College of Natural Sciences and Mathematics
Annual Student Research Symposium
Posters presented at 2:00 pm, April 25, in Main Hall

TITLES

Department of Biology

Trench or Die: Why do many Soybean Loopers Fail to Trench
Erin Sizemore
Faculty Mentor: David Dussourd

Recolonization of benthic organisms following drought
Sara Richardson and Terri Lundberg
Faculty Mentor: K.C. Larson

Fragmentation in a Southern Oak-Hickory Forest: Impacts on Species Richness and Invasibility
R. Meeker
Faculty Mentor: K.C. Larson

Morphological plasticity in two types of *Lonicera* in response to light availability
Jason C. Walker
Faculty Mentor: K. C. Larson

Fish Response to Isolation in a Semi-permanent
High Ozark Mountain Stream
Andrew N. Dick
Faculty Mentors: Dan Magoulick and K.C. Larson

Apototic Induction in the Intestinal Epithelium of the Marine Snail *Aplysia californica* and the Sprague-Dawley Rat
D. DeLynn Hearn Hollicail ow8 0 484.3

Department of Chemistry

Reactivity of a Monomeric Nickel-borohydride, the Hydride Bullet
Rosemary Galloway, Stacey LeLievre, and Andrea Phelps
Faculty Mentor: Patrick Desrochers

A Study of the Structure and Spectral Properties of Ethylene Cation
Micah L. Abrams
Faculty Mentor: Jeffrey A. Draves

Spectroscopic Studies of *cis*- and *trans*-Dibromoethene
Micah Abrams, Michael Arvin, Ryan Dossey,
Vince Dunlap, Lisa Sullinger, and David St. Johns
Faculty Mentors: Paul Krause and Jeffrey Draves

Analysis of Metal Concentrations in Tucker Creek Park Area
Melissa Allen, Chuck Munson, Steven Stock,
Michael Arvin, and Rachael Rodrigue
Faculty Mentor: Jeffrey A. Draves

Analysis of Heavy Metals and Bioaccumulation in Tucker Creek
Tony Delany, John Isanhart, Angela Winey, Johnna Woods
Faculty Mentor: Jeffrey A. Draves

Nutrient Species Analysis in the Waters of Tucker Creek
Gary Dobbs and Jason Thessing
Faculty Mentor: Jeffrey A. Draves

Binding Efficiencies of Mitomycin C to DNA Systems
R. Dinnan, J. Moix, and M. Ziegelmeier
Faculty Mentor : Patricia Draves

Binding of (+)-CC-1065 to DNA and Simple Chromatin Systems
Vince Dunlap, and Shane Sparks
Faculty Mentor: Patricia Draves

Solvent Induced Stabilization of Naphthalene Anion
Micah L. Abrams
Faculty Mentor: Henry F. Schaefer III
(Center for Computational Quantum Chemistry, UGA)

Department of Computer Science

A Digital Logic Design Using the Figure of Decimal Digit Eight
Billy J. Franks and Mohammad M. Bhuiya
Faculty Mentor: D. S. Tomer

Department of Mathematics

Approximating Schrödinger potentials using Darboux transformations
Mary Branton – Housley
Faculty Mentors: Danny Arrigo and Fred Hickling

Schrödinger's equation and potentials used to models alpha-decay
Chad Fendt
Faculty Mentors: Danny Arrigo and Fred Hickling

Darboux transformations of the variable wave speed equation
Bryan Gipson and Garth Johnson
Faculty Mentors: Danny Arrigo and Fred Hickling

Darboux transformation and wave equation systems
Sarah Jacobs
Faculty Mentors: Danny Arrigo and Fred Hickling

The heat equation with time independent source terms
Brandon S. Lindley
Faculty Mentors: Danny Arrigo and Fred Hickling

Department of Physics and Astronomy

Modeling of the eye of *Littorina*
Christopher Melton
Faculty Mentor: Stephen R. Addison

Acoustic Properties of Porous materials
David James and Kevin Dillion
Faculty Mentor: Carl Frederickson

Analyzing Techniques with Scanning Electron Microscope and X-Ray Fluorescence
Mark Denton
Faculty Mentor: Rahul Mehta

ABSTRACTS

Department of Biology

Trench or Die: Why do many Soybean Loopers Fail to Trench

Erin Sizemore
Faculty Mentor: David Dussourd

Cabbage loopers and several other caterpillar species cut a trench across leaves of prickly lettuce (*Lactuca serriola, Asteraceae*) and other plants with secretory canals. The trench severs the canals and reduces exudation of latex at the distal feeding site. In contrast most soybean loopers (*Pseudoplusia includens*) do not cut trenches on prickly lettuce and starve when left exclusively with this species. We tested if only some soybean loopers are capable of trenching or if they all trench, but only some are stimulated to trench prickly lettuce. Larvae were sleeved on four different plant species with different types of canal systems and on one plant species that does not emit exudates. We found that most, if not all, soybean loopers are capable of cutting a trench; only 8 loopers out of 75 failed to trench plants with exudates (dandelion, cucumber, and mulberry). Plantain, which does not emit exudate, was not trenched. Most larvae also failed to trench prickly lettuce apparently because the copious latex is too toxic.

Recolonization of benthic organisms following drought

Sara Richardson and Terri Lundberg
Faculty Mentor: K.C. Larson

Disturbance (any event that disrupts ecosystem structure or function) in stream ecosystems can produce noticeable changes in the invertebrate biodiversity. Disturbances can occur naturally (e.g., fires, floods, droughts) or result from human activities (e.g., dams, gravel mining, pollution). Loss of surface flow during periods of drought is one of the most stressful natural disturbances for aquatic organisms. This study was designed to evaluate the effects of drought on benthic macroinvertebrate assemblages in the Buffalo River. We sampled the macroinvertebrate communities of a lower reach of the Buffalo River that has permanent and temporary sections both before and immediately following drought conditions, from winter 1999 through winter 2000. Results of our investigation show that the macroinvertebrate communities in the permanent and temporary sections of the stream are similar in richness and diversity except during February (~3 weeks after flow was restored) when diversity was significantly higher at the temporary site. Multivariate analysis suggests that the taxonomic composition of the two sites was structured more by season than by flow pattern. However, some differences in taxonomic composition and functional structure did occur. For instance, members of the caddisfly family Hydroptilidae were much more numerous at the temporary site than the permanent one during March. Also, the number of piercers/herbivores showed the same pattern. These results suggest that even the community of a relatively large stream can recover quickly following drought, but there may be some differences in the taxonomic composition and trophic structure.

Fragmentation in a Southern Oak-Hickory Forest: Impacts on Species Richness and Invasibility

R. Meeker
Faculty Mentor: K.C. Larson

Habitat fragmentation results in the isolation of habitats from one another, increases the ratio of edge area to interior area, and reduces the total area of habitat. Smaller habitats often exhibit more dramatic microclimatic characteristics (higher light levels, higher soil temperatures, and lower soil moisture), are more susceptible to invasion from both non-indigenous and indigenous invasive plant species, and exhibit lower species richness than larger habitats. Smaller fragments are also more likely to display "edge" effects. I measured the impacts of fragment size (<5 ha, >10 ha but <15ha, and >20 ha) and distance from the edge of the fragment (0, 5m, 20m, and 50m) on (1) tree densities for Eastern red cedar, *Juniperus virginiana*, and hardwood species collectively, (2) tree/shrub species richness, and (3) frequency of the invasive vine *Lonicera japonica*. The fragments were man-made, and all edges were cut more than 30 years ago. The fragments were formed from a southern oak-hickory forest at Ft. Chaffee, an Army National Guard base in northwestern Arkansas. The invasive, non-indigenous *L. japonica* and the invasive, indigenous *J. virginiana* are more abundant along edges.

Preliminary analysis indicates these species are also more abundant in smaller fragments and that species richness is greater in large fragments.

Morphological plasticity in two types of *Lonicera* in response to light availability

Jason C. Walker
Faculty Mentor: K. C. Larson

Japanese honeysuckle (*Lonicera japonica*) is an invasive vine that is currently outcompeting its native congener coral honeysuckle (*Lonicera sempervirens*). Some studies have demonstrated that in response to herbivory and CO2 enhancement, *L. japonica* was more plastic than its native congener. *L. japonica* has also been shown to be more morphologically plastic than *L. sempervirens* in response to climbing supports. The goal of this study was to compare morphological plasticity of *L. japonica* and *L. sempervirens* in response to light. My hypothesis was that *L. japonica* would show greater plasticity than would the *L. sempervirens*. The study included seventy-two honeysuckle plants that were grown in three separate light treatments-

form of increasing fish density over the course of the study. These results show that fish survival during adverse conditions depends on the availability of deep pool habitat that is often compromised by in-stream gravel mining or lack of respect for riparian zones.

Apototic Induction in the Intestinal Epithelium of the Marine Snail *Aplysia californica* and the Sprague-Dawley Rat

D. DeLynn Hearn Holleman, Josh King, and Ulysses B. Haley
Faculty Mentor: Steven W. Runge

This study examines the role of context in apoptotic induction and compares apoptotic induction in intestinal epithelial tissue of a mollusk, *Aplysia californica*, and the Sprague-Dawley rat. The intestinal epithelial tissues of these organisms were incubated in aerated

absence of Na+ the Na^+/H^+ exchanger will be unable to function. Should HMA have an effect on the apoptotic rate in Na+-free medium, we will then conclude that it is affecting the cells non-specifically. This project is ongoing and will continue into the summer. A progress report and planned experiments will be presented.

Department of Chemistry

Reactivity of a Monomeric Nickel-borohydride, the Hydride Bullet

Rosemary Galloway, Stacey LeLievre, and Andrea Phelps
Faculty Mentor: Patrick Desrochers

We have uncovered a monomeric transition metal borohydride, Tp*Ni(H_3B-H). This compound has potential in the short term for insights it should provide on halocarbon (possibly fluorocarbon) reductions mediated by transition metals (see following reaction).

$$Tp^*NiBH_4 + R\text{-}X \rightarrow Tp^*Ni\text{-}X + R\text{-}H + BH_3$$

Preliminary results indicate that the reaction rate has a dependence on [Tp*NiBH_4] and [R-X], implying an overall second order rate law. A deuterium isotope effect has been observed in these measurements, indicating rate limiting hydride transfer may be central to this reaction.

Even more exciting is the potential this borohydride compound may hold for hydrocarbon activation mechanisms. Methane and borohydride are isoelectronic and isostructural. Characteristics and reactivity of Tp*Ni(H_3B-H) may be extrapolated to Tp*Ni(H_3C-R) or hydrocarbons in general.

A Study of the Structure and Spectral Properties of Ethylene Cation

Micah L. Abrams
Faculty Mentor: Jeffery A. Draves

Ab initio and density functional electronic structure methods were employed for the determination of the equilibrium structure, torsion angle potential energy surface (PES), and harmonic vibrational energy levels of ethylene cation. Due to the shallow well in the torsion angle PES, the accurate description of the system is greatly dependent upon the level of electron correlation and basis set size. Utilizing the coupled cluster method including single and double excitations augmented by a perturbative correction for connected triple excitations [CCSD(T)] and using a C(18s5p2d1f/4s3p2d1f) and H(5s2p1d/3s2p1d) basis set, we determined a torsion angle of 21.0 degrees and a torsional energy barrier of 0.99 kJ/mole, which is the most accurate determination to date. The vibrational energy levels were determined at the CCSD(T) level with a C(10s6p2d/5s3p2d) and H(5s2p/3s2p) basis set. The determined ν_7 mode is 943 cm^{-1}. The standard correction for the vibrational energy at the set level of theory is 2.3%. Therefore, the harmonic vibrational frequency is 921 cm^{-1}, which is within 1.6% of the experimentally determined ν_7 mode (907 cm^{-1}).

Spectroscopic Studies of *cis*- and *trans*-Dibromoethene

Micah Abrams, Michael Arvin, Ryan Dossey,
Vince Dunlap, Lisa Sullinger, and David St. Johns
Faculty Mentors: Paul Krause and Jeffrey Draves

Halons are a class of halogenated chemical compounds that contain bromine. The use of halons as a fire retardant has resulted in wide dispersal of the compounds throughout the troposphere and stratosphere. Subsequent photochemistry of the halons results in the formation of BrO which is particularly effective in depleting stratospheric ozone. Spectral properties of halons have not been well characterized primarily because the massive bromine atoms require low temperature and high-resolution instrumentation to accurately measure spectroscopic parameters. In this study we report our analysis of several ro-vibrational bands of cis- and trans-dibromoethene. Infrared spectra were

Nutrient Species Analysis in the Waters of Tucker Creek

Gary Dobbs and Jason Thessing
Faculty Mentor: Jeffrey A. Draves

For the past several years water quality investigations have been conducted along Tucker Creek to assess the effects of nutrient loading. The current investigation examined the loading of calcium, phosphate, nitrate, and alkalinity between Salem Road and Country Club Road. The levels of calcium and nitrate found in the creek exceed EPA primary and

Solvent Induced Stabilization of Naphthalene Anion

Micah L. Abrams
Faculty Mentor: Henry F. Schaefer III
(Center for Computational Quantum Chemistry, UGA)

Experiments utilizing photoelectron spectroscopy have extrapolated the adiabatic electron affinity (AEA) of naphthalene from the AEAs of a series of naphthalene/water clusters. The AEA of naphthalene was measured at -0.20 eV and the AEA of the naphthalene/single water cluster was measured at 0.11 eV. It was shown that a single water molecule could stabilize the naphthalene anion. However, the structural details of ionic species, especially weakly bound ionic species are extremely sparse. The present study utilized density functional electronic structure methods to determine the equilibrium geometries and AEAs for neutral naphthalene, neutral naphthalene/water clusters, and their respective anions. Ab initio electronic structure methods were also employed to test the validity of the density functional results for the equilibrium geometries and AEAs. Our results have shown that the position of the water above the naphthalene ring exhibits both translational and rotational freedom. The freedom arises from the difference in energy between the most symmetric conformation (C_{2v}) and the least symmetric conformation (C_1) of the neutral and anionic naphthalene/water clusters, which are only 111 cm^{-1} and 4 cm^{-1}, respectively. The electronic structure methods also determined an AEA of -0.20 eV for naphthalene and 0.12 eV for the naphthalene/water cluster, which correlates very well with previous theoretical and experimental data.

Department of Computer Science

A Digital Logic Design Using the Figure of Decimal Digit Eight

Billy J. Franks and Mohammad M. Bhuiya
Faculty Mentor: D. S. Tomer

A combinational network to drive a seven-segment indicator using the figure of eight, is designed to display all decimal digits and a subset of English characters. Standard algorithms (Karnaugh method and Quine-McCluskey method) are used to minimize all Boolean functions in the design with and without don't care minterms. Some programs are also developed in assisting and verifying the final form of simplified Boolean functions. Furthermore, all output Boolean functions are explored to implement all possible two-level non-degenerate implementations: And-Or, Nand-Nand, Or-And, Nor-Nor, And-Or-Invert (And-Nor, Nand-And), Or-And-Invert (Or-Nand, Nor-Or).

Department of Mathematics

Approximating Schrödinger potentials using Darboux transformations

Darboux transformations of the variable wave speed equation

Bryan Gipson and Garth Johnson
Faculty Mentors: Danny Arrigo and Fred Hickling

Third order Darboux transformations are first constructed for a transformed version of the

Department of Physics and Astronomy

Modeling of the eye of *Littorina*

Christopher Melton

Analyzing Techniques with Scanning Electron Microscope and X-Ray Fluorescence

Mark Denton
Faculty Mentor: Rahul Mehta

Samples of rocks (some meteoritic) and pure elemental samples have been analyzed using the EDS (Energy Dispersive Spectrometer) of a SEM (Scanning Electron Microscope) and also with XRF (X-ray Fluorescence). Both system use Si(Li) x-ray detector. The samples x-rays are generated by an electron beam (of variable energy up to 20 keV) in the SEM and by radioactive sources of ^{55}Fe and ^{241}Am in the XRF. Low energy K-, L- and M-shell X-rays (below 3 keV) were measured using EDS while higher energy X-rays (above 20 keV to ~80 keV) were measured using XRF. The region between 3 and 20 keV was investigated using both the system. The overlapping energy region allowed us to compare the sensitivity of the two techniques and normalize some results. These include the results of elemental ratios for the rocks and the K/L shell and the L/M shell x-ray ratios for the pure elemental samples. The magnification power and image detail available with the SEM are also discussed.