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## Inside the Leaves of Pitcher Plants: Tools for Understanding Community Ecology and Species Invasions

Natural habitats typically encompass large areas and contain many species, making it difficult to determine how all of these species interact and how their interactions can change under different conditions. Because of this complexity, it is nearly impossible for ecologists to experimentally address fundamental questions about the dynamics and interactions of species within a habitat. The northern pitcher plant, *Sarracenia purpurea*, provides a unique opportunity to address these important questions. *S. purpurea* is a carnivorous plant and is dependent on obtaining nutrients from insects that fall into its pitcher rather than from the soil. Its leaves trap rainwater, creating a microscopic aquatic habitat that has the dynamics of larger systems, but on a much smaller spatial and shorter time scale. This microbial system is easily replicated in the laboratory and has rapid dynamics that allow questions to be addressed in a matter of days that would take weeks to years with other types of organisms. This system has proven to be a powerful model for ecological studies of the fundamentals of community dynamics for decades.

This dissertation work uses the pitcher plant system to address fundamental questions about species introductions, including how species with different characteristics affect invasion success into a new habitat. Due to the simplicity of the pitcher plant community, this research has also been able to examine the affect that species invasions have on all species dynamics in the community. Results to date indicate that a competitively superior species introduced into the middle level of a food web is the most likely to successfully invade and establish in the community, causing great changes in community dynamics. This result is counter to a commonly assumed tradeoff between competitive ability and needed resistance to consumers in middle trophic level species.

The pitcher plant system is dominated by bacteria, which are difficult to identify to species. To date, studies of the ecology of microbial systems have been limited to those bacterial species that can be grown in the laboratory (culturable on agar), which is less than 1% of the diversity within a community. The use of molecular biology techniques has revolutionized this field; microbial systems can now be studied by examining the genomes of all of the bacteria within these systems (metagenomics). This dissertation research has tested whether the results of prior work on this system (with culturable bacteria) are robust when all bacteria in the system are considered. To date, it has been found that each pitcher has its own unique bacterial assemblage, with very little overlap in bacterial species among leaves. It appears that the bacteria are likely a random subset of bacteria near the pitcher plant leaf, and specialized bacteria are not needed for the decomposition of the trapped insects and to release nutrients for the plant. The dynamics of the bacterial community are also being investigated. At the beginning of the season each pitcher plant community has one dominant and several common bacterial species, while the majority of the community is rare species. At the end of the season, within each pitcher dominance disappears and the community is composed of a high diversity of rare species and no overlap in species identity from plant to plant. Current dissertation research is now using metagenomics as a tool to identify how bacterial diversity is affected by the invasion success of the competitively dominant super species in previous experiments.