**Project Proposal: Evolutionary trade-offs in a predator-prey relationship**

*Introduction and Background*

As globalization and anthropogenic climate change increase, previously stable ecosystems are being threatened by invasive species and temperature rise. While these changes are on too small of a time scale to allow species-wide evolution, individual organisms in local communities are able to undergo a rapid adaptation in order to cope with a changing environment (3). This phenotypic plasticity takes form in several ways. Arthropods acclimating to higher temperatures in order to resist desiccation is an example of responding to environmental change (2), while intertidal snails developing thicker shells in the presence of predatory crabs (7) and plants increasing their amount of defense glands (1) are defense strategies developed to resist predation.

While the latter form of phenotypic plasticity is effective in reducing the number of species consumed by predators, evidence suggests that it comes at the cost of growth and reproductive ability in plant organisms. For plants in areas with high levels of resource availability, growth rate and secondary metabolism – responsible for herbivore-resistant defenses – are inversely related; the more nutrients being dedicated to defense, the less available for growth (4). Additionally, a greater presence of herbivores inciting an increase in defensive structures and a reduction in floral volatile organic compounds causes reduced attraction of plants to pollinators, leading to delayed flowering, lower seed production, and ultimately less reproduction (5).

*Questions and Goals*

The knowledge that plants must sacrifice reproductive ability in order to develop greater predatory defenses does not inherently give rise to conclusions regarding the extent to which this trade-off effects persistence or the optimal amount of defense required to thrive in the presence of a predator. Therefore, with this study I plan to answer the question: Which strategies, in terms of the ratio of defensive ability to reproductive ability, yield the strongest population of a plant species in the presence of a predator?

*Methodological Approach*

This plant-herbivore relationship will be modeled using a spatially-explicit two species lattice model. Cells will be updated asynchronously according to rules derived from the defensive and reproductive abilities of the plant species; mainly, high defensive ability reduces the probability of the plant being colonized by the herbivore while low reproductive ability reduces the probability of the plant colonizing an empty cell. The defensive ability and reproductive ability of the plant species will be selected using one of several curves modeled after the theta logistic curve (6), and will remain continuous throughout each simulation because reproduction is assumed to be asexual. The size of the plant population will be measured after simulating the dynamics for several thousand time steps.

*Expectations and Implications*

The expected outcome of this study is a definite proportion of defensive ability to reproductive ability which causes the most successful plant species in a predatory relationship. This result will likely be one (or more) of three possible outcomes: low reproductive and high defensive ability, low defensive and high reproductive ability, or moderately low reproductive and defensive ability - a high reproductive and defensive ability is unlikely due to resource limitation (1).

Once quantified, this outcome will give insight as to which of the two traits are more important in plant persistence, and allow ecologists to adapt their strategies in conservation and invasive species mitigation accordingly. Further research could expand this study to involve competition between more than two species and account for non-plant organisms.

*Key References*

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