Project Summary: Biocomplexity

Biocomplexity: Common Mycorrhizal Networks… Active or Passive Channels? Interacting Roles of Mycorrhizal Fungi, Soil Resources and Plants in Carbon and Nutrient Transfers

This proposal describes research on biocomplexity in an oak woodland ecosystem. The goal is to discover how spatial and temporal distributions of soil resouirces (carbon and nutrients, principally) interact with mycorrhizal fungi and plant roots to form belowground common mycorrhizal networks or CMNs. The central hypothesis is: Although CMNs consist of plant roots and mycorrhizal fungal species, flows of carbon and nutrients in CMNs are not wholly determined either by plants or fungi. The magnitude and direction of flows are determined by interactions among plant species, mycorrhizal fungal species and soil resources—resources whose availability changes in complex ways in space and time. Changes in any one of the 3 components will result in altered CMN structure and function. We predict that changes in the 3 components will significantly alter fungal and plant species composition and soil resource distribution, resulting in long-term changes in plant community dynamics, soil stability, nutrient cycling rates, and ecosystem production.

This proposal uses an integrated and iterative research approach in a series of events bringing the researchers and students together. Theses events include annual field campaigns, workshops, exchanged of students between different universities, collection of data on a common web site, and synthesis meetings.

Proposed experiments focus on field and greenhouse studies where structure and function of CMNs is studied at a range of scales. Small, scale tools include light microscopy, scanning electron microscopy with elemental analyses, and nuclear magnetic resonance imaging of intact CMNs. Intermediate scale work uses a minirhizotron camera to obtain images of roots growing undisturbed in soils in the field. At larger scales, flows of carbon and nutrients through CMNs will be measured using stable isotopes of C and N in greenhouse chambers and field plots. The spatial and temporal extent of CMNs in field plots will be mapped using molecular methods to identify fungal and plant species in CMNs. This proposed work will expand our understanding of how fungal networks belowground access and distribute soil resources to plants, including mechanisms by which CMNs can alter plant competition and plant spatial distribution. Focus on effects of fungal species on CMN function will answer questions about functional redundancy of microbial species. Use of an workshops, field campaigns, synthesis meetings, and lab rotations will test this approach as a tool for studying biocomplexity. This project will train students to think broadly about complex systems and about the value of applying multiple skills and tools to a complex problem. The research will help us understand the dynamic interactions between oaks and grasses in oak woodlands in California, perhaps allowing us to more successfully preserve and restore these woodlands. By comparing biocomplexity above- and below-ground in a model system, the oak woodland/savannah, we expect to learn general principles about how above and below ground systems are linked.