Project plan: Evolution and diversification of communities with complex life cycles.

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Keywords: Resource specialization, complex lifecycles, evolutionary diversification

Ecology seeks to understand how interactions between organisms and their environment determines their abundance and distribution. Many different models and theories have been created to formalize our understanding of ecology. The aim of these are to answer fundamental questions related to species interaction and community. The strength of some models can be determined by how accurately they reflect reality (Lindahl 2012), while others are trying to offer insights into a system, expanding our understanding of ecology. With my master thesis, I hope to help glean into the reality of certain community compositions to expand our understanding and insight of them. Most models concerning consumer-resource interaction assume that all indivduals of a given species are essentially identical (Miller & Rudolf 2011). But, ontogenetic niche shifts, the process of a species successively occupying distinct niches, is exceedingly common among multicellular organisms (Wilbur 1980). In some taxa, this is particularly obvious: for example, anurans and holometabolic insects undergo complete metamorphosis; but in other taxa it might be less obvious: for example, as many fish grow from small to large the composition of their food sources change. This change of niche within the life of an organism is potentially important for understanding community compositions (Wilbur 1980, Nakazawa 2015). Models incorporating ontogenetic niche shifts have recently been explored to a greater extent using mathematical modeling. Saltini *et al.* (2023) found that communities with species with complex life cycles could have increased diversity compared to the communities with simple life cycles. But this was true, only as long as immigrants or mutations were not restricted to minor trait shifts, otherwise community diversity was largely the same. This finding is surprising. It is therefore important to investigate to what extent it is general or whether it depends on the particular assumptions made by these authors. In my master's thesis, I wish to investigate the robustness of their finding by building and analyzing a mathematical model that maintains an ontogenetic niche shift but otherwise differs in as many aspects as possible from the one by Saltini *et al*. (2023) In particular, my model will be formulated in discrete time with non-overlapping generations (rather than in continuous time) and will allow for arbitrary resource distributions (rather than Gaussian resource distributions). Thus, my model applies to species living in seasonal environments. If this model reaches similar results as Saltini *et al.* (2023), it would strengthen the evidence that their conclusions are not dependent on the details of their model but truly are the consequence of an ecological niche shift. My thesis will thus contribute to our understanding of the role of complex life cycles for community assembly.

With this project, I hope to answer how complex life cycles affect community assembly through adaptive diversification and immigration. I hypothesize that, given certain conditions are fulfilled, species richness will be higher when compared to that of communities with simple life cycles only.

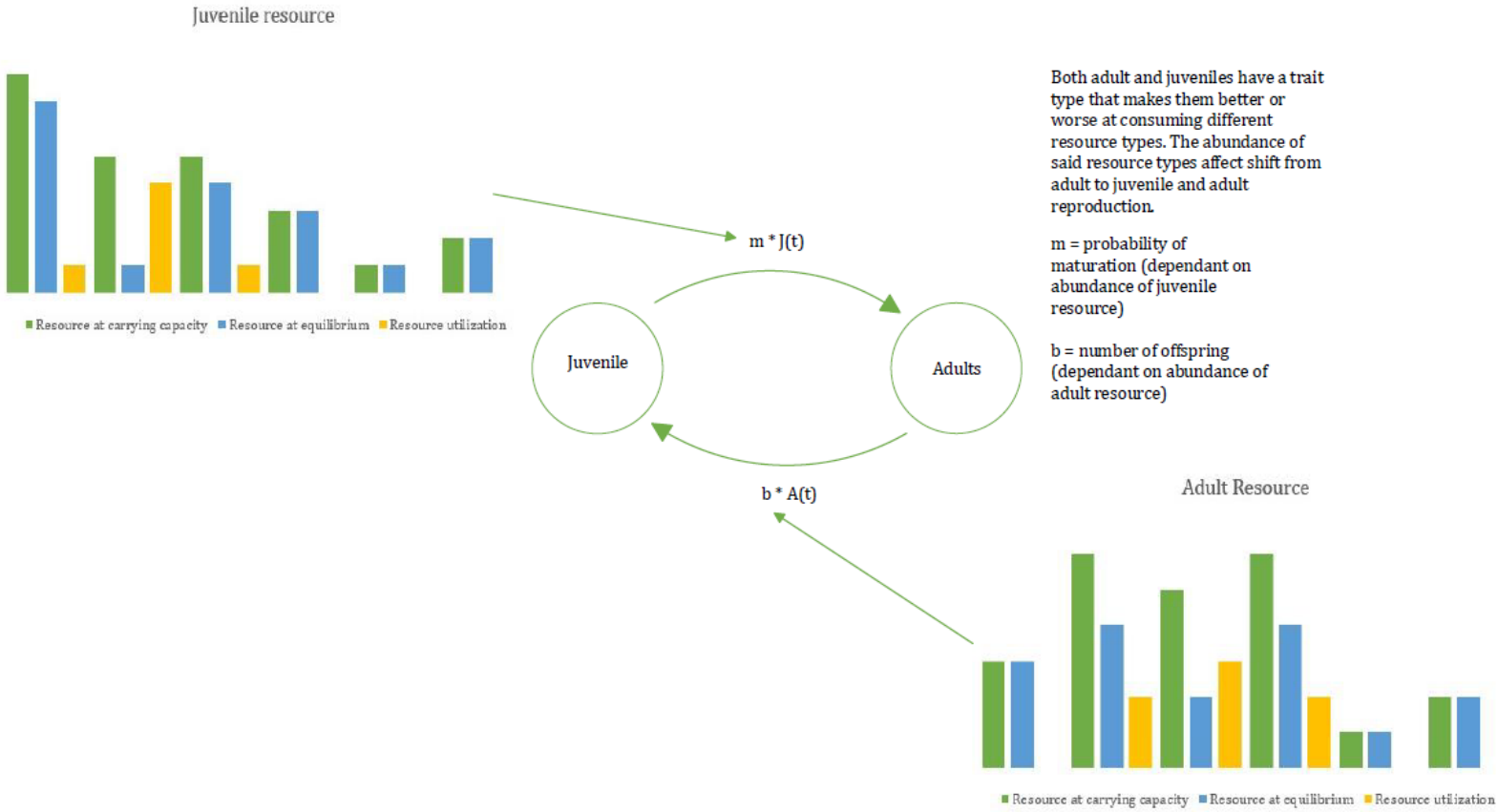

Figure 1: An illustration of the model I wish to create in my degree project.

Explanation of Model

We will model the dynamics of a population of individuals with a complex life cycle. Individuals start out as larvae, then mature into adults at which stage they reproduce. The probability of maturation of a juvenile individual depends on the amount of resources it consumes and thus on the abundance of the resources available to juveniles and the individuals' resource gathering traits as a juvenile. Similarly, the number of offspring produced by an adult individual depends on the amount of resources it consumes and thus on the abundance of resources available to adults and the individuals' resource gathering traits as an adult (figure 1). The resource gathering traits of juveniles and adults are assumed to be genetically determined and can thus change due to mutation and selection. I will investigate community assembly by following the fate of mutants with small

phenotypic effect and of immigrants with randomly chosen phenotypes. The model will be analyzed with individual-based computer simulations.

Preliminary plan

The first couple of weeks will be spent writing a research plan and reading relevant literature. After this is completed, I will continue to research the subject while learning more about the technical aspects required of me for this project, such as which coding language will be most appropriate. When that has been decided upon, I will start to create and test the model, while doing this I will continue to read on the subject to prepare for writing the final report and understanding any results the model might produce. After I feel that the model and subject is sufficiently researched, I will begin writing the final report, while still doing simulations and fine tuning the model.

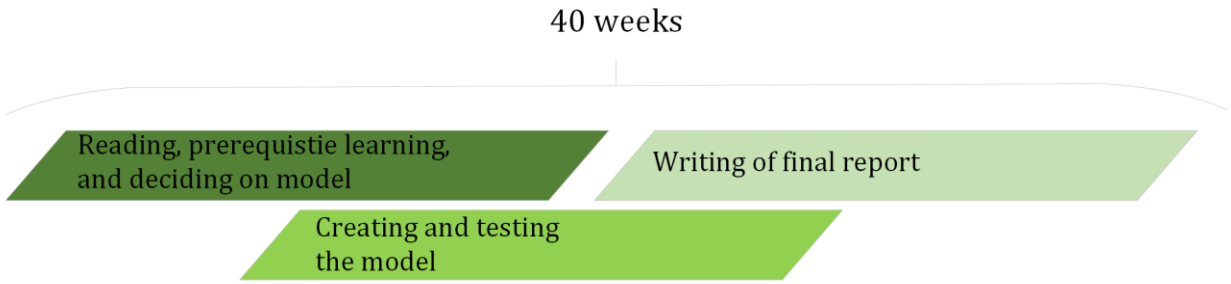

Figure 2: A rough outline of my schedule during the degree project.

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