The Perplexing *Pyrola* Project
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Abstract:

My current research is examining the evolution and mycorrhizal ecology of myco-heterotrophic and mixotrophic plants. Myco-heterotrophs are a phylogenetically diverse group of non-photosynthetic plants that exploit ectomycorrhizal fungi by stealing carbon assimilated by unrelated plants via a common mycorrhizal network. Mixotrophs are plants that retain the ability to photosynthesize, but depend primarily on heterotrophic gain of carbon, and they are often interpreted as intermediate stages in the evolutionary progression toward obligatory myco-heterotrophy. I have begun to examine a pair of closely related *Pyrola* (Pyrolaceae) species to investigate the early stages of myco-heterotrophy. *P. picta* is a common photosynthetic member of the genus, while its sister species *P. aphylla* is non-photosynthetic and presumably myco-heterotrophic. I am using stable isotopes to examine the degree of myco-heterotrophy of each species and nucleotide sequence analysis to examine their mycorrhizal associations.

The goals of this project are: 1) Verify the presence of a common mycorrhizal network from which *Pyrola* species receive nutrition, 2) Quantify the carbon and nitrogen received from the mycorrhizal network by *Pyrola* species, 3) Test for the affect of light limitation on heterotrophic gain of carbon by *P. picta*, 4) Identify the mycorrhizal fungi associating with *Pyrola* species and, 5) Examine the ordering of host specificity and trait loss in myco-heterotrophic plants.

Thus far, the results of this work are as follows: the isotopic behavior of the non-photosynthetic species *P. aphylla* is that of an obligate myco-heterotroph. While the green *P. picta* shows potential mixotrophy based on extreme $^{15}$N enrichment compared to other photosynthetic understory plants from the same location. Based on nucleotide sequence analysis from clone libraries of *P. picta* roots, it does not appear to be a mycorrhizal specialist, associating with a phylogenetically broad range of ectomycorrhizal fungi. There is high potential for the formation of common mycorrhizal networks between *Pyrola* species and overstory trees as many of the ectomycorrhizal taxa found to associate with *Pyrola* are known to associate with overstory trees as well.

Future directions of this research includes: identification of the mycorrhizal associates of *P. aphylla*, and tests of this specie’s mycorrhizal specificity, further use of stable isotopes of N and C, both naturally abundant, and $^{13}$C labeling experiments, to test for the effects of light on heterotrophic carbon assimilation in *P. picta*. Recently Tom and I have begun to discuss a NMN (nuclear magnetic resonance) experiment using the obligate myco-heterotroph *Sarcodes sanguinea* and its mycorrhizal host *Rhizopogon ellenae* to examine nitrogen and carbon transport from mycorrhizal fungus to myco-heterotroph.