Changes at CECG

Jenn Macalady, Department of Geosciences, is the new CECG Director as of July 1, 2011. Jay Regan, Department of Civil & Environmental Engineering, is the Assistant Director. Dr. Macalady, who served on the CECG Committee for several years, succeeds Anne Thompson, Department of Meteorology, who held the position from 2008-2011.

CECG also has a new name — the Center for Environmental geoChemistry and Genomics. Led by Dr. Macalady, CECG will build on the strengths and infrastructure of previous incarnations, including an energetic commitment to fundamental science relevant to the environment, while directing new efforts toward genome-enabled investigations of the earth system.

Since 1997, CECG has brought biologists, chemists, engineers and geoscientists together in joint initiatives. The new Center will bring together experts in both genomics and environmental geochemistry, leveraging Penn State’s historical strengths in both disciplines to create new interdisciplinary funding opportunities.

Breaking Down Plant Biomass to Make Fuel

Several years ago, on a drive back to State College from Washington, D.C., it dawned on Ming Tien how to insert proteins into the lignin polymer as it is being synthesized by the plant. By doing so, he thought the resultant mixed polymer would more easily degrade.

Using a mixed polymer is similar to the strategy used by manufacturers to change the composition of plastic bags to make them biodegradable.

This spring, Tien and John Carlson (School of Forest Resources) formed a company based on a method for modifying how lignin is synthesized in plants—the product of that initial musing.

“This is an invention that could make a big impact—extracting cellulose from plant material,” said Tien, professor of Biochemistry and Molecular Biology, of the method that was patented by the University. “These transgenic plants will be easier to process for biofuels.”

Tien began investigating lignin—what he calls “nature’s plastic” that gives plants their rigidity—when his Ph.D. adviser asked him to help another graduate student who was researching the renewable carbon source. At the time, it was a mystery how nature degraded lignin.

As a post doc, Tien identified a lignin-degrading enzyme—lignin peroxidase—in fungi that is fundamental to understanding how nature gets energy from wood. Since then, Tien has sought to understand how these enzymes work and also to discover other lignin-degrading enzymes.

One of these enzymes is found in the insect gut of the Asian longhorned beetle, an invasive pest found in China and Korea. On this project, Tien is collaborating with Kelli Hoover (Department of Entomology).

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The 14th Annual Environmental Chemistry Student Symposium (ECCS) was held at the Chemistry Building and the Life Sciences Bridge on April 8-9, 2011.

The symposium is organized by a graduate student committee with the help of a faculty mentor. This year the faculty mentor was Dr. Jose Fuentes. The Co-chairs were Carla Rosenfeld and Rachel Wagner and the committee members were Doug Call, Elizabeth Herndon, Claudia Rojas, Valerie Watson, Joseph Orlando, Nick Rose, Rupesh Ram, Elizabeth Bosak, Hengjing Yan, Amrita Bhattacharyya, Jennifer McElhoe, Tanushree Dutta, and Greg Garner.

Winners of this year’s Student Symposium are as follows:

2011 Photo Contest
1st Place - Jennifer McElhoe, Environmental Engineering
2nd & 3rd Place - Sunando Roy, Integrative Biosciences

Oral Sessions
Environmental Chemistry
1st Place - Kelli Golanoski, University of Maryland
2nd Place - Kelly Murphy, Chemistry

Environmental Sciences
1st Place - Claire Fleeger, Geosciences
2nd Place - Rebecca Eckert, Wildlife & Fisheries Science

Meteorology and Climate
1st Place - Yinfei Li, Plant Pathology
2nd Place - Shantanu Jathar, Carnegie Mellon University

Undergraduate
1st Place - Kevin Sanchez, Meteorology

Posters Sessions
Crop, Soil, and Geosciences
1st Place - Rupesh Kariyat, Plant Biology
2nd Place - David Jones, previous PSU student

Environmental Engineering and Ecology
1st Place - Justin George
2nd Place - Matthew Yates, Environmental Engineering

Meteorology and Chemistry - Tie for 1st Place
1st Place - Eric Poweleit, Chemistry
1st Place - Caroline Normile, Meteorology

Undergraduate Poster Session
1st Place - Nikolai Balashov, Meteorology/Music
2nd Place - Cara Nordberg, Agriculture

T-Shirt Design Contest
Daniel Mendenhall, Curriculum & Instruction

Keynote Speakers for ECCS

Dr. Patrick J. Megonigal, Deputy Director and Senior Scientist of the Smithsonian Environmental Research Center was the external Keynote Speaker on Friday, April 8, 2011.

Dr. Carmen Enid Martinez, Department of Environmental Soil Chemistry, Penn State University, was the internal Keynote Speaker on Saturday, April 9, 2011.

Dr. Megonigal’s talk title was, “Will Wetland Responses to Elevated CO₂ Amplify or Attenuate Climate Change?”


Yan Developing System to Improve Wastewater Treatment

For the past three years, Hengjing Yan has been experimenting with different ways to enhance the bacteria responsible for nitrification in microbial fuel cells.

While other researchers are using microbial fuel cells to implement nutrient removal in the wastewater treatment process, Yan has developed a system that not only removes nitrogen and organic matter from wastewater but also does not require aeration.

“Because it does not use the aeration process, it uses less energy and so is less expensive,” said the Ph.D.

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(Cont. from Page 2) **Yan Developing System to Improve...**

candidate in the Department of Civil and Environmental Engineering of her system that uses single-chamber air-cathode microbial fuel cells.

Yan’s system enhances nitrogen removal by enriching the bacteria with a diethylamine-functionalized polymer. That, in combination with precolonization of nitrifiers, results in a 98-percent maximum ammonium removal efficiency and a 100-percent maximum chemical oxygen demand (COD) removal.

Besides not needing aeration, Yan’s system produces electricity at a maximum power density of 945 mW/m² projected cathode electrode, which can be used to power further organic-matter removal. The improvement of power production would require significant scaling up of her system, a project for the future, Yan said.

“Combining energy recovery with wastewater treatment is a benefit to society and helps us live in a cleaner, greener way,” said Yan, who won first place in the Environmental Engineering and Biochemistry poster division at the 2010 CECG Student Symposium.

Yan’s next step is to apply her system to wastewater from the Penn State Wastewater Treatment Plant.

**Perennial Weed May Remove Cadmium from Contaminated Soils**

A weedy plant in the Mustard family commonly found in the American West may help to advance understanding of how plants interact with soils with high levels of cadmium.

Carla Rosenfeld, a doctoral student in Crop and Soil Sciences, is analyzing the root systems of three varieties of pennycress (Thlaspi) to see whether and how they clean up cadmium-contaminated soils. Her research is focused on how cadmium cycles in the presence of plants and the types of complexes cadmium forms with organic matter.

“Understanding cadmium cycling within natural systems will enable us to develop remediation plans that enhance ecosystem functions and services in severely contaminated areas,” Rosenfeld said.

**Yan Developing System to Improve...**

Yan with six continuous flowed microbial fuel cells that she designed for high efficient nitrogen removal.

**Yan Developing System to Improve...**

Carla Rosenfeld and colleagues are developing a system to remove cadmium from contaminated soils.

Common and alpine pennycress plants being grown in small rhizoboxes in the greenhouse prior to analysis at the synchrotron facility at Brookhaven National Lab.

While Rosenfeld’s study includes areas where high levels of cadmium occur naturally, she also has identified several areas where cadmium contamination is the result of anthropogenic activities. One of these is Palmerton borough in Carbon County (Pa.), home to two zinc-smelting plants that operated for more than 80 years.

In 1983, the U.S. Environmental Protection Agency designated Palmerton a superfund site because of high levels of hazardous metals found in soils. Those metals included cadmium, zinc and lead, all of which were emitted during the smelting process.

The result: Large areas around and in Palmerton looked like moonscapes as they were completely devoid of vegetation.

While high concentrations of cadmium—defined as 5-10 ppm or higher—interrupt photosynthesis in many plants, some plants can tolerate the metal, Rosenfeld said.

For her research, Rosenfeld is comparing plant-soil interactions among three types of pennycress, each of which responds differently to cadmium. Common pennycress is sensitive to high concentrations of cadmium while two ecotypes of alpine pennycress interact differently. One variety is tolerant but not able to take up large quantities of the metal and the other is able to accumulate large quantities of cadmium in its roots and leaves.

Rosenfeld is no stranger to research involving environmental contamination. After earning a Masters in Environmental Management (MEM) from Duke University, she worked for an environmental consulting firm in the San Francisco area on a remediation project involving a petroleum refinery.

“There’s a lot to learn about how plants take up nutrients and metals and the difference in what roots of sensitive plants do and what roots of more tolerant plants do,” Rosenfeld said.
2011 Research Initiation Grant (RIG)

The objective of Research Initiation Grants is to help fund new initiatives at Penn State in the areas of environmental chemistry and geochemistry. Submitted proposals for RIGs are encouraged to be innovative and groundbreaking in order to lead to outside funding. Interdisciplinary submissions are encouraged and proposals from individuals starting their research careers.

The recipients of the Research Initiation Grant competition for 2011 are: Jenn Macalady, Department of Geosciences, and Bill Burgos, Department of Environmental Engineering, with their submission of “Biogeochemistry of Coal-Associated Iron Mounds” and Ken Davis, Thomas Lauvaux, and Soumaya Belmecheri, Department of Meteorology, for “Preliminary Investigation of Trace Gas Emissions from Marcellus Shale Drilling.”

James Bristow, Special Speaker for 2011 Wine and Cheese Event

February 1, 2011, James Bristow, Deputy Director of Department of Energy, Joint Genome Institute, visited Penn State to give the Keynote talk at the annual CECG Wine and Cheese event. The inclement February weather nearly prevented Dr. Bristow from attending, but he persevered and arrived just in time to give his talk entitled, “High Throughput Genomics to Address Problems in Energy and Environment” in the Alumni Fireside Lounge at the Nittany Lion Inn.

2011 CECG Summer Fellow Recipients

Carrie Clippard, Department of Chemistry, Undergraduate student
Camille Stephen, Department of Biochemistry and Molecular Biology, Graduate student
Robbie Wolford, Department of Civil & Environmental Engineering, Graduate student

The CECG accepts fellowship applications for Penn State undergraduate or graduate students to pursue work on research topics related to environmental chemistry during summer sessions. This is a broad request where research areas ranging from the biological sciences to engineering to geochemistry are considered. We fund proposals with a 50% matching component. Students submitting winning proposals receive up to $1500 from CECG, to be paid via wage payroll with the host faculty member providing at least that amount from other sources. Students are selected on the basis of intellectual promise, academic record, and faculty recommendations.

(Cont. from Page 1) Breaking Down Plant Biomass to Make Fuel

While his research initially was key to the pulp and paper industry, the U.S. Department of Energy has also supported his research because of DOE’s interest in using enzymes to convert cellulose to the biofuel ethanol. Lignin is a barrier to accessing cellulose.

Tien is part of the University’s Center for Lignocellulose Structure and Formation, a DOE Energy Frontier Research Center, dedicated to advancing conversion of plant biomass into fuels.

“When we understand how nature makes cellulose, then we can tinker with it for our own energy needs,” Tien said.

The Center for Environmental geoChemistry and Genomics
Jenn Macalady, Director
2217 Earth-Engineering Science Building
University Park, PA 16802

Contributions made by Margaret Hopkins, Debra Lambert, Jenn Macalady, and Anne Thompson

This Publication is available in alternative media on request. Penn State is committed to affirmative action, equal opportunity, and the diversity of its workforce.

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