

ABSTRACTS OF PRESENTATIONS AT THE 2009 (119th) ANNUAL MEETING OF THE TENNESSEE ACADEMY OF SCIENCE

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BOTANY

J. HILL CRADDOCK, CHAIR

A PRELIMINARY EVALUATION OF THE FLORA AND VEGETATION OF SEASONALLY WET LIMESTONE CEDAR GLADES OF THE SOUTHEASTERN UNITED STATES. *Kimberly Norton* and Dwayne Estes, Austin Peay State University, Clarksville, Tennessee.* Seasonally wet areas in limestone cedar glades of central Tennessee, central Kentucky and northern Alabama were characterized using soil, hydrology and vegetation. In addition, communities were evaluated according to U.S. Army Corps of Engineers wetland delineation procedures. Based on the study of 10 sites, 100 species were documented in 47 families and 86 genera. Sites are characterized by shallow soils less than 10 cm that are saturated from winter through late spring. Sites appear to meet the requirements to be classified as wetlands, but additional soil sampling, hydrologic monitoring, spring floristic data and vegetation analysis to determine percent cover of all species are yet to be completed.

A NEW SPECIES OF *POLYMNIA* (ASTERACEAE) FROM THE SEQUATCHIE VALLEY OF TENNESSEE. *Dwayne Estes, Austin Peay State University, Clarksville, Tennessee.* *Polymnia* (Asteraceae) is a North American genus of robust herbs containing three species: *P. canadensis*, *P. laevigata*, and *P. cossatotensis*. *Polymnia canadensis* is widespread in eastern North America whereas *P. laevigata* is a rare species found only in a few areas of the southeastern U.S. The third species, *P. cossatotensis*, is restricted to four sites in the Ouachita Mountains of Arkansas. In September 2008, a fourth undescribed species of *Polymnia* was discovered on calcareous forested slopes in the southern portion of the Sequatchie Valley of Marion County, Tennessee. Currently, it is known from just two populations 5 km apart. This new species differs from the other three members of the genus in its combination of extremely dissected leaves and prominent pubescence. It will be named in honor of John T. Beck, a colleague formerly at the University of Tennessee and one of the best field botanists in the southeastern U.S.

VITIS RUPESTRIS (VITACEAE) REDISCOVERED IN TENNESSEE. *Sunny Hart* and Dwayne Estes, Austin Peay State University, Clarksville, Tennessee.* *Vitis rupestris* (Vitaceae), or rock grape, is a globally uncommon species discontinuously distributed from Texas and Oklahoma east to Virginia and Pennsylvania. The species inhabits flood-scoured limestone or cherty streambeds, cobble bars, outcrops and bluffs. Rock grape

was first collected in Tennessee by Augustine Gattinger in 1880 from an island in the Cumberland River near Nashville, Davidson County. The species was erroneously reported from several sites in Tennessee during the 1960s–1980s but these collections are based on misidentifications. In September 2008, after having not been seen for 128 years, we discovered a single population of seven vegetative individuals in Montgomery County, Tennessee, approximately 50 river-miles downstream from the original Gattinger location. The newly discovered population occurs on a limestone ledge of a barren-like slope above the Cumberland River in association with other rare species including *Cornus obliqua* and *Solidago rupestris*; it represents the only extant population in Tennessee.

RELATIONSHIPS AMONG THE DENSITY OF THE INVASIVE SPECIES BUSH HONEYSUCKLE (*LONICERA MAACKII*), INVASIVE SPECIES MANAGEMENT FREQUENCY, AND ARBOREAL COVER FOR FORESTS IN RADNOR LAKE STATE NATURAL AREA. *Jesse Germeaad, Travis Treece*, Daniel Wakefield*, Robert Loeb, and Steve Ward, Lipscomb University, Nashville, Tennessee (JG, TT, DW), Pennsylvania State University, Dubois Campus, Dubois, Pennsylvania (RL), and Radnor Lake State Natural Area, Nashville, Tennessee (SW).* Density of *Lonicera maackii*, both < 1 m and > 1 m tall, undergoing repeated eradication treatments versus one treatment over a seven year period was examined in forested slopes and level areas of the Radnor Lake Natural Area, Nashville, Tennessee. Honeysuckle density and tree (> 2.5 cm dbh) basal area measurements were made in 200 eight meter radius plots. Correlations were not significant between total basal area and one year treatment for both < 1 m and > 1 m and for annual treatment and > 1 m for both level and slope plots. Correlations were significant (0.01 level) for annual treatment and < 1 m for both level and slope plots. T-tests of differences between plot means with unequal sample sizes and unequal variances showed significant differences (0.01 level) between the means for one year versus annual treatment except for the plants < 1 m in level plots.

CURRENT STATUS OF *BUCKLEYA DISTICHOPHYLLA* (NUTT.) TORR. IN TENNESSEE. *Roger A. McCoy, Tennessee Natural Heritage Program, Nashville, Tennessee.* First described from Greene County, Tennessee, in the mid-nineteenth century, *Buckleya distichophylla* is a semi-parasitic shrub of the Santalaceae family. This globally rare, Southern Appalachian endemic is tracked in North Carolina, Virginia, and Tennessee, where it is listed as threatened. Heritage Program staff attempted to visit all known sites containing *B. distichophylla* in Tennessee as many

occurrences had not been updated in over 25 years. Presently, there are eleven extant occurrences, two occurrences extirpated from past reservoir construction, and four others could not be relocated. All extant occurrences are associated with stream or river systems within the Blue Ridge Physiographic Province where the shrub parasitizes a variety of tree species. The highest ranked occurrences, each with over 200 individual shrubs, are found on dry, somewhat exposed sites within the NatureServe Ecological Systems of Southern and Central Appalachian Oak Forest (and Xeric Oak Forest) and Southern Appalachian Low Montane Pine Forest.

A PRELIMINARY FLORA OF THE TENNESSEE RIVER GORGE, HAMILTON AND MARION COUNTIES, TENNESSEE. *Emily Blyveis* and Joey Shaw, University of Tennessee at Chattanooga, Chattanooga, Tennessee.* The Tennessee River Gorge (TRG) is a twenty six mile long river canyon located on the southeastern region of the Cumberland Plateau in Hamilton and Marion counties, Tennessee. The subject of this inventory is strictly the southern gorge land area which includes ca. 4,003 hectares from the riparian edge to the escarpment apex. The TRG contains many unique habitat types within the riverine, upland, and gorge areas. The goals of this study are to inventory the vascular flora of the TRG, document the presence of rare, threatened, endangered and introduced species, report county records for Hamilton and Marion counties, and compare the completed inventory to seven other regional floras to determine the relative species richness of the TRG. From March to October 2009, 20 collecting trips were made, and a total of 247 specimens were collected. One hundred forty six species from 64 families have been documented thus far. The dominant families are Fabaceae with 17 taxa and Asteraceae with 12 taxa. Eighteen introduced species were documented, including *Albizia julibrissin*, *Lonicera japonica*, and *Paulownia tomentosa*.

A PRELIMINARY FLORA OF SEQUATCHIE VALLEY IN SEQUATCHIE COUNTY, TENNESSEE. *John Evans* and Joey Shaw, University of Tennessee at Chattanooga, Chattanooga, Tennessee.* The vascular flora of the Sequatchie Valley and its eastern escarpment in Sequatchie County, Tennessee, is currently under study. The Sequatchie Valley is generally considered to be part of the Cumberland Plateau physiographic province; however, a number of geological and ecological factors distinguish the valley from the plateau proper. Geologically, the Sequatchie Valley was initiated by a breach through the normally resistant sandstone cap rock that overlays the Cumberland Plateau. Extensive erosion of the underlying limestone has resulted in a long, narrow valley floor that is 400 m lower than the surrounding plateau. The valley is warmer and dryer than the plateau, and is physically isolated from other low-lying areas to the east and west. Although nine separate floras have previously been conducted on the Cumberland Plateau, very little attention has been given to the Sequatchie Valley. The isolation and unique physiography of the valley suggest that the floristic composition may be different from the elevated plateau, as well as the neighboring Ridge and Valley and Eastern Highland Rim physiographic provinces. As of October, 2009, approximately 1300 specimens have been collected. Of these, 342 species in 96 families have been positively identified. This study will continue through the summer of 2010.

ALLELOPATHIC INFLUENCE OF *RHUS GLABRA* L. *Harold A. Simmons and Mark Montgomery, Northwest Mississippi*

Community College, Southaven, Mississippi. Examination of plots within, and adjacent to, *Rhus glabra* L. stands revealed the following: (a) fewer species of other plants grew within the smooth sumac stands compared to adjacent plots; (b) assays for effects of fruit and leaf leachates on lettuce seed germination and bean radicle elongation demonstrated allelopathic interference. Leachate from fruit clusters of sumac did not affect percentage germination of lettuce seed; leaf leachate had a definite effect in reducing and retarding seed germination. Both fruit and leaf leachate decreased growth of bean radicles, showing an effect either on cell division and/or elongation. The identification of water soluble chemicals causing these allelopathic effects is in progress. Whether the effects on radicle elongation are due to affecting cell division and/or cell elongation is under investigation.

CURRENT STATUS OF *CLEMATIS MOREFIELDII* IN TENNESSEE INCLUDING NEW POPULATIONS AND HABITAT MODELING. *Todd Crabtree, Tennessee Department of Environment and Conservation, Nashville, Tennessee.* *Clematis morefieldii* was described in 1987 by Dr. Robert Kral after being discovered in 1982 by James Morefield near Huntsville, Alabama. It was listed as an endangered species in 1992 at the federal level and is also listed as state endangered. It was discovered in Tennessee in 2003 and subsequent surveys in 2005 and 2009 by the Tennessee Natural Heritage Program revealed 11 new populations. For the 2009 survey a GIS model was developed to target areas of suitable habitat. A solar analysis of occurrences in Tennessee led to information that was utilized in developing a habitat model. Aspect, soils and slope were included in this interpreted model. All of the known occurrences are within dry calcareous forests. These forests are classified by NatureServe as the Southern Ridge and Valley/Cumberland Dry Calcareous Forest. Although *C. morefieldii* occurs within the dry forest, the surrounding forest is much more mesic.

ESTABLISHMENT OF PERMANENT PLOTS AND ANALYSIS OF WOODY VEGETATION IN THE TENNESSEE RIVER GORGE, MARION AND HAMILTON COUNTIES, TENNESSEE. *Gerald Woodworth* and Joey Shaw, University of Tennessee at Chattanooga, Chattanooga, Tennessee.* The Tennessee River Gorge is located five miles to the west of Chattanooga, Tennessee, in the Cumberland Mountains along 27 miles of the Tennessee River. Previous studies in the area have shown the region to be understudied and highly diverse. Studies using long-term monitoring plots have shown their usefulness in observing changes over time and discovering the underlying causes. I established 100 plots of 100 m² in the gorge. The plots were distributed within communities identified in 1984 for the Tennessee River Gorge Trust. All woody species over 5 cm dbh were recorded within the plot and field identification was attempted for all species. The basal area, dominance, frequency and importance were calculated for the plots, communities, and all plots combined. The results were compared to the descriptions of the communities of the gorge. The results of many communities matched their descriptions. However, there were several communities with results that did not match up with their descriptions. This is primarily due to succession in communities that were in early successional stages or due to a low sample number. This study is beneficial by allowing a more detailed analysis and comparison of future change within the communities of the gorge.

CELL AND MOLECULAR BIOLOGY

MICHAEL W. THOMPSON, CHAIR

INACTIVATION OF BAD VIA A PKC- SIGNALING PATHWAY IS LINKED TO PROTECTION FROM RAPAMYCIN-INDUCED APOPTOSIS BY IGF-1 IN SARCOMA CELLS. *Kuntebommanahalli Thimmaiah, John Easton, Larry Sylvester, Paul Grisham, Ray Cox, Harold Simmons, Augustinus Rinaldy, and Peter J. Houghton, Northwest Mississippi Community College, Southaven, Mississippi (KT, LS, PG, RC, HS, AR), and St. Jude Children's Research Hospital, Memphis, Tennessee (KT, JE, PH).* Rapamycin induced apoptosis in sarcoma cells is inhibited by IGF-1 through a pathway independent of Ras-Erk-1/2 and Akt. IGF-1 induces Bad phosphorylation (S112, S136, S155) in a pathway involving PI3K and PKC. Gene knockdown of Bad, Akt1, Akt2, PKC- μ , PKC- ϵ or PKC- θ was achieved by using small interfering RNAs. Results indicate IGF-1 signaling to Bad requires activation of PI3K, PKC (μ , θ , ϵ) but not mTOR, Ras/Erk-1/2, PKA, or p90^{RSK}. Further, cells overexpressing pEGFP-N1, wt-Bad, or Bad with a single site mutated (S112A; S136A; S155A), two sites mutated (S112A/136A; S112A/155A; S136A/155A) or the triple mutant (TM) were tested. IGF-1 protected completely against rapamycin induced apoptosis in cells overexpressing wt-Bad, and mutants having either one or two sites of phosphorylation mutated. Collectively, this data suggest that IGF-1 induced phosphorylation of Bad at multiple sites *via* a pathway involving PI3K and PKCs is important for protecting sarcoma cells from rapamycin induced apoptosis.

TRANSLATION MACHINERY OF ADENOVIRUS IS INDEPENDENT ON HOST 4E INITIATION FACTOR BUT UNDER THE CONTROL OF BOTH VIRAL IRES AND HOST RIBOSOMAL S6. *Augustinus Rinaldy, Kuntebommanahalli Thimmaiah, Larry Sylvester, Harold Simmons, Paul Grisham, Ray Cox, John Easton, Phillip E. Brenton, and Peter J. Houghton, St. Jude Children's Research Hospital, Memphis, Tennessee (AR, KT, JE, PH), Northwest Mississippi Community College, DeSoto Campus, Southaven, Mississippi (AR, KT, LS, HS, PG, RC), McGill University, Montreal, Quebec, Canada (PB).* CAP-dependent translation is primarily the canonical concert activity of *eIF4* and *rS6*. The *eIF4*, however, is under the control of repressor *4EBP1*. Phosphorylation of both *4EBP1* and *rS6* reflects the translational efficiency, either in homeostatic or completely shutdown mode. This translation machinery can be affected through viral infection resulting in CAP-independent pathway. It is initiated by inactivation of *4EBP1* through its phosphorylation bypassing the CAP's role in assisting the small ribosomal subunit to scan the AUG start codon. This mechanism is achieved through a specific *IRES* sequence upstream of the start codon in the untranslated region of the majority viral mRNA and some eukaryotic mRNA. We observed this phenomenon after the infection of sarcoma cells (Rh1) with adenovirus as indicated by the simultaneous phosphorylation of *4EBP1* and *rS6*. The initial driving factor of this adenovirus-based-translation-machinery is under the control of the hypothetical adenoviral *IRES* sequence.

INTERACTION OF APOLACTOFERRIN WITH THE HEMOPEXIN DOMAIN OF PRO-MMP-2. *Michael W. Thompson, Caroline A. Spencer-Green, and Rebecca L. Seipelt, Middle*

Tennessee State University, Murfreesboro, Tennessee. Although apolactoferrin (ApoLTF) is capable of inhibiting a low molecular weight form of MMP-2, recent reports indicate that ApoLTF may also interact with pro-MMP-2, resulting in its subsequent activation. To test this hypothesis, ApoLTF and HoloLTF were subjected to immunoprecipitation analysis to determine if the two proteins interact, and if so, which domains are involved in this interaction. ApoLTF co-immunoprecipitated with Pro-MMP-2 and with active MMP-2, but failed to co-immunoprecipitate with forms of MMP-2 lacking the hemopexin domain, indicating that the interaction likely involves the hemopexin domain of pro-MMP-2 and MMP-2. HoloLTF failed to co-immunoprecipitate with any form of pro-MMP-2 or MMP-2, indicating that the metal-free form of lactoferrin is required for the physical interaction to occur. Thus, it is likely that the interaction of ApoLTF with the hemopexin domain of Pro-MMP-2 interferes with the binding of pro-MMP-2 to TIMP-2, thus disrupting the ternary complex that localizes pro-MMP-2 to the pericellular compartment and resulting in its subsequent activation.

THE EFFECT OF 6-OHDA ON LOCOMOTION AND EGG LAYING IN *C. ELEGANS* UNDER THE STIMULATION OF A CHEMICAL ATTRACTANT. *Anwesa Chakrabarti* and Nick Ragsdale, Belmont University, Nashville, Tennessee.* Parkinson's Disease is a neurodegenerative disorder that upsets locomotor activity. This disease is brought about by the death of dopaminergic cells of the nervous system. 6-hydroxydopamine (6-OHDA) is an environmental toxin that has been found to kill these neurons, but few studies have characterized its effects. Previous studies at Belmont University have looked at the influence of 6-OHDA on motility and egg laying in *Caenorhabditis elegans* (*C. elegans*). Their results showed that the neurotoxin increases locomotion, contrary to what was expected. Therefore, this study adds to these previous studies by examining the influence of 6-OHDA on locomotor activity using a more natural stimulus. The data from this study will hope to show that 6-OHDA increases locomotor activity to this more natural stimulus. This effect may be due to the differential binding of dopamine between D1-like and D2-like neurons.

BRAIN-DERIVED NEUROTROPHIC FACTOR (BDNF) EXPRESSION IN MDA-MB-231 CANCER CELLS. *Andrew Hall*, Amber M. Burch, and Jon H. Lowrance, Lipscomb University, Nashville, Tennessee.* Brain-Derived Neurotrophic Factor (BDNF) is member of a family of neurotrophic growth factors expressed within various mammalian tissues and cells. In neurons, BDNF functions by supporting the survival as well as promoting the development and differentiation of infantile neurons. However, the function of BDNF in other types of non-neuronal cells is not well defined. Since BDNF is anti-apoptotic in neurons, this study examines the expression of BDNF in cancer cells, specifically the primary cell line, MDA-MB-231. In these breast cancer cell lines the expression of BDNF was demonstrated by RT-PCR. In addition, BDNF was determined to be slightly over expressed by RT-PCR. The results suggest that BDNF expression in the breast cancer cell lines could contribute to the tumorigenic aspect of cancer cells and provides a positive foundation for further research into the function of BDNF in cancer and its anti-apoptotic nature.

CHEMISTRY

DANIEL J. SWARTLING, CHAIR

A COMPUTATIONAL STUDY OF THE HETEROLYTIC BOND DISSOCIATION ENERGY OF WATER IN METAL-LOENZYME ACTIVE CENTER MIMICS. **Derek B. Allison***, **Jordan A. Gault***, and **J. Dominic Smith**, *Lipscomb University, Nashville, Tennessee*. The active site of α -Carbonic Anhydrase was modeled with metals other than zinc and using imidazole in place of histidine to calculate the heterolytic bond dissociation energy (BDE) of the H_2O ligand. Density Functional Theory (DFT) was used to calculate geometry optimizations and single point energies for the metal complexes. A correlation between charge-to-radius ratio and BDE was found. These data suggest that the catalytic activity of the enzyme active center could be maximized in an artificial setting with an active center biomimic. Although Zn^{2+} is the metal center found in nature, it is less catalytically active than Sc^{3+} , Ti^{3+} , Ti^{4+} , and Mn^{3+} , and in similar settings.

THEORETICAL STUDIES OF HYDROGEN ABSTRACTION FROM HYDROFLUOROPROPANES. **Wasana Senevirathna*** and **Titus Albu**, *Tennessee Technological University, Cookeville, Tennessee*. Hydrofluoropropanes are extensively used as alternatives to chlorofluorocarbons in various industrial, commercial, and household applications. Hydrogen abstraction from hydrofluoropropanes is the most important degradation reactions occurring in the atmosphere. The first part of this study focuses on the complete analysis of saddle points with the goal of finding all saddle points of the hydrogen abstraction reaction from hydrofluoropropanes by OH radicals. We used the hybrid-density functional theory mPW1B95-44.0 level of theory with the 6-31G (d,p) basis set for all geometry optimizations and energy calculations. We found 119 new saddle points which, when added to the previously reported 269 saddle points, give a total of 388 saddle points for all 28 hydrofluoropropanes. In the second part of the study, we calculate the rate constants for selected hydrofluoropropanes: $(CH_2FCF_2CF_3)$, $(CHF_2CHF_2CF_3)$, and $(CF_3CH_2CF_3)$ using variational transition state theory with multidimensional tunneling contribution over the temperature range 200–1500 K.

SYNTHESIS AND CHARACTERIZATION OF SOLVOCHROMATIC DYES. **Andy Standley***, **Jeremiah Woodcock***, and **Andrienne Friedli**, *Middle Tennessee State University, Murfreesboro, Tennessee*.

AN IMPROVED METHOD FOR SYNTHESIZING 5-ALKYLIDENEMALONATE DERIVATIVES OF MELDRUM'S ACID VIA KNOEVENAGEL CONDENSATION. **Casey J. McCormick*** and **Daniel J. Swartling**, *Tennessee Technological University, Cookeville, Tennessee*. Several aromatic and heteroaromatic aldehydes and cyclic ketones were reacted with Meldrum's acid in the presence of a basic catalyst to perform a Knoevenagel

ville, Tennessee. This presentation is an improvement to a method for separating a racemic mixture of DL-histidine. Other methods have used liquid bromine, lead acetate, and ninhydrin spray, etc., to test for D-histidine. Since these methods are hazardous and time consuming we propose a method that gives rapid results and is very safe. Racemic histidine is reacted with D-tartaric acid to make two diastereomeric salts, one of which is insoluble. After filtration of the precipitate, it is redissolved and applied to an ion exchange column to remove the tartrate. Determination of the absorbance of the histidine in the eluent shows if histidine is present instead of tartaric acid. Analysis is performed using a polarimeter and a chiral column on a HPLC and compared to DL-histidine and L-histidine.

ENZYMATIC AND MASS SPECTRAL ANALYSIS OF MUTANT AND WILD TYPE SELENOMETHIONYL DIHYDROFOLATE REDUCTASE. **Molly E. Broderick***, **Kathleen M. Broderick***, and **Jeffrey 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 16, also subjected to these analyses for both the wild-type and selenoprotein, will be presented.

PRETREATMENT OF SWITCHGRASS FOR THE GLYCO-SYL BIOCONVERSION TO CELLULOSIC ETHANOL. **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 provide a more 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 various pre-treatment methodologies on several readily available and/or proposed feedstocks, and 2) the resultant yield in ethanol for each feedstock.

SYNTHESIS OF A SERIES OF ALLOXAN THIOSEMICARBAZONES AND REACTIONS WITH PLATINUM AND PALLADIUM. **Andrea Wilson***, **Erica Stoner***, and **Edward C. Lisic**, *Tennessee Technological University, Cookeville, Tennessee*.

A NEW SERIES OF POTENTIAL MEDICINAL COMPOUNDS: 5-ACETYLURACIL THIOSEMICARBAZONES

HARTREE-FOCK STRUCTURES OF ALKOXY-SILANES AND PROPOSED SOL-GEL PRODUCTS. *Tara Greer**, *Ngee Sing Chong*, *William H. Ilsley*, and *Judith Iriarte-Gross*, Middle Tennessee State University, Murfreesboro, Tennessee. The results of Hartree-Fock 3-21G* and 6-31G** and density functional B3LYP 6-31G** calculations performed on a series of alkoxy-silanes and several proposed Sol-Gel products will be reported. At the HF 6-31G** level, the alkoxy-silanes, $\text{Si}(\text{OR})_4$, R=H, Me, Et and $\text{Si}(\text{OMe})_4$, exhibit tetrahedral geometry about each silicon, with average Si-O distances of 1.647, 1.623, and 1.624 and 1.619Å, respectively and the average O-Si-O angles are 111.22, 109.50, 109.50, and 109.48°, respectively. For R= Me, Et and $\text{Si}(\text{OMe})_4$, the average Si-O-C angles are 126.16, 126.45, and 126.32°, respectively. At the HF 6-31G** level, the alkoxy-silanes, $\text{O}[\text{Si}(\text{OR})_3]_2$, R=H, Me, Et, also exhibit tetrahedral geometry about each silicon, with average Si-O distances of 1.625, 1.615, and 1.616Å, and bridging Si-O distances of 1.625, 1.622, and 1.623Å, respectively, for R= H, Me, and Et. The average Si-O-Si bridge angles are 139.48, 155.96, and 155.97°, respectively.

THEORETICAL MODELING OF ELECTRON TRANSFER RATES BETWEEN CYTOCHROME C AND SMALL TRANSITION METAL COMPLEXES. *Thusitha Pathirathne** and *Scott Northrup*, Tennessee Technological University, Cookeville, Tennessee. An accurate description of electrostatic fields around proteins and their redox partners at various salt concentrations is essential to analyze specific interactions at the molecular level as electrostatic interactions is the key phenomenon that facilitate electron transfer (ET) reactions. The Poisson-Boltzmann equation has been widely used in conjunction with Brownian dynamics to calculate diffusional rate constants for ET between redox partners. In this work we enhanced the existing Brownian dynamics methodology, and the enhanced model is proved to be more robust as it models the electrostatic fields more accurately at various ionic strengths. Second-order kinetics of electron transfer between cytochrome c and seven transition metal ion complexes was quantitatively modeled, and intrinsic ET rate parameters were extracted. Marcus reorganization energies for all reactions are found to be large compared to the range observed for physiological ET, thus explaining why this series of reactions are slower than biological ET.

COMPARATIVE PROTEOMICS OF TRICLOSAN TOXICITY TO GREEN ALGAE *CHLAMYDOMONAS REINHARDTII*. *Upul Deepthike* and *Jeffrey O. Boles*, Tennessee Technological University, Cookeville, Tennessee. The toxicity of triclosan, a chlorinated biphenyl ether antimicrobial compound, to microalgae is well-documented. In those studies, assessment of toxicity has almost exclusively been performed by measuring impacts on biomass or growth curves of microalgae. However, cell population or its growth characteristics may not represent the vitality of an algae culture as toxicants may cause some obscured physiological alternations in the cells. Emphasizing the fact that the proteome of an organism may better represent its characteristics including vitality, this work purposes a comparative proteomic approach as an alternative toxicity measurement method. Dinoflagellate unicellular microalgal species *Chlamydomonas reinhardtii* was used as a model alga. Two dimensional electrophoresis maps of phenol-extracted proteins from control and triclosan-treated (30 ng/mL) cell cultures showed a significant difference, and thirty eight differentially expressed spots were visually identified.

THE PREPARATION AND MASS SPECTRA STUDIES OF A SERIES OF TRIMETHYLSILYL AND TRIMETHYLGERMYL OXY AND THIO CHLOROALKANES. *Brian M. Agee**, *Eugene A. Kline*, *David J. Crouse*, *Daniel J. Swartling*, and *Gene A. Mullins*, Tennessee Technological University, Cookeville, Tennessee. A system of alpha-chloro-omega-trimethylsilylalkoxanes heated in sealed tubes produced varying yields of cyclic ethers in a former study. Following this study, there was minimal evidence that supported the occurrence of these reactions in the mass spectrometer. A homologous series of molecules of the general formula $\text{Me}_3\text{Si}(\text{Ge})\text{O}(\text{S})(\text{CH}_2)_n\text{Cl}$, where $n = 2$ to 6, were synthesized in this study with oxygen or sulfur atoms adjacent to the silicon or germanium and their fragmentation patterns were studied by GCMS. The major fragmentations of the compounds generally included losses of methyl radicals, the $(\text{CH}_3)_2\text{-Si}(\text{Ge})\text{-Cl}$ cation, and trimethylsilyl- and trimethylgermyl- ions. However, most common abundant ions observed included the $(\text{CH}_3)_2\text{-Si}(\text{Ge})\text{-Cl}$ cation and the rearrangement ion $(\text{Cl})(\text{CH}_3)_2\text{Si}(\text{Ge})\text{O}(\text{S})\text{CH}_2$. It was assumed that the cyclic ethers and cyclic thioethers formed with neutral radical losses and formation of $(\text{CH}_3)_2\text{-Si}(\text{Ge})\text{-Cl}$ and $(\text{Cl})(\text{CH}_3)_2\text{Si}(\text{Ge})\text{O}(\text{S})\text{CH}_2$ rearrangement cations in varying amounts favoring the less strained ring sizes.

MICROWAVE ASSISTED ENZYMIC HYDROLYSIS AND PEPTIDE MAPPING IN THE UNDERGRADUATE BIOCHEMISTRY LABORATORY. *Kevin Lavender**, *David Jones*, *Gabrielle Clayton**, *M. Todd Garrett**, *Roy F. Jang**, *Alex W. Renfro**, *Margarita N. Weatherman**, and *Kent Clinger*, Lipscomb University, Nashville, Tennessee. Laboratories are constantly striving for faster ways to demonstrate modern procedures. Protein digestion can be a time-consuming procedure. A microwave-assisted digestion reduces the time required dramatically. Previous methods have been shown to work with cytochrome C and trypsin as the digestive enzyme. This paper shows that microwave-assisted digestion can be applied to other proteins and proteases such as: myoglobin, hemoglobin, chymotrypsin, and papain. All proteins discussed have a chromophore so detection can be easily obtained on an HPLC using a reverse-phase column.

METAL EXTRACTION FROM AQUEOUS SOLUTIONS USING THIOSEMICARBAZONE AND SEMICARBAZONE CHELATING RESINS. *Amanda J. Crook**, *Edward C. Lisic*, and *Dale D. Ensor*, Tennessee Technological University, Cookeville, Tennessee. The presence of heavy metals in natural waters is an increasing problem due to industry practices and man-made disasters, such as the ash spill at the TVA power plant in Harriman, Tennessee. As the environmental consciousness of the population is raised, the demand for stricter regulations on the amounts of metals present in water sources will increase. This study presents the results of removing metal ions from aqueous solutions using a series of chelating resins. Dry weight distribution, D_w , values were measured by a batch technique for a series of resins containing different functional moieties at selected pH values. The results for the uptake of nickel, cadmium, and cobalt as a function of pH, resin loading, and structure of the chelating group will be presented. These materials offer the potential to effectively extract and separate metals at environmentally important aqueous conditions.

ENGINEERING AND ENGINEERING TECHNOLOGY

ISMAIL FIDAN, CHAIR

CAPSTONE PROJECT EXPERIENCES FOR ELECTRICAL ENGINEERING TECHNOLOGY ELECTRONICS OPTION. *Adel Salama, Austin Peay State University, Clarksville, Tennessee.* We present our experience of advising undergraduate electrical engineering technology students for their capstone design project to satisfy TAC of ABET. In the electronics option of electrical engineering technology, the capstone design experience is provided to students via the two-course sequence of ENGT 4220 Communication Systems II and ENGT 4200 Linear Electronics. A team-oriented design project in the electrical engineering technology/electronics option incorporates technology standards and realistic design constraints, and it requires formal reports and oral presentations. During the first 8 week term, students started a capstone design project as part of ENGT 4220 Communication Systems II and complete it in the course ENGT 4200 Linear Electronics in the second eight week term. Course descriptions, project definitions, and samples of student work completed in the two terms were adequate to achieve the capstone projects satisfactorily.

AUTONOMOUS SECURITY DRONE AS A CAPSTONE PROJECT. *David Fiorino*, Grant Brewer*, and Adel Salama, Austin Peay State University, Clarksville, Tennessee.* Capstone project is to apply and demonstrate the knowledge and skills have learned in the engineering technology program at Austin Peay State University. This involved the application of engineering practices in mechanical, electrical, and manufacturing; as well as work-environment-related skills such as team work, time management, and product development. The product development skills taken into consideration include marketing strategies such as choosing a target audience and choosing the design of the product to meet the needs of that audience. The project chosen was an electronic surveillance device that could be used as a primary security measure or as a secondary system that could be integrated into a larger security network. The design consisted of a pre-programmed robot with a wireless camera mounted to it that is capable of transmitting to various peripherals for recording and viewing options. In the development of the design mechanical modifications had to be made to the product in order to make it versatile in a myriad of environmental applications and manufacturing of these modifications had to be calculated in the projected cost of the product.

BUILD A REMOTE CONTROL SECURITY ROBOT AS A CAPSTONE PROJECT. *Grant Brewer* and Adel Salama, Austin Peay State University, Clarksville, Tennessee.* Build a security robot that can be controlled remotely by an operator with an IR remote control. Not only will the operator have the ability to control the robots movement but he will also be able to control a camera to view all angles between the front and rear of the robot. Also, operator will have the ability rotate robot 360 degrees so camera will be able to view all angles around the robot. Robot will be programmed using Java. It will have sonar and IR sensor to provide obstacle avoidance capabilities. The robot utilizes rubber tracks for improved mobility and provides the ability to move over small obstacles. All video signals will be transmitted

for viewing on either a TV or computer monitor. It will be powered by rechargeable batteries with a built in battery recharger. Lastly, the robot itself will be inexpensive.

ADDITIVE MANUFACTURING—A DEVELOPING TECHNOLOGY. *Chin-Zue Chen, Austin Peay State University, Clarksville, Tennessee.* Additive Manufacturing (AM) technology was originally developed for rapid prototyping, and recent advances in additive fabrication equipment and materials allow the prototyping processes to produce a wider range of production parts. AM and Subtractive Manufacturing (SM) are compared. The development of a roadmap for research and standards in AM are described. The working principles and examples of technologies and materials developed in AM, such as Stereolithography (SLA), Selective Laser Sintering (SLS), Fused Deposition Modeling (FDM), and 3-D printing, are introduced. Metal fabrications including Electron Beam Free-form Fabrication (EBF3) are covered. Based on the technologies that have been developed and are currently being developed for AM, it can be concluded that AM technology will tremendously change the way we design and produce products in the future.

PROTOTYPING A DIGITAL OTTOSCOPE. *John Ralston* and Chin-Zue Chen, Austin Peay State University, Clarksville, Tennessee.* This is a capstone project to design a digital ottoscope and build a prototype for form, fit, and function testing. The team composed of students with different concentrations and concurrent engineering approach was applied during the design phase. The team first studied an optical ottoscope provided by School of Nursing, defined the problem, and brainstormed ideas of modifications. A digital microscope was used as the key device; a base and handle assembly, a LED coupler, and an adapter for specula and channeling the LED light into the specula were designed and manufactured with CAD software and CNC machines. The prototype assembly was tested and the magnification of digital images taken is larger than viewed through the optical ottoscope. The digital ottoscope prototype was a success; digital ottoscope images provide objective records and eliminate inaccuracy, paper work, etc. for physicians. But further human engineering consideration and software design are needed for mass production.

GEOLOGY AND GEOGRAPHY

ROBERT MARK SIMPSON, CHAIR

THE NEED FOR MONITORING OF CARBON DIOXIDE AS A CONTAMINANT IN THE SUBSURFACE ENVIRONMENT SURROUNDING SOLID WASTE DISPOSAL SITES IN TENNESSEE. *Randy M. Curtis, Gresham, Smith, and Partners, Nashville, Tennessee.* There are currently no official regulatory mandates for monitoring carbon dioxide gas or indicators of excessive carbon dioxide dissolved in groundwater near closed or abandoned landfills in Tennessee. Carbon dioxide is a significant component of landfill gas produced by decaying solid waste. In settings where leachate has escaped into the soil or rock underlying a disposal facility, a separate cycle of methane and carbon dioxide production can begin in the subsurface, greatly increasing the volume of gas produced around and beneath the landfill. There are also no requirements to detect or

track carbon dioxide concentrations which could exceed 40% by volume of the gas in the soil atmosphere. Excess carbon dioxide can displace normal soil oxygen and produce systematic and major changes in groundwater chemistry parameters such as pH, dissolved oxygen, alkalinity, and specific conductance. This could affect long term groundwater monitoring system variability and assumptions about groundwater contamination boundaries.

IMPROVING THE FLASH FLOOD WARNING PROGRAM USING A GIS-BASED FLASH FLOOD INDEX. *Joanne Logan, Tim Prather, David Hotz, and Brian Boyd, University of Tennessee (JL, TP), and National Weather Service, Morristown WFO (DH, BB).* The National Weather Service (NWS) provides flash flood warnings by comparing flash flood guidance (FFG), the volume of rain per given time that cause minor flooding, with predicted rainfall amounts. The FFG and threshold runoff relationship is a function of the current soil moisture conditions. Complex terrain introduces deficiencies to FFG derivations, reducing the influence of soil moisture in mountainous areas. The Colorado Basin River Forecast Center (CBRFC) developed a Relative Flash Flood Potential Index (RFFP) that uses high resolution GIS datasets such as soil type, slope, forest cover, and land use to define the physiographic character of watersheds in FFMP. A similar GIS-based flash flood index is being evaluated in the NWS Morristown forecast area of the southern Appalachians.

ONE DIMENSIONAL HYDRAULIC MODELING OF THE ST. FRANCIS RIVER BELOW WAPPAPELLO DAM, MISSOURI. *Gregory H. Nail, University of Tennessee at Martin, Martin, Tennessee.* The United States Army Corps of Engineers (USACE) one dimensional open channel hydraulics flow modeling software, Hydrologic Engineering Center—River Analysis System (HEC-RAS) was used to model the St. Francis River, Missouri. The model simulates flow on a 55 river mile reach of the St. Francis River, extending from Wappapello Dam downstream to St. Francis, Arkansas, for a wide range of discharges. Extensive surveyed stationing and ground elevation data exists in the form of a previously developed HEC-2 model. This HEC-2 model has been converted to HEC-RAS, and significantly enhanced by the addition of stationing and ground elevation data obtained using a GIS software application, HEC-GeoRAS. Results presented and discussed include steady flow verification, and some preliminary hypothetical unsteady flows, including inundation mapping.

GEOCHEMICAL INVESTIGATION OF POTENTIAL TOXIC METAL RELEASES FROM TVA COAL ASH SURFACE IMPOUNDMENTS INTO NEARBY RIVER WATERS AND SEDIMENTS. *Matt Jones*, Miller Wyllie*, Jennifer Pickering*, Caitlin Shannon*, Scott Crombie, and Warner Cribb, Middle Tennessee State University, Murfreesboro, Tennessee.* This research investigates geochemical evidence of coal ash release from four Tennessee Valley Authority power plants which store coal ash on site: Paradise, New Johnsonville, Gallatin, and Widows Creek. Upstream and downstream river sediment and water samples were collected at each plant, as well as at two TVA fossil plants which do not store ash on site: Cumberland and Bull Run. Concentrations of toxic metals contained in coal ash were measured in each sediment and water sample by x-ray fluorescence and inductively coupled plasma

mass spectrometry. Comparison of upstream to downstream metals concentrations shows that a geochemical signature similar to that of the December 22, 2008, Kingston spill (notably significant downstream increases As, Pb, Tl, Ba) is not present at any plant included in the study. However, results also suggest that all plants release low concentrations of toxic metals into nearby waterways from sources other than surface impoundments.

DRUG-RELATED CRIME ANALYSIS FOR CROSSVILLE, TENNESSEE. *Martin Kimbrell* and Dr. Peter Li, Tennessee Technological University, Cookeville, Tennessee.* Case Study: Drug-related Crime data was taken from T.B.I.'s Database that occurred in Crossville, Tennessee. This data was analyzed using ArcInfo. Assumptions were made and followed for the three years of data collected. An event occurred in Crossville, that proved the assumptions, and data was again compared. Information was provided relative to the closing of an establishment in Crossville, Tennessee. This information was discovered prior to the establishment closing, and will be compared to new information gained while the establishment was closed.

OPTIMIZATION OF X-RAY FLUORESCENCE SPECTROMETRY FOR ENVIRONMENTAL ANALYSIS OF ARSENIC AT LOW CONCENTRATIONS IN SEDIMENT AND SOIL MATERIALS. *Jennifer Pickering*, Jessica Tonish*, James Cares*, and Warner Cribb, Middle Tennessee State University, Murfreesboro, Tennessee.* This research focuses on optimization of x-ray fluorescence spectrometry (XRF) methods for measurement of As in soil and sediment at concentrations less than 20 ppm. XRF measurement of As at low concentrations is difficult because the primary As energy level is very close to two energy levels of Pb, a metal associated with As in minerals. The proximity and intensities of the Pb energy levels to that of As effectively 'absorb' the As energy, making its measurement at low concentrations unreliable. A secondary As energy level with no Pb interference can instead be measured, but with lower analytical sensitivity. Results show that sensitivity of As analysis is optimized by independent measurement of both Pb energy levels and the primary As energy level, followed by mathematical corrections for the Pb intensity absorption effects. This model was calibrated and tested using 10 USGS and NIST standards containing 0.12–18.9 ppm As.

ANNOTATED BIBLIOGRAPHY OF THE BIG SOUTH FORK OF THE CUMBERLAND RIVER BASIN, TENNESSEE AND KENTUCKY. *Robert Liddle and Steve Bakaletz, Office of Surface Mining, Knoxville, Tennessee, and National Park Service, Oneida, Tennessee.* Since 2004, the Office of Surface Mining and the National Park Service have cooperated to develop a bibliography for the Big South Fork of the Cumberland River Basin. The purpose of the annotated bibliography is to allow researchers and land management agencies easy access to information pertaining to this 1360 square mile area. The area includes portions of Anderson, Campbell, Fentress, Morgan, Pickett, and Scott County in Tennessee; and McCreary, Pulaski, and Wayne County in Kentucky. The database contains over 1200 citations and 670 abstracts dating from 1820 to present. It includes over 300 journal articles and 124 theses/dissertations. The Big South Fork National River and Recreation Area has over 550 of these publications stored at their park headquarters

in Oneida, Tennessee. The information will be included in a database managed by the National Park Service. The project should be completed in 2010. Draft copies of the bibliography are available in spreadsheet format from rliddle@osmre.gov.

TELECONNECTIONS AND TORNADOGENESIS IN TENNESSEE: A SPATIAL PERSPECTIVE. *Robert Mark Simpson and Jesse Winchester**, University of Tennessee at Martin, Martin, Tennessee. We investigated the changes in the patterns of tornado formation, or tornadogenesis, between the extreme phases of the following teleconnections: the El Nino/Southern Oscillation (ENSO), the Pacific/North American (PNA) pattern and the North Atlantic Oscillation (NAO) in Kentucky and Tennessee for the years 1950–2007. The findings were not significant statistically, however the El Nino, the PNA Positive and the NAO Positive tended to produce fewer, more widely scattered patterns of tornadogenesis while the La Nina, the Reverse PNA and the NAO Negative phase produced slightly more storms, stronger storms and storms with greater clustering along two axis: 1) from northern Kentucky to southern Tennessee and 2) clustering along the Ohio and Mississippi Rivers. These results suggest that tornadogenesis is a product of all of pertinent teleconnections. Further investigation should include the neutral phases of each of these teleconnections and a seasonal analysis of these storms.

SINKHOLE FLOODING MAP IN COOKEVILLE. *Peter Li, Evan Hart, Hugh Mills, Derrick Ho, and Martin Kimbrell*, Tennessee Technological University, Cookeville, Tennessee. Cave density and drainage density maps were processed and created to show the unique hydrology features occurring in karst region in Cookeville area. SCS method was used to find volume of 3 hour, and 24 hour 100-year return flood. The results indicate that 2.1% of Cookeville urban growth boundary will be inundated. A 7% of public housing in Cookeville are under flood zones, compared to 1% of residential flooded structures. This has posed the question of environmental justice issue in a small city like Cookeville. Rational method was also applied to delineate the flood zones. The Coefficient of Areal Correspondence shows a 51% spatial correlation between SCS and Rational Method. A recent storm validates the flood zones generated from this study.

AGGLOMERATION EFFECTS IN THE AUTOMOBILE INDUSTRY: A LOOK AT SUPPLIER AND ASSEMBLY PLANT LOCATIONS IN THE SOUTH. *Austin Rutledge**, University of Tennessee at Knoxville, Knoxville, Tennessee. The United States is the world's largest market for automobiles and, in recent decades, has seen substantial amounts of foreign direct investment. This investment has resulted in the creation of new supplier networks which could substantially impact local economies. As foreign automobile manufacturing continues to emerge in the south, however, different factors of competitive advantage are influencing location decisions than were present when automobile manufacturing began in the early 20th century Rust Belt. This research suggests the levels of agglomeration in the south will not be analogous to those exhibited by the traditional automobile manufacturing regions. As such, policymakers should reconsider decisions regarding the recruitment of automobile manufacturing firms, especially the much sought after 'assembly plant.'

HEALTH AND MEDICAL SCIENCES

J. MICHAEL REDDING, CHAIR

EVALUATING THE ANTIMICROBIAL ACTIVITY OF MELITTIN ON *STAPHYLOCOCCUS AUREUS*. *Christina Russell* and Chad Brooks*, Austin Peay State University, Clarksville, Tennessee. Novel therapies to combat multidrug resistant *Staphylococcus aureus* (*Sa*) infection is of increasing interest as more people become ill with these infections in hospitals and communities. To this end, a 26 amino acid peptide derived from honey bee venom, melittin, was evaluated for its bactericidal efficacy against *Sa*. Experimentation revealed that melittin has a half-life of approximately two days at room temperature and pH tolerance range of approximately > 4 and < 10 . Also, 10.1 μg could kill 1×10^6 *Sa* bacteria in 15 minutes *in vitro*. Mice that were cutaneously infected with *Sa* showed significantly greater zones of inflammation compared to infected-mice treated with a melittin gel after 24 hours indicating possible therapeutic uses *in vivo*. Most interesting is that *Sa* serially passed in the presence of melittin never showed enhanced resistance while other *Sa* cultures became resistant to many other antibiotics, such as streptomycin, indicating possible longer utility in medical settings.

H1N1 FEARS INDUCE BETTER HEALTH. *Kenny Kennedy*, Trenton Gaasch, and Chad Brooks*, Austin Peay State University, Clarksville, Tennessee. On June 11th, 2009, the World Health Organization indicated that approximately 20% to 40% of the world's population will become infected with H1N1. Reacting to this information, some communities outwardly showed indifference while others temporally closed schools, wore face masks and even used thermal imaging equipment to scan for potentially infected/sick people boarding airplanes. Given the media coverage of these events, public officials were left with a dilemma of possibly underreacting leading to a fear of substandard protection of the community or overreacting leading to a mismanagement of funds. A survey of 159 students at Austin Peay State University was conducted to gauge their perception of and a few factors surrounding the influenza pandemic. Generalized conclusions include that most students felt above average in their knowledge of H1N1 and were not particular worried about becoming infected. Also, science students were approximately 21% more likely to receive the H1N1 vaccine.

TESTERONE IS REQUIRED FOR NORMAL RIGHT VENTRICULAR FUNCTION AND RIGHT VENTRICULAR LOAD STRESS RESPONSE. *Karen A Beasley*, H. C. Champion, James D. West, J. H. Newman, and Anna R. Hemnes*, Vanderbilt University, Nashville, Tennessee (KB, JW, JN, AH), and University of Pittsburg, Pittsburg, Pennsylvania (HC). *Rationale:* The role of sex hormones in right ventricular (RV) structure and function in stress such as pulmonary hypertension response is unknown. *Methods:* C57BL/6 male mice underwent castration (CAS) or sham (CON) at 7 weeks of age and pulmonary artery banding (PAB) or sham (CON) at 10 weeks generating 4 experimental groups: CON-CON, CAS-CON, CON-PAB, CAS-PAB. After 2 weeks of PAB or CON, hemodynamic measurements were made and tissues harvested. *Results:* CAS-CON did not alter RV/LV+S or RVSP; stroke volume and dP/dT fell vs. CON-CON. CON-PAB effected two-fold RV enlargement with increase in RV systolic pressure

(RVSP) vs. CON-CON. CON-PAB caused a drop in ejection fraction vs. CON-CON. RV/LV+S in CAS-PAB mice were unchanged from CON-CON and RVSP was not increased. CAS-PAB affected a drop in dP/dT vs. CON-CON. **Conclusions:** RV contractile force at rest and hypertrophy in response to load stress require testosterone.

BACILLUS PUMILUS ENDOSPORES: A POSSIBLE MODEL FOR DETECTION OF BACILLUS ANTHRACIS. *Merranda D. Holmes* and Stephen M. Wright, Middle Tennessee State University, Murfreesboro, Tennessee.* The growing threat of bioterrorism, particularly the disease anthrax, has necessitated the study of non-virulent organisms that model *Bacillus anthracis*. An ideal anthrax model should possess endospore dimensions and surface composition comparable to *B. anthracis*. *Bacillus atrophaeus* and *B. thuringiensis* are reportedly acceptable simulants. This study analyzed *Bacillus pumilus* as a possible model for *B. anthracis*. Scanning electron microscopy revealed that *B. pumilus* endospores had dimensions similar to *B. anthracis*. Antibody-antigen binding was evaluated for fluorescent detection of *B. pumilus*. Monoclonal anti-*B. atrophaeus* was added to a microarray of *Bacillus* spp. endospores, followed by a secondary fluorescently-labeled antibody. The monoclonal antibody bound *B. atrophaeus* and *B. pumilus* only. Additionally, polyclonal anti-*B. anthracis* bound *B. atrophaeus*, *B. thuringiensis* and *B. pumilus*. These studies indicate that *B. pumilus* endospores have dimensional and compositional similarities with *B. anthracis* and with recognized simulants, suggesting that *B. pumilus* may be an appropriate non-pathogenic model for *B. anthracis*.

A LABEL-FREE METHOD FOR DETECTION AND DIFFERENTIATION OF BACILLUS SPP. ENDOSPORES. *Shannon B. Murphy* and Stephen M. Wright, Middle Tennessee State University, Murfreesboro, Tennessee.* Rapid identification of *Bacillus anthracis* endospores is crucial for implementing a response strategy during a suspected terrorist attack. Because current detection methods are based on time-consuming culture and fluorescence techniques, an optical biosensor is being developed to identify an unknown endospore in real-time without fluorescent labels. This study was conducted to enumerate, detect, and differentiate endospores of *B. atrophaeus*, *B. pumilus*, and *B. thuringiensis* as simulants for *B. anthracis*, and to perform preliminary testing of the biosensor. Fluorescence analysis showed polyclonal *B. atrophaeus* antibodies bound all three organisms, monoclonal *B. atrophaeus* antibody cross-reacted with *B. pumilus*, and monoclonal *B. thuringiensis* antibody bound only *B. thuringiensis*. The limit of fluorescence-based detection was approximately 30 endospores. The biosensor showed comparable sensitivity, with results complete within 30 minutes. The biosensor detected endospore-antibody binding without fluorescent labels, suggesting that this system holds promise for rapid identification of *B. anthracis* endospores.

SMALL COLLAGEN PEPTIDES INCREASE ANGIOGENESIS. *Robert B. Burress*, Dylan Addis, Amber M. Burch, and Beth Conway, Lipscomb University, Nashville, Tennessee.* Angiogenesis, the formation of new blood vessels from pre-existing capillaries, is crucial for solid tumor growth. Regulation of angiogenesis, therefore, must be looked at as a therapeutic agent for treating solid tumors. Previously explored large, extracellular matrix (ECM) derived peptides have been shown to negatively regulate angiogenesis. Additionally, multiple pepti-

dases restricted to small ECM substrates are up-regulated and essential to angiogenesis, but their function remains unknown. We hypothesize that small, ECM-derived peptides play a crucial, stimulatory role in angiogenesis. Using matrigel assays in mice, we show that trypsin digested collagen fragments smaller than 3 kDa produce an increased angiogenic response compared to bFGF, a known angiogenic promoter. Furthermore, inclusion of these small peptides in the presence of protease inhibitors known to suppress angiogenesis rescues blood vessel formation. Further work using *in vitro* assays with endothelial cells will be necessary to show these peptides' role in a more natural, physiological state.

EFFECTS OF ECE-1 ISOFORMS AND NEPRILYSIN EXPRESSION ON BREAST CANCER CELL INVASION. *Matthew Anderson*, Alex Baldrige*, Amber M. Burch, and Beth Conway, Lipscomb University, Nashville, Tennessee.* Breast cancer cell invasion is an essential step in tumor metastasis. Endothelin converting enzyme-1 (ECE-1) is a proinvasion metalloprotease that cleaves Big Endothelin to endothelin-1, while the metalloprotease neprilysin acts as an invasion inhibitor by degrading endothelin-1. Previously studied expression levels of ECE-1 and neprilysin suggest a correlation to the invasiveness of other cancer cells, but little is known about the expression of these enzymes in human breast cancer cells. We performed standard and quantitative RT-PCR to compare the expression levels of the four ECE-1 isoforms and neprilysin in low invading MCF-7 and highly invasive MDA-MB-231 breast cancer cell lines. ECE-1d expression was increased in the invasive breast cancer cells, while the other isoforms did not largely differ. Interestingly, neprilysin was dramatically suppressed in MDA-MB-231 cells compared to MCF-7 cells. These results are consistent with our hypothesis that ECE-1 isoforms promote breast cancer cell invasion, while neprilysin abrogates this process.

DIFFERENTIAL REQUIREMENT OF ENDOTHELIN CONVERTING ENZYME-1 FOR INVASION IN HUMAN BREAST CANCER CELLS. *William Hardeman*, Amber M. Burch, and Beth Conway, Lipscomb University, Nashville, Tennessee.* Breast cancer patients have a high probability of exhibiting tumor metastasis and invasion into tissues and organs outside the primary tumor. These patients often express high levels of the amino acid peptide endothelin-1 (ET-1) and its G-protein coupled receptors that are involved in increased tumor invasion and progression. Endothelin converting enzyme-1 (ECE-1) is a metalloprotease that cleaves the pro-form of ET-1 to yield an activated substrate that can enhance tumor invasion. Therefore, the inhibition of this key enzyme may lead to decreased tumor growth and invasion. Previous studies have shown that the low invading MCF-7 cells are sensitive to ECE-1 inhibition. Therefore, we hypothesized that the incremental addition of a specific ECE-1 inhibitor, [DVal22, Phe33]-Big Endothelin-1 (16-38), to the highly invasive MDA-MB-231 cells would likewise suppress invasion. However, our results indicate that MDA-MB-231 cells do not require ECE-1 for *in vitro* invasion, suggesting that these breast cancer cell lines have a differential requirement for ECE-1 in invasion.

PROLIFERATIVE EFFECTS OF ESTRADIOL, BISPHENOL A, AND TARTRAZINE ON MCF-7 CELLS IN A SOFT AGAR ASSAY: A PILOT STUDY. *Samantha J. White* and Sarah Lundin-Schiller, Austin Peay State University, Clarksville, Ten-*

nessee. Endocrine disrupting chemicals (EDCs) are substances capable of changing the function of endocrine systems. The objective here was to establish methods for a soft agar bioassay for estrogenic EDCs using estrogen responsive MCF-7 cells. Cells were cultured in 0.35% agarose for 2–21 days, colonies were stained with crystal violet, and colony number was assessed. Cells were treated with either control (vehicle only), estradiol (1 or 10 nM), bisphenol A (1 or 10 nM) and tartrazine (1 or 10 nM). MCF-7 cells grew in spherical colonies within the agar. Colonies with diameters $\geq 300 \mu\text{m}$ were counted. Two weeks of growth provided the greatest difference in mean colony number between control and estradiol. Bisphenol A and tartrazine did not stimulate a significantly different colony growth compared to control in any experiment though additional concentrations should be tested. The last two passages of cells demonstrated a diminution in estrogen responsiveness overall.

MATHEMATICS AND COMPUTER SCIENCE

YURILY BULKA, CHAIR

SPECTRAL THEORY OF MÊLÉ GRAPHS. *Casey McKnight**, *Austin Peay State University, Clarksville, Tennessee*. The aim of this talk is to develop Mélé graphs which are graphs that incorporate both discrete and continuous graphs in a unified framework. To discover the appropriate Laplacian operator to use with these graphs, we start with totally discrete graphs and populate one edge with equidistributed vertices. Increasing the number of vertices on this one edge to infinity might reveal the behavior of the graph in the continuum limit. The eigenvalues of the Laplacian operator (that we currently work with) fall into two categories: those coming from the discrete part of the graph and those coming from the populated (or string-like) edges. The eigenvectors corresponding to the continuous eigenvalues involve the entire graph while the eigenvalues of the discrete vertices isolate behavior to the discrete subgraph. What we end up with is a non-standard eigenvalue problem and a first order approximation of the spectrum of a Mélé graph

EVOLVING A BLACKJACK STRATEGY WITH GENETIC PROGRAMMING. *Robert D. French**, *East Tennessee State University, Johnson City, Tennessee*. One area of interest in Artificial Intelligence is Game Strategies, which are algorithms for playing finite games based on either the entire history of moves, or the current state of the game. Discovery of perfect game strategies, those which cannot lose, is a formidable computational challenge. However, evolution of approximate strategies, those which make difficult—but imperfect—opponents, by way of genetic programming has been shown. Such a system is demonstrated here, as an introductory example to Genetic Programming.

BASE-3 PRIME NUMBERS AND A CHARACTERIZATION OF CANTOR PRIMES. *Ben Ntatin*, *Austin Peay State University, Clarksville, Tennessee*. A detailed geometric construction and an arithmetic characterization of the Cantor set (named after Georg Cantor, 1845–1918) is provided. The properties of the Cantor set which make it a great source of counter examples in real analysis and topology are discussed.

We also give a characterization of the set of Cantor primes, which consists of prime numbers p such that $1/p$ belongs to the Cantor set.

FOUR DIMENSIONAL JULIA SETS. *Wherry Caleb* and Ben Ntatin.*, *Austin Peay State University, Clarksville, Tennessee*. A Julia set can be obtained in the complex plane by iterating a complex function. However, if a quaternionic function is iterated, a 4-dimensional Julia set is obtained. After introducing usual complex Julia sets, the process of the rendering quaternion Julia sets is considered and some graphic examples are provided. Features of quaternion Julia sets are summarized and contrasted with complex Julia sets.

AN EXPONENTIALLY FITTED ONE-STEP METHOD FOR STIFF SYSTEMS. *Samuel Jator*, *Austin Peay State University, Clarksville, Tennessee*. An exponentially fitted one-step method is proposed for stiff systems in ordinary differential equations. The stability of the method is discussed and numerical examples are given to show the accuracy of the method.

A SIXTH ORDER SECOND DERIVATIVE METHOD FOR INITIAL VALUE PROBLEMS. *Ramanjit K. Sahi and Samuel N. Jator*, *Austin Peay State University, Clarksville, Tennessee*. A second derivative method (SDM) of order 6 is developed via interpolation and collocation procedures and is used to solve initial value problems (IVPs) without the need for starting values and predictors. We show that by applying a global approach there is improvement in accuracy. We have compared the numerical results of the SDM with existing methods in the literature.

LOCAL UNIQUENESS OF A SOLUTION OF MULTIPLE VOLTERRA INTEGRAL EQUATIONS WITH LOCALLY LIPSCHITZ KERNELS. *Yuriy Bulka*, *Austin Peay State University, Clarksville, Tennessee*. We look at a class of nonlinear integral equations that are more general than ordinary Volterra equations: we call them the Multiple Nonlinear Volterra Integral Equations (MNVIE). These equations are used to model general causal systems with memory, which are physically realizable, and hence important in applications. We make an assumption that the kernels of the equation are *locally Lipschitz*, which is weaker than the standard Lipschitz condition assumption. We then show that the solution of the finite-dimensional MNVIE is *locally unique*. Our approach is based on the Contraction Mapping Theorem. Then we find the set of extra conditions to be imposed for the result to carry over to the infinite-dimensional equation.

A STUDY OF THE HAZARD RATE FUNCTION OF A GENERALIZED MODIFIED WEIBULL MODEL. *Han Wu and Ramesh Gupta*, *Austin Peay State University, Clarksville, Tennessee, and University of Maine, Orono, Maine*. A generalization of the modified Weibull distribution has been proposed by J.M.F. Carrasco et al. to model monotone as well as non-monotone failure rates. However, they have given incorrect results for the hazard failure rates. Our study provides some sufficient conditions for the shapes of the hazard rates. To estimate the model parameters, maximum likelihood estimates and the observed information matrix are obtained. Some analytical results about the turning points of the hazard rate function are also provided.

MICROBIOLOGY

JOHN M. ZAMORA, CHAIR

CHARACTERIZATION OF METHICILLIN-RESISTANT STAPHYLOCOCCUS AUREUS ISOLATES FROM COMMUNITY DORMITORY SHOWERS AT BELMONT UNIVERSITY. *Amanda M. Castro* and Jennifer T. Thomas, Belmont University, Nashville, Tennessee.* Methicillin-Resistant *Staphylococcus aureus* (MRSA) is a potentially pathogenic bacterium that was historically found only in hospital settings. This gram-positive bacterium is resistant to antibiotics within the penicillin family and is becoming more and more of a threat in public places. For this reason, I chose to identify and characterize MRSA found in and around shower stalls in community style bathrooms in two dormitories at Belmont University. After confirming isolation of *Staphylococcus aureus* by growth on differential media, gram staining, and coagulase testing, isolates were identified as MRSA using a disk-diffusion assay to test antibiotic resistance. A total of 34 *S. aureus* isolates were found and 14.7% (5/34) of these isolates showed antibiotic resistance by having a zone of inhibition less than or equal to 10mm. The MRSA isolates had zones ranging from 8–10 mm in diameter and were concentrated in one men's bathroom that was tested. In addition, these isolates were shown to express a protein, PBP2A, that confers resistance. This data is in agreement with previous research showing MRSA across campus. Future studies on these isolates will determine their mechanism of resistance and the presence of a pathogenic factor, PVL.

CORRELATING BORRELIA BURGDORFERI PLASMID CONTENT WITH SURVIVAL IN DIFFERENT ANIMAL SERA. *Krystle Irizaray*, Jillian Kay, and Chad Brooks, Austin Peay State University, Clarksville, Tennessee.* *Borrelia burgdorferi* (*Bb*) is maintained in nature by a complex enzootic cycle which is reliant on *Ixodes* ticks and many different animal hosts. Adding to its complexity is a multi-component genome consisting of a linear chromosome and twenty one different plasmids. This study hypothesizes a dependent relationship between the enzootic cycle of *Bb* and the maintenance of its genome. These data described supports that specific, but unknown, animal factors induce retention of specific plasmids in a host-dependent manner. These data also indicate that specific plasmids have possible necessary role(s) during the infection of particular animal species. In particular, the linear plasmid of 17 kilobases appears to be necessary in all animals examined. The data generated in this research supports the hypothesis that *Bb* plasmids are maintained in an animal host-dependent manner and lays the ground work to focus on more laborious gene-by-gene studies to better understand the biology of *Bb*.

HUMULUS LUPUS ALPHA ACID ISO-DERIVATIVES AS A NOVEL ANTIMICROBIAL APPROACH AGAINST STAPHYLOCOCCUS AUREUS. *Kathryn White*, Marc Smith, and Chad Brooks, Austin Peay State University, Clarksville, Tennessee.* The medical communities are well aware of the increasing numbers of resistant bacteria pathogens. Novel reactive therapies and prophylactic therapies are problematic to bring to market mainly due to poor knowledge of the human biological consequences. Therefore, natural bactericidal remedies are becoming a more popular avenue of research. Keeping with this notion, curiosity has led to a better understanding of just how

hop plant extracts gave ancient communities the preservative power to keep their foods safe from microbial decay. Hop plants produce a natural antimicrobial extract called humulone. The range of humulone's bactericidal effects has not been well characterized. To this end, the variables of concentration, temperature, volume-kinetics, pH and time were used to evaluate humulone's bactericidal efficacy against *Staphylococcus aureus*. Conclusion: humulone demonstrates tolerance for a broad range of the variables and is bactericidal to *S. aureus* at concentrations as low as 0.3% humulone.

THE EFFECTS OF BIO-ONE® ON THE NITROGEN FIXATION PROCESS. *Jay Pannell*, Amber M. Burch, Jon H. Lowrance, and Kent Gallaher, Lipscomb University, Nashville, Tennessee.* Chemical fertilizer is a major capitol expense in the developing world. Strategies to amend soil with naturally occurring nitrogen fixing bacteria have met with differing levels of success. This study focuses on the usefulness of Bio-One®, a stable suspension of two nitrogen fixing bacteria, *Clostridium pasteurianum* and *Azotobacter vinelandii*. Bacteria were isolated and subjected to sugar fermentation analyses and catalase tests to verify the identity of the constituent species. Ammonium enrichment in soil was tested by the Kjeldahl method. *In vitro* cultures of *C. pasteurianum* formed an apparent symbiotic relationship with *A. vinelandii*. Symbiosis between the two species may be significant to ammonium enrichment of soil, as *C. pasteurianum* is known to be anaerobic. Kjeldahl confirmed ammonium enrichment of soil by Bio-One®.

ANTIBACTERIAL, ANTIFUNGAL, ANTIVIRAL, AND ALLELOPATHIC EFFECTS OF ERIODICTYON CALIFORNICUM. *Nicole Y. Foster and John M. Zamora, Middle Tennessee State University, Murfreesboro, Tennessee.* *Eriodictyon californicum*, yerba santa, is a perennial evergreen Californian shrub that was used medicinally by Native American tribes. In an effort to determine the range of activity of *E. californicum*, several biological assays were performed. The disk diffusion method was performed for antibacterial and antifungal activity. The plaque assay using coliphage was used to determine antiviral activity. The mung bean and the onion root assays were used to determine allelopathy. *Eriodictyon californicum* activity is predominately against gram-positive bacteria and a few gram-negatives. *E. californicum* was active against *Rhizopus stolonifer* and *Saccharomyces cerevisiae* but none of the other fungi. *E. californicum* had activity against the coliphage virus. *E. californicum* extracts were able to inhibit the growth of mung beans and reduce the rate of mitosis in onion root tips. *E. californicum* exhibits a range of biological activity and efforts should be made to isolate and identify active compounds of each assay.

ISOLATION AND IDENTIFICATION OF CELLULOSE-DEGRADING MICROORGANISMS. *Robert S. Richardson* and John M. Zamora, Middle Tennessee State University, Murfreesboro, Tennessee.* Cellulose is a polymer of glucose and is the most ubiquitous organic material in nature. Few microorganisms can break down cellulose and utilize it as an energy source because of its β (1,4) glycosidic bonds. Currently, paper product degradation is a problem in landfills and paper mills. There is a need to isolate and identify the microorganisms that are best at degrading cellulose. Eight different soil samples were taken from southern Marshall County, Tennessee and

plated on Minimal Salts Cellulose Agar to determine if cellulose was utilized. The cellulose degraders from each of the samples were isolated on Tryptic Soy Agar and identified by Gram staining and BBL Crystal nteric/Nonfermenter Identification System. Biometry or CO₂ evolution was done on the cellulose-degrading microorganisms from laboratory isolates and sample isolates to determine which microorganisms were the best cellulose-degraders. The most robust cellulose degraders were *Salmonella enteritidis* and *Klebsiella pneumoniae*, and all of the *Pseudomonas* species.

ANTI-VIRAL PROPERTIES OF HERBAL TEAS. *Justin M. Sadd* and John M. Zamora, Middle Tennessee State University, Murfreesboro, Tennessee.* The antiviral effect of herbal teas could present an alternative and less costly approach to viral control. Black tea, chaparral tea, green tea, and white tea were compared against a negative control (tryptic soy broth) and a positive control (anti-T4 antibody) by measuring the plaque forming units per mL (pfu/mL) of the phage grown with *Escherichia coli* B. When the phage is incubated with the positive control, almost complete inhibition of the virus was observed. When the phage was incubated with the teas, the pfu/mL of the phage was greatly inhibited. The chaparral tea had the greatest inhibitory effect on the phage, while green tea had the least effect. The black and white tea had approximately the same inhibitory effect on the phage.

PHYSICS AND ASTRONOMY

EUGENE DE SILVA, CHAIR

A COMPARISON OF THE EFFECT OF ALUMINUM BATS VS. WOOD BATS IN BASEBALL. *Isaac Adams* and Eugene de Silva, Lincoln Memorial University, Harrogate, Tennessee.* This study includes the comparison of the velocities of aluminum bats and wood bats used in baseball against the momentum of a baseball. The ball's air resistance and the applied force by the bat on the ball are calculated to derive a correlation among various types of bats used in baseball games. The velocity of the pitch is also recorded separately to make predictions for unknown velocities and types of bats.

A STUDY OF APPLICATIONS OF PHYSICS IN FREE THROWS IN BASKETBALL. *Samantha Thomas* and Eugene de Silva, Lincoln Memorial University, Harrogate, Tennessee.* The four most important L's in basketball are: Lock-stand at the same spot just behind the foul line each time, with your foot on the same side as your shooting hand slightly advanced, which frees up the shoulder motion on that side; Load-lift the ball just above the armpit, creating a V between the thumb and forefinger and keep your elbow straight; Look-look at the metal plate that attaches the rim to the backboard; Lift-lift with the legs and raise the shooting arm as though reaching out of the top of a telephone booth, and then "wave goodbye" with a flick of the wrist. In this work, the four L's will be controlled, and the angle of inclination, force applied on the ball, and the velocity of the ball will be studied to derive a suitable combination for a successful throw.

USING A LASER TO MEASURE THE SPEED OF LIGHT IN JELLO. *Beth Mattie* and Eugene de Silva, Lincoln Memorial University, Harrogate, Tennessee.* This experiment will investi-

gate Snell's law as it applies to everyday light. This law explains what happens to the trajectory of a beam of light as it passes from one medium to another. In this experiment, we will observe what occurs when a laser beam passes through transparent Jello. During the experiment, the angle of refraction will be measured as the laser travels through the Jello. The variables of this experiment are the consistency of the Jello, the distance between the Jello and the laser, and the method used to measure the refraction. This experimental result will be extended to other materials for further investigations.

EVALUATING THE RELATIONSHIP BETWEEN AGE/GENDER AND LUMBAR STRENGTH USING TORQUE AND ANGLE ANALYSIS. *Naquita Ahern* and Eugene de Silva, Lincoln Memorial University, Harrogate, Tennessee.* The Lumbar Extension Machine provides resistance over a full range of isolated lumbar motion, seventy-two degrees, or over a selected limited range. The pelvic restraint system eliminates contribution of gluteus and hamstring muscles, allowing for a more targeted exercise area. In addition, isolation of the lumbar spine muscles enhances stability and allows for specific, intensive strengthening. The MedX machine is able to detect a lack of reasonable effort by the patient. The MedX software generates a strength curve to compare the patient's strength and range of motion to established age and gender norms. This paper explores the possible correlation of age and gender and lumbar strength. The MedX Lumbar Extension machine and software will be used to generate data in order to compare the effects of each variable.

APPLICATION OF PHYSICS FOR A HOMERUN. *Samantha Christian* and Eugene de Silva, Lincoln Memorial University, Harrogate, Tennessee.* Hitting a homerun in baseball or softball is every player's dream. In this work, the factors contributing for a homerun will be investigated. The speed of the bat, the weight of the bat and the ball, and the distance that the ball must be hit for the ball to go over the fence will be recorded for over thirty applications. The gathered results will be used to derive relevant combinations to indicate the probabilities of a homerun.

SCIENCE AND MATH TEACHING

JOHN NIEDZWIECKI, CHAIR

A QUANTITATIVE ANALYSIS OF PRE- AND POST-SURVEY DATA FROM MIDDLE SCHOOL GIRLS ATTENDING THE MTSU EYH. *Jennifer Hsley*, Autumn Tanner*, and Judith M. Iriarte-Gross, Middle Tennessee State University, Murfreesboro, Tennessee.* Middle Tennessee State University is the home of the first Expanding Your Horizons in Science and Mathematics (EYH) Conference in Tennessee. MTSU held its first EYH Conference in 1997, attended by over 300 middle school girls. The goals of EYH are to: "encourage young women to pursue STEM (science, technology, engineering, mathematics) careers and to motivate girls to become innovative and creative thinkers ready to meet 21st century challenges." We have not had the opportunity until now to do a comprehensive analysis on the impact of the conference on the young women who participate in the MTSU EYH. We created in-depth pre-conference and post-conference evaluations for the girls to complete in order to gather data about their EYH experience. We will present results

obtained from a preliminary analysis of the evaluations and our tentative conclusions based on this data from EYH Conferences held in 2006, 2007, and 2008.

EYH ALL GIRL AFTER SCHOOL SCIENCE CLUB. *Cacy DeSheles**, *Alyse Hawk**, *Judith Iriarte-Gross*, and *Leigh Gostowski*, *Middle Tennessee State University, Murfreesboro, Tennessee*. The MTSU WISE (Women In Science and Engineering) student organization started a science club for local middle school girls to continue the momentum of the annual MTSU Expanding Your Horizons conference. The EYH All Girl After School Science Club meets once a month and membership in the club is open to all girls who have attended EYH. The middle school science teachers encourage girls to participate and keep parents informed of the club's activities. WISE members choose a monthly theme in an area of STEM and research appropriate experiments or other activities. Of greater importance, WISE women work closely with the girls, serving as mentors and role models. The girls benefit by working closely with college women who enjoy science and math. We will discuss our activities and share comments of the girls who have attended the EYH All Girl After School Science Club.

SERVICE LEARNING IN MICROBIOLOGY: SIMULTANEOUS FOOD SAFETY EDUCATION FOR STUDENTS AND SENIORS. *Richard J. Coppings*, *Jackson State Community College, Jackson, Tennessee*. Students enrolled in a general microbiology class carried out a Service Learning project during the 2008 academic year. Students interviewed independently living seniors, assessed their risk for experiencing a foodborne illness, and educated them regarding how to avoid such problems. Students helped formulate a variety of forms and checklists to carry out the project. Pairs of students then screened seniors, and visited those that had agreed to participate. One student asked several survey questions, and used a flipchart presentation to educate the senior(s). The second student evaluated the senior's kitchen including refrigerator temperatures. Seniors (1) do not recognize their elevated risk for foodborne illness, (2) do not follow all current food safety recommendations, (3) refrigerators are often too warm, and (4) are receptive to food safety education. It was concluded that student interest and retention of course information were improved. Students also learned research techniques. Student reflections of the project were positive.

CHEMICAL EDUCATION RESEARCH IN THE NON-SCIENCE MAJORS CLASSROOM. *Kathy Greer**, *Judith Iriarte-Gross*, and *Martha Weller*, *Middle Tennessee State University, Murfreesboro, Tennessee*. For the last three semesters, we have been observing how non-science majors learn physical science. Students are given many different tools to help them learn chemistry and physics. Some of the tools are collaborative learning activities, peer teaching, group problem solving, and the use of clickers in lecture. We also teach physical science by connecting the science to civic issues such as energy, and how energy consumption impacts our environment. Students are given the opportunity to learn how science and civic engagement work together. We will discuss what we have learned from our experiences and our plans for the future.

PROJECT SEED RESEARCH: SYNTHESSES, IR ANALYSES AND MOLECULAR MODELING STUDIES OF METAL

CHLORIDE-SILICON ETHOXIDE SOL-GEL MATERIALS. *Tara Greer**, *Judith Iriarte-Gross*, *Ngee S. Chong*, and *William Ilesley*, *Middle Tennessee State University, Murfreesboro, Tennessee*. Several sol-gel materials were synthesized using silicon ethoxide in ethanol. Various metal chlorides were added to the sol-gel intermediates. Inert atmosphere techniques were used in the synthesis. The materials were analyzed using IR spectroscopy. Modeling studies were also conducted on the sol-gel intermediates and products. This project was funded by Project SEED of the American Chemical Society. In addition to chemistry, career possibilities, college experiences, and service to the community were discussed.

COMSOL AS A TOOL FOR TEACHING AND RESEARCH IN PHYSICS AND CHEMISTRY. *Eugenie de Silva** and *Eugene de Silva*, *Missouri University, Columbia, Missouri*, and *Lincoln Memorial University, Harrogate, Tennessee*. COMSOL software will be used during this presentation to highlight how teaching physics and chemistry can be done without any laboratory facilities. Through several examples from physics and chemistry, it will be shown how advance research can be carried out using this software. The user-friendly nature of COMSOL software and its wide-range of coverage make this tool truly a teacher's aide in physics and chemistry teaching and research.

CLASSROOM CODE OF CONDUCT: CREATING AN ENVIRONMENT FOR LEARNING. *Jennifer T. Thomas*, *Belmont University, Nashville, Tennessee*. Beyond the challenges of teaching our disciplines effectively, many faculty members have become troubled by the distractions of technologies, such as cell phones and laptop computers, as well as general unprofessionalism and lack of civility of students in the classroom. In an effort to overcome these challenges, I have developed a code of conduct that is included in my course syllabi and outlines the expectations for students in the course. These expectations include areas of courtesy, personal responsibility, technology, and professionalism. I have found that by clearly detailing these expectations with supporting rationale, students can successfully meet my expectations, gain confidence in their abilities to navigate the academic and professional world, and better participate in their own learning.

A QUALITATIVE STUDY OF THE SCIENCE YOUTH LEADERSHIP INTERNSHIP PROGRAM AT THE GREAT SMOKY MOUNTAINS INSTITUTE AT TREMONT. *Zena Tenenbaum** and *Kim Sadler*, *Middle Tennessee State University, Murfreesboro, Tennessee*.

SCIENCE AND MATH TEACHING ABSTRACTS PRESENTED AT THE 2008 ANNUAL MEETING OF THE TENNESSEE ACADEMY OF SCIENCE**

INCORPORATION OF HANDS-ON ECOLOGICAL STUDIES INTO THE SUMMER SCIENCE AND MATH ACADEMY AT APSU. *Donald L. Sudbrink, Jr.*, *Alan Bottomlee*, and

The above-listed abstract was omitted from the *Journal of the Tennessee Academy of Science* 84 (1-2)

Willodean D. S. Burton, *Austin Peay State University, Clarksville, Tennessee (DS, WB), Kenwood High School, Clarksville, Tennessee (AB)*. In 2008, Austin Peay State University initiated the Summer Science and Math Academy for high school student success in science and math. Part of the curriculum developed for the Academy provided students with two weeks of instruction in ecology, agriculture, and soils. Instructional methodology included lectures integrated with hands-on field/laboratory activities. Quantitative evaluation included pre-testing before instruction and post-testing afterwards. Students improved their science scores, resulting in a statistically significant difference in the pre- and post-test scores. In qualitative evaluations, students said the Academy made science more enjoyable, related science to real life, and helped them prepare for college with more confidence about science and math. High school teachers said that learning activities were appropriate for high school students, they improved student skills, and that they would use the curricular activities in their classroom instruction. Evaluations will be used to revise curriculum for the 2009 SAMA.

ZOOLOGY

ANDREW BARRASS, CHAIR

NEW RECORDS OF THE NINE-BANDED ARMADILLO, *DASYPUS NOVEINCINCTUS* (MAMMALIA, XENARTHRA, DASYPODIDAE), IN SOUTHEAST TENNESSEE. **Timothy J. Gaudin, S. Erich Eichler*, and James C. Brinson***, *University of Tennessee at Chattanooga, Chattanooga, Tennessee*. For over 150 years the nine-banded armadillo, *Dasyopus novemcinctus*, has been expanding its range into the southern United States. Previous studies have suggested an average expansion rate of 7.8 km/year, with the fastest expansion in the southern Great Plains at a rate of 11 km/year. Beginning in August, 2008, we collected four road-killed specimens of *D. novemcinctus* from southeast Tennessee, two from Marion County and two from Franklin County. These records represent an extension of approximately 325 km to the east and 375 km to the north of previously published range limits. The new records imply an expansion rate far in excess of previous estimates. The two Franklin County specimens were collected atop the Cumberland Plateau at elevations of 462 and 583 meters. These are likely elevation records for the southeastern United States, and suggest further northward and eastward expansion of the species is likely. The ecological implications of this increased rate of geographic expansion will be discussed.

POPULATION CHARACTERISTICS OF WHITE-TAILED DEER (*ODOCOILEUS VIRGINIANUS*) AT A SITE IN WESTERN TENNESSEE. **Jeremy S. Dennison*, Robert E. Kissell, Jr., Steve W. Stephenson, and Michael L. Kennedy**, *The University of Memphis, Memphis, Tennessee (JSD, MLK), The University of Arkansas, Monticello, Arkansas (REK), and Milan Army Ammunition Plant, Milan, Tennessee (SWS)*. Population density and other selected natural-history parameters of white-tailed deer (*Odocoileus virginianus*) were measured at the Milan Army Ammunition Plant, in western Tennessee, from 2005 through 2008. Specifically, we estimated population density, sex ratio, litter size, and age structure. Methods utilized included aerial and ground-based thermal imagery, a special doc-only

harvest, and data collected through annual-hunter harvest. Population density was estimated at 12.3 ha (30.3 ac) per deer (December 2008). Sex ratio was calculated as 1 male per 2.94 females, and litter size was estimated at 1.29 young per female. Mean age of harvested deer (2005–2008) was 2.31 years. Overall, natural-history traits suggested a sustainable deer population with potential for population growth.

RECORDS OF MAMMALS FROM UNICOI COUNTY, TENNESSEE. **Michal A. Summers and Michael L. Kennedy**, *The University of Memphis, Memphis, Tennessee*. Records of mammals from Unicoi County, Tennessee, were compiled to assess the species richness occurring within the county. Fieldwork was conducted; literature records surveyed, and selected museum collections examined. Results revealed the presence of 52 species representing seven orders and 14 families. Biodiversity was high among bats, shrews, moles, rodents, and carnivores. Based on species richness and the high percentage of taxa known in the area, Unicoi County could represent a biodiversity hot spot for mammals in the southern part of the Appalachian Mountains.

AN ECOLOGICAL AND SYSTEMATIC ASSESSMENT OF THE GENUS *SYLVILAGUS* IN TENNESSEE. **Tim T. Nguyen*, Edward Warr, Roger Applegate, and Michael L. Kennedy**, *The University of Memphis, Memphis, Tennessee (TTN, MLK), and Tennessee Wildlife Resources Agency, Nashville, Tennessee (EW, RA)*. An ecological and systematic assessment of the genus *Sylvilagus* was conducted in Tennessee during 2009. Specimens of three species of rabbits (eastern cottontail, *Sylvilagus floridanus*; Appalachian cottontail, *S. obscurus*; and swamp rabbit, *S. aquaticus*) were examined. Our purpose was to confirm the distribution of each species within the state utilizing key skull features to verify identification and to identify sites that could serve as management or conservation areas for each taxa. Specimens were examined from the University of Memphis Mammal Collection, and literature records were recorded. Additionally, skulls provided by hunters across Tennessee were utilized. Results suggested a statewide distribution for eastern cottontails, and a more limited range for Appalachian cottontails and swamp rabbits in the state. Given the distributions of species and degree of public lands across Tennessee, numerous sites exist for management and conservation programs. Sustainability of these species in the state appears bright.

VARIATION IN SUSCEPTIBILITY TO RANAVIRUS AMONG TADPOLE DEVELOPMENTAL STAGES. **Nathan A Haislip*, Matthew J. Gray, and Jason T. Hoverman**, *University of Tennessee at Knoxville, Knoxville, Tennessee*. Amphibian populations are declining globally and one cause is emerging infectious disease. Ranaviruses are responsible for the majority of amphibian mass mortality events in North America, yet research into factors that govern host susceptibility is limited. Our objective was to compare host susceptibility among four developmental stages for seven amphibian species. Each stage was exposed to 10^3 PFUs of *Ranavirus* in a water bath for four days and survival monitored for 14 days. The egg stage was the least susceptible stage. *Lithobates sylvaticus* and *Scaphiopus holbrookii* were the most susceptible species with 85–100% mortality rates across stages. Using stage-specific estimates, the likelihood of survival from egg through metamorphosis when exposed to ranavirus was 7% across species. Our results indicate

that ranavirus is capable of causing catastrophic mortality of some species, but this likelihood depends on the developmental stage.

THE EFFECTS OF SHORT-TERM STRESS ON CORTICOSTERONE, LEUKOCYTES, AND PROSTAGLANDIN E₂ IN MALE SOUTHEASTERN FIVE-LINED SKINKS (*PLESTIODON INEXPECTATUS*). *Ryan J. Seddon* and Matt Klukowski, Middle Tennessee State University, Murfreesboro, Tennessee.* Increased glucocorticoid levels are an important component of the stress response. Glucocorticoids induce physiological and behavioral changes by binding to three different types of receptors. The main glucocorticoid in reptiles is corticosterone. While immunosuppressive effects of chronically elevated corticosterone are well known, acutely elevated corticosterone levels may actually enhance immunity. For example, transient increases in corticosterone enhance macrophage migration inhibition factor, upregulate cytokine receptors on T-cells, and alter prostaglandin levels. Prostaglandin E₂ is a downstream mediator of fever and systemic inflammation. Here I tested whether acutely stressed lizards had elevated prostaglandin E₂ levels and increased heterophil to lymphocyte ratios. Twenty-four male *Plestiodon inexpectatus* were captured with half being bled immediately and half after one hour of confinement. Corticosterone levels were significantly higher in the confined group. While PGE₂ levels did not differ significantly, they were significantly positively correlated with corticosterone levels. Heterophil to lymphocyte ratios remain to be examined.

SURVEY OF THE MAMMALS AT RUSSELL CAVE NATIONAL MONUMENT. *A. Christopher Grow* and Michael J. Reddy, The University of Memphis, Memphis, Tennessee.* In 2002, a survey of the mammals at Russell Cave National Monument (RCNM) in Jackson County, Alabama, was initiated to assess mammalian biodiversity. This is part of a general effort by the National Park Service (NPS) to appraise species richness and floristic diversity on lands under their supervision. Also, this survey is being conducted because of the need for information from which management decisions relating to conservation and management at RCNM. Sampling procedures include utilization of live traps, mist nets, scent stations, infrared cameras, spotlights, and general observations. At this time, 29 species, representing 8 orders and 14 families, have been verified on the site. Greatest biodiversity has been observed in the bats (Family Vespertilionidae) and rodents (Family Cricetidae). One endangered species, *Myotis grisescens* (gray myotis), is known from the site. The biodiversity observed at RCNM is compared to that known for the region.

AN ECOLOGICAL ASSESSMENT OF THE VIRGINIA OPOSSUM (*DIDELPHIS VIRGINIANA*) IN WESTERN TENNESSEE. *Daniel M. Wolcott* and Michael L. Kennedy, The University of Memphis, Memphis, Tennessee.* An ecological assessment of Virginia opossums (*Didelphis virginiana*) was conducted in winters of 2006–2009 at the Meeman Biological Station in western Tennessee. Sampling was conducted on a trapping grid with 50 traps spaced approximately 150 m apart in a 5 × 10 pattern. Trapping was for 40 nights during each year. Overall, there were 6,000 trap-nights. Population density, sex ratio (based on captures), total length, and body weight were determined. Population density was estimated as 1 Virginia opossum per 4.1 ha; 61% of captures were male; mean total length was 755 mm for males and 738 mm for females; and mean

weight for males was 2.2 kg and for females 2.1 kg. Values for natural-history traits are discussed in light of previous reports.

TEMPERATURE EFFECTS ON LOCOMOTOR PERFORMANCE IN A LATITUDINALLY WIDESPREAD SPECIES, *NERODIA SIPEDON*. *Lacy Danikas* and Vincent Cobb, Middle Tennessee State University, Murfreesboro, Tennessee.* Animals with broad geographic ranges frequently show adaptation to regional conditions. For ectotherms, most physiological processes are temperature dependent and are thereby subject to pressures of natural selection. The northern watersnake is one of the most wide ranging snake species in North America, and is exposed to a wide range of environmental conditions, making it a good model species to test latitudinal gradients. We examined the effect of temperature on neonate locomotor performance from northern and southern localities for this species. Maximal crawling and swimming speed differed significantly between the two populations, with the southern population exhibiting optimal terrestrial locomotor performance at a temperature 5°C higher than that of the northern population. Optimal temperatures varied between latitudes only for terrestrial tests, suggesting possible differences in habitat use. This pattern of separation indicates possible thermal adaptations to regional climatic conditions and could potentially influence selective pressures.

DEMOGRAPHICS OF THE RED-EARED SLIDER POPULATION AT RADNOR LAKE NATURAL AREA, NASHVILLE, TENNESSEE. *James T. Arnett and Stephen D. Gragg*, Lipscomb University, Nashville, Tennessee.* In July of 2002, Lipscomb researchers began collecting demographical data on the aquatic turtle populations at Radnor Lake by means of capture, tagging and release methods. The red-eared slider, *Trachemys scripta*, was the species of greatest interest in this study. During the activity seasons of 2002–2006, 132 were tagged and 19 were recaptured. Population estimates were attempted using the Schnabel method, resulting in an estimated 468 sliders in the Radnor population. The male-to-female ratio was found to be significantly different (0.05 level) from 1:1 (1.6:1). Mean carapace and plastron lengths were found for males (19.6 and 17.7 cm, respectively) and females (21.0 and 19.4 cm, respectively). These results were comparable to those of a 1977–1978 study conducted on the same slider population. From this we concluded that the red-eared slider population at Radnor Lake has remained relatively stable in the intervening 31 years.

EFFECT OF SUBSTRATE ON THE LOCOMOTOR PERFORMANCE OF RECENTLY-FED NORTHERN WATERSNAKES. *Carly Neilson*, Hailey Burton, Lacy Danikas, and Vincent Cobb, Middle Tennessee State University, Murfreesboro, Tennessee.* Snakes, unlike most animals, do not masticate their food. This results in food remaining in the stomach for a prolonged period, potentially having negative anti-predator effects for recently-fed individuals. Forty-five 3–4 month old Northern Watersnakes (*Nerodia sipedon*) were tested for an effect of feeding on locomotor ability. Both crawling and swimming speeds were measured using a 2 m racetrack lined with photocells at 0.5 m intervals. We measured maximal speeds using three treatments of 15 snakes each: pre-feeding, 3 hour post-feeding and 24 hour post-feeding. For all treatments, snakes were faster in aquatic trials than in terrestrial trials. Within aquatic trials, swimming speeds did not differ between treatments possibly facilitated by

the buoyancy and reduced friction of water. However, for terrestrial trials, both post-feeding treatments resulted in significantly slower crawling speeds. We predict that recently-fed watersnakes would be less likely to venture into terrestrial environments than other individuals.

THE EFFECT OF ETHANOL ON THE WORKING MEMORY OF *DANIO RERIO*. *Olawale A. Osinusi* and Lori McGrew, Belmont University, Nashville, Tennessee.* Previous research has shown that at high concentrations ethanol either stunted the development of zebrafish or produced deformities in the offspring. This study focuses on the effects of ethanol on the working memory of zebrafish, *Danio rerio*. We hypothesized that chronic exposure at higher concentrations would reduce the ability of zebrafish to learn a task. Two concentrations of ethanol were used, 0.5% and 1.0%, and compared to a control group (0% ethanol). *Danio rerio* were treated continuously for two weeks and then allowed to recover for 24 hours. The fish were then taught a task (to choose the correct side of a t-maze). Fish were rewarded for choosing the correct side and punished for choosing the incorrect side. There was no significant difference observed between groups in this task, suggesting that chronic ethanol administration does not cause long-lasting impairment in the working memory of adult zebrafish.

THE EFFECT OF PREDATION ON INTRASPECIFIC COMPETITION IN THE STREAMSIDE SALAMANDER, *AMBYSTOMA BARBOURI*. *Elizabeth Schriener* and John Niedzwiecki, Belmont University, Nashville, Tennessee.* *Ambystoma barbouri* larvae live in ephemeral streams and must reach metamorphosis before these locations dry up in the spring. The majority of these larvae do not meet this cutoff, so they have cultivated behaviors that increase their individual chances for sufficient development. We hypothesized *A. barbouri* larvae exhibit asymmetric competition that is maintained by interference interactions. To test this idea, we raised *A. barbouri* larvae in 3 treatment groups: isolated, grouped fed-separately, and grouped fed-together. We also examined the effect of a predator's presence on *A. barbouri* asymmetric competition. We saw significant differences in the change in coefficient of variation among the growth rates of the larvae for the treatments, indicating interference is directly related to size asymmetry. With fish chemical cues, the asymmetry of the larval competition was dampened in the fed together treatment but not in the fed separately treatment, suggesting differences between feeding and non-feeding times.

SPATIAL DISTRIBUTION OF BATS IN A HUMAN IMPACTED CAVE SYSTEM. *Riley S. McCormick and Andrew N. Barrass, Austin Peay State University, Clarksville, Tennessee.* Bat conservation relies heavily on knowledge of the spatial distribution of species and habitat use among species. There is little quantitative information on the behavior of species as they disperse and use available habitat. Furthermore, little data exists on large-scale spatial patterns of bat communities inside cave systems. Surveys of Dunbar Cave indicate high use within chambers not impacted by human activity. Bats were individually plotted by GIS and near neighbor distances determined for analysis of spacing. Analysis of dispersion using the Morishita Index indicates the fragile population of *Perimyotis subflavus* are slowly increasing and using available habitat. Availability and use of habitat are constrained by varying levels of human interferences. The spatial arrangement of bats suggests avoidance

of highly impacted cave chambers. The results indicate that our methods and novel database are useful tools for resolving practical questions in applied ecology, conservation biology, and restoration of cave roosting species.

COMPARING TRENDS IN GENETIC AND MORPHOLOGIC DIVERGENCE WITHIN AND AMONG THREE ANIMAL ORDERS. *Eric Drab*, Mario L. Bacelar*, Joliann Penn*, Andrew D. Mashchak*, Kirk M. Weber*, Neville A. Trimm, Jr., and Richard A. Seidel, Southern Adventist University, Collegedale, Tennessee (ED, MLB, JP, ADM, NAT, RAS), and Miami University, Oxford, Ohio (KMW).* Accurate species identification is crucial across all areas of biology. The increasing use of DNA bar-coding as an alternative to morphologic species delimitation warrants a quantitative examination of their agreement. Our study investigated whether genetic and morphologic analyses within amphipods, fishes and seabirds yielded similar trends across orders. COI gene fragments for amphipods, fishes, and seabirds displayed divergences of $24.8 \pm 1.2\%$, $18.3 \pm 0.9\%$, $14.8 \pm 0.4\%$, respectively. Morphologic distances were calculated using geometric morphometrics. Nineteen shape difference magnitudes were measured for each animal order by computing the displacements of corresponding morphologic landmarks. Standard distances were obtained by dividing the magnitude sum by the pixel length of images analyzed. Preliminary results show a mean shape difference of 1.89 ± 0.23 for amphipods, while shape differences for fishes and seabirds are being calculated. While present results are preliminary, final results will improve both theory and practice in modern taxonomy.

ESTABLISHING CRITERIA TO CHARACTERIZE THE HABITAT OF *TRITOMA SANGUISUGA* IN SYLVATIC AREAS OF MIDDLE TENNESSEE. *Ryan S. Alexander* and C. Steven Murphree, Belmont University, Nashville, Tennessee.* *Triatoma sanguisuga*, a conenose bug, is a vector of Chagas disease, a potentially deadly disease caused by the hemoflagellate *Trypanosoma cruzi*. Chagas disease is an emerging infectious disease in North America and research regarding the preferred habitat of *T. sanguisuga* is needed to determine the relative abundance, distribution, and infection rate of this species. We propose that the habitat of *Triatoma sanguisuga* in middle Tennessee can be defined by a set of criteria involving tree and tree-hole characteristics. The results of this research suggest the importance of certain tree and tree-hole characteristics in locating the habitat of *T. sanguisuga* in middle Tennessee, particularly in terms of tree size and the degree of weathering of tree-hole cavities.

EVALUATING MACROINVERTEBRATE COMMUNITY DIVERSITY IN PONDS UTILIZING TWO SAMPLING TECHNIQUES. *Laura Ashlie Farmer and Steven W. Hamilton, Austin Peay State University, Clarksville, Tennessee.* Milan Army Ammunition Plant (MLAAP), a munitions production facility in west Tennessee, comprises 90.48 km² of hardwood forest and agricultural fields. MLAAP's Integrated Natural Resources Management Plan couples organismal research and land use practices to develop sustainability of natural resources. Macroinvertebrates are among the taxa being studied. June 2009 began a research project comparing sampling techniques to access macroinvertebrate diversity in pond communities at MLAAP. Funnel-trap and dip-net methods were employed. Four funnel-traps were set at each pond and left for two consecutive 48-hour periods. A week later dip-net samples were collected with two

collectors sampling simultaneously for 30 minutes in each pond. There was no significant difference in either taxa richness or Shannon-Weaver diversity when comparing the two sampling methods. Dip-net sampling was more time efficient and required fewer people and person-hours to complete. Dip net samples

added to taxa richness, particularly in the orders Coleoptera, Hemiptera and Odonata.

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