

ABSTRACTS OF PAPERS PRESENTED AT THE 111TH MEETING

AGRICULTURAL SCIENCES SECTION

SHIVENDRA V. SAHI, CHAIR

COMPARATIVE CHARACTERIZATION OF SELECTED *HYPERICUM* SPECIES WITH AMPLIFIED FRAGMENT LENGTH POLYMORPHISM AND HIGH PERFORMANCE LIQUID CHROMATOGRAPHY ANALYSES. **Mary Cherry, A. Naseer Aziz, Deborah Long, and Roger J. Suave**, Cooperative Agricultural Research Program, Tennessee State University, Nashville, Tennessee. St. John's Wort has a range of medicinally important qualities. The object of this study was to present a quantitative analysis of pharmaceutically important constituents and molecular marker characterization from selected *Hypericum* species. Leaf samples from five species and cultivars of *Hypericum* (*H. frondosum* var. Sunbrust, *H. grandiflorum*, *H. patulum* var. Sungold, *H. perforatum*, *H. perforatum* var. Topas) were used for Amplified Fragment Length Polymorphism (AFLP) and High Performance Liquid Chromatography (HPLC) analyses. Purified DNA samples were analyzed using an automated DNA analyzer (Global IR² DNA Analyzer and Sequencer, LI-COR, Lincoln, NE). The AFLP profiles obtained provided ample polymorphism to distinguish these species. HPLC (Hewlett Packard Series 1100, Atlanta, GA) analysis was used to identify rutin, hypericin, pseudohypericin, and hyperforin in the above-mentioned species. Methanol-extracts of dry leaves were quantified with a C18 (Vydac, Hesperia, CA) column. The five species had varied quantities of the four tested compounds. The AFLP profiles, paired with the metabolite concentration results, will help in identifying suitable candidates for marker-assisted breeding of *Hypericum* species.

BOTANY SECTION

CAROL BASKAUF, CHAIR

MICROHABITATS OF THE RARE *DALEA FOLIOSA* AND ITS CONGENER *DALEA GATTINGERI* IN MIDDLE TENNESSEE. **Jennifer N. Thompson, Jeffrey L. Walck, and Siti N. Hidayati**, Middle Tennessee State University, Murfreesboro, Tennessee. The microhabitat of the federally endangered *Dalea foliosa* was compared to the common cedar glade endemic *D. gattingeri* to guide establishment of new populations and management of *D. foliosa*. Four study sites were located in Davidson, Wilson, and Maury counties. Approximately 10 mature plants of each species were randomly selected, as well as 10 points in habitat not supporting either species but appearing suitable for *D. foliosa*. Plants of *D. foliosa* grew in sites with higher coverage of leaf litter and herbaceous vegetation, with lower cov-

erage of gravel/bare soil, and on deeper soil than those of *D. gattingeri*. Sites appearing suitable for *D. foliosa* but from which it was absent had higher coverage of leaf litter and moss/lichen than sites with the species. Soil nutrients, pH, and organic matter did not differ appreciably between the sites. An ephemeral stream or wash usually is present at *D. foliosa* sites.

PRELIMINARY REPORT ON NATIVE PLANT LANDSCAPING FOR MANAGEMENT OF ARCHAEOLOGICAL SITES IN MIDDLE TENNESSEE. **LinnAnn Welch*, Kurt E. Blum, and Jeffrey L. Walck**, Radnor Lake State Natural Area, Nashville, Tennessee (LW), and Middle Tennessee State University, Murfreesboro, Tennessee (KB, JW). The purpose of this study was to investigate the effectiveness of replacing archaeological sites dominated with fescue to native forbs and grasses. Thirty-two 0.04 ha plots were established in an old field near Mound Bottom in the Harpeth River Valley, Cheatham County, Tennessee. The field was disked in autumn 1999, and the plots were sown with varying numbers of native wildflowers and grasses in late winter 2000. Coverage, density, height, and reproduction of plants that were sown and those not sown (volunteers) were recorded in the autumns of 2000 and 2001. Higher production and reproduction and lower amount of volunteers were predicted in plots sown with greater numbers of native species than those with lesser numbers. Of the ten species sown: five were judged to be successful, three were moderately successful, and two never established. Less volunteer species were present in the second year of the study than the first year.

THE VASCULAR FLORA OF RATTLESNAKE FALLS, MAURY COUNTY, TENNESSEE. **Dwayne Estes***, Austin Peay State University, Clarksville, Tennessee. Rattlesnake Falls is located in the eastern escarpment of the Western Highland Rim in Maury County, Tennessee. It is one of the highest waterfalls in Middle Tennessee and is surrounded by nearly 40 ha of steep wooded ridges and deep rocky ravines. The vascular flora of this area was sampled from February 2000 to August 2001. The diverse flora includes 558 species and infraspecific taxa representing 321 genera and 106 families. Families with the largest number of species include *Asteraceae*, *Poaceae*, and *Fabaceae*. Rare plant taxa at Rattlesnake Falls include the federally listed *Helianthus eggertii* and possibly *Apios priceana*. State listed taxa include *Lilium michiganense*, *Juglans cinerea*, and *Parnassia grandifolia*.

MICROPROPOGATION OF THE VENUS FLY-TRAP (*DIONAEA MUSCIPULA*) USING IN VITRO TECHNIQUES. **Mark S. Green* and S. K. Ballal**, Tennessee Technological University, Cookeville, Tennessee. Micropropagation of Venus Fly-trap (*Dionaea muscipula*) was initiated by using explants from stem and leaf cutting. Modified Murashige and Skoog medium supplemented with growth regulators, which included 1-naphthacetic acid (NAA) at concentrations of 0.2–4 mg/liter and 6-furfurylaminopurine (Kinetin) at concentrations of 0.2–2 mg/liter.

* Student author.

Source material was obtained from Carolina Biological Supply and commercially purchased plants. Regeneration with commercial sources was difficult because of fungal contamination. Plants obtained from Carolina Biological Supply were free of contamination and therefore served as the initial culture source of explant material. Explants were transferred to test tubes containing the pre-sterilized medium under a laminar flow hood using basic aseptic techniques. All explants were incubated in the dark at 21°C for four weeks prior to exposure to illumination. Rapid shoot growth occurred after one week of exposure to growflux lights at room temperature. Explant material was extracted from newly cultured plants and then transferred and maintained in soil filled containers.

EFFECTS OF DIFFERENT GROWTH HORMONES AND LIGHT IN LEMNACEAE (DUCKWEEDS) IN TISSUE CULTURE. *Girija S. Shinde and S. K. Ballal, Tennessee Technological University, Cookeville, Tennessee.* Duckweeds are members of the family Lemnaceae. They are small, fast-growing, aquatic plants with relatively simple morphology. Duckweeds have been employed as experimental organisms for a variety of developmental studies in the laboratory, and most recently for their potential in wastewater remediation. However, *in vitro* studies of duckweed growth are limited. No attempt has been made on comparative studies of the different taxa of Lemnaceae in culture. The plants used in these experiments were collected from wetlands on the Cumberland Plateau. The plants were maintained and aerated in aquarium tanks containing water collected from the respective habitats. The tank water pH was maintained the same as that of the wetland water. Callus induction and frond proliferation were tested using different media such as Murashige and Skoog (MS) organic, MS salt base, and Gamborg's B₅. In addition, different combinations of auxins (IAA, IBA, 2,4-D) and cytokinins (kinetin) were tested. The cultures were maintained in both light and dark environments to induce callus formation and organogenesis. The water maintained in the laboratory for all the three taxa, namely *Lemna*, *Spirodela*, and *Wolffia* suffered a ten-fold loss in total organic carbon while nitrogen concentration remained constant. This may explain the bleaching effect on these taxa.

RELATIONSHIP OF FOUR PULMONARIA SPECIES REVEALED BY FLORESCENT-AMPLIFIED FRAGMENT LENGTH POLYMORPHISM. *Suping Zhou, Xianzhang Meng*, A. Naseer Aziz, and Roger J. Sauve, Tennessee State University, Nashville, Tennessee.* We evaluated the use of fluorescent-amplified fragment length polymorphism (F-AFLP) markers to distinguish four species of *Pulmonaria*. Eight *MseI* and *EcoRI* selective primers with sixty-four primer combinations were tested. F-AFLP profiles were obtained by using a Global IR2 DNA Analyzer (LI-COR, Lincoln, NE.). F-AFLP fragments were scored, analyzed, and converted into numerical data using Gene ImagIR software (version 3.52, LI-COR). Nine primer combinations that yielded 421 markers were selected out. The genetic relationship among different *Pulmonaria* species determined by analysis of these F-AFLP markers using TreeCon program agrees to the taxonomic classification.

DEVELOPMENT OF LIGHT-ENERGY TRANSDUCTION DURING CHLOROPLAST MORPHOGENESIS. *Jefferson G. Lebkuecher, Lorenzo E. Altmon*, Greg K. Harris*, Kellie L. Wallace*, and Amanda R. Wilding*, Austin Peay State Univer-*

sity, Clarksville, Tennessee. Development of light-energy transduction was examined using modulated chlorophyll *a* fluorescence following exposure of etiolated *Helianthus* cotyledons to 200 $\mu\text{mol photons}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$ for 1, 3, 6, 12, and 18 h. The results demonstrate: (1) conversion of excess excitation energy into heat, called thermal dissipation, limits energy flux through photosystem (PS) II during development of PS-II, (2) following development of maximum electron-transport potential within PS II, thermal dissipation decreases allowing for increased photochemical utilization of excitation energy, and (3) changes of the magnitude of thermal dissipation help maintain an optimal, manageable energy flux through the photosystems during the development of photochemistry.

CONTINUED EVALUATION OF THE EFFECTS OF WATER QUALITY ON PRIMARY PRODUCTION IN MILLER CREEK. *Delores A. Burkemper*, Anna B. Windham*, Nathan L. Parker*, and Jefferson G. Lebkuecher, Austin Peay State University, Clarksville, Tennessee.* The United States Natural Resource Conservation Service has targeted Miller Creek, Robertson County, Tennessee for water quality improvement. During the last week of August 2001, primary production was assessed in the middle and lower reaches of Miller Creek and in the lower reach of Buzzard Creek, known to have good water quality. Primary production of autochthonous photoautotrophic periphyton was significantly greater in the lower reach of Miller Creek, indicative of nonpoint-source pollution, relative to the other sites. *In situ* growth followed by chlorophyll *a* fluorescence analysis of the pollution-intolerant alga, *Selenastrum capricornutum*, demonstrate that relative to the other sites, the water quality of lower Miller Creek significantly decreased the efficiency of photosynthesis and reproduction rate. The results indicate poor water quality in the lower reach of Miller Creek and the need to improve water quality.

CELL AND MOLECULAR BIOLOGY SECTION

JOHN ZAMORA, CHAIR

THE ROLE OF *BST1p* IN PROTEIN SORTING AND VESICLE FORMATION AT THE ENDOPLASMIC RETICULUM (ER) IN *SACCHAROMYCES CEREVISIAE*. *Chris Kaiser and Matt Elrod-Erickson, Massachusetts Institute of Technology, Cambridge, Massachusetts, and Middle Tennessee State University, Murfreesboro, Tennessee.* Protein transport through the secretory pathway of eukaryotic cells consists of a series of vesicle budding, targeting, and fusion steps that deliver protein cargo from one membrane-bounded organelle to the next. Proper sorting of secretory proteins requires that cargo molecules be segregated from resident proteins as transport vesicles form. Mutations in the *BST1* gene of *Saccharomyces cerevisiae* disrupt proper sorting at the endoplasmic reticulum (ER): a subset of secretory proteins are transported with reduced kinetics, and resident proteins leak more rapidly from the ER. These mutations also affect vesicle budding. *BST1* encodes a resident ER membrane glycoprotein with homologs in yeast, worms, fruit flies, plants, mice and humans. Sequence analysis shows these proteins all share a motif characteristic of lipases. Current efforts are aimed at testing the hypothesis that *BST1* directly affects protein sorting into vesicles by altering the lipid environment in the vicinity of forming vesicles.

DIFFERENTIAL EFFECTS OF REOVIRUS TYPE 3 ON TRANSFORMED AND NON-TRANSFORMED CELLS. *Spence R. Dowlen* and Anthony Farone, Middle Tennessee State University, Murfreesboro, Tennessee.* Reovirus Type 3 Dearing can induce apoptosis and viral lysis in cells. Studies have found that reovirus selectively kills transformed cells while having no significant effect on non-transformed cells. Using human fibroblast WI-38 cells and the transformed WI-38RA cells, this study explored apoptosis levels as well as cell viability using Hoechst/propidium iodide staining following treatment with reovirus for 2, 8, 24, 48, and 72 h. Differences in infectivity of the two cell lines were determined using an infectious center assay. Reovirus exposure resulted in lower cell viability and higher levels of apoptosis that concurred with higher infectivity in the transformed cells compared to the non-transformed cells. It appears that the cell death observed was due to both apoptosis and viral lysis. These results provide further understanding of the mechanisms involved in reovirus-induced cell death in transformed cells. The ability of reovirus to selectively target transformed cells is currently being investigated in cancer therapy trials.

NUCLEAR CHANNELS AND THEIR ASSOCIATION WITH γ -TUBULIN. *John R. Palisano and Elizabeth K. Traister*, The University of the South, Sewanee, Tennessee, and Pennsylvania State College of Medicine, Hershey, Pennsylvania.* Although nuclear channels (NC) have been described in a variety of cells, their function has not been fully investigated. This investigation used immunofluorescent techniques to examine the formation and function of NC in HeLa cells, a human cervical cancer cell line. NC are defined as invaginations of the nuclear envelope (NE) that traverse the nucleoplasm, thus forming a ring-like nucleus. The resulting tunnel is devoid of nucleic acid and may contain cytoplasmic elements. Extensive observations of HeLa cells from synchronized and nonsynchronized cultures indicate that the majority of the NC were observed in cells that were in late telophase or very early interphase. In approximately half the channels, γ -tubulin was associated with the centrioles that serve as the microtubule organizing center for the spindle apparatus. If the NC do facilitate nucleocytoplasmic transport, as other investigators suggest, their presence should increase as the cell enters interphase because the greatest nuclear-to-cytoplasmic exchange of information occurs during interphase. Our investigation indicates that the channels may play either an active or passive role during a transitional stage of NE reassembly and are then incorporated into the spherical nucleus as the cells progress through interphase.

HIGH CONCENTRATION CATIONIC LIPID REAGENTS PROVIDE OPTIMAL TRANSFECTION EFFICIENCIES IN TWO CELL LINES. *Andrew D. Korzyniowski* and David B. Ekkens, Southern Adventist University, Collegedale, Tennessee.* In order to analyze the biological function of a propriety DNA sequence, a series of transfection protocols were first optimized for L-cells and SK-N-SH cells. Transfections were initially performed using the reporter gene β -galactosidase plasmid in conjunction with Qiagen cationic lipid transfection reagents SuperFect and Effectene. Enzyme activity was qualitatively measured with in situ X-gal staining as well as quantitatively measured through spectrophotometric measurements of CPRG and ONPG substrate cleavage. Data from the latter two assays was combined with Biuret protein assay data to give a measure of

specific enzyme activity. Data from the latter three assays indicated that SuperFect was the most favorable transfection reagent for these cell lines, transfecting with optimal efficiency under high DNA:reagent conditions. Both cell lines displayed a non-specific activity for X-gal substrate cleavage.

USING TIME-LAPSE IMAGING TO DETECT CENTROSOMAL DEFECTS LEADING TO ANEUPLOIDY. *Andrea L. Kuntaraf*, Joyce Azevedo, Cristina Montagna, and Thomas Reid, Southern Adventist University, Collegedale, Tennessee.* Centrosomal instability may lead to aneuploidy, thus, inducing cancer. Two sets of experiments were done on aneuploid and diploid mouse colorectal cancer cell lines. The first involved immunofluorescence detection of centrosomes using a specific monoclonal antibody against gamma-tubulin. The second constructed GFP-tagged gamma-tubulin and centromere protein B (CENPB) expression vector clones. This was necessary for the living cells to be analyzed using time-lapse imaging. The results of the immunocytochemistry supported the hypothesis that centrosomal defects play a key role in the development of aneuploid. However, the precise functional correlation remains to be established.

A GENERIC PROCEDURE FOR MAKING PHOTOMICROGRAPHS USING BRIGHTFIELD MICROSCOPY. *Artyom V. Shneyder* and Mary Ann Asson-Batres, Tennessee State University, Nashville, Tennessee.* Photomicrography is essential for any discipline that deals with microscopic objects. In this study photos of specimens were taken using various types of film on a Nikon bright field microscope with the goal of producing good quality photographs according to a standardized protocol. Photographs were scanned and edited using Adobe Photoshop. Variables tested were light intensity, filtration, film type, magnification, and aperture size. Due to individual differences in any optical equipment, all film types and conditions available must be tested so that the results can be evaluated and the best conditions selected for future use. We determined that Tungsten films (although recommended) do not produce better images, filtration impacts film tint, minimal aperture improves resolution, and, as long as predetermined protocol is followed exactly, high quality, reproducible results are obtained.

ALLELOPATHIC EFFECTS OF HERBAL EXTRACTS. *Melanie J. Messina* 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 hot water extracts of several medicinal herbs, including chaparral, burdock root, red clover, paud' arco, periwinkle, noni, garlic, yucca, flax seed, and yellow dock, inhibited the growth of bean sprouts. This assay is used as a screening test for allelopathy as well as for anticancer activity. Most of the herbal extracts inhibited the growth of the bean sprouts. Chaparral, yellow dock, paud' arco, and yucca were the most inhibitory. To determine what was occurring microscopically, onion root tip squashes were prepared and fixed onto slides. Altered cell morphology and differences in number of mitotic cells were observed in many of the hot water extracts. There appear to be allelopathic chemicals in many of these medicinal herbs.

BRIEF BUTYLtin EXPOSURE INDUCES IRREVERSIBLE

INHIBITION OF THE CYTOTOXIC FUNCTION OF HUMAN NATURAL KILLER CELLS, IN VITRO. *Margaret M. Whalen, Stephanie A. Green, and Bommanna G. Loganathan, Tennessee State University, Nashville, Tennessee (MMW, SAG), and Murray State University, Murray, Kentucky (BGL).* Our earlier studies demonstrated that environmentally relevant concentrations of butyltins (BTs) inhibited the tumor-killing function of human natural killer (NK) cells. In this study we examined whether the inhibition of NK-cell cytotoxic function induced by a brief exposure (1 h) to BTs was reversible when the cells were allowed to recover in BT-free media for up to 6 days. Exposure to 300 nM TBT for 1 h caused an approximately 65% decrease in NK-cytotoxic function, whether the lymphocytes were given as long as a 6 day recovery period or no (0 h) recovery period. There was no recovery of NK-cytotoxic function following removal of the compound. Exposure to 5 μ M DBT for 1 h caused a 41% decrease in cytotoxic function with a 0 h recovery, and an 83% decrease after a 24 h recovery period. There was no significant recovery of NK-cytotoxic function when the lymphocytes were allowed to incubate in DBT-free media for up to 6 days. The results indicate that short term exposure to BTs causes persistent negative effects on NK-cell ability to kill cancer cells.

THE EFFECT OF LOWERING CELLULAR LEVELS OF CYCLIC ADENOSINE MONOPHOSPHATE ON THE CYTOTOXIC FUNCTION OF HUMAN NATURAL KILLER CELLS. *Amanuel K. Bariagaber and Margaret M. Whalen, Tennessee State University, Nashville, Tennessee.* The effect of lowering cellular levels of cyclic 3', 5' adenosine monophosphate (cAMP) on the cytolytic function and phospholipase C (PLC) γ activity of natural killer (NK) cells has not been studied. The present study examines whether exposure of NK cells to cAMP lowering compounds such as adenylyl cyclase (AC) inhibitors (MDL and DDA) can affect their cytolytic function and PLC activity. Our data show that when NK cells are exposed to MDL (25 μ M) or DDA (200 μ M) for varying lengths of time (10, 30, and 60 min) the cytolytic function and PLC activity are inhibited. We noted that 60 min pretreatment with MDL or DDA caused 96% and 38% inhibition of cytolytic function of NK cells, respectively. We also investigated whether the effect of lowering cAMP proceeds through its effector cAMP-dependent-protein kinase (PKA) activity. One hour pretreatment of NK cells with the PKA inhibitor, H-89 (10 μ M), caused 70% inhibition of cytotoxic function. Furthermore, we show that pretreatment of NK cells with 10 μ M H-89 caused 33, 41 and 25% inhibition of IP turnover after 10, 30, and 60 min, respectively. These data indicate that the inhibitory effect of decreased cAMP levels on NK cell function may at least partially be mediated by decreased PKA activity.

CHEMISTRY SECTION

JAMES C. HOWARD, CHAIR

ANALYSES OF SMALL AMOUNTS OF METHANOL IN WOOD DISTILLATES. *Eugene A. Kline and Daniel J. Swartling, Tennessee Technological University, Cookeville, Tennessee.* Analyses for small amounts of organic components in ppm levels were studied with the 300 MHz NMR and GC/MS. Several samples of light oils from wood distillates produced under different conditions and processed differently, were composed of hundreds of compounds. Methanol had some practical impor-

tance and was the analyte in all cases. Problems including solubility of the mixture, solvents and internal standards with isolated chemical shifts in the NMR, different rates of vaporization of various components and molecular weight limits in the GC/MS, and chemical reactions with internal standards with the various mixtures were studied. Both methods detected methanol, but results were more reproducible and more accurate in the NMR when compared to known standards. Using an alcohol as the internal standard, methanol was found in concentrations of less than 100 ppm.

A COMPUTATIONAL LOOK AT ARYL (CYCLOPENTADIENYL) BORONIUM IONS. *William H. Isley, Middle Tennessee State University, Murfreesboro, Tennessee.* Preliminary results of ab initio studies substituted arylboronium ions 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 most of these species exhibit linear geometry about the boron atom.

ELECTROCHEMISTRY OF MOLTEN NITRATE ELECTROLYTES AND APPLICATIONS FOR LITHIUM BATTERIES. *Melvin H. Miles, Middle Tennessee State University, Murfreesboro, Tennessee.* Molten nitrate electrolytes exhibit much lower melting points than halide electrolytes. The best molten nitrate systems for lithium battery applications are the LiNO₃-KNO₃ (42-58 mol%) eutectic that melts at 124°C and the LiNO₃-NaNO₃ (56-44 mol%) eutectic that melts at 187°C. These melts are chemically stable towards decomposition up to 470°C. Thus both eutectics provide a wide liquid operating temperature range readily exceeding 200°C. Furthermore, these molten nitrate eutectics offer high ionic conductivities and low viscosities. The electrochemical reduction of LiNO₃ yields insoluble Li₂O that blocks further reduction of the molten nitrate and allows the electro-stability region to be extended to the reversible reduction of lithium ions. This provides an electrochemical window of 4.5 V for the LiNO₃-KNO₃ and LiNO₃-NaNO₃ eutectics. Therefore, the use of lithium anodes with 4 V cathode materials is possible in molten nitrate electrolytes that contain sufficient LiNO₃. Lithiated transition metal oxide cathode materials such as LiMn₂O₄ are being investigated for high voltage lithium cells using molten nitrate electrolytes. Possible applications include military thermal batteries as well as batteries for geothermal bore holes and alarm systems.

SIGNATURES AS DESCRIPTORS IN TWO DIMENSIONAL QUANTITATIVE STRUCTURE RELATIONSHIP. *Donald P. Visco Jr. and Ramdas S. Pophale*, Tennessee Technological University, Cookeville, Tennessee.* To create a focused library of compounds with a desired property range, we developed a 2D-Quantitative Structure Relationship (QSR) using a new descriptor called signature. The signature features were explored with the help of three data sets. Activity of 121 HIV-1 protease inhibitors, HPLC capacity factors of 22 energetic materials (two sub-sets, ODS, CPS) and octanol/water partition coefficient for 12865 compounds made up the three data sets. The results were achieved with a forward stepping regression method. The predictive ability of the QSRs was tested on test sets for every case barring the energetic materials. Multiple correlation coefficient, significance, and stability of coefficients were the criteria for the choice of the model parameters. The QSR coefficients for the

energetic materials were used to form (linear) diophantine equations. The equations were solved for sets of the targeted property. Solutions to these equations were used to determine compounds with the property in the given range.

EFFECTS OF EXPERIMENTAL CONDITIONS ON COVERAGE OF FUMED SILICA BY ORGANOSILANES. *Celeste M. Matthews** and *Andrienne C. Friedli*, *Middle Tennessee State University, Murfreesboro, Tennessee*. Organosilanes have been used to coat silica gel for use in liquid chromatography and potential environmental applications due to their ability to physisorb small organic molecules. Three organosilanes (phenyltrichlorosilane, 1-phenyl-4-trichlorosilylbutane, and 1-phenyl-11-trichlorosilylundecane) were used to derivatize fumed silica with different surface characteristics. The amount of adsorption of an organosilane onto silica and the degree of physisorption and/or chemisorption of the organosilane films was assessed by Thermal Gravimetric Analysis. The temperature of the silica pretreatment, the identity of the organosilane, and the presence of base were varied to determine the effects on silica coverage. The silica was untreated, superhydrated, or heated to 150°C, 350°C, or 600°C prior to use. The organosilanes were used to derivatize Aerosil 380 in order for silane chain length to be compared. Decreasing coverage was found for increasing silica pretreatment temperatures while increasing coverage was found for increasing silane chain length. Triethylamine did not improve silica coverage.

NOVEL SELENIUM CONTAINING TRYPTOPHAN ANALOGS AND THEIR POTENTIAL USE IN THE DETERMINATION OF THREE DIMENSIONAL PROTEIN STRUCTURES. *James A. Henderson**, *Duane M. Hatch**, and *Jeffrey O. Boles*, *Tennessee Technological University, Cookeville, Tennessee*. In the last decade the preparation of Selenomethione (SeMet) containing proteins has proved to be a valuable tool in the determination of three dimensional structure by Multiwavelength Anomalous Diffraction (MAD) techniques. Furthermore, selenium-77 nuclear magnetic resonance spectroscopy has been shown to be an important probe of enzymatic structure and function. Analogs of amino acids that occur at low natural abundance in proteins, such as L-methionine (Met) and L-tryptophan (Trp), are excellent tools for protein characterization since their structural and catalytic roles are minimal. The potential utility of a selenium containing tryptophan analog, β -selenolo[3,2-b]pyrrolyl-L-alanine ([3,2-b]SeTrp), has recently been demonstrated in the literature. This study shows promise for similar incorporations of its isomer, β -selenolo[2,3-b]pyrrolyl-L-alanine ([2,3-b]SeTrp), adding to the arsenal of heavy-atom amino acid derivatives for use in the characterization of proteins. The synthesis and preliminary results of the bioincorporation of the [2,3-b]SeTrp isomer will be presented.

DESIGNING METAL-CONTAINING LIQUID CRYSTALS BASED ON BIPYRIDINE LIGANDS. *Robert E. Bachman*, *The University of the South, Sewanee, Tennessee*. Metal-containing liquid crystals offer the opportunity to combine the unique properties of metal complexes with the technologically important property of liquid crystallinity. Bipyridine complexes are ubiquitous in inorganic coordination chemistry, displaying many unique properties such as photoluminescence and photocatalytic activity. However, bipyridine complexes have so far largely resisted efforts to be incorporated into liquid crystalline systems. We have recently succeeded in designing simple 4,4' derivatives

of bipyridine that can be used to create liquid crystalline complexes with square planar platinum(II) fragments. In this presentation, we will explore the relationships between the molecular and supramolecular structures and the phase behavior of these complexes.

NUCLEAR QUADRUPOLE RESONANCE STUDIES OF WEAKLY COORDINATING ANIONS OF INTEREST IN INDUSTRIAL CATALYSIS. *Gary P. Wulfsberg*, *Jamie Wilcox**, and *Rachell Briggs**, *Middle Tennessee State University, Murfreesboro, Tennessee*. Success of the metallocene polymerization process for producing polymers depends on the anion found with the organozirconium cation being as weakly coordinating to zirconium as possible. This is best achieved by halogenating the outside of a large anion of low charge. When heavier halogens are used, the coordinating ability of the anion can profitably be studied using ^{35}Cl , ^{81}Br , and ^{127}I nuclear quadrupole resonance (NQR) spectroscopy. We have studied a series of salts and covalent derivatives of successively less-coordinating organic anions: $\text{ClCH}_2\text{CO}_2^-$, $\text{Cl}_2\text{CHCO}_2^-$, $\text{Cl}_3\text{CCO}_2^-$, $\text{XCH}_2\text{SO}_3^-$, $\text{Cl}_3\text{CSO}_3^-$. Coordinating ability of the oxygen atoms of the anion produces a dependence of the anion's NQR frequencies on the electronegativity of the metal, while there is no such dependence in purely ionic salts, where the NQR frequencies vary with the radius of the cation instead. (Supported by University Committees for Faculty Research and Non-Instructional Assignments.)

DETERMINATION OF AMMONIA IN DIESEL ENGINE EXHAUST. *Tye Ed Barber*, *Norma L. Ayala*, *John M. E. Storey*, *Mike Kass*, and *John Thomas*, *Tennessee Technological University, Cookeville, Tennessee (TEB, NLA)*, and *Oak Ridge National Laboratory, Oak Ridge, Tennessee (JMES, MK, JT)*. To meet new emission standards, diesel engine manufacturers are studying the use of exhaust aftertreatment systems for internal combustion diesel engines. One type of aftertreatment system under study uses urea ($\text{CH}_4\text{N}_2\text{O}$) and a catalyst to reduce oxides of nitrogen (NO_x) with a selective catalytic reduction (SCR) process. In these systems, a urea solution is injected into the exhaust upstream of the catalyst supported on a monolith. When the urea reaches the storage catalyst, it reduces the NO_x . Under ideal, stoichiometric conditions, the reduction of NO_x is very efficient. Under transient conditions and at low operating loads typical of engines, excess ammonia (NH_3) can be formed and can be emitted. To study the catalyst behavior, a high-speed ultraviolet absorption spectrometer was constructed for analysis of engine exhaust. The system uses a long path, low volume gas cell with a high-speed photodiode array giving it a temporal resolution of approximately 50 milliseconds. In this presentation, the performance of the ultraviolet system will be discussed and compared to a commercially available photoacoustic analyzer for the analysis of NH_3 .

METHODS DEVELOPMENT FOR THE DETECTION OF TRACE METABOLITES FROM THE BIODEGRADATION OF POLYCYCLIC AROMATIC HYDROCARBONS BY YEASTS. *Huiyon Kim**, *Ngee-Sing Chong*, and *Beng-Guat Ooi*, *Middle Tennessee State University, Murfreesboro, Tennessee*. Gas chromatography-mass spectrometry (GC-MS) in conjunction with solid phase micro-extraction (SPME) has been used to characterize the biodegradation products of polycyclic aromatic hydrocarbons (PAHs) at trace levels in yeast cultures. The metabolites of PAHs such as phenanthrene and chrysene are characterized

and compared to those produced by bacterial biodegradation performed in other laboratories. Derivatization techniques based on various reagents including trimethylchlorosilane, acetic anhydride, and trifluoroacetic anhydrides have been developed for the analysis of the hydroxy and dihydrodiol derivatives of the PAHs. The extraction efficiencies of different SPME fiber coatings such as Carboxene[®], polydimethylsiloxane, and polyacrylate will be evaluated. The advantages of using SPME for the study of PAH biodegradation are the ability to sample both the headspace and the liquid media, the "non-intrusive" nature of SPME or its adaptability for metabolite monitoring, as well as the low detection limits afforded by the SPME preconcentration of analytes prior to GC-MS analysis.

EFFECTS OF QUERCETIN AND GENISTEIN ON GLUTATHIONE LEVELS IN HUMAN MONOCYTIC PROGENITOR CELLS (U937 CELLS). *William Boadi, Peter Iyere, and Samuel Adunyah, Tennessee State University, Nashville, Tennessee (WB, PI), and Meharry Medical College, Nashville, Tennessee (SA).* Diets that contain an abundance of fruit and vegetables are protective against a variety of diseases, particularly cardiovascular disease and epithelial (but not hormone-related) cancers. The principal nutrients thought to provide the protection afforded by fruit and vegetables are the antioxidants and dietary fibre (non-starch polysaccharides). The effects of quercetin and genistein (both plant flavonoids and antioxidants) against iron (Fe^{2+}) induced oxidation on glutathione (GSH) in human leukemia U937 cells were investigated. Cells were maintained at 37°C under 5% CO_2 tension in RPMI 1640 medium containing 10% FBS and 50 units/ml each of penicillin and streptomycin. Following incubation for 24 h at 37°C , the cells were pelleted by low speed centrifugation, resuspended in 5% metaphosphoric acid (MPA), and centrifuged at $3,000 \times g$ for 10 min at 4°C . The supernatant was used to measure GSH levels as described by the GSH assay kit from Pierce (Cat. No. 354102). GSH levels were expressed as μmol per milligram of protein. GSH levels increased in a dose-dependent manner with increasing quercetin and genistein levels. Of the two flavonoids, quercetin had more marked effect on enhancing GSH levels compared to their respective controls ($P < 0.01$). Our data demonstrate that quercetin and genistein application to human leukemia U937 cells before Fe^{2+} exposure enhances U937 cell GSH levels. These observations suggest that flavonoids may be useful for prevention and treatment of metal-induced oxidation in leukemia cells.

A PORTABLE DEMONSTRATION OF VAT DYEING SIMULATED WITH INDIGO CARMINE. *David G. Figueredo* and Martin V. Stewart, Middle Tennessee State University, Murfreesboro, Tennessee.* An interesting chemistry demonstration for young students is the process by which blue jeans are dyed. However, the chemical reduction of water insoluble indigo to a water soluble leuco form makes this vat-dyeing procedure prohibitively lengthy and cumbersome. Blue indigo dye is reduced to its pale yellow leuco form by sodium dithionite (sodium hydrosulfite, $\text{Na}_2\text{S}_2\text{O}_4$) over a steam bath. An immersed cloth removed from the vat and exposed to the atmosphere turns blue because the leucoindigo solution is oxidized back to the original water insoluble indigo. Sulfonation of indigo affords indigo carmine, whose sodium salt readily dissolves in water. Thus, substituting indigo carmine for indigo provides a demonstration that simulates all chemical aspects of the vat-dyeing process except the difficult and time consuming dissolving of indigo. This procedure

was then packaged in a portable form for distribution to a diverse population of demonstrators during National Chemistry Week.

VIEWING SURFACES WITH ATOMIC FORCE MICROSCOPY. *Cameron K. Gren*, Elizabeth A. Western*, and Andrienne C. Friedli, Middle Tennessee State University, Murfreesboro, Tennessee.* Atomic Force Microscopy (AFM) is a common technique for imaging relatively flat surfaces on the nano- and microscale. We have used a Thermomicroscopes Explorer AFM in contact, noncontact, and liquid contact mode to examine the topography of everyday objects as well as research samples. Examples of standard surfaces include a compact disc, aluminum grains, a soft drink bottle, an eeprom chip, and a calibration grid. In each case, x , y , and z dimensions of features were measured. Research samples were planar and spherical surfaces coated with organic thin films. Substrates included silicon wafers, glass, mica, glass beads, and colloidal silica. In general, the lower limit of image resolution was 50 nm due to experimental configuration.

SYNTHESIS AND ANALYSIS OF SELENIUM ALKOXIDES. *Tim Decha-Umphai* and Judith M. Iriarte-Gross, Middle Tennessee State University, Murfreesboro, Tennessee.* Alkoxides have had a major impact in sol-gel chemistry. This process is used to synthesize glass or ceramic materials. Selenium alkoxides have already been synthesized, and very little is known about their chemistry. Further research and analysis of selenium alkoxide chemistry is needed. The synthesis of selenium alkoxides is being investigated using a non-hydrolytic sol-gel method. All intermediates and products are being characterized by H-1, C-13, and Se-77 NMR spectroscopy. The non-hydrolytic sol-gel synthesis and spectroscopic data will be presented and discussed.

SYNTHESIS AND QUANTITATIVE STUDIES OF TELLURIUM SILICATE SOL-GEL MATERIALS. A PROJECT SEED I RESEARCH SUMMER AT MTSU. *Valencia Smart**, Judith M. Iriarte-Gross, and William Ilsley, Middle Tennessee State University, Murfreesboro, Tennessee.* In this research, tetraethyl orthosilicate, $\text{Si}(\text{OCH}_2\text{CH}_3)_4$, was doped with telluric acid, $\text{Te}(\text{OH})_6$, or tellurium (IV) chloride, TeCl_4 . A sol-gel product was synthesized. The reaction time, pH, and quantity of reactants were varied. Intermediates and products were analyzed by IR spectroscopy. Computational calculations were conducted to determine the molecular geometries of the proposed intermediates and products. Results from this Project SEED I research project will be presented and discussed.

SYNTHESIS AND ANALYSIS OF SELENIUM SILICATE SOL-GEL MATERIALS. A PROJECT SEED RESEARCH SUMMER AT MTSU. *Samuel Deputy*, Judith M. Iriarte-Gross, William Ilsley, Middle Tennessee State University, Murfreesboro, Tennessee.* Selenium doped sol-gel glasses were produced using selenious acid (H_2SeO_3), or selenium (IV) chloride (SeCl_4), as dopants within a tetraethyl orthosilicate, $\text{Si}(\text{OCH}_2\text{CH}_3)_4$, sol-gel matrix. The pH of the system was varied as were reaction times. The intermediates and glasses were analyzed using IR spectroscopy. Computational calculations were conducted to identify the molecular geometries and energies of the compounds being studied. Results will be presented and discussed.

QUANTITATIVE SPECTROPHOTOMETRIC METHODS OF ANALYSIS FOR THE DETERMINATION OF TELLURIC

ACID. **Freneka F. Minter*** and **Judith M. Iriarte-Gross**, Middle Tennessee State University, Murfreesboro, Tennessee. The purpose of this study is to see if small amounts of telluric acid, $\text{Te}(\text{OH})_6$ could be analyzed. There are many methods of analysis in the literature for the determination of $\text{Te}(\text{OH})_6$, but these methods are time-consuming and require careful control of the experimental conditions. In alkaline medium, tellurium (VI) absorbs strongly in the ultraviolet region, and a spectrophotometric method is based on this absorption. Using an ultraviolet spectrophotometric method in the determination of $\text{Te}(\text{OH})_6$ increases the ease and the speed of the determination of $\text{Te}(\text{OH})_6$ concentrations. This study describes a quantitative method for the determination of $\text{Te}(\text{OH})_6$ based upon its absorption in the ultraviolet region of the spectrum.

ABSORPTION STUDIES OF Cd(II) AND Cu(II) BY MONO- AND DI- THIOPHOSPHINIC ACIDS IMPREGNATED ON A SOLID SUPPORT. **Nick Bridges*** and **Dale D. Ensor**, Tennessee Technological University, Cookeville, Tennessee. Heavy metal contamination is a concern in the production of high purity mineral acids for agricultural uses or in analytical analysis. The heavy metals could be toxic to humans and animals or could render an unwanted interference in analytical analyses. The removal of Cd(II) and Cu(II) from mineral acids was studied using liquid extractants, Cyanex 301, containing dithiophosphinic acid groups and Cyanex 302, with monothiophosphinic acid groups, that had been impregnated with inert polymeric substrates. The thiophosphinic acid groups showed the strongest affinity for Cd(II), as would be predicted by the Hard/Soft acid and base concept. The dry weight distribution (D_w) was measured in batch experiments and compared to see how changes in acid concentration or length of time of resin exposure affected the D_w . The concentration of the acid affected the uptake of the metal ion, but had little effect on the rate of uptake. A competitive study was conducted to determine the effects of having the Cd(II) and Cu(II) ions in the same solution and how that affects the individual D_w for each metal. In this study Cd(II) uptake was the highest when the Cu(II) concentrations were low. As the concentration of Cu(II) increased, the competition for reactive sites had a negative effect on the D_w for Cd(II).

NEW INSIGHTS CONCERNING THE USE OF β -CHLOROALANINE AND MONOVALENT CATIONS IN THE TRYPTOPHAN SYNTHASE SPECTROPHOTOMETRIC KINETIC ASSAY. **Duane M. Hatch***, **James A. Henderson***, and **Jeffrey O. Boles**, Tennessee Technological University, Cookeville, Tennessee. Bacterial tryptophan synthase is a $\alpha_2\beta_2$ heterodimer that catalyzes the last two steps in the biosynthesis of L-tryptophan. The $\alpha_2\beta_2$ complex dissociates reversibly into two monomeric α subunits (M_r 28,700) and one dimeric β_2 subunit (M_r 86,000). The α subunit catalyzes the cleavage of indole-3-glycerol phosphate to indole and 3-glyceraldehyde 3-phosphate (α reaction), while the pyridoxal phosphate dependent β_2 -subunit catalyzes the condensation of indole with L-serine to form L-tryptophan (β reaction). The physiologically important $\alpha\beta$ reaction is the sum of the α and β reactions. Since this enzyme is currently getting much broader attention, we sought to reinvestigate the kinetic assay design and reaction conditions. Our preliminary results will be presented.

ENGINEERING AND ENGINEERING TECHNOLOGY SECTIONS

DONALD P. VISCO JR., CHAIR

SEDIMENT LEVELS IN THE HARPETH RIVER WATERSHED: A PROGRESS REPORT. **Dorene A. Bolze**, **Richard E. Lockwood**, and **David J. Wilson**, Harpeth River Watershed Association, Franklin, Tennessee (DB), Advent Group, Brentwood, Tennessee (RL), and Cumberland River Compact, Nashville, Tennessee (DW). A two-year study of sediment concentrations in the Harpeth River watershed is being carried out to better understand the impacts of type of land use and damage to riparian vegetation on stream sediment concentrations and stream bank erosion. Thirty volunteers and thirty-eight sampling stations are involved; approximately seven hundred data sets have been acquired to date. The study has focused particularly on measurements during and immediately after rains. Measurements include stream stage, turbidity (by turbidity tube), and rain gage reading. Selected samples are analyzed for Total Suspended Solids (TSS), and a few Imhoff cone determinations of settleable solids have been made. Excellent correlations between TSS and turbidity have been observed, validating the use of turbidity in this study. A number of comparisons of streams have been made by means of the Wilcoxon rank sum test (the data are not normally distributed); several statistically significant differences have been found.

A LEARNING OBJECTS FRAMEWORK FOR ELECTRONICS ENGINEERING TECHNOLOGY EDUCATION. **Adel Salama** and **Ashraf Saad**, Austin Peay State University, Clarksville, Tennessee, and Georgia Technological University, Savannah, Georgia. Learning Objects have been promoted by several leading organizations as a viable approach to standardize the creation of educational content libraries. Such organizations include: 1) The IEEE Learning Technology Standards Committee, 2) The IMS Global Learning Consortium, 3) The United States Government: Advanced Distributed learning initiative, as well as 4) The European Union (PROMETUS program and the ARIADNE project). As a result of these projects, a standardized approach for specifying Learning Objects and their associated metadata for educational settings is bound to emerge. One of the most important educational questions pertaining to the use of Learning Objects is how will such objects be developed, then interconnected or sequenced in order to achieve certain desired learning outcomes for a particular learner? We present an approach for interconnecting learning objects for electronics engineering technology education that can lead to creating a platform for the development of Learning Objects for undergraduate education.

BANDWIDTH CHANGES OF INTRACRANIAL PRESSURE DYNAMICS INDUCED BY DILATORY CEREBROVASCULAR CHALLENGE. **Michael L. Daley**, **Massroor Pourcyrous**, **Shelly Timmons**, and **Charles W. Leffler**, The University of Memphis, Memphis, Tennessee (MLD), and The University of Tennessee Health Science Center, Memphis, Tennessee (MP, ST, CWL). Continuous knowledge of cerebrovascular responsiveness would improve the intensive care management of a patient with severe head-injury. This study explored the development of a method designed to continuously evaluate cerebral vascular reactivity during intracranial pressure (ICP) and arterial blood pressure (ABP) monitoring. Cerebrovascular dilation was provoked in 6 piglets with cranial window placements by the induction of

either hypercapnia or hypoxia. Identification modeling was used to determine the bandwidth (BW) of a second order model of ABP transmission to ICP. For each challenge, BW, indices of cerebrovascular reserve, cerebral perfusion pressure (CPP), and pial arteriolar diameter were determined. Significant increases in mean BW, indices of cerebrovascular reserve, and pial arteriolar diameter were determined. BW values were strongly exponentially correlated with an index of cerebrovascular reserve. These results suggest that changes of BW in relation to changes of CPP provide continuous information on cerebrovascular activity.

ASSEMBLY LINE SIMULATION AT WHITE HYDRAULICS, INCORPORATED, HOPKINSVILLE, KENTUCKY. Stephen T. Worth, Austin Peay State University, Clarksville, Tennessee. The goal of this research is a schematic model of the manufacturing assembly facilities of White Hydraulics, Inc. The study focuses on a family of parts that are of similar geometry, the High volume production line, and ultimately will cover the Low volume production line. The objective was to evaluate the existing manufacturing capabilities and offer solutions for a redesign of the assembly layout utilizing a cellular manufacturing approach. To establish baseline parameters, the occupied space and the material flow in the existing environment was investigated. The model was designed to reflect the layout and space used by various machines, as well as the space occupied by inventory, parts, and additional equipment. The subsequent redesign and implementation of a cell only used existing equipment. Secondly, the cell was formed on the basis of the existing setup and processing times, since reengineering of the machining would require expert knowledge and the impact on manufacturing time is difficult to estimate. This approach allows the company to gain knowledge about the behavior of the cell and then decide which processes and change over operations require improvements. Ultimately, time discrete simulation was used to predict performance of the existing design in terms of throughput time, the average work-in-progress (WIP), required workers, and fulfilling the customer's demand. It will be compared to the newly designed cell and, if necessary adjustments to the model can be implemented. However, considering the large amount of input needed to accurately predict WIP and throughput time precisely, different strategies could be pursued. For instance the models outline the issues involved in the current system by highlighting inherent system characteristics. Such interdependencies could be the relationship between the buffer size and the variation (machine downtime, setup time etc.) within the system. As opposed to using large buffers for decoupling purposes the model demonstrates reduced inventory and optimized material flow in a cellular approach. Such an assertion could even be supported by comparing less precise values of average, WIP, throughput time of the respective system layouts. As a platform for this endeavor, Arena Simulation Software was purchased and used to pursue the intended goals.

SHRINKAGE AND CREEP OF NORMAL-STRENGTH AND HIGH STRENGTH CONCRETE. Pingsheng Zhu* and Xiaoming Sharon Huo, Tennessee Technological University, Cookeville, Tennessee. Shrinkage and creep are two major time-dependent material properties of concrete. Compared with normal strength concrete, high strength concrete has different mixture proportions and different shrinkage and creep deformations. Determining the shrinkage and creep of high strength concrete is important for the determination of prestress losses and long-term

deformations of prestressed girders. A laboratory experiment on the shrinkage and creep of a normal strength concrete and a high strength concrete was conducted at Tennessee Technological University. Specimens were measured for temperature, shrinkage, and creep deformation. Results show that shrinkage and creep of high strength concrete differs from normal strength concrete in three aspects: 1) it has smaller shrinkage and creep effects; 2) it develops more quickly during the early age of concrete; 3) after a short period, it will develop slowly and become stable.

DETERMINATION OF SHORT-TERM AND LONG-TERM PRESTRESS LOSSES. Francis Y. Ung* and Xiaoming Sharon Huo, Tennessee Technological University, Cookeville, Tennessee. Prestressed concrete bridge members will undergo different loading stages, including prestressing release, beam and slab weight, superimposed dead load, and live load. The stress in the prestressing steel varies continually with time due to the effect of concrete shrinkage and creep, and the steel relaxation. The reduction in the prestressing steel is known as the prestress loss. This paper discusses six different methods that either are currently in use or have been proposed to predict prestress losses. These six methods are: three nationwide methods—the AASHTO Standard method, the AASHTO LRFD method, and the AASHTO Lump Sum method; a modified AASHTO method; a PCI method; and a proposed time-step method. The first four methods calculate prestress losses at ultimate stage, whereas the last two methods calculate the time-dependent prestress losses at different time intervals. A comparison of these six methods is conducted and presented in table and chart.

USE OF A HEAT-FLOW METER APPARATUS TO EVALUATE REFLECTIVE INSULATION SYSTEMS. Parag S. Kanade* and David W. Yarbrough, Tennessee Technological University, Cookeville, Tennessee, and R&D Services, Inc., Cookeville, Tennessee. Reflective insulations utilize low-emittance aluminum foils to reduce radiative heat flow across building assemblies such as wall cavities, attics, and floors. The insulating systems created by reflective insulating materials are presently evaluated using hot-box facilities that are expensive and time consuming to operate. The use of a heat-flow-meter apparatus built in accordance with ASTM C 518 and modified to permit variation in heat-flow direction has been studied in this research. R-values obtained for assemblies with two reflective air spaces were compared with a correlation based on thermal data obtained at the United States National Bureau of Standards in the 1960s. The current work yielded R-values from 3 to 12% greater than the earlier values. The average difference between the two sets of data was about 6%. Similar results were obtained for assemblies with three air spaces. The results of this research indicate potential for the use of a heat-flow-meter apparatus to evaluate the performance of reflective insulations.

THERMODYNAMIC MODELING OF HYDROGEN FLUORIDE MIXTURES. Donald P. Visco Jr and Barath Baburao*, Tennessee Technological University, Cookeville, Tennessee. A modification of an association equation of state, which was proven successful for pure hydrogen fluoride, is extended towards its mixtures. Various mixtures like HF-R22, HF-CFCl₃, HF-HCl, etc that are important in the refrigerant and foam blowing agent industries are considered. Vapor liquid equilibria for all these mixtures at various states are reported and compared to experiment, where applicable. For some of the mixtures the model predicts

liquid-liquid-vapor equilibria at lower temperatures. These phase splits and the miscibility limits in the LLE region are a primary interest of this work.

EVALUATION OF CHANGES OF CEREBRAL NEAR-INFRARED SPECTROSCOPIC RECORDINGS INDUCED BY ORTHOSTATIC BODY TILT. *Richard L. Pasley and Michael L. Daley, The University of Memphis, Memphis, Tennessee.* To explore the preliminary development of a non-invasive method for assessing the state of cerebrovascular tone, near-infrared spectroscopic recordings were obtained prior to, during, and following a 20-degree orthostatic body tilt. Over 100 recordings obtained from eight different subjects were analyzed. The results of 87 artifact-free recordings showed that changes of oxyhemoglobin increased 78% of the time with head down tilts and decreased 71% of the time when the subject returned horizontal. In contrast, deoxyhemoglobin did not show a predictable pattern with tilt and tended to be almost random. It can only be speculated that unlike arterial flow, venous drainage varies from the baseline condition to the challenge condition. Thus, any attempt to extrapolate local flow changes from the computation of the difference of oxyhemoglobin and deoxyhemoglobin recordings appears to be invalid.

ETHICS IN SCIENCE AND TECHNOLOGY SECTION

RUBYE PRIGMORE-TORREY, CHAIR

TAMING A TWO-HEADED BEAST: ETHICAL ISSUES IN THE USE OF GENETIC TECHNOLOGIES. *Matt Elrod-Erickson, Middle Tennessee State University, Murfreesboro, Tennessee.* The early part of the twenty-first century likely will be known as the "Genomics Era". The incredible potential for diagnosis and treatment of human disease using the genetic technologies that are emerging at an increasingly rapid pace from research in both the public and private sector is alluring. However, the advent of these technologies also brings with it a number of profound ethical questions and an equally incredible potential for abuse. This paper will touch on some of the current successes and future hopes for applying genetic technologies to curing disease, but also will discuss a number of the ethical, social, and legal problems that will arise from the use of these technologies.

CYBER CRIMES: CAUSES AND SOCIAL CONSEQUENCES.

Joseph M. Kizza, University of Tennessee, Chattanooga, Chattanooga, Tennessee. The recent terrorist attack on America has made us reflect on the security of our national digital infrastructure. Questions abound whether there is a sure way to protect the infrastructure. If recent cyber attacks like the distributed denial of service attacks (DDoS), E-mail attacks like the Manila-generated "Love Bug", the "Killer Resume", and "Code Red", give us any indication of how prepared we are, it is that we are a long way from being prepared. Not only did these incidents expose law enforcement agencies' lack of expertise in digital forensics, they also alerted our complacent society to the weaknesses in computer network infrastructure, the poor state of the nation's preparedness, the little knowledge many of us have about computer security, the lack of efforts to secure the infrastructure, and the vulnerability of cyberspace businesses. In order to get a grasp of, understand the magnitude of, and find a solution to the

problem we are faced with, we need to look at and get an idea of the causes, costs, and social consequences of these attacks. This is the focus of this paper.

CHANGES IN SCIENTIFIC PUBLICATIONS DUE TO SPONSOR BIAS CLAIMS. *Rebecca Seipelt, Middle Tennessee State University, Murfreesboro, Tennessee.* Conflict of interest has long been recognized as cause for concern in reporting scientific research. As scientists, our data is scrutinized by the peer-review process in the hopes of limiting inaccurate or misinterpreted results and conclusions. Recent retractions of multiple research reports have damaged the reputations of the research community and several medically-related journals. Inaccurate conclusions have been blamed on sponsor bias and the related conflicts of interest. In response to this damage, several medically related journals have revised their conflict of interest policies for authors and also their publication policies. The changes in research publication policies and the implications for research, sponsorship, and publication will be discussed.

GEOLOGY AND GEOGRAPHY SECTION

DAVID LUMSDEN, CHAIR

IMPLICATIONS OF CARBON AND OXYGEN ISOTOPIC RATIOS IN PALEOZOIC CHERT AND HOST CARBONATE ROCKS IN THE VICINITY OF CHATTANOOGA, TENNESSEE. *Habte Giorgis Churnet, The University of Tennessee, Chattanooga, Chattanooga, Tennessee.* Variation of Carbon isotopic ratios in carbonate deposits of the Chattanooga area is consistent with secular variation reported in the literature for the Paleozoic of other regions. Heavy oxygen isotope enrichment in Paleozoic chert nodules of the Chattanooga area is much lower than that determined in Cenozoic chert bearing carbonates elsewhere. In fact, the Mississippian carbonate host rock is slightly more enriched than the chert in the Fort Payne Formation, and likely indicates disequilibrium conditions and/or contamination of the silicifying fluid. Oxygen isotopic ratios in Middle Ordovician and Mississippian carbonates are within the range of secular variations in temperature reported in the literature for these age rocks. However, Oxygen isotopic ratios in Cambrian to Ordovician Knox Group chert nodules and in the host carbonates are quite low. Three possible explanations include: (1) the $\delta^{18}\text{O}$ values of the diagenetic solutions or the Cambrian Ocean are very low, (2) the Oxygen isotopic ratios are not well preserved, or (3) the diagenetic solutions are of a higher temperature. Presence of breakthrough breccia in Chattanooga similar in setting to telethermal Mississippi Valley Type deposits elsewhere in the Knox Group is indicative of involvement of fluids of higher temperatures. Calculations yield temperatures up to 53°C (on ice free basis) for Knox Group at Chattanooga, which would have been too hot for an ocean in which brachiopods survived. It is more likely that warmer fluids diagenetically altered the Knox Group carbonate rocks. Likewise, silicification not only in the Knox Group but also in the Middle Ordovician carbonates (48–58°C) was from warm fluids. Silicification of the Mississippian Fort Payne is at a higher temperature (41°C) than the host carbonate diagenetic temperature of 13°C (on modern $\delta^{18}\text{O}_{\text{w}}$) basis. It appears that the chertification temperatures are least estimates of the diagenetic fluid temperatures owing to contamination by the oxygen ratio of the protolith. These tentative interpretations are

based on a minimum of one sample from each deposit mentioned above.

THE MALONE COLLECTION. *Malcolm T. Sadler and James X. Corgan, Austin Peay State University, Clarksville Tennessee.* Every day scores of visitors to the Clarksville Public Library walk past a display of 700 marine organisms. In the display, labels discuss the classification, variability, and ecology of marine life, while some labels identify books and Internet resources that aid in interpreting animals and plants. Clarksville's Customs House Museum has 1900 additional identified specimens in storage. These specimens will be used in exhibits such as "The Rocky Shore" and in kits that stress identification skills. Kits will serve youth groups and senior citizens. Dr. F. J. Malone and his family, creators of The Malone Collection, were at a United States Navy facility on Andros Island, Bahamas in 1974. Collecting natural history specimens became a hobby, but specimens were never identified. Every town has collectors of butterflies, minerals, etc. These items can be lost when a collector dies. Yet science teachers can curate collections. In this case, personal treasures are becoming a community resource.

PROVENANCE OF THE PEORIA LOESS IN THE NORTHERN MISSISSIPPI EMBAYMENT. *David N. Lumsden, Joseph W. Galluzzi, Patrick A. Drouin, and Charles H. Lumsden, The University of Memphis, Memphis, Tennessee.* The Peoria Loess caps two regionally prominent topographic highs in the Northern Mississippi Embayment (NME), Crowley's Ridge, Arkansas and the Chickasaw Bluffs, Tennessee. Changes that took place in the pathway of the Mississippi-Missouri-Ohio river system in the NME during Late Wisconsinan suggest that the proximal source of wind-deflated silt for the Peoria varied substantially in the interval of its deposition (circa 22,000 to 10,000 years BP). The basic question we asked is: "Can XRD of bulk samples be used to define mineralogical variations within the Peoria Loess, thereby providing a basis for interpretation of its provenance and depositional history?" We focused on feldspar and dolomite mineralogy in samples from five exposures along Crowley's Ridge and five along the Chickasaw Bluffs. Samples from Minnesota, Illinois, and Iowa provided insight into source area compositions. The Peoria Loess in the NME contains an average of 5–7% Na-feldspar ($d_{002} = 3.18\text{--}3.20\text{Å}$) and 2–4% K-feldspar ($d_{220} = 3.23\text{--}3.25\text{Å}$). The feldspar proportion varies randomly from location to location and is essentially similar on both features. Below the modern soil dolomite varies from 6–13% at seven locations, is absent at two locations and is present in the two basal samples at one other. The silt-sized dolomite grains have a similar near-stoichiometric composition and abraded appearance, wherever present. Neither feldspar nor dolomite abundance varies systematically with depth, except for the absence of dolomite in the modern soil. The similarity in abundance and composition of feldspar and dolomite in the Peoria Loess of both Crowley's Ridge and the Chickasaw Bluffs makes mineral-based subdivision difficult. The uniform abundance of dolomite below the modern soil suggests that soils did not have a chance to form during Peoria deposition.

HISTORY OF SCIENCE SECTION

MARY B. FARONE, CHAIR

PUBLIC RESPONSE TO THE DOMINION ASTROPHYSICAL OBSERVATORY, 1914–1918. *George E. Webb, Tennessee*

Technological University, Cookeville, Tennessee. Between the 1914 announcement of the selection of Victoria, British Columbia, as the site of the Dominion Astrophysical Observatory (DAO) and the completion of the facility four years later, the community learned of the design and other details of the large telescope and the role the new instrument would play in the advance of astronomy. The DAO also attracted attention for its potential value to Victoria's cultural landscape and to the city's economic growth. Not only would the observatory contribute to science, but it also would alert the public to the climatic and intellectual advantages of the provincial capital, already noted for its political importance. A careful examination of the public discussion of the observatory provides valuable insight concerning the important role played by science in the cultural evolution of Canada in the early twentieth century.

GALILEIANA. *Brother Kevin Ryan, Christian Brothers University, Memphis, Tennessee.* Notes on the three major writings of Galileo; comments on some of his minor writings; the trial by the Roman Catholic Church; articles of indictment; a method of measuring the distance to stars.

MATHEMATICS AND COMPUTER SCIENCE SECTION

JAMES B. HART, CHAIR

A CHARACTERIZATION OF PRIME NUMBERS BASED ON DIFFERENTIATION. *Dennis P. Walsh, Middle Tennessee State University, Murfreesboro, Tennessee.* We present a Differentiation-based test for primality, which uniquely characterizes prime numbers. Specifically, we prove that a positive integer n is prime if and only if the n -th derivative of function g , given by $g(x) = \exp(\sum_{k=1}^n x^k/k)$, evaluated at $x = 0$ is equal to $(n-1)!+1$. We also show that the afore-mentioned function g is a generating function for the number of homocyclic permutations in the symmetric group $S(n)$.

ON STRONG EMBEDDINGS OF CAYLEY GRAPHS. *Xiaoya Zha, Middle Tennessee State University, Murfreesboro, Tennessee.* Suppose A is a group and X is a generating set of A . The Cayley graph $G(A, X)$ is a graph whose vertex set is A and two vertices v_1 and v_2 are adjacent if there exists a group element g in X such that $gv_1 = v_2$. A strong embedding (also called a closed 2-cell embedding) of a graph in some surface is an embedding of the graph such that every face is homeomorphic to a closed disk. In this talk we will show that if X is a generating set of A with minimum number of elements, then $G(A, X)$ has a strong embedding in some surface. This verifies a special case of the Strong Embedding Conjecture, which says that every 2-connected graph has a strong embedding in some surface.

SCOTT DOMAINS—MODELS FOR PROGRAMMING SEMANTICS. *James B. Hart, Middle Tennessee State University, Murfreesboro, Tennessee.* The goal of computer program development is to construct a program that satisfies a given family of logical formulas. There are three steps to this development: Specification, Synthesis, and Verification. In the denotational approach to programming semantics, this threefold process is studied by assigning types to data objects (computations) specifying

the operations that may be performed on them, equipping these types with an information-based partial ordering, and creating a topology based on this partial ordering whose open sets represent the logical formulas. Programs are viewed as special functions between types. As a class, these types are known as Scott Domains. In this talk, we briefly examine and motivate the mathematical structure of Scott Domains.

AN ALTERNATIVE APPROACH TO A SPECIAL TYPE OF TRIGONOMETRIC EQUATIONS. *Max Y. Melnikov, Middle Tennessee State University, Murfreesboro, Tennessee.* An alternative (compared to the standard approach) technique is discussed in solving one special type of trigonometric equations. It is shown that in many cases this technique is more productive and much easier to understand. Some function analysis problems, related to this type of trigonometric equations are also discussed notably simplifying the analysis procedure.

A TRAPEZOIDAL TYPE METHOD WITH RATIONAL COEFFICIENTS FOR INITIAL VALUE PROBLEMS. *Tim Agee*, Samuel N. Jator, and Stephanie J. Carpenter*, Austin Peay State University, Clarksville, Tennessee.* In this paper the Pade' rational approximations are used as basis functions to derive a Trapezoidal-type method with rational coefficients. The convergence properties of the method are studied, which reveals that it can be used to solve a variety of problems with great reliability. The method is tested on some numerical examples by applying the method both iteratively and directly and the results are compared with the conventional Trapezoidal Rule. The results show that the method is accurate and also indicate that the construction of higher order methods, which will even yield better accuracy, are possible.

MATHEMATICS AND SCIENCE TEACHERS SECTION

REBECCA SEIPELT, CHAIR, AND
MICHAEL RUTLEDGE, CHAIR

MATHEMATICAL MODEL FOR PLANETARY TEMPERATURE INCLUDING THE INFLUENCE OF CARBON DIOXIDE. *Earl F. Pearson, Middle Tennessee State University, Murfreesboro, Tennessee.* A model is described that calculates the expected temperature of a planet located 93,000,000 miles from a sun that is burning at 5776 K. The energy captured by the planet is assumed to warm the planet until the energy radiated through blackbody radiation is equal to that received from its sun. Planck's relationship for blackbody radiation is assumed as well as Stefan's Law, which states that the total energy radiated is proportional to the fourth power of the absolute temperature of an object. Carbon dioxide is added to the atmosphere causing some of the radiation emitted by the planet to be absorbed and re-radiated back toward the planet. This prevents some of the radiation from escaping into space and causes the familiar "Greenhouse Effect." The model shows saturation of the absorption occurs at less than 5 ppm of carbon dioxide leading to a limit on the temperature increase. The temperature predicted by the model is 288 K.

PROBLEM SOLVING IN ENTOMOLOGY: KEEPING AHEAD

OF THE STUDENTS. *David B. Ekkens, Southern Adventist University, Collegedale, Tennessee.* Problem solving is an accepted way of teaching students to think and assimilate concepts. However, if the problem is too easy to solve, i.e. if the answer is readily available, learning may be replaced by copying. An entomology problem, based on a published study on gypsy moth populations and Lyme disease cases, was assigned to entomology students. The students were given partial (hypothetical) data from the published paper and told they would need more information that the teacher would supply on demand. The day after the problem was assigned, one student came in with a reprint of the published paper, which she had found via an Internet search. Consequently, the problem for the next year was rewritten, using hypothetical animals and diseases so that students could not find the actual paper.

STUDENT ASSESSMENT OF TRADITIONAL AND NON-TRADITIONAL COURSE ELEMENTS IN A FIRST GENETICS COURSE. *Rebecca Seipelt, Middle Tennessee State University, Murfreesboro, Tennessee.* In an effort to help students learn in a variety of ways, I have integrated technology-enhanced and other non-traditional materials into my college sophomore genetics course. The non-traditional course materials are divided into two categories: technology-enhanced and non-technology-enhanced. Technology-enhanced, non-traditional elements were the availability of practice problems, practice problem solutions, course notes, course grades, and course announcements via the Internet. One non-technology-based element was the use of concept maps. The traditional elements were class attendance, lab attendance, textbook, and lab book. Student assessment was performed via an internet-posted survey during the spring following the fall course. Twenty-one of 48 students responded to the survey. All assessed elements scored very high on average, greater than 4 on a scale of 1-5. When ranked in order, the elements in which students were active ranked highest, regardless of their traditional or non-traditional origin. These findings and others will be discussed.

INCORPORATING AWARENESS OF PROFESSIONAL ETHICS INTO SCIENCE COURSES. *Amy E. Jetton, Middle Tennessee State University, Murfreesboro, Tennessee.* An awareness of professional codes within specific fields of science or engineering is not common among undergraduates. Various government and accrediting agencies have increased requirements for teaching professional behaviors and codes. National Institute of Health Training Grants require graduate student training in the "Responsible Conduct of Research" (RCR), and the Accreditation Board for Engineering and Technology requires that accredited programs incorporate teaching of the Code of Ethics of Engineers into all levels of education including freshman courses. After attending a summer workshop, I have begun incorporating the teaching of professional ethics into my own course at MTSU. I will detail my current experience with teaching an ethical decision-making process and awareness of RCR into an animal physiology class. I will discuss various methods of incorporating the teaching of professional ethics into any science or mathematics course at any level.

TEACHING EVOLUTION: A COMPARISON OF DATABASE INFORMATION AND "WET" LAB EXPERIMENTS. *Steve R. Karr and Mary V. Ball, Carson-Newman College, Jefferson City, Tennessee.* There now exist numerous databases containing DNA

and protein sequences. The Biology Workbench (<http://workbench.sdsc.edu>) website offers "one-stop shopping" in that it brings together many of these databases into one site. At this site, you can search databases, align sequences, and generate inferred phylogenetic trees. As useful as this information is in teaching evolution, it does not readily allow for the student to do actual lab experiments. Here, we compare use of such databases to lab experiments testing the cross-reactivity of antibodies. Antibody/antigen reactivity was examined using the double diffusion (Ouchterlony) technique. The database sequence information compared favorably with antibody cross-reactivity.

STUDENT-RUN ELECTRONIC-JOURNALS IN SCIENCE EDUCATION. *Philip M. Mathis and John D. DuBois, Middle Tennessee State University, Murfreesboro, Tennessee.* The past decade has witnessed explosive growth in the number and kinds of available electronic-journals (e-journals) in science. However, only a few of these are student-operated and feature student research, despite the fact that such journals clearly offer the opportunity to: (1) foster and publicize student research; (2) promote analysis and evaluation of research; (3) promote computer literacy; (4) develop student leadership skills; (5) encourage collaboration and interdisciplinary involvement; and (6) augment program offerings such as scientific literature courses. Factors to be considered in developing a student-run e-journal include operational procedures, the method and frequency of student officer appointments, faculty oversight, copyright policy, Web connections, journal publicity, and building "team spirit." A number of Web sites and other resources useful to e-journal builders will be presented.

A STUDENT-RUN ELECTRONIC-JOURNAL: SUCCESS STORY AT MIDDLE TENNESSEE STATE UNIVERSITY. *John D. DuBois and Philip M. Mathis, Middle Tennessee State University, Murfreesboro, Tennessee.* An important part of scientific investigation is the dissemination of research results and conclusions. Understanding the mechanisms of disseminating this information is an important part of the graduate and undergraduate science experiences. Launched in the spring of 1997, *Scientia*, The Journal of Student Research (<http://www.mtsu.edu/~scientia>) highlights research efforts and achievements of students in the College of Basic and Applied Sciences at Middle Tennessee State University. *Scientia* allows students to experience first-hand the operations of a professional scientific journal. Students fill all officer positions and the editorial board. Governance and promotion of *Scientia* are the responsibilities of the board of faculty facilitators, representing each department and chaired by the Dean of the College. The student editorial board reviews manuscripts and the editor makes final accept/reject decisions. The Web site manager maintains the Web site and posts accepted manuscripts. The success of this electronic-journal will be described.

SURVIVING THE SCIENCE PIPELINE: HOW TO PROVIDE WOMEN STUDENTS WITH THE TOOLS TO SUCCEED IN SCIENCE. *Judith M. Iriarte-Gross, Middle Tennessee State University, Murfreesboro, Tennessee.* Numerous reports and studies have suggested reasons why women too often choose non-science related careers. Cited reasons include a lack of confidence in their intellectual abilities, a distorted view of who a scientist is, and isolation from other women in science. Thus there is a compelling need for the early mentoring of female students, for

educating parents and faculty regarding the unique problems of female students, and for providing female students with opportunities for exposure to and interaction with female scientific professionals. There are programs in place at MTSU that address these concerns such as a strong undergraduate research program which includes the McNair Scholars Program, Expanding Your Horizons for middle school girls, and Project SEED of the ACS for high school students. These programs will be discussed with a focus on preventing and plugging leaks in the pipeline

CHARACTERIZING THE LEARNING STYLES OF AFRICAN AMERICANS (SEVENTH GRADE SCIENCE STUDENTS; COLLEGE SCIENCE STUDENTS; MIDDLE, HIGH SCHOOL, AND COLLEGE SCIENCE TEACHERS; AND SCIENCE PROFESSIONALS) AS IDENTIFIED BY DUNN, DUNN, AND PRICE LEARNING STYLE INVENTORIES. *Don R. Perine and Patricia Patterson, Middle Tennessee State University, Murfreesboro, Tennessee.* This study was performed to determine how African Americans prefer to function, learn, concentrate, and perform in their educational activities in the areas of: (a) immediate environment, (b) emotional, (c) sociological needs, and (d) physical needs, and whether or not these preferences remain constant from adolescence to adulthood and whether or not the issue of under-representation of African Americans in the sciences can still be addressed by implementing learning style methodology for adults or should this methodology be addressed during the adolescent years. The author chose the methodology of a learning style inventory (Dunn, Dunn and Price Learning Style Inventory (LSI), and Productive Environment Preference Survey (PEPS) to generate the necessary data to address the hypothesis of there being no difference in the learning style preferences of seventh grade African American science students, and the preferences of adult African American college science students, science teachers, and science professionals. The data suggest that the learning style preferences of the students are nearly identical to those of the adults, especially in the areas of Motivation, Structure, Learning Alone/Peer Oriented, Authority Figure Present, Visual, Tactile, Kinesthetic, Requires Intake, and Afternoon/Morning Person.

A TEACHER ENHANCEMENT PARTNERSHIP FOR RUTHERFORD COUNTY MIDDLE SCHOOL SCIENCE TEACHERS. *Patricia M. Patterson, Middle Tennessee State University, Murfreesboro, Tennessee.* Twenty-four science teachers participated in nine workshops during January–June 2001, as part of a 2000 Tennessee Higher Education Commission Eisenhower Professional Development Grant. An analysis of 1999 TerraNova test scores showed a 15–25% decrease in the average objective performance index (OPI) from 1998. Based upon observing instruction in middle school classrooms across Rutherford County, it was concluded that middle school science teachers needed extensive in-service to increase student comprehension. Training was done in the areas of communication of concepts with students to increase student's understanding of concepts and application of these concepts to solve science problems. Workshops led by experienced science teachers used a variety of teaching techniques, including hands-on/minds-on inquiry-based activities based on the *National Science Education Standards* and *Tennessee Science Curriculum Framework*. From these workshops, it was concluded that science teachers in other surrounding counties would benefit from similar workshops. The teachers left be-

lieving, "Learning science is something students do, not something that's done to them."

TECHNOLOGY TOOLS FOR TEACHING MATHEMATICS.

Mary B. Martin and Dovie L. Kimmins, *Middle Tennessee State University, Murfreesboro, Tennessee*. The question answered here is how to present mathematics and general science materials in a professional fashion that is also time-effective. After reviewing a variety of software, we settled on a basic array of three software packages: Scientific Notebook, PowerPoint, and Snagit. This presentation will display the results of using this software. Next, the presentation will focus on the "best practices" for designing presentations, which include high quality graphs and equations. There will be three parts to discussion: Generating mathematics and graphics quickly that can be used in print material or for PowerPoint, web display, etc.; "Best Practices" for using PowerPoint, and in particular for using PowerPoint effectively in generating mathematical presentations; and, briefly, methods of animating or altering your display methods using Dreamweaver, Frontpage, or Macromedia Flash. After trying a variety of software, the following three conclusions were reached: 1) Scientific notebook makes the best graphics and equations, 2) Snagit is cheap and easy and will paste graphics or pictures from any electronic source into any application which supports picture formats (gif, etc.), and 3) The best media for presentation, either web or otherwise, is PowerPoint. This is true even if you want animation, although it will not allow you to generate buttons. Using these software packages, you can make presentation materials that appear very professional, have a minimum of preparation time, and a quick learning curve (compared to other software). What is given up in flexibility is gained in time.

RE-CIPE: A RESEARCH GROUP METHODOLOGY ENCOURAGING RELATIONSHIP, COMMUNITY, INDIVIDUAL VOICE, PERSONAL EXPERIENCE, AND EMPOWERMENT.

Terra L. Smith, *The University of Memphis, Memphis, Tennessee*. A research group methodology helps promote a laboratory climate with the goal of empowering undergraduate students to use research as a problem-solving tool. The components of the method are relationship, community, individual voice, personal experience, and empowerment (Re-CIPE). Relationship focuses on the interactions between the professor and the student researcher as well as with other students, while community highlights the context that supports research activities and the student researcher's responsibilities to research subjects and the local community. Individual voice is an important medium of exchange between the student and other members of the course. Personal experiences help promote understanding of research topics. Empowerment is sought as an outcome of the learning environment. The research group methodology, Re-CIPE, relies on the importance of relationships, humanity and ethics, voice, experiential learning, and the negotiation of power to help promote understanding among undergraduate student researchers.

THE USE OF A UNIT MAP AND MANIPULATIVES TO TEACH DIMENSIONAL ANALYSIS. **Edward L. Brown**, *Lee University, Cleveland, Tennessee*. Dimensional Analysis has historically been presented in textbooks in a piece-meal approach, leaving it up to the students to recall past relationships among units and applying those relationships to new problems. A new approach has been developed where the relationships between

units are displayed in a "map" and cards containing conversion information are used as manipulatives to convert between units. With this teaching aid, students are able work complicated problems in chemistry with a minimal amount of instruction. This raises the confidence level of students and results in an increase in learning.

MIDDLE TENNESSEE STATE UNIVERSITY WOMEN IN SCIENCE, MATHEMATICS, ENGINEERING, AND TECHNOLOGY UNDERGRADUATE PROGRAMS. **Judith M. Iriarte-Gross***, **Judith A. Hankins**, **Brenda Parker**, **Chrisila Petty**, and **Ginger H. Rowell**, *Middle Tennessee State University, Murfreesboro, Tennessee*. There is a critical need for recruitment, retention, and graduation of women in science, mathematics, engineering, and technology (SMET) in this country. The low rate at which women are entering the SMET pipeline is troubling, especially considering that even more of the low paying jobs require an increase in science, mathematics, and technology literacy. MTSU is graduating slightly less than the national percentage of women in the SMET disciplines, yet university-wide, the majority of both undergraduate and graduate students are female (54%). Given these numbers, and the growing employment opportunities in SMET at MTSU, there is a strong need for a program to attract, retain, and graduate women in SMET at MTSU. The planning and implementation of a Women in Science Undergraduate Program (WISUP) at MTSU will be presented and discussed.

BRINGING TECHNOLOGY AND CONSUMERISM TO PHYSICAL SCIENCE LABORATORIES. **Dara Grissom and Judith Iriarte-Gross**, *Middle Tennessee State University, Murfreesboro, Tennessee*. The purpose of this research is to bring real life experiences into the physical science laboratory. We want to make the laboratory interesting and applicable for the non-science majors who are required to take this course. Our development of several new laboratories for the Physical Science 1030 course is our first step towards achieving this goal. We are introducing new technology in these laboratories such as the TI-83+ graphing calculators, computers, and Vernier Lab Pros and probes. The consumer-oriented laboratories intrigue the non-science students. The knowledge gained from these laboratory activities will enable students to make intelligent choices about not only science, but also about their health and finances. Some of the new laboratories we are developing include: "Combustion of Fuels", "What is the Best Antacid?", "Citrus Juice", and "How Much Fat is in Your Munchies?". From these laboratories, students learn graphing skills, consumer chemistry, energy conservation, and most importantly, science literacy.

MEDICAL SCIENCE SECTION

DAVID M. O'DROBINAK, CHAIR

PHOTOLYASE: A DNA REPAIR ENZYME. **Michael DeCuyper and S. K. Ballal**, *Tennessee Technological University, Cookeville, Tennessee*. Enzymatic photoreactivation is a direct mechanism to repair UV-induced cyclobutane pyrimidine dimers. Exposure to ultraviolet radiation (200–300 nm) promotes the formation of a cyclobutyl ring between adjacent pyrimidine residues on the same DNA strand so as to form an intrastrand dimer. Such dimers locally distort DNA's base-paired structure, interfering

with transcription and replication, and ultimately leading to cell death. Photolyases absorb blue or near-UV light via intrinsic chromophores. Two types of chromophores have been isolated: 5,10-methylenetetrahydrofolate (MTHF), which confers an absorption maximum around 380 nm, and 8-hydroxy-5-deazariboflavin, which gives an absorption maximum of approximately 440 nm. Photolyase is a structure specific DNA binding protein whose specificity is determined by the backbone structure of DNA at the binding site. This contrasts with the sequence specific DNA-binding proteins which rely on hydrogen bond donors and acceptors in the grooves of the complex. The reaction is a light-initiated cycloreversion of the cyclobutyl ring joining the two pyrimidines. The photoexcited photolyase molecule transfers an electron to the PYR<>PYR dimer and the resulting anion radical splits into two separate pyrimidines. Although the enzyme has previously been isolated in all groups of all phyla except placental mammals, little work has been done with fungi and fewer studies have been done using *Chaetomium globosum*, a species with high UV damage resistance. In this study an attempt is made to isolate fungal DNA photolyase utilizing a new, less hazardous form of the bacterial plasmid photorepair assay. Utilizing a specific streptomycin resistant plasmid gene, resistance is conferred to a streptomycin-sensitive bacterial strain via plasmid DNA photorepair subsequent to fractionization of *C. globosum* cell free extract by size exclusion chromatography.

SECOND REPORT OF *TRYPANOSOMA CRUZI* IN *TRITOMA* SP. (REDUVIDAE) IN MIDDLE TENNESSEE. **Francisco Delgado, Anthony L. Newsome, and Charles R. McGhee**, Vanderbilt University, Nashville, Tennessee (FD), and Middle Tennessee State University, Murfreesboro, Tennessee (ALN, CRM). In 1998 the recovery of *Trypanosoma cruzi* (the etiological agent of Chagas's disease) from *Triatoma sanguisuga* (an insect vector) in middle Tennessee was reported. Subsequent studies identified an infected individual and family dog that resided in the same household. In addition, two of three raccoons trapped nearby had hemocultures positive for *T. cruzi*. In July one of us (FD) recovered a single *T. sanguisuga* at an apartment complex located next to Edwin Warner Park in Nashville, Tennessee. The intestinal tract was removed and the small amount of contents suggested the insect had not fed recently. However, when viewed by phase contrast microscopy highly motile flagellates were observed. Subsequently smears were Giemsa stained and a presumptive identification of *T. cruzi* was made based on the C shape in some flagellates and the presence of a large kinetoplast. Giemsa stained slides and additional fixed smears were sent to the Centers for Disease Control and Prevention in Atlanta, Georgia, which confirmed the presumptive identification of *T. cruzi*. Closer examination showed a predominance of the epimastigote stage and the trypanomastigote stage to a lesser extent. The recovery of *T. cruzi* from a vector in an urbanized area is of potential significance to human health. It further suggests that one or more groups of mammals in an urban area of middle Tennessee may harbor *T. cruzi* and serve as a reservoir for infecting insect vectors. Likely sources of infection could be raccoons, opossums, and perhaps dogs kept outside.

MICROBIOLOGY SECTION

ANTHONY FARONE, CHAIR

AN UNUSUAL POLYUNSATURATED C₂₇ HYDROCARBON FROM THE MARINE DINOFLAGELLATE *PYROCYSTIS LU-*

NULA. **Jeffrey Leblond and Peter Chapman**, Middle Tennessee State University, Murfreesboro, Tennessee and United States Environmental Protection Agency (NHEERL), Gulf Ecology Division, Gulf Breeze, Florida. Studies of the lipids of algae have revealed a diversity of compounds, of which several are considered useful biomarkers with potential for characterizing phytoplankton community composition. To extend this approach and characterize the lipids of marine dinoflagellates, compositional data were obtained for sterols of over forty species. In the course of this work, *Pyrocystis lunula* was found to contain an abundant quantity of a long-chain polyunsaturated hydrocarbon. The molecular weight (364) and retention time obtained by GC/MS analysis suggested a C₂₇ compound, which was confirmed by reduction to give the straight chain alkane, *n*-heptacosane. The carbon number and number of double bonds suggest formation by decarboxylation of long-chain polyunsaturated C₂₈ fatty acid shown to be a constituent of phospholipids. This hydrocarbon was not found in any other genus of the examined dinoflagellates, and appears to be one of the first identifications of a hydrocarbon in this class of algae.

ISOLATION AND IDENTIFICATION OF AMYLASE-PRODUCING MICROORGANISMS. **Shawn C. Robichaud* and John M. Zamora**, Middle Tennessee State University, Murfreesboro, Tennessee. Microbial enzymes are used in the baking, brewing, distilling, starch, and textile industries. Amylases are the enzymes that break down starch. The purpose of this study was to isolate and identify amylase-producing organisms. Several laboratory strains of organisms were plated onto starch agar to determine if these organisms produced amylase. Soil samples were inoculated onto starch agar. Bacteria capable of breaking down the starch were isolated and identified to species. Forty organisms were grown in liquid culture and starch breakdown was determined using a spectrophotometric assay. Results were obtained and bacterial amylase units were calculated for each organism. Statistical analysis was used to determine the best starch degraders. The best starch degraders were *Bacillus* spp. These environmental isolates may be useful in the production of amylase.

IDENTIFICATION OF SELECTED BACTERIAL PATHOGENS FROM THE VENOM AND ORAL CAVITIES OF *AGKISTRODON CONTORTRIX MOKASEN* AND *AGKISTRODON CONTORTRIX CONTORTRIX*, NORTHERN AND SOUTHERN COPPERHEADS. **Daniel R. French* and Don Dailey**, Austin Peay State University, Clarksville, Tennessee. The bacterial diversity in the venom and oral cavities of two subspecies of Copperheads, the Northern and Southern Copperheads was investigated. Seventeen Northern and Southern Copperheads in the Kentucky Reptile Zoo in Slade, Kentucky and two Northern Copperheads at Austin Peay State University in Clarksville, Tennessee were surveyed. Eight selective media were used to select for specific groups or genera of bacteria. Ninety-three isolates were obtained from the oral cavity of the 36 Copperheads. The majority of the isolates were species of *Staphylococcus*; the second and third-most-common genera were *Streptococcus* and *Pseudomonas*, respectively. Only one bacterium (*Streptococcus* sp.) was isolated from the 36 venom samples. The venom also was used in a disk diffusion assay to test for antibacterial activity. All venom samples demonstrated inhibitory effects on all four test bacteria—*Escherichia coli*, *Aeromonas hydrophila*, *Staphylococcus aureus*, and *Pseudomonas aeruginosa*.

ADVANTAGES IN INTERSPECIES COMPETITION OF *ESCHERICHIA COLI* SELECTED FOR RESISTANCE TO ANTIMICROBIAL TRICLOSAN. **Eric Freund***, **Tim Decha-Umphai***, and **Steve Wright**, *Middle Tennessee State University, Murfreesboro, Tennessee*. Several species of bacteria, including *Escherichia coli*, *Staphylococcus aureus*, and *Pseudomonas aeruginosa*, have been shown to develop resistance to triclosan, an antimicrobial agent commonly found in antibacterial consumer products. Organisms resistant to triclosan could become more prevalent in nature if resistance to triclosan also resulted in advantages in interspecies competition. This experiment evaluated whether competitive advantages could be demonstrated when *E. coli* developed resistance to triclosan by comparing an antibiotic-producing *Bacillus* sp. inhibitory effects on resistant and non-resistant strains of *E. coli*. After selecting for a triclosan-resistant strain of *E. coli*, the resistant and non-resistant strains were tested against an antibiotic producing *Bacillus* sp. to examine acquired advantages. It was shown that *E. coli* resistant to triclosan demonstrated greater survivability than the non-resistant strain in interspecies competition, suggesting a competitive advantage that could be maintained in nature.

PHYSICS AND ASTRONOMY SECTION

LING JUN WANG, CHAIR

HOW TO ROTATE EINSTEINIAN SPACE. **Ling Jun Wang**, *The University of Tennessee, Chattanooga, Chattanooga, Tennessee*. The rotational behavior of Einsteinian space is discussed in the context of rotational transformation between the Schwarzschild metric and the Kerr metric obtained for weak field within the limit of $(\omega) < c$. The transformation on the equatorial plane is discussed in detail. The transformation thus obtained is a direct consequence of Einstein's field equation. It has been found that the transformation is local in nature, and no global uniform rotational transformation is possible. The rotational time dilation and angle contraction derived from this transformation are locally consistent with the time dilation and length contraction of special relativity of a co-moving system with a linear velocity $v = \omega r$.

OBSERVATION OF UNIVERSAL BEHAVIOR IN CORRELATIONS BETWEEN ELECTRON DENSITY FUNCTIONS. **Preston J. MacDougall**, *Middle Tennessee State University, Murfreesboro, Tennessee*. Power laws are one of the signatures of complex systems that exhibit scale-free behavior. Power laws also figure prominently in fundamental atomic physics, from Moseley's discovery of atomic number to density functional theory. We present correlations between electron density functions obtained, both computationally and experimentally, for atoms, molecules, and crystals. The basic form of particular correlations persists for all types of matter considered. Surprisingly, the same result is observed between corresponding functions in momentum space. We discuss similarities between molecular systems that are at equilibrium, and complex systems in states of self-organized criticality.

IS IT REAL OR DOES IT JUST LOOK THAT WAY? **Eric T. Lane** and **Thomas A. Orofino**, *The University of Tennessee, Chattanooga, Chattanooga, Tennessee*. Do relativistic length, time, and mass changes actually occur or are they merely obser-

vational effects? When a rocket ship zips past at six tenths of the speed of light, we measure a meter stick on the ship to be only 80.0 centimeters long. The time between ticks of a clock on the ship take about 1.250 second on our clock. One kilogram mass on the ship appears to have a mass equal to 1250 of our grams. Curiously, when we ask the captain of the rocket ship to make the same measurements of our meter stick, clocks, and masses, he finds the same thing we did. What's going on? We can't both be observing real changes, can we? We wish to argue that neither result represents physical reality, as Special Relativity is a theory of observation.

EXPERIMENTAL STUDIES ON THE NATURE OF BONDING OF DNA-BIPYRIDYL-(ETHYLENEDIAMINE)PLATINUM(II) AND DNA-NETROPSIN COMPLEXES IN SOLUTION AND ORIENTED WET-SPUN FILMS. **R. L. Marlowe**, **A. Szabo**, **S. A. Lee**, and **A. Rupprecht**, *The University of Tennessee, Chattanooga, Chattanooga, Tennessee (RLM)*, *University of Toledo, Toledo, Ohio (AS, SAL)*, and *University of Stockholm, Stockholm, Sweden (AR)*. The stability of complexes of NaDNA with bipyridyl-(ethylenediamine)platinum(II) (abbreviated [(bipy)Pt(en)]²⁺) and with netropsin has been studied using two techniques: (i) ultraviolet (UV) melting experiments were done on NaDNA·[(bipy)Pt(en)]²⁺, showing that the [(bipy)Pt(en)]²⁺ ligand stabilizes the DNA double helix structure; and (ii) swelling measurements (via optical microscopy) as a function of relative humidity were done on wet-spun oriented films of NaDNA·[(bipy)Pt(en)]²⁺ and of NaDNA-netropsin. The swelling data show that an irreversible transition of the films occurs at high relative humidity, first for the NaDNA-netropsin, then for pure NaDNA, and lastly for the NaDNA·[(bipy)Pt(en)]²⁺. These results are indicative that the [(bipy)Pt(en)]²⁺ complex stabilizes the intermolecular bonds which mediate the film swelling characteristics. A model is suggested for the binding of [(bipy)Pt(en)]²⁺ to DNA to explain why the swelling experiments show this ligand as increasing the intermolecular bond strength between the DNA double helices, while netropsin decreases this degree of stabilization.

EFFECT OF PHASE ON FAST FOURIER TRANSFORMS WITH APPLICATIONS TO TIME-SERIES PHOTOMETRY. **Travis Laurance*** and **Eric Klumpe**, *Middle Tennessee State University, Murfreesboro, Tennessee*. The reliability of the assumption inherent in a fast Fourier transform that the phase at time zero for all modes present is zero is put to test. Using a noise free signal made up of two sinusoidal components with different frequencies, a phase shift was applied to one of the signals and the results of the fast Fourier transform (FFT) were examined. It was found that phase does indeed affect the FFT results, specifically in cases where the signal is shorter than a critical length of time. Thus phase must be taken into account when using the FFT algorithm to analyze signals. This study was conducted with special emphasis to time-series photometry and the Whole Earth Telescope.

INVESTIGATION OF METAL-DIELECTRIC MULTILAYER AS AN IMPROVED BIOCHEMICAL SENSOR. **C. Brad Bennett**, **J. N. Munday**, and **W. M. Robertson**, *Middle Tennessee State University, Murfreesboro, Tennessee*. Experiments are described concerning the excitation of surface guided waves on metal-dielectric thin-film multilayers, and investigations into the possibility of using these multilayers as biochemical sensors are discussed. We make a brief comparison between surface plas-

mons and surface guided waves. We also discuss theoretically the reflective properties of multiplayer thin-films that will allow their use as sensors. Our attempts at fabricating such a sensor necessary for our experiments along with our results are described in great detail.

PHYSIOLOGY AND BIOCHEMISTRY SECTION

DARRIN L. DEMOSS, CHAIR

SEASONAL CHANGES IN RED CELL NUCLEOSIDE TRIPHOSPHATE LEVELS IN MALE FENCE LIZARDS. **Matthew Klukowski**, *Middle Tennessee State University, Murfreesboro, Tennessee*. Elevated levels of red blood cell nucleoside triphosphates (NTP) decrease the affinity of hemoglobin for oxygen in many vertebrates and thus may facilitate the unloading of oxygen to the tissues. It was hypothesized that red cell NTP levels would be greater during the breeding season than the nonbreeding season in male fence lizards, *Sceloporus undulatus*, for two reasons: physical activity levels are much greater and environmental temperatures are cooler during the breeding season than the nonbreeding season. Both of these factors would be expected to increase the relative importance of unloading versus obtaining oxygen. Red cell NTP levels were greater during the breeding season than the nonbreeding season by an average of 16%. This seasonal change in organophosphates may enhance the unloading of oxygen to the tissues during the breeding season when males are extremely active patrolling their home ranges and engaging with conspecifics.

ZOOLOGY SECTION

JAMES A. HUGGINS, CHAIR

AN ASSESSMENT OF INTERLOCALITY VARIATION IN CHARACTER RELATIONSHIPS OF BLACK BEARS IN THE WESTERN UNITED STATES. **Binh Tran, Melvin L. Beck, and Michael L. Kennedy**, *The University of Memphis, Memphis, Tennessee*. Relationships of morphologic characters were assessed in the black bear *Ursus americanus*. Twenty-four cranial measurements were examined from bears collected from 11 localities in the western United States. Character relationships were determined using correlation values and the Mantel test. Overall, results suggested high correlations among selected characters. Additionally, associations among some characters remain rather stable throughout the area sampled while others appeared variable.

AN ASSESSMENT OF CATCH-PER-UNIT-EFFORT TO MONITOR POPULATION TRENDS OF SMALL MAMMALS IN WESTERN TENNESSEE. **Heidi L. Hopkins* and Michael L. Kennedy**, *The University of Memphis, Memphis, Tennessee*. Species richness and species abundance distributions were assessed in three habitat types (forest, early successional field, forest/early successional field edge) using Sherman live traps. Thirty transects of 10 traps each were established in respective habitat types during fall, winter, and spring seasons. Species richness and species abundance distributions were determined from results based on approximately 900 trap nights in each habitat per season. Results to date indicate greatest species richness in edge

habitat followed by field and forest, respectively. Species with the greatest abundance distributions were: white-footed mouse *Peromyscus leucopus*, forest and edge; eastern cotton rat *Sigmodon hispidus*, field. Independent mark-recapture studies were conducted to determine estimates of absolute abundance of species in each habitat type and provide comparative data for relative abundance measures derived from transect sampling. Results suggest that indices derived from live trapping based on catch-per-unit effort can be used to monitor population trends of small mammals.

STATUS OF *CAMBARUS WILLIAMI* BOUCHARD AND BOUCHARD, AN ENDEMIC CRAYFISH TO THE ESCARPMENT OF THE EASTERN HIGHLAND RIM OF TENNESSEE. **Roger A. McCoy and David I. Withers**, *Tennessee Division of Natural Heritage, Nashville, Tennessee*. *Cambarus williami* (no common name) was described in 1995 by R. W. Bouchard and J. W. Bouchard (*Notulae Naturae*, Number 471) from specimens collected at Brawley's Fork in Cannon County, Tennessee. *Cambarus williami* is distinguished from the closely related *C. friaufi* and *C. brachydactylus* by gonopod and annulus ventralis morphology. The species is apparently restricted to small, spring-fed, gravel and chert-bottomed streams, where it inhabits burrows constructed in the substrate. It was reported only from Brawley's Fork until the Division of Natural Heritage initiated surveys in 2000. Currently, *Cambarus williami* is reported from 13 sites in 10 streams, all within the escarpment of the Eastern Highland Rim in the East Fork Stones drainage. *Cambarus williami* has not been found in similar habitats in adjoining watersheds. The Tennessee Wildlife Resources Agency listed the species as Endangered in 2001.

THE RATCHET AND THE RED QUEEN: THE MAINTENANCE OF SEX IN PARASITES. **R. Stephen Howard**, *Middle Tennessee State University, Murfreesboro, Tennessee*. An important unresolved problem in evolutionary biology is to account for the adaptive significance of sexual reproduction in parasites. Recent theoretical studies describe two possible mechanisms that may favor sex over asex: (i) interactions with other parasites, and (ii) interactions with the vertebrate immune system. In the present study I used individual-based computer simulation models to explore a third possibility—that sex in parasites is favored as the result of direct interactions with hosts. I tested this hypothesis by tracking the progress of asexual lineages into sexual populations for various combinations of parasite virulence and rates of transmission to hosts. In general, these results suggest that coevolutionary interactions promote coexistence between sexual and asexual parasites, selecting for the accumulation of clonal diversity and thus undermining any potential long-term advantage to sex. The incorporation of stochastic mutation accumulation (Muller's ratchet) into the model however, reverses the pattern and generates a decisive advantage to sex over a wide range of parameter space. This result may explain the observation that sex is more common among long-lived parasitic species as compared to their free-living relatives.

SCENT MARKING AND MATE CHOICE IN THE PRAIRIE VOLE *MICROTUS OCHROGASTER*. **Shawn A. Thomas***, *The University of Memphis, Memphis, Tennessee*. Olfactory communication through scent marking is common among mammals and provides information to conspecifics about the competitive ability, identity, or attractiveness of an individual. Females sup-

posedly can assess male quality based on their scent. However, mate choice based on scent marking by males has not been tested experimentally. In a series of laboratory experiments with prairie voles *Microtus ochrogaster*, females did not choose males based on their frequency or pattern of scent marking. Additionally, females did not advertise their interest in a particular male through scent marking. Scent marking appears to advertise individual identity, but in prairie voles, the frequency and pattern of scent marking is not a reliable predictor of dominance or mate choice. Mate choice is a complex phenomenon and apparently depends on a suite of phenotypic male characteristics that have precedence over quantity of scent marks.

BREEDING STRATEGIES OF THE AMERICAN ELK IN RESPONSE TO PREDATION RISK. *Jerry O. Wolff, Toni Van Horn*, Emily Hopkins*, and Aaron Stoudt*, The University of Memphis, Memphis, Tennessee.* Prey animals such as elk may alter their behavior in the presence and absence of predation risk with respect to differing levels of vulnerability. We gathered data on rutting behavior of bull elk in predator-free (Rocky Mountain National Park; RMNP) and predator-rich (Yellowstone National Park; YNP) environments. Data were gathered on group size, foraging behavior, vigilance, fighting versus ritualized aggression, and other risk-taking behaviors of bull and cow elk in the two study sites. We hypothesized that elk in YNP would spend more time in vigilance, less time foraging, exhibit more ritualized and less combat aggression, form larger group sizes, and spend more time close to cover than those in RMNP. Data were gathered from mid September through October 2001. The results will be applied to adaptive strategies associated with risk-avoidance theory.

A SURVEY OF BATS AT SHILOH NATIONAL MILITARY PARK. *Paige E. Pierce*, Michael L. Kennedy, and James A. Huggins, The University of Memphis, Memphis, Tennessee (PEP, MLK) and Union University, Jackson, Tennessee (JAH).* From May through October 2001, bats were surveyed at Shiloh National Military Park, Hardin County, Tennessee. Sampling was conducted using mist nets in dry and wet habitats throughout the park. Nets were set for capture usually 3 to 4 days per week. Results indicated the capture of over 120 individuals representing seven species. *Lasiurus borealis* (red bat), *Myotis austroriparius* (southeastern myotis), *Pipistrellus subflavus* (eastern pipistrelle), and *Nycticeius humeralis* (evening bat) were species captured most frequently. Demographic information for each species is discussed.

ASSOCIATION OF SELECTED HABITAT VARIABLES TO CAPTURE SUCCESS OF RACCOONS *PROCYON LOTOR*, VIRGINIA OPOSSUMS *DIDELPHIS VIRGINIANA*, AND STRIPED SKUNKS *MEPHITIS MEPHITIS*. *Roger A. Baldwin, Allan E. Houston, and Michael L. Kennedy, The University of Memphis, Memphis, Tennessee (RAB, MLK) and The University of Tennessee, Knoxville, Tennessee (AEH).* During the fall and winter of 2000–2001, raccoons *Procyon lotor*, Virginia opossums *Didelphis virginiana*, and striped skunks *Mephitis mephitis* were live-trapped on an 8 × 8 grid (traps spaced at 230 m intervals) at the Ames Plantation in Fayette and Hardeman counties in western Tennessee. The purpose of the study was to determine the association of selected habitat variables to capture success. At each trap site, over 20 variables were measured, and correlation analysis was used to determine the association of var-

iables with captures. Percent slope, number of logs present, and number of pine snags >35 cm dbh were found to have the highest correlations with capture success.

SPATIAL ASSOCIATION OF RACCOONS *PROCYON LOTOR* IN WESTERN TENNESSEE. *Jason B. Jennings*, Michael L. Kennedy, Troy A. Ladiné, and Shannon Maris-Danley, The University of Memphis, Memphis, Tennessee.* Spatial association (the occurrence of an individual in relation to another) of a population of raccoons *Procyon lotor* was assessed during the winters of 1991–2001 at the Meeman Biological Station in Shelby County, Tennessee. From mark-recapture data on a 5 by 10 grid (traps spaced at an interval of approximately 150 m), spatial associations were determined from movements documented on the grid. Results indicated that raccoons at this site utilized much of the same space. Support for intraspecific exclusion of raccoons by others was lacking. Data were examined in relation to age and sex.

AN EVALUATION OF WITHIN- AND AMONG-STREAM VARIATION OF BIOASSESSMENTS IN THREE STREAMS. *Rebecca Houtman*, Steven W. Hamilton, and Joseph R. Schiller, Austin Peay State University, Clarksville, Tennessee.* The United States Environmental Protection Agency has published Rapid Bioassessment Protocols for assessing the biotic integrity of streams. These techniques employ several ecologically relevant measures of community structure, function, and pollution tolerance, i.e. metrics, considered to be sensitive to stream degradation. The metrics are selected to cover a wide range of structural and functional properties of aquatic biological communities. The preliminary data of this study test the implied assumption that sampling two riffles of a single stream reach provides an accurate representation of the macroinvertebrate assemblage of the stream and, therefore, a reliable bioassessment. Five riffles from each of three reaches were collected and analyzed from Buzzard Creek to test these assumptions. Two riffles were sampled and analyzed from a single stream reach in each of three streams to assess among stream variation. These preliminary results are used to determine if within stream variation is greater than among stream variation.

PRELIMINARY SURVEY OF TURTLES OF THE TENNESSEE RIVER GORGE. *Daniel C. Kuntz*, Chris Manis, and David E. Collins, Southern Adventist University, Collegedale, Tennessee and Tennessee Aquarium, Chattanooga, Tennessee.* During the summers of 2000 and 2001 several species of turtles were trapped and observed visually along several miles of the Tennessee River Gorge. The purpose of this turtle survey was to better understand the local populations of turtles in the Tennessee River. As pollution takes its toll on animals of various groups, it was thought wise to keep track of the turtles in the local area in order to assess the health of the population. This preliminary study reports the kinds of turtles and the locations in which they were trapped, comparing the two trapping seasons. The results showed that *Trachemys scripta* was the most abundant turtle trapped (possibly up to 70% of the turtles trapped). Further analysis of the data will form a baseline against which future population fluctuations will be monitored.

A TEST OF THREE MIST-NET CONFIGURATIONS TO ASSESS CAPTURE SUCCESS OF BATS OVER STREAM CORRIDORS. *L. Michelle Gilley* and Michael L. Kennedy, The*

University of Memphis, Memphis, Tennessee. Three different mist-net configurations were utilized to assess capture success of bats foraging over stream corridors. The three configurations consisted of an "I" (net placed directly across stream), a "T" (one net placed directly across stream and one net positioned perpendicular to first net in midstream), and a "Z" (two nets positioned along the banks of stream and a center net running diagonal between the two nets). Trapping was conducted during the summer months of 2000 and 2001. For statistical analyses, ANOVA and chi-square goodness of fit tests were used to compare capture success of each treatment. The study consisted of 675 net nights and 220 total captures (85 "I", 62 "T", 73 "Z"). Results suggested that the "I" configuration was the most efficient procedure for capturing bats when considering net-area and equally efficient when treating each configuration as a single net-set.

AN ASSESSMENT OF SELECTED DEMOGRAPHIC FEATURES OF A POPULATION OF RACCOONS *PROCYON LOTOR*. *John R. Hisey**, *Michael L. Kennedy*, *Troy A. Ladine*, and *Shannon A. Maris-Danley*, *The University of Memphis, Memphis, Tennessee.* Selected demographic data were assessed for 268 raccoons captured on a 5 by 10 grid using live traps spaced approximately 150 m apart at the Meeman Biological Station in western Tennessee. The work was conducted during the winters of 1991–2001. Annual turn-over rates (the percentage of animals present during 1 year but not the following year) averaged 79% and varied between 50.0% and 100.0% over the 10 years. Mean individual persistence times (mean of the number of years for each animal to disappear from the population) were also compared among years and age classes and between sexes. More males were captured than females for all but 1 year, with the sex ratio varying from 1:0.6 to 1:1.2. The population consisted of primarily age class II or older individuals.

CAPTURE TRENDS FROM A MARK-RECAPTURE STUDY OF MALE AND FEMALE RACCOONS *PROCYON LOTOR* IN WESTERN TENNESSEE. *Brian D. Carver** and *Michael L. Kennedy*, *The University of Memphis, Memphis, Tennessee.* We examined 11 years (1991–2001) of mark-recapture data to assess differences in capture trends of male and female raccoon *Procyon lotor*. Animals were studied on a 5 by 10 grid using live traps during the winter of 1991–2001 at the Meeman Biological Station in Shelby County, Tennessee. Overall (annually or with years combined), no differences were found in the number of males and females captured, the probability of recapture, or the average number of captures per individual between the sexes. The average greatest distance moved between captures was higher for males than females.

GROWTH OF THE FRESHWATER MUSSEL *PYGANODON GRANDIS* IN TWO WEST TENNESSEE BORROW PITS. *David H. Kesler* and *Naomi Van Tol*, *Rhodes College, Memphis, Tennessee (DHK).* We determined the growth of the Giant Floater, *Pyganodon grandis* (Say, 1829), in two west Tennessee borrow pits. Individuals from one borrow pit (Grandis Canyon = GC), were measured for length, numbered, and either returned to GC or transplanted in a nearby borrow pit (Humphreys Pit = HP). Change in length after a year was significantly greater in HP (ANCOVA $F = 33.3$; $d.f. = 1,109$; $P < 0.001$). Ford-Walford plots gave L_{∞} values for GC and HP mussels of 125.6 mm and 209.0 mm, respectively. Values of k were 0.361 for mussels in GC and 0.137 for HP mussels. We also determined the length-

age relationship of individuals from GC by examining shell internal annuli. Mean $\pm SE$ values for L_{∞} and k from these data were 169.0 ± 16.93 mm and 0.184 ± 0.059 , respectively. These values gave predicted length changes significantly greater ($t = 6.39$; $d.f. = 35$; $P < 0.001$) than length changes observed in GC individuals, but significantly less ($t = 2.93$; $d.f. = 71$; $P < 0.002$) than those in individuals moved to HP. These results demonstrated that growth rate determinations from annuli measurements are unreliable unless environmental conditions remain static.

MUSSELS OF THE WOLF RIVER, TENNESSEE AND MISSISSIPPI. *D. H. Kesler*, *D. Manning*, *N. Van Tol*, *L. Smith*, and *B. Sepansky*, *Rhodes College, Memphis, Tennessee (DHK).*

We sampled freshwater mussels (Unionidae) in the Wolf River and its tributaries in Shelby and Fayette counties, Tennessee, and in Benton County, Mississippi. We identified 25 species and recorded the specific locations of 4,284 individuals. Mussels were abundant upstream from the Collierville, Tennessee sewage effluent, which also coincides with the extent of headcutting from earlier channelization. Downstream from this location, mussels were very rare in the river, but abundant in adjoining borrow pits. Some of the species we report are unique or rare in western Tennessee. One species, the Fat Mucket (*Lampsilis siliquoidea* (Barnes, 1823)) is reported nowhere else in Tennessee besides the Wolf River and three species, the Pink Heelsplitter (*Potamilus alatus* (Say, 1817)), the Plain Pocketbook (*Lampsilis cardium* Rafinesque, 1820), and the Spike (*Elliptio dilatata* (Rafinesque, 1820)) have not been reported to occur in western Tennessee. The Southern Hickorynut (*Obovaria jacksoniana* (Frierson, 1912)) has been reported in only one other Tennessee river and the Southern Rainbow (*Villosa vibex* (Conrad, 1834)) has been reported in only two other Tennessee rivers.

TROPHIC TRANSFER OF METALS FROM SEAGRASS TO EPIPHYTES AND GRAZING INVERTEBRATES. *Pamela N. Monger** and *Frank C. Bailey*, *Middle Tennessee State University, Murfreesboro, Tennessee.* Aquatic pollution is a factor influencing the components of a seagrass ecosystem. The objectives of this project were to determine if: 1) bioaccumulation of copper, cadmium, and lead occurs in seagrass, epiphytes, and epifauna, 2) metal levels are higher in samples from a more impacted site, and 3) trophic transfer of copper occurs from epiphytes to snails in the laboratory. Sample collection occurred at two sites near Gulf Breeze, Florida. Metal analysis was completed using atomic absorption spectrophotometry. There were significant differences found in metal levels between sites, as well as interaction effects. The trophic transfer of copper was determined in the laboratory by dosing periphyton plates with copper and allowing field-collected snails to graze. Copper levels in dosed snails were significantly higher than controls, suggesting that metal presence and trophic transfer may be a concern.

ACTIVITY OF COMMON SNAPPING TURTLES IN A SEASONALLY DRYING WETLAND. *Tamara J. Berthel** and *Brian T. Miller*, *Middle Tennessee State University, Murfreesboro, Tennessee.* Although common snapping turtles are a well studied species, relatively little is known about how they cope with seasonally drying habitats. Daily and seasonal activity patterns of common snapping turtles *Chelydra serpentina* were investigated from June to September 2001 at Sinking Pond, Coffee County, Tennessee, using radio-telemetry techniques. Hydrographs of Sinking Pond are characterized by abrupt seasonal rises and falls

with maximum water depths ranging from zero feet in the summer and fall to 11.5 feet in the winter and spring. Turtles began to dig down into the leaf litter of the pond basin as water levels began to fall in mid July. Rather than migrating to other bodies of water, the turtles remained buried in the basin after the pond was completely desiccated, possibly in a state of estivation. Individuals continued to stay buried in the dry basin and were located at the same sites two months later.

A TRICHOPTERAN SURVEY OF SEVERAL TRIBUTARIES OF SULPHUR FORK CREEK AND RED RIVER, ROBERTSON COUNTY, TENNESSEE. *Ken J. Davenport* and Steven W. Hamilton, Austin Peay State University, Clarksville, Tennessee.* Caddisflies (order Trichoptera), an order of insects related to moth and butterflies, are an important part of the food web in

freshwater environments and the larvae are used as bioindicators in the assessment of water quality. Adult caddisflies were sampled from Brush, Miller, and Buzzard creeks in Robertson County, Tennessee from May 1999 to April 2001. Brush Creek is a third order and Miller Creek is a fourth order tributary of Sulphur Fork Creek. Buzzard Creek is a third order tributary of Red River. These streams are located in the Western Pennyroyal Karst ecoregion of the Interior Plateau. Adults were collected using ultraviolet light traps and males were identified to species. A total of 13 families, 33 genera and 63 species have been identified to date. At least two new state records and several new county records are included. Based on published 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 typical of this region.