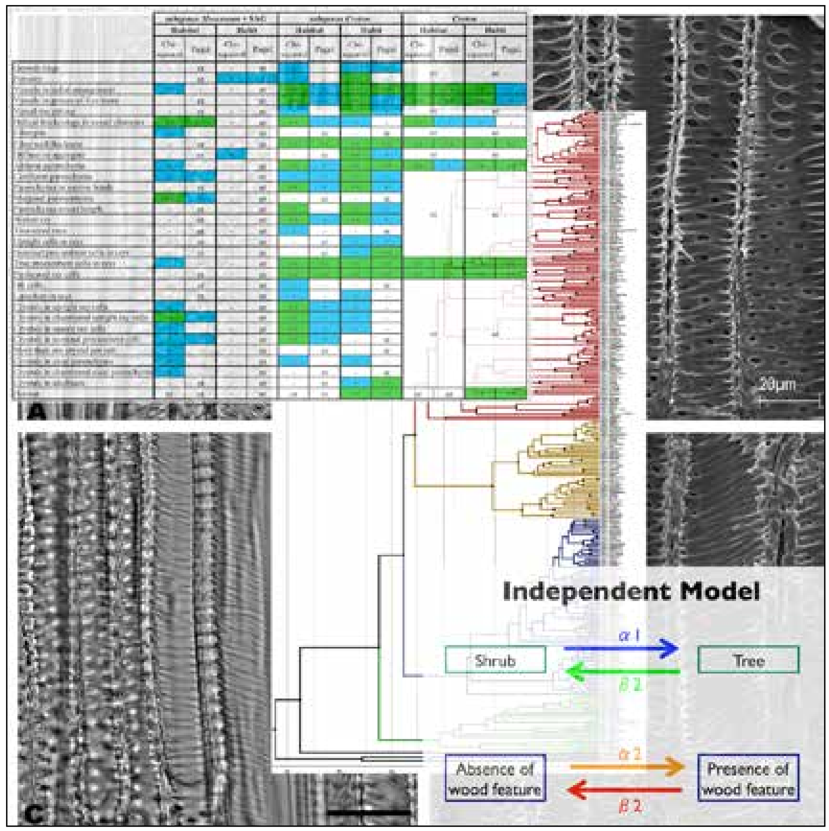
Research in Progress
Forest Products Laboratory

Evolution of Ecophysiological Wood Anatomical Diversity

A pine, a birch, and an oak can grow within meters of each other—in the same environmental conditions—and any or all of these three trees could be supporting a grape vine's growth. Each of these organisms represents a completely different wood anatomical solution to ecological and environmental conditions and all four are somewhat unrelated—evolutionarily divergent. This broad, long-term project seeks to understand how unrelated and anatomically different species can inhabit the same environments and how variation in growth form (tree, shrub, and liana) and wood structure influences the ability of woody species to survive in disparate environments. Understanding the fundamental drivers of wood evolution can influence forest management and plantation forestry for solid wood and fiber and improve our understanding of forest responses to disease, invasive species, and global climate change.



Combining the explicit hypothesis testing of modern phylogenetic comparative methods with traditional wood anatomy helps characterize patterns of evolution and test models of underlying wood evolutionary processes.

Background

To gain a robust and holistic understanding of the form and function of wood, variations in anatomical structure must be evaluated using the evolutionary history of woody plants in relation to environmental factors. Historically, wood anatomical studies have not simultaneously assessed these factors in a quantitatively rigorous fashion—they have most notably not accounted for the relatedness of species when attempting to identify broad trends in wood evolution and have not examined the effect of growth form on wood anatomical structure. Recent advances in phylogenetic comparative methods can incorporate available data, bridge historical gaps in comparative wood anatomy, and provide the basis for statistically robust concepts of wood evolution.

Objectives

Objectives of this project are to test existing hypotheses in wood evolution against large datasets, uncover new patterns and hypothesize new processes in wood evolution, and test the broad applicability of new hypotheses in a wide range of distinct datasets to establish statistically robust hypotheses and verify, amend, or replace existing anecdotal or untested concepts.

Approach

We will use existing datasets and collect new information on wood anatomical characters for vascular plant species representing major groups of woody plants. We will use the most up-to-date hypotheses about evolutionary history of land plants based on a molecular dataset of published sequences and implement modern phylogenetic comparative methods to analyze wood comparative data in an evolutionary framework.

Expected Outcomes

We expect to (1) obtain a framework to guide our interpretation of wood evolution as we build a functional understanding of wood diversity, (2) construct a new synthesis of wood evolution in accordance with statistically robust analysis of available data, and (3) use that synthesis as a foundation for a predictive model of wood response to environment. Woody biomass is a significant global carbon sink, so understanding variation in wood anatomy and its evolution is important for evaluating the consequences of how changing environmental conditions may drive wood anatomical variation and impact carbon fixation, wood utilization, and possibly even long-term species diversity.

Timeline

The project is ongoing.

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