

2008 Science Division Undergraduate Research Poster Conference - Earlham College



Sponsored by the Earlham Ford-Knight Endowed Fund

Tuesday, October 21st
Noyes Hall 7:00 – 9:00 PM

Welcome!

On behalf of the Science Division at Earlham College, we are very pleased to welcome you to the Sixth Annual Earlham Undergraduate Research Conference. Thank you for your participation and for your help in making this a successful event!

In 2003, a group of Earlham scientists received a 3-year grant from the Merck/AAAS foundation to support collaborative student/faculty research and to create a forum to enable faculty and undergraduate students from all of the Sciences to present their results to the Earlham Community. This forum has become an annual Poster Session held in the fall and is open to all students from the college who completed a research experience either on campus or at another institution.

We hope you enjoy the poster session.

Corinne Deibel,
Associate Professor of Chemistry
Earlham College

Special Thanks

Teresa Shipley
Mary Bogue
Greg Mahler
Alice Shrock

Poster	Title*	Discipline
1	Trace Metal Investigation Of Surface Water, Sediment And Biological Samples From A Local Watershed	Chemistry
2	Development Of A Metal Speciation/Toxicology Laboratory Experiment	Chemistry
3	Effect Of Nutrient Addition On Methane Oxidation Rates In Florida Landfill Cover Soils	Chemistry
4	Synthesis Of Tungsten Oxo/Imido With N-Heterocyclic Carbene Ligands	Chemistry
5	Use Of Density Functional Theory To Suggest Molecular Geometry And Degree Of Back-Donation In Transition Metal Complexes	Chemistry
6	Separation And Quantitative Measurement Of Vitamin E Components On C-18 TLC-UV Plates	Chemistry
7	Progress Toward The Total Synthesis Of Avenic Acid And Related Analogs	Chemistry
8	From Arson To Duct Tape: Developing Forensic Applications For The Undergraduate Analytical Chemistry Laboratory	Chemistry
9	The Expression of Metallothionein I in Indiana Game Fish Exposed to Copper	Chemistry
10	Investigation Into the Relationship Between Membrane Phospholipid Composition and Cell Division in E-Coli	Biology/Chemistry
11	Identification Of A Putative Camp-Binding Protein Involved In Regulation Of Nitrate Assimilation In <i>Caulobacter Crescentus</i>	Biology/Chemistry
12	Effect Of 2,3,7,8-Tetrachlorodibenzo-P-Dioxin On Cultured Mouse And Human Podocytes	Biology/Chemistry
13	Using Genetic Analysis To Investigate Drug Resistance In Malaria Parasites	Biology/Chemistry
14	Refining The Annotation Of Malaria Genomes	Biology
15	The Effects Of Isolation And Plant Population Size On Host-Specialist Interactions And Plant Fitness In Two Species Of <i>Physalis</i> (Solanaceae)	Biology
16	<i>Leptinotarsa Junta</i> Larval Feeding Preference Following Interspecific And Intraspecific Attacks On <i>Solanum Carolinense</i>	Biology
17	Aquatic Plant Survey Of Ohio's Glacial Lakes	Geology
18	Moderate Tsunamis And Great Storms Leave Little Sedimentary Evidence In Hokkaido, Japan	Geology
19	Sedimentary evidence for great tsunamis near Tokachi, Hokkaido, Japan	Geology
20	An Inexpensive Self-Contained Field Deployable Water Parameter Measuring Device	Computer Science
21	Phonotactic Patterns And The Sub-Regular Hierarchy	Computer Science
22	Research Opportunities for Undergraduates	General

* Student presenters listed in alphabetical order on the back page.

TRACE METAL INVESTIGATION OF SURFACE WATER, SEDIMENT AND BIOLOGICAL SAMPLES FROM A LOCAL WATERSHED (RICHMOND, IN)

Ana Stolar¹, Nidal Atallah², Michael Deibel*¹, John Iverson², and Meg Streepey³
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Earlham College, Richmond, IN 47374

Springwood Lake, created in 1930 by confining a spring-fed wetland, is a shallow lake of approximately 8 acres, which has been historically linked to potential contamination from nearby industrial facilities and landfill runoffs. To characterize the potential heavy metal contamination of this lake, surface water and biological samples were analyzed using ICP-AES and GFAAS, while sediment cores were analyzed using XRF. Standard reference materials were analyzed to validate each method. Sediment core analysis reveals a trace metal pattern indicating past contamination of Cd, Cr, Cu, Pb and Zn in the lake. Analysis of surface water indicates moderately hard water with low levels of dissolved metals. Various tissue samples from six fish and 4 turtles were analyzed. Tissue samples were prepared by freeze-drying and microwave digestion. Cadmium and Pb levels were generally higher in the musk turtle than in the snapper, red-ear or painted turtles. The red-ear turtle kidney had the highest level of Cd among all tissues/species. In fish samples, the gills had higher Pb levels than other tissues. These preliminary data indicate the need for additional cores to more fully describe the area of contamination and for additional biological samples to understand the potential community consequences of the contamination. This work was funded by a grant from the Keck Foundation.

**DEVELOPMENT OF A METAL SPECIATION/TOXICOLOGY
LABORATORY EXPERIMENT**

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While the total dissolved level of heavy metals is an important indicator of contamination, the toxicity of heavy metals in aqueous systems depends on the speciation of the metal, which significantly affects bioavailability. The goal of this project was to develop an integrated lab that involved the measurement of the total dissolved Cu, the free Cu^{2+} activity and the resulting toxicity in solutions of various chemical composition. The Cu speciation results were also compared to those predicted by chemical speciation modeling (Visual MINTEQ 2.51). ICP-AES was utilized to determine total dissolved Cu and an ion selective electrode was used to measure the free Cu^{2+} activity. The toxicities were then measured using both a daphnia model and a bacterial model. The solutions measured included Cu only, Cu with EDTA and Cu with fulvic acid. The results showed a strong correlation between free Cu^{2+} activity and the measured toxicity in both model systems. In addition, there was general agreement between the measured values and the values calculated by Visual Minteq. This lab module will be implemented in our Chem 371 Environmental Chemistry and Toxicology course this Fall. This work was funded by a grant from the Keck Foundation.

EFFECT OF NUTRIENT ADDITION ON METHANE OXIDATION RATES IN FLORIDA LANDFILL COVER SOILS

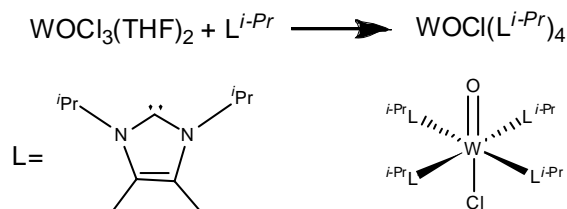
Kaitlin Flynn, Patrick Chanton, and Koenraad Mahieu*
Departments of Environmental Engineering and Oceanography
Florida State University, Tallahassee, FL 32306

Methanotrophic bacteria oxidize methane and are ubiquitous, found in many soils and environments. Landfills constitute a significant anthropogenic methane emission source. By effectively engineering the cover soils of these landfills, methane emission rates can be reduced. Methanotrophs are affected by nutrient and moisture levels, particularly ammonium, copper, nitrate, and phosphate. Samples from the landfill in Springhill, FL were analyzed. Incubation was started by adding CH₄ to reach a concentration of approximately 6% in the headspace. The reaction rate was measured by taking samples and measuring the CH₄ concentration on a gas chromatograph with a flame ionization detector (FID). The reaction rate was calculated from the loss of CH₄ between two samples minus the amount of CH₄ in the removed sample. Experiments confirm that methane oxidation can benefit from the addition of fertilizer. A combination of 25mg Cu²⁺/kg_{soilDW} and 100mg NO₃-N/kg_{soilDW} more than doubled the oxidation rate. Extra addition of phosphate did not improve oxidation significantly. Addition of ammonium did not harm oxidation at the concentration levels of 100mg NH₄-N/kg_{soilDW} used in these experiments. This work was supported by the National Science Foundation and Waste Management INC.

**SYNTHESIS OF TUNGSTEN OXO/IMIDO WITH
N-HETEROCYCLIC CARBENE LIGANDS**

Ishani Gammana Liyange, Andrew J. Ross, Lori A. Watson*
Department of Chemistry
Earlham College, Richmond, IN 47343

New reactive tungsten complexes were synthesized with oxo, imido, and N-heterocyclic carbene ligands. With a wide variety of catalytic functions such as polymerization, hydrogenation and C-X activation, these organometallic compounds can be used in a variety of chemical applications. After confirming the synthesis of the metal ligand complexes using NMR, salt metathesis reactions were performed in order to determine whether chloride ligands were present as inner sphere ligands. Using computational chemistry, probable structures of the metal ligand complexes were obtained. Further studies of molecular structure using x-ray crystallography are planned. This work was supported by a grant from the Camille and Henry Dreyfus Foundation and from the Stephen and Sylvia Tregidga Burges Endowed Research Fund.



**USE OF DENSITY FUNCTIONAL THEORY TO SUGGEST MOLECULAR
GEOMETRY AND DEGREE OF BACK-DONATION IN
TRANSITION METAL COMPLEXES**

Martin Gachoro, Lori A. Watson*
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Density Functional Theory provides a good method to computationally investigate the electronic and molecular structure of compounds. This two-fold project begins an investigation of oxo and imido tungsten complexes with N-heterocyclic carbene ligands as well as determines the extent of back donation into a carbonyl group of a wider variety of transition metal complex. In the first part of the project, various possible isomers of $(L^{iPr})_4WOCl$ where $(L^{iPr}=C(N(iPr)_2CCH_3)_2)$ are calculated in order to predict the experimentally obtained structure. Progress was also made in determining the ΔH and ΔH^\ddagger of the reaction. The second project seeks to establish computationally the degree of back donation into a CO group using a number of different *trans* ligands, metals, and oxidation states. The degree of back donation is determined by the change in the C=O stretching frequency as well as occupancy levels of relevant molecular orbitals. Correlation with *trans* ligand type (π -donor/acceptor) and metal identity is discussed. This latter project will be modified and incorporated into an upper-level Inorganic Chemistry laboratory course when complete. This work was supported by a grant from the Camille and Henry Dreyfus Foundation and from the Stephen and Sylvia Tregidga Burges Endowed Research Fund.

SEPARATION AND QUANTITATIVE MEASUREMENT OF VITAMIN E COMPONENTS ON C-18 TLC-UV PLATES

Lila Jensen, Sinovia Snow, Xiao Jiang and Paul Ogren*

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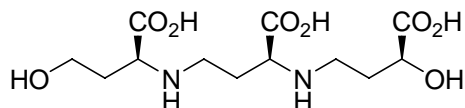
The tocopherols and tocopherol acetate collectively comprise "Vitamin E". The risk of oxidative degradation of the tocopherols under standard protocols for isolation and HPLC analysis can be reduced with TLC methods requiring less rigorous isolation methods. Therefore quantitative TLC may offer a good alternative analytical method. Fluorescent C-18 TLC plates are used with a methanol mobile phase to separate Vitamin E components in a variety of standards and samples. Spot intensities under 254 nm UV illumination are recorded with a digital camera using LabVIEW[®]/Vision[®] programming software for image acquisition and quantitative analysis. The most commonly found components, α -tocopherol acetate, and the RRR α - β - and δ -tocopherols, appear as overlapping spots. These can be fitted to a set of overlapping 2D Gaussian peaks using a Levenberg-Marquardt non-linear fitting algorithm, with an option for treating the residual pixel absorbances with a Gram-Charlier correction for skew. Spot absorbance sums for standards fit a nearly linear calibration curve; use of this curve for "unknown" samples gives results with uncertainties on the order of 10%. This precision level makes the TLC method useful both for quick initial surveys of samples and for comparison with HPLC-based methods using more extensive isolation procedures. This work was funded by the Earlham Ford-Knight Endowed Fund and the Matthews Student/Faculty Research in Physical/Biological Science Fund.

**PROGRESS TOWARD THE TOTAL SYNTHESIS OF AVENIC ACID AND
RELATED ANALOGS**

Shane L. Hogle, Darut Prasertsri and Mark G. Stocksdale*

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Graminaceous plants, when grown in iron-poor soil produce and secrete low molecular weight chelating compounds (phytosiderophores) for the sequestering and active transport of iron to the plant itself. We are interested in synthesizing Avenic Acid (the phytosiderophore produced by oats) and related analogs in order to explore the scope and limitations of this iron-transport system. We now present our continued synthetic progress. This research was funded by a grant from the United States Department of Agriculture.



Avenic Acid

FROM ARSON TO DUCT TAPE: DEVELOPING FORENSIC APPLICATIONS FOR THE UNDERGRADUATE ANALYTICAL CHEMISTRY LABORATORY

Sam Hamed, Katherine Hostetler, Luigi Bol, and Corinne Deibel*

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Experiments exposing students to analytical method development while exploring their interest in forensic chemistry will be introduced in the Analytical laboratory curriculum. The first technique that was investigated is Ion-trap Gas-Chromatography-Mass Spectrometry (GC-MS) as it has become an integral part of every forensic laboratory. Two applications were developed: cocaine on currencies, and accelerants identification. MS/MS parameters and conditions were optimized in order to achieve maximum sensitivity for cocaine, resulting in the elimination of the need for concentration of the extract. Cocaine levels extracted from individual local dollar bills ranged from 2.1 to 15.9 μg . In the arson lab, parent ions characteristic of hydrocarbons commonly used as accelerants, were selected for pattern recognition. Tandem mass spectrometry greatly improved both the detection and identification of ignitable liquid residue, as accelerant components were clearly distinguished from interfering pyrolysis products (burned carpet). X-ray fluorescence (XRF) is a non-destructive technique used to provide the elemental compositions. In addition to being portable, it will not alter or damage the evidence. Three different materials were studied to determine if they could be differentiated based on their elemental profiles: bullets, duct tape and lipstick. Preliminary results of bullets show a different trace elemental profile (Zn, Sn and Sb) of their lead projectile. This research was funded by a Ford/Knight grant from Earlham College.

THE EXPRESSION OF METALLOTHIONEIN I IN INDIANA GAME FISH EXPOSED TO COPPER

Leomar Bautista, Juan Hernandez, Chris Owens and David Matlack*, DVM
Department of Chemistry, Earlham College

The metallothioneins (MTs) are a family of cysteine-rich, low molecular weight, highly conserved polypeptides that putatively help regulate zinc homeostasis in the cell. MTs up-regulate in response to metal toxicosis in a number of organisms, including humans and some fish. This up-regulation may serve as a protective mechanism and enhance survivability, but it may be at the expense of long-term fitness. The purpose of this research was to determine the pattern of expression of MT I in Indiana game fish exposed to copper. Copper sulfate is frequently used in ponds to control algae. It is toxic to invertebrates at low doses, but many fish seem able to survive low doses of copper. Studying the expression of Mt I in fish exposed to copper is the beginning of a longer survivability versus reproductive fitness study with implications for local fish pond management. Fingerling channel catfish, red-ear sunfish, blue gill and large mouth bass were divided into test (n=3 per species) and control groups (n=3 per species.) Test fish were exposed to 1pp copper in their tank water for seventy-two hours. Fish were anesthetized with Tricaine and then sacrificed intra-operatively while the liver, kidney and muscle tissues were harvested. One half of the tissue was processed for immunohistochemistry using mouse anti-fish MT I antibody and goat anti-mouse fluorescent antibody. The other half of the tissue was lysed and homogenized for quantitative analysis. There was no significant difference in tissue fluorescence between test and control groups. There was inadequate protein in the tissue homogenate for ELISA or Western blot, so dot blot was performed and confirmed that was no significant difference between test and control groups. Future studies would involve higher doses of copper exposure and the use of larger fish to ensure adequate tissue samples for quantitative analysis. This work was funded by a grant from the Keck Foundation.

**INVESTIGATION INTO THE RELATIONSHIP BETWEEN MEMBRANE
PHOSPHOLIPID COMPOSITION AND CELL DIVISION IN
ESCHERICHIA COLI**

James Haley, Rakesh Sikdar and William T. Doerrler*
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Louisiana State University, Baton Rouge, LA 70803

The gene encoding *Bacillus subtilis* phosphatidyl serine synthase (BpssA) was overexpressed in the *Escherichia coli* double-knockout mutant BC202. BC202 harbors deletions of *yqjA* and *yghB* resulting in altered phospholipid composition, temperature sensitivity and defects in cell division. BpssA overexpression did not restore the ability of BC202 to grow at 42 °C, nor did it result in restoration of wild type cell division. Contrary to what was reported by another group, significant changes in the levels of the membrane lipids were not observed following overexpression of *pssA*. This research was supported by the Howard Hughes Medical Institute.

**IDENTIFICATION OF A PUTATIVE CAMP-BINDING PROTEIN
INVOLVED IN REGULATION OF NITRATE ASSIMILATION
IN CAULOBACTER CRESCENTUS**

Michelle R. Crane, Melissa Marks, and Sean Crosson*
Department of Biochemistry and Molecular Biology
University of Chicago, Chicago, IL 60637

Understanding the molecular and genetic basis of nitrogen metabolism and assimilation by prokaryotes has become increasingly relevant as usage of artificial sources of nitrogen have significantly perturbed the global nitrogen cycle. A forward genetic screen of ~16,000 *Caulobacter crescentus* transposon insertion mutants was conducted in order to identify genes involved in nitrate assimilation in this freshwater bacterium. Forty mutants with defects in growth on nitrate were identified, seven mutants were mapped and characterized, and one mutation in gene *CC2702* was further studied. *CC2702* encodes a hypothetical protein that has homology to the cAMP binding domain of cAMP Receptor Protein (CRP) from *Escherichia coli* at its amino-terminus and a putative DNA-binding domain in its C-terminus. Knockout strains of both *CC2702* and the hypothesized five-gene operon in which it lies (*CC2700-CC2704*) were constructed in order to characterize their role in nitrate assimilation. Protein sequence alignment in combination with crystal structure analysis confirmed homology of four crucial amino acid residues responsible for the binding of cAMP in *E. coli*, indicating that *CC2702* likely binds cAMP or a similar nucleotide. Characterization of this gene may shed light on a previously unknown mechanism for regulation of nitrogen metabolism in *C. crescentus*. This work was supported by the Department of Biochemistry and Molecular Biology at The University of Chicago.

**EFFECT OF 2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN ON
CULTURED MOUSE AND HUMAN PODOCYTES.**

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Kidney Disease Section, Kidney Diseases Branch, NIDDK/NIH, Nucleic Acid Sections,
Laboratory of Metabolism, NCI/NIH¹; Department of Health and Human Services,
Bethesda, Maryland; Earlham College, Richmond IN.²

2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) is a potent halogenated aromatic hydrocarbon and persistent organic pollutant (POP) that has been implicated in wasting syndrome, chloracne, immunosuppression, damage to the fetus of laboratory animals and tumorigenesis. Additionally, benzo[a]pyrene, also a polycyclic aromatic hydrocarbon, has been shown to inhibit the growth of glomerular mesangial cells while affording a growth advantage to glomerular visceral epithelial cells.

These effects are mediated by the aryl hydrocarbon receptor, a member of the bHLH/PAS transcription factor family of proteins. In the cytoplasm, Ahr exists in complex with Hsp90, ARA9 and p23. After a ligand (of which TCDD and most other polycyclic aromatic hydrocarbons are an example) binds to Ahr, it translocates to the nucleus and heterodimerizes with ARNT. The heterodimer recognizes and binds to DREs (dioxin responsive elements) and promotes gene transcription of target genes.

In this study we hypothesized that mouse and human podocytes treated with concentrations of TCDD from 10 nm to 10 μ M would show phenotypic alterations and altered expression of podocyte differentiation markers such as podocin, nephrin, synaptopodin and WT1. We demonstrated that human and mouse podocytes and HepG2 cells express Ahr at the level of DNA and protein and that in initial studies there is no correlation between increased levels of TCDD in corn oil and higher levels of podocyte toxicity after either 24 or 48 hours. This work was supported with funds from the National Institutes of Health, Department of Health and Human Services through the National Institute of Diabetes, Digestive and Kidney Disease, Kidney Disease Section.

USING GENETIC ANALYSIS TO INVESTIGATE DRUG RESISTANCE IN MALARIA PARASITES

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¹Laboratory of Vector and Malaria Research, NIAID,
National Institutes of Health, Rockville, MD

²Earlham College, Richmond, IN

Malaria is responsible for 500 million cases of disease and 1-3 million deaths per year and is caused by four species of parasites: *Plasmodium falciparum*, *P. vivax*, *P. malariae* and *P. ovale*. Resistance to anti-malarial drugs such as chloroquine (CQ) and quinine (QN) has been a major problem for malaria control since the 1950's. Understanding the genetic basis of drug resistance is important for choosing appropriate treatment and for developing new drugs. The ability to reproduce the complete life cycle of *P. falciparum* in the laboratory has enabled the generation of three genetic crosses, which we used to search for genes linked to drug resistance in this species. The lack of continuous in vitro culture of *P. vivax* has created a challenge to pursuing similar studies in this species. Initial experiments using animal models to characterize the drug response of different *P. vivax* strains and the establishment of short-term in vitro drug inhibition assays will provide the basis for a genetic cross in this species. Initial experiments were performed to choose an efficient polymerase chain reaction (PCR) diagnosis method for molecular identification of *P. vivax* for future field work to validate genes in this species linked to drug resistance.

REFINING THE ANNOTATION OF MALARIA GENOMES

Will Vincent, Chris Meserve, Xander Rowland, Lindsey Howlett, Gaya Hettiarachchi, Alfred Simkin, Doug Hardesty, Doug Armour, Caroline Hackett, and Peter L. Blair*
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Malaria remains a global scourge to human life and existence and is responsible for up to 500 million cases and 3 million deaths annually. Therefore the need to establish and design novel malaria drug and vaccine strategies is crucial yet remains challenged, in part, due to the current status of malaria gene annotations. While the human malaria (*P. falciparum*) genome deserves the majority of attention, the accuracy of the rodent model (*P. yoelii*) genome is imperative for the traditional pipeline of drug/vaccine development and validity studies. Our research utilizes published large-scale datasets, notably Expressed Sequence Tags (ESTs), comparative genomics, and bioinformatic approaches to resolve and correct the current *P. yoelii* gene annotations. To date our research group has examined over 10% of the genes in the *P. yoelii* 17XNL genome (approximately 5,700 total predicted genes) and has successfully confirmed or corrected more than 100 genes, of which 60% required intron/exon boundary correction. This initial assessment justifies the need for annotation refinement. This presentation will offer both a description of our methodology and an update of results. Our data is currently available on the free online genomic resource, PlasmoDB (www.plasmodb.org), for dissemination to the greater malaria research community. This research was funded by an NIH Academic Research Award (R15 AI068675-01).

**THE EFFECTS OF ISOLATION AND PLANT POPULATION SIZE ON
HOST-SPECIALIST INTERACTIONS AND PLANT FITNESS
IN TWO SPECIES OF *PHYSALIS* (SOLANACEAE)**

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Blandy Experimental Farm
University of Virginia, Winchester, VA 22620

The study of population and community dynamics in isolated habitats is a matter of increasing importance as urban development and other anthropogenic factors fragment the landscape. This study examined how isolation affects the spatial distribution of specialist pollinators. We have also examined how isolation affects levels of herbivory, and how all these interactions impact plant fitness. *Physalis longifolia* and *Physalis heterophylla* and their associated specialist insects were used as a study system. Locations of patches of both species of *Physalis* and *Solanum dulcamara*, a plant which also hosts the herbivore, were recorded with GPS and levels of isolation were determined using ArcGIS software. Proportion of plants occupied by the herbivore did not vary with level of isolation, patch size or presence of a patch edge. In one case the number of pollinators was predicted by level of isolation and patches with more edge had more flowers. Fruit and seed set were very high and did not vary isolation, patch size or presence of a patch edge. This work was supported by the National Science Foundation Research Experience for Undergraduates fellowship.

***LEPTINOTARSA JUNTA* LARVAL FEEDING PREFERENCE
FOLLOWING INTERSPECIFIC AND INTRASPECIFIC
ATTACKS ON *SOLANUM CAROLINENSE***

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Department of Biological Science
Florida State University, Tallahassee, FL

During their long course of co-evolution with insect herbivores, plants have developed a broad range of defense mechanisms to combat insect attacks. Most plants maintain a pre-formed constitutive defense regardless of the herbivore threat level. However, herbivory can also trigger plants to induce internal changes. This induced resistance can be indirect (by attracting predators and parasitoids of the herbivore) or direct (reducing food supply, limiting nutritional value, reducing preference, etc). Perhaps most interesting is the fact that these induced responses affect not only the attacking herbivore, but can also indirectly affect subsequent feeders. In particular, specificity in the induced resistance has garnered much attention recently. Since plants in nature are normally attacked sequentially it is logical that the induced response would be tailored to a particular species; potentially creating a “priority” effect and reducing the plant’s capacity to respond to subsequent herbivores of a different species. In this study, the specificity of induction and response was examined via the behavioral response (feeding preference) of *Leptinotarsa juncta* larvae to interspecifically and intraspecifically damaged *Solanum carolinense*. The herbaceous weed *Solanum carolinense* was exposed to herbivory by *Leptinotarsa juncta* the false potato beetle and *Spodoptera exigua*, the beet armyworm. Leaves from these plants were fed to *L. juncta* in a no-choice food preference test. Very little behavioral difference was found to indicate the detection of a species-specific induced response or a resulting diet preference. This work was funded by a NSF REU program.

AQUATIC PLANT SURVEY OF OHIO'S GLACIAL LAKES

Katherine J. Marshall, Dr. James K. Bissell*, David Kriska, and Allison Parker
The Cleveland Museum of Natural History

As a part of an ongoing glacial lake survey, five of Ohio's thirty-three glacial lakes, Fox Lake, Long Lake, Nettle Lake, Odell Lake, and Snow Lake, were surveyed this summer. The data indicated that four of the surveyed lakes contained at least one rare plant species, as listed by the Ohio Department of Natural Resources. At Long Lake *Nuphar vairegata*, a State endangered plant, was found. *Potamogeton zosteriformis*, a potentially threatened plant, was found at Long, Nettle, and Snow Lake. The State threatened *Wolffiella gladiata* was found at Fox Lake. Additionally, all five of the surveyed lakes contained at least one of the following invasive species: *Myriophyllum spicatum*, *Najas minor*, or *Potamogeton crispus*. Some native plant species that were found in these lakes during previous surveys were not present in these same lakes in the summer of 2008. The increasing abundance of invasive species has negatively impacted the native plant populations within the lakes. The survey indicates that protective measures need to be taken to stop the spread of these invasive species in order to ensure that the native glacial lake ecosystem remains intact. This work was supported by the Botany and Natural Areas Departments of the Cleveland Museum of Natural History and by the Kirtlandia Society.

**MODERATE TSUNAMIS AND GREAT STORMS LEAVE LITTLE
SEDIMENTARY EVIDENCE IN HOKKAIDO, JAPAN**

Katie Delbecq*¹, Wes Nutter¹, Yuichi Nishimura², Yugo Nakamura², Kazuomi Hirakawa³ and Andrew Moore¹

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²Institute of Seismology and Volcanology, Hokkaido University, Sapporo, 007-0835, Japan

³Laboratory of Geocology, Graduate School of Environmental Earth Science, Hokkaido University, N-10 W-5, Kita-ku, Sapporo, 060-0810, Japan

Neither the 2003 Tokachi-oki tsunami nor a great storm that struck the Tokachi coast in February 2007 left sedimentary traces distinguishable from normal marine sedimentation in coastal sediments near Otsu, a town with a clear record of prehistoric tsunamis. The lack of preservation of moderate-sized tsunamis and great storms suggests that either favorable circumstances are required for preservation, or that this area has experienced larger events than those that occurred in 2003 and 2007. The 2003 Tokachi-oki earthquake ($M_w = 8.3$) spawned a tsunami that reached heights of up to 4 m near the fishing port of Otsu. Nevertheless, a ~5 m high sand dune along the coast prevented inundation landward of the dune in all but the most favorable circumstances. In one area, an artificial cut through the dunes allowed the tsunami to reach an inland marsh, but even here no sedimentary record of the tsunami remained five years after the event. A very large storm struck the same area in February 2007. The storm surged higher than 4 m, and inundated dunes nearby that were mantled with ash from the 1739 eruption of Tarumae, suggesting that this was the first time in more than 350 years that such waves reached the dune. Nevertheless, the storm did not breach the 5 m dune near Otsu, and in a location 1.5 km northeast of Otsu, a lower dune of ~2 m allowed inundation of no more than 200 m inland, as marked by a line of debris still visible one year later. Deposition from this storm was not distinguishable from normal marine deposition during our survey. Because the Tokachi coastline is protected by a low dune that effectively limits events smaller than about 5 m from entering the sedimentary record, preservation of smaller events requires favorable circumstances, and is unlikely. This work was supported by the Stephen and Sylvia Tregidga Burges Endowed Research Fund.

**SEDIMENTARY EVIDENCE FOR GREAT TSUNAMIS NEAR TOKACHI,
HOKKAIDO, JAPAN**

Wes Nutter¹, Katie Delbecq*¹, Yuichi Nishimura², Yugo Nakamura², Kazuomi Hirakawa³
and Andrew Moore¹

¹Department of Geosciences, Earlham College, Richmond, IN 47374

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Sand sheets that fine and thin landward in a sequence of marsh deposits near Otsu, southeastern Hokkaido, suggest that at least nine large tsunamis have struck this coast since marsh deposition began more than 3000 years ago. These sand sheets extend landward up to ~2 km, and extend too far inland to have resulted from either large storms or moderate tsunamis. The sand sheets appear in a 2 m thick sequence of marsh deposits that begin with peat formation on marine mud. The sand sheets are laterally continuous along at least 1.5 km of coast, and extend inland variably, with 4 of the 9 disappearing by 1 km from the coast, and 5 of the 9 disappearing by 1.5 km inland. The deposits are correlative to similar sheets in a marsh ~40 km southwest of Otsu, suggesting that these events were at least regional in extent. The sand sheets appear to represent a mix of dune sand and offshore sand, and contain minerals indistinguishable from the modern beach (although older units contain significantly more pumice). The sheets thin and fine landward, although they are rarely more than 20 cm thick at their seaward edge. No sedimentary structures were visible in outcrop exposures of the sand sheets or peels taken of the sediments. The 2003 Tokachi-oki tsunami (~4 m high) left no record of its passage in this marsh, nor did great storms in February 2007 and May 2008. These sheets probably represent, then, the deposits of either storms or tsunamis greater than those recorded historically; the February 2007 storm in particular overwashed dunes unaffected by storms for more than 350 years, making storms an unlikely cause for these sand sheets. This work was supported by the Stephen and Sylvia Tregidga Burges Endowed Research Fund.

AN INEXPENSIVE SELF-CONTAINED FIELD DEPLOYABLE WATER PARAMETER MEASURING DEVICE

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Typical self-contained water parameter measurement devices with the capability to store and transmit readings via the public switched telephone network are very expensive and almost always use proprietary software. Here we present a simple, inexpensive design based on commodity off-the-shelf hardware, open source software, and an industry standard water sonde. The unit is powered with a small solar panel, housed in a waterproof case with a battery, and communicates data via an embedded cell phone. All of this makes it possible to deploy the unit in remote locations without power or wireline/wireless data service. To analyze the reported parameters, we built a simple mashup with Google Earth which visualizes the data. This work was funded by a grant from the Keck Foundation.

PHONOTACTIC PATTERNS AND THE SUB-REGULAR HIERARCHY

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Human language learning is one of the great mysteries of cognitive science. Humans do not master lexicons simply through memorizing every word they hear; they must somehow implicitly gain an understanding of what phonetic patterns typify valid words in a given language. Our research is in the intersection of Phonotactics (the study of such phonetic patterns) and the Theory of Computation. Phonologists generally model phonotactic patterns as stringsets and describe them using formalisms that are generally equivalent to Finite State Automata (FSAs). Stringsets described in such a way are called Regular Stringsets, and are problematic because they are provably unlearnable by the simplest formal models of learning---Inductive Inference Machines (IIMs). Jeff Heinz has created a database of nearly all currently attested phonotactic patterns and has developed learning algorithms for each pattern's representative stringset, but the formal properties of the classes of stringsets learnable by his algorithms are not yet well understood. We are developing algorithms to categorize these stringsets with respect to the Sub-Regular Hierarchy, a well known hierarchy of classes of stringsets in which each level corresponds to specific abstract cognitive capabilities, and which includes some classes learnable by IIMs.

We have developed an efficient algorithm for determining if an FSA describes a stringset in the simplest class of the Sub-Regular Hierarchy, the Strictly Local (SL) stringsets and to determine if that stringset is learnable by an IIM. We have used this to categorize the phonotactic patterns in Heinz's database, most of which turn out to be learnable stringsets in this simplest class.

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