

ABSTRACTS OF PAPERS PRESENTED AT THE 110TH MEETING

BOTANY SECTION

FELIX G. COE, CHAIR

FLORISTIC STUDIES IN THE HAYNES BOTTOM WILDLIFE MANAGEMENT AREA, MONTGOMERY COUNTY, TENNESSEE. **Edward W. Chester**, *Austin Peay State University, Clarksville, Tennessee*. The Haynes Bottom Wildlife Management Area (WMA) consists of about 1000 acres purchased by the Tennessee Wildlife Resources Agency from private landowners in 1996. At that time the area was mostly in agricultural production (row crops, wheat, pasture) with some secondary woodlands. Much of the WMA is within bottomlands of the Cumberland River and several wetland habitat types are included. The entire area shows the results of extensive anthropogenic usage since settlement. Conversion into a WMA began in 1999 with the construction of dikes, pools, ponds, food plantings, and other enhancements to attract wildlife, mostly migratory waterfowl. A study of the vascular flora during 1997-1999 before construction began indicated that the vascular flora includes 550 species representing 108 families and 327 genera. Major families are the Asteraceae and Poaceae; major genera are *Carex* and *Quercus*. Twenty-two percent of the taxa are introduced and four state-listed taxa were found.

ARENARIA LANUGINOSA REDISCOVERED AND A NEW COUNTY RECORD FOR APIOS PRICEANA IN TENNESSEE. **Dwayne Estes*** and **Edward W. Chester**, *Austin Peay State University, Clarksville, Tennessee*. Spreading Sandwort (*Arenaria lanuginosa*) is a lax perennial of open woods and bluffs primarily found on the Coastal Plain from southeastern Virginia to Texas. The species was found in Giles County on bluffs of the Elk River in 1948. It has not been collected since and is listed as endangered-possibly extirpated in the state. We located two small populations in Giles County during July of 2000, including a very small population at the site of the 1948 collection. Price's Potato Bean (*Apios priceana*) is a perennial, twining legume of mesic woods and thickets. It is globally rare (threatened federally, endangered in Tennessee) and known from fewer than 30 populations in Alabama, Illinois (historic only), Kentucky, Mississippi, and Tennessee. There are eight previous county occurrences in Tennessee but two of these are historic. Our record is from Giles County on a dry wooded road bank. Voucher specimens are at APSC and TENN.

A COMPARATIVE STUDY OF THE INVASIVE *LIGUSTRUM SINENSE* AND THE NATIVE *FORESTIERA LIGUSTRINA* (OLEACEAE) IN CEDAR GLADE/WOODLAND HABITATS OF MIDDLE TENNESSEE: GROWTH CHARACTERISTICS. **Lorna L. Morris*** and **Jeffrey L. Walck**, *Middle Tennessee State University, Murfreesboro, Tennessee*. *Ligustrum sinense* Lour. is

an exotic shrub of the southeastern United States, which grows, with the native shrub *Forestiera ligustrina* (Michx.) Poir. in the cedar glade/ woodland habitats of middle Tennessee. The goal of our research was to identify growth characteristics that might influence the invasiveness of *Ligustrum*. Plants of both species were sampled along glade edges and in red cedar/hardwood forest at Stones River National Battlefield, Rutherford County, Tennessee. Edge- and forest-plants of *Ligustrum* had greater stem diameters than those of *Forestiera*. *Ligustrum* plants in the forest were taller than those along the edge, whereas *Forestiera* plants were about the same height in these two habitats. Moreover, edge-plants of *Ligustrum* had a smaller leaf area than forest-plants, whereas leaf area of *Forestiera* did not differ between habitats. The results suggest that *Ligustrum* might be an aggressive invader due to the ability to adjust its growth in response to light environment.

THE "FROST FLOWER" PHENOMENON IN *VERBESINA* (ASTERACEAE) AND OTHER VASCULAR TAXA. **Thomas E. Hemmerly** and **Katrina B. Dollar***, *Middle Tennessee State University, Murfreesboro, Tennessee*. Frostweed, *Verbesina virginica* L., and certain other species of angiosperms commonly form in winter collars or ribbons of ice around the basal stems of the plants. Field data, collected in an effort to explain the cause of this intriguing phenomenon, are presented. It appears that the ice crystals are formed from water exuded from the stems.

DISTRIBUTION OF ALKALOID-CONTAINING PLANT SPECIES IN A MIXED MESOPHYTIC FOREST. **Meredith L. Moore*** and **Felix G. Coe**, *Tennessee Technological University, Cookeville, Tennessee*. A survey of the vascular flora of a 23 ha section of the Roaring River watershed in Jackson County, Tennessee was conducted to evaluate the distribution of alkaloid-containing species in a Mixed Mesophytic Forest. Documented were 240 species, 177 genera, and 77 families in two years of fieldwork. Eighty-eight species are new county records. Over 45% of the species tested positive for alkaloids. Most alkaloid-containing species were herbs (86 species) or vines (9 species). The most bioactive families were the Asteraceae (10 species) and the Brassicaceae (7 species). Tests were conducted to determine if alkaloids-containing species were more prevalent in certain habitats. The results indicated that the distribution of alkaloid-containing species did not differ significantly between habitats at the 0.05 alpha level.

OBSERVATIONS ON THE USE OF MEDICINAL PLANTS BY THE KUNA INDIANS OF PANAMA. **Tamara Berthel*** and **Thomas E. Hemmerly**, *Middle Tennessee State University, Murfreesboro, Tennessee*. Prior to the advent of synthetic pharmaceuticals, plants were the sole source of medications for early humans, and they continue to play this role in the lives of indigenous peoples throughout the world. We present here a compen-

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dium of plants used in traditional Kuna medicine, where they are gathered, how they are prepared and administered, and any spiritual beliefs associated with the plant preparations. The student author obtained cultural information during a stay with a Kuna family in San Blas, Panama during the summer of 2000. Additional information was collected via electronic mail from several Kuna Indians, other Panamanians, and faculty members at The Institute for Tropical Ecology and Conservation. Representative species include *Genipa americana*, *Morinda citrifolia*, *Neurolaena lobata*, *Saccharum officinarum*, *Theobroma cacao*, and *Zamia skinneri*.

ETHNOBOTANY OF THE RAMA OF SOUTHEASTERN NICARAGUA. *Felix G. Coe and Gregory J. Anderson, Tennessee Technological University, Cookeville, Tennessee, and University of Connecticut, Storrs, Connecticut.* The Rama are one of three Amerindian groups of eastern Nicaragua. Their uses of 232 species of plants in 178 genera and 77 families were documented in three years of fieldwork. Included are 193 medicinals, 75 food plants, and 95 for other uses. Almost 80% of Rama medicinals are native to eastern Nicaragua, and used to treat more than 30 human ailments. Over 70% of the medicinals are bioactive, most are herbs (41%) or trees (38%), and leaves are the most frequently utilized plant part. Most are prepared as decoctions and are administered orally. Most food plants are domesticates, and only 18 of 37 domesticates are native to the New World tropics. The Rama people are the most highly acculturated group of eastern Nicaragua. Therefore, this study is important because it provides a written record of the oral history of a group whose cultures and natural resources are fast disappearing.

A METHOD TO EVALUATE THE EFFECTS OF AQUATIC POLLUTION ON THE DEVELOPMENT OF THYLAKOID PROTON MOTIVE FORCE. *Jefferson G. Lebkuecher, Lorenzo E. Altmon*, Greg K. Harris*, Kellie L. Wallace*, and Amanda R. Wilding*, Austin Peay State University, Clarksville, Tennessee.* Methodologies were tested to determine the best protocol to evaluate the effects of water quality on development of the proton motive force across thylakoids in algae using a system designed to measure modulated chlorophyll fluorescence from leaves (FMS 2; Hansatech Instruments). Aliquots of 4×10^5 *Selenastrum capricornutum* cells suspended in 0.5 ml of nutrient solution were placed in clear plastic vials (1.2 cm diameter). The fiber-optic cable of the fluorescence monitoring system, which leads the internal light sources and detector to the sample, was situated 3 mm above the surface of the suspension. Dark-adapted origin fluorescence was determined as the average modulation-beam ($1.8 \mu\text{sec}$ pulse; $0.05 \mu\text{mol m}^{-2} \text{sec}^{-1}$) signal over 1.6 sec. A 0.7 sec pulse of bright white light ($3000 \mu\text{mol m}^{-2} \text{s}^{-1}$) was used to generate maximum fluorescence immediately followed by 1.5 min of $200 \mu\text{mol m}^{-2} \text{sec}^{-1}$ white light to generate steady-state fluorescence. During the final 0.7 sec of $200 \mu\text{mol m}^{-2} \text{sec}^{-1}$ light exposure, another pulse of $3000 \mu\text{mol m}^{-2} \text{sec}^{-1}$ white light was applied to generate light-adapted maximal fluorescence. Light-adapted origin fluorescence was determined by exposure to 5 sec of far-red light (735 nm peak). The relative strength of the thylakoid proton motive force (0.51 (0.02) in *S. capricornutum* evaluated by this protocol is similar to that measured in healthy, light-exposed leaves. The results demonstrate that this experimental design can be used to evaluate the effects of aquatic environments on the development of the thylakoid proton motive force in algae suspended in an aqueous medium.

CONTINUED EVALUATION OF THE EFFECTS OF WATER QUALITY IN THE SULPHUR FORK CREEK WATERSHED ON PERIPHYTON PRODUCTION AND PHOTOAUTOTROPH PHOTOCHEMISTRY. *Jefferson G. Lebkuecher, Alex S. Flynt*, M. C. Bone*, Maria H. Bailey*, and Ben H. Hicks*, Austin Peay State University, Clarksville, Tennessee.* Effects of water quality in the Sulphur Fork Creek watershed and Buzzard Creek of Robertson County, Tennessee on periphyton production and photoautotroph photochemistry were evaluated during May, July, and September of 1999. Primary production was determined from chlorophyll *a* accumulation rates on submerged glass slides. Trophic relationships were evaluated by calculating the autotrophic index, a ratio of heterotroph to photoautotroph biomass. Primary photochemistry was evaluated using chlorophyll *a* fluorescence. The site at lower Buzzard Creek had significantly lower rates of primary production, indicative of good water quality, relative to stream sites within the Sulphur Fork Creek watershed. The lower Buzzard and lower Miller Creek sites had significantly higher autotrophic index values during the September sampling period, indicative of the more extensive canopy cover and thus organic detritus input at these sites during this time of the year. In situ growth during the July sampling followed by chlorophyll *a* fluorescence analysis of the pollution-intolerant alga *Selenastrum capricornutum* demonstrate that relative to the other stream sites, the poor water quality of the west fork of upper Miller Creek resulted in significantly: (1) increased origin fluorescence yield, indicative of decreased efficiency of light-energy transfer by antennae pigments, (2) decreased quantum efficiency of photosystem-II photochemistry, and (3) decreased reproduction rate. Overall, the results are consistent with the 1998 evaluations of water quality at the same sites and indicate poor water quality within the Sulphur Fork Creek watershed, especially in the west fork of upper Miller Creek.

A QUADRAT SURVEY CONCURRENT WITH THE DEVELOPMENT OF A NATURE TRAIL AT MID-SOUTH YOUTH CAMP IN CHESTER COUNTY, TENNESSEE. *Paul G. Fader and Daniel R. French*, Freed-Hardeman University, Henderson, Tennessee, and Austin Peay State University, Clarksville, Tennessee.* Mid-South Youth Camp is located in Chester County Tennessee, which is divided between the Coastal Plain and the Western Tennessee Uplands. The 31 ha camp is on the Coastal Plain portion of the county. The development of the nature trail at Mid-South Youth Camp included a plant quadrat survey as well as the identification of trees, and other plants along the trail. This research was conducted from January to September of 2000. Ecological measurement was accomplished by utilizing the quadrat method. Ten quadrats were randomly selected in the east sector of the trail area. The forest is a southern mixed hardwood forest with three different habitats. Tree genera included *Quercus*, *Liquidambar*, and *Carya* (east section), *Pinus* (west section), and *Carya*, *Acer* and *Quercus* (north section). Documented were 31 families, 33 genera, and 44 species (three exotic) at Mid-South Youth Camp.

CELL AND MOLECULAR BIOLOGY/ MEDICAL SCIENCE SECTION

HAO NGUYEN, CHAIR, AND DAVID M. O'DROBINAK,
CHAIR

SEQUENCE AND STRUCTURE CONTRIBUTIONS TO U1
SNRNA PROCESSING. *Rebecca L. Seipelt, Michael W.*

Thompson, and Brian C. Rymond, *Middle Tennessee State University, Murfreesboro, Tennessee (RLS), and University of Kentucky, Lexington, Kentucky (MWT, BCR)*. A group of RNAs, small nuclear ribonucleic acids (snRNAs), is required for eukaryotic cell life by virtue of the activity within a larger complex called the spliceosome. The spliceosome subunits interact with premature messenger RNA to produce mature messenger RNA. Lengthened forms of snRNAs have been identified as putative precursor snRNAs. These RNAs are lengthened at their 3' ends, which must be removed to yield the mature, active forms. RNase III is one protein that has been shown to participate in processing these snRNAs. Using U1 snRNA, we found that nucleotides contained completely within a single putative stem-loop structure are important for RNase III cleavage by modification interference assay. Point mutations were generated to delineate the contribution of structure and sequence contributions and evaluated in vitro. Mutations in the stem are important structurally, however, mutations in the loop are also essential. Additional point mutations are being generated.

GLYCERALDEHYDE-3-PHOSPHATE DEHYDROGENASE IN ACUTE LYMPHOBLASTIC LEUKEMIA CELL LINES. Dara Grieger*, Natalia Krynetskaia, and William Evans, *University of Tennessee, Memphis, Memphis, Tennessee (DG), and St. Jude Children's Research Hospital, Memphis, Tennessee (NK, WE)*. Mercaptopurine (MP) is an important antileukemia medication used in acute lymphoblastic leukemia (ALL) treatment regimens. Characterization of cellular components within malignant lymphoblasts treated with MP is essential to elucidate the mechanism of its antileukemic effects. It was previously found that MP treatment of ALL cells promoted transport of the cytosolic protein glyceraldehyde 3-phosphate dehydrogenase (GAPDH) into nuclei. Nuclei of various ALL cells demonstrated different levels of GAPDH before MP treatment. We analyzed GAPDH forms in the nuclear extracts of three ALL cell lines—MP sensitive (Molt4, Nalm6) and UT resistant (P12) using fast protein liquid chromatography (FPLC). We found that while GAPDH is a tetramer after purification, it was present in the nuclear extracts in tetrameric, dimeric and monomeric forms. The ratios of these forms are different among MP sensitive and MP resistant cell lines. In all tested nuclear extracts we also found a multi-protein complex containing GAPDH.

INSERTION OF T7 EPITOPE INTO THE (-FACTOR RECEPTOR OF SACCHAROMYCES CEREVISIAE AFFECTS PHEROMONE SIGNAL TRANSDUCTION PATHWAYS AND LIGAND AFFINITY BINDING. Jason S. Cathelyn*, *University of Tennessee, Knoxville, Knoxville, Tennessee*. Plasmid vectors were developed for expression of a functional form of the *Saccharomyces cerevisiae* (-factor receptor tagged in three different positions at the N-terminal end with a T7 epitope. The T7 epitope is the natural amino terminal end of the T7 major capsid protein and establishes a monoclonal antibody binding site within the N-terminal region of the (-receptor (Ste2p). The three different insertional sites were engineered into the STE2 gene on separate vectors and transformed in yeast cells creating strains A1942, A1755, and A1781. Radioligand binding studies demonstrated that strain A1781 has a 15-fold reduction in binding affinity to (-factor while strain A1942 appears to have almost the same affinity as the wild type receptor. Strains A1781 and A1942 respond to (-factor similarly to wild type cells in growth arrest assays and induction of pheromone-responsive genes. In com-

parison with cells containing the native receptor, there is an observable decrease in surface-expression of Ste2p in the plasma membranes of these engineered strains that affects their usefulness in radioligand binding studies and pheromone-receptor functional interaction assays.

ACTIVATION OF MDR1 GENES BY MUTANT P53 REQUIRES INTERACTION WITH A CELLULAR PROTEIN. A. Gandhi*, J. Sampath, L. H. Shapiro, G. P. Zambetti, K. W. Scotto, and J. D. Schuetz, *Christian Brothers University, Memphis, Tennessee (AG), St. Jude Children's Research Hospital, Memphis, Tennessee (JS, LHS, GPZ, JDS), and Memorial Sloan-Kettering Cancer Institute, New York City, New York (KWS)*. We have recently shown that endogenous MDR1 (multi drug resistance) gene is activated by mutant p53-281G. To determine the mechanism, deletion analysis was performed and revealed upregulation of the MDR1 basal promoter (-107/+30) by p53-281G and other p53 mutants. Further deletions identified a specific region required for upregulation by mutant p53. This region contained an Ets binding site. Loss of the Ets-site (deletion or specific mutation) decreased basal MDR1 transcription. Specific mutation of the Ets-site in the basal MDR1 promoter abrogated transactivation by mutant p53s. However, decreased basal transcription was not responsible for impaired mutant p53 transactivation because MDR1 NFY promoter mutants retain transactivation by mutant p53 despite dramatically reduced basal activity. Previous studies suggested that mutant p53s required and interacted with cellular proteins. Because of these findings, we used in vitro studies to demonstrate p53-281G specifically interacted with the Ets-1 protein in pull down assays. Cumulatively, these studies suggest that MDR1 activation in vivo by mutant p53s require the cellular protein, Ets-1.

REOVIRUS SEROTYPE-DEPENDENT REPLICATION AND INDUCTION OF INTERLEUKIN-8 IN HUMAN MONOCYTES. Spence Dowlen* and Anthony Farone, *Middle Tennessee State University, Murfreesboro, Tennessee*. Significant increases in inflammatory cytokine gene expression are stimulated by T3D in a rat alveolar macrophage cell line compared to T1L. In this study we sought to determine if a similar pattern of cytokine expression occurred in the human monocyte cell-line, THP-1. THP-1 cells were treated with T1L, T3D, or medium alone and supernatants were tested for interleukin-8 (IL-8) by ELISA. IL-8 is a cytokine responsible for neutrophil influx during the inflammatory response. Monocytes also were assayed for viral replication and viability. Cells treated with reovirus T3D had increased levels of IL-8 expression compared to cells treated with reovirus T1L. These results support the hypothesis that monocytes respond differently to T1L and T3D. Replication and viability studies demonstrated that T3D yielded significantly more viral progeny than T1L and was more cytopathic. These results correspond with animal studies in which more prominent respiratory inflammation was seen with T3D than T1L.

CELL POLARITY AND CYTOKINESIS IN SACCHAROMYCES CEREVISIAE. Matt J. Elrod-Erickson and Sylvia S. Sanders, *Middle Tennessee State University, Murfreesboro, Tennessee, and Howard Hughes Medical Institute, Massachusetts Institute of Technology, Cambridge, Massachusetts*. The establishment of an intrinsic cell polarity and the execution and regulation of cytokinesis are among the most fundamentally important processes in basic cell and developmental biology. We have devised

a simple but effective method for identifying yeast mutants with defects in cytokinesis. Passing populations of mutagenized yeast over filters with uniform diameter cylindrical pores that are slightly larger than the average diameter of a yeast cell gives a >200-fold enrichment of mutants that fail to separate mother and daughter cells through successive generations. Such mutants can then be identified by microscopic observation. Secondary screens allow the identification of those mutants that have cytokinesis defects. Using this method we screened the equivalent of a million viable mutagenized yeast cells and identified mutations in four genes that cause defects in cytokinesis. Related screens designed to allow for more rapid identification of the mutant genes are currently in progress.

DETECTION OF HUMAN DNA FROM UNITED STATES CURRENCY. *Penny L. Vestal**, *David C. Winston*, and *Anthony L. Farone*, *Middle Tennessee State University, Murfreesboro, Tennessee (PLV, ALF)*, *Wake Forest University School of Medicine, Winston-Salem, North Carolina (DCW)*. The application of DNA typing to the identification of individuals provides objective evidence in the analysis of biological material obtained in criminal cases. Since the advent of the polymerase chain reaction (PCR), amplification of DNA from evidence samples has been applied in genetic characterization of individuals. A \$2 bill was given to four individuals. The bills were then circulated between all four individuals. The DNA was extracted from the money by using the double swab method. After collection, the double swab samples were labeled and stored at 4°C pending DNA extraction and quantitation. DNA samples were purified using the standard phenol/chloroform method or the InstaGene matrix system. Cells were lysed by boiling in the presence of the matrix. Samples were then resolved by gel electrophoresis in a 1.5% agarose gel and photographed. The PCR product was a fragment or fragments of DNA of defined length. By comparing product bands from the known molecular-weight markers, we were able to identify product fragments, which were of the appropriate size. In our study, all of the examined samples were correctly attributed.

THE EFFECTIVENESS OF ZINC OMADINE® AS A FUNGICIDAL. *Ben A. Ingersoll** and *S. K. Ballal*, *Tennessee Technological University, Cookeville, Tennessee*. Internal environments in the United States in the last decade have deteriorated due to the increase in the number of homes that are "closed systems." Products used by consumers, such as paint and surface coverings, have been shown to harbor microorganisms which act as allergens. These microorganisms are responsible for aggravating respiratory problems such as allergy and asthma. Zinc Omadine (is a derivative of pyridinethiol which is a zinc complex of 2-pyridinethiol-1-oxide. Zinc Omadine (is claimed to be an effective fungistat, and many paint manufacturers are interested in using it as a component in paints. We experimented with various concentrations of this chemical to kill mycelial and spore germination of *Aspergillus niger*, *Chaetomium globosum*, and *Penicillium funiculosum* against various concentrations of Zinc Omadine (on Potato Dextrose Agar. The results of Zinc Omadine (at various strengths to create the fungistatic effects are discussed.

EXPRESSION OF CELL CYCLE MARKERS DURING POSTNATAL DEVELOPMENT OF RAT COLON. *Hao Nguyen*, *University of Tennessee, Martin, Tennessee*. Colorectal carcinogenesis closely resembles the natural development of the colon, in reverse. Therefore, elucidating the pattern of cell cycle

pathways during natural development can, in theory, help us understand the mechanism of carcinogenesis. Markers for cell cycle and signal transduction and tumor suppressors were examined by immunohistochemical staining in postnatal rat colons. Preliminary data indicated that cell cycle activators like cdk1 and cdk4 were expressed at high levels throughout postnatal development of the rat colon. Cdc25A, which controls cdk1 activity, was expressed at very low levels throughout development and maximally at day 14 after birth. MAP kinases and transcriptional factors were expressed at maximum levels around day 7 to 14 after birth. Interestingly, tumor suppressors, p53 and Rb, also were expressed at maximum levels around day 7 after birth. Examination of the complete sets of markers for cell cycle and signal transduction is required to decipher the possible interactions among these enzymes and, thus, the mechanism for postnatal development.

CHEMISTRY SECTION

JAMES C. HOWARD, CHAIR

IDENTIFICATION OF MOLECULAR REACTIVE SITES WITH AN INTERACTIVE VOLUME RENDERING TOOL. *Preston J. MacDougall and Christopher E. Henze*, *Middle Tennessee State University, Murfreesboro, Tennessee, and NASA Ames Research Center, Moffett Field, California*. EVolVis is a synthesis of recent advances in quantum chemistry and state-of-the-art computer graphics techniques. A brief review of the topological properties of the total electron charge distribution will be presented, as well as a description of the new visualization technique. Selected applications, with relevance to biomolecular modeling, will be presented. In addition to being beautiful, the images we will present contain new information that is both physically and chemically significant.

THE ROLE OF DISPERSIVE AND DIPOLAR INTERACTIONS ON THE SOLVENT INDUCED FREQUENCY SHIFTS OF ACETONE AND ACETONITRILE. *Kristie L. Gholson** and *George S. Devendorf*, *Middle Tennessee State University, Murfreesboro, Tennessee*. Gas to liquid vibrational frequency shifts of the CO stretch of acetone and CN stretch of acetonitrile have been measured in a collection of solvents with different polarizabilities and dipole moments to investigate the effects of these solvent properties on solvent-solute interactions. The solvent induced repulsive force and its effect on the frequency shift is calculated theoretically and the remaining attractive portion of the frequency shift is used to determine the magnitude of an empirical, mean-field attractive parameter, C_a . Using a simple theoretical formulation of C_a as a guide, correlations of C_a with the polarizability and dipole moments of selected subsets of solvents reveal dispersive interactions that scale with the square of the polarizability, while dipolar interactions appear to behave in a more complex way that cannot be simply related to the magnitude of the dipole moment of the solvent.

MODELING SOLVENT INDUCED FREQUENCY SHIFTS OF POLYATOMIC SOLUTES WITH A BREATHING SPHERE MODEL. *George S. Devendorf*, *Middle Tennessee State University, Murfreesboro, Tennessee*. The solvent induced force on a vibrating solute is modeled using a hard-core repulsive mean field attractive solvent-solute interaction. The repulsive force on

a polyatomic vibrational mode is calculated using a spherical volume derivative equal to the excluded volume derivative (with respect to a given vibrational mode, Q) of a fused spherical polyatomic solute immersed in a solvent of hard spheres. The diameter of this "breathing sphere" solute is a sensitive function of the asphericity of the excluded volume of the fused sphere solute. The effects of the attractive interaction on the solute vibration are expressed through a single parameter whose magnitude is fixed using experimental frequency data. The breathing sphere model is more sensitive and adaptable to polyatomic vibrations than previous pseudo-diatom adaptations. Current applications with acetonitrile and acetone will be presented.

DISCOVERY VIDEOS: ASSESSMENT OF THE EFFECTIVENESS OF ACTIVE LEARNING BY STUDENTS VIEWING DIGITALLY ANIMATED VIDEOS OF DESCRIPTIVE INORGANIC CHEMISTRY LAB EXPERIMENTS. *Gary P. Wulfsberg, Barbara N. Young, and Lyubov Hoffman Laroche**, Middle Tennessee State University, Murfreesboro, Tennessee (GPW, BNY), and University of British Columbia, Vancouver, British Columbia (LHL). We have written several discovery laboratory experiments, also useable as discovery demonstration-discussions, to encourage active learning by students working to discover periodic reactivity trends in inorganic chemistry. Since some of these reactions are too vigorous for inexperienced students to perform and are also problematic as demonstrations in classrooms without hoods, we prepared digitally animated, artistically illustrated, musically scored videos of two of the experiments (on the activity series of metals and the acidity of cations). A crossover-design chemical education research project was carried out to compare the effectiveness of using the videos versus having the instructor demonstrate the reactions. We compared student attitudes and comments, and the ability of students to recall visual descriptive details, to recall periodic concepts, and to apply these concepts to predict additional reactions. Copies of the video can be obtained by sending a blank VCR tape to GPW, Box 405, Chemistry Department, MTSU, Murfreesboro, TN 37132.

HYDROSILYLATION OF α -OLEFINS CATALYZED BY CHLOROPLATINIC ACID. *Charles M. Baldwin, Jeff Jones*, and Molly Escue**, Union University, Jackson, Tennessee. The chloroplatinic acid-catalyzed reaction of 1-tetradecene with a polysiloxane prepolymer was studied to discover optimal reaction conditions and determine the kinetics of the reaction. The effects of varying the temperature program, percent excess of α -olefin, and source of the α -olefin were investigated. The reactivity of the hydroxyl group was compared with the reactivity of the olefinic reaction center in 1-tetradecene. The progress of all reactions was monitored by FTIR and NMR spectroscopy. The solubility characteristics of the products and the residual monomer concentration were qualitatively determined. It was concluded that evidence existed to support both addition and substitution pathways for the reaction.

THE DEVELOPMENT OF A NEW EXTRACTIVE SCINTILLATION COCKTAIL FOR THE ANALYSIS OF ACTINIDES. *Dale D. Ensor, Stephen W. Glover*, Hao Wang**, Tennessee Technological University, Cookeville, Tennessee. The presence of alpha-emitting actinide isotopes in our environment, whether from natural sources or as a result of man-made activities, is of concern to scientists and the population as a whole. Traditional

methods for the determination of alpha emitters rely on either proportional counting or alpha spectroscopy. These methods require time-consuming sample preparation to eliminate radiological and chemical interferences. In this study, a PERALS[®] spectrophotometer in combination with a new extractive scintillation cocktail was used in the detection of plutonium, americium, thorium, and uranium isotopes in water and simulated wastewater samples. Excellent recoveries were found for U, Pu, and Am (99, 95, and 98%, respectively). The new cocktail offers a one-step approach to determine total alpha-emitting actinide isotopes in a sample.

CAN SMOOTHING CORRECT A POOR CHROMATOGRAPHIC METHOD? *Martin V. Stewart and Allen E. Tate**, Middle Tennessee State University, Murfreesboro, Tennessee. A Gaussian algorithm was applied to smooth digitized GC-MS data having distorted chromatographic peaks due to both temperature programming and overloading of the capillary column. Apparent retention times and ratios of integrated peak areas, including those from trace analysis through tangent-skim integration, were plotted against increasing filter values set to the full width at half-maximum of the peak height (FWHM) in the resulting smoothed chromatograms. When FWHM was progressively increased, the retention times eventually converged to accurate values established by chromatograms having symmetrical peaks without smoothing; however, no such simple convergence was observed for the corresponding integrations.

ANALYSIS OF CONTAMINATION ON SOLAR PANELS RETURNED FROM MIR SPACE STATION. *Linda Arney Wilson, Gale A. Harvey, M. Lisa Manier, and Kent A. Hagler**, Middle Tennessee State University, Murfreesboro, Tennessee (LAW, KAH), NASA/Langley Research Center, Hampton, Virginia, (GAH), and Vanderbilt University, Nashville, Tennessee (MLM). After approximately ten years of space exposure in low Earth orbit, a segment of a solar array consisting of eight panels was removed from the Mir core module. One panel was sent to NASA for analysis. The primary contamination consists of a non-uniform film of oxidized silicones, produced when outgassing products from the silicone adhesive and potting compound used in the construction of the cells came in contact with atomic oxygen found in low Earth orbit. Unflown solar cells similar to those returned from Mir were obtained. The outgassing of an unflown cell was compared to that of a Mir cell. The Mir cell outgassed at a rate two orders of magnitude higher than that of the unflown cell. GC/MS analysis indicated that the outgassing products were lower molecular weight silicones. This project has important implications for future space missions including the International Space Station.

A COMPUTATIONAL LOOK AT ARYL(CYCLOPENTADIENYL)BORONIUM IONS. *William H. Isley*, Middle Tennessee State University, Murfreesboro, Tennessee. Preliminary results of RHF/3-21g* and RHF/6-31g* ab initio studies of fluoro- and methyl-substituted arylboronium ions of the type $[(C_5H_5X_n)BY]^+$ ($X = F, Me; Y = H, F, Me, C_2Cl_5$) and $[(C_5H_5X_n)B]_2^+$ ($X = H, F, Me$) will be presented. The effect of both the number and type of substituent on the predicted geometry will be discussed as well as the importance of relevant molecular orbitals in stabilizing the predicted geometries. Preliminary results suggest that, in general, these species exhibit linear geometry about the boron atom.

EXPERIMENTAL AND CALCULATED SELENIUM-77 CHEMICAL SHIFTS FOR THE SERIES, $(\text{CH}_3)_{4-x}\text{Si}(\text{SeCH}_3)_x$, $x = 1-4$. **Zahra Rezaei***, **Judith M. Iriarte-Gross**, and **William Isley**, *Middle Tennessee State University, Murfreesboro, Tennessee*. The nature of the selenium-silicon bond in the series, $(\text{CH}_3)_{4-x}\text{Si}(\text{SeCH}_3)_x$, was investigated using both experimental and theoretical methods. Selenium-77 NMR chemical shift data, absolute shielding constants, calculated selenium-silicon bond lengths and bond angles were determined. Gas phase ab-initio calculations such as Hartree-Fock (HF), Density Functional Theory (DFT), and second order Moller-Peset Perturbation Theory (MP2) methods have been conducted on these compounds and will be discussed. Current work is focusing on similar studies for the analogous tellurium compounds.

MOLECULAR MODELING OF PROTEIN KINASE C ISOFORMS. **SirCrease D. Brooks***, **Julie Rubio***, and **Abby L. Parrill**, *University of Memphis, Memphis, Tennessee*. Protein Kinase C (PKC) is a family of proteins that plays an important role in cellular signaling events including those involved in tumor promotion, this protein family is an attractive target for therapeutic intervention. PKCs consist of a ligand-binding domain (C1), a regulatory domain (C2) and catalytic domains (C3 and C4). There are eleven isozymes of PKC whose relative importance in tumor promotion has not been thoroughly elucidated. Homology models of the C1 domains of PKC- α , PKC- δ (C1a domain), and PKC- ζ have been developed based on the crystal structure of the PKC- δ C1b domain. These models have been refined using molecular dynamics simulations and the interactions of each of these domains with phorbol ester, a tumor-promoting ligand, have been computed and compared with the published binding affinities of each domain. Hydrogen bonding energies calculated are partially responsible for the observed experimentally binding affinity differences.

MOLECULAR MODELING OF ADENOSINE RECEPTORS AND THEIR LIGANDS. **Charles Singer***, **Brandy Harper***, **Frank Onyemaewa***, **Peter K. Bridson**, and **Abby L. Parrill**, *University of Memphis, Memphis, Tennessee*. Adenosine receptors (ARs) belong to the G protein coupled receptor (GPCR) family of proteins, which have seven transmembrane helices (TM) arranged in a helical bundle. As their name suggests, the endogenous ligand for these receptors is adenosine, which regulates physiological activity in a variety of systems (e.g. circulatory, CNS, reproductive, immune system, respiratory), making these receptors an attractive target for therapeutic intervention. A wide variety of adenosine and xanthine derivatives act as potent and specific antagonists of these receptors. As adenosine receptors have no solved structures, homology modeling was required in order to develop initial protein structures, which were then refined by polarity conserved position hydrogen bond optimization, ligand docking, and molecular dynamics simulations. The resulting models of the A_1 , A_{2A} , and A_3 receptor subtypes were found to correlate with published impact of site mutations on ligand binding.

TRIACETONE ALCOHOL FROM PHORONE HYDROLYSIS. **Hitendra R. Patel*** and **Martin V. Stewart**, *Middle Tennessee State University, Murfreesboro, Tennessee*. The compound 2,6-dihydroxy-2,6-dimethyl-4-heptanone is commonly called triacetone alcohol. This trimer of the aldol self-condensation of acetone has not received much attention because it is neither com-

mercially available nor is there a published method for its direct preparation. An optimized synthetic method is presented for obtaining triacetone alcohol in high purity and good yield through exhaustive hydrolysis of phorone using an oxymercuration-demercuration procedure. GC-MS was employed to determine the product distribution of the reaction mixture both qualitatively and quantitatively. Special emphasis was placed on finding chromatographic conditions that provided accurate analyses. Partial support from the Undergraduate Research Council of the College of Basic and Applied Sciences at MTSU is gratefully acknowledged.

THE CHEMISTRY OF TELLURIC ACID. **Frenka F. Minter*** and **Judith M. Iriarte-Gross**, *Middle Tennessee State University, Murfreesboro, Tennessee*. Telluric Acid, $\text{Te}(\text{OH})_6$, is a potential Tellurium-125 Nuclear Magnetic Resonance (^{125}Te NMR) spectroscopy chemical shift reference and a potential sol-gel precursor. Telluric acid is stable in air and can be purchased commercially. Previous work has shown the $\text{Te}(\text{OH})_6$ is insensitive to concentration, temperature, and to acidic pH. In the basic pH range of 6 to 10, a precipitate formed in the $\text{Te}(\text{OH})_6$ solution. We have conducted additional pH studies on $\text{Te}(\text{OH})_6$. We also have characterized the $\text{Te}(\text{OH})_6$ solutions and precipitates using ^1H and ^{125}Te NMR spectroscopy and FT-IR. Results of our work will be presented and discussed.

SYNTHESES OF SELENIUM AND TELLURIUM ALKOXIDES. **Hadi D. Arman***, **S. Timothy Decha-Umphai***, and **Judith M. Iriarte-Gross**, *Middle Tennessee State University, Murfreesboro, Tennessee*. The syntheses of selenium, $[\text{Se}(\text{OR})_4]$, and tellurium, $[\text{Te}(\text{OR})_4]$, alkoxides are being investigated. These compounds will be characterized by ^1H , ^{13}C , ^{77}Se , and ^{125}Te NMR spectroscopy. These alkoxides are precursors for the sol-gel process. We are exploring the different properties of higher order selenium and tellurium alkoxides. Potential applications of the products of the sol-gel process will be identified.

ACTIVITY COEFFICIENTS FOR THE DOT COM GENERATION. **C. Ashley Loflin***, **Roy W. Clark**, and **Judith M. Bonicamp**, *Middle Tennessee State University, Murfreesboro, Tennessee*. We describe the use of relatively inexpensive, computerized osmometers to measure the practical osmotic coefficient of 1-1 strong electrolyte solutions. This data can be converted to mean ionic activity coefficients ((γ)) using nonlinear curve fitting and a spreadsheet. Data smoothing via the curve fit allows an acceptable determination of activity coefficients for a 1-1 strong electrolyte in about three hours. In the past, many long and tedious experiments were needed to determine the mean ionic activity coefficient of a solute. The computer-assisted, spreadsheet-driven method should appeal to young scientists of the dot-com generation, those who have grown up with the notion, "my way, right away!"

DIFFERENTIATION OF HYDROCODONE AND METABOLITES FROM OTHER OPIATES IN HUMAN URINE. **Jennifer Pendergrast*** and **Judith M. Bonicamp**, *Middle Tennessee State University, Murfreesboro, Tennessee*. Hydrocodone, a synthetic narcotic analgesic, is prescribed in place of the natural opiates, morphine or codeine. Hydrocodone is habit forming and is subject to abuse. Due to similarities in structure, hydrocodone or its metabolites may interfere in broad screening of urine for morphine, codeine, 6-monoacetylmorphine, and other synthetic an-

algescics such as oxycodone. Thus far, we have differentiated hydrocodone, heroin, codeine, morphine, and their metabolites from each other using solid phase extraction, followed by simplified and accelerated thin-layer chromatography employing sample application discs and one detection reaction. The detection limit is about 200 ng/ml for the unconjugated drugs in water. We have examined human urine specimens of patients taking hydrocodone and oxycodone, because (1) the metabolites and not just the parent drug are potential interferences in opiate screens, and (2) metabolite patterns assist in demonstrating which parent drugs were ingested. (Supported by Ansys Diagnostics, Laguna Hills, CA)

SYNTHESIS AND ANALYSIS OF ZINC SILICATE SOL-GEL MATERIALS. *Vickie Bouttavong**, *Frenka F. Minter**, and *Judith M. Iriarte-Gross*, *Middle Tennessee State University, Murfreesboro, Tennessee*. The sol-gel process using zinc oxide and zinc nitrate provides a new method for the controlled synthesis of zinc silicate materials. We studied the sol-gel chemistry of zinc silicates because they are used in the production of new zinc silicate glasses and ceramics. These materials have potential application as dental ceramics such as posterior tooth filling materials. Factors such as pH, alkoxide, molar ratio of water to alkoxide, and temperature affect the nature of the sol-gel products. In this work, the pH and solvent of the reactions were varied. Materials were characterized by IR spectroscopy and scanning electron microscopy. The syntheses and analytical results are presented and discussed.

PROTECTIVE EFFECT OF QUERCETIN AND GENISTEIN ON IRON AND COPPER INDUCED OXIDATIVE METHYL LINOLENATE DAMAGE. *William Boadi*, *Peter Iyere*, and *Samuel Adunyah*, *Tennessee State University, Nashville, Tennessee (WB, PI)*, and *Meharry Medical College, Nashville, Tennessee (SA)*. Antioxidants are now widely recognized as including (-tocopherol (vitamin E), ascorbic acid (vitamin C), and (-carotene. While pharmacological doses of the above individual vitamins may have beneficial effects, often there is either no effect or harmful effects. Thus, for more reliable antioxidant effect an adequate dietary supply of a mixture of flavonoids seems preferable. The protective effect of two structurally different flavonoids namely quercetin and genistein was investigated in methyl linolenate oxidation. Antioxidative activity was determined by oxidizing methyl linolenate suspended in a buffer solution with either ferrous chloride (5 (M) or cupric chloride (7.5 (M) and hydrogen peroxide (0.1 mM) with and without flavonoid sample (10 or 20 (M). Following incubation of the samples for 16 h at 37(C, the degree of oxidation was measured by the thiobarbituric acid assay. Of the two flavonoids, quercetin had a more marked effect on inhibiting lipid peroxidation. These results suggest that the protective effect of these flavonoids in methyl linolenate may be attributed to the hydroxyl scavenging potency in a direct manner.

THE PURIFICATION OF WILD TYPE AND SELENOMETHIONYL PYRROLIDONE CARBOXYL PEPTIDASE (PYRase) FOR STABILITY STUDIES. *William Duvall** and *Jeffrey Boles*, *Tennessee Technological University, Cookeville, Tennessee*. Pyrrolidone carboxyl peptidase (PYRase) is a proposed member of a new structural class of proteins, as none of the cloned homologous PYRases exhibit sequence homology with other known peptidases. The exact physiological function of PYRase remains unknown at this time. Research with this protein

has been hampered due to the accelerated loss of activity following purification and the lack of sufficient storage protocols for this enzyme. Enzymatic activity loss is substantial within one day. The subject of this research was the expression, purification and stability studies of a wild type aminopeptidase. The purification, stability protocols and enzymatic assay used for accessing activity loss will be presented.

THE PURIFICATION OF WILD TYPE AND SELENOMETHIONYL DIHYDROFOLATE REDUCTASE FOR STRUCTURAL AND ENZYMATIC STUDIES. *Carley Chandler**, *Michele Dinsmore**, and *Jeffrey Boles*, *Tennessee Technological University, Cookeville, Tennessee*. Selenomethionine (SeMet) and more recently, telluromethionine (TeMet) are used as phasing tools in macromolecular crystallography. Little information is available concerning the solution state structure of proteins where methionine has been substituted with SeMet or TeMet. These initial studies were undertaken to set up thermal denaturation/renaturation experiments to test the theory that unfolded proteins containing SeMet or TeMet may not refold back to the same structure as that found in the native state. We plan to use Se-77 and Te-125 NMR Spectroscopy to examine this question. The *E. coli* dihydrofolate reductase (DHFR) has 5 Met residues available for replacement. DHFR has become our protein of choice for the study and analysis of selenoproteins and telluroproteins in general due to its ease of preparation and excellent stability. For these reasons continued development in purification strategies and mechanistic understanding warrant further attention to this protein.

STUDIES OF TELLURIC ACID AND TELLURIUM DIOXIDE DOPED SILICA SOL-GEL MATERIALS. A PROJECT SEED RESEARCH PROJECT AT MTSU. *Sayena Sadjadi**, *Judith M. Iriarte-Gross*, *William H. Iisley*, and *Barry Farris*, *Glencliff High School, Nashville Tennessee (SS)*, *Middle Tennessee State University, Murfreesboro, Tennessee, (JMI-G, WHI)*, and *Columbia Academy, Columbia, Tennessee (BF)*. The silica sol-gel process using telluric acid and tellurium dioxide powder provides a new method of investigation in producing telluric acid and tellurium dioxide incorporated silicate glasses and ceramics. An experimental method was developed to synthesize telluric acid and tellurium dioxide doped sol-gel materials. The pH of the reactions was varied. Proton NMR chemical shifts, FT-IR data, and computational calculations are reported and discussed.

STUDIES OF SELENIOS ACID DOPED SOL-GEL MATERIALS. A PROJECT SEED RESEARCH PROJECT AT MTSU. *Salar Sadjadi**, *Judith M. Iriarte-Gross*, *William H. Iisley*, and *Barry Farris*, *Glencliff High School, Nashville, Tennessee (SS)*, *Middle Tennessee State University, Murfreesboro, Tennessee, (JMI-G, WHI)*, and *Columbia Academy, Columbia, Tennessee (BF)*. The process of silica sol-gel reactions leading to the production of glass through the use of selenious acid has been the essential part in developing new techniques related to the controlled synthesis of selenium dioxide, SeO₂, doped silicate. An experimental method using either the methoxy or ethoxy ligand was developed and optimized to synthesize silicate materials that contain selenium. Two different analytical techniques were used to analyze materials formed from the sol-gel solutions. Infrared Spectroscopy was used for the analysis of solid materials, and Nuclear Magnetic Resonance (NMR) Spectroscopy was used for

the analysis of liquid materials. Results will be presented and discussed.

DETERMINATION OF TRIHALOMETHANE FORMATION POTENTIAL. *Mohamed Y. Z. Aboul Eish* and Martha J. M. Wells, Tennessee Technological University, Cookeville, Tennessee.* During the chlorination of raw municipal drinking water, natural organic matter containing humic and fulvic acids is linked to the formation of potentially harmful by-products, particularly the trihalomethanes CHCl_3 , CHBrCl_2 , CHBr_2Cl , and CHBr_3 . Humic and fulvic acids from terrestrial and aquatic sources were characterized in this research to determine how best to monitor them and optimize water treatment. The trihalomethane formation potential was measured at pH 6 and 9, both before and after incremental exposure to varying levels of activated carbon. Also, levels of dissolved organic carbon, ultraviolet absorption, and fluorescence properties were determined. Results were compared to show the trends and differences that occur among humic and fulvic acids from different sources. The significance is the increased ability to review and predict the impact of natural organic matter upon by-product formation during water treatment, and may reasonably be performed as screening procedures by water utilities.

ENGINEERING AND ENGINEERING TECHNOLOGY SECTION

MICHAEL L. DALEY, CHAIR, AND
DONALD P. VISCO, CHAIR

STUDY OF ENGINEERING PROPERTIES OF ARTIFICIAL WOOD: COMPARISON ANALYSIS. *Fernando J. Pacheco* and Fyodor Shutov, Tennessee Technological University, Cookeville, Tennessee.* The first replacement of natural wood was plastic lumber, followed by solid artificial wood, and now a new family of porous artificial woods (PAW). Engineering properties for each material differ; therefore, some applications are more suitable for each one. The new PAW is based on the mixture of virgin and/or waste plastics and natural wood wastes (such as sawdust or wood flour, byproducts of furniture and construction industry). The new family of PAW uses conventional equipment and processes that are inexpensive and environmentally friendly. Conventional tools can transform porous artificial wood into useful construction projects because it can be nailed, cut, or screwed. Being a good thermo insulator, PAW has porous structure (similar to that of natural wood) provided by environmentally friendly commercial blowing agents.

THE EXPLICIT TVD SCHEME TO HIGH SPEED FLOWS. *Wensheng Shen* and Sam Han, Tennessee Technological University, Cookeville, Tennessee.* This paper provides an introduction to the second order high resolution explicit TVD scheme developed by Roe and Sweby. An implementation of this scheme is described with detail for one-dimensional conservative Eulerian conservative equations and is extended to a two-dimensional gas-dynamics problem using the fractional step method. A FORTRAN code is developed based on the scheme. Numerical examples, which are compared with either existing experiment results or other numerical solutions, show excellent accuracy of the

TVD scheme to capture shocks and discontinuities in the high speed flows.

DIE CASTING SIMULATION USING TWO ROBOTS. *Donald R. Harris Jr.*, Mark E. Brockman*, and Chin-Zue Chen, Austin Peay State University, Clarksville, Tennessee.* The project involved two robots simulating a die cast procedure. The robots had independent operations but shared the work envelope. To prevent a collision and achieve the correct timing, communication was utilized between two robots to coordinate work. An I/O terminal board was built for each robot controller for wiring, and hand-shaking communication approach was applied in the robot programs. For the assurance of collision prevention, several different scenarios were tested and the results were successful.

INCREASED CEREBRAL PERFUSION AND LOSS OF CEREBROVASCULAR RESERVE DENOTED BY AN INCREASED CORRELATION INDEX. *Sulhyung Han*, Charles Leffler, and Michael L. Daley, University of Memphis, Memphis, Tennessee (SH, MLD), and University of Tennessee Health Sciences Center, Memphis, Tennessee (CL).* In the United States, approximately 2 million head injuries occur each year. The economic and emotional toll of this public burden is very high. The overall goal of this research effort is to improve methods of bedside neurophysiological monitoring during intensive care management and as a result improve outcome. The purpose of this study was to examine the relationship between invasively obtained measures of changes in capillary blood cell velocity and flow using laser Doppler flowmetry to changes of two proposed indices of cerebrovascular reserve derived from intracranial and arterial pressure recordings. Using a cranial window coupled with video recordings and laser Doppler flowmetry, the relation between changes of indices of cerebrovascular reserve and changes of capillary flow induced hypercapnia were determined in piglets ($n = 4$). Percent change in flow was strongly correlated ($P < 0.05$) with percent change in flow for both indices. These preliminary results indicate that simultaneous changes in the proposed indices of cerebrovascular reserve reflect corresponding changes of cerebral capillary flow.

NEAR INFRARED SPECTROMETRY: CEREBRAL RESPONSES INDUCED BY BODY TILT. *Richard Pasley, Charles Leffler, and Michael L. Daley, University of Memphis, Memphis, Tennessee (RP, MLD), and University of Tennessee Health Sciences Center, Memphis, Tennessee (CL).* Towards the goal of developing a non-invasive device to identify impaired characteristics of cerebral arterial blood flow, a two channel near infrared spectrometer was used to measure changes in cerebral oxyhemoglobin (HbO_2) and hemoglobin (Hb) in normal subjects. Responses were simultaneously obtained from two sites on the subject's forehead with one just above the left eye, the other above the right eye. After several minutes in the prone position the subject's bed was tilted, head down, 20° for 10 min. Analysis of 83 recordings obtained from 6 subjects revealed: 1) all exhibited a salient increase of HbO_2 during tilt; 2) 66% demonstrated low frequency oscillations in range of 0.5–2 cycles/min; and 3) 19% exhibited apparent compensatory responses induced by cerebral autoregulation. Research is ongoing to further study the apparent compensatory responses and the low frequency oscillations induced by head-down body tilt.

THE PROPERTIES OF LOW DENSITY POLY(ETHYLENE) COMPOSITES FILLED WITH STARCH. **Soondeuk Jeung*** and **Fyodor Shutov**, *Tennessee Technological University, Cookeville, Tennessee*. Using compression molding technique composite materials based on the mixture of various agricultural waste products and LDPE (Low Density Poly Ethylene) as the matrix have been produced. Starch powder has been used as a filler to increase the biodegradability and to reduce the cost of the final product. Processing time, pressure, and temperature for different starch/LDPE ratios have been optimized and mechanical properties of the developed composites have been studied at various ratios of starch/LDPE composites.

PRODUCTION AND STUDY OF THE PROPERTIES OF LOW DENSITY FLEXIBLE POLYURETHANE FOAM FILLED WITH WOOD FLOUR. **Sathyam Bharadwaj-Somaskandan*** and **Fyodor Shutov**, *Tennessee Technological University, Cookeville, Tennessee*. Low density, two component, casting flexible Polyurethane Foam (PUF) was produced according to commercial standards, using as a filler wood flour of two average sizes: 250 and 70 (m. Foams with varied weight percentages of filler to Polyol have been produced and studied. Scanning electron microscopy analysis demonstrated that the fillers aligned themselves in the foam matrix along the cell wall and the cell size decreased with increase in content of filler. At the same time, the foam density increased with increasing of the filler content. The only limitation in increasing the filler content is the high viscosity of the filled polyol component that hinders the foaming. The relationship between the filler size and content and mechanical properties such as strength, flexibility and aging ability have been studied. This foam can be used for packaging applications.

ADAPTIVE MODELING OF INTRACRANIAL PRESSURE DYNAMICS BY IDENTIFICATION TECHNIQUES AND USE OF A COMPLIANCE INDEX. **Monroe Sparks***, **Charles Lefler**, and **Michael L. Daley**, *University of Memphis, Memphis, Tennessee (MS, MLD), and University of Tennessee Health Sciences Center, Memphis, Tennessee (CW)*. Towards the goal of developing enhanced neurophysiological monitoring techniques used in the intensive care management of patients with head-injury, parametric model estimation using an autoregressive moving average model and a recently proposed method to extract an index of intracranial compliance from the intracranial pressure recording were employed to characterize differences in cerebrovascular state induced by normocapnia and hypercapnia. Preliminary analysis with a first order model applied to 40 sec recordings of arterial blood pressure and intracranial pressure revealed that the Z-plane pole position was always greater than 0.9. However, the change in the location of the pole with change in cerebrovascular state induced by hypercapnia failed to correspond to changes of intracranial compliance. These preliminary results suggest that real-time adaptive modeling with the use of identification techniques coupled with real-time estimates of intracranial compliance will require more study to determine its value as an enhanced neurophysiological monitoring technique.

THERMODYNAMIC MODELING OF CANDIDATE POLYURETHANE FOAM BLOWING AGENTS. **Donald P. Visco Jr.**, *Tennessee Technological University, Cookeville, Tennessee*. Pure hydrofluorocarbons (HFC's), such as refrigerants R245fa and R365mfc, as well as mixtures of these refrigerants with some hydrocarbons are being examined as long-term replacements for

the ozone-depleting chlorofluorocarbons in the polyurethane foam blowing agent industry. As a first step in modeling the thermodynamic properties of alternative foam-blowing agent mixtures for use during process design, models for the pure substances are needed. As such, we have investigated the vapor-liquid equilibrium and vapor pressure as predicted by three engineering equations of state: Peng-Robinson (Stryjek-Vera), and two constructs of the Statistical Associating Fluid Theory (SAFT), namely SAFT-HS (uses only a hard-sphere reference) and SAFT-VR (uses a variable range for the dispersive interaction). Our results for the pure component modeling of R-245fa and R-365mfc indicate that the SAFT-VR model provides the best thermodynamic description relative to experimental data for both HFC's. Thus, we will present our mixture results for the systems mentioned above for only the SAFT-VR model. When present, we will compare these predictions to experimental data.

A DESIGN ANALYSIS OF A HEATING AND COOLING SYSTEM UTILIZING GROUND WATER AS AN ENERGY SOURCE. **Hua Zhu and J. D. Mo**, *University of Memphis, Memphis, Tennessee*. The modern environment movements toward pollution control and energy saving have demonstrated a great need for the further development of natural resources and their applications. This paper is an exploratory study on the feasibility of Ground Water Heat Exchange Piping System that make use of ground water as an energy source for residential heating and cooling. A one-story house located in Memphis, Tennessee area was chosen as the simulation model. A variety of parameters such as the orientation and the size of the room, the number of people, the desired room temperature, etc. are discussed regarding their influence on the performance.

A REVIEW OF HUMAN EFFORTS TO WALK ON WATER. **J. D. Mo**, *University of Memphis, Memphis, Tennessee*. Walking on water just like on ground has been a dream of human beings for centuries. French scientist, Da Vince was said to be the first one who invented a mechanism to walk on water in fiction movies even though nothing can be found on the world's technology shelf. Numerous researchers around the world are still trying different ideas and hope to make the human's dream come true. This paper gives a brief review on those ideas that either have been reported in the literature or are collected from the author's practices. It can be foreseen that humans may eventually have a walk on water, and will be a potential sport activity on water like racing on ground today.

EXPERIMENTAL STUDY OF EARLY-AGE SHRINKAGE OF HIGH PERFORMANCE CONCRETE DECK SLABS UNDER DIFFERENT CURING TECHNIQUES. **X. Sharon Huo and Ling Ung Wong***, *Tennessee Technological University, Cookeville, Tennessee*. The prevention of shrinkage cracking at early age and the protection against moisture loss from fresh high performance concrete (HPC) are crucial to the long-term strength and durability of concrete. The objective of this experimental study was to examine the early-age shrinkage of HPC under various curing methods. Laboratory experiments were conducted to investigate shrinkage development, temperature increase, and evaporation rate at early-age of HPC specimens with different curing methods. Four curing techniques and two curing durations of 3-days and 7-days were applied to concrete deck slab and cylindrical specimens. The curing methods included the traditional curing material, curing compound spray, cotton mat, and

polyethylene blanket. Cost analysis of curing materials and comparison study on the behavior of test specimens were performed to determine the features of different curing techniques. Finally, suggestions and comments will be presented for future curing practice.

MECHANICAL PROPERTIES OF HIGH DENSITY RIGID POLYURETHANE FOAM FILLED WITH DIFFERENT TYPES OF FILLERS. *Balachandhar Krishnamurthi* and Fyodor Shutov, Tennessee Technological University, Cookeville, Tennessee.* High density rigid polyurethane (PUR) foam has been filled with various kinds of filler having different chemical nature and size: expandable polystyrene beads (size 0.254–2.54 mm diameter, wood flour (size > 212 microns) and nano clay particles (individual platelets are a mere 1 nm thick and 100–1000 nm across). Mechanical behavior of filled PUR foams has been studied at various contents of filler (up to a maximum of 80% per polyol component in case of wood flour and up to a minimum of 10% per polyol component in case of nano clay particles). Compared to the unfilled rigid PUR foam, the composites exhibited improved mechanical properties. In the case of nanocomposite the ratios of mechanical properties versus filler loading is high. The mechanism of reinforcement in the case of nanocomposites is proposed based on the homogeneous dispersal at the microscopic level of the nano filler, which results in improved and unexpected properties of very thin PUR films and struts inside the cellular structure of the foam.

PROCESSING AND PROPERTIES OF ARTIFICIAL WOOD BASED ON COMPOSITES OF VIRGIN HIGH DENSITY POLYETHYLENE AND WOOD FLOUR. *Vaibhav V. Apte (and Fyodor Shutov, Tennessee Technological University, Cookeville, Tennessee.* A family of so called "Artificial Wood" or "Eco-Wood" materials has been developed based on the composites from virgin high density polyethylene (HDPE) as a matrix and wood flour as a filler, using the injection molding technique. The relationship between the HDPE/wood flour ratio and various ingredients has been studied to improve the mechanical properties and optimize the processing parameters. The properties are compared with the virgin HDPE and natural wood.

ETHICAL STANDARDS AND RULES OF CONDUCT EDUCATION FOR ELECTRICAL/ELECTRONICS ENGINEERING TECHNOLOGY STUDENTS. *Adel Salama, and Ashraf Saad, Austin Peay State University, Clarksville, Tennessee, and University of Cincinnati, Cincinnati, Ohio.* Students and graduates of Electrical/Electronics Engineering Technology must be educated to the highest standard of professionalism, integrity and competence. The course on engineering ethics includes case studies to motivate the students to study and discuss these cases. These cases can be developed in enough technical depth to interest students, so that meaningful discussions of ethical issues, standards, and rule of conduct can take place. The ethical standards are more specific goals toward which students and graduates should aspire in professional performance and behavior.

ETHICS IN SCIENCE AND TECHNOLOGY SECTION

RUBY TORREY, CHAIR

CONCERN OR ORWELLIAN NIGHTMARE? EMERGING ETHICAL ISSUES. *Claudia O. Torrey and Ruby Prigmore*

Torrey, Tennessee Technological University, Cookeville, Tennessee. Whether or not one is affiliated with an academic institution that has a medical school, there are ethical issues that will increasingly emerge as we proceed through the twenty-first century. Some will contend that the computer age has invited more "big brother" scrutiny. This author submits that the technology has outpaced the law, and thus, as a society, we should be thinking already of our individual responsibility. This paper will give an overview of the Internet; highlight some ethical issues regarding science and engineering; and, address the intersection of law, health science, and ethics.

ETHICAL ISSUES IN BIOMEDICAL AND RELATED RESEARCH. *Ruby P. Torrey, Tennessee Technological University, Cookeville, Tennessee.* Research in the academy using human subjects is not limited to medical research. The biological, behavioral and exercise sciences, as well as nursing, nutrition, and music therapy all use human subjects in many of their experiments. This type of research has reached a crisis level due to many unethical practices that have occurred. If humans are to be used in research experiments, they must be clearly informed of the nature of the research and the goal to be achieved, plus the role they are expected to play. The subjects must be apprised of any risks involved as well as benefits. The subjects must give evidence of thoroughly understanding the experience they are to undertake and their willingness to participate by giving an informed consent in writing. The current status of this type of research and several case studies will be reviewed.

CITIZENS' GROUP STUDY OF SEDIMENTATION IN THE HARPEATH RIVER WATERSHED. *David J. Wilson, Vanderbilt University, Nashville, Tennessee.* Erosion and sediment are identified in Tennessee's 305b reports as a major problem in the state's streams. The state must develop Total Maximum Daily Loads for sediments in streams within the next two years. The data for this are inadequate for many streams, and agency budgets preclude collection of needed data, necessitating the use of data collected by volunteers. The Cumberland River Compact and the Harpeth River Watershed Association have therefore organized a two-year sediment study on the Harpeth River. The study plan has been reviewed by the Corps of Engineers, the United States Geological Survey, the Tennessee Department of Environment and Conservation, and the Tennessee Department of Agriculture's Nonpoint Source Program to insure the data will be usable by these agencies. Participation by a volunteer scientist in developing the study plan and necessary protocols, training volunteers, quality assurance/quality control, and maintenance of records will be described.

THE NEED FOR ETHICS EDUCATION IN ENGINEERING. *John A. Gordon, Amber L. Pemberton, and M. Jason Mellons, Tennessee Technological University, Cookeville, Tennessee.* Let's face it; we don't live in an ethical society! However, the health and safety of the general public rests on the adequacy and reliability of designs. Engineering societies and state legislatures have decreed that engineers have ethical obligations to their profession, clients, and employees. There is little doubt that engineers face job-related ethical problems on a regular basis. This presentation will feature a panel wherein a moderator will ask the following questions of young engineering students concerning professionalism and ethics. What is required to become a registered professional engineer (PE)? What is the American So-

ciety of Civil Engineers Code of Ethics, and what responsibilities does it demand of civil engineers? What responsibilities does the State of Tennessee demand of all engineers and PE's. How does the young engineer learn of and acclimate to the ethical demands of the profession? Are we doing what is needed in undergraduate education?

ETHICS IN SCIENCE AND TECHNOLOGY: YOUR NET MY NET AND OTHER PRIVACY TALES. *Joseph Migga Kizza, The University of Tennessee, Chattanooga, Chattanooga, Tennessee.* Morality as a custodial system of peoples' shared values and Ethics as a system that fosters philosophical inquiry into human actions, are two systems that are bi-polar in a sense that each system has two views: the first view being that of the actor and the second of the spectator. Individually we all have our moral stand on every aspect of human actions—a moral view. And for every moral stand we take, individually, we have a relevant and plausible explanation for that action—an ethical view. For every view we take as actors, whether moral or ethical, there is a corresponding view from the witness of the action, the spectator. This dual nature of morality and ethics, when considered in the context of the information age, opens a Pandora's box the contents of which are not only disturbing but also their unforeseen consequences are a threat to the very identity of both the actor and spectator. "Your Web, My Web and Other Privacy Tales" is a peep into this box to explore these consequences.

ELECTRONIC COMMERCE: UPDATE ON LAW AND ETHICS. *M. Gene Bailey and Ruth Knight Bailey, Johnson City, Tennessee, and East Tennessee State University, Johnson City, Tennessee.* Rapid growth in the field of electronic commerce raises ethical concerns in computer science, which are reflected in a growing body of law. This paper presents an overview of ethical and legal issues relating to digital signatures; clickwrap agreements; terms of use for internet sites; domain names, cybersquatters; trademark, patent, and copyright problems in cyberspace; website development and hosting agreements; web privacy; and content licensing agreements. Discussion of the Uniform Computer Information Transactions Act is included.

GEOLOGY AND GEOGRAPHY SECTION

RICHARD G. STEARNS, CHAIR

THE RATIONAL COMPREHENSIVE MODEL AND ENVIRONMENTAL DECISION MAKING WITHIN THE CITIES OF HUDSON AND STREETSBORO, OHIO. *Emmanuel K. Mbobi, Austin Peay State University, Clarksville, Tennessee.* This study documents the processes through which Hudson and Streetsboro, Ohio have made critical environmental decisions. Newspaper articles reflecting environmental issues, zoning meeting minutes, and town hall council meeting minutes were analyzed for deliberations and actions used in formulating local ordinances. Such deliberations included environmental problems such as water pollution and wetland destruction. The study utilized the Rational Comprehensive Decision-making Model, a five stage theoretical model for recognizing the problem, developing consensus on overall facts and objectives, identifying alternative solutions, making choices, and suggesting policy implementation. Despite the contiguity of both cities, their approach to local decision-making differed considerably. Hudson's decision-making

process approached the stages expounded in the theoretical model, but Streetsboro's process ended abruptly in the Model's third stage. Using the Rational Comprehensive Model, the presentation examines the processes and policy activities reflecting Model use that was carried out by both cities.

DIRECTION COSINES: A NEW ANGLE ON COMPOSITIONAL DATA ANALYSIS OF HYDRAULIC GEOMETRY. *Gregory S. Ridenour, Austin Peay State University, Clarksville, Tennessee.* Because hydraulic geometry exponents are unit-sum constrained (i.e., closed, or compositional data sets), they should not be analyzed by standard multivariate statistics. Two methods have been designed for such data: 1) transformation to the logarithms of ratios following projection onto the simplex, and 2) analysis by directional statistics following projection onto the unit sphere. This study compared both methods by performing significance tests for a difference in mean hydraulic geometry between a main channel and its tributaries; both methods indicated that there was no significant difference. Transformation to the unit sphere offered a slight advantage over the log-ratio transformation on the simplex because the domain of hydraulic geometry exponents included negative values, whose logarithms are undefined. Analysis on the simplex remains appropriate for true compositions (those consisting of only positive numbers) in light of the fact that the log-ratio transformation is an invariant measure.

ALTERED PHYSICAL AND BIOLOGICAL PROCESSES: THE CASE OF HURRICANE FLOYD'S IMPACT ON THE PAMLICO SOUND AND THE CHESAPEAKE BAY. *Robert A. Sirk, Austin Peay State University, Clarksville, Tennessee.* Pamlico Sound, North Carolina, and the Chesapeake Bay, represent the largest estuary ecosystems in North America. Formed from terrestrial, freshwater and marine interactions, and powered by equally interactive physical and biological processes, estuarine environments represent unique ecological communities. In September 1999, Hurricane Floyd struck the Middle Atlantic coast, bringing heavy precipitation and flooding of several of the estuaries' tributary-basins. Applying a spatial perspective, and utilizing an immediate, and a longer term temporal perspective, the presentation will: (1) examine selected physical and biological impacts to the Pamlico Sound and Chesapeake Bay estuaries of this freshwater outflow, (2) discuss the ecological importance of nutrient and chemical laden runoff into both estuaries, and (3) speculate on potential future estuary ecological disruptions arising from the Hurricane Floyd event.

SINKHOLES AND CAVES IN TENNESSEE: A QUANTITATIVE COMPARISON OF GEOGRAPHIC DISTRIBUTION. *Gregory A. Shofner* and Hugh H. Mills, Tennessee Technological University, Cookeville, Tennessee.* To quantitate surface karstification we have devised a "karst index", a measure of the density of hachured (closed) contour lines within a given area. All of Tennessee east of the Coastal Plain was divided into blocks with dimensions 2.5 minutes of latitude by 2.5 minutes of longitude (i.e., one ninth of a standard topographic quadrangle), and the karst index determined for each block. Using data from the Tennessee Cave Survey we then also determined the total number and the total length of caves falling into each block. Regional maps of the sinkhole index are grossly similar to those of cave number and length. The mean number of caves ranges from 0.75 for blocks with low karst indices to 12.7 for those with the high-

est indices. On a block-by-block basis, however, the correlation between the sinkhole index and caves is relatively weak, with *r*-values ranging from 0.29 for the Eastern Highland Rim to 0.11 for the Central Basin.

ARCHAEOLOGICAL INVESTIGATIONS AT KELLYTOWN (40WM10): A FORTIFIED LATE MISSISSIPPIAN VILLAGE IN TENNESSEE'S CENTRAL BASIN. *Gary Barker and Gerald Kline, Tennessee Department of Transportation, Nashville, Tennessee.* In October of 1998 archaeologists with the Tennessee Department of Transportation (TDOT) conducted a Phase I level archaeological evaluation of a proposed right-of-way needed for the widening of the intersection of Old Hickory Boulevard (SR 254) and Hillsboro Road (SR 106) in south Nashville, Tennessee. The preliminary investigations revealed prehistoric archaeological remains potentially eligible for listing in the National Register of Historical Places were present in the project construction corridor. Between January and July of 1999, Phase II and III level investigations carried out by TDOT revealed the presence of a fortified late Mississippian village (circa 1450 AD). A minimum of 10 structures including one with an intact floor, two palisades with bastions and six human burials were documented. This presentation provides a brief summary of data derived from TDOT investigations at this important newly discovered village site.

VERTEBRATE FOSSIL SITE IN GRAY, TENNESSEE. *Nick Fielder, Walter Klippel, and Paul Parmalee, Tennessee Division of Archaeology, Nashville, Tennessee (NF), and University of Tennessee, Knoxville, Tennessee (WK, PP).* Highway construction in Washington County, Tennessee uncovered a deposit of bedded clays containing fossil plants and vertebrate animal remains. Identified animals include tapirs, elephant, turkey, alligator, turtle, frog and rhinoceros. The rhino has been identified as genus *Teleoceras*, which dates to the Miocene to Pliocene periods. Preservation and long term research is planned.

CONODONTS FROM THE BANGOR LIMESTONE (CHESTERIAN) NEAR HUNTSVILLE, ALABAMA. *Jih-Pai Lin* and Katrina Hunter*, Tennessee Technological University, Cookeville, Tennessee.* Twenty channel samples representing mostly limestone were taken from the new exposures of the Bangor Limestone at Monte Sano Mountain near Huntsville, Alabama. Distribution of conodonts from these samples, combined with information by a previous investigation, allowed us to interpret the stratigraphic setting and biostratigraphy of a nearly complete section of the Bangor. Results suggest that most of the Bangor was deposited in a shallow-water, shelf environment. However, the anomalously large numbers of conodonts in one restricted interval near the bottom of the formation probably represent deposition in an offshore, deep-water environment where the rate of sedimentation was low. Conodonts from the condensed interval represent several standard Chesterian conodont zones and, by comparison with conodonts from the rest of the section, suggest a tentative correlation of the Bangor to no more than the Haney Limestone through the lower part of the Menard Formation in the standard North American Illinois Basin section.

HISTORY OF SCIENCE SECTION

JONATHAN L. THORNDIKE, CHAIR

AFTER ONE HUNDRED YEARS, A NEW FLORA OF TENNESSEE. *Thomas E. Hemmerly, Middle Tennessee State Uni-*

versity, Murfreesboro, Tennessee. In 1901, Augustin Gattinger published *The Flora of Tennessee*, the first book devoted to the plant life of the entire state of Tennessee. Now, almost a century later, a second publication, sponsored by the Tennessee Native Plant Society, to be entitled *Wildflowers of Tennessee*, is nearing completion. This presentation contrasts the two publications.

EARLY CONTRIBUTIONS TO TENNESSEE BOTANY: RICHARD OWEN CURREY. *Betty McNeely and Thomas E. Hemmerly, Middle Tennessee State University, Murfreesboro, Tennessee.* Richard Owen Currey (1816–1865) has been recognized as an early leader in Tennessee scientific circles, especially as the author of an 1857 study of Tennessee geology and as an innovator in science education and publishing. Less well known are Currey's contributions to Tennessee botany. In addition to scattered scientific articles on the subject, Currey was the primary Tennessee collector for the great American systematic botanists John Torrey and Asa Gray, his "interesting plants" being recognized in their seminal work *A Flora of North America*. Currey's botanical skills were developed during his medical education at the University of Pennsylvania and, more extensively, by his work with C. W. Short at Transylvania University.

THE YELLOW FEVER EPIDEMIC OF 1878. *Mary B. Farone, Middle Tennessee State University, Murfreesboro, Tennessee.* The summer of 1878 was wet and hot in the lower Mississippi Valley, providing the ideal breeding grounds for the *Aedes aegypti* mosquito. The female *Aedes aegypti* mosquito is the vector of the yellow fever disease. In 1878, Memphis was a major hub of cotton production in the United States, with a population of over 48,000. When outbreaks of yellow fever were reported in the spring of 1878 in the West Indies, islands involved in trade along the Mississippi River, physicians argued for quarantine measures. Not wanting to interfere with the lucrative trade of Memphis, city officials rejected the quarantine. In August of 1878, the first official case of yellow fever was reported in Memphis. Four days later, more than half of the city's population had fled—only to be turned away by cities enforcing quarantines against Memphis citizens. In the first half of September, at least 200 people died per day. The large African-American population, which is usually resistant to the disease, also succumbed to the infection as never before. Frosts in late October brought an end to the spread of yellow fever in Memphis. However, the impact of the epidemic on the city and national public health care has been long lasting.

ASTRONOMY IN THE EARLY TWENTIETH CENTURY: CANADIAN AND AMERICAN PERSPECTIVES. *George E. Webb, Tennessee Technological University, Cookeville, Tennessee.* Between November 1917 and May 1918, two major reflecting telescopes were completed. The Hooker Telescope at Mt. Wilson Observatory near Los Angeles, California, and the Dominion Astrophysical Observatory reflector near Victoria, British Columbia, represented the two largest telescopes at the time and would remain so until just before World War II. The campaigns to secure these instruments, however, were quite different. The Hooker reflector was made possible by private funding arranged by noted astronomer George Ellery Hale, while the Dominion observatory instrument was financed by national and local government in Canada. A comparison of the two efforts reveals intriguing insights concerning the two nations' differing perspectives on the place of science in the early twentieth century.

GERARD TROOST, A 150-YEAR RETROSPECTIVE. **James X. Corgan**, *Austin Peay State University, Clarksville, Tennessee*. In 1850 cholera epidemics swept Nashville. People died, including Gerard Troost. On the 150th anniversary of his death it is time to appraise Troost's impact on Tennessee. When he arrived, in 1827, he opened the Nashville Natural History Museum, set up Tennessee's first known weather station, and offered public lectures in the sciences. In 1828 he joined the University of Nashville faculty. In several fields, such as zoology, he was the first Tennessean to offer a formal, term-long course. In 1831 he became the first scientist employed by the State. As State Geologist he analyzed soils, rocks, and waters. He wrote many scientific papers. He also collected geological, biological, and archaeological specimens that went to experts in the eastern states and Europe. He cofounded a scientific-technical journal. Today Tennessee's government scientists and Tennessee's teachers of the natural sciences follow paths that Troost pioneered. So do many others, such as meteorologists. Troost had broad impact.

AN ACADEMIC GENEALOGY OF THE MEMBERS OF THE CHEMISTRY DEPARTMENT AT MIDDLE TENNESSEE STATE UNIVERSITY. **Tammy J. Melton**, *Middle Tennessee State University, Murfreesboro, Tennessee*. The authors researched the academic genealogy of the twenty-four members of the Chemistry Department at Middle Tennessee State University. Only doctoral advisors or co-advisors were included in the genealogical tree; post-doctoral associations were omitted. In the few instances where doctoral degrees were not earned, the highest degree earned is cited. Although the members of the department are diverse in the array of sub-disciplines of chemistry studied, and in the variety of universities attended, the academic genealogies appear to converge on a limited number of European scientists. The impact of these early European scientists on the development of modern scientists is obvious. The genealogy and various databases and methods used to accomplish the research will be presented.

MATHEMATICS AND COMPUTER SCIENCE SECTION

JOHN SCHOMMER, CHAIR

BLOCK SIMPSON-TYPE METHODS FOR THE NUMERICAL SOLUTION OF INITIAL VALUE PROBLEMS. **Samuel N. Jator**, *Austin Peay State University, Clarksville, Tennessee*. In this paper, a continuous Simpson's method is derived by the integrand approximation approach. Some finite difference methods are recovered from the continuous form and applied simultaneously over successive blocks of meshes for a direct solution of initial value problems. This is made possible by the fact that the Jacobian matrix associated with the finite difference methods has an almost block diagonal form. We observed that the technique speeds up computation and avoids the use of the conventional predictor-corrector approach generally employed when applying the Simpson's method. The convergence and the stability properties of the methods are analyzed, which show that the methods can be reliable for the right class of problems. Numerical results are presented.

GENERALIZED REALCOMPACTNESS: SIX APPROACHES. **John J. Schommer**, *The University of Tennessee, Martin, Martin,*

Tennessee. Realcompactness is characterized primarily in six different ways, each of which invites a weakening of one kind or another. Ultrafilters, extensions of continuous functions, rings of continuous functions, uniformities, compactifications, and measure theoretic techniques have all been profitably employed to provide methods for defining realcompactness. In this talk we will provide a broad overview of the main generalizations of realcompactness, as well as provide results obtained recently about the equivalence of two of these generalizations, almost and almost* realcompactness. Almost realcompactness is equivalent to almost* realcompactness when every regular closed set is support.

MATHEMATICS AND SCIENCE TEACHERS SECTION

SARAH BARLOW, CHAIR

INSTRUMENTAL ANALYSIS FEEDBACK APPROACH TO STUDENT PREPARATION OF SOLUTIONS: AN INTERIM REPORT. **Nyanguila Kakolesha***, **Virginia L. Mattie***, and **Judith M. Bonicamp**, *Middle Tennessee State University, Murfreesboro, Tennessee*. Our purpose was to design an experiment that helps students improve their skills in making solutions. We used a non-threatening instrument feedback approach based on a constructivist model. After preparing solutions of known concentrations and serially diluting them, students use a spectrophotometer and an osmometer to find the absorbance of colored solutions and the osmolality of colorless solutions. Students compare their instrument results with those from standard solutions and thus diagnose their own inaccuracies in mixing solutions. They are given ample time to correct their mistakes if they elect to. The study has involved 171 quantitative analysis students so far. Surveys designed to elicit students' reactions to the instrument feedback approach show an overwhelmingly positive response. A demographic survey to determine whether holding part-time or full-time jobs had a negative impact on their experiment grade showed no significant correlation between hours worked and grade earned.

VISUAL TOOLS FOR TEACHING MATH TO BLIND STUDENTS. **Deborah Koning**, *Middle Tennessee State University, Murfreesboro, Tennessee*.

Abstract not available

YOU TOO CAN TEACH MATH TO BLIND STUDENTS. **April Lynn Rice**, *Jackson State Community College, Jackson, Tennessee*. Have you ever taught a student who had a disability? A student may have a learning disability such as dyslexia, hyperactivity or attention deficits such as Attention Deficit Disorder, or even physical disabilities such as speech, hearing, or sight impairments. According to the Americans with Disabilities Act and section 504 of the Rehabilitation Act, as instructors we must make accommodations for disabled students. I believe that through compromise, along with patience and imagination, all disabled students can be taught. Furthermore, I firmly believe that blind students can learn mathematics. Even competencies such as geometry and three-dimensional graphing have been successfully taught to blind students. I intend to convince instructors that they can teach blind students.

PROJECT SEED. A RESEARCH SUMMER FOR HIGH SCHOOL STUDENTS AT MIDDLE TENNESSEE STATE UNIVERSITY. *Judith M. Iriarte-Gross and William Ilsley, Middle Tennessee State University, Murfreesboro, Tennessee.* Project SEED is a program of the American Chemical Society that brings high school students into a research lab for eight to ten weeks during the summer. We have been mentoring Project SEED students at MTSU since 1997. Project SEED scholars must complete one year of high school chemistry, meet specific financial guidelines, and must be interested in conducting scientific research. In the Iriarte-Gross and Ilsley SEED group, students are assigned an individual research project. SEED students participate in weekly group meetings and present chemistry demonstrations to K-8 students attending campus science camps. The students are required to write a research quality paper at the end of their eight weeks. SEED students have a rewarding summer of research, become a part of an active research group, and ask for more science! Hands-on research and personal mentoring is the core of Project SEED at MTSU.

GETTING STARTED WITH INTERNET TECHNOLOGY IN YOUR COURSE. *Sarah F. Barlow and Brenda L. Kerr, Middle Tennessee State University, Murfreesboro, Tennessee.* Incorporating Internet technology in a course brings a world of opportunities and knowledge to students. Researching topics for individual and group projects, utilizing electronic discussion groups, submitting assignments electronically, and developing a course web page are activities which expand the realm of the classroom. This presentation describes faculty and technology specialist involvement in the development of Internet opportunities for students. The session presents the basics of integrating Internet technology into coursework.

NISQUALLY NATIONAL WILDLIFE REFUGE, OLYMPIA, WASHINGTON: CASE STUDY OF THE UNITED STATES FISH AND WILDLIFE SERVICE ENVIRONMENTAL EDUCATION VISION. *Laurina Lyle, Austin Peay State University, Clarksville, Tennessee.* A case study of the Nisqually National Wildlife Refuge, Olympia, Washington was conducted, summer 2000. The refuge lies within the Nisqually River delta. Bordered on the east by I-5 and sandwiched between two urban centers, Tacoma and Olympia, unique opportunities exist for public environmental and science education. The purpose of this investigation was to study the refuge outreach efforts. Scope of plan, educational materials, and delivery plan were assessed. Interviews with refuge personnel, refuge volunteers, teachers, and members of the Nisqually Tribe were conducted. While results showed that the scope of the refuge educational plan was aligned with North American Environmental Education Association recommendations, educational materials lacked local and site relevancy. Teachers received minimal guidance and instruction in respect to field trip planning and biotic inventory.

USING STUDENTS AS COOKIEASES TO MODEL GENETIC RECESSIVENESS, PENETRANCE, AND EXPRESSIVITY. *Rebecca L. Seipelt, Middle Tennessee State University, Murfreesboro, Tennessee.* Different mutations in the same gene can yield proteins with different activity levels. This variability can be observed in the physical appearance of the trait. One such example is observed in albinism, an autosomal recessive genetic disorder in the enzyme tyrosinase. The correlation of genetic mutations with altered enzyme activities, and thus variability in ap-

pearance (phenotype) can be a difficult concept for students. A simulation was developed to familiarize students with these ideas in a more tangible, personal way. Students are used as the enzyme tyrosinase to break a cookie substrate. A variety of genetic mutations is then introduced to the tyrosinase gene product (student) to illustrate variability in enzyme activity. Students then graph and correlate the enzyme activity to the variation in the albinism physical appearance. In addition to modeling recessiveness, this model also can be used to explain penetrance, expressivity, compound heterozygosity, and genetic dominance by haploid insufficiency.

CONCEPT MAPS AS TOOLS FOR PERSONALIZING AND INTEGRATING ABSTRACT GENETIC IDEAS. *Rebecca L. Seipelt, Middle Tennessee State University, Murfreesboro, Tennessee.* Concept maps were originally developed in the 1970's as a method of taking notes. This technique has been used to brainstorm, organize thoughts and ideas, and show visual representations of these ideas. I used this technique to familiarize non-majors with ideas in biology, as well as a summative assignment to review a human genetics course. The human genetics assignment was constructed to integrate a number of ideas introduced during the semester. Students were given 22 words or phrases learned during the course. Students chose twelve words to link to two other terms and themselves. Each term was linked to the student so that concepts are not only integrated into their existing topic knowledge, but also become personally meaningful. On the connection line, a brief explanation of why the words were connected was required. Student maps, as well as an analysis of the word choice and connection preference, will be presented.

TEACHING DOCTORATES IN BIOLOGY—IS THERE A NICHE? *Michael L. Rutledge, Middle Tennessee State University, Murfreesboro, Tennessee.* The Doctor of Arts (DA) and the departmentalized Doctor of Education (EdD) degrees in biology represent different paradigms in doctoral education for biologists. The degrees embrace the philosophy that there is a need, especially at the undergraduate level, for broadly prepared biologists with expertise in biological education. To determine if such programs are successful in achieving their goals, graduates from two of the most active programs offering "teaching doctorates" in biology were surveyed. Results suggest the programs are successful in achieving their goals, and there is a niche, especially in community colleges and smaller four-year colleges, for broadly prepared biologists with expertise in biological education.

AT THE HEART OF SCIENCE REFORM: STRENGTHENING TEACHERS' PHYSICAL SCIENCE CONTENT KNOWLEDGE. *Todd Gary and Kris Neal, Tennessee State University, Nashville, Tennessee.* Tennessee State University and four Middle Tennessee school districts have worked together for five years to reform science education systemically by providing every K-6 grade student in 128 schools with an inquiry-based, hands-on science curriculum. This nationally validated curriculum involves several units focusing on physical science such as electric circuits, magnets, and motors. In order to strengthen the teachers' physical science content knowledge required to teach these units effectively, we created two weeklong institutes focusing on physical science related to the curriculum and state standards. The sixty K-6 teachers involved in these institutes were assessed with classroom observations, content questionnaires and concept maps prior to this experience and afterwards. Our results show that

teachers significantly increased their physical science content knowledge and applied this learning to their classroom teaching after the institute. The experience is being expanded to include more teachers and to utilize these teachers as physical science resource teachers in their districts.

MULTI-INSTITUTIONAL INITIATIVE TO IMPROVE UNDERGRADUATE SCIENCE AND MATHEMATICS EDUCATION. *Jack Rhoton and Preston Prather, East Tennessee State University, Johnson City, Tennessee, and University of Tennessee, Martin, Tennessee.* The results of the 1999 Conference on Undergraduate Science and Mathematics Education at East Tennessee State University will be reviewed and compared with the results of a similar conference at The University of Tennessee, Martin in 1998 and with the results achieved from a similar conference on Undergraduate Science and Mathematics Education at The University of Tennessee, Knoxville in the Spring of 2000. The emphasis during this panel symposium will be on the implications of the current initiatives for reform for undergraduate curriculum and instruction. The purposes of these three conferences, were to: 1) facilitate discussion among science and mathematics faculty and education faculty and visiting consultants on the curricular and instructional implications of current trends and issues related to undergraduate science and mathematics education; 2) provide a creative arena for conceiving new ideas for unprecedented curricular and instructional innovations that are based upon the best-known educational principles and practices; 3) promote awareness and interest in the potential benefits of developing a prototype Laboratory for Study of Innovative Undergraduate Science and Mathematics Education in response to issues and needs in undergraduate science and mathematics education; and 4) prepare a Conference Report and Recommendations for Undergraduate Science and Mathematics Education for review by institutions of higher education. Each panel member will provide an overview of conference results and implications for reform for undergraduate science and mathematics education. The panel members will elicit responses and comments from the audience and engage attendees in a discussion of the results and findings of the panel.

SERIAL DILUTION OF SOLUTIONS IN QUANTITATIVE ANALYSIS WITH INSTRUMENT FEEDBACK—AN UPDATE. *Virginia L. Mattie*, Nyanguila Kakolesha*, and Judith M. Bonicamp, Middle Tennessee State University, Murfreesboro, Tennessee.* Quantitative analysis students who perform well on exam questions about solution calculations often have trouble making standard solutions and serially diluting them to desired concentrations. We have developed a helpful exercise that students find objective and interesting. After receiving instructions on solution mixing, students prepare serial dilutions and then use simple lab instruments (Spectronic 20D and a freezing-point depression apparatus) to compare their solutions to standard solutions. An instrument feedback loop can result, providing them an incentive to try again if they failed to "match" instrument readings. Our results are for 32 Quantitative Analysis students from the spring 1999 class who completed a 45-point exercise and two questionnaires. We suspected that grades would suffer for students who worked more than 20 hours at an outside job, but our statistical analyses showed no correlation between students' major, gender, age, or off-campus hours working, and the grade earned on the experiment.

EXPANDING YOUR HORIZONS IN SCIENCE AND MATHEMATICS: A HANDS-ON CONFERENCE FOR MIDDLE SCHOOL GIRLS. *Tracy Balls*, Patricia Welch*, and Judith M. Iriarte-Gross, Middle Tennessee State University, Murfreesboro, Tennessee.* Expanding Your Horizons in Science and Mathematics (EYH) Conferences were created in 1976 by the Math/Science Network. The first EYH in middle Tennessee was held on October 25, 1997 at Middle Tennessee State University. We introduced three hundred middle school girls to science and math fields ranging from polymers to physics to pathology. The primary goal of EYH is to acquaint young women with science and mathematics based careers. At EYH conferences, young women interact with professional women who are active in science and math careers, listen to a keynote address by a woman in science, and participate in hands-on activities. The single sex groups encourage the young women to explore science and math in a comfortable setting and to meet other young women with the same interests. EYH conferences provide young women with the knowledge they need to make informed choices about science and mathematics now in middle school and later as high school and college students. Highlights of workshops will be presented and discussed.

BRINGING SCIENCE TO LIFE: RESEARCH AND DEVELOPMENT OF APPLIED LABS FOR PHYSICAL SCIENCE. *Dara Grissom* and Judith Iriarte-Gross, Middle Tennessee State University, Murfreesboro, Tennessee.* The purpose of this research is to bring real life experiences into science labs. We want to make the labs interesting to not only science majors, but also to the non-science majors. Our development of several new labs for the Physical Science 100 course is our first step towards achieving this goal. The knowledge gained from these laboratory activities enables students to make intelligent choices about not only science, but also about their health and finances. Through the studies of pH of household materials, combustion of fuels, nuclear popcorn, antacid studies, and the analysis of drinking water, these students learn graphing skills, applications of nuclear chemistry, energy conservation, and most importantly, skills they can apply outside the workplace. As a result of this research, we hope that students can attain the knowledge to apply this information to their everyday lives.

MICROBIOLOGY SECTION

STEPHEN M. WRIGHT, CHAIR

DETECTION OF *BORRELIA BURGDRORFERI* IN POTENTIAL TICK VECTORS FROM SELECTED COUNTIES OF ARKANSAS. *Safawo Gullo, Southern Adventist University, Collegedale, Tennessee.* Lyme disease is a multi-system infection that is encountered in many parts of the world. This research has primarily focused on screening of selected species of hard ticks for *Borrelia burgdorferi* by Polymerase Chain Reaction (PCR) assay. Between 1990 and 1994, a total of 15,489 adult and nymphal stages of ticks were collected in northwest Arkansas. Outer surface membrane protein A and flagellin oligonucleotide primers were utilized to screen the ticks. Only two percent of the screened ticks harbored *B. burgdorferi* DNA. No *Borrelia* DNA was detected in males and nymphs. Among the PCR-positive ticks two were *Amblyomma americanum*, two were *Dermacentor variabilis*, while 17 (81%) were *Ixodes scapularis*. This report is

the first PCR-confirmed case of *B. burgdorferi* isolated from tick vectors in northwest Arkansas. However, further studies are needed to document the prevalence of Lyme disease in Arkansas and the rest of Southern States.

THE DETECTION OF *BORRELIA LONESTARI*, POSSIBLE AGENT OF A LYME DISEASE-LIKE ILLNESS, IN *AMBLIYOMMA AMERICANUM* (ACARI: IXODIDA) FROM MIDDLE TENNESSEE. **Teresa Stegall**, Middle Tennessee State University, Murfreesboro, Tennessee. Lyme disease, caused by the bite of a *Borrelia burgdorferi*-infected tick, is not considered endemic in the Southeastern United States. Yet, the number of physician-reported cases of erythema migrans (EM) rashes, the hallmark symptom of Lyme disease, is steadily increasing in this region. The bite of *Amblyomma americanum* has been associated with many EM rashes despite evidence that it is an incompetent vector of Lyme disease. In 1996, an uncultivable spirochete, *Borrelia lonestari*, was found and described in *A. americanum* and is believed to be the etiologic agent of a Lyme-like illness. The object of the current investigation was to detect whether *B. lonestari* is present in *A. americanum* populations from Middle Tennessee. Ticks were collected and subjected to the polymerase chain reaction using *Borrelia* genus-specific primers. Dot-blot analyses were performed using probes derived from the Borrelial flagellin gene. These analyses confirmed that *B. lonestari* is present in the *A. americanum* population in Middle Tennessee.

DETECTION OF COXSACKIE A9 VIRUS IN *AMBLIYOMMA AMERICANUM*. **Jennifer Krepp*** and **Stephen M. Wright**, Middle Tennessee State University, Murfreesboro, Tennessee. Human enteroviruses, including polioviruses, hepatitis A virus, coxsackie A and B viruses, and echoviruses have been implicated in poliomyelitis, hepatitis, respiratory illness, gastrointestinal illness, and aseptic meningitis. Recently in Middle Tennessee, several cases of aseptic meningitis, attributed to coxsackie A9 infection, seemed to coincide with tick bites. Enterovirus transmission is primarily fecal-oral; transmission by blood-feeding arthropods has not been shown. To evaluate ticks for the presence of coxsackie A9 virus, the gut contents of nearly 200 ticks were removed and pooled in groups of four. cDNA was prepared and amplified by the polymerase chain reaction using primers specific for enteroviruses. Coxsackie A9 was detected by hybridizing with a coxsackie A9-specific probe in three of nearly 50 samples. This represents the first report of enterovirus presence in ticks and suggests the potential for arthropod transmission of coxsackie A viruses.

ANTIVIRAL AND ANTIBACTERIAL PROPERTIES OF CITRUS FRUITS AND HERBAL TEAS. **Miriam Kee*** and **John M. Zamora**, Middle Tennessee State University, Murfreesboro, Tennessee. The use of plants in the treatment of disease is as old as folk medicine. Over 1500 antimicrobial and cytotoxic chemicals have been isolated from plants. The purpose of this study was to see if the juice from citrus fruits had antiviral activity against T4 phage. Herbal teas also were tested for antiviral activity against T4 phage. The phage was diluted and mixed with either the juices or the teas. The phage dilutions were then mixed with *Escherichia coli* B and a plaque assay was performed. Lemon juice, grapefruit juice, orange juice, peppermint tea, and antioxidant tea all lowered the number of plaque forming units/ml. Lime juice and grapefruit juice also lowered the number of bacteria that grew on tryptic soy agar.

CHARACTERIZATION OF A NOVEL *LEGIONELLA*-LIKE AMOEBAL PATHOGEN IN HUMAN MACROPHAGES. **Nathan D. Bryant***, **Mary B. Farone**, and **Anthony L. Farone**, Middle Tennessee State University, Murfreesboro, Tennessee. A new *Legionella*-like amoebal pathogen (LLAP) was isolated from a hospital cooling tower. A human monocyte cell-line, THP-1, was treated with LLAP to determine the potential for infectivity and to assess the virulence of the organism upon these cells. The monocytes were differentiated with phorbol myristate acetate (10^{-7} M) for 48 h prior to treatment with the LLAP, *Legionella pneumophila*, or medium alone. The THP-1 cells were harvested at 24 h intervals post-infection. Macrophage viability, macrophage cell number and viable bacteria/ml were determined at each time point. Our results have shown that both *L. pneumophila* and the LLAP decreased viability of the THP-1 cells to below 60% viability compared to the control culture, which remained at greater than 80% viability throughout the experiment. Colony counts of *L. pneumophila* and LLAP-Z demonstrated that the organisms were able to replicate in the macrophages as evidenced by an increase in the numbers of bacteria throughout the experiment. These results indicate that a new LLAP may be an important human pathogen.

LIPOPOLYSACCHARIDE-INDUCED PROTEIN EXPRESSION IN *ACANTHAMOEBA POLYPHAGA*. **Jeffrey S. Fisher**, **Amanda Wagner**, and **Anthony L. Farone**, Middle Tennessee State University, Murfreesboro, Tennessee. The purpose of this study was to examine the LPS-induced patterns of protein expression in *Acanthamoeba polyphaga*, an organism whose major food source is gram-negative bacteria. Amoebae were treated with 10 (g/ml) and 25 (g/ml) LPS for three, six, nine, and 12 h intervals, and cell lysates were examined for differential protein expression by sodium dodecyl sulfate-polyacrylamide gel electrophoresis (SDS-PAGE) and scanning densitometry. The resulting protein profiles showed induction of nine novel proteins by 10 (g/ml) LPS and 11 novel proteins by 25 (g/ml) LPS, with six novel proteins commonly expressed within 3 h. Down-regulation of one protein by both LPS treatments was detected at all time intervals. Results from these studies may lead to further understanding of the LPS response in amoebae and may also lead to novel therapies for gram-negative sepsis.

STEROLS AS BIOMARKERS IN *GYMNODINIUM BREVE*: DISTRIBUTION IN DINOFLAGELLATES. **Jeff D. Leblond** and **Peter J. Chapman**, Middle Tennessee State University, Murfreesboro, Tennessee, and United States Environmental Protection Agency (NHEERL), Gulf Ecology Division, Gulf Breeze, Florida. The ability to use sterol biomarkers to distinguish certain dinoflagellates, such as the toxic species *Gymnodinium breve*, from other species within the same class would be of considerable scientific and economic value. *Gymnodinium breve* has been shown by others to possess two principal novel sterols, (24S)-4(-methylergosta-8(14),22-dien-3(-ol) (ED) and its 27-nor derivative (NED), not previously known to be present in other dinoflagellates. Characterization of free and esterified sterols from laboratory cultures of *G. breve* and of samples from a recent bloom in the Gulf of Mexico has confirmed the predominance of these two sterols. This has prompted a study of the sterol signatures of more than 30 dinoflagellates. ED and NED also were shown to be the primary sterols of the closely related dinoflagellates *G. mikimotoi* and *G. galatheanum*. They also are found as minor components of the more complex sterol profiles of other mem-

bers of the *Gymnodinium/Peridinium/Prorocentrum* (GPP) taxonomic group.

PHYSICS AND ASTRONOMY SECTION

LING JUN WANG, CHAIR

SPHERICAL CAVITY RINGDOWN SPECTROSCOPY OF WATER. *Ling Jun Wang, Candice Jackson*, and Robert Shaw, The University of Tennessee, Chattanooga, Chattanooga, Tennessee (LJW, CJ), and Oak Ridge National Laboratory, Oak Ridge, Tennessee (RS)*. Spherical liquid cavities have been fashioned by fabricating and filling glass blown spherical vessels. Using 2 picosecond pulses near 800 nm, we have demonstrated the cavity ring down of pulses circulating in these liquid spheres is linearly affected by the solution absorbance. The absorption of a laser dye molecule (Exaction 800, Exaction Chemical Co, Dayton, OH) in carbon disulfide solvent has been examined. Determining the maximum voltage value of each signal oscillation and then fitting the data to an exponential quantified the ring down pattern. By comparing each solution ringdown coefficient to that of the pure solvent, we were able to calculate the solution absorbance. The data produced a linear absorbance vs. concentration plot.

MICROMACHINED SI-TIPS WITH LOW ACCESS RESISTANCE FOR THE PATCH-CLAMPING OF A SINGLE CELL. *Scott A. Renkes*, Franz J. Baudenbacher, Robert A. Weller, I. Scott Ramsey, and John P. Wikswo, Vanderbilt University, Nashville, Tennessee*. Patch clamp techniques using glass micropipettes allow the measurement of electrical currents flowing through individual voltage- and ligand-gated membrane ion channels. The limitations of this technique include measurement durations of only an hour, high resistance and capacitance of the micropipette and the correspondingly low frequency response, and low probability of success for achieving a gigaohm seal. We believe it may be possible to overcome several of these limitations by using the technologies perfected for integrated circuits and microelectromechanical systems (MEMS) technologies to develop an instrumented silicon MicroBottle, i.e., micropipette on a silicon chip.

STUDY OF STAINS IN CONSTELLATION-X MIRRORS. *Pei Xiong-Skiba, Jeffery Houze*, William Jones, and Darell Engelhaupt, Austin Peay State University, Clarksville, Tennessee (PXS, JH), and Marshall Space Flight Center, Huntsville, Alabama (WJ, DE)*. A key step in making the Constellation-X telescope is to electroplate a nickel cobalt phosphorous shell on a gold-coated mandrel. The plating solution penetrated the gold coating during electroplating resulting in stains on the surface of the mandrel and the gold coating. This work concentrates on identifying the causes of this leakage. The primary cause for the stains on the chromium oxide (mandrel) and gold interface is the hydrogen gas produced in nickel cobalt phosphorous electroplating. The nickel cobalt phosphorous bath produces a deposit with less than 100% efficiency. This in turn produces hydrogen gas at the surface of the plated piece. Some of the hydrogen atoms permeate through the gold coating and blister the gold film. Under severe cases, the gold film is torn in the blistered areas. Thus, the plating solution enters the interface through the holes, making stains on the chromium and gold surfaces.

A MODEL FOR LIGHT SCATTERING FROM DIESEL SOOT PARTICLES. *Patricia G. Hull, Tennessee State University, Nashville, Tennessee*. A new instrument, the Diesel Particle Scat-terometer (DPS) determines the size distribution and optical properties of the particles in diesel exhaust by analyzing the light scattered from a stream of exhaust drawn through the instrument. It measures intensity and polarization transformation information from the light scattered by the particle stream, then simultaneously fits the several angle dependent curves it measures with a model based on calculations of scattering from spheres. Although diesel soot particles are generally not spherical, a large randomly oriented collection of them produces light scattering features very similar to those for light scattering from spheres. Light scattering from soot particles of various shapes and porosity was calculated using the coupled-dipole approximation method. The DPS was calibrated by determining how the size distribution and optical properties its program predicts for 'spheres' compares to the properties of the soot particles used in the coupled-dipole calculation.

ZOOLOGY SECTION

DAVID H. KESLER, CHAIR

PARASITE INTERACTIONS AND THE EVOLUTION OF VIRULENCE. *Stephen Howard, Middle Tennessee State University, Murfreesboro, Tennessee*. Accounting for the widespread distribution of sexual reproduction in nature is an enduring problem in biology. In recent years, two hypotheses for the maintenance of sex have attracted much attention. The mutational deterministic hypothesis (MD) predicts that sex is selected solely because it reduces the population mutation load. The Red Queen (RQ) hypothesis suggests that sex is adaptive as a defense against co-evolved pathogens. Recent experiments have called two critical assumptions of the MD hypothesis into question. Evolutionary biologists are now focusing increased attention on the RQ hypothesis as a general theory of sex. One interesting possibility is selection against deleterious mutations may interact with the RQ to generate an advantage to sex. While previous studies have shown this is possible in small populations ($n = 1000$) for a small number of host-parasite interaction loci (2-3), little is known about the potential for this mechanism to operate in large populations. Results from the present study show that the advantage persists in large populations (100,000), and that it tends to become larger as the number of host-parasite interaction loci increases. These results also show that the accumulation of mutations by Muller's ratchet is possible even in large populations, provided that parasites drive asexual genotypes through periodic population bottlenecks.

DISTRIBUTION AND MOVEMENTS OF ALLIGATOR SNAPPING TURTLES IN THE TENNESSEE PORTION OF KENTUCKY LAKE. *A. Floyd Scott and Scott Sutton*, Austin Peay State University, Clarksville, Tennessee*. Although not reported until 1954, the Alligator Snapping Turtle (*Macrochelys temminckii*) was first discovered in what is now Kentucky Lake in 1938 near the community of Big Sandy in Benton County. Since then, 23 specimens from 10 additional localities in five counties have been documented. This paper includes a detailed summary of the distribution data for the species in Kentucky Lake and presents the results of radio tracking studies carried out

over the past 10 years on several adults from Stewart and Houston counties.

TRICHOPTERAN SURVEY OF BRUSH CREEK, ROBERTSON COUNTY, TENNESSEE. *Ken J. Davenport* and Steven W. Hamilton, Austin Peay State University, Clarksville, Tennessee.* Caddisflies (Insecta: Trichoptera) were sampled from Brush Creek in Robertson County, Tennessee from May 1999 to September 2000. Brush Creek is a third order tributary of Sulphur Fork Creek and Red River in the Western Pennyroyal Karst region of the Interior Plateau. Caddisflies are an important part of the food web in fresh water environments and serve as bioindicators in the assessment of water quality. Adults were collected using ultraviolet light traps and males were identified to species. A total of 14 families, 29 genera and 63 species have been identified to date. At least one new state record and several new county records are included. Based on checklists of Tennessee and Kentucky caddisfly fauna and the preliminary data thus far obtained, this poorly surveyed area appears to have a moderately rich trichopteran fauna.

PRELIMINARY DATA ON A DISTRIBUTION STUDY OF CROTALUS IN MIDDLE TENNESSEE. *Danny L. Bryan, Cumberland University, Lebanon, Tennessee.* Herpetologists have long been debating on the subspecies of *Crotalus horridus* and its distribution in many of the eastern states. Now that many states within its natural range report declining populations, investigations on the status of this species should be conducted in Tennessee. Given the current rate of habitat destruction and over harvesting, this may soon become a threatened species in Middle Tennessee if not in the entire state. My preliminary data, based on specimens collected in selected Middle Tennessee counties, indicate that the yellow phase may already be declining.

CHEMOSENSORY ASSESSMENT OF PREDATION RISK IN PLETHODONTID SALAMANDERS: DETECTION OF SNAKE CUES, ACTIVITY CHANGE, REFUGE USE, AND THE ROLE OF PREDATOR DIET. *Kurt J. Regester*, Middle Tennessee State University, Murfreesboro, Tennessee.* Pre-contact predator detection enables prey species to respond behaviorally before an attack is initiated. In the laboratory, substrate-choice experiments tested adult *Plethodon dorsalis*, *Desmognathus fuscus*, and *Eurycea cirrigera* for an avoidance response, the influence of predator diet on avoidance response, and changes in activity and refuge use associated with chemical cues of predatory snakes. *Plethodon dorsalis* and *D. fuscus* avoid substrates conditioned with cues of *Diadophis punctatus*. *Eurycea cirrigera* avoid substrates conditioned with cues of *Nerodia sipedon*, apparently retaining the chemosensory ability to detect predators following metamorphosis. Species-specific predator-diet sensitivity was not evident. *Desmognathus fuscus* decrease and *Eurycea cirrigera* increase activity on *D. punctatus*-conditioned substrates. *Plethodon dorsalis* and *D. fuscus* do not alter refuge use in response to *D. punctatus* cues. Detection of snake cues and rapid adjustment of activity or location could permit salamanders to avoid microhabitats frequented by snakes, decrease the probability of encountering snakes, and enhance fitness.

NATURAL HISTORY NOTES ON A RECENTLY DISCOVERED POPULATION OF STERNOTHERUS MINOR PELTIFER (STRIPENECK MUSK TURTLE) IN WHITEOAK CREEK, HOUSTON AND HUMPHREYS COUNTIES, TENNESSEE.

Scott Williamson and A. Floyd Scott, Austin Peay State University, Clarksville, Tennessee.* Whiteoak Creek is a tributary of the Tennessee River (Kentucky Lake) that flows westward through Middle Tennessee in parts of Houston and Humphreys counties. In the summer of 1999, three specimens of *Sternotherus minor peltifer* (Stripeneck Musk Turtle) were discovered in the creek's lower reaches. These records were well to the west and north of any previous reports for the species. Following this discovery, we initiated a study (still on-going) of *S. m. peltifer* in Whiteoak Creek to obtain information on its distribution, population attributes, and movements. Turtles have been captured by hand while wading, canoeing, and snorkeling the creek. All captured specimens have been weighed, measured, given an individual mark (notches in marginal scutes), and, when possible, sexed. Six adults have been fitted with radio transmitters to study movements. As of 1 October 2000, six sites distributed along a 20 km reach of the creek have produced 42 individuals ranging from juveniles to adults. Females outnumber males approximately 2 to 1 (24:13); juveniles number five. Microhabitats where turtles have been found fall into two distinct categories. Ledges, crevices, and boulders of deeper pools along limestone bluffs yielded 26 specimens; submerged organic cover (root masses, logs, limbs, and other organic debris) produced the other 16 animals. To date, movement data are too limited to allow any generalizations.

AN ASSESSMENT OF INTERSPECIFIC ASSOCIATION BETWEEN OPOSSUMS AND RACCOONS IN WESTERN TENNESSEE. *Brian D. Carver*, University of Memphis, Memphis, Tennessee.* Chi-square analysis was used to assess the co-occurrence of the Virginia opossum (*Didelphis virginiana*) and raccoon (*Procyon lotor*) at 15 sites (eight upland; seven bottomland) in western Tennessee. Co-occurrence was determined using standard scent-station procedures and presence or absence of tracks of target species. Results indicated that the two species co-occurred in regard to spatial distribution in greater frequency than expected. Additionally, opossums and raccoons occurred independently less frequently than expected. Evidence for competitive interactions was lacking.

AN ASSESSMENT OF HABITAT COMPOSITION WITHIN HOME RANGES OF WHITE-TAILED DEER IN WESTERN TENNESSEE. *Jason B. Jennings*, R. David Frederick, Pin-Shuo Liu, Theresa J. Cross*, and Michael L. Kennedy, University of Memphis, Memphis, Tennessee.* Home ranges of white-tailed deer (*Odocoileus virginianus*) were estimated at the Milan Army Ammunition Plant in Carroll and Gibson counties, Tennessee. Animals were located using standard radio-telemetry procedures, and home ranges calculated using minimum convex polygon (MCP) techniques. For males and females, annual and seasonal home ranges were determined. Home ranges were overlaid onto habitat coverages of the site, and percentage of each habitat type determined within home ranges of individual deer. Males exhibited no seasonal differences in habitat composition or time spent within each habitat type. Females exhibited more variation in both habitat composition and time spent in each habitat type. Results reflect that white-tailed deer demonstrate a wide tolerance for habitat.

FLIGHT SPEEDS OF FOUR NEOTROPICAL BATS. *Heidi L. Hopkins*, C. Sanchez-Hernandez, M. L. Romero-Almaraz, L. M. Gilley, and M. L. Kennedy, University of Memphis, Memphis,*

Tennessee, and Universidad Nacional Autonoma de Mexico, Mexico City, Mexico. We measured the flight speeds of 209 neotropical bats consisting of four species all belonging to the family Mormoopidae. They included *Pteronotus davyi*, *P. parnellii*, *P. personatus*, and *Mormoops megalophylla*. The study was conducted in the central region of the state of Colima in Mexico. Bats were captured and taken to a nearby flyway that was constructed through dense brush. The tunnel was 15 meters in length, 1.5 meters in height, and 1.5 meters in width. Results reflected little difference in speeds of male bats versus female bats. Average speeds (kilometer per hour) for males and females combined, were 12.5, 15.8, 16.9, and 17.3 for *P. davyi*, *P. parnellii*, *P. personatus*, and *M. megalophylla*, respectively.

A COMPARISON OF SMALL MAMMAL CAPTURE SUCCESS IN UNTREATED AND LYSOL-TREATED SHERMAN LIVE TRAPS. **L. Michelle Gilley***, **Michael L. Kennedy**, **James A. Huggins**, **Heidi L. Hopkins***, and **Kyle Hopper***, *University of Memphis, Memphis, Tennessee*. Hantavirus Pulmonary Syndrome, a rodent-borne viral disease, has prompted much concern for students and professionals working with small mammals. The Center for Disease Control and Prevention recommends decontaminating equipment in order to reduce the risks of contracting the disease. A study was conducted fall 1999 to determine the effects on capture success of small mammals by decontaminating traps with Lysol disinfectant. Treated traps were placed in a 1:10 Lysol solution prior to placement along transect lines at six locations in western Tennessee and one location in El Paraiso, Mexico. The study consisted of 5600 trap nights, with 110 animals captured in treated traps and 114 captured in untreated traps. Statistical analyses were used to compare differences of capture success between trap type and: (1) total captures, (2) species, and (3) location. No statistical differences were found in any of the three comparisons in capture success between Lysol-treated and untreated traps.

EFFECT OF CAVITY ENTRY SIZE ON NEST SITE SELECTION BY CAROLINA CHICKADEES. **T. David Pitts**, *The University of Tennessee, Martin, Martin, Tennessee*. Carolina Chickadees (*Poecile carolinensis*) are small, cavity-nesting birds. They are permanent residents in woodlands throughout much of Tennessee. The criteria that chickadees use when selecting a nest cavity are, with the exception of some generalities, unknown. I hypothesized that since they face competition from several other larger species of birds for the use of nesting cavities, chickadees would preferentially nest in cavities with an entry size that inhibits larger species from using the cavity. I tested this hypothesis by placing pairs of nesting tubes in chickadee nesting habitat. The nesting tubes were identical except for the diameter of the entry. The results from two nesting seasons support my hypothesis. Chickadees nested significantly more often in the nest tubes with small diameter entries. This suggests that chickadees evaluate and compare different cavities in an attempt to identify the one that is most suitable for nesting.

INTRADERMAL MITE, *HANNEMANIA SP.* (ACARINA: TROMBICULIDAE), INFESTATIONS DIFFER IN POPULATIONS OF SYNTOPIC PLETHODONTIDS. **Kurt J. Regester***, *Middle Tennessee State University, Murfreesboro, Tennessee*. Although mites of the genus *Hannemania* parasitize amphibians across a wide geographic and taxonomic range, the first Tennessee records are reported.

Differences in infestation among syntopic salamanders are also noted. Larvae embed in the integument and are easily quantified as pustules that form when host connective tissues encapsulate the mite. Significant differences were evident in 77 southern two-lined (*Eurycea cirrigera*) and 20 dusky salamanders (*Desmognathus fuscus*) occupying similar microhabitat. *Eurycea cirrigera* were more heavily infested (prevalence: 48.7%, abundance: 3.8, range 1–24) than *D. fuscus* and harbored more mites on their limbs (48.5%, range: 0–11) than other body regions. The extent of distention in appendages was documented by photographing animals with high densities, where impaired limb function was noted. Gross deformities of the limbs could decrease mobility and impair foraging, antipredator, and reproductive activities. Attempts to quantify non-pathogenic effects of *Hannemania* parasitism may elucidate our current decline in amphibians.

COMPARATIVE STUDY OF CAPTURE EFFICIENCY AND MORTALITY OF FIVE-LINED SKINK, *EUMECES FASCIA-TUS*, USING PITFALL, FUNNEL, AND MODIFIED GLUE TRAPS. **Theodore T. Ives Jr.*** and **Joseph R. Schiller**, *Austin Peay State University, Clarksville, Tennessee*. We compared capture efficiency and mortality rates of the Five-Lined skink, *Eumeces fasciatus*, captured with pitfall, funnel, and modified glue traps. Trapping occurred over 22 days. Seventeen *E. fasciatus* were captured. Lizards captured on the glue traps ($n = 10$) experienced 20% mortality rate (2 deaths) and those captured in pitfall traps ($n = 7$) experienced 0% mortality. No lizards were captured in the funnel traps. Glue traps were the most efficient on a time of effort basis, but pitfall traps were a safer capture technique that required less researcher time for monitoring. The two mortalities on glue traps occurred early in the study, and subsequent trap and procedural modifications may have reduced mortality in glue traps to levels comparable to pitfall traps. Thus, we feel glue and pitfall traps can both be an efficient and safe way of capturing small to medium sized lizards.

AMONG RIFFLE VARIANCE OF BIOASSESSMENTS USING MACROINVERTEBRATE COMMUNITY ASSEMBLAGES IN STREAMS OF ROBERTSON COUNTY, TENNESSEE. **Rebecca Houtman***, **Joseph R. Schiller**, and **Steven W. Hamilton**, *Austin Peay State University, Clarksville, Tennessee*. The United States Environmental Protection Agency (EPA) has published Rapid Bioassessment Protocols (RBP) for assessing the biotic integrity of streams. These techniques employ several ecologically relevant measures of community structure and function (i.e. metrics) considered sensitive to stream degradation. They cover a wide range of structural and functional properties of aquatic communities. Our preliminary data test the implied assumption of the RBP that a single riffle of a single stream reach is an accurate representation of the macroinvertebrate assemblage of the stream. We sampled five riffles within a reach of three different streams in the Sulphur Fork Creek watershed, Robertson County, Tennessee. Macroinvertebrates were identified to family and enumerated to calculate metrics. We compared eight metrics among riffles within a single stream reach among streams. Most metric values varied greatly among riffles. The distribution of four of the metrics overlapped extensively between streams and thus provided little basis for discriminating differences between the streams. Only three of the metrics could statistically differentiate among streams.