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A SOIL AND WATER SCIENCE DEPARTMENT PUBLICATION

Myakka

Microbial Ecology in Soil, Water and Environmental Sciences

contents

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Microbial Ecology Programs

From the Chair…

Microbial ecology is changing at an exceptionally rapid rate, particularly with the development of new methods and increased understanding of the importance of microorganisms to fundamental processes in soils and waters. Naturally occurring microorganisms are involved in virtually all processes in soil and water, ranging from pedogenesis and elemental cycling, to the detoxification of environmental pollutants. Human activities can impact many of these processes, and a clear understanding of the fundamental controls on microbial activities is required to predict the directions and magnitudes of these activities.

The Soil and Water Science Department (SWSD) has been very active in research and education on the role of microorganisms in regulating water quality including pathogens, remediation of contaminated sites, ecosystem restoration, sequestration of carbon, production of greenhouse gases, and plant productivity. These little giants play a major role in regulating various functions in the ecosystems (agriculture lands, forested lands, range lands, urban lands, and wetlands and aquatic systems) we study in our department. The microbial ecology programs of Ogram, Graham, and Teplitski are well integrated into all research thrust areas of the department.

Future directions in soil and water microbial ecology are difficult to predict given the speed at which the science is changing; however, the general trend is toward linking microbial activities across scales, and it is in this general area that a significant thrust of SWSD's future efforts are directed. Many, if not most, environmental processes that are observed at landscape and watershed scales are affected at the microscale: interactions among and between microorganisms and their immediate environment are responsible for many processes that regulate ecosystem functions. Detailed characterization of these processes at the scale of the bacterial cell and smaller, to the interface between the cell and its substrate (e.g. mineral, plant receptor, or environmental contaminant) is required to fully understand processes at higher scales. Soil and water microbiology is, by nature, interdisciplinary, and research across such broad scales will require collaboration between a variety of disciplines, including microbiologists, mineralogists, physicists, chemists, and scientists with the ability to synthesize and model these interactions across scales. The department is committed to strengthening soil and water microbiology programs to address current and future needs of our clientele, while advancing the science in this area. In this newsletter we highlight select programs related to microbial ecology in soil, water, and environmental sciences.

K R Reddy

Dr. K. Ramesh Reddy, Chair, Soil and Water Science Department,106 Newell Hall, Box 110510, University of Florida, Gainesville, Florida 32611. Telephone 352-392-1803, Fax 352-392-3399, Email: krr@ufl.edu

Research Activities in Soil Microbial Ecology Laboratory

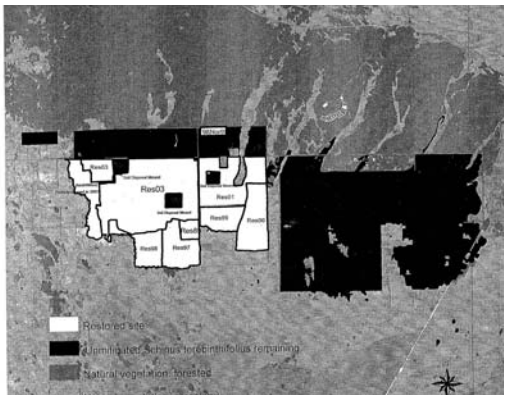
The Soil Microbial Ecology Laboratory (http://molecol.ifas.ufl.edu) led by Andy Ogram is engaged in a range of activities that include research, teaching, and a service component. We recently received funding to continue investigating linkages between microbial community structure and function in nutrient impacted regions of the Everglades, and, with collaborators in the UF College of Medicine, will use a highly innovative approach using functional microarrays to evaluate controls on methanogenesis and sulfate reduction.

An on-going project includes identification and optimization of microbial processes leading to degradation of the banned, but persistent, pesticide DDT and its daughter products DDE and DDT in organic soil from around Lake Apopka. Graduate student Hiral Gohil is currently enriching bacteria that are capable of utilizing DDT as a terminal electron acceptor, a process that appears to result in greatest loss of DDT and DDE in her studies. DDT is also highly hydrophobic, a property that greatly decreases its availability for microbial attack in organic soils. Hiral will soon begin investigating novel approaches to increasing the bioavailability of DDT for microbial attack.

Haryun Kim has been working with us to investigate nitrogen dynamics in an area of the Santa Fe watershed that is impacted by cattle and nursery operations. Haryun is using a combination of biochemical and molecular ecological approaches to define controls on different routes for nitrogen cycling at the site.

Abid Al-Agely runs the Soil Microbiology Core facility, and is active in research, teaching, and service activities. He conducts a practical short-course on his area of specialization, mycorrhizal fungi, every summer (http://conference.ifas.ufl.edu/soils/micro/index.html). In addition, he manages the service arm of the core facility, for which he conducts a range of biological assays for customers. These assays include mycorrhizal inoculum potential and mycorrhizal colonization assays, as well as production of inocula. For additional information on soil microbial ecology programs, contact Andy Ogram at aogram@ufl.edu.

Microbial Community in Wetlands



Phospholipid fatty acid analysis (PLFA) is based on the determination of "signature" lipid biomarkers from the cell membranes and walls of microorganisms. Phospholipids are an essential part of intact cell membranes, and information from the lipid analysis provides quantitative insight into three important attributes of microbial communities: viable biomass, community structure, and nutritional status. We in the Wetland Biogeochemistry Laboratory are currently using PLFA profiles to characterize microbial community composition in several wetland ecosystems. This technique was applied in the restored wetlands of the Hole-in-the-Donut (HID) region of the Everglades National Park, Florida. We found that 1) there was accretion of organic matter and general shift from N limitation in restored younger sites to P limitation in the older sites, 2) soil microbial community in restored sites were different from that in the native vegetation site, 3) seasonal variation (dry versus wet) in microbial community composition in younger restored sites was greater than relatively older sites. Communities in restored sites were characterized by higher relative abundance of fungal biomarkers and higher ratios of gram negative to gram positive compared to the undisturbed native vegetation site. The biomarker for actinomycetes was found to be significantly correlated with phosphorus concentrations in soils. There did not appear to be any association between fungal biomarkers and soil P. Our results indicate that extreme restoration processes may influence the ecosystem development processes by influencing the microbial community composition for a short term.
For additional information, contact Kanika Sharma at: kanika@ufl.edu

Do Natural Enemies Regulate Entomopathogenic Nematode Spatial Patterns?

Entomopathogenic nematodes (EPN) have been shown to be important natural enemies of *Diaprepes abbreviatus*, a major weevil pest of citrus in Florida and the Caribbean Basin. In regions where endemic EPN species diversity and predation of weevil larvae are high, the insect is a minor pest; whereas, the weevil can cause growers to abandon citriculture in regions with fewer species and little predation by EPN. Accordingly, we are studying biotic and abiotic factors that regulate spatial patterns of EPN across the Florida citrus industry. Nematophagous fungi (NF) have been shown to respond in a density dependent manner to EPN when they emerge in high numbers from insect cadavers and when EPN are added to soil as an augmentation biocontrol tactic. Predation rates by NF also vary depending on the species combinations of NF and EPN, suggesting the possibility that some EPN species may have a competitive advantage in habitats that favor particular NF. Among the EPN endemic in Florida citrus groves, the numbers of *Steinernema diaprepesi* and *S. glaseri* were unaffected by three species of *Arthrobotrys* (trapping fungi) in soil bioassays, whereas numbers of *Heterorhabditis indica, H. zealandica* and *S. riobrave* were reduced significantly. In contrast, two endoparasitic fungi (*Catenaria* sp. and *Myzocytium* sp.) whose zoospores require free water to locate and infect nematodes, had no effect on numbers of *H. indica*, but preyed heavily on the other four EPN species. *H. indica* is frequently the dominant species detected in parts of Florida with poorly drained soils and high water tables. Ongoing research is characterizing the spatial patterns of NF in Florida to better understand their habitat requirements and their potential to affect EPN communities. For additional information, contact Jim Graham at: jhgrahm@ufl.edu.

Welcome… Incoming Students Summer and Fall 2008

Subodh Acharya, PhD (Rao Mylavarapu)
Elena Azuaje, MS (Nick Comerford)
Pamela Brown, MS (Alan Wright)
Maninder Chahal, MS (Gurpal Toor)
Hao Chen, PhD (Lena Ma)
Aldo Fritz, PhD (Amy Shober)
Sean Fromang, MS (Chris Wilson)
Lisa Gardner, PhD (Ramesh Reddy)
Ashok Garg, PhD (Rao Mylavarapu)
Piyasa Ghosh, PhD (Lena Ma)
Luke Gommerman, MS (Rex Ellis)
Hollie Hall, PhD (Jim Jawitz)
Amy Hylkema, MS (Amy Shober)
Matthew Jablonski, MS (Gurpal Toor)
Michael Jerauld, MS (Jim Jawitz)
Dakshina Kadiyala, PhD (Yuncong Li/Rao Mylavarapu)
Davie Kadyampakeni, PhD (Kelly Morgan/Peter Nkedi-Kizza)
Kamaljit Kamaljit, PhD (Gurpal Toor)
Jongsung Kim, PhD (Sabine Grunwald)
Jason Lessl, PhD (Lena Ma)
Cassandra Medvedeff, PhD (Patrick Inglett)
Lucy Ngatia, PhD (Ramesh Reddy/ Ben Turner)
Travis Roberts, MS (Carl Fitz)
John Rowland, PhD (John Cisar)
Kiara Winans, PhD (Ramesh Reddy)
Dana Woolley, MS (Patrick Inglett)
Richard Yudin, PhD (Yuncong Li)
Tan Xu, MS (Alan Wright)

Who Listens when Microbes Talk?

What started as a project on understanding the intricacies of bacterial cell-to-cell communications in a symbiosis between a model legume *Medicago truncatula* and its bacterial partner, *Sinorhizobium meliloti,* has led to some exciting new discoveries that could potentially lead to developing biological control for coral diseases and improving safety of minimally processed foods, like oysters and vegetables.

In the Microbial Community Ecology Laboratory, Mengsheng Gao has identified two novel bacterial genes that may function in detecting bacterial quorum sensing signals. She has also discovered what looks like a regulatory RNA, a molecular "switch" that may help further time the onset of "quorum." Bacteria rely on quorum sensing to detect whether the number of individuals within a population reached a certain threshold at which enough bacteria are present for a coordinated attack on a plant or animal host. By learning to manipulate bacterial quorum sensing, it may very well be possible to develop novel pharmaceuticals that do not kill the pathogen, but rather specifically interfere with the ability of a pathogen to cause a disease. It should also be possible to "trick" the bacteria into aggregating into multicellular clumps, so that these clumps could then be removed by catching them in microscopic traps.

Studies of cell-to-cell communication in host-associated microbial communities have led to several exciting collaborations. Clayton Cox (above), who joined the Teplitski group recently, was awarded a prestigious NSF Graduate Student Fellowship to learn about the role of cell-to-cell signaling in the interactions between native oyster-associated microbes and the invading human pathogens. In collaboration with Dr. A.C. Wright (Department of Food Science and Human Nutrition), Clay also plans to find how to use this knowledge to improve microbiological safety of raw shellfish.

Cory Krediet and Stephanie Halbig in collaboration with Dr. Kim Ritchie (Mote Marine Laboratory) are learning whether it will be possible to develop biological control formulations for treating coral diseases. Cory (right) is an Alumni Fellow and a Ph.D. candidate in Interdisciplinary Ecology; his NSF Fellowship application was awarded an Honorary Mention.

For additional information, contact Max Teplitski at: maxtep@ufl.edu

Soil and Water Science Distinguished Seminar

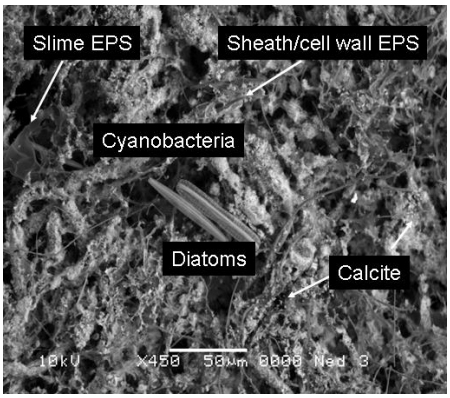
Dr. Don Sparks, S. Hallock du Pont Chair of Soil Chemistry and Department Chairman University of Delaware, presented the key note lecture on **"Shining Light on Biogeochemical Processes in the Earth's Critical Zone** at the 9th Annual SWS Research Forum, September 12, 2008.

Dr. Sparks is internationally recognized for his research contributions in the areas of: kinetics of soils chemical processes, surface chemistry of soils and soil components using in-situ spectroscopic and microscopic techniques. Dr. Sparks Environmental Soil Chemistry Laboratory focuses on how toxic metals such as arsenic, nickel, and zinc and plant nutrients such as phosphorus and sulfur are bound (sorbed) on soils. His research uses bright light sources generated at syncrotron facilities (associated with National Laboratories) to determine the forms (species) of the metals and nutrients in the soil at the molecular scale. This information is necessary to make accurate predictions about how easily the contaminant will leach into the water supplies, and determine its toxicity and bioavailability to plants, animals, and humans. His research also conducts speciation research on metal contaminated soils and on plants that accumulate large quantities of metals (hyper-accumulators). The results of these studies are useful in developing effective strategies for soil remediation. Additional details of his research and teaching programs can be found at: http://ag.udel.edu/plsc/faculty/sparks.htm

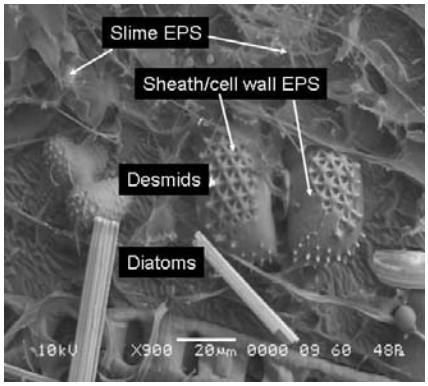
Biofilm Communities: The Everglades Periphyton

Within open water slough environments of the Florida Everglades, periphyton represents the main source of primary production. These "biofilm communities" are complex structures composed primarily of cyanobacteria and algae, but also contain significant bacterial biomass. Current research is identifying and quantifying molecules and macromolecules that will influence the myriad of roles of the biofilms – from their potential palatability at the base of the food web to their functionality within the wetland environment. This project is conducted in collaboration with the South Florida Water Management District (Scot Hagerthey and Sue Newman).

In the high mineral, low P areas of the Everglades, cyanobacterial dominated periphyton mats dominate. The mats from WCA-2a have been found to contain four different cyanotoxins, ranging from neurotoxins to skin irritants, potentially further deterring would be grazers. In addition to having a high C:P ratio and toxins present, these mats also precipitate large amounts of calcium carbonate, resulting in encrustation of the mats. Deposition of calcite is on the extracellular sheaths and polymers (EPS) secreted by the cyanobacteria. Biochemical analyses of the polysaccharides that make up these polymers indicate a glucose, xylose, and fucose rich polymer. Conversely, in low mineral, low P areas of the Everglades (WCA-1), desmid dominated periphyton mats dominate and do not precipitate calcium carbonate. The EPS secreted is reflective of the desmids, and polymers contain significant proportions of glucose, galactose, and mannose, in addition to arabinose, xylose and fucose.



Epipelon collected from the interior of WCA-2a. Diatoms and some filamentous algae evident, majority of the cyanobacteria and EPS material is calcified.



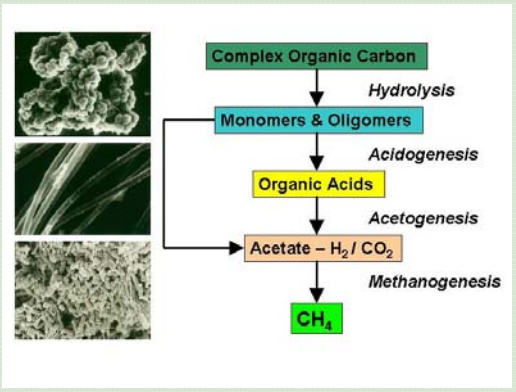
Periphyton collected from the interior of WCA-1. Diatoms and desmids visible within EPS matrix.

Increased mineral content of the water along with the biochemical structure of the EPS within the biofilms from WCA-2a results in an overall increase in cohesive strength, making these mats capable of stabilizing sediments, an important role regulating sediment transport.

This research helps to understand ecosystem function of the abundant periphyton mats within the Florida Everglades. This research will not only be used in the broader context of comparison of functionality with other wetland ecosystems, but also when making management decisions to determine how habitat manipulations will affect the base of the food web. For additional information contact Brent Bellinger at: bbelling@sfwmd.gov

Microbial Conversion for Bioenergy and Waste Treatment

The *Bioenergy and Sustainable Technology Laboratory* conducts basic and applied research on environmental biotechnology, with particular emphasis on anaerobic microbiology and the practical application of anaerobic digestion technology for waste management/treatment and renewable energy production from biomass and organic residues. Our optimization of robust biodigester ecosystems is rooted in the modular arrangement of metabolic functions that microbial guilds perform in nature.



Microbiology of Anaerobic Digestion

Anaerobic digestion is a process by which a complex mixture of symbiotic microorganisms transforms organic materials under oxygen-free conditions into biogas, a mixture of mostly methane and carbon dioxide. Anaerobic digestion occurs naturally in anaerobic environments, such as landfills, sediments, saturated soils and animal intestinal tracts. In practice, anaerobic digestion is the engineered methanogenic decomposition of organic matter carried out in reactor vessels, called digesters. As much as 90% of the biodegradable organic fraction of a waste can be stabilized in anaerobic treatment by conversion to methane gas. Since the process uses a mixed microbial culture, no sterilization step is required and the diversity of microbial species confers fermentation stability and substrate independence. Under controlled conditions, anaerobic digestion offers a holistic treatment solution that stabilizes wastes, controls odors, reduces pathogens, minimizes environmental impact from waste emissions, and maximizes resource recovery while simultaneously being a net energy producer. The co-products of anaerobic digestion – nutrients and fiber – reduce the need for synthetic fertilizers and soil conditioners that are produced using less sustainable methods, providing cost savings and environmental benefits. Nutrients contained in the organic matter are conserved and mineralized to more soluble and biologically available forms, providing a more predictable biofertilizer.

For further information, visit Biogas – A Renewable Biofuel or contact Ann Wilkie at acwilkie@ufl.edu.

Southern Regional Cooperative Soil Survey Conference

Innovative Technologies for the New Soil Survey

July 14-17, 2008, Gainesville, FL (http://conference.ifas.ufl.edu/SSC/)

This conference was hosted by UF-SWSD (chair: S. Grunwald) and Natural Resources Conservation Service (NRCS) (co-chair: D. Peterson) aiming to bring together representatives of the National Cooperative Soil Survey in the southern states for discussion of technical, scientific, and general questions and issues. Topics ranged from digital methods and technologies such as GIS, geospatial analysis, remote sensing LIDAR, soil spectroscopy, soil sampling designs, web applications and database management. A status report of the current national soil survey program was presented by Micheal Golden, Director Soil Survey, NRCS Washington D.C. A field trip that focused on Florida soils and a demonstration of digital soil mapping techniques complemented the conference.

Faculty, Staff, and Students

Ann Wilkie has been named winner of the third annual Florida Energy Achievement Award. The award, presented by the Florida Solar Energy Center (FSEC), recognizes a company, organization, or individual that has made a significant achievement in the efficient utilization of energy, energy conservation, energy education, or renewable energy in the state of Florida.

Nick Comerford was elected as the 2009 President of Soil Science Society of America. Nick has accepted the Center Director's position at the North Florida Research and Education Center, Quincy, Florida.

Yuncong Li was awarded the Wachovia Extension Professional Award for his outstanding contributions in extension and outreach.

Tom Obreza was awarded the Dallas Townsend Extension Professional Enhancement Award for his outstanding contributions in extension and outreach.

Gurpal Toor was appointed an Associate Editor of the Journal of Environmental Quality.

Jehangir Bhadha (Advisor, Jim Jawitz) was awarded the 2008 College of Agriculture and Life Sciences Outstanding International Student Award.

Debolina Chakraborty (Advisor, Vimala Nair) was awarded third place in the 2008 Minority Student Poster Contest at the ASA/CSSA/SSSA International Annual Meetings held Oct. 5-9 at Houston, TX.

Ryan Graunke, an undergraduate research student with Ann Wilkie and recent graduate of SNRE/University of Florida, has won the Association for the Advancement of Sustainability in Higher Education's 2008 "Student Research on Campus" Sustainability Award for his paper: "Food and Fuel: Biogas Potential at Broward Dining Hall."

Jaya Das (Advisors, Samira Daroub and George O'Connor) was awarded first place in the S-10 division poster competition at the 2008 Soil Science Society of America annual meeting in Houston, Texas.

We are pleased to announce the arrival of twins, Julia and Melissa on June 22, 2008, and to congratulate their proud parents **Maria Silveira** (SWSD) and **Joao Vendramini** (Agronomy), Range Cattle REC, Ona.

Congratulations to PhD student **Andrea Albertin** and her husband on the birth of their son Matthias on October 3rd, 2008. He is a delightful, happy, and healthy baby.

We would like to also congratulate PhD student **Qin Lu** and her husband on the birth of their son Michael Zhang On December 2, 2008. Both mother and baby are doing well.

Congratulations to the following students and staff for their outstanding accomplishments:

Frederick B. Smith Scholarship: **Jared Sweat**

Soil and Water Science Department Outstanding Undergraduate Award: **Julie Ruh**

William K. "Bill" Robertson Fellowship 2008–2009: **Debolina Chakraborty**, (Advisor Vimala Nair) *and* **Shiny Mathews**, (Advisor Lena Ma)

Victor W. Carlisle Fellowship 2008-2009: **Victoria Gardner**, (Advisor Mary Collins)

Sam Polston Memorial Fellowship 2008-2009: **Alex Cheesman**, (Advisors, Ramesh Reddy and Ben Turner)

Bill Reve Superior Accomplishment Award: **Brandon Hoover**

Congratulations!

Summer 2008 Graduates

Master of Science

Subodh Acharya (Mylavarapu)
Matthew Miller (O'Connor)
John Rowland (Snyder)
David Mahnken (Wilson)
Richard Yudin (Li)

Fall 2008 Graduates

Bachelor of Science

Audrey Rotrock

Master of Science

Lori Clark (Toor)
Bernard Fungo (Grunwald)
Stephen McCullers (Clark)
Jessica McKay (Grunwald)
Joseph Sewards (Clark)
Rotem Shahar (Obreza)
William Vogel (Osborne)

Myakka

(pronounced 'my-yak-ah' – Seminole word for "big waters") gives a special identity to our department, as it is also the name of Florida's State Soil, Myakka fine sand. The State of Florida has the largest total acreage of Myakka fine sand (sandy, siliceous, hyperthermic Aeric Alaquod) on flatwood landscapes.

In Memoriam

William H. Reve

William H. Reve, Senior Laboratory Technician, Soil and Water Science Department at the University of Florida, died in Gainesville, Florida on November 15, 2008. He was born on September 2, 1954. He is survived by his wife of 30 years, Kathy Reve and 17 year old son, Jeff Reve. Bill worked as Senior Laboratory Technician for 30 years in the department. Bill worked with Dr. Dean Rhue in managing the Soil Chemistry Core Laboratory. Over the years, Bill helped many graduate students in chemical analysis of their research samples. He was one of the most dedicated staff members of the department. He will be missed by faculty, staff, and students. To recognize Bill's service to the department, the SWSD Superior Accomplishment Award will named as **Bill Reve Superior Accomplishment Award**. Each year this award is given to one staff member for their outstanding service to the department. Bill was one of the past recipients of this award.

9th Annual Soil and Water Science Research Forum

The 9th Annual Soil and Water Science Research Forum **http://soils.ifas.ufl.edu/forum/**) was conducted on **September 12, 2008**, in Gainesville, Florida. This year, **Dr. Don Sparks,** S. Hallock du Pont Chair and Chairperson, Department of Plant and Soil Science, University of Delaware was the featured keynote speaker at the forum. We thank all our sponsors (**Florida Association of Environmental Soil Scientists, Hydromentia, Inc., DB Environmental Labs, Inc**) for their generous support of this year's forum. The forum showcased research programs for several junior faculty members including: Carl Fitz (Ecological Modeling, Ft. Lauderdale REC); Patrick Inglett (Biogeochemistry, Gainesville); Kelly Morgan (Nutrient Management and Modeling, Southwest Florida REC); Max Teplitski (Microbial Ecology, Gainesville); Gurpal Toor (Urban Landscapes and Organic Contaminants, Gulf Coast REC); and Alan Wright (Nutrient Management and Biogeochemistry, Everglades REC).
Congratulations to the following winners of the 2008 Annual Forum $500 research award.
Oral Presentation: **Melissa Martin**. Poster Presentations: **Sylvia Lang**, **Jason Neumann**, **Alex Cheesman**, and **Haryun Kim**.

Please plan to attend the 10th Annual Soil & Water Science Research Forum September 11, 2009.

From our former students …

Brian Murphy—
In 2001, I graduated from the Soil and Water Science department under the Environmental Management in Agriculture Interdisciplinary Studies program with Dr. Graetz as my advisor. As an undergrad, I was fortunate to have worked as an OPS lab technician for Dr. Ma and her post-doc, Dr. Tait Chirenje. Tait exposed me to the wonderful world of GIS while assisting him on an urban arsenic soils study. Since then I have immersed myself in the geospatial industry both at a academic level and through my work with 3001 International, Inc.

I continue to reside in my hometown of Gainesville with my beautiful wife (and my dentist) Sara. For the past five years, I have been working at 3001 International, Inc., now a wholly owned subsidiary of Northrop Grumman. As an Area Director I am a part of their Business Development division where I report directly to the Senior VP. I travel frequently across the U.S. to help uncover business opportunities with a variety of federal, state, and local governmental agencies. One of our most recent "wins" of local interest was being selected by the St. John's River Water Management District to provide them with 2009 updates to their digital orthophotography library, operating with a budget of nearly $1.4 million.

I love my job, the people I get to meet and work with, and having the ability to work with imagery, LiDAR, maps, GIS and photogrammetric products; I owe it all to having had such a great academic exposure through the Soil and Water Science Department. Brian can be reached via email at bemurf@gmail.com