lower concentrations of predator cues. In fact, the decrease in predator cue concentration leads to weaker predator NCEs on prey. Therefore, mussel bed complexity may determine the impact of predator NCEs on community assembly by limiting the detection of waterborne predator cues in prey.

Thus, I will test the hypothesis that the impact of predator NCEs on community assembly decreases with mussel bed complexity. To test my hypothesis, I will conduct a manipulative field experiment in rocky intertidal habitats along the Atlantic coast of Nova Scotia (Canada) that uses predatory green crabs (*Carcinus maenas*) and blue mussels (*Mytilus edulis*, *M. trossulus*), common invertebrates along this coast, as a model system.