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BOTANY

DWAYNE ESTES, CHAIR

RELOCATION SUCCESS OF FEDERALLY THREATENED *SCUTELLARIA MONTANA* (LAMIACEAE, LARGE-FLOWERED SKULLCAP) FROM A PROPOSED HIGHWAY CORRIDOR. ***Jennifer Boyd* and Joey Shaw***, *The University of Tennessee at Chattanooga, Chattanooga, Tennessee.* We transplanted and investigated the post-transplantation success of *Scutellaria montana* (large-flower skullcap) to increase understanding of the feasibility of relocating this federally threatened species. Specifically, activity consisted of transplanting 49 *S. montana* individuals from an area that would be impacted by highway corridor construction in Chattanooga, Tennessee, to a nearby established population during summer 2009. Transplanted individuals were fenced to provide herbivory protection. A preliminary evaluation conducted three weeks post-transplantation found that ~78% of individuals appeared to be in excellent health, while 10 individuals exhibited water stress and one individual was missing. One year later, we found ~98% of the 48 remaining transplanted individuals to be in excellent health, exhibiting greater individual stem height, leaf number, and reproductive output in 2010 than 2009. These measures of success, as well as decreased evidence of browsing, suggest that transplantation combined with protective fencing can allow for successful relocation of *S. montana*.

THE EFFECTS OF CANOPY THINNING AND BURNING ON TRANSPLANTATION OF FEDERALLY THREATENED *SCUTELLARIA MONTANA* (LAMIACEAE, LARGE-FLOWERED SKULLCAP) IN A SOUTHEASTERN DECIDUOUS FOREST. ***H. Mae Kile*, Joey Shaw, and Jennifer Boyd***, *The University of Tennessee at Chattanooga, Chattanooga, Tennessee.* The Tennessee Army National Guard Volunteer Training Site in Catoosa County, Georgia, has a security directive to clear vegetation around their perimeter, including some habitat of federally threatened *Scutellaria montana*. To improve our understanding of transplantation for mitigation and the effects of light availability with overstory canopy thinning and fire with prescribed burning on *S. montana*, 100 affected individuals were relocated onsite during spring 2010. A 96% survival rate was observed three months after transplantation. Instantaneous leaf-level gas exchange measurements showed that both burning and thinning treatments had trends of increasing the net photosynthetic rate, stomatal conductance, and leaf mass per area (LMA). A higher LMA may allow thicker leaves to have more chloroplasts, increasing photosynthetic capacity. Increased leaf number was also observed in the thinning treatment, suggesting a strategy to take advantage of increased light availability. Burning and thinning treatments appear to have positive effects on plant growth.

PLANT CONSERVATION AND THE ENDANGERED SPECIES ACT. ***Geoff Call,*** *U.S. Fish and Wildlife Service, Cookeville, Tennessee.* The Endangered Species Act (ESA) is Federal legislation intended to provide a means to conserve the ecosystems upon which endangered and threatened species depend and to provide programs for the conservation of those species, thus preventing extinction of plants and animals. This presentation describes ESA programs used to conserve plants and their habitats. Topics covered include: how species become federally listed; differences between treatment of plants and animals under the ESA; and cooperative efforts among state, federal, and private partners in Tennessee to recover species that are listed as threatened or endangered under the ESA.

THE VASCULAR FLORA OF THE TENNESSEE RIVER GORGE, HAMILTON AND MARION COUNTIES, TENNESSEE. ***Emily Blyveis* and Joey Shaw***, *The University of Tennessee at Chattanooga, Chattanooga, Tennessee.* The Tennessee River Gorge (TRG) consists of 26 miles of river canyon within the Cumberland Plateau of Hamilton and Marion counties, Tennessee. The gorge contains 18 vegetation types and is home to several rare species. The focus of this study was to inventory the vascular flora of the southern half of the TRG, a 4,003-ha area. The presence of rare and introduced species was documented as well. During the 2009 and 2010 growing seasons, 42 collecting trips were made to the TRG and 546 specimens were collected. A total of 402 species from 105 families were documented including four rare species: *Castanea dentata*, *Cotinus obovatus*, *Panax quinquefolius*, and *Scutellaria montana*. Fifty-nine introduced species were documented, including *Albizia julibrissin*, *Lonicera japonica*, *Paulownia tomentosa*, and *Pueraria montana*.

THE BAA-TANY GOAT PROJECT AND ROAN MOUNTAIN'S UNIQUE GREEN ALDER BALD. ***James T. Donaldson, Todd V. Eastin, Frosty Levy, Roger A. McCoy, and Joseph Powell****, *East Tennessee State University, Johnson City, Tennessee (JD, FL, JP), Shady Valley, Tennessee (TE), and Tennessee Natural Heritage Program, Nashville, Tennessee (RM).* The Baa-tany Goat Project uses goats for restoring the globally-rare grassy and alder balds on Roan Mountain, North Carolina and

Tennessee. Roan's balds predate European settlement and their origins are enigmatic. Estimates suggest that > 75% of its grassy balds have been lost in the last 100 years with most of that loss occurring in the last 50 years following U.S. Forest Service acquisition and removal of livestock. The Post-Pleistocene Megaherbivore Theory is the basis for our project: goats, as browsers, selectively remove the woody plants invading the balds. The Alder Bald is unique to Roan, and preliminary examination suggests that it supports the Megaherbivore Theory.

IMPACTS OF GOAT BROWSING AND DISEASE ON *LILIUM GRAYI*, GRAY'S LILY, ON ROAN MOUNTAIN. ***Joe Powell*, Frosty Levy, and James T. Donaldson,*** *East Tennessee State University, Johnson City, Tennessee.* The flora of Southern Appalachian high elevation balds has strong representation of northern disjuncts and regional endemics. Among the endemics, the showy *Lilium grayi* (Gray's lily) is most noteworthy for its historical significance and high public profile. As bald vegetation changes in response to human and natural environmental shifts, active bald management has been implemented on public lands. Among managed balds, the Roan Mountain massif supports a large population of *L. grayi*. The purpose of this study was to describe the demography of adult plants, to compare browsed and non-browsed plots, and to determine the extent to which disease may impact survival and reproduction of *L. grayi* on Roan Mountain. Clusters of diseased and healthy plants were found. Plants in close proximity tended to be alike in disease status and those distant were unalike. A pathogenic fungus, *Pseudocercosporella inconspicua*, may be the disease pathogen.

AN OVERVIEW OF FLORISTIC STUDIES IN TENNESSEE'S NATIONAL WILDLIFE REFUGES. ***Edward W. Chester and Stephanie Gunn-Zumo,*** *Austin Peay State University, Clarksville, Tennessee, and Louisiana Office of Coastal Protection and Restoration, Baton Rouge, Louisiana.* The U.S. National Wildlife Refuge System (NWR) includes more than 550 units managed by the U.S. Fish and Wildlife Service for conservation and restoration of fish, wildlife, plants, and their habitats. Most are open at least part of the year for recreation and public use, including environmental education, hunting, fishing, hiking, bird watching, and various other activities. There are seven NWR's in Tennessee, where management for migratory waterfowl is the primary objective. Five are in the Mississippi River drainage, i.e., Chickasaw, Hatchie, Lower Hatchie, Lake Isom, and Reelfoot (the latter extends into Kentucky). One, the Tennessee NWR, is in the Tennessee River drainage while Cross Creeks NWR is in the Cumberland River drainage. All include a variety of habitat types but wetlands predominate. This report provides an overview of Tennessee refuges and discusses the status of floristic work completed in each to date.

THE VASCULAR FLORA OF THE CLARKS RIVER NATIONAL WILDLIFE REFUGE, MARSHALL, MCCRACKEN, AND GRAVES COUNTIES, KENTUCKY. ***Matt S. Bruton* and Dwayne Estes,*** *Austin Peay State University, Clarksville, Tennessee.* Kentucky is one of seven states in the U.S. to have lost more than 80% of its wetlands. Most of the 1,266,000 wetland acres lost were in western Kentucky, a region formerly covered by extensive swamps, bottomland hardwood forests, marshes, and wet prairie. The Clarks River National Wildlife Refuge (9,500 acres) was established to protect a large tract of remaining wetlands in western Kentucky. The purpose of this study was to conduct an inventory of the vascular flora of the refuge. Fieldwork consisted of approximately 40 collection trips. Over 500 specimens have been vouchered, representing 93 families and 243 genera, and comprising 401 intraspecific taxa. Collecting to date has produced 335 native species (85%) and 64 (16%) non-native species. *Baccharis halimifolia*, a shrub native to the Outer Coastal Plain of the U.S., was discovered for the first time in Kentucky during this study.

TAXONOMY OF *LANTANA* SECT. *LANTANA*: STATUS AND CHALLENGES. ***Roger W. Sanders,*** *Bryan College, Dayton, Tennessee.* Taxonomy of *Lantana* sect. *Lantana* is obfuscated by a propensity of the plants to form fertile hybrids and by a long history of horticultural hybridization and repeated cycles of naturalization and unassisted hybridization among adventive and native plants. Moreover, massive numbers of available herbarium specimens make comprehensive loans impractical. Current hypotheses of species limits among Mesoamerican and South American herbarium samples are based on extrapolation from earlier biosystematic studies of Caribbean taxa. Recent studies are focused on 1) verifying taxonomic criteria for species and species-groups (primarily trichome, leaf, and bract structure), 2) clarifying the disposition of nomenclatural types, 3) documenting variation of taxonomic criteria through digital photography conducted at the respective herbaria, and 4) seeking species markers using DNA extracted from herbarium specimens. To date, the molecular studies have not been successful; however, new efforts are being made in collaboration with Queensland government labs and the University of Washington.

MACROTHELYPTERIS TORRESIANA (THELYPTERIDACEAE) NEW TO KENTUCKY, WITH AN UPDATE OF ITS CONTINUED EXPANSION IN THE UNITED STATES. ***Courtney E. Gorman*, Matt S. Bruton*, and Dwayne Estes,*** *Austin Peay State University, Clarksville, Tennessee.* *Macrothelypteris torresiana* (False Maiden Fern) is an invasive exotic Asian species first collected in the United States from Seminole County, Florida, in 1904. Since then it has been documented from much of the lower southeastern United States and is now found throughout most of the region between South Carolina, Florida, and eastern Texas. Recently, *M. torresiana* has been expanding its range northward into the interior of the United States with reports from southern Tennessee, southwestern Virginia, and southern Illinois. Here, we report the first occurrence of *M. torresiana* from Kentucky and discuss the spread of this species in the U.S. since 1970. A discussion of the ecological conditions and associated flora of the Todd County, Kentucky, population is also presented.

THE DISTRIBUTION, ABUNDANCE, AND HABITAT COLONIZATION OF THE INVASIVE SUBMERSED MACROPHYTE, *HYDRILLA VERTICILLATA*, IN THE OBED WILD AND SCENIC RIVER, MORGAN COUNTY, TENNESSEE. ***Dwayne Estes, Chris Fleming, Angelina D. Fowler*, and Nathan Parker,*** *Austin Peay State University, Clarksville, Tennessee (DE, AF, NP) and BDY Environmental LLC (CF).* The Obed Wild and Scenic River is part of the Emory River Watershed (ERW) and is located within the Cumberland Plateau. The ERW is infested by the invasive aquatic macrophyte, *Hydrilla verticillata*. In 2010, a study was initiated for the U.S. National Park Service to determine the origin of the *Hydrilla* infestation and the distribution and relative abundance of the species within the

ERW. Fieldwork occurred from July–September 2010. The source for *Hydrilla* was found to be a private lake that feeds into Daddy's Creek in Cumberland County. From the source it has expanded downstream at least to Harriman in Roane County, a distance of more than 50 miles. A systematic survey of 29.5 miles of the ERW, from Devil's Breakfast-table on Daddy's Creek to Camp Austin on the Emory River, revealed that *Hydrilla* covers 26% of this portion of the ERW and prefers pool and run habitats.

FLORISTIC SURVEY OF THE OCOEE RIVER GORGE. ***Sunny Hart*, Emily Blyveis, Matt S. Bruton, Clea Klagstad, Nathan Parker, Dwayne Estes, and Joey Shaw,*** *Austin Peay State University (MB, CK, NP, DE) and University of Tennessee at Chattanooga, Tennessee (SH, EB, JS).* The Ocoee River Gorge (ORG) is one of the longest river gorges in Tennessee and is situated within the transition zone between the Ridge and Valley and Blue Ridge Mountains. In July 2010, a study was initiated to document all species/intraspecific vascular plant taxa within the ORG, to document populations of rare and invasive plant species, and to map the plant communities present. Sixteen collecting trips made from July to November have yielded approximately 500 species including 12 species of conservation concern. Noteworthy collections also include first reports for *Fraxinus quadrangulata* and *Carya carolinae-septentrionalis* from the Blue Ridge and a first report of the non-native *Lathyrus sylvestris* from Tennessee. Additional work to document the flora and vegetation will be conducted through 2011.

RECENT ADDITIONS AND NOTEWORTHY VASCULAR PLANT COLLECTIONS FROM TENNESSEE. ***Dwayne Estes, Todd Crabtree, and Joey Shaw,*** *Austin Peay State University, Clarksville, Tennessee (DE), Tennessee Natural Heritage Program, Nashville, Tennessee (TC), and The University of Tennessee at Chattanooga, Chattanooga, Tennessee (JS).* The Fifth Checklist of Tennessee Vascular Plants published in 2007 documented 2,874 species and intraspecific vascular plant taxa from Tennessee representing 860 genera and 182 families. Additional field and herbarium work conducted since 2007 have resulted in the discovery of several new vascular plant records. Of these, nine represent species new-to-science including new types of *Allium*, *Carex*, *Clematis*, *Glandularia*, *Helianthus*, *Lysimachia*, *Polymnia*, and *Symphyotrichum*. Four species were found which represent state records for native species including *Ceolorachis rugosa*, *Ceanothus herbaceus*, *Leptopus phyllanthoides*, and *Packera paupercula* var. *pseudotomentosa*. Nine species were found which represent state records for non-native taxa including *Bidens pilosa*, *Cyrtomium fortunei*, *Hosta* sp. (specific identity to be determined), *Indigofera hirsuta*, *Ipomoea cordatotriloba*, *Kyllinga odorata*, *Lathyrus sylvestris*, *Marsilea* sp. (specific identity to be determined), and *Vicia hirsuta*.

A FLORAL SURVEY AND *CASTANEA DENTATA* (FAGACEAE, AMERICAN CHESTNUT) CENSUS AT BENDABOUT FARM, BRADLEY COUNTY, TENNESSEE. ***Amelia Harris*, J. Hill Craddock, and Joey Shaw,*** *The University of Tennessee at Chattanooga, Chattanooga, Tennessee.* Bendabout Farm is a 1,619-ha family farm in Bradley County, Tennessee. Portions of this land have been owned by the same family since 1841, making it a valuable piece of land in Tennessee's Ridge and Valley. Floristic inventories in this region have not kept pace with that of quick suburban development. The farm includes habitats such as upland hardwood forests, lowland forests, wetlands, open pastures and pine forests. Wooded areas are managed with prescribed burns to improve wild game habitat. There are two major goals of this study, the first being to conduct a thorough inventory of the Farm's flora. Since June 2010, 15 collecting trips were made documenting 204 species from 64 families. Introduced species comprise 8% of the total species count. The farm has been instrumental in American chestnut breeding efforts since 1994. Saplings from old rootstocks have been reported from the farm, and documenting the location of these saplings is the second goal of the project. Intensive chestnut research will begin in summer 2011.

IMPACTS OF NONPOINT-SOURCE POLLUTION ON DIATOM COMMUNITY STRUCTURE AND OXYGEN METABOLISM IN THE RED RIVER WATERSHED OF NORTHCENRTAL TENNESSEE. ***Jefferson G. Lebkuecher, Stacy M. Rainey*, Chelsea B. Williams*, and Alex J. Hall****, *Austin Peay State University, Clarksville, Tennessee.* Six streams in the Red River Watershed were sampled to evaluate the impacts of nonpoint-source pollution on the structure of benthic diatom assemblages and whole-stream oxygen metabolism. The three most abundant taxa sampled in the watershed were *Nitzschia linearis* (16.4%), *Navicula reichardtiana* (15.4%), and *Navicula tripunctata* (7.2%). These taxa are tolerant of habitat degradation due to excessive sediments and nutrient enrichment. Poor water quality in all six streams was indicated by (1) high Siltation Index values for diatom assemblages revealing the loss of biotic integrity as a result of erosion, (2) high rates of whole-stream oxygen metabolism characteristic of eutrophic conditions, and (3) low ratios of whole-stream gross primary production to respiration typical of heterotroph-dominated habitats associated with poor quality water. The results reveal the negative impacts of nonpoint-source pollution on the ecological integrity of diatom communities and oxygen dynamics in streams of the Red River Watershed.

THE EFFECTS OF *LONICERA MAACKII* ON THE DIVERSITY OF SMALL WOODY PLANTS AT WARNER PARKS IN NASHVILLE, TENNESSEE. ***Julianna Bejma* and Darlene Panvini,*** *Belmont University, Nashville, Tennessee.* The prevalence of exotic plants can lead to a decrease in biodiversity in surrounding areas. *Lonicera maackii*, bush honeysuckle, is an exotic shrub commonly found in Tennessee. This project examines the impact of *L. maackii* on the diversity of small woody plants in three plot types: honeysuckle removed six months prior to data collection, honeysuckle present, and honeysuckle historically absent. Woody plants less than 1 m tall were counted and identified in five 10 m^2 plots. Height of small shrubs in five 1 m^2 subplots was measured and assigned to height classes. No significant difference in presence of honeysuckle and native species was found between plot types; however, a general trend suggests that with more data, a significant difference would be found between plots with and without honeysuckle. This project is in the early phase of a long-term study of the impact of *L. maackii* on small woody species.

GENETIC DIVERSITY OF *DALEA FOLIOSA* USING ISSR MARKERS. ***Jay Pannell*, Wes Rogers*, Amanda D. Williams, and Mary K. Sledge,*** *Lipscomb University, Nashville, Tennessee.* *Dalea foliosa* is a federally endangered species. Previous studies have shown that genetic variation is greatest among Tennessee

populations. The goal of this project was to assess genetic diversity among three accessions of *D. foliosa* held by the National Plant Germplasm System (NPGS): PI 648967, PI 648968, and PI 648969. Ten plants from each population were grown in the greenhouse. Genomic DNA was isolated and analyzed with ISSR markers 857, 861, and 881 producing a total of 213 bands. Genetic diversity for pairs of plants was determined using Nei and Li's coefficient of genetic similarity. This analysis showed that two of the populations studied were closely related while a third population showed greater genetic diversity. This information will be used to select genetically diverse parents to set up a polycross for the production of seed for field testing.

ALLELOPATHIC ACTIVITY OF *PASSIFLORA INCARNATA* EXTRACTS AS MEASURED BY *HORDEUM VULGARE* AND *RAPHANUS SATIVUS*. ***Adam W. Keasling* and Frank Bailey**, Middle Tennessee State University, Murfreesboro, Tennessee.* Allelopathy is the inhibitory activity of plant-produced chemicals upon other plants. These allelochemicals are of interest because they represent potentially novel pharmacophores possessing herbicidal activity that may target undiscovered molecular receptor sites. The objective of this study was to test the allelopathic activity of *Passiflora incarnata* extracts against the monocotyledonous and dicotyledonous test species *Hordeum vulgare* and *Raphanus sativus*. Continuous exposure to total aqueous extracts of *P. incarnata* caused statistically significant germination inhibition at all tested concentrations for *H. vulgare*, but only at the highest concentration for *R. sativus*. A 14-day growth assay showed that initial 24-h exposure to total aqueous extracts had no effect on either harvested dried weights or leaf-bleaching ratios of either test species; however the delayed 24-h exposure showed significant leaf-bleaching in *H. vulgare*. Lastly, bioassay-guided sequential-solvent extractions (varying polarity) were done. Several extracts of differing polarity were active in *H. vulgare* but only one against *R. sativus*.

CELL AND MOLECULAR BIOLOGY

MICHAEL W. THOMPSON, CHAIR

PROSTATE SPECIFIC MEMBRANE ANTIGEN PROCESSES LAMININ DOWNSTREAM OF MATRIX METALLOPROTEASES IN ENDOTHELIAL CELL ACTIVATION AND ANGIOGENESIS. ***Alex Patterson*, Bobby Rampp*, Amanda D. Williams, and Beth Conway**, Lipscomb University, Nashville, Tennessee.*

RELATIVE LEVELS OF CX-26 MRNA LEVELS IN GT1-7 CELLS FOLLOWING PASSAGING. ***Megan J. Walker* and Gilbert R. Pitts**, Austin Peay State University, Clarksville, Tennessee.* The episodic release of gonadotropin-releasing hormone (GnRH) is pivotal for successful reproductive function as GnRH regulates follicle-stimulating hormone and luteinizing hormone which are required for steroidogenesis and gametogenesis. Each GnRH neuron has an oscillator which regulates the timing of GnRH secretion. It has been proposed that gap junctions, such as connexin 26, are key structures in synchronizing the release of GnRH. This study utilized reverse-transcriptase real-time polymerase chain reaction to investigate the level of Cx26 mRNA within GT1-7 cells after passaging. GT1-7 cells were chosen for this study because they are an immortalized cell line derived from GnRH neurons and they mimic *in vivo* patterns of GnRH secretion. This study demonstrates that the level of Cx26 mRNA increased in a time-dependent manner following passaging, suggesting that Cx26 may play a role in communication between gondatropin-releasing hormone cells.

ASPARAGINE^{362} INCREASES ZINC AFFINITY OF LEUKOTRIENE A_4 HYDROLASE THROUGH INTERACTIONS WITH ZINC-BINDING RESIDUES. ***Michael W. Thompson, Alexis Schaible*, Frank C. Bailey, and Rebecca L. Seipelt**, Middle Tennessee State University, Murfreesboro, Tennessee.* Leukotrine A_4 hydrolase (LTA_4H) is a pro-inflammatory zinc metallopeptidase/epoxide hydrolase that contains an atom of zinc at the active site. This zinc ion is bound to two histidine residues and a glutamate residue at the active site center. One of these residues, Asn^{362}, was mutated to Gln (N362Q), Glu (N362E), and Leu (N362L). While the N362E and N362L mutants exhibited minimal catalytic activity and reduced zinc affinity, the N362Q mutation exhibited reduced catalytic activity and slightly reduced zinc affinity, indicating that Asn^{362} likely influences the chemical environment of the nearby zinc coordinating residue Glu^{363} through a possible hydrogen bond interaction. Trp^{356}, situated at the edge of the active site cleft, appears to help maintain the conformation of the enzyme but does not appear to contribute significantly to zinc binding. A better understanding of catalysis by LTA4H will help further the design of drugs to target the inflammatory process.

THE EFFECTS OF 6-HYDROXYDOPAMINE ON CHEMOTAXIS IN *CAENORHABDITIS ELEGANS*. ***Lindsey Dalton* and Nick Ragsdale**, Belmont University, Nashville, Tennessee.* Recent investigations have looked at the effect of 6-hydroxydopamine (a known neurotoxin to the dopaminergic neurons) on the locomotion of *Caenorhabditis elegans* (*C. elegans*) in response to a physical stimulus. An unexpected result was an increase in velocity that occurred within the first 5–10 seconds following the physical stimulus. While *C. elegans* undoubtedly responds to physical stimuli in the wild, a more natural stimulus is the chemotaxis to a food source. The current study investigates the intentional chemotaxis of *C. elegans* toward known attractants following 6-hydroxydopamine treatment.

SMALL EXTRACELLULAR MATRIX PEPTIDES REGULATE ENDOTHELIAL CELL ACTIVATION. ***Bobby Rampp*, Alex Patterson*, Amanda D. Williams, and Beth Conway**, Lipscomb University, Nashville, Tennessee.* Angiogenesis is regulated by numerous factors, including the extracellular matrix (ECM) and large ECM fragments. ECM clearance by proteases is one of the initial steps in the formation of new blood vessels. Matrix metalloproteases (MMPs), the major class of proteases implicated in angiogenesis, degrade numerous intact ECM proteins to fragments ranging from 20–50 kDa in size. However, multiple other proteases required for angiogenesis do not efficiently degrade large proteins and prefer small peptide substrates. However, the contribution of small ECM peptides to angiogenesis has not been studied. We hypothesize that these proteases may contribute to angiogenesis by producing small, bioactive peptides from larger degradation fragments from the ECM. Using major components of the ECM such as collagen and laminin, we generated small peptides and tested endothelial cell activation using adhesion assays. Our results show that endothelial cell activation is increased in the presence of small ECM peptides, thus supporting our hypothesis.

THE EFFECTS OF ROTENONE ON CHEMOTAXIS IN *CAENORHABDITIS ELEGANS*. ***Julie Malkowski* and Nick Ragsdale***, *Belmont University, Nashville, Tennessee. Caenorhabditis elegans* (*C. elegans*) has been utilized as a model for Parkinson's disease. Common practice is to induce the loss of dopaminergic neuronal death utilizing various neurotoxins. One such neurotoxin is 6-hydroxydopamine (6-OHDA). 6-OHDA supposedly works by inhibiting some of the enzymes utilized to make catecholamines. It is hypothesized that this enzymatic inhibition results in the production of oxygen radicals that eventually kill the dopaminergic neuron. To investigate this hypothesis, the current research utilized rotenone as a comparison dopaminergic neuronal neurotoxin. Rotenone has been investigated thoroughly and has been shown to kill neuronal cells via oxidative damage after the inhibition of electron transfer in the mitochondrial electron transport chain. A comparison between the effects of rotenone versus 6-OHDA was made to determine if *C. elegans* chemotaxed in a similar fashion following treatment with either neurotoxin.

THE EFFECTS OF DOPAMINE ON CHEMOTAXIS IN *CAENORHABDITIS ELEGANS*. ***Luke Starner* and Nick Ragsdale***, *Belmont University, Nashville, Tennessee.* A series of experiments has characterized the loss of dopaminergic neurons in the soil nematode *Caenorhabditis elegans* (*C. elegans*). These previous investigations utilized 6-hydroxydopamine (6-OHDA) to kill the dopaminergic neurons and then determined the mean velocity of the worms after a physical stimulus. To elaborate on the investigation, dopamine was given to the worms following 6-OHDA treatment. A potential flaw to this experimental design is the short time period that the investigation recorded following a physical stimulus. Thus, the current experiment investigates the effect of dopamine on the chemotaxis of *C. elegans* to a volatile attractant.

THE EFFECTS OF AGING ON CHEMOTAXIS IN *CAENORHABDITIS ELEGANS*. ***Kathryn Roach* and Nick Ragsdale***, *Belmont University, Nashville, Tennessee.* As the body ages, it accumulates damage from oxygen radicals. Additionally, the body's ability to prevent additional oxidative damage diminishes. The current study investigates the affect of aging on the ability of *Ceanorhabditis elegans* to chemotax to a known attractant.

OLFACTORY RESPONSES OF *C. ELEGANS* TO SELECTED BACTERIAL SPECIES. ***Gabrielle Facey* and Robert T. Grammer***, *Belmont University, Nashville, Tennessee.* The study of olfaction and chemotaxis in the nematode *Caenorhabditis elegans* gives insight into human olfaction and the integration of sensory and motor functions. Chemotactic studies have been previously reported using various chemicals and different species of bacteria. Previous work done in this lab examined the chemotactic behavior of *C. elegans* to benzaldehyde as a function of prior exposure. Now, in current work, that technique is being attempted with various bacteria. The chemical isoamyl alcohol—a known attractant to *C. elegans*—was tested using this behavioral assay, and the results resembled literature values. With the results found with isoamyl alcohol serving as a positive control, we are now seeking to examine the behavior of *C. elegans* toward *E. coli* OP50 and *Serratia marcescens* in the migration assay.

CHARACTERIZATION OF THE DEAD ELVIS (DEL) MUTATION IN ZEBRAFISH. ***Lauren Milleville*, Michael R. Taylor, Charles A. Lessman, and Ethan A. Carver,*** *University of Tennessee at Chattanooga, Chattanooga, Tennessee (LM, EC), St. Jude's Children's Hospital, Memphis, Tennessee (MT), and University of Memphis, Memphis, Tennessee (CL).* During embryonic development, a subset of cells differentiate into discrete muscle tissues. This process allows the embryo to propel itself, to contract the heart muscle to drive blood throughout the organism, and to perform other functions necessary for continued existence. Our project is focused on a specific zebrafish mutant, dead elvis, discovered through a novel screening methodology in Lessman's laboratory at the University of Memphis. The dead elvis mutation manifests a non-motile phenotype starting around 20 h after fertilization for embryos that are homozygous for the allele. The dead elvis mutation has obvious myotome defects. This research project involves the characterization of the dead elvis mutation utilizing immunohistochemistry and confocal microscopy techniques to observe muscle formation and sarcomeric assemblages. A further study of this mutation may aid in the understanding of myotome development within skeletal muscle and lead to more insight into human neuromuscular disease conditions.

THE ROLE OF ENDOTHELIN CONVERTING ENZYME-1 IN HUMAN BREAST CANCER CELL INVASION. ***Molly Watson*, Amanda D. Williams, and Beth Conway.*** *Lipscomb University, Nashville, Tennessee.*

BRAIN DERIVED NEUROTROPHIC FACTOR EXPRESSION IN PROSTATE CANCER CELLS DURING STRESS. ***Kyle Brawner*, Amanda D. Williams, and Jon Lowrance.*** *Lipscomb University, Nashville, Tennessee.*

BRAIN DERIVED NEUROTROPHIC FACTOR EXPRESSION DURING CELLULAR STRESS IN T-LYMPHOBLASTS. ***Porter W. Maerz*, Amanda D. Williams, and Jon Lowrance.*** *Lipscomb University, Nashville, Tennessee.*

ENDOTHELIN CONVERTING ENZYME-1 EXPRESSION LEVELS IN BREAST CANCER CELLS. ***Ben Kellum*, Amanda D. Williams, and Beth Conway.*** *Lipscomb University, Nashville, Tennessee.*

CHEMISTRY

DANIEL J. SWARTLING, CHAIR

HARTREE-FOCK AND DENSITY FUNCTIONAL MODELING OF THE RAMAN SPECTRA OF MELAMINE DERIVATIVES AND B-LACTAM ANTIBIOTICS. ***William H. Ilsley and Ngee-Sing Chong,*** *Middle Tennessee State University, Murfreesboro, Tennessee.* Computational modeling, using Hartree-Fock and density functional methods of lactam-based antibiotics and precursors for the melamine-cyanuric acid complex, was performed to understand the Raman spectral data of these compounds. Modeling of these compounds in the gas and aqueous phases, as well as the chemisorbed species on the surface of silver, would enable the interpretation of their chemical structures by spectroscopists. Since the structures of these compounds are sensitive to pH, aqueous samples of these compounds, at various buffered pHs, were probed by Raman spectroscopy and surface-enhanced Raman spectroscopy after

the adsorption of these compounds onto silver colloidal nanoparticles. Preliminary modeling results suggest that the Raman spectra of these compounds are most closely reproduced using the B3LYP/LANA2MB methodology. In general there appears to be a close correlation of observed wavenumbers and the theoretical prediction by modeling. However, there is a lack of agreement between the experimental and theoretical values for the relative intensities of the peaks.

BEYOND THE COOKBOOK: LEARNING ABOUT KINETICS IN GENERAL CHEMISTRY LABORATORY. ***Stephanie E. Meadows* and Scott H. Northrup,*** *Tennessee Technological University.* This project was designed to take student comprehension of chemical kinetics and the rate law to a deeper level in the general chemistry laboratory. Extending an already existing laboratory experiment, Kinetic Study of the Reaction between Ferric and Iodide Ions (Iodine Clock Reaction), students were challenged to complete a follow-up activity. In this activity they were asked to apply their knowledge of the discovered rate law to prepare a solution that would react in a period of time of their choosing. Of the eight sections of general chemistry at TTU, four performed the follow-up activity and four served as the control. Based on pre- and post-assessment of all sections, students demonstrated they gained knowledge in the completion of the original laboratory experiment with very little additional benefit of performing the extended activity, within statistical uncertainty. The performance of individual sections was widely varying, indicating the importance of how graduate teaching assistants managed their sections.

EXTRACTIVE CHROMATOGRAPHY FOR THE TREATMENT OF USED NUCLEAR FUEL. ***Matthew D. Gott*, Dale D. Ensor, and Richard A. Bartsch,*** *Tennessee Technological University, Cookeville, Tennessee (MDG, DDE), and Texas Tech University, Lubbock, Texas (RAB).* The removal of cesium from high-level nuclear waste has been successfully accomplished using calixarene-benzocrown-6 ether compounds. New extractive chromatographic resins have been prepared using lipophilic calix [4] arene-benzocrown-6 ethers in the 1, 3-alternate conformation functionalized with pendant acidic groups on an inert polymeric substrate. The compounds used were CAB6anisole, containing the -C(O)$NHSO_2$PhOCH pendant group, and CAB6methyl, containing the -C(O)$NHSO_2CH_3$ pendant group. In alkaline solutions, cesium was strongly retained by the new resins, and the presence of the pendant acid groups reduced the strength of this interaction so that cesium was stripped at low acid concentrations. The results mimic data obtained from a previous solvent extraction study. These materials exhibited a high selectivity for cesium over sodium, potassium, and strontium at salt concentrations < 0.5 M. Column studies showed cesium was retained from 0.01 M NaOH and then easily stripped with 0.01 M HNO_3. These materials show promise for removal and concentration of cesium from alkaline high-level radioactive waste.

USING LIQUID FLOW IN PLASTIC MODELS TO DEMONSTRATE GRAVITY CURRENTS IN THE CLASSROOM. ***Harvey F. Blanck,*** *Austin Peay State University, Clarksville, Tennessee.* Naturally occurring gravity currents include events such as air flowing through an open front door, a volcanic eruption's pyroclastic flow down a mountainside, and the spread of the Bhopal disaster's methyl isocyanate gas. Gravity currents typically have a small height to distance ratio. I have constructed plastic models for high viscosity planar and radial spreading using a series of connected cells. The resulting gravity currents have a large height to distance ratio making them suitable for classroom demonstrations. Laminar flow in the models was achieved by using a concentrated sucrose solution. Simple incremental transfer equations were used in a spreadsheet to calculate the expected gravity current profiles by using spreadsheet columns for model cells and rows to show a change with time. Calculated liquid heights are in good agreement with the actual liquid heights in the model's cells at steady state.

REFINEMENT OF THE SPECTROPHOTOMETRIC ANALYSIS OF Hg (II) USING DITHIZONE. ***Stephen Kojo Okine* and Hong Zhang,*** *Tennessee Technological University, Cookeville, Tennessee.* Spectrophotometric analysis of Hg(II) using dithizone is widely used in analyzing various Hg(II) samples. However, the procedures available in the literature are limited regarding its application in studying Hg(II) reactions over long durations or in the presence of humic acids. The major problem of concern is the decomposition of dithizone at room temperature in the dark. Experiments were conducted to address this issue and refine this method as an analytical tool for the research. Our results show that dithizone solution, instead of chloroform (solvent), should be used to zero the spectrophotometer; the concentration of dithizone should remain sufficiently high depending on the duration of the study; a fresh calibration curve should be obtained if the study spans more than 1 h; and the presence of humic acids at levels below 100 ppm appeared to have no effect on the analysis. With these factors controlled, satisfactory analytical results can be obtained.

MASS SPECTROMETRIC IDENTIFICATION OF DIFFERENTIALLY EXPRESED PROTEINS IN *CHLAMYDOMONAS REINHARDTII* DUE TO TRICLOSAN TOXICITY. ***Upul Deepthike* and Jeffrey O. Boles,*** *Tennessee Technological University, Cookeville, Tennessee.* A comparative proteomic approach was used to identify toxic effects of the widely used antibacterial agent triclosan to green microalga *Chlamydomonas reinhardtii.* Two-dimensional electrophoresis maps obtained for extractable proteins from triclosan-treated (50 ng/mL) and control algal cultures showed significant down- and up-regulation of certain proteins due to the effects of triclosan. NanoESI-QTOF mass spectrometric analysis and subsequent peptide mass fingerprinting were performed to identify the differentially expressed proteins. Identified down-regulated proteins indicated that triclosan interferes with several vital biological processes including mitochondrial oxidative phosphorylation in *C. reinhardtii.* In addition, several up-regulated proteins revealed the presence of molecular-level defensive mechanisms in the alga against triclosan toxicity. These results suggest that studying of proteomic changes in test organisms induced by environmental toxicants is useful in understanding the modes-of-action of the toxicants.

PROTEOMIC PROFILING OF UNNATURAL AMINO ACID TOXICITY THROUGH DIFFERENTIAL EXPRESSION OF *WILD TYPE* VS. TELLUROPROTEINS IN *ESCHERICHIA COLI* DL41(DE3) pCOCK. ***Sarah C. Brinkley* and Jeffrey O. Boles,*** *Tennessee Technological University, Cookeville, Tennessee.* Three-dimensional conformation of proteins can be solved with greater ease by utilizing unnatural amino acids (UAAs) and x-ray crystallography. Because most atoms naturally occurring in

proteins do not have sufficient mass to interact with x-ray radiation, UAAs offer a solution to the "phase problem." Bioincorporation of L-telluromethionine (TeMet) can introduce useful scattering centers through a simple benchtop procedure; unfortunately, cytotoxicity of TeMet substantially reduces *in vivo* uptake. Understanding the effects of TeMet, through proteomics, has the potential to explain incorporation difficulties. Differential expression of Met auxotroph, *Escherichia coli* DL41 (DE3) pCOCK, has revealed proteomic variation in cells forced to use TeMet in the translation of proteins. Differentially expressed proteins were identified by nano-ESI/qTOF/MS leading to proposed mechanisms by which proteome variation occurs.

CHARACTERIZATION OF VOLATILE ORGANIC COMPOUNDS FROM MOLDS USING GAS CHROMATOGRAPHY-MASS SPECTROMETRY. ***Chelsey Crowell* and Beng Guat Ooi,*** *Middle Tennessee State University, Murfreesboro, Tennessee.* Molds found both indoor and outdoor have been known to cause adverse health effects. Species of *Penicillium* such as *P. chrysogenum* and *P. digitatum* can be found on wallpaper, carpets, and fabrics in homes. As the molds propagate, they produce mycotoxins that can trigger asthma and hay fever symptoms. In addition, molds produce microscopic spores for the purpose of propagation. Following the recent flood devastation in Nashville, many residents and business owners are faced with remediation efforts as a part of the restoration of their flooded homes and buildings because of serious mold infestation. Since dead mold and spores can still be allergenic, it is necessary to have a reliable method for detecting any microbial volatile organic compounds (MVOCs) released from spores. The purpose of this research project is to develop a GC-MS method for detecting the mycotoxins and MVOCs and to distinguish among the different species of mold.

CALIBRATION OF DIAPHRAGM VACUUM GAUGE MEASUREMENTS OF WATER ASPIRATOR PERFORMANCE. ***Alae Rabiei* and Martin V. Stewart,*** *Middle Tennessee State University, Murfreesboro, Tennessee.* The water aspirator is an apparatus commonly used in chemistry laboratories to evacuate closed systems to the limit of the vapor pressure of water. Previous work showed that a type of polypropylene water aspirator (NALGENE Labware, no. 6140-0010) designed to consume less water gave optimum performance in producing a vacuum under the low water pressure experienced in the Davis Science Building at MTSU. This was established by careful measurements with a diaphragm vacuum gauge (Marshall Instruments, Inc., no. 80755). The gauge was calibrated through simultaneous measurement of pressure on partially evacuated systems with the vacuum gauge and a mercury-filled, open-end, U-tube monometer read to the nearest 0.1 mm Hg and corrected for temperature, latitude, and altitude. A nonlinear calibration curve was initially obtained due to mechanical error in the gauge, but a linear calibration curve having a near unity correlation coefficient was obtained when the gauge was lubricated.

A HISTORY OF THE CHEMISTRY SECTION OF THE TENNESSEE ACADEMY OF SCIENCE: 1940–2010. ***Stokes R. Swann*, James X. Corgan, and Martin V. Stewart,*** *Middle Tennessee State University, Murfreesboro, Tennessee (SRS, MVS), and Austin Peay State University, Clarksville, Tennessee (JXC).* A study of the history of the Chemistry Section of the Tennessee Academy of Science from its inception in 1940 through 1986 was initiated by Corgan and updated through 2007 by Stewart. These studies concluded that the total number of oral presentations of the Chemistry Section at annual TAS meetings may be divided into either two or three distinct phases that are closely related to the growth, development, and research priorities of Tennessee colleges and universities and the impact of the increasing number of poster presentations since the official incorporation of a poster session in 1995. These data have now been refined by taking into account the number of papers from particular institutions instead of just the total number of papers, which reveals a more complex pattern of overlapping periods of dominance of individual Departments of Chemistry.

REGIOSELECTIVE REDUCTIONS OF POLYHALOHETEROAROMATICS. ***Rachael Hall* and Scott T. Handy,*** *Middle Tennessee State University, Murfreesboro, Tennessee.* Substituted heteroaromatics are at the core of many important compounds. For example, drugs such as tamoxifen, lipitor, and vioxx contain heteroaromatics. In addition, organic dye molecules and the materials used in the latest solar energy cells also are based on heteroaromatics. Although there are many routes to such compounds, certain substitution patterns are still very difficult to prepare. As part of an on-going project focused on the development of cross-coupling reactions to prepare substituted heteroaromatics from the halogenated versions, we were interested in selectively having just one position halogenated. Since it was easy to prepare dihalo compounds, regioselective dehalogenation was attempted. Thus, treatment of a number of polyhaloheteroaromatics with copper(I) chloride and sodium borohydride in methanol afforded the monohalo products in good yield after short reaction times. The scope of these conditions and synthetic applications will be discussed.

ONE-POT IODINATION/CROSS-COUPLINGS IN ROOM TEMPERATURE IONIC LIQUIDS. ***Lindsey Bailey* and Scott T. Handy,*** *Middle Tennessee State University, Murfreesboro, Tennessee.* The use of room temperature ionic liquids (RTILs) as environmentally benign (green) alternatives to conventional organic solvents is increasingly well established. Nevertheless, this approach still generally involves the use of significant amounts of conventional organic solvents for extraction and purification following each reaction. From this standpoint, sequential reactions offer a clear advantage, since multiple transformations can be performed in a one-pot fashion, reducing the number of workups and purifications required. Given that one of the outstanding features of RTILs is the ability to tune their properties, they would appear to have great potential in the area of sequential reactions. In light of our interest in cross-coupling chemistry, one application we have been studying is combining a halogenation and a cross-coupling reaction in a one-pot fashion. Our studies to this end and the scope and limitations of these reactions will be reported.

ANNULATED CARBAZOLES AS NEW DONORS FOR DYE SENSITIZED SOLAR CELLS. ***Jessica Treadway*, Ian Hunter, and Scott T. Handy,*** *Middle Tennessee State University, Murfreesboro, Tennessee.* The development of alternative, non-fossil-fuel-based energy sources is an area of critical need both nationally and globally. Solar energy certainly is one of the most attractive of these alternatives but still requires less expensive materials that are more efficient and absorb a greater range of

the solar spectrum. In this respect, dye-sensitized solar cells (DSSC), particularly organic dye-sensitized, hold significant promise. The basic structure of these dyes follows a common motif of an amine-containing donor, an electron-withdrawing acceptor, and a central linker for conjugation. Many dyes of this type have been reported, but the focus is virtually exclusively on the central linker region. We are studying annulated donor groups, which should afford better chromophores with expanded spectral coverage and shorter syntheses. These new donors can then be used to prepare new dyes with a variety of linkers for the development of the next generation of DSSCs.

A SERIES OF ALLOXAN THIOSEMICARBAZONES AND REACTIONS WITH PLATINUM AND PALLADIUM. ***Talon Hill*, Andrea Wilson, Maxie Phillips, Jason L. Freeman, and Edward C. Lisic,*** *Tennessee Technological University, Cookeville, Tennessee.* This work will present the synthesis and ^{1}HNMR characterization of alloxan tertbutyl thiosemicarbazone and then compare to our series of alloxan thiosemicarbazide (All-TSC) ligands. This ligand acts as a chelating tridentate ligand with Pd(II) when reacted with potassium tetrachloropalladate. ^{1}HNMR characterization supports our postulated structure.

ENZYMATIC AND MASS SPECTRAL ANALYSIS OF MUTANT AND WILD-TYPE SELENOMETHIONYL-DIHYDROFOLATE REDUCTASE. ***Kathleen Broderick* and Jeffery O. Boles,*** *Tennessee Technological University, Cookeville, Tennessee.* The biosynthetic incorporation of unnatural amino acids, primarily selenomethionine, has been used for over a decade to facilitate structural determination of proteins. This substitution has been shown to lead to instability and incomplete incorporation in some target proteins. In this study, the stability, level of incorporation and catalytic activity of selenomethionyl-dihydrofolate reductase (Se-Met DHFR) and wild type DHFR have been analyzed for catalytic activity and stability. The sensitivity to cyanogen bromide and trypsin for mass spectral analysis will be presented. A methionine to leucine mutation at position 6, also subjected to these analyses for both the wild-type and selenoprotein, will be presented.

ADSORPTION OF ATMOSPHERIC MERCURY (Hg(II)) BY TOP SOIL THROUGH LEACHING OF RAIN WATER: A PRELIMINARY LABORATORY SIMULATION STUDY. ***Carrie Thompson* and Hong Zhang,*** *Tennessee Technological University, Cookeville, Tennessee.* This research project originated from a scientific question about the fate of Hg deposited from the atmosphere to soils. Laboratory simulation experiments were conducted to study the interactions of mercury (II) with soil during leaching. This was done by administering Hg(II) solutions of different concentrations through columns of the samples of a top soil for ~35 min and then analyzing the leachate for Hg(II) spectrophotometrically using dithizone. The experimental setup included a group of columns filled with 10 or 30 g of soil samples. Our results show that the Hg(II) added was nearly completely adsorbed by the soil samples during about half hour of leaching; the Hg(II) adsorbed by the soil cannot be leached out by water. More Hg(II) was adsorbed during the second time of leaching of the same soil samples. Future work will involve leaching experiments with various soils to compare the results.

UV-VIS ABSORBANCE OF HUMIC ACIDS EXPOSED TO UVB LIGHT: A PRELIMINARY STUDY. ***Zachary Andreasen* and Hong Zhang,*** *Tennessee Technological University, Cookeville, Tennessee.* Humic acids (HAs) are naturally synthesized polymers widely distributed in soils and waters. The photochemical decomposition of a commercial HA (Aldrich) was studied by means of UV-Vis spectroscopy. A photochemical set-up was assembled using four UV-B florescence lamps around an anchored quartz tube on a stirring plate. The set- up was enclosed with aluminum foil and cardboard. The reactor contains 100 mL of the solution of the HA tested. The HA solutions of 10 and 30 ppm were each exposed to UVB light. We found that the UV absorbance of the HA exposed to UV light decreased with increasing of the exposure duration. The changes of the UV spectra reflect the structural changes of the HA. More prominent spectra changes were observed at 200–300 nm and the higher HA concentration. The effect of the photochemical decomposition of HAs on the photochemical redox of metals is of interest for further research.

INVESTIGATION OF RAMAN SPECTROSCOPY FOR THE QUANTITATIVE ANALYSIS OF NANOPARTICLE MIXTURES. ***Christopher Fowler* and Andrew Callender,*** *Tennessee Technological University, Cookeville, Tennessee.* Previous studies by toxicologists have suggested that the properties and functionality of synthetic metal and metal oxide nanomaterials may pose significant problems when the materials are released to the environment. We have explored the use of Raman spectroscopy detection and chemical identification of TiO_2 and ZnO nanomaterials as thin films of solids dried onto an inert substrate to differentiate the nanoparticles from each other. Quantitative analysis using partial least squares regression was employed using MATLAB. Calibration was improved by using 15 factors, as well as covering the spectrum range from 250–3200 cm^{-1} shift.

PHOTOCHEMICAL REDUCTION OF Hg (II) BY HUMIC ACID: A PRELIMINARY STUDY. ***Stephen Kojo Okine*and Hong Zhang,*** *Tennessee Technological University, Cookeville, Tennessee.* Humic acids in natural waters were found to reduce Hg(II) to Hg(0) in sunlight. However, our knowledge of the kinetics and mechanism for this reaction remains limited. We studied the mechanism and kinetics of Hg(II) photochemical reduction in the presence of humic acids. The photochemical setup was composed of four UVB fluorescence lamps and a quartz tube that contained $Hg(NO_3)_2$ and Acros humic acid solution. Hg(II) was analyzed spectrophotometrically using dithizone. Our preliminary results show that at 1 ppm Hg(II) and ~113 ppm humic acid, Hg(II) can be reduced to various extents both in the dark and light. The photochemical reduction occurred at faster rates than the dark one. Our preliminary study appears to suggest that Hg(II)-humic acid complexes probably would not be the major species that are prone to the photoreduction; hence, under the experimental conditions, Hg(II) probably may not be significantly reduced through primary photoreduction.

SYNTHESIS AND BIOLOGICAL STUDIES OF PALLADIUM (II) ACETYLPYRAZINE-THIOSEMICARBAZONE COMPLEXES. ***Michael Beck*, Rachel Swindle, Sean Reilley, and Edward C Lisic,*** *Tennessee Technological University, Cookeville, Tennessee.* Several new acetylpyrazine semicarbazone and thiosemicarbazone ligands have been synthesized in our laboratory and characterized by ^{1}H NMR spectrometry. These new compounds ligate copper (II) and palladium (II) in a tridentate

fashion. The antimicrobial activity of the square planar palladium (II) compounds has been tested by determining the minimum inhibitory concentrations against four bacteria (*Bacillus subtilis, Staphylococcus aureus, Escherichia coli,* and *Pseudomonas aeruginosa*), two yeast (*Canida albicans* and *Sacchromyces cervisiae*), and a mold (*Aspergillus niger*).

DNA BINDING STUDIES OF THIOSEMICARBAZONE COMPLEXES. ***Julia Filer*, Victoria Holcomb, Keyuri Patel, and Edward C. Lisic,*** *Tennessee Technological University, Cookeville, Tennessee.* Thiosemicarbazones have a range of medicinal properties such as antitumor, antifungal, antiviral and antibacterial abilities. These compounds are vividly colored, ranging from fluorescent red to orange. We have studied the DNA binding properties, by utilizing UV-VIS spectroscopy, of a series of thiosemicarbazone molecules and of some metal complexes of Pd^{2+} using these thiosemicarbazone ligands. The thiosemicarbazones include quinolinecarboxaldehyde thiosemicarbazone and alloxan thiosemicarbazone. The ligands are mostly planar molecules, as well as the metal complexes, where the central palladium atom is in a square planar environment surrounded by these tridentate ligands. This planarity offers the possibility of these complexes to physically intercalate into DNA.

SYNTHESIS OF A SERIES OF NAPHTHOQUINONE SULFONIC ACID THIOSEMICARBAZONE LIGANDS AND REACTIONS WITH PALLADIUM (II). ***Megan Monteen*, Maxie Phillips, and Edward C. Lisic,*** *Tennessee Technological University, Cookeville, Tennessee.* The synthesis and ^{1}H NMR characterization of a series of 1,2 naphthoquinone 4-sulfonic acid thiosemicarbazone (NQSA-TSC) ligands will be presented, including dimethylthiosemicarbazone and tert-butylthiosemicarbazone. These water-soluble ligands react with many different transition metal ions in aqueous solution to form highly colored complexes. Structures of these ligands are inferred through ^{1}H NMR characterization. The synthesis of some palladium complexes of these NQSA-TSC will also be described, as well as their binding characteristics on a solid support system.

SYNTHESIS AND CHARACTERIZATION OF SIX NEW PLATIUM(II) QUINOLINE-2-CARBOXALDEHYDE THIOSEMICARBAZONE COMPOUNDS. ***Sandra Miselem, Maxie Phillips, James Ryan Wilson, and Edward C. Lisic,*** *Tennessee Technological University, Cookeville, Tennessee.* Previous research involved synthesis of six new quinoline-2-carboxaldehyde thiosemicarbazone compounds (QCA-TSC), characterized through ^{1}H NMR, melting point determination, IR spectroscopy, and UV-Visible spectroscopy, for the purpose of forming complexes with transition metals. Those compounds were recently reacted with Pd (II) and Pt (II). We present here the synthesis and ^{1}H NMR characterization of six new Pt (II) quinoline-2-carboxaldehyde thiosemicarbazone (Pt-QCA-TSC) and six new Pd-QCA-TSC compounds. The general formulas are [Pt(QCA-TSC)Cl] and [Pd(QCA-TSC)Cl]. Various entries on thiosemicarbazones in the literature indicate a potential use in biological and biomedical applications.

SYNTHESIS OF A SERIES OF 1,2-CYCLOHEXANEDIONE THIOSEMICARBAZONE COMPOUNDS. ***Max Phillips* and Edward C. Lisic,*** *Tennessee Technological University, Cookeville, Tennessee.* Five 1,2-cyclohexanedione thiosemicarbazone derivatives have been synthesized and characterized by ^{1}H NMR. These compounds were synthesized by two separate techniques and the two methods were compared based on purity of product. These substances are to be used as potential tetradentate ligands to react with Pd^{2+} and Pt^{2+} which should form square planar complexes. Entries made in previous literature pertaining to thiosemicarbazones indicate significant applications in biological and biomedical science.

COMPARISON OF KNOEVENAGEL CONDENSATIONS IN DMF VERSUS [BMIM]Br VERSUS CHOLINE CHLORIDE/UREA. ***Jungwun Hwang* and Daniel J. Swartling,*** *Tennessee Technological University, Cookeville, Tennessee.* The Knoevenagel condensation was carried out using Meldrum's acid and aromatic aldehydes or cyclic ketones. The condensation reactions were performed in three different solvent systems: a conventional organic solvent (DMF), an ionic liquid (1-butyl-3-methylimidazolium bromide), and a deep eutectic solvent (choline chloride/urea). The comparison of the different types of solvent systems was an attempt to pursue green chemistry.

METHODS IN THE PRODUCTION OF 5-ALKYLIDENEMALONATE DERIVATIVES OF MELDRUM'S ACID. ***Casey J. McCormick* and Daniel J. Swartling,*** *Tennessee Technological University, Cookeville, Tennessee.* Several 5-alkylidenemalonate derivatives of Meldrum's acid have been synthesized using two methods, Knoevenagel condensation and an enamine/Grignard dual synthesis, to give products with cyclic, aromatic, heteroaromatic, and acyclic side chains. These products are to be used in further synthetic steps to produce analogs of the potent neurotransmitter, GABA (γ-aminobutyric acid). Drugs such as Neurontin® and Lyrica® are analogs of GABA owned by Pfizer, Inc. These drugs have been shown to regulate calcium-dependent voltage channels in the brain and are used to treat neuropathic pain, epilepsy, and prophylaxis of chronic migraines.

PRETREATMENT OF CELLULOSIC FEEDSTOCKS AND CONVERSION TO SIMPLE SUGARS BY ENZYMATIC SYSTEMS: A BIOFUEL INTIATIVE. ***Jessika Pinto* and Jeffrey O. Boles,*** *Tennessee Technological University, Cookeville, Tennessee.* Cellulosic ethanol that originates from perennial grasses and municipal waste is an alternative fuel that can reduce our dependency on foreign oil while at the same time providing an environmentally friendly fuel source. A large amount of municipal waste sorted for recycling is never recycled and ends up in landfills. Approximately 60% of municipal waste is organic and very high in cellulose content. Unfortunately, the commercial availability of cellulosic ethanol is plagued at this time by the slow hydrolysis of cellulose (which produces the required sugar monomers necessary for bioconversion). This project investigates 1) the feasibility of producing a more rapid, reproducible activity assay; 2) increasing the rate of hydrolysis via adjustments to temperature; 3) various pre-treatment methodologies on several readily available feedstocks; and 4) the resultant yield in ethanol for each feedstock.

LC-MS/MS AND SPME-GC-MS/MS ANALYSIS OF SEIZED CLANDESTINE DRUGS TO ESTABLISH A CHEMICAL FINGERPRINT DATABASE. ***Sri Bharat Madireddy* and Jeffrey O. Boles,*** *Tennessee Technological University, Cookeville, Tennessee.* Methamphetamine, a potent psycho-stimulant, abuse has been a major cause of concern throughout the world, especially in Tennessee. Illicit manufacture of methamphetamine

in clandestine laboratories has been carried-out with the use of minimal over-the-counter ingredients. There is a law enforcement desire to establish a correlation between a drug-related crime scene and a clandestine chemist. The current research focuses on developing a *chemical fingerprint* database for seized methamphetamine by LC-MS/MS and GC-MS/MS techniques. Selecting for specific markers—namely, pseudoephedrine and benzylmethylketone (synthetic precursors), N-formylmethamphetamine (synthetic intermediate), and caffeine (adulterant)—allows such a fingerprint to be constructed. The qualitative and quantitative data-set this research provides will potentially create an advantage to criminal investigation in that 1) drug-related crimes can be linked to clandestine chemists and 2) the methods utilized to synthesize methamphetamine, which evolve with the increasing restriction of starting materials, can be more rapidly determined.

POCIS EXTRACTION AND LC-MS/MS ANALYSIS OF STIMULATORY DRUGS OF ABUSE TO EXAMINE ANY SEASONAL VARIATION IN VARIOUS WATER BODIES. ***Vanaja Reddy Bodeddula* and Jeffrey O. Boles,*** *Tennessee Technological University, Cookeville, Tennessee.* Amphetamine-type-stimulants (ATS) are commonly prescribed for attention deficit hyperactivity disorder (ADHD). ATS drugs are being used illegally by some students to stay awake during exams. The goal is to simultaneously identify 16 stimulatory drugs of abuse and to observe any variation in their concentrations over an academic year. Polar Organic Chemical Integrative Sampler (POCIS) disks were deployed in seven sites located near the University of South, Sewanee campus. Samples extracted from the disks were analyzed on Liquid Chromatography Mass Spectrometry (LC-MS/MS). The analytical method was successful in determining certain stimulants in streams, chlorination tank, and sewer. None of the drugs under investigation were present in drinking water lakes. The above results were obtained during summer of 2010, when school was not in session. The next step involves deployment of POCIS disks during fall 2010, as the probability of identifying more compounds would potentially increase when the school was in progress.

DEVELOPMENT OF AN IMPROVED FILTER PAPER ASSAY FOR THE DETERMINATION OF ENZYMATIC ACTIVITIES OF CELLULASE ENZYMES. ***Henry Abougor* and Jeffrey O. Boles,*** *Tennessee Technological University, Cookeville, Tennessee.* National Renewable Energy Laboratory (NREL) adopted a standard method to measure cellulase activity in terms of filter-paper units: the International Union of Pure and Applied Chemists (IUPAC) standard filter paper assay (Ghose, 1987). The assay has been criticized for a number of reasons, mostly for the difficulties encountered in determining the initial dilution needed for 4% conversion of 50 mg of Whatman #1 filter paper. Recently, NREL proposed an automated system using a modified Cyberlaps C400 robotics deck. Unfortunately, most laboratories are not equipped with this instrument. The filter paper unit is not clearly defined, but what is defined is the quantity 0.1875 FPU, indicating the number of mg of enzyme that produces 2.0 mg of glucose/h. We hope to simplify the filter paper assay, especially the calculation part of the method by capitalizing on the definition of 0.1875 FPU. We will also compare the specific activity of cellulase at different cellulase concentrations.

ENGINEERING AND ENGINEERING TECHNOLOGY

ISMAIL FIDAN, CHAIR

MULTIPLE CURVE PRESENTATION AND ZOOMING PROCESSOR USING FPGA. ***Dhushyanth Venkatesan* and Omar Elkeelany,*** *Tennessee Technological University, Cookeville, Tennessee.* The proposed design is about the implementation of a hardware graphical display custom processor for generating and manipulating plots based on time varying input signals. The objective of the design is to reduce the size and increase the speed in comparison to available custom processors in the market. A custom processor of multiple signal plots with two independent zooming capabilities is designed, implemented, and tested with two known time varying sine wave signals (e.g., 5 KHz,10 KHz sine waves). The plots are generated on a display module. The target technology of the custom processor is the Altera FPGA chip (Cyclone II EP2C35F672C6). This design uses only 42% of the *logic elements* in the FPGA and its *fmax* is 50.0 MHz. Currently the design accommodates only two sine waves. But room has been provided for addition of two more and their zooming, in case any requirement arises in the future.

INCREASING THE STUDENT QEP SKILLS IN ADDITIVE MANUFACTURING PROJECTS. ***Kenan Hatipoglu* and Ismail Fidan,*** *Tennessee Technological University, Cookeville, Tennessee.* Tennessee Technological University (TTU)'s Quality Enhancement Plan (QEP) is a five-year university initiative to improve the quality of student learning. The plan is designed to improve students' critical thinking/real-world problem solving using active learning strategies. The QEP is part of the TTU Strategic Plan and a component of the Southern Association of Colleges and Schools (SACS) Reaffirmation of Accreditation Process. The details of the plan are available at www.tntech.edu/qep. In this QEP project, students' critical thinking and real-world problem solving skills are improved with a number of team-based Additive Manufacturing projects. SolidWORKS, Pro/Engineer, AutoCAD and SPORE software tools are used at the design phase. ZCorp 3D printing technology is used to produce the solid models of the designed pieces. Student teams report their findings, teamwork, and communication practices at the end of the semester. This presentation reports this current practice from the beginning of the semester to its end.

AUTOMATIC PARKING SYSTEM USING MICROCONTROLLERS AS A CAPSTONE PROJECT. ***Hugo J. Chavez*, Stephen McKinley*, and Adel Salama,*** *Austin Peay State University, Clarksville, Tennessee.* Generally speaking most of us have had trouble with parking at some point. The frustration is known by those who have been affected by parking. In today's world, with developing technology and an increase in automation technology, a team of students in engineering technology developed the Automated Parking System (APS). APS offers a wide variety of benefits, including safety, costumer convenience, parking efficiency, and reduction in crime rates. Simplicity is the key to this system. Typically, persons must arrange 5–10 min of their daily schedules for finding parking spaces. With APS, persons simply arrive at their destinations and leave the parking to APS. It only takes a matter of minutes for APS to park your vehicle in a safe and secure parking garage equipped with the latest technology to keep your belongings protected. The future

will certainly need systems for controlling parking. APS has the potential of meeting tomorrow's demands, today!

INTRODUCING ADDITIVE MANUFACTURING INTO THE APSU ENGINEERING TECHNOLOGY CURRICULUM. ***Chin-Zue Chen and Adel Salama,*** *Austin Peay State University, Clarksville, Tennessee.*

POLYACRYLAMIDE-MMT NANOCOMPOSITE HYDROGELS: EFFECT OF NANOPARTICLE LOADING ON PROTEIN ELECTROPHORETIC MOBILITY. ***Jeffery W. Thompson*, Holly Stretz, Pedro Arce, Harry Ploehn, and Hongsheng Gao,*** *Tennessee Technological University, Cookeville, Tennessee, and University of South Carolina, Columbia, South Carolina.* One of the primary problems associated with the use of hydrogels for bioseparations is the handling of the gel after performing electrophoresis. These gels often break apart rending any result useless. Typically, these gels consist of a polyamide backbone, usually polyacrylamide, with no reinforcement. Nanocomposite hydrogels consisting of Polyamide backbone and a Montmorillonite (MMT) dispersed phase are well known to increase the strength of hydrogels used in a variety of applications. Rheological information will presented showing reinforcement of the gel with increased MMT filler. Swelling information will be presented showing interaction of the MMT with the gel. The effective mobility of Ovalbumin and Carbonic Anhydrase, two model proteins in a PAM-MMT nanocomposite under an electrophoretic driving force of 6.7 V/cm, will be presented over a range of compositions of the MMT nanoparticles.

ANALYSIS AND VALIDITY OF THE METHOD OF AVERAGING IN ELECTROCHEMICAL SYSTEMS. ***Rajavardhan Reddy Nagolu*, Vinten D. Diwakar, and Pedro E. Arce,*** *Tennessee Technological University, Cookeville, Tennessee.* The mathematical analysis of mass transport in chemical systems usually involves the method of averaging to obtain system level information from the microscopic domain. Reactions in such systems are usually assumed to be occurring in the bulk (homogeneous reactions). However, in electrochemical systems, the reactions are heterogeneous and usually occur on catalytic surfaces. To analyze the role of averaging, this work is organized based on different cases of electrochemical kinetics. Firstly, the linearized zeroth order form of the Butler-Volmer equation (Tafel kinetics) is analyzed followed by general first order kinetics and then the classic Butler-Volmer type of kinetics. The system parameters varied are geometric (aspect ratio) and kinetic parameters. From this work it is inferred that the averaging technique doesn't work for all ranges of system parameters but is valid only for certain ranges of system parameters and can be used with confidence only within these ranges of applicability.

PREDICTION OF SURFACE TENSION FOR DILUTE BINARY AQUEOUS SYSTEMS USING A MOLECULAR THERMODYANMIC-BASED MODEL. ***Naresh Tadisina*, Natalia Shlonimskaya*, Donald P. Visco, Joseph J. Biernacki, and Hamed Kayello*,*** *Tennessee Technological University, Cookeville, Tennessee.* A molecular-based modeling approach is sought for surface tension predictions in dilute aqueous solutions. Amines and glycol ethers were studied because they present opportunities for use as shrinkage reducing admixtures (SRA) in concrete, a surface tension related application. Various modeling approaches were considered including pure-component strategies, binary interaction corrections, and averaging techniques, none of which were found to be predictive. A number of conjectures, however, regarding the relationships between molecular structure and behavior of the surface tension slope were identified and the conjectures validated experimentally. A quantitative structure property relationship was finally developed for a set of 14 compounds. This group contribution approach based on the Signature molecular descriptor appears to be a promising alternative. The ultimate goal of this research is to develop computational strategies that enable rapid and accurate identification of potential new molecular structures for targeted applications.

COMPARATIVE PYROLYSIS KINETICS FOR ONE LEGUME AND TWO GRASS HAYS. ***Jessica D. Murillo*, Preejith Ambuken*, Tiffany Hughes*, Joseph J. Biernacki, and C. Pat Bagley,*** *Tennessee Technological University, Cookeville, Tennessee.* Reactions involved in plant biomass pyrolysis are studied. Various biomass feedstocks have been considered for which kinetic information is unavailable. One objective of this work was to compare the pyrolysis of a legume (alfalfa hay) and two grass hays (sorghum-sudangrass and tall fescue). Alfalfa hay, a premium life stock, would likely not be considered as a biofuel feedstock, but provides a basis upon which to compare the two grasses, which are of poor nutritional content and could be considered for biofuel conversion. Thermalgravimetric analysis (TGA) was performed at heating rates of 5, 10, 30 and 50 °C/min. Analysis of TGA rate curves show that the decomposition of the two hays can be modeled by a moisture evaporation step and three decomposition steps, while the legume required more steps to be simulated. Alternative approaches that account for the dramatic change in pyrolysis efficiency as a function of heating rate were used.

SYNTHESIS AND CHARACTERIZATION OF CORE-SHELL NANOPARTICLES OF POLYSTYRENE AND POLYMETHYLMETHACRYLATE. ***Verónica Carranza*, Dennis Chicoma, and Reinaldo Giudici,*** *São Paulo University, São Paulo, Brazil, and Tennessee Technological University, Cookeville, Tennessee.* Core-shell nanoparticles are structures composed of a core of one material and a shell of another material, providing a wide range of different properties. To obtain a final equilibrium morphology, two aspects must be monitored, i.e., the thermodynamics and kinetics. Core-shell nanoparticles of polystyrene and polymethylmethacrylate were synthesized and characterized through emulsifier-free emulsion polymerization in two stages. Kinetics-based factors were controlled to obtain a final morphology (such as process temperature, initiator and monomer concentrations, and the effect of surface modifiers agents [acids, salts, co-monomers and crosslinker] in seed formation). Results showed that both the crosslinker and co-monomer are the best alternatives to achieve a stable seed and with small diameter. Moreover, the core with uniform coating is obtained in the second stage to reach an equilibrium at the core-shell morphology. The characterization of these particles showed the size, morphology, molecular weight, glass transition temperature, and colloidal stability among other important properties.

ROLE OF JOULE HEATING IN ELECTROKINETICS SOIL CLEANING: EFFECT OF THE NUSSELT NUMBERS IN CAPILLARY MODELS. ***Cynthia Torres*, Pedro Arce, and Dale Ensor,*** *Tennessee Technological University, Cookeville, Tennessee.*

Application of electrical field in cleaning contaminated soil is a technology that still is not well understood. One important aspect to quantize is the role of Joule heating and the effect of the Nusselt Number for the case on soils with non-uniformed properties. Joule heating is the result of applying a voltage that leads to the generation of heat due to electrical resistance of the soil. The temperature increase could drastically affect the efficiency of the cleaning process. By using fundamentals of fluid mechanics in conjunction with electrokinetics principles (i.e., Electrokinetics Hydrodynamics [EKHD]), this research is focused on the analysis of rectangular capillary domains and how the Nusselt affects the flow inside the domain for non-symmetrical conditions. Suggestions for further research will also be discussed.

THE DESIGN OF POTENTIALLY NEW SHRINKAGE REDUCING ADMIXTURES (SRA) USING COMPUTER AIDED MOLECULAR DESIGN WITH THE SIGNATURE MOLECULAR DESCRIPTOR. ***Hamed Kayello*, Donald P. Visco, and Joseph J. Biernacki,*** *Tennessee Technological University, Cookeville, Tennessee.* Shrinkage reducing admixtures (SRA) have been developed to reduce or perhaps eliminate shrinking cracking in concrete. SRAs belong to a special type of organic chemicals known as nonionic surfactants. Surfactants are amphiphilic compounds that, when mixed with water, accumulate at the solution-air interface and reduce the surface tension of the mixture significantly. Many classes of compounds have been proposed as SRAs (i.e., glycol ethers, siloxanes/poly-siloxanes, and poly-oxyalkylene alkyl ether). In this work, we use a computer-aided molecular design technique with the Signature molecular descriptor in order to design new chemicals with low surface tension that might serve as SRAs. Though the technique starts with glycol ethers, other structures with a combination of functional groups are generated. These new compounds are potential SRAs that might have a greater reducing effect on the surface tension of the cement paste's pore solution.

WATER MOBILITY IN POLYMER ELECTROLYTE MEMBRANE FUEL CELLS DURING SUB-ZERO ISOTHERMAL COLD-STARTS. ***Antonio O. Pistono* and Cynthia A. Rice-York,*** *Tennessee Technological University, Cookeville, Tennessee.* Commercialization of fuel cells is currently desired. There are three main hurdles for polymer electrolyte membrane fuel cells: cost, cathode catalyst durability, and freeze tolerance. Performance of fuel cells in cold climates suffers due to the inherent presence of product water in both the solid and liquid form. Accumulation of ice causes significant losses in the form of structural deformation and reactant gas blockage; however supercooled water may remain in a liquid form till −48°C. The accumulation of ice is a function of material, preconditioning type and water content, freeze rate, freeze temperature, cold start load, and thermal gradients within the membrane electrode assembly. Water was produced through application of electrical load (water fill test). A modified electrochemical impedance spectroscopy method was performed at varying times during the fill test. Changes in spectra due to supercooled water and ice content are apparent.

EFFECT OF ANODE CATALYST LAYER POROSITY ON PERFORMANCE OF A DIRECT FORMIC ACID FUEL CELL. ***Akshay S. Bauskar* and Cynthia Rice-York,*** *Tennessee Technological University, Cookeville, Tennessee.* Electrochemical oxidation of formic acid has attracted much attention in the last few years as a high efficiency power source for portable electronic devices such as cell phones and laptop computers. In the present investigation, the influence of a pore-former in the electrocatalyst of the anode of a Direct Formic Acid Fuel Cell (DFAFC) performance is studied. Direct paint technique is used to prepare the membrane electrode assembly (MEA) using *Pt-Ru* (50:50% by wt) as the anode catalyst, and *Pt* Black as the cathode catalyst, a pore-former and Nafion® ionomer. Li_2CO_3 is used as a pore-former during the preparation of MEA. Higher DFAFC performance is obtained because the network of pores in the anode side allowed easy removal of reaction species, thereby increasing the catalyst site available for formic acid oxidation. There was an increase in maximum power density by 25% when pore-former was added to the anode catalyst ink.

INFLUENCE OF SULFATED ZIRCONIA-DOPED NAFION COMPOSITE MEMBRANES AND CATALYST LAYERS ON DIRECT METHANOL FUEL CELL PERFORMANCE. ***Shilpa Beravelli*, Cynthia Rice-York, J. Dalton York, Emory Hannah*, and Akshay S. Bauskar****, *Tennessee Technological University, Cookeville, Tennessee.* Fuel cells are an attractive alternative to many energy conversion/storage devices. In recent years, due to the system simplicity, easy handling of liquid methanol and high specific energy (3800 kcal/L) compared to H2 (658 kcal/L at 360 atm) direct methanol fuel cells (DMFCs) are being recognized as one of the most attractive power sources for portable devices. To address the fuel crossover limitation of DMFCs, sulfated zirconia (S-ZrO_2) is doped in the nafion membrane to reduce the free pore volume. Performance was improved when the S-ZrO_2 is at catalyst layer interface with no fuel crossover reduction. To understand the enhancement in the performance, S-ZrO_2 was doped in the catalyst layer. The addition of S-ZrO_2 at the catalyst layer interface improves DMFC performance. This confirms that the additive, by virtue of both its acidity and hydrophilicity, promotes proton transport.

AN EVALUATION OF THE HYDRODYNAMICS PRESENTED FOR FLOW PAST AN ELECTRODE IN THE PRESENCE OF AN APPLIED MAGNETIC FIELD. ***Jeffery W. Thompson*, SethWynne, and Vinten Diwakar****, Tennessee Technological University, Cookeville, Tennessee.* Analysis of a rectangular parallel plate electrode under magnetohydrodynamic boundary layer flow will be presented. The goal of this project was to determine under what conditions an electrode's efficiency may go from being diffusion limited to reaction limited. Our model determines conditions wherein a dimensionless group, the magnetic Reynold's number may drastically alter the flow profile around the electrode. Higher flow rates are determined around the electrode for high values of the magnetic Reynold's number. Increased convection in our system will enhance mass transport around the electrode, thereby introducing a mass transfer limited regime for our electrode.

ANALYTICAL APPROACH EXAMINING ELECTROSTATIC POTENTIAL IN DIVERGENT AND CONVERGENT CHANNELS TO INVESTIGATE ROLE OF CHANNEL MORPHOLOGY IN MICROFLUIDIC APPLICATIONS. ***Parvin Golbayani*, Kevin T. Seale, Jonathan R. Sanders, and Pedro E. Arce****, Tennessee Technological University, Cookeville, Tennessee (PG, JS, PA), and Vanderbilt University, Nashville, Tennessee (KS).* Analytical study of the electrostatic

potential in divergent and convergent channels was investigated. Distribution of electrostatic potential is given by the solution of 2D Poisson-Boltzmann Equation (PBE) with both long channel and Debye–Huckel approximations. As a product of the investigation, one can assess the behavior of the electrostatic potential inside of a convergent-divergent section. Three key parameters have been identified to describe the electrostatic potential behavior: the angle (α) of the convergent (or divergent) section (related to the walls of the channels) that handles the "magnitude" of the deviation with respect to a straight channel; the ratio of the wall potentials, R, which handles the symmetrical/non-symmetrical aspects of the electrostatic potential; and the ratio of the width to the length (γ) that controls the "shape" of the channel section. Results will be shown through a series of portraits that capture key behaviors of the electrostatic potential with respect to the three parameters described above.

OPTIMIZATION OF PENG-ROBINSON EOS FOR SUPERCRITICAL CO_2. ***Franklin Angulo*, Jeffery Thompson*, Mario Oyanader, and Holly Stretz,*** *Tennessee Technological University, Cookeville, Tennessee.* Supercritical fluids are an integral part of many large-scale industrial applications and indeed represent a new environmentally responsible green solvent. As such, they are increasingly used in classroom settings, for example to demonstrate extraction behavior. Supercritical fluids are observed to have both fluid and vapor-like properties which enable them to be very powerful solvents. However, some common equations of state, in this case specifically the Peng-Robinson EoS, do not always represent accurately the pressure/volume/temperature relationships for CO_2 at the supercritical conditions. Therefore, our goal is to optimize this equation of state to more suitably match experimental observations. We report a strategy by which parameters were subject to change to produce a much more representative model.

GEOLOGY AND GEOGRAPHY

PETER LI, CHAIR

A SPATIAL ANALYSIS OF THE SOUTHERN CAVE FISH. ***Charles Sutherland****, *Tennessee Technological University, Cookeville, Tennessee.* The Southern Cave Fish appears within 96 of the more than 9000 caves in Tennessee. The purpose of the study is to determine patterns to its distribution. Patterns were analyzed by the use of GIS spatial statistics function examining the following variables: cave dimensions, geology, land use, and drainage density. Results show significant correlations between cave dimension and likelihood of a Southern Cave Fish site. Also significant are the distributions to cave fish in relation to geology, land use, and drainage density. A geospatial analysis of caves with the Southern Cave Fish will provide greater insight about their habitat and may play a role in better understanding the species.

COLLEGE STUDENTS' CARBON FOOTPRINT. ***Peter Li,*** *Tennessee Technological University, Cookeville, Tennessee.* The study shows the amount of carbon emitted annually from college students at Tennessee Technological University. Survey data represent various household backgrounds, from one- to six-person house scenarios. On average, houses of larger size emitted less carbon per capita with living-together conditions. Students with maximum working hours, such as more than 25 working hours per week, have little time to put out carbon with their schedule. Grade distribution shows that student in the middle of the pack put out the most carbon while students on lower or higher grade produced less carbon. Compared to total population, college students have generated more carbon than they should. The report shows the need for awareness of a carbon-reducing lifestyle.

ANALYZING TORNADO TRACK DENSITIES IN KENTUCKY AND TENNESSEE USING GEOSPATIAL TECHNIQUES. ***Robert Mark Simpson,*** *University of Tennessee at Martin, Martin, Tennessee.* Previous research on tornado touchdowns in Tennessee and Kentucky has shown that there are preferred areas in which tornadoes that do touch down tend to become violent. This study examines tornado tracks from 1950–2009 and uses the centroid of each track as the likely place where the tornado strength and width would be at its greatest in order to more accurately assess the tornado threat. Kernal density of the tracks and kriging interpolation of the destructive potential of storms were used to assess this threat. The results indicate that western Tennessee, northern Middle Tennessee, and areas in the Cumberland Plateau have the greatest threat from damaging tornadoes.

POTENTIAL AREAS ACROSS TENNESSEE FOR SOLAR POWER PLANTS. ***Blake Smelcer* and Peter Li,*** *Tennessee Technological University, Cookeville, Tennessee.* The purpose of this project is to determine suitable locations for the development of multi-scale solar-power generating sites based on terrain characteristics (slope), land use and land cover, distances from towns and cities, distances from prohibited areas (federal/state land), sizes of feasible areas, and amount of solar radiation at the location. The objective is to analyze the entire state for areas with flat slopes, proper land use and cover types, and at proper distances outside urban/developed areas for redistribution. The remaining objectives were to filter the feasible land based on sizes of current small and large scale plants and to factor in the amount of radiation across the area for greater potential for development. The results show the rank of each county based on the percentage of available land it contains and the average amount of solar radiation it receives. In conclusion, many areas are available across the entire state for the development of solar power plants.

CRIME RATE ANALYSIS OF THE UNITED STATES. ***Jacob K. Peterman* and Peter Li,*** *Tennessee Technological University, Cookeville, Tennessee.* The study investigates crime rates across the United States for the years of 2008 and 2009. The purpose of this project was to analyze crime rate against other variables to understand any correlation between them. Variables, such as religious adherence, unemployment rates, racial diversity, population density, and divorce rates, are organized, processed, and compared with the crime rates from seventy U.S. metropolitan areas in the search for the most significant variable. Results showed a significant trend between crime rate and religious adherence, as well as crime rate and racial diversity. In conclusion, crime in America was analyzed, and a significant correlation was discovered. This discovery could lead to better analysis of city dynamics and city planning for major metropolitan areas across the United States.

HEALTH AND MEDICAL SCIENCES

J. MICHAEL REDDING, CHAIR

ESTROGEN REGULATES RIGHT VENTRICULAR LOAD STRESS RESPONSES IN THE PULMONARY ARTERY BANDING MODEL. ***Karen B. Maynard*, James D. West, John H. Newman, and Anna R. Hemnes,*** *Vanderbilt University, Nashville, Tennessee. Methods:* C57BL/6 female mice underwent ovariectomy (OVX) or sham (CON) at 12 weeks of age and pulmonary artery banding (PAB) or sham (CON) at 16 weeks. Echocardiography, *in vivo* hemodynamics, and RV hypertrophy were assessed two weeks following. *Results:* OVX alone increased systolic function as measured by cardiac output and stroke volume. OVX–PAB mice had diminished RV hypertrophy compared with CON-PAB mice. PAB resulted in RV dilation on echocardiography that was attenuated by OVX. *In vivo* hemodynamics confirmed a decrease in RV volumes with OVX-PAB vs. CON-PAB. RV systolic pressure was similar in CON-PAB and OVX-PAB groups. While PAB alone had a minimal effect on systolic function, there was markedly diminished diastolic function. OVX-PAB animals had improved RV power generation and diastolic function compared with CON-PAB. *Conclusions:* Estrogen deprivation affects RV systolic function at baseline and results in diminished RV hypertrophy with improved systolic and diastolic function in a load-stress model.

ONE UNIVERSITY'S RESPONSE TO THE H1N1 PANDEMIC OF 2009. ***Elisa Lund*, Kenny Kennedy, and Chad Brooks,*** *Austin Peay State University, Clarksville, Tennessee.* During the fall of 2009, Austin Peay State University faced a new challenge shared with other American universities, the H1N1 influenza virus. An influenza task force was convened by the Provost and representative of all major divisions of University operations. The approach was to 1) communicate/educate the campus, 2) maintain surveillance of students and faculty/staff, 3) employ GPS mapping to manage "hot spots" of illness and potentially contaminated rooms, 4) quarantine and care for sick students, and 5) vaccinate. As part of understanding the student body, surveys explored student perceptions of H1N1 and their knowledge of H1N1 biology and personal hygiene. The impact of H1N1 on campus was 212 people were reported to have influenza-like-illness. Successes and lessons learned will be discussed.

HISTORY OF SCIENCE

GEORGE E. WEBB, CHAIR

KEPLER'S DETERMINATION OF THE INCLINATION OF THE ORBIT OF MARS. ***Brother Kevin Ryan, FSC,*** *Christian Brothers University, Memphis, Tennessee.* Kepler's Three Laws of Planetary Motion are well known. Not so well known is a preliminary discovery concerning the plane of Mars' orbit. Both Ptolemy and Copernicus made a mistake in this matter. Kepler corrected them. His three methods to show the correct plane of Mars' orbit will be explained.

POPULAR VISIONS OF OAK RIDGE: THE FIRST DECADE. ***George E. Webb,*** *Tennessee Technological University, Cookeville, Tennessee.* During the decade following the end of World War II, the Manhattan Project facilities received much publicity and attention. Dramatic symbols of the importance of science in mid-20th century American, these formerly "secret cities" were discussed in newspapers and other periodical, becoming part of the nation's popular culture as the Cold War became a central concern of the American government and population. Oak Ridge, Tennessee, attracted the greatest proportion of interest throughout this period. Popular periodicals discussed the scientific work being carried out at the facility and also examined the community itself, showing that Oak Ridge, for all its scientific sophistication, was in many ways a typical American town. As the postwar decade continued, Oak Ridge was increasingly identified as the "atomic city" and even appeared in several popular films.

CENTENNIAL STUDIES: THE HISTORY OF HISTORIES OF THE TENNESSEE ACADEMY OF SCIENCE, 1914-PRESENT. ***James X. Corgan,*** *Austin Peay State University, Clarksville, Tennessee.* General histories of the Academy appeared in 1914, 1927, 1938, and 1998. An archive covers the history of early years in depth. Three Academy journals are well known. They document the past. Two studies characterize the Junior Academy. The roots of the Collegiate Division are detailed in Academy proceedings. Academy involvement with Science Fairs, the Westinghouse Science Talent Search, NSF, and similar programs is recorded. Biographical sketches identify Academy officers. Sectional histories are discussed in 14 published abstracts and many short notes. Nine abstracts and three texts further illuminate Academy history. With all that has been done, much remains undone.

CENTENNIAL STUDIES: JESSE SHAVER, SELF-MADE SCIENTIST AND SERVANT SCHOLAR. ***Nora Beck,*** *Tennessee Parks and Greenways Foundation, Nashville, Tennessee.* Jesse Milton Shaver grew up in poverty and began his working life well before he entered the sixth grade—at age 17. He helped guide the work of a host of science and education organizations in Tennessee and in the country, and for a quarter century edited the *Journal of the Tennessee Academy of Science.* His best-known contribution to scientific literature is the volume currently available as *Ferns of the Eastern Central States with Special Reference to Tennessee.* Research shows he produced much more, not only in his published work but in the expanding circles of scientific education he inspired. He maintained a driving personal ambition and the vision to rise beyond that, for his efforts furthered the cause of understanding Tennessee's natural history, made permanent contributions to the body of botanic data, and endeared him to the many student teachers he motivated and challenged.

CENTENNIAL STUDIES: TAS AND THE 1927 AAAS MEETING IN NASHVILLE. ***George E. Webb,*** *Tennessee Technological University, Cookeville, Tennessee.* Celebrating the 15th anniversary of its founding, the Tennessee Academy of Science played an important role in the 1927 Nashville meeting of the American Association for the Advancement of Science. The Academy had encouraged the AAAS to meet again in Nashville (the association had met previously in Nashville in 1877) and its members served in several capacities to coordinate local arrangements. The Academy's primary function at the meeting, however, was to organize a special memorial tribute to the noted

astronomer and Nashville native, Edward Emerson Barnard, who had died a few years earlier. Not only was a special Barnard memorial session of the Academy held in cooperation with the astronomy section of AAAS, but one of the major public addresses also focused on the life of the famous astronomer. The 1927 meeting was viewed as a great success and reinforced the Academy's place in the scientific community.

MATHEMATICS AND COMPUTER SCIENCE

HAN WU, CHAIR

A PARALLEL FINITE ELEMENT METHOD FOR THE CONVECTION-DIFFUSION-REACTION EQUATION. ***Robert D. French*, Casey L. McKnight*, Amber N. O'Connell*, and Ben Ntatin,*** *Austin Peay State University, Clarksville, Tennessee.* The Finite Element Method is a technique for the numerical solution of partial differential equations (PDE). The fundamental idea is that a continuous solution to the governing PDE modeling a physical system can be approximated by discrediting the domain into a set of finite geometrical elements, which are triangles for a two-dimensional domain. We then approximate the value of the solution at the nodal points. We introduce the finite element method and present a parallel software package for solving two-dimensional, second order, linear PDEs using this method. To demonstrate the effectiveness of this parallel finite element technique, we treat the convection-diffusion-reaction equation at a very fine precision and show improvements in both time and accuracy over sequential methods.

A NOTE ON THE STEEPEST DESCENT METHOD, (HIKING IN THE MOUNTAINS). ***Ben Ntatin,*** *Austin Peay State University, Clarksville, Tennessee.* The notion of linearity is fundamental for numerous considerations in mathematics and engineering science. It is well known that many physically significant problems may be reduced to a linear equation of the form $Ax = b$. Typical examples of how such equations arise are found in models involving the heat, the wave, or the Schrodinger equation. Solutions of such equations are, in fact, the equilibrium points of the system they model. Consequently, considerable effort has been devoted to developing constructive techniques for the determination of solutions to such operator equations. We consider the case where A is a large matrix and give a detail description of an algorithm to solve such a problem. Some practical applications are also provided.

A SIMPLE AND EFFECTIVE METHOD TO PREDICT SEEDED TOURNAMENT OUTCOMES. ***Stephen J. Robinson,*** *Belmont University, Nashville, Tennessee.* Predicting the outcomes of sporting events has always been an attractive yet elusive endeavor. Much work has been done in previous decades to improve models that depend on specific team strengths, such as point-spread data. Others work on the premise of a lack of knowledge about which teams are playing in the tournament, and a popular method within this latter category relies on seed numbers. In order to capture relevant historical data, the model presented here builds on seed number models by including the overall winning percentage of those seeds. This best-fit approach 1) provides reasonably good matches with empirical probabilities associated with individual games and overall tournament results and 2) gives insight into unexpected results and likely future behavior.

INITIAL VALUE METHOD VERSUS BOUNDARY VALUE METHOD. ***Ramanjit K. Sahi,*** *Austin Peay State University, Clarksville, Tennessee.* Many practical applications in fields such as physics, engineering design, and other scientific disciplines encounter ordinary differential equation (ODE) problems. Due to its dynamical nature, exact solutions are particularly difficult. Thus, we need to approximate the solutions to ODEs by using appropriate difference equations. In this presentation, I will look at two types: Initial Value Methods (IVM's) and Boundary Value Methods (BVM's). Using a Second Derivative Method (SDM) which is an IVM, I will show that it is more efficient and accurate in its solutions as compared to a BVM given by Brugnano and Trigiante. The SDM is developed via interpolation and collocation procedures, and is used to solve initial value problems without the need for starting values and predictors.

MICROBIOLOGY

JOHN M. ZAMORA, CHAIR

THE INFLUENCE OF ENVIRONMENTAL PH ON GROUP B STREPTOCOCCUS VIRULENCE FACTOR EXPRESSION. ***Caitlin Anderson*, Caroline Eubanks*, Stephen Gragg*, Amanda D. Williams, and Jon Lowrance,*** *Lipscomb University, Nashville, Tennessee.* Group B Streptococcus (GBS) asymptomatically colonizes the gastrointestinal tracts in a large percentage of the population. GBS can develop into an invasive pathogen that can threaten neonates, the elderly, and the immune-compromised. Many bacterial species contain two-component regulatory systems—a partnership of a sensory protein and a regulator protein that responds to the bacteria's environmental stimuli. The CsrR/S and CiaR/H two-component systems of GBS are such systems, and their expression may further explain GBS's potentially invasive nature. In the present study, we tested the influence of pH changes on the GBS virulence genes CsrR/S and CiaR/H. GBS was grown in pH 5, 7, and 9 conditions and then analyzed for gene expression. The results presented information concerning pH's influence of virulence factors in GBS and confirmed that changes in environment present signals to GBS to transform to an invasive pathogen through up-regulation of virulence factor genes.

ANALYSIS OF INTERFERON REGULATORY FACTOR-3 LEVELS IN CELL LINES EXPRESSING HUMAN PAPILLOMAVIRUS. ***Brittney D. Everhart* and Jennifer T. Thomas,*** *Belmont University, Nashville, Tennessee.* Cancer is a disease caused by excessive abnormal cell growth that affects close to 12 million people a year. Cervical cancer, found only in women, has recently gained attention from the development of the vaccine, Gardasil. The most prevalent cause of cervical cancer is infection with the human papillomavirus (HPV). HPV promotes cervical cancer primarily by attacking the tumor-suppressor proteins, p53 and pRb. In addition, HPV is allowed to thrive in the body by inhibiting the immune responses that normally occur. One mechanism is preventing interferon regulatory factor 3's (IRF-3) ability to activate antiviral genes. This research is designed to study the difference in levels of IRF-3 between cell lines expressing high-risk HPV and cell lines that do not express

HPV. We are currently using western blot technique to determine IRF-3 protein levels in our cell lines and the possible impact of HPV on IRF-3 expression.

THE ANTIMICROBIAL EFFECTS OF HERBS AND SPICES ON GRAM-POSITIVE AND GRAM-NEGATIVE BACTERIA. ***Ariel Ouellette* and Darlene Panvini,*** *Belmont University, Nashville, Tennessee.* Herbs and spices have been used for thousands of years due to their ability to add color and flavor to food, as well as their healing and antimicrobial properties. While many factors play a role in the antimicrobial activity of herbs and spices, three aspects that were observed in this experiment: 1) Gram-stain of the microorganisms, 2) origin of the microorganisms (found on body or in soil), and 3) plant part (e.g., leaf, flower, root) being derived as the herb/spice. Zones of inhibition were measured in cultures of five bacteria exposed to disks saturated with extracts from nine different herbs/spices. The type of herb/spice and type of bacteria each shows significance in determining antimicrobial activity of herbs/spices; Gram-negative bacteria show more resistance to antimicrobial activity. No correlations were found between bacteria origin and antimicrobial activity or between the structure of the plant and antimicrobial activity.

EFFECT OF HUMAN PAPILLOMAVIRUS ON LEVELS OF TLR-9 IN CERVICAL CARCINOMA CELL LINES. ***Jessica E. Rix* and Jennifer T. Thomas,*** *Belmont University, Nashville, Tennessee.* Cervical cancer affects over half of a million women worldwide. Human Papillomaviruses (HPV) are the cause of over 90% of cervical cancer cases. HPV is separated into high-risk and low-risk types depending on their ability to cause cancer. In high-risk types, the E6 and E7 proteins inactivates the tumor suppressor proteins, p53 and pRb. High-risk HPV is also shown to reduce the body's immune response. One of the ways it does this is by inhibiting the inflammatory response of Toll-like Receptor 9 (TLR-9) in cells that express E6 and E7 from HPV 16 and HPV 18, both high-risk types. This current project will test the effects of HPV 31, another high-risk type on levels of TLR-9, as well as the levels of TLR9 in HPV negative cervical cell lines.

ANALYSIS OF INTEGRIN PROTEIN LEVELS IN CERVICAL CELL LINES EXPRESSING HUMAN PAPILLOMAVIRUS. ***Emily L. Smothers* and Jennifer T. Thomas,*** *Belmont University, Nashville, Tennessee.* Human papillomaviruses (HPVs) are the leading cause of sexually transmitted diseases of viral origin. The two categories of HPV are high- and low-risk; high risk is associated with anogenital cancer, whereas low risk is associated with genital warts. It is estimated that 11,000 women in the United States are diagnosed with cervical cancer each year. Viral proteins E6 and E7 are of interest, as they have been shown to facilitate rapid cellular and, therefore, viral proliferation and impede apoptosis. Other proteins are involved in the infectious cycle of viruses, especially those that function in cell to cell adhesion. Integrin is one such protein. Seven cell lines and the techniques gel electrophoresis and Western blotting are currently being used to determine if there is a relationship between HPV and integrin protein expression. Determination of such a relationship may impact the future of both cervical cancer and HPV research.

EVALUATING THE ADAPTATION OF *STAPHYLOCOCCUS AUREUS* TO SEVERAL ANTIBIOTICS TO COMPARE EFFICACY OF MELITTIN, A NOVEL ANTIMICROBIAL THERAPY. ***Krystle Irizarry*, Christina Russell, and Chad Brooks,*** *Austin Peay State University, Clarksville, Tennessee.* It has been well recognized that *Staphylococcus aureus* can adapt to various antibiotic regiments and this has been a source of mounting concern in the treatment of "staph" infections. Novel drug therapies that target microbial systems the microbe can ill afford to do without and that the microbe cannot adapt relatively few/simple mutations to circumvent are of great interest to clinicians. This study builds on data supporting melittin, a 26-amino acid peptide extract of honey bee venom, as a novel drug therapy for *S. aureus*, providing a mechanism of death that has thus far not proved survivable. Comparisons were made between melittin and erythromycin, tetracycline, penicillin, ampicillin, and vancomycin. Serial antimicrobial exposure passages of *S. aureus* organisms showed no change in resistance to melittin while gradual resistances were observed against the other antibiotics.

HYDROGEN PRODUCTION VIA GLYCEROL FERMENTATION BY BACTERIUM *ENTEROBACTER AEROGENES*. ***Jared Averitt* and Sergei A. Markov,*** *Austin Peay State University, Clarksville, Tennessee.* Glycerol was used as a substrate for H_2 production by bacterium *Enterobacter aerogenes* in the test tubes and bioreactor. The highest H_2 production rate was observed under 2% glycerol in the culture medium. The glycerol uptake efficiency by bacteria in the bioreactor was found to be 65% during the 6-day period, matching glycerol uptake efficiency observed in the test tubes experiment (65%). Hydrogen production from glycerol (2% glycerol, v/v) by *E. aerogenes* in the bioreactor and test tubes was measured over the 6 days, showing the maximal H_2 rate at 650 mL g^{-1} dry weight h^{-1}. The yield of H_2 production from glycerol at 0.89 mol/mol in the bioreactor was high, corresponding to the theoretical yield of 1 mol of H_2 per 1 mol of glycerol.

BIODIESEL AND HYDROGEN GENERATION FROM CARBON DIOXIDE AND WATER BY SEQUENTIAL USE OF MICROORGANISMS IN BIOREACTORS. ***Luke Holliday* and Sergei A. Markov,*** *Austin Peay State University, Clarksville, Tennessee.* Conversion of light energy and CO_2 into biofuels by sequential use of microorganisms was studied. First the oil production by microalga *Chlorella vulgaris* was investigated in tubes and in a photobioreactor using CO_2. Algal biomass was dried and oil was extracted. High oil content was found in *Chlorella* cells. Algal oil was converted into biodiesel. A photobioreactor for biodiesel generation from microalgae was made from clear PVC 10 feet tubes (6' diameter) with a small slope (10%). The mixture of 5% CO_2 and air flowed up from bottom of tubes to the top as gas bubbles. Next, glycerol, a by-product of biodiesel production, was used for making biohydrogen (H_2) by bacterium *Enterobacter aerogenes* in test tubes and in a bioreactor. Higher H_2 production rates for up to 1600 mL g^{-1}·DW h^{-1} were observed when bacterial cells grew in the presence of 2% glycerol on a medium containing inorganic salts.

PHYSICS AND ASTRONOMY

EUGENE DE SILVA, CHAIR

KICK DRUM TUNNELS: A PHYSICAL ANALYSIS OF A RECORDING TECHNIQUE. ***Phil Feurtado****, *Belmont University, Nashville, Tennessee.*

SPIN-SPIN EFFECTS IN MODELS OF BINARY BLACK HOLE SYSTEMS. ***Scott H. Hawley,*** *Belmont University, Nashville, Tennessee.* We implemented a parallel multigrid solver to solve the initial problem for 3 + 1 General Relativity. This involves solution of elliptic equations derived from the Hamiltonian and the momentum constraints. We use the conformal transverse-traceless method of York and collaborators which consists of a conformal decomposition with a scalar that adjusts the metric, and a vector potential w^i that adjusts the longitudinal components of the extrinsic curvature. The constraint equations are then solved for these quantities such that the complete solution fully satisfies the constraints. We apply this technique to compare with theoretical expectations for the spin-orientation and separation-dependence in the case of spinning interacting (but not orbiting) black holes. We write out a formula for the effect of the spin-spin interaction which includes a result of Wald as well as additional effect due to the rotation of the mass quadrupole moment of a spinning black hole.

THE JERK VECTOR IN PLANETARY MOTION. ***Arjun Tan, Gene Mize, and Matthew Edwards,*** *Alabama Agricultural and Mechanical University, Normal, Alabama.* The jerk vector is the time derivative of the acceleration vector, or the second derivative of the velocity vector, or the third derivative of the position vector. The jerk vector is usually small for the familiar problems in mechanics and is seldom discussed in the literature. In this study, the jerk vector in planetary motion is analyzed in the usual plane polar coordinates, as well as in the Cartesian and Lagrangian (intrinsic) coordinate systems. The variations of the jerk vector components are studied in the three coordinate systems. Plots of the vector components are shown for true anomaly intervals of 45°.

EXACT VALUES OF DYNAMICAL QUANTITIES IN PLANETARY MOTION. ***Arjun Tan, Gene Mize, and Matthew Edwards,*** *Alabama Agricultural and Mechanical University, Normal, Alabama.* Exact values of dynamical quantities in planetary motion, such as position, velocity, and acceleration, in terms of the constants of motion, have appeared in the literature for special locations of the planet in its elliptic orbit, such as the endpoints of the major and minor axes, and the endpoints of the latera recta. In this study, exact values of the position, velocity, and acceleration vectors have been calculated at every 15° intervals of the true anomaly from the perihelion. Exact values of the jerk vector are calculated at every 30° and 45° intervals of the true anomaly.

DISCOVERING THE ANGULAR JERK IN PLANETARY MOTION. ***Arjun Tan and Matthew E. Edwards,*** *Alabama Agricultural and Mechanical University, Normal, Alabama.* In analogy with the jerk vector, the angular jerk vector is defined as the time derivative of the angular acceleration vector, the second derivative of the angular velocity vector, or the third derivative of the angular coordinate vector. The angular jerk is zero for uniform circular motion but not in planetary motion. In this study, the variations of the angular velocity, angular acceleration, and angular jerk with the polar coordinate are studied in Keplerian motion. The locations of their maxima, minima, and inflection points are found analytically.

SCIENCE AND MATH TEACHING

JOHN NIEDZWIECKI, CHAIR

THE MORE THINGS CHANGE, THE MORE THEY STAY THE SAME: A COLLABORATIVE INVASIVE PEST PLANT EDUCATION PROJECT. ***Kim Cleary Sadler,*** *Middle Tennessee State University, Murfreesboro, Tennessee.* The expression, "the more things change, the more they stay the same," was most likely never referring to invasive species, but sixth grade students at Campus School in Murfreesboro, Tennessee, would be glad to set you straight about the impact of invasive plants. Middle Tennessee State University Center for Environmental Education, Stones River National Battlefield, Children's Discovery Center, Tennessee Exotic Pest Plant Council, Stones River Watershed Association, and Murfreesboro Parks and Recreation Greenway staff partnered with Campus school on a year-long invasive plant species project. Partner organizations provided resources and support while student teams researched the ecological benefits of planting native plants and read technical reports about invasive exotic plants. Students presented what they learned to key organizations in the county plus restored part of the greenway. Not only did students learn about protecting their natural heritage, but they were also empowered about knowing how to effect positive change in their community.

TRENDS IN ASSIGNMENTS AND EXAMS IN BIOLOGY COURSES. ***Darlene Panvini,*** *Belmont University, Nashville, Tennessee.* Faculty utilize various criteria to determine the number of exams and assignments to administer in undergraduate biology courses. This study examines the balance between exams and assignments and the percent weight given to each type of assessment. Specifically, with an increasing prevalence of group work, inquiry-based learning, service-learning projects, and research assignments, has the number of exams administered changed over time and what role do lab assignments play in determining students' grades? Analysis of biology syllabi covering a fourteen-year period (1996–2010) suggest that more weight was placed on exams and there were fewer small assignments in the earlier courses but that more recent courses utilize frequent assignments and emphasize exams less. Courses for non-majors tended to have fewer assignments while majors' courses placed more weight on exams. The significance of this study for student learning in biology courses and the impact on faculty and student workloads will be addressed.

HERE'S THE POOP ABOUT THE PROCESS OF SCIENCE IN A HIGH SCHOOL BIOLOGY CLASSROOM: MAKING SCIENCE REAL IN THE NSF TRIAD GK-12 PROGRAM. ***Jerrod D. Shipman*, Mary B. Farone, E. Lewis Myles, Kim C. Sadler, Tory Woodyard, and Anthony L. Farone,*** *Middle Tennessee State University, Murfreesboro, Tennessee (JS, MF, KS, TW, AF), and Tennessee State University, Nashville, Tennessee (LM).* Creative methods to introduce students to the scientific method are lacking; especially in inclusion courses where students' attention spans are typically very short. By coming up with a hands-on simulation of a real biological research method, I was able to get students thinking their way through the scientific method instead of memorizing the steps. The lesson began with a brief introduction of the scientific method by relating the steps to problems the students may have faced in their own lives. The students were then put into groups of three students and were given two pieces of simulated feces. Each piece was a different

shade of brown and students were to determine why the feces samples were different using the steps of the scientific method. While this method has some initial squeamishness given that the students initially believed the fecal samples were real, the students quickly became engaged and absorbed the information presented.

ENGAGING HIGH SCHOOL ECOLOGY BIODIVERSITY LAB ACTIVITIES IN THE NSF TRIAD GK-12 PROGRAM. ***Alison N. Carey*, Mary B. Farone, E. Lewis Myles, Kim C. Sadler, and Anthony L. Farone,*** *Middle Tennessee State University, Murfreesboro, Tennessee (AC, MF, KS, AF), and Tennessee State University, Nashville, Tennessee (LM).* Students in Oakland's Honors Ecology class are learning about the biodiversity of plants and animals in middle Tennessee. Lab activities have introduced collection and sampling methods, identification, and data presentation. Leaf litter was collected and insect diversity examined by use of Berlese funnels. To look at plant diversity, students used hula-hoops to determine sample area and surveyed a field near Oakland. Plants that were present inside the hula-hoop were identified and counted. After collecting several samples, each group presented the data in a graph. Some students will be applying these methods to their own research projects that will compare the biodiversity in various habitats.

ZOOLOGY

TIMOTHY J. GAUDIN, CHAIR

EARLY IRON DEPOSITION IN TEETH OF THE STREAMSIDE SALAMANDER, *AMBYSTOMA BARBOURI.* ***Michael A. Anderson* and Brian T. Miller,*** *Middle Tennessee State University, Murfreesboro, Tennessee.* In some salamander species, as well as various other vertebrates, iron-rich molecules are sequestered in the enamel and enameloid layers of teeth. In adults, the frequently orange-brown coloration of dental cusps facilitates visual iron detection. However, the diminutive size of embryos and early-stage larvae hinders visual confirmation; consequently, the ontogenetic stage during which iron is first deposited in teeth is not known. We utilized scanning electron microscopy and energy dispersive X-ray spectroscopy to examine the teeth of embryonic and larval Streamside Salamanders, *Ambystoma barbouri*, to determine the earliest developmental stage during which iron can be detected in teeth and to quantify the relative iron concentration along a longitudinal axis. Iron was found in first-generation teeth of embryos, suggesting that yolk, rather than diet, is the source of iron deposited in teeth of early-stage salamanders. Moreover, as in adults of heterospecifics, iron was present in a decreasing apical-basal gradation.

THE EFFECTS OF SHORT-TERM STRESS ON CORTICOSTERONE, LEUKOCYTES, TESTOSTERONE, AND PROSTAGLANDIN E2 IN MALE SOUTHEASTERN FIVE-LINED SKINK (*PLESTIODON INEXPECTATUS*). ***Ryan Seddon* and Matthew Klukowski,*** *Middle Tennessee State University, Murfreesboro, Tennessee.* Levels of corticosterone (CORT), the major glucocorticoid in reptiles, increase during stress. While immunosuppressive effects of chronically elevated corticosterone are well known, acutely elevated CORT levels may actually enhance immunity. We tested for effects of a 1-h acute confinement stress on plasma CORT, prostaglandin E2 levels (PGE2), and leukocyte numbers in male skinks. CORT levels and eosinophil:lymphocyte ratios were significantly elevated in confined lizards, but confinement did not have a significant effect on plasma PGE2 levels. In mammals, PGE2 has a very short half-life; thus in experiment two, we determined the effects of shorter periods of confinement. Male lizards subjected to 15 or 30 min of confinement had elevated CORT levels, but PGE2 levels were still unaffected. Results from a third experiment in which we tested the effects of a 2-h confinement on plasma CORT, testosterone, and leukocyte ratios will also be discussed.

EFFECTS OF FOOD DEPRIVATION ON PLASMA CORTICOSTERONE AND TRIGLYCERIDES IN WATER SNAKES, *NERODIA SIPEDON.* ***Alison Carey* and Matthew Klukowski,*** *Middle Tennessee State University, Murfreesboro, Tennessee.* Food restriction has been shown to be stressful in a variety of vertebrates, but little work has been done in snakes. The purpose of this study was to determine if plasma corticosterone levels rose in response to a mild food deprivation in water snakes (*Nerodia sipedon*) and to determine the effects of food deprivation on plasma triglyceride, uric acid, glucose, and lactate levels. Snakes that were starved for 15 days lost body mass, had elevated baseline corticosterone, and depressed levels of triglycerides and uric acid. Elevation of corticosterone levels would be expected to help snakes mobilize stored energy, such as fat and protein, allowing them to survive periods of restricted feeding. Depressed levels of triglycerides seem to be associated with mild starvation in snakes. Uric acid is the main excretory product of protein breakdown in reptiles. Low uric acid levels might also be a useful marker of starvation.

EFFECTS OF MATERNALLY TRANSFERRED METHYLMERCURY CHLORIDE ON STRESS INDUCED CORTICOSTERONE LEVELS IN *NERODIA SIPEDON* NEONATES. ***J. Patrick W. Cusaac*, Raymond C. Wright, Cassandra Henry, and Frank C. Bailey,*** *Middle Tennessee State University, Murfreesboro, Tennessee.* Stress responses in ectothermic organisms play a crucial role in their ability to survive. Cause and response interactions of stressors are relatively well studied; however studies showing the effects of heavy metal toxicity on stress are lacking, particularly in squamate reptiles. The purpose of this study was to show the effects of maternally transferred methylmercury chloride on stress-induced plasma corticosterone (a hormone that normally increases in response to stress) levels in Northern Water Snake (*Nerodia sipedon*) neonates. The objective of this study was to determine if neonates from methylmercury-dosed females exhibit a diminished increase in corticosterone in response to confinement stress when compared to controls. Gravid females were dosed with 0, 10, or 10,000 ug/Kg methylmercury. We found no significant difference in corticosterone levels between dosing treatments (ANOVA; $F_{df=2} = 1.046$; $P = 0.395$). We therefore conclude that methylmercury chloride has no effect on stress induced corticosterone levels in neonate *N. sipedon*.

FECAL SAMPLES AS AN INDICATOR OF MERCURY ABSORPTION IN DOSED NORTHERN WATER SNAKES, *NERODIA SIPEDON.* ***Raymond C. Wright*, J. Patrick W. Cusaac, Cassandra Henry, and Frank C. Bailey,*** *Middle Tennessee State University, Murfreesboro, Tennessee.* Reptiles are underrepresented in ecotoxicology, with most studies focusing on tissue concentrations of contaminants. Little research has been

conducted on contaminant effects in reptiles. This study was part of a larger ongoing project looking at maternal transfer of methylmercury from mother to neonates in *Nerodia sipedon* and behavioral effects on the neonates. In the study, 24 gravid female *N. sipedon* were randomly assigned to one of three treatments: a control (0), 10, and 10,000 ug/Kg methylmercury chloride. The objective of this portion of the project was to see how much mercury was absorbed by each dosed snake, by analyzing the amount that was excreted in the feces. In the 10 ug/Kg treatment, 12.3% of the dosed mercury was excreted in the feces (range = 4.2%–32%). In the 10,000 ug/Kg treatment, 4.3% was excreted (range = 2.1%–6.6%). At each dose level, the majority of the mercury was absorbed by the gravid females.

NICHE PARTITIONING AND OVERLAP BETWEEN WINTERING WOODPECKERS IN A BOTTOMLAND HARDWOOD FOREST IN NORTHWEST TENNESSEE. ***Caitlin M. Gussenhoven and H. Dawn Wilkins,*** *University of Tennessee at Martin, Martin, Tennessee.* Woodpeckers belong to the bark-foraging guild and are known for partitioning resources. Our goal was to describe niche overlap and breadth of four commonly observed woodpeckers in a bottomland hardwood forest during the winter. Observations of woodpecker behavior and location were taken every 30 sec for 15 min. Downy Woodpeckers (*Picoides pubescens*) were observed foraging on small main branches and peripheral branches, possibly reducing niche overlap with larger species. Yellow-bellied Sapsuckers (*Sphyrapicus varius*), who primarily forage on sap, were specialized on living trees. Red-bellied Woodpeckers (*Melanerpes carolinus*) were observed primarily foraging on the trunk and main branches, while Red-headed Woodpeckers (*Melanerpes erythrocephalus*) were observed on main branches. Niche overlap was the highest between Red-bellied and Red-headed woodpeckers, and we observed aggressive interactions between them. Red-bellied Woodpeckers are resident species, whereas Red-headed Woodpeckers are irruptive migrants, which may lead to annual changes in niche relations between the two species.

AN ASSESSMENT OF CHROMOSOMAL POLYMORPHISM IN THE SOUTHERN SHORT-TAILED SHREW (*BLARINA CAROLINENSIS*): IS HABITAT A FACTOR? ***Christopher Grow*, Melvin Beck, and Michael Kennedy,*** *The University of Memphis, Memphis, Tennessee.* In natural populations, chromosomal polymorphisms provide a rich source of data for studying relationships of chromosomal rearrangement and speciation. Because of a high level of reported chromosomal polymorphism and a generalist strategy for habitat, the southern short-tailed shrew (*Blarina carolinensis*) makes an interesting model for assessing chromosomal rearrangements and their relationship to natural history traits. Therefore, the purpose of this study was to investigate the relationship of chromosomal rearrangements with selected habitat factors. The study was conducted with *B. carolinensis* sampled at the Meeman Biological Station, Shelby County, Tennessee. Chromosomes were derived using G-banding techniques, and selected habitat variables were recorded at sites of capture using standard procedures. Data suggested variability in habitat factors among sites. Chromosomal/habitat associations are discussed.

RELATIONSHIP OF THE OCCURRENCE OF THE VIRGINIA OPOSSUM AND SELECTED HABITAT VARIABLES. ***Daniel Wolcott* and Michael Kennedy,*** *The University of Memphis, Memphis, Tennessee.* Increasing abundance and an expanded distribution of the Virginia opossum (*Didelphis virginiana*) creates a need to better understand habitat features associated with the species. Therefore, during 2008–2010, we studied (using mark/recapture techniques) the association between occurrence (based on capture) of Virginia opossums and selected habitat variables. The investigation was conducted at the Meeman Biological Station in Shelby County, Tennessee. Animals were captured using live traps baited with canned cat food. Upon capture, opossums were tagged with ear tags and released at the site of capture. Occurrence and habitat features were assessed using statistical procedures. Results are discussed in light of previous studies.

AN EXAMINATION OF INTERSPECIFIC ASSOCIATION BETWEEN EASTERN WILD TURKEY AND WHITE-TAILED DEER. ***Corey Young*, Jeremy Dennison, Andrew Madison, and Michael Kennedy,*** *The University of Memphis, Memphis, Tennessee (CY, JD, MK), and Union University, Jackson, Tennessee (AM).* Measures of the degree of interspecific association between different species are useful in assessing spatial relationships between taxa. Therefore, we studied interactions between two important game species (eastern wild turkey, *Meleagris gallopavo*, and white-tailed deer, *Odocoileus virginianus*). The study was conducted at the Milan Army Ammunition Plant in Carroll and Gibson counties in western Tennessee during 2009 and 2010. Infrared-triggered cameras placed over bait stations of shelled corn were used to determine spatial relationships. We used a coefficient of association to assess potential interactions. Data revealed eastern wild turkey and white-tailed deer at the same site on occasion but simultaneous occurrences were rare. Results are discussed in light of previous investigations.

EVALUATING MACROINVERTEBRATE DIVERSITY IN POND COMMUNITIES: A COMPARISON OF TWO SAMPLING TECHNIQUES. ***Laura A. Farmer and Steven W. Hamilton,*** *Austin Peay State University, Clarksville, Tennessee.* Due to the presence of groundwater contamination at the Milan Army Ammunition Plant (MLAAP), the installation is required to conduct research on its impact to aquatic communities. In June 2009, we began a macroinvertebrate diversity study comparing the efficacy of two sampling techniques in ten ponds at MLAAP. Four funnel-traps per pond were set for two consecutive 48-h periods during June and December 2009 and April 2010. Dip-net samples were collected in June and November 2009 and April 2010, with two individuals sampling simultaneously for 30 min in each pond. A total of 146 taxa were identified. Results from the two sampling methods revealed no significant differences in taxon richness or Shannon-Weaver diversity. Jaccard's Similarity Coefficient values indicated a difference in taxon sets collected. Taxon accumulation curves suggest that using both sampling methods would better assess diversity of pond habitats. Our data indicate that choice of sampling technique should consider habitat structure.

THERMAL ECOLOGY OF HIBERNATION IN THE MIDLAND WATERSNAKE. ***Jerrod D. Shipman* and Vince A. Cobb,*** *Middle Tennessee State University, Murfreesboro, Tennessee.* Hibernation is a thermally important time for reptiles, as they seek shelter to escape from potentially life-threatening temperatures. Little is known about the overwintering habits of reptiles

in the southern U.S. In this study, we used Midland Watersnakes along the Stones River, surgically implanted with radio transmitters and temperature loggers, to document ingress and egress patterns, potential winter activity, and body temperature variation during hibernation. Snakes chose to hibernate immediately adjacent to their area of activity in the river. Mean hibernation duration was 113 ± 6.5 days. Snakes only occasionally exhibited observable underground activity. Mean body temperature during hibernation was 7.32°C. Snake body temperatures tracked local air temperatures and water temperatures closely throughout hibernation, indicating the snakes did not seek refuges deep enough to buffer them from daily temperature variation. Interestingly, body temperatures during hibernation were only slightly warmer than those reported for northern latitude species by several studies.

THE EFFECT OF OLDER CONSPECIFICS ON GROWTH RATE AND SURVIVAL IN LARVAL TOBACCO HORNWORMS, *MANDUCA SEXTA*. ***Davene M. King* and Nancy L. Buschhaus**, University of Tennessee at Martin, Martin, Tennessee.* The tobacco hornworm, *Manduca sexta,* is a common agricultural pest that can, over two weeks, increase 10,000 times its size at hatching. Given that females lay several eggs at a time on a plant that may already have eggs/larvae, we examined the growth of *Manduca sexta* with and without the presence of older conspecifics. We separated hornworm eggs and placed several in plastic containers with abundant artificial food in treatments where there were only eggs or where there were eggs and 6-day-old larvae. There was no significant difference in the growth rate of hornworms that were placed with older conspecifics versus those in containers with no older conspecifics. However, older conspecifics had a significant negative effect on the percent survivability of their younger conspecifics. These results suggest that female *Manduca sexta* may benefit from choosing oviposition sites without the presence of older conspecifics.

A COMPARISON OF INSECT COLLECTIONS USING CDC LIGHT TRAPS EQUIPPED WITH INCANDESCENT AND GREEN LIGHT-EMITTING DIODE LIGHT SOURCES. ***Katie L. Rice* and C. Steven Murphree**, Belmont University, Nashville, Tennessee.* Centers for Disease Control (CDC) light traps equipped with an incandescent bulb are the standard for collecting night-flying insects. Recent research has demonstrated that CDC light traps equipped with green LED bulbs attract greater numbers of some insects (e.g., biting midges). This study compared collections from a standard CDC incandescent light trap with those of a trap equipped with three green LED bulbs in a wooded area in Davidson County, Tennessee. Collections in ethanol were removed twice weekly between late September and late October. A preliminary analysis of the collections has shown that the trap equipped with the incandescent bulb attracted a greater diversity of species and a greater number of individuals than the trap equipped with green LED bulbs.

REPELLENT PROPERTIES OF COMMON HERBS OF THE FAMILY LABIATAE AGAINST THE AMERICAN DOG TICK, *DERMACENTOR VARIABILIS*. ***Sarah E. Ayers*, Barbara B. Ward, and C. Steven Murphree**, Belmont University, Nashville, Tennessee.* The threat of contracting diseases vectored by ticks has been a consistent catalyst for the production of effective tick repellents. In recent years, public demand has shifted towards natural repellents and has subsequently directed researchers towards the production of plant-based products that are as effective as their synthetic counterparts (e.g., DEET). The repellency of three common herbs of the family Labiatae [*Salvia officinalis* (sage), *Ocimum basilicum* (basil), and *Lavandula angustifolia* (lavender)] against *Dermacentor variabilis* was observed using an *in vitro* assay. An essential oil extract from each herb, dissolved in acetone, was tested at 10%, 25%, and 50% concentrations. Significant repellency was detected for both lavender and basil extracts at concentrations of 25% and 50%. No significant repellency was observed for sage extract or for any essential oil at the 10% concentration level.

SPECIES DIVERSITY OF WOODPECKERS IN A WATER TUPELO SWAMP AND A BOTTOMLAND HARDWOOD FOREST IN NORTHWEST TENNESSEE. ***Leah M. Good and H. Dawn Wilkins**, The University of Tennessee at Martin, Martin, Tennessee.* As primary cavity excavators, woodpeckers fill an important niche in forested ecosystems. The diversity of trees in a forest may influence the abundance and diversity of woodpeckers present. Our goal was to compare woodpecker diversity between a water tupelo swamp and a bottomland hardwood forest in northwest Tennessee. We set up five points approximately 250 m apart in each habitat. We played 10 seconds of Barred Owl (*Strix varia*) calls at the beginning of each minute of the 3-min observation period. A diversity rarefaction was run on the total abundance of woodpeckers in each habitat type to determine if the two areas were equally diverse. Preliminary data showed that the bottomland hardwood forest was more diverse than the water tupelo swamp. Further description of the species composition of each area may lead to a better understanding of the relationship between tree diversity and the needs of different woodpecker species.

REASSESSMENT OF THE FISHES OF THE LITTLE RIVER SYSTEM, WESTERN KENTUCKY. ***Andrew S. Riggs* and Rebecca E. Blanton**, Austin Peay State University, Clarksville, Tennessee.* The Little River represents one of the most impaired watersheds in western Kentucky due to continued nonpoint source pollution associated with agriculture and urbanization. To evaluate historical changes in habitat, water, and fish community quality, we sampled fishes and conducted habitat assessments, comparing our findings to those of previous studies. Comparisons of current Kentucky Index of Biotic Integrity scores to scores from previous studies indicate the water quality and fish diversity in the Little River have decreased over the past ten years. Several intolerant species persist in the Little River watershed, including the rare *Etheostoma microlepidum*. Habitat and water quality scores for each site where this species occurs have declined, and its status in the Little River should be closely monitored. Future work will include examination of historical land-use changes in the system to highlight areas most in need of management.

CONSERVATION GENETICS OF A SPOTTED SALAMANDER (*AMBYSTOMA MACULATUM* (SHAW 1802) LOCAL POPULATION IN SOUTHEAST TENNESSEE. ***Daniel S. Armstrong* and Thomas P. Wilson**, University of Tennessee at Chattanooga, Chattanooga, Tennessee.* Genetic substructure is common in metapopulation scenarios as a result of local adaptation, genetic drift, and often limited gene flow between subpopulations. However, the use of genetic markers for inferring local population demography has been virtually nonexistent despite the potential uses of genetic markers for this

purpose. Population demography is an important consideration for conservation biology because loss of genetic diversity may have deleterious effects on the long-term viability of a population. The use of microsatellite markers to examine population structure can also reveal demographic information that would be more difficult or impossible to obtain using traditional ecological studies. Management strategies should consider the existence of fine-scale genetic substructure as well as the effective population size in order to more efficiently preserve the long-term viability of populations. The ongoing present study examines genetic diversity and population structure in a local population of the spotted salamander (*Ambystoma maculatum*) in southeast Tennessee.

MEACHAM POND REVISITED: AN ASSESSMENT OF ECOLOGICAL FACTORS FIVE YEARS LATER. ***Lauren Adan, Sandra Bann, Brittni Beard, Myeshia Coleman, Joshua Crowder, Brianne Dillahay, Joseph Guillet, Nathalia Hayashi, Ethan Horner, Krystle Irizarry*, Jeffrey Kane, Prashant Khiatani, Michelle Liew, LaDetra Major, Jonathan Martin, Chris Mills, Jaret Quitoriani, Paige Rasmussen*, Aaron Ross, Christa Ryder, Megan Snyder, Joshua Taylor, Jessica Whitley, Chelsea Williams*, Felicia Williams, and Willodean Burton,*** *Austin Peay State University, Clarksville, Tennessee.* The purpose of the study was to perform a more in-depth analysis of Meacham Pond by observing pollution and toxicity levels, and their effects on abiotic and biotic aspects of the pond. Meacham Pond was formed in a sinkhole located on the Austin Peay State University campus. Five years ago, an ecological assessment of Meacham Pond was conducted, examining multiple aspects ranging from microbial growth to water toxicity. During the ensuing 5-year interval, the pond was subjected to drought, floods, nearby construction, and an increase in campus population. In the present study, microbial growth, water toxicity, soil nutrients, soil arthropods, algae, and macroinvertebrates were analyzed to determine their variation over time. The study revealed that there was an increase in pond contamination; however, the pond sustained a large diversity of organisms.

EFFECTS OF MULTIPLE PREDATION CUES ON *PHYSID* SNAIL BEHAVIOR. ***Amy Fehrmann* and John Niedzwiecki,*** *Belmont University, Nashville, Tennessee. Physa* sp. snails dwelling in the streams around Nashville face a variety of predator threats. Chemical cues can stimulate anti-predatory behavior in a variety of aquatic systems. We tested the addition of single cues and a combination cue of crayfish odor and crushed snail odor, and observed changes in behavior. We found that snails react quickest and crawl out of the water in response to a cue containing only crayfish odor, but the reaction with a combination cue is more complex. The snails remain stationary for approximately an hour before crawling out of the water and remaining there. The threat of the combination cue, indicating an actual predation event has occurred, may compel the snails to stay still to have a better chance of survival in the face of the predatory threat.

Note: For entries without abstract text, no text was received as of publication deadline. * Student presenter.