OAK RIDGE NATIONAL LABORATORY

PLANT SYSTEMS BIOLOGY

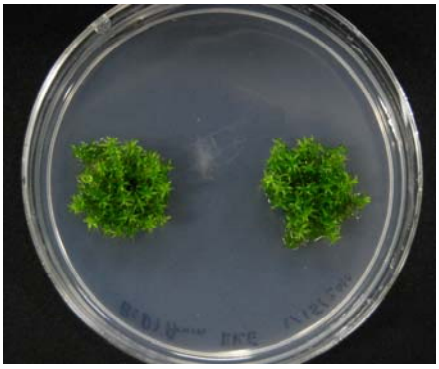
March, 2010

New scientists join the Plant Systems Biology Group: Dr. Jingui "Jay" Chen will join the group later in the year from the University of British Columbia, Vancouver, Canada. Jay brings mid-career scientific leadership and technical expertise in functional characterization of genes and gene families. Dr. Wellington Muchero from the University of California, Riverside will also join us later this summer bringing with him enthusiasm and a strong publication record in quantitative genetics, gene discovery, and association mapping.

Weston participates in Gordon Research Conference: David Weston participated in the Plant-Herbivore Interaction Gordon Research Conference held February 21 to 26 in Galveston, Texas. His invited talk was delivered within the "Interaction Models: From Ecology to Genes" section of the conference. David's presentation focused on gene co-expression networks and their use as (1) integrators of omics data, (2) as a way to scale across levels of biological organization, and (3) as a tool for species comparisons. His experience in gene co-expression networks began as an outgrowth of DOE-sponsored research and has continued through his LDRD project on developing a systems biology approach for linking genetic and environmental constraints to primary productivity in model and non-model plant species.

Bourland to visit ORNL: Anne Bourland from the Institute for Research on the Environment and Sustainability, Newcastle University, UK recently published an article entitled "Exploiting the potential of plants with crassulacean acid metabolism for bioenergy production on marginal lands". The article was featured in the 2009 April issue of the Journal of Experimental Botany. An invitation was extended and Anne has agreed to visit ORNL this summer and share with us her thoughts on next-generation biofuels.

Physcomitrella used as a model organism: Physcomitrella is a species of moss recently sequenced in 2008 by the Department of Energy's Joint Genome Institute. There is strong scientific interest in this species, for which there exists large numbers of EST sequences, whole genomic libraries in BAC vectors, multiple cDNA libraries, RNA interference lines, and a gene expression chip. David Weston is using Physcomitrella to conduct exploratory studies into the gene regulation when plants are experience an environmental stress. This organism will hopefully complement Arabidopsis in studying basic mechanisms of response as plants are subjected to a range of biotic and abiotic stressors.



Staff to present at Southern ASPB meetings in Knoxville: The Southern Section of the American Society of Plant Biologist (ASBP) will be held April 10 to 12 in Knoxville, Tennessee. Rhonda Egidy, Abhijit Karve, Sara Allen, and David Weston will participate. Rhonda will present a poster entitled "Characterization of the heat shock response across Arabidopsis ecotypes. This research was conducted a part of her year-long internship through the HERE program.

Kalluri and colleagues publish ultramicroscopy article: Udaya Kalluri working in collaboration with Thomas Thundat and others, use AFM and a single case of mode synthesizing atomic force microscopy (MSAFM) to characterize the ultrastructure of *Populus* cell walls. The results of this novel AFM imaging are important in understanding the molecular architecture of plant cell walls, which may shed light on the challenge of efficient cellulosic ethanol production. The article, senior-authored by Laurene Tetard is entitled "Spectroscopy and atomic force microscopy of biomass" and will be available within the month in the journal Ultramicroscopy.

Field collection trip to West Virginia: Nancy Engle, Joanne Childs, Lee Gunter, Sara Jawdy and Alex Meyers traveled to the West Virginia University to sample biomass from a pedigree of hybrid poplar trees established at that site three years ago. The trip was in late January, and involved an extensive collection of stem samples from over 760 individual trees. The samples will be processed for wood chemical analysis and then data analyzed using quantitative trait loci (QTL) approaches. The results will be used to identify candidate genes involved in wood chemistry. WVU faculty Steve DiFazio is a partner in this research.

Lasers are bright idea for chemical composition of soil: Madhavi Martin, laser spectroscopist in the group, published a recent article on the use of laser-induced breakdown spectroscopy (LIBS) to detect soil carbon. She had previously used this technique to characterize the chemical composition of wood and engineered wood products. The article entitled "Novel multivariate analysis for soil carbon measurements using laser-induced breakdown spectroscopy" was published in the January/February issue of the Soil Science Society of America Journal. Promotional materials were developed on this article and featured in a recent issue of CSA News (see attached). CSA News is a monthly newsletter from the Crop, Soil, and Agronomy tri-societies.

Weston agrees to serve on proposal review panel: David Weston was invited to serve as a reviewer in computational biology and bioformatics for the Department of Energy, Office of Biological and Environmental Research (BER) Genomic Science program. The panel will review proposals that are submitted in response to Funding Opportunity Announcement DE-FOA-0000143 Computational Biology and Bioinformatic Methods to Enable a Systems Biology Knowledgebase. This initiative is envisioned to be a cyber-infrastructure for systems biology information and data that not only includes data storage, retrieval and management, but also enables new knowledge acquisition and management, through free and open access to data, analysis tools, and information for the scientific research community. The review will take place in Washington, D.C. on April 27-28.

Staff attend JGI User Group: Several staff including Lee Gunter, Sara Jawdy, and XiaohanYang attended the JGI User Group meeting recently held in Walnut Creek, California. In addition to sitting in on user group discussions, all participated in a training workshop on Phytozome. Phytozome is a web-based resource developed by the Department of Energy's Joint Genome Institute and the Center for Integrative Genomics to facilitate comparative genomic studies among green plants.

Using Lasers to Measure Soil Carbon

Long-term storage of carbon (C) in soils is a potential strategy to mitigate rising CO_2 concentrations in the atmosphere. Management options for enhancing soil C in agroecosystems include reduced tillage, crop rotations, improved grazing strategies, and residue incorporation. Such practices could sequester large amounts of C during the next century. Quantifying changes in soil C due to land management has, however, proven problematic and will continue to be met with mixed success until methods are developed to measure and verify changes in soil C.

A team of scientists at Oak Ridge National Laboratory, the University of Tennessee, and Los Alamos National Laboratory has explored the use of laser-induced breakdown spectroscopy (LIBS) as a rapid and potentially field-deployable technique for measuring C in soils. While the technique has proven useful in earlier studies, an obstacle to widespread use of LIBS has been the lack of a consistent calibration for use across different soils. Scientists have now addressed this challenge and demonstrated that reliable measurements of soil C can be achieved using LIBS regardless of soil characteristics. Results from the study were published in the January–February issue of the *Soil Science Society of America Journal*.

A hammer-driven coring device is commonly used to sample soils. Extracted soil cores are contained within a plastic sleeve and transported to the laboratory for analysis.

The difficult and elusive goal of obtaining a single calibration model with LIBS was tackled by analyzing soils with different sand, silt, and clay compositions. With LIBS, a small portion of a sample is subjected to a high-energy laser. Light emitted from the resulting plasma provides an elemental fingerprint of the material. In the case of soil C, the novelty of the method resides in the use of multivariate analysis to determine the best experimental conditions to collect LIBS data on soils and to construct robust calibration models independently of the type of soils. In addition, the multivariate technique allows the whole spectral fingerprint to be used instead of just specific emission lines assigned to C.

Madhavi Martin, a laser spectroscopist who led the study, has applied LIBS to topics that range from criminal forensics to food-web dynamics.

"LIBS is a powerful technique, one that has many applications in the soil sciences," Martin says. "Based on the results of our current investigation, LIBS provides a robust method for soil C detection. Soil scientists, land managers, and instrument developers should find these results encouraging."

The potential of LIBS for analysis of soil C was first noted in 2001 by scientists at Los Alamos National laboratory and colleagues from the USDA. The difficulties of calibrating LIBS for quantitative analysis of soil C were identified and are related to microscopic and macroscopic heterogeneity in all soils. In applying LIBS to soil C analysis, Michael Ebinger, a co-author on the study, notes that "the analytical signal from C in soils is small and is masked by absorption of that signal by the ever-changing soil matrix." Martin says her team's research solves these issues.

Carbon concentrations were determined using laser-induced breakdown spectroscopy on replicated compressed disks of soil. Evidence of laser ablation can be seen as diagonal lines across the sample disks.

Scientists at Oak Ridge and Los Alamos National Laboratory, in partnership with the University of Tennessee, continue to explore the potential application of laser-based techniques in the environmental sciences. With methodologies like LIBS to assist them, soil scientists hope they can eventually identify the agricultural practices that provide maximum benefits to farmers and the climate alike.

Adapted from Martin, M.Z., N. Labbé, N. André, S.D. Wullschleger, R.D. Harris, and M.H. Ebinger. 2010. Novel multivariate analysis for soil carbon measurements using laser-induced breakdown spectroscopy. Soil Sci. Soc. Am. J. 74:87–93. View the full article online at http://soil.scijournals.org/content/vol74/issue1

Madhavi Martin uses laser-induced breakdown spectroscopy to measure carbon in compressed disks of soil.