Nonconstant Positive Steady States and Pattern Formation of a Two Competing Species with Common Predator Model Incorporating Prey-Taxis

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Central questions in ecology seek explanation for distribution, abundance, and co-existence of species. It is well known that a competitive exclusion can occur between species competing for a resource where one species may drive another species to extinction. However, the presence of a predator can force the mediation of a coexistence state between the three species. Prey-taxis, the preferential movement of a predator towards areas of high prey density, is also well known to impact distribution of predator and prey species in predator-prey models. To what extent predator mediated coexistence is influenced by other predator mediated effects such as prey-taxis is less studied. Focusing on a 1D spatial domain, we show through linearized stability analysis of the positive equilibrium solution that prey-taxis can destabilize the homogeneous predator mediated coexistence state. We investigate the existence and stability of the nonconstant positive steady state by Crandall-Rabinowitz bifurcation theory. Through numerical simulation we show that the model captures the formation and evolution of various striking structures and interesting patterns when small perturbations to the homogeneous steady state are made.