Elucidating Mechanisms of Rust Pathogenesis for Engineering Resistance in Poplar

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Project Goals: The formidable challenge of engineering durable resistance in poplar against leaf rust is being addressed by investigation of the molecular basis for the virulence of *Melampsora larici-populina* towards *Populus* spp. Comparative genomics of small secreted proteins from other rust or fungal pathogens has provided an initial set of candidate secreted effector proteins (CSEPs) that is being screened for immune suppression in tobacco and poplar with the aim of revealing common mechanisms and host factors targeted by pathogens. Molecular interactions of poplar host factors and rust effectors probed by proteomics will provide targets for manipulation in transgenic poplar for use by the research community.

Abstract: An increasingly important goal in bioenergy research is to enhance the quality and availability of lignocellulosic feedstocks to match improvements in conversion processes to extend our diminishing supply of fossil fuels. *Populus* species present an attractive and sustainable target for enhancement via modern genetic engineering. Poplar trees grow rapidly and can produce significant biomass in short times when cultivated as short rotation woody crops. Additionally, because poplar has favorable cell wall characteristics, and also relatively high cellulose and low lignin levels, it can yield substantial energy. However, rust disease arising from *Melampsora* species is one of the most significant threats to poplar.

Our research aims to address the challenge of deciphering the interactions between *M. larici-populina* and poplar in an effort to engineer resistance in poplar through molecular intervention of pathogenesis. Our approach applies complementary molecular, genomic, biochemical and plant transformation approaches in order to understand the physiological disruption of the poplar defense and nutrient acquisition systems by rust fungus effectors, and to develop a set of transgenic poplar biotypes for broad use to more deeply probe the mechanisms of rust-poplar interactions and thereby develop disease resistance. The objectives are to use high-throughput screens in tobacco and poplar in order to identify key effectors of *Melampsora larici-populina*, as well as their poplar targets, and to construct an experimental system to

identify the most important genes involved in host defense against rust infection. This approach and new tools will enable us to test our overarching hypothesis that key rust effectors will either bypass the poplar immune system and/or suppress effector-triggered immunity through conserved mechanisms, and that an analysis of these interaction networks will provide for new approaches to develop rust-resistant poplar.

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