

## ABSTRACTS OF PAPERS PRESENTED AT THE 108TH ANNUAL MEETING

## BOTANY SECTION

Louis Myles, Chair

**METHIONINE SULFOXIMINE: ITS INFLUENCE ON THE GROWTH OF SOYBEAN PLANTS.** *Lee Campbell\**, *E. L. Myles*, *D. Long*, and *C. Caudle*, *Tennessee State University, Nashville, Tennessee*. The fight against plant diseases has been a problem for man since the beginning of crop cultivation. There are many types of pathogens that cause diseases in plants. Such pathogens include viruses, bacteria, and fungus. This study deals with the defense mechanism found in the soybean plant (*Glycine max*). The stressor that is used in this study is Methionine Sulfoximine (MSO). MSO is an amino acid analog that inhibits the production of glutamine. MSO is used in this study because it has the ability to mimic the effects of the disease caused by the bacterium *Pseudomonas syringae*. Five different cultivars: Essex, Hutcheson, MD86-5785, Suzuyataka, and York were exposed to 0, 12, and 24  $\mu\text{M}$  MSO. The cultivars were exposed for 10 days. On the 10th day, the total weight and total length of the plant were recorded. There was a significant difference between the control and experimental groups at 24  $\mu\text{M}$  for all cultivars. Cultivar MD86-5785 was the only one that showed a significant difference from the control at both 12 and 24  $\mu\text{M}$ . More work is needed to identify a soybean cultivar that is more than marginally tolerant. Future research will concentrate on gene expression of tolerant soybean cultivars.

**HERBAL REMEDIES AMONG THE MELUNGEONS.** *Carolyn Bonner\** and *Thomas E. Hemmerly*, *Middle Tennessee State University, Murfreesboro, Tennessee*. Melungeons are people of the Southeastern United States who reportedly are descendants of the Portuguese. Melungeons are an endangered ethnic group: only approximately 2,000 remain. Many are marrying outside of the Melungeon clan. In the research for this paper, there was an opportunity to interview some of the Melungeon people. They live in Hancock County, Sneedville, Tennessee, near Newman's Ridge, where they can actually trace their roots. Because they were an isolated people, the Melungeons had their own herbal remedies to use in taking care of illnesses and injuries. Many of these remedies are still used today because they were handed down from generation to generation. The remedies documented here came directly from the Melungeon people but are by no means all of the remedies that they used. Many of their remedies are used by other cultures today.

**STRUCTURE OF THE FOREST COMMUNITIES AT TAYLOR HOLLOW, NORTHEASTERN SUMNER COUNTY, TENNESSEE.** *Joe Schibig*, *Volunteer State Community College, Gallatin, Tennessee*, and *Austin Peay State University, Clarksville, Tennessee*. Four topography-based forest communities were studied at Taylor Hollow, an oldgrowth forest owned by the Nature Conservancy. Systematic, permanent plot-sampling of seedling,

sapling, and large trees revealed a growing dominance of maples, primarily *Acer saccharum* in all forest communities. Importance values (IV) for tree species in sapling and large tree classes were determined using this formula:  $\text{IV} = (\% \text{ density} + \% \text{ frequency} + \% \text{ basal area})/3$ . The dominant species of the large tree class (diameter breast height  $\geq 10.2$  cm) on the two ridges flanking the hollow in order of descending IV were *Acer saccharum*, *Quercus prinus*, *Liriodendron tulipifera*, *Fagus grandifolia*, and *Quercus velutina*. Dominant species on the south-facing slope of the hollow were *Fagus grandifolia*, *Acer saccharum*, *Quercus velutina*, *Carya glabra*, and *Quercus alba*. Dominants on the north-facing slope were *Acer saccharum*, *Fagus grandifolia*, *Quercus alba*, *Carya ovata*, and *Liriodendron tulipifera*. The most important taxa on the floor of the hollow were *Acer saccharum*, *Juglans nigra*, *Ulmus* spp., *Carya cordiformis*, and *Carpinus caroliniana*. Overall (for all community types), *Acer saccharum* had an IV of 21.3 in the large tree class; in the sapling class (dbh = 2.5 to 10.2 cm.), *Acer saccharum*'s overall IV was 40.5. In the seedling class (dbh < 2.5 cm.), maples, primarily *Acer saccharum*, accounted for an overall IV of 22.8; IV for seedlings was determined using the formula:  $\text{IV} = (\% \text{ density} + \% \text{ frequency})/2$ . Mixed mesophytic species such as *Tilia americana*, *Aesculus octandra*, and *Magnolia acuminata* are rare in middle Tennessee but were significant components at Taylor Hollow, especially on the lower slopes and valley floor.

**PRELIMINARY REPORTS OF THE VASCULAR FLORA OF THE ROARING RIVER WATERSHED, JACKSON COUNTY, TENNESSEE.** *Felix G. Coe*, *Tennessee Technological University, Cookeville, Tennessee*. Preliminary results of an inventory of the Vascular Flora of the Roaring River Watershed system started in the spring of 1997 to present indicates a high species diversity. Documented to date are 383 species in 277 genera and 101 families. The families with the largest number of species include the Asteraceae (47 species), Poaceae (21), Fabaceae (17), Brassicaceae (14), Lamiaceae (14), Liliaceae (14), and Ranunculaceae (12). Species collected are compiled in an annotated list.

**AN ANALYSIS OF THE WOODY STRATA IN XERIC-SITE CHESTNUT OAK FORESTS, NORTHWESTERN HIGHLAND RIM, KENTUCKY AND TENNESSEE.** *Edward W. Chester*, *Christine E. Harris\**, *Sandra Gonzalez*, and *Keri K. Denley*, *Austin Peay State University, Clarksville, Tennessee*. Forests dominated by xerophytic oaks, especially chestnut (mountain) oak (*Quercus prinus* = *Q. montana*), occupy many rocky-gravelly, nutrient-poor ridges and upper slopes between the Cumberland and Tennessee rivers in southwest-central (Lyon and Trigg counties) Kentucky and northwest-central (Stewart County) Tennessee. Those xeric-site remnants that are least disturbed may represent some of the best remaining examples of pre-settlement forests of the region. We here characterize the woody strata of ten such forest stands in the three-county area of Land Between

The Lakes. Stands were specifically and non-randomly selected based on topography and xeric conditions, the presence of numerous and mature chestnut oaks in the canopy, and the lack of recent disturbance. Based on data from 45 0.04-ha plots, all strata are dominated by *Q. prinus*, and mesophytic species such as sugar maple (*Acer saccharum*) are mostly lacking in the understory, suggesting stability in these remnants.

THE VASCULAR FLORA OF THE CLEAR FORK NEW RIVER RIPARIAN COMMUNITIES OF THE BIG SOUTH FORK NATIONAL RIVER AND RECREATION AREA. **Claude J. Bailey\*** and **Felix G. Coe**, *Tennessee Technological University, Cookeville, Tennessee*. The vascular flora of the Clear Fork (CF) and New River (NR) riparian zones was systematically studied from February to October 1997-1998. The flora consisted of 398 species in 261 genera and 98 families. The two largest plant families are the Asteraceae (72 species) and the Poaceae (27). Of the 398 species collected, 31 are introduced, 12 are considered rare in Tennessee and Kentucky, and two are federally threatened. Previously unknown populations of Barbara's button's (*Marshallia grandiflora*), Cumberland rosemary (*Conradina verticillata*), Cumberland sandgrass (*Calamovilfa arcuata*), and Rockcastle aster (*Aster saxicastelli*) were located.

THE HERBACEOUS FLORA OF MATURE CHESTNUT OAK FORESTS, NORTHWESTERN HIGHLAND RIM, KENTUCKY AND TENNESSEE. **Christine E. Harris\*** and **Edward W. Chester**, *Austin Peay State University, Clarksville, Tennessee*. The herbaceous stratum was sampled in ten mature chestnut oak (*Quercus prinus* L.) stands in Lyon County, Kentucky (1 stand), Trigg County, Kentucky (7 stands), and Stewart County, Tennessee (2 stands). All stands are on xeric, rocky-gravelly, nutrient-poor convex ridges and upper slopes within Land Between The Lakes National Recreation Area. Coverage is mostly by bryophytes-lichens (57.3%), bare ground, including exposed rock and gravel (20.0%), and leaf litter-other organic debris (18.2%). Herbaceous plants include 119 species dominated by *Danthonia spicata* (11.4% of IV/200) and *Carex artitecta* (10.1%). Dominant families (% of IV) are: Poaceae (19.3), Cyperaceae (13.8), Asteraceae (13.1), Fabaceae (12.8), and Vitaceae (7.7). These five families (13.2% of families, 46.6% of species) contribute 67% of IV. Dominant genera (% of IV) are *Carex* (13.8), *Danthonia* (11.4), *Lespedeza* (8.1), *Panicum* (5.9), *Vitis* (5.1), *Smilax* (4.2), and *Solidago* (3.3). These seven genera (0.9% of genera, 21.8% of species) account for 52% of IV.

THE VASCULAR FLORA OF THE CLEAR FORK AND NEW RIVER GORGES, BIG SOUTH FORK NATIONAL RIVER AND RECREATION AREA, TENNESSEE: A PRELIMINARY REPORT. **Barbara E. Goodson\*** and **Felix G. Coe**, *Tennessee Technological University, Cookeville, Tennessee*. An inventory of the Vascular Flora on the gorge slopes of the Clear Fork and New River of the Big South Fork National River and Recreation Area (BSFNRA) is in progress. The study area includes portions of Fentress, Morgan, and Scott counties on the Cumberland Plateau of Tennessee. During the 1998 growing season 242 species in 169 genera and 61 families were documented.

CHARACTERIZATION OF WETLAND HABITAT TYPES WITHIN TENNESSEE WILDLIFE RESOURCES AGENCY'S HAYNES BOTTOM, MONTGOMERY COUNTY, TENNESSEE. **S. Joy Stephens\*** and **Edward W. Chester**, *Austin Peay*

*State University, Clarksville, Tennessee*. The Tennessee Wildlife Resources Agency purchased approximately 393 ha (971 acres) of farmland in Montgomery County, Tennessee, in 1996 for potential development into a wildlife management unit. At the time of purchase, the land was in agricultural production (rowcrops, pasture) with some secondary woodlands and included both upland and Cumberland River bottomland landscapes. There are significant wetland habitats, including bottomland hardwood forests, riverside forests, an apparently abandoned river meander channel (slough), marshes, wet meadows, bottomland drainage ditches, and upland ponds. During 1998, the vegetation, soils, and hydrology were characterized for the largest bottomland hardwood forest (approximately 6 ha), using United States Army Corps of Engineers methods (circular quadrats for vegetation). Also, the Cumberland River streamside forest was sampled from a mid-forest transect using the quarter method for canopy and subcanopy. The vascular flora of all wetland sites was surveyed and the data used to floristically characterize the sites.

DEVELOPMENT OF PHOTOSYNTHETIC WATER OXIDATION DURING CHLOROPLAST MATURATION. **Jefferson G. Lebkuecher**, **Kurt A. Haldeman**, **Christine E. Harris**, **Sonia L. Holz**, **Sary A. Joudah**, and **Darcy A. Minton**, *Austin Peay State University, Clarksville, Tennessee*. Light-induced development of photosynthetic water oxidation was followed during irradiance of etiolated sunflower cotyledons. Primary photochemistry was studied by evaluating chlorophyll a fluorescence emissions from seedlings grown in continuous darkness for 6 d followed by exposure to 100  $\mu\text{mol photons}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$  for time periods of 1, 3, 6, and 12 h. During the 1 h to 3 h irradiance period, PS-II concentration and quinone<sub>A</sub> to quinone<sub>B</sub> electron-transport activity within newly synthesized PS II increased significantly. During this same 1 h to 3 h irradiance period, water-splitting efficiency within the PS-II pool as a whole decreased significantly. These results indicate that development of water-oxidation activity lags behind development of quinone<sub>A</sub> to quinone<sub>B</sub> electron-transport capacity and that the rate-limiting step during the development of PS II is the ability of the oxygen-evolving complex to extract electrons from water.

BULRUSH RESPONSE TO SIMAZINE AND METOLACHLOR IN CONSTRUCTED WETLANDS FROM A CONTAINER NURSERY. **Stacey N. Lansford\***, **G. K. Stearman**, **D. B. George**, **K. L. Carlson**, and **C. D. Belew**, *Tennessee Technological Center, Cookeville, Tennessee*. A container plant nursery (450 m<sup>2</sup>) and constructed wetland cells were constructed at Baxter, Tennessee, to determine removal rates of pesticides, nitrogen and phosphates by constructed wetlands. Container nursery runoff was pumped at three flow rates into fourteen gravel subsurface flow constructed wetland cells. Seven of the 5.3 × 1.3 m cells contained bulrush and seven cells had no plants. Pesticides, simazine and metolachlor were applied to the container nursery at 4.48 kg/ha and 2.24 kg/ha, respectively. Hydraulic retention times for the wetlands cells were 2, 3, 4, 6, 8, and 12 days. Simazine, metolachlor, nitrate and phosphate removal were measured and evaluated based on presence of plants, plant density, hydraulic retention time and depth of wetlands. Pesticide and nitrogen removal (>80%) was greater in the cells with plants and at hydraulic retention times greater than 3 days. In a related environmental growth chamber study using microcosms filled with gravel, bulrush plant height declined at simazine and metolachlor

rates of 1,000 ng/ml and when applied together at 750 ng/ml. New stem growth declined to zero at rates of 600 ng/ml.

**VEGETATION AND HERPETOFAUNA OF WETLAND HABITATS ON TENNESSEE WILDLIFE RESOURCES AGENCY'S HAYNES BOTTOM PROPERTY, MONTGOMERY COUNTY, TENNESSEE.** *Scott Williamson\**, *S. Joy Stephens\**, *A. Floyd Scott*, and *Edward W. Chester*, *Austin Peay State University, Clarksville, Tennessee*. Haynes Bottom is a 393 ha (971 acre) tract along the Cumberland River in southwestern Montgomery County, Tennessee. The property was purchased in 1996 by the Tennessee Wildlife Resources Agency for eventual development as a wildlife management unit. From European settlement to present, the land has been used primarily for agriculture, including row crops and pasture. The site supports a variety of habitat types, including the Cumberland River and a first-order stream, bottomland hardwood forests, bottomland drainage ditches, upland ponds, and an apparent abandoned river meander channel (slough) with associated marshes and meadows. This report presents preliminary results of a study of the flora and herpetofauna of these wetland habitats that was begun in 1998. A data base on the area's biological resources will be established for use in future management and research.

**STAND STRUCTURE AND MORTALITY PATTERNS IN AN OLD-GROWTH MIXED-MESOPHYTIC FOREST.** *S. Torreano*, *N. Nunley*, and *T. O. Hay*, *The University of the South, Sewanee, Tennessee*. Relatively little is known about how stand structure and species composition of old-growth forests change with time. We are studying stand structure, successional change, and mortality patterns in Thumping Dick Cove (DC), a 40 ha old-growth, mixed, mesophytic forest near Sewanee, Tennessee. Our objective is to document whether changes have occurred in the structure, species composition, and mortality patterns since these were first reported in 1982, following a period of heavy upper canopy mortality. In 1996 over 23% of the relative density (basal area basis) of the overstory (trees greater than 15 cm dbh) was occupied by northern red oak (*Quercus rubra* L.), 13% by hickory (*Carya* sp.), 15% by sugar maple (*Acer saccharum* Marsh.), 7% by white oak (*Q. alba* L.) and 8% yellow-poplar (*Liriodendron tulipifera* L.). This represents some change relative to the densities reported in 1982 (13% northern red oak, 17% hickory, 16% sugar maple, 8% white oak and 8% yellow-poplar. Significance will be discussed. Potential recruitment of hickory and oak will likely be limited due to a scarcity of stems of those species in the understory and mid-canopy. Importance values for the understory population of these species were 10 times less than those for sugar maple. Sugar maple comprised 50% of the reproduction (stems less than 6.4 cm dbh and > 1.4 m in height). Yellow-poplar will increase in importance in this forest, especially in gaps. Although no dominant tree species is likely to disappear in this forest, flowering dogwood (*Cornus florida* L.) comprised < 0.6% of reproduction and is being replaced by sugar maple and other species in the understory (relative occurrence is 73% for sugar maple and 24% for dogwood). Decreased overstory mortality among oaks and the hickories and increased mortality of sugar maple and chestnut oaks suggest that dominant canopy replacement by other species will be less rapid than previously expected.

## CHEMISTRY SECTION

Jeffrey O. Boles, Chair, and Dan Swartling, Chair<sup>1</sup>

**PRE-CONCENTRATION OF SELENIUM SPECIES BY SOLID-PHASE EXTRACTION.** *J. J. Harwood and Ying Gu*, *Tennessee Technological University, Cookeville, Tennessee*. As the toxicological and physiological importance of selenium has become more evident during the past twenty years, there has been increasing interest in this essential element. Analytical methods with which to analyze specific forms, or species, of selenium ions at trace concentrations are needed. We investigated preconcentration of selenite, selenate, seleno-methionine, and seleno-cysteine by strong anion exchange solid-phase extraction (SAX), with analysis by graphite furnace atomic absorption spectrometry (GF-AAS). Two SPE cartridges were compared, the Alltech Maxi-Clean IC-OH and the Whatman Solid-phase Extraction Device. With the Alltech column, different eluents, pH, and counter ions were compared. Seleno-methionine is quantitatively preconcentrated on the Alltech SAX column at high pH (11), but is not retained at neutral pH. Inorganic selenium and seleno-cysteine are not quantitatively recovered with either acetate or EDTA eluents. Seleno-cysteine is not retained on the Whatman SAX column. Ion chromatography and chemical oxidation with permanganate were used to verify the hypothesis that chemical transformation of selenium ions occurred during the preconcentration procedure. Our results indicate that some redox transformation of inorganic selenium occurred on SAX columns. Oxidation of selenite to selenate on SAX columns occurs when acetate is used as eluent. (Analysis by GF-AAS precludes use of HCl eluent.) Small amounts of selenite and selenate appear to be transformed to elemental selenium on SAX columns prior to elution. We will present results of present experiments to improve recoveries of selenium anions through pretreatment of the Alltech SAX column with dilute acid solution.

**AB-INITIO STRUCTURES OF CYCLOPENTADIENYLBORONIUM IONS: A PRELIMINARY STUDY.** *William H. Isley*, *Middle Tennessee State University, Murfreesboro, Tennessee*. Preliminary results of RHF/3-21g\* and RHF/6-31g\* ab initio studies of substituted fluoro- and methyl-substituted cyclopentadienylboronium ions of the type  $[(C_5H_{5-n}X_n)BX]^+$  (X = F, Me; Y = F, Me) and  $[(C_5H_{5-n}X_n)B]_2^+$  (X = H, F, Me) will be presented. The effect of both the number and type of substituent on the predicted geometry will be discussed as well as the importance of relevant molecular orbitals in stabilizing the predicted geometries.

**SYNTHESIS AND CHARACTERIZATION OF A NEW CLASS OF MULTIDENTATE LIGANDS: ARYL DITHIOSEMICARBAZONES.** *Edward C. Lisic and Chris Morrow*, *Tennessee Technological University, Cookeville, Tennessee*. A new class of multidentate tetradentate ligands has been synthesized from a series of 1,2-quinones by reaction with 4-methyl, 3-thiosemicarbazide, and also with 4,4-dimethyl, 3-thiosemicarbazide. These ligands were used in reactions with  $Cu^{2+}$  to form the neutral metal complexes Cu(DTSC). The ligands were characterized by <sup>1</sup>H NMR and IR and the UV-VIS spectra of the ligands and complexes were obtained.

**THE DISTRIBUTION OF JUNGIAN PERSONALITY TYPES OF THE MIDDLE TENNESSEE STATE UNIVERSITY CHEM-**

ISTRY FACULTY AS DETERMINED BY THE MYERS-BRIGGS TYPE INDICATOR. **Wayne D. Riley**, *Middle Tennessee State University, Murfreesboro, Tennessee*. The content and the structure of any course is affected in a large part by the professor. Factors such as the effective knowledge base, the personal experiences and the personality of the instructor play a major role in how the students are taught. This study was concerned with the personalities of the Middle Tennessee State University chemistry faculty based upon the Jungian theories of personality types. The Myers-Briggs Type Indicator was the diagnostic tool used to determine each professor's type. The distribution of the faculty's types was compared to a general distribution of student's personality types who were enrolled in chemistry and general science classes. Results show that nearly 80% of the professors were described by 25% of the 16 types whereas the students were nearly evenly distributed across all 16.

SURFACE CONTAMINATION DETECTION BY INFRARED SPECTROSCOPY. **Norma L. Ayala, Megan Woody, Tye Ed Barber, and G. Louis Powell**, *Tennessee Technological University, Cookeville, Tennessee (NLA, MW, TEB), and Lockheed Martin Energy Systems, Oak Ridge, Tennessee (GLP)*. Even with stricter environmental regulations, oil contamination remains a major environmental problem. Most methods for the determination of hydrocarbon contamination are based on the extraction of the hydrocarbons followed by the analysis of the extract to quantify the contamination. In the past, these techniques were based on extractions with halogenated solvents. Due to the destruction of the ozone layer, these techniques have been replaced with methods based on hexane extractions and extractions using solid phase extraction materials. It has been reported that these new methods have poor reproducibility and can be expensive. These methods also can be time consuming and are not appropriate for field applications. A rapid screening technique is under development for determination of hydrocarbon contamination using infrared spectroscopy. The technique is based on diffuse reflectance infrared Fourier transform spectroscopy (DRIFTS). Contamination is detected by comparison of the infrared spectrum of the sample to the infrared spectrum of an uncontaminated reference. This presentation will discuss the problems and strengths associated with this technique.

A BREATHING SPHERE MODEL FOR MOLECULAR VIBRATIONS IN DENSE FLUIDS. **George Devendorf**, *Middle Tennessee State University, Murfreesboro, Tennessee*. Changes in the vibrational spectra of molecules as they go from a gas to a solvated phase are a key experimental probe of interactions between the solute and surrounding solvent. Good molecular models of the solvent and vibrating solute are necessary to link observed spectral changes with solvent-solute interaction potentials and dynamics. A simplified approach, which models the vibrating solute as an expanding, or "breathing sphere", is being developed. Though simple in form, such a vibrational model offers advantages over current diatomic solute models, especially in modeling the multi-dimensional motions of polyatomic vibrations. Applications of the breathing sphere model to HCl in Ar and/or neat CO<sub>2</sub> will be discussed.

CALCULATION OF EL NINO'S OCEANIC EXCESS THERMAL ENERGY USING TOPEX SATELLITE ALTIMETRY DATA. **Harvey F. Blanck**, *Austin Peay State University, Clarksville, Tennessee*. The United States/French TOPEX/POSEIDON

satellite altimetry data is accurate to within 3-5 centimeters which, allows for the detection of large area, low profile hills and valleys on the ocean surface. One particularly large bump that occurred during 1997 and persisted into 1998 was in the equatorial Pacific basin and was associated with the El Nino phenomenon during this time period. Although other factors influence the size of bumps, a major contributor is excess thermal energy. Warm water is less dense than cool water and will float somewhat like ice with a portion above the surface of cooler surrounding water. Since the bump height can be used to estimate the excess thermal energy in the warmer water using the coefficient of thermal expansion, the density, and the heat capacity of salt water, it is believed that the calculations will be useful for the introduction of these basic concepts in chemistry courses.

DEVELOPMENT OF AN INFRARED SENSOR FOR THE DETERMINATION OF NATURAL GAS COMPOSITION. **Tye Ed Barber, Serhiy Y. Hnatshyn, Norma L. Ayala, John M. Storey, and Jeffrey S. Armfield**, *Tennessee Technological University, Cookeville, Tennessee (TEB, SYH, NLA), and Oak Ridge National Laboratory, Oak Ridge, Tennessee (JMS, JSA)*. To minimize emissions and to obtain maximum efficiency, natural gas engines have to be optimized to operate at certain air/fuel ratios and timing. One limitation to obtaining optimal performance is the variable composition of natural gas. The variable composition of natural gas is due to natural differences in gas composition and the addition of gases by the natural gas vendor. Since the composition of natural gas is variable, the combustion characteristics of the gas also are variable. While this variation does not greatly influence the performance of simple burner systems, it can dramatically impact the performance of engines. Engines that have been optimized to operate on one gas composition will perform poorly with another gas composition. This can result in higher emissions and shorter engine lifetime. To address this problem, an infrared gas sensor is being developed that can control engine parameters. The goal of this project is to allow an engine to operate at maximum efficiency using a wide range of fuel compositions. Currently, the sensor designs under study are based on the absorption of infrared radiation. In this presentation, the sensor designs and the application of the sensor will be discussed.

SYNTHESIS OF NEW CHELATING AGENTS WITH POTENTIAL APPLICATION IN SEPARATIONS. **Dan Swartling, Liusheng Zhu, Ken Nash, Teresa McMahon, and Dale Ensor**, *Tennessee Technological University, Cookeville, Tennessee*. Separation of lanthanides and actinides is one of the most difficult of metal ion separations. Lanthanide/actinide separation depends upon the slightly stronger interaction of trivalent actinides with ligands containing soft bases (S, Cl, or N). On the other hand, lanthanide and actinide ions are stabilized in coordination complexes by binding with multidentate ligands as opposed to monodentate ligands. Two new chelating agents were synthesized: 1,10-phenanthroline-2,9-dimethylenephosphonic acid (PDPA) and 1,10-phenanthroline-2,9-dimethylenecarboxylic acid. The overall yield of the five-step synthesis of PDPA was 33%.

IS THE OXIDIZING AGENT CE(IV)/SiO<sub>2</sub> A GENUINE EXAMPLE OF A SOLID-SUPPORTED-REAGENT SYSTEM? **Martin V. Stewart and David G. Lancaster**, *Middle Tennessee State University, Murfreesboro, Tennessee*. No reaction is detected by <sup>1</sup>H NMR spectroscopy when 2,5-di-*tert*-butylhydroquinone is stirred for five min at room temperature over powdered

ceric ammonium nitrate or silica gel or a physical mixture of both. However, a quantitative yield of 2,5-di-*tert*-butyl-1,4-benzoquinone is obtained when the hydroquinone is similarly stirred over a sample of silica gel whose surface was previously coated with ceric ammonium nitrate. Thus, the oxidizing agent Ce(IV)/SiO<sub>2</sub> is confirmed to be a genuine example of a solid-supported-reagent because it constitutes a discrete chemical system that has reactive properties not displayed by its individual components or by a physical mixture of them. Partial support from the Undergraduate Research Council of the School of Basic and Applied Sciences at Middle Tennessee State University is gratefully acknowledged.

THE SYNTHESIS OF L-TRYPTOPHAN AND NOVEL L-TRYPTOPHAN ANALOGS USING TRYPTOPHAN SYNTHASE. *David C. O'Kin\* and Jeffrey Boles, Tennessee Technological University, Cookeville, Tennessee.* There are currently only two metalloid-containing unusual amino acids available for use as biosynthetically incorporated X-ray diffraction labels in proteins, selenomethionine (SeMet) and telluromethionine (TeMet). The latter of the two and most desirable from the endpoint of X-ray crystallography (TeMet) is very difficult to work with owing to its instability. X-ray crystallography requires a heavy-atom derivative be made of a protein in order to interpret the data from the diffraction experiment. In order to facilitate structural determinations in this manner it would be of interest to have available several such diffraction labels. This project concerns the attempt of synthesis of selenium and tellurium containing analogs of L-Tryptophan (Trp) as well as other optically active analogs of Trp. Chemical synthesis of these compounds has proven unsuccessful due to the instability of several intermediates or the racemic nature of the final products. We have obtained the expression system for both the wild type heterotetrameric enzyme ( $\alpha_2\beta_2$ ) and the homodimer ( $\beta_2$ ) and purified both by established protocols. Indole, 5-chloro-indole, 5-bromo-indole, 5-methoxy-indole, 5-amino-indole, 5-hydroxy-indole, 4-hydroxy-indole, 5-nitro-indole, benzo(b)selenophene, and benzo(b)tellurophene were tried as substrates. Six different tryptophan analogs were produced and were characterized by thin layer chromatography and mass spectrometry.

MICROWAVE DIGESTION TECHNIQUES IN FORENSIC GUNSHOT RESIDUE ANALYSIS. *Donald I. Carman and Linda Wilson, The Tennessee Bureau of Investigation, Nashville, Tennessee, and Middle Tennessee State University, Murfreesboro, Tennessee.* Upon the discharge of a firearm, a great volume of gaseous combustion products from the gunpowder and primer is expelled from the firearm and deposited on the shooter's hands (GSR). The identification and quantitation of antimony, barium and lead are indicative of a person having fired a firearm or being near the discharge of a firearm. The hands of the shooter are swabbed using cotton swabs dipped in dilute nitric acid solution. The swabs are sent to the forensic laboratory for GSR analysis using graphite furnace atomic absorption spectrophotometry. The conventional method includes digestion of the swabs in 10% nitric acid at 80°C for 2.5 h. The current project investigates the use of microwave digestion in order to shorten digestion times. Percentage recoveries of the analytes from swabs digested by the microwave procedure were compared to those prepared by the conventional technique and were found to be comparable.

DETERMINATION OF THE STRUCTURE OF THE PROD-

UCT OF BIMOLECULAR COUPLING OF ORGANIC RADICALS. *Sabrina Bonner and Rudy Gostowski, Austin Peay State University, Clarksville, Tennessee.* In previous work the rate constant for the bimolecular coupling of organic radicals was determined using Fast Scan Cyclic Voltammetry and digital simulation. The constants were found to correlate with the steric hindrance of the molecule. The radicals were previously assumed to form head-to-head dimers. The goal of this study was to determine the structure of the product of the bimolecular coupling. Large amounts of the radical were produced by bulk electrolysis and allowed to form their product. The product was identified to be a dimer by mass spectroscopy. Further work will determine the structure of the product using Nuclear Magnetic Resonance Spectroscopy and X-Ray Crystallography.

THE EFFECT OF ANALGESIC DRUGS ON THE SURFACE TENSION OF EMU OIL AND OTHER COMMERCIALY AVAILABLE OILS: A COMPARATIVE STUDY. *Ming Y. Lien\* and James C. Howard, Middle Tennessee State University, Murfreesboro, Tennessee.* This study investigated the difference in surface tension of various oil solutions as potential delivery agents for topical analgesic drugs using a Cenco-du Nouy Precision Tensiometer. The oils studied include canola, emu, mineral, olive, peanut, and vegetable as well as mixtures of each oil with dimethyl sulfoxide (DMSO) and 2-propanol. The drugs studied included acetaminophen, aspirin, ibuprofen, and naproxen. Results showed analgesic drugs in pure oil solutions significantly decreased the surface tension of all the oils. Emu oil displayed the smallest difference. Drugs in the DMSO/oil solution significantly increased or decreased the surface tension in all but acetaminophen in DMSO/emu oil solution and aspirin in DMSO/olive oil solution. Drugs in the 2-propanol/oil solutions significantly increased the surface tension in all except aspirin in the 2-propanol/mineral solution. Drugs in emu oil with DMSO and 2-propanol differed from other oil solutions but did not exhibit the greatest or the least difference.

DYNAMICS OF PROTEIN-PROTEIN DOCKING: CYTOCHROME *c* AND CYTOCHROME *c* PEROXIDASE REVISITED. *Gabriel Castro, Charles A. Boswell, and Scott H. Northrup, Tennessee Technological University, Cookeville, Tennessee.* The dynamics of the docking step in the electron transfer reaction between yeast cytochrome *c* peroxidase and iso-1-cytochrome *c* has been studied using the Brownian dynamics method. In particular we have calculated the bimolecular rate constant at which a specific complex, the X-ray crystalline complex, can form in solution by translational and rotational diffusion in a field of force. Complexation criteria have been assessed based on the simultaneous alignment of three atom-atom contacts, as well as alternative criteria. The proteins are able to align one or two contacts at remarkably high rates, in fact, at rates approaching the diffusion-controlled limit for two spheres reactive over their entire surfaces. Three contacts may align, and hence the specific complex may dock, at rates on the order of 10<sup>8</sup> mol<sup>-1</sup>s<sup>-1</sup>, which is quite representative of the experimental association rate constant for ET-competent complex(es). The formation of the specific complex is strongly influenced by the favorable electrostatic interaction between these proteins. It is striking that a specific protein-protein complex can form within one order of magnitude as fast as two spherical proteins can touch at any orientation. It remains plausible that the high ET tunneling rate in this system can take place through a single highly favorable specific complex

using a single high efficiency pathway. Still the contribution from a nonspecific set of complexes is not ruled out, particularly considering the marginal reproduction of the ionic strength dependence in the formation of the X-ray complex.

**ALDOL CONDENSATION PRODUCTS PRODUCED DURING THE STATIC DRYING OF ACETONE OVER 4A MOLECULAR SIEVE.** *Xiaoming Wang\**, *Martin V. Stewart*, and *Terrence A. Lee*, *Middle Tennessee State University, Murfreesboro, Tennessee*. Static drying of acetone over 4A molecular sieve at room temperature causes contamination with aldol condensation products. GC-MS was employed to analyze the product mixture, which consists of the dimers diacetone alcohol and mesityl oxide together with lesser amounts of the trimers triacetone alcohol and semiphorone. Synthetic methods were developed to prepare the latter two components for use as chromatographic standards to quantify the product distribution. Triacetone alcohol was obtained from phorone through hydrolysis by an oxymercuration/demercuration route. Formation of the cyclic pyronyl ether, the major product of hydrolysis conducted with aqueous sulfuric acid in THF, is negligible during oxymercuration/demercuration because carbocation formation is avoided. Partial dehydration of triacetone alcohol to semiphorone is accomplished during vacuum distillation from a trace amount of 85% phosphoric acid. A graduate student stipend from the College of Graduate Studies at Middle Tennessee State University for the 1998 summer semester is gratefully acknowledged.

**PRODUCTION OF HYDROGEN FROM SUCROSE VIA AN ENZYMATIC PATHWAY.** *Mark Orr and Jonathan Woodward*, *Tennessee Technological University, Cookeville, Tennessee*, and *Oak Ridge National Laboratory, Oak Ridge, Tennessee*. An enzymatic pathway has been developed to evolve hydrogen from sucrose. The pathway consists of hydrolyzing the sucrose with invertase. The resulting glucose is oxidized to gluconic acid by the enzyme glucose dehydrogenase with a concomitant reduction of NADP<sup>+</sup> to NADPH. The cofactor is then oxidized by hydrogenase reproducing the NADP<sup>+</sup> and releasing a molecule of hydrogen. For low sucrose concentrations stoichiometric yields have been produced. These yields have been improved by the incorporation of glucose isomerase which catalyzes the conversion of the fructose product of sucrose hydrolysis to glucose.

**TEMPERATURE AND PH EFFECTS ON THE AQUEOUS HYDROLYSIS OF CHLORPYRIFOS.** *Meredith R. Rogers\** and *John P. DiVincenzo*, *Middle Tennessee State University, Murfreesboro, Tennessee*. Many insecticides are nerve agents which are not only lethal to pests but also harmful to numerous other organisms in the environment. Chlorpyrifos, the active ingredient in Dursban® and Lorsban®, is an organophosphorous insecticide. It is used in agricultural applications, around residential houses and on golf courses. The effects of Dursban® leaching into nearby rivers, streams or lakes can be studied by determining its hydrolytic degradation rate. Its degradation is thought to assume first-order kinetics, which is affected by water quality parameters such as temperature, pH and calcium concentration. Rate constants at varying temperatures, pHs and calcium concentrations were determined in milli-Q distilled water using liquid-liquid extraction and gas chromatography with an electron capture detector.

**AB-INITIO CALCULATIONS OF THE GEOMETRY OF OR-**

**GANIC RADICALS.** *Terry Bailey and Rudy Gostowski*, *Austin Peay State University, Clarksville, Tennessee*. The bimolecular reaction rates of 9-aryl-fluorenyl radicals were found to correlate with steric hindrance. The steric hindrance was quantified as the dihedral angle of the aryl group estimated using AM1 and PM3 implemented in MOPAC. However, the structure of 9-phenyl fluorenyl radical was considered uncertain due to the nearly free rotation of the phenyl group. In this work ab-initio calculations found in the program GAMESS were used to refine the structure determination. When the N31 basis set was used in an UHF calculation the result was quite different from the MOPAC AM1 and PM3 methods. The difference was considered to be due to delocalization effects in the MOPAC calculation.

**SOL-GEL SYNTHESIS OF ZINC DOPED SILICATE WITH VARIOUS ALCOHOL SOLVENTS.** *Freneka Minter\**, *Judith Iriarte-Gross*, and *Jessica C. Shamblin\**, *Middle Tennessee State University, Murfreesboro, Tennessee*. Silicon alkoxide sol-gel chemistry has been shown to be useful in the preparation of silicon oxide glasses and ceramics for over twenty years. The nature of the sol-gel products is dependent on many factors such as pH solvent, molar ratio of water to alkoxide and length of the hydrocarbon chain in the alkoxy functional group. Zinc salts were incorporated into silica sol-gel materials. Zinc silicates are of interest as dental materials. The effect of various alcohol solvents was investigated. Preliminary 1-H data are reported. This work was supported by Project SEED on behalf of F. Minter.

**SPECTROELECTROCHEMISTRY OF FREE RADICALS.** *Natalie C. Parks and Rudy Gostowski*, *Austin Peay State University, Clarksville, Tennessee*. A combination of spectroscopy and electrochemistry was used to measure the rates of formation, rates of decay, and concentration of free radicals, cations, and anions. Simultaneous spectra of the transients are the result of using spectroscopy coupled with electrochemistry to generate and control the redox reactions. The apparatus consists of an electrolytic cell that contains the reagent to produce the desired transients. This cell is placed between the light source and the spectrometer. The amount of light absorbed is proportional to the number of moles of transient in the solution. As the rate of formation increases so does the light absorption and as the radical decays the light absorption decreases.

**SECONDARY STRUCTURE ANALYSIS OF WILD TYPE AND SELENOMETHIONYL DIHYDROFOLATE REDUCTASE.** *Pavan Marpaka*, *Steve LaBrenz*, and *Jeffrey O. Boles*, *Tennessee Technological University, Cookeville, Tennessee* and *Texas A&M Institute of Biosciences and Technology, Houston, Texas*. Since the use of selenomethionine is becoming widespread as a phasing tool for macromolecular crystallography, and since comparative structural studies in the solution state were lacking, we thought it would be interesting to compare the solution state structures of wild type and selenomethionyl dihydrofolate reductase by circular dichroism (CD). These initial studies were undertaken to set up thermal denaturation/renaturation experiments in order to test the theory that unfolded proteins containing selenomethionine or telluromethionine may not refold back to the same structure as that found in the native state (Huber, 1997). An improved one day purification of wild type and SeMet-dhfr will be discussed which results in reproducibly pure protein. Additionally, the comparison of wild type and SeMet-dhfr far-ultraviolet CD spectra will be presented.

AB-INITIO STUDIES OF ALKYL CATIONS OF THE GROUP 16 ELEMENTS. *Jessica C. Shamblin\**, *Judith M. Iriarte-Gross*, and *William H. Ilsley*, Middle Tennessee State University, Murfreesboro, Tennessee. The results of the gas phase ab initio (RHF/3-21g\*) studies of Group 16 methyl cations will be reported. Enthalpies of Inversion for each compound from the tetrahedral through the planar intermediate structures are reported. Geometric parameters, and bonding characteristics will be discussed. The structure of trimethyltelluronium iodide also will be discussed.

AB-INITIO STUDIES OF GROUP 16 ALKOXIDES. *Barbara Cortner\**, *Judith M. Iriarte-Gross*, and *William H. Ilsley*, Middle Tennessee State University, Murfreesboro, Tennessee. Alkoxides are of interest as reagents in the sol-gel method to synthesize glass or ceramic materials. Selenium and tellurium alkoxides have been synthesized but relatively little is known about their structures. Gas phase ab initio (RHF/3-21g\*) have been conducted on the Group 16 alkoxides. The results of these calculations will be discussed.

THE DETERMINATION OF ACID DISSOCIATION CONSTANTS FOR A DIPHOSPHONIC ACID. *Teresa E. McMahon*, *Dale D. Ensor*, and *Daniel J. Swartling*, Tennessee Technological University, Cookeville, Tennessee. Diphosphonic acids form very stable complexes with a variety of metal ions. These ligands have been used as stripping agents in nuclear waste treatment and as carrier molecules in nuclear medicine. This study reports the characterization of a new chelating agent, 1,10-phenanthroline-2,9-dimethylenephosphonic acid, PDPA. The acid dissociation constants of PDPA were determined potentiometrically at 0.01 M ionic strength and 25°C. The results will be compared with literature values for other diphosphonic acids and used in further characterization of PDPA.

THE DEVELOPMENT OF NEW EXTRACTIVE SCINTILLATION COCKTAILS FOR THE ANALYSIS OF ACTINIDES. *Dale D. Ensor* and *Hao Wang*, Tennessee Technological University, Cookeville, Tennessee. The determination of low levels of actinides in water samples and aqueous waste streams generally involves a lengthy and complicated process. The Photon Electron Rejecting Alpha Liquid Scintillation Spectrometer (PERALS®), in combination with extractive scintillators, has been shown to provide an efficient alternative to traditional methods for the detection of actinides. The commercially available extractive scintillation cocktail, ALPHAEX®, has been applied to a number of actinides in a variety of oxidation states. For example, ALPHAEX® has been used to determine plutonium and americium in individual samples and in mixtures with recoveries > 98.4%. The separation of these two elements was accomplished by selective extraction after adjusting the acidity of the aqueous sample. The goal of this research was to evaluate more efficient extractants in order to develop an extractive scintillation cocktail that would extract all the actinides in acid concentrations of 0.1 M to 1.0 M. The first extractant tested was 4,4'-nonanedioyl-bis(2,4-dihydro-5-methyl-2-phenyl-3H-pyrazol-3-one), H<sub>2</sub>NDBP, a tetradentate compound prepared by linking two acyl pyrazolone units. The second extractant tested was bis(octyl)methanediphosphonic acid, OMDP (Sample provided by Eichrom Industries, Inc., Darien, IL). The results showed that the cocktail based on H<sub>2</sub>NDBP showed excellent ability to separate the tetravalent actinides from the uranyl ion and trivalent actinides. The OMDP extractive cocktail showed excellent ex-

traction efficiencies > 98% for tetravalent, trivalent, and uranyl ions between 0.1 M HNO<sub>3</sub> and 1.0 M HNO<sub>3</sub>. The application of these extractive scintillation cocktails for the analysis of Pu(IV), Am(III), Th(IV), and UO<sub>2</sub>(VI) both individually and in mixtures will be presented. A one step process for the determination of the total alpha content of natural and wastewater samples using the cocktail containing OMDP will be proposed.

INVESTIGATION OF THE DINITROSALICYLIC ACID REDUCING SUGAR REACTION. *Matthew A. Finn* and *Timothy M. Cofer*, Tennessee Technological University, Cookeville, Tennessee. Dinitrosalicylic acid (DNS) is a reagent widely used in the assay of reducing sugars to include the products from the enzymatic cleavage of sucrose by invertase. Color development in this reaction is very sensitive to available acidic hydrogen. When the reaction between DNS and a mixture of glucose and fructose is conducted in the presence of HCl, a decrease of color is observed as the HCl concentration increases. This trend also is observed when using various carboxylic acid buffers. The DNS-reducing sugar reaction conducted in either citrate or acetate buffers shows a decrease in color as the concentration of buffer is increased at pH 4.69. Modification of the assay to neutralize the available protons from the buffer prior to initiating the DNS reaction results in constant color development at all buffer concentrations examined. Investigation is underway to determine the effect of these buffers on the invertase-catalyzed reaction itself.

## ENGINEERING AND ENGINEERING TECHNOLOGY

Gladius Lewis, Chair, and Adel Salama, Chair

THE USE OF LOW EMITTANCE SURFACES FOR RESIDENTIAL AND INDUSTRIAL INSULATION. *David W. Yarbrough*, Tennessee Technological University, Cookeville, Tennessee. The use of low-emittance aluminum foil to create enclosed reflective air spaces can provide thermal resistances that compete favorably with mass insulations. Guarded hot box data obtained in past years at the National Bureau of Standards and Commercial Laboratories has been used to produce predictions of thermal resistance on a wide range of temperatures, temperature differences, and heat-flow direction. Heat losses from process piping and other high-temperature surfaces can be economically reduced by the application of low-emittance materials. Selected results will be discussed.

KINETIC STUDY OF THE REACTION BETWEEN COAL FLY ASH AND CALCIUM HYDROXIDE. *J. J. Biernacki*, Tennessee Technological University, Cookeville, Tennessee. The kinetics of the reaction between fly ash and calcium hydroxide (CH) is being investigated. The objective of this study is to develop kinetic expressions, activation energies and reaction mechanism information, that can be incorporated into existing automata-based microstructural simulations. At this time the reaction of a mid range CaO containing type-F ash with CH has been investigated at temperatures between 25°C and 60°C. TGA, XRD and other chemical analyses have been used to correlate the rate of hydrate formation and CH consumption as a function of temperature. Thus far the results suggest that the reaction rates are dependent on Ash/CH ratio and that the reaction stoichiometry and activation energies may have similar dependencies. Future

work will focus on confirming these results and extending the study to explore the effect of CH surface area and solution chemistry on reaction rates. The goal is to develop predictive mathematical models for simulation of microstructure development and subsequent properties of blended cements.

**FRACTURE BEHAVIOR OF AN ADVANCED PARTICULATE COMPOSITE MATERIAL.** *Gladius Lewis, The University of Memphis, Memphis, Tennessee.* The present study examines the effects on the fracture toughness (determined using disk-shaped compact tension specimens) and strength (determined via modulus of rupture in bending, MOR, experiments) induced by reinforcing two M-class high-speed tool steels with particulate alumina ( $Al_2O_3$ ). It is shown that the fracture toughness remains relatively uninfluenced for increasing  $Al_2O_3$  content, provided that full density is maintained in the composite material. By contrast, MOR decreases with increasing  $Al_2O_3$  content. Calculated critical natural flaw sizes indicate that the reinforcement particles do not act as inherent fracture-inducing flaws. Micrographical evidence that highlights the role of carbide and  $Al_2O_3$  distributions in the fracture behavior of these materials is presented. The implications of the present results, e.g. the use of these steels as advanced cutting tool materials, is discussed.

**DISPERSION OF A WASTE PLUME IN A TIDAL ESTUARY: TWO MODELS.** *David J. Wilson, Eckenfelder Inc., Nashville, Tennessee.* The dispersion and flushing of wastes discharged into tidal estuaries is of some concern along the highly industrialized east coast of the United States. Regulatory agencies routinely require mathematical modeling efforts in their permitting and enforcement activities. Existing models are often unsuitable, since several are one-dimensional and therefore cannot model transverse dispersion, while others are unable to model a change in direction of the tidal current. More elaborate models require massive input data sets and budgets of several hundred thousand dollars. Two models suitable for use with desktop computers will be described and results obtained with them will be presented. One describes tidal behavior throughout an estuary. The other, a 2-dimensional model, describes the advection, longitudinal dispersion, and transverse dispersion of waste entering the estuary along a length of its bank. These models were developed for use at a site on the Delaware River, a tidal estuary.

**WORK FORCE SKILLS AND EDUCATION IN TENNESSEE: A FRAMEWORK FOR IMPROVEMENT.** *Ted S. Lundy, Terri Anderson, Jerry B. Ayers, Tim Dean, and Don Sadler, Tennessee Technological University, Cookeville, Tennessee (TSL, JBA), Putnam County Schools, Cookeville, Tennessee (TA, DS), and Nashville Technological Community College, Cookeville Campus, Cookeville, Tennessee (TD).* This paper proposes long-term educational improvements in Tennessee from Kindergarten through the Doctoral degree related to the current and expected future growth in employment within manufacturing. Tennessee has done well in recruiting manufacturing enterprises during the last three decades but has not yet put the educational system on track for the major shift towards manufacturing jobs as the most important part of the economy. In order for the citizens of the state to achieve significant long-term improvements from their own training and education, an innovative and creative educational framework must be established that relates where we are now to where we need to be in the 21st century and beyond. Any such framework must have great flexibility for continual

modifications based on status of the whole spectrum of the changing needs of society. To begin the process for the Upper Cumberland Region of Tennessee, we have established a five-member team with each team member having agreed to contribute not only to his/her part of the K-PhD spectrum, but also to the concept that through mutual cooperation, we can set a pattern for meaningful positive changes in the overall educational system.

**ON THE VORTEX, VORTEX GENERATION AND ITS APPLICATIONS.** *Jiada Mo and John I. Hochstein, The University of Memphis, Memphis, Tennessee.* Vortex flow, incompressible and compressible, has become a significant branch of modern fluid dynamics and vortex flow applications have been in many industrial flow systems as well as in modern aircraft aerodynamics. This presentation will provide a comprehensive review of the mechanism of vortex generation, vortex flow nature and existing means for managing vortex to generate favorable flow patterns for various applications. Examples of various successful applications of vortex flows will be discussed and future research on vortex flow structure, control and potential applications will be explored as well.

**STRUCTURAL DESIGN WITH HIGH PERFORMANCE CONCRETE BRIDGES.** *Xiaoming (Sharon) Huo, Tennessee Technological University, Cookeville, Tennessee.* Recently high performance concrete (HPC) has been used in infrastructure construction. Benefits of using HPC include fewer girder lines required, longer span capacity of girders, less long term and short term deflections, higher tensile and compression strengths, reduced creep and shrinkage deformation, less prestress losses, longer life cycle and less maintenance of bridges. The author has conducted a research on several issues on structural design of bridges using UPC. The results from a parametric study have shown that girders with a cross-section that can hold a large number of prestressing strands, especially 0.6" diameter strands, would be preferred in HPC applications. The research results also indicate that the higher compressive strength of UPC has a major impact on the structural design of bridges, while the increase on allowable tension has a minor impact. New predicting equations for prestress losses with the consideration of the effects of lower creep and shrinkage deformations of HPC have been recommended.

**EVIDENCE OF DYNAMIC COMPRESSION OF THE CEREBRAL VASCULATURE INDUCED BY CHANGES OF PLEURAL PRESSURE DURING VENTILATION.** *Michael L. Daley, Richard Pasley, and Charles W. Leffler, The University of Memphis, Memphis, Tennessee (MLD, RP), and The University of Tennessee, Memphis, Memphis, Tennessee (CWL).* Our laboratory observations with a cranial window have demonstrated that during normal tone the intracranial pressure (ICP) and arterial blood pressure (ABP) recordings are not similar. However, as the cerebrovasculature dilates the corresponding ICP and ABP recordings become progressively similar. Furthermore, measurement of pial venous blood flow by freeze-frame video-micrometry reveals: a) flow increases with increasing vascular dilation; and b) flow during the expiration phase of ventilation is uniformly higher than the corresponding flow inhalation flow for all states of vascular dilation. The purpose of this study was to develop a preliminary test of the premise that when cerebrovascular tone is intact, compression of the cerebral capillary bed and ve-



nules occurs during positive pressure inhalation and this compressional effect progressively reduces as tone is lost. Preliminary measures of pial venous blood flow and anatomical changes of the pial venous vasculature during positive pressure inhalation support our premise.

**THE CYBERCLASSROOM AS A MEANS FOR DISTANCE LEARNING: TOOLS AND METHODS.** *Ashraf Saad and Adel Salama, The University of Cincinnati, Cincinnati, Ohio, and Austin Peay State University, Clarksville, Tennessee.* Web-based instruction is offering a new and powerful avenue for distance learning. In a distance learning setting, the student cannot follow regular classes in the conventional university setting. Offering courses on the Web can therefore enable such a student the means to achieve his educational goals by simply connecting to the course Web site. Few universities are currently offering whole academic degrees on-line but the numbers of such degrees are increasing at a rapid pace. Several commercial software packages are now available for the creation of Web-based courses. In addition to helping an instructor with the design of an on-line course, these packages include such features as creating a discussion group, email, and a whiteboard. Other important features include the ability to create homework and exams as well as assessment tools. In such a setting, the traditional role of the instructor is transformed to being a facilitator. A crucial design decision for an on-line course is whether it should be offered in a synchronized versus an asynchronous setting. Resolving the administrative issues associated with offering a Web-based course is an important factor for it to succeed in achieving its goal as a vehicle for distance learning.

**EFFECTIVENESS OF COMPUTER-BASED SELF-TEACHING VERSUS TRADITIONAL LECTURE-BASED COURSE IN ELECTRONIC ENGINEERING TECHNOLOGY.** *Adel Salama, Austin Peay State University, Clarksville, Tennessee.* Students in higher education have a greater degree of self-discipline, therefore a self-teaching technique can be a successful tool. This draws the attention to the fact that a Computer-based "Courseware" can help, but not replace the university lecture completely. The computer-based courseware includes a series of specialized modules consistent with the traditional lecture-based course, where the lecturer can be satisfied that part of his material is adequately covered by the courseware. This would enable substitution for the lectures. There are many reasons for developing computer-based self-teaching for Electronic Engineering Technology. First of all, it shows a suitable discipline technique and it relies heavily on large quantities of diagrammatical information. Also, students will be able to use the module as a guide if they miss a lecture. Therefore, this computer-based course may lead to a large reduction in teaching time with no significant difference in learning.

**MONITORING TRAUMATIC BRAIN INJURY: APPLICATION OF SPECTRAL ANALYSIS TO DETECTION OF B-WAVES.** *Richard Pasley\*, Matthew J. L. Connolly, Henrietta Bada, Shelly Timmons, Charles W. Leffler, and Michael L. Daley, The University of Memphis, Memphis, Tennessee (RP, MLD), Cornell University, Ithaca, New York (MJLC), and The University of Tennessee, Memphis, Tennessee (ST, CWL).* Some patients with traumatic brain injury demonstrate B-waves in arterial and intracranial pressure which are slow oscillations of about 1 to 8 cpm associated with alterations in brain-stem

function induced by the initial traumatic event or its secondary complications. However, low frequency oscillations of intracranial and arterial pressure within the same frequency range also can be induced by changes of pressure within the thoracic cavity associated with positive-pressure ventilation and active respiration. The purpose of this study was to devise a spectral analysis method for detecting low frequency oscillations and identifying B-waves. Spectral analysis of clinical recordings of arterial and intracranial pressure sampled at a rate of 250 Hz for 10 min was accomplished using a linear frequency modulation model. Results of this analysis demonstrate respiratory-induced pressure waves have sub-harmonics associated with the rate of ventilation whereas B-waves are denoted by a single low frequency peak.

**DECREASING OF WATER ABSORPTION OF POROUS POLYMERS USING ULTRASONIC AND VIBRATION IMPREGNATION TECHNIQUES.** *Weijing Dang and Fyodor Shutov, Tennessee Technological University, Cookeville, Tennessee.* This study has explored the ultrasonic and vibration effect for decreasing the water absorption of solid porous polymer materials by impregnation of polymer powder. Ultrasonic cleaner (Model 5210) and vibration machine have been used to test this effect. It was demonstrated that both ultrasonic and transmitting vibration promote the polymer powder impregnation into the layers of skin of porous materials. The higher the amount of the impregnated polymer particles, the less the water absorption of the porous materials. It was concluded that thin layers of polymer films inside the pores prevent the water penetration into the materials. The results of this work demonstrate the feasibility of ultrasonic and vibration impregnation techniques for commercial applications. These techniques can provide the water and moisture protection of mineral and polymeric porous building materials in constructive industry.

**ESTIMATION OF EFFECTIVE DIFFUSIVITY OF GAS IN PLASTIC FOAM BY A GRAVIMETRIC METHOD.** *Vijay G. Tadinada\* and J. Richard Booth, Tennessee Technological University, Cookeville, Tennessee.* The Effective Diffusion Coefficients of gases in plastic foam are computed by using a Gravimetric Method, and the coefficients are compared with those available in the literature. A quick basic program records the time-dependent weight loss data of a foam sample upon depletion of the gas. Scaled Time is calculated based on the effective thickness and diffusion time. Unaccomplished Change Weight Ratio ( $UCR_w$ ) is the ratio of instantaneous weight loss to equilibrium weight loss. The slope of the graph of  $UCP_w$  vs. Scaled Time yields the Effective Diffusion Coefficient.

**DEVELOPMENT OF PRESSURE SHEAR PULVERIZATION PROCESS FOR MECHANICAL RECYCLING OF POLYETHYLENE-BASED SCRAP.** *Tapan Patel\* and Fyodor Shutov, Tennessee Technological University, Cookeville, Tennessee.* A new principle of pulverization of thermoplastic polymers has been developed: Pressure Shear Pulverization (PSP) process. PSP is a proprietary, non-extrusion process and is realized inside a specially designed pulverizer. It is very different from cryogenic grinding, various versions of solid state shear extrusion (SSSE), and other conventional size reduction processes. PSP process is capable of producing a wide range of particles from coarse to very fine. It is possible to control average particle size and particle size distribution by manipulating the processing parameters. This paper deals with the pulverization of pre-consumer and post-

consumer LDPE-based plastics scrap by PSP process. As a model system, we have also studied the processibility and properties of virgin LDPE. Physical properties such as melting point, enthalpy of fusion, percent crystallinity, melt flow index, intrinsic viscosity, and average molecular weight of virgin LDPE and polymeric powders were determined to understand the behavior of polymer under the combined action of thermally and mechanically induced stresses. Scanning electron micrographs indicate the irregular shape, different surface texture, and high aspect ratio of the particles.

**STUDY OF MELT FLOW INDEX AND INTRINSIC VISCOSITY PROPERTIES OF VARIOUS VIRGIN POLYMERS AND PLASTIC SCRAP.** *Jenny Lau Eik Lang\**, *Fyodor Shutov*, and *Patel Tapan\**, *Tennessee Technological University, Cookeville, Tennessee*. The main objective of this project is to determine the Melt Flow Index (MFI) and Intrinsic Viscosity (IV) of various virgin polymers and plastic scrap. Kayence-Melt Indexer is used to test MFI based on ASTM D1238. For IV, the viscometer type OC is used to run tests based on the ASTM D1601-86. According to data, the MFI values for virgin polymers have a very wide range, such as (g/10 min): LDPE-50.0, PP-11.0, PS-21.0, PVC-25.7, PET-74.8. The IV values produce the following data for different particle size of virgin low density polyethylene: virgin pellet-62.3, less than 90 microns-72.13, 180 to 212 microns-65.05, 500 to 600 microns-62.8, 1000 to 1180 microns-71.67, 1700 to 2000 microns-68.46 and for scrap-113.4. Various values for MFI and IV are discussed based on the differences in the chemical and physical structures of the tested polymers.

**MODEL OF DYNAMICS OF INTRACRANIAL PRESSURE.** *Chunzhi Wang\**, *Adam Meledeo*, *Richard Pasley*, *Charles W. Leffler*, and *Michael L. Daley*, *The University of Memphis, Memphis, Tennessee (CW, RP, MLD)*, *Texas A&M University, College Station, Texas (AM)*, and *The University of Tennessee, Memphis, Memphis, Tennessee (CWL)*. Clinical recordings of intracranial pressure (ICP) of patients with traumatic brain injury demonstrate a wide range of dynamic characteristics. For one pathophysiologic state, the ICP and arterial blood pressure (ABP) recordings demonstrate a marked similarity. While in another pathophysiologic state, the two pressure recordings are markedly dissimilar. The purpose of this study was to develop a mathematical model, which describes the possible physiologic mechanism, which underlies the wide range of dynamic changes observed in ICP recordings. The major feature of this model is the characterization of compression of the capillary bed and venules induced by changes of pressure within the thoracic cavity associated with positive pressure ventilation. Under conditions of intact cerebrovascular tone, the compression effect is maximal and the corresponding dynamics of the ICP and ABP recordings are dissimilar. The compressional effect progressively reduces as tone is lost until the dynamics of the two pressure recordings are markedly similar.

**THE PROPERTIES OF POLYURETHANE ELASTOMERS FILLED WITH 3-DIMENSIONAL FILLER.** *Yuan Yuan\** and *Fyodor Shutov*, *Tennessee Technological University, Cookeville, Tennessee*. Polyurethane open-pore foams of different pore size were used as 3-dimensional filler to reinforce two-component polyurethane solid elastomers. Tensile properties of the new composite elastomers tensile strength at break, percent elongation and tensile modulus were tested and compared with the virgin

elastomers. From the results of the experiments it was concluded that the tensile modulus of the composite material increased from 12% to 60% and the value of tensile strength at break increased 20%-60% due to the presence of 3-dimensional fillers. In addition, the experiments showed that the smaller the pore size of the 3-dimensional filler, the better the reinforcement effects. Possible application of a novel family of advanced composites is discussed.

**COMPUTER MODELING OF PLANAR DIFFUSION SYSTEM WITH BORON NITRIDE AS A SOLID SOURCE.** *Y. Wang\** and *Joseph J. Biernacki*, *Tennessee Technological University, Cookeville, Tennessee*. With ever increasing numbers of silicon semiconductor devices being manufactured, the technology to produce doped silicon wafer must keep pace with production demands. Introduced in the 70's, the boron nitride planar system is an excellent source of p-type boron dopant and is widely used in bipolar, MOS, discrete and mixed technologies and other device types. The study of the planar diffusion system covers an extensive research area. There is a large body of literature on the discrete process steps. However, these steps have not been assembled into a system model. The purpose of this work is to develop and verify a dynamic simulation for hydrogen injection and subsequent H<sub>2</sub>O vapor dispersion, HBO<sub>2</sub> formation and dispersion and B<sub>2</sub>O<sub>3</sub> film consumption and film thickness on the BN surface. This study is the first step in developing a more comprehensive model that includes B<sub>2</sub>O<sub>3</sub> deposition and diffusion into the Si wafer and is an effort to develop engineering tools for the optimization, and sustained development of the planar diffusion system.

**EVALUATION OF EFFECTIVE DIFFUSION COEFFICIENTS OF CO<sub>2</sub> IN CLOSED-CELL POLYURETHANE FOAM SPECIMENS.** *Phaneendra B. Kondapi\** and *J. Richard Booth*, *Tennessee Technological University, Cookeville, Tennessee*. A gravimetric desorption method is adapted to evaluate the effective diffusion coefficients of CO<sub>2</sub> in closed-cell rigid polyurethane foams. Using this method, the time dependent weight loss data is obtained for foams having different uniform densities. Thin-slice accelerated aging technique is employed in conducting these experiments. The slope of the weight loss with scaled age predicts the effective diffusion coefficient. Thickness-scaled age parameter is computed from the effective diffusion thickness and the diffusion time. The results obtained from this method are compared to those predicted from the diffusion coefficient void-fraction model reported by Cuddihy and Moacanin.

## ETHICS IN SCIENCE AND TECHNOLOGY

Ruby Prigmore-Torrey, Chair

**A CASE STUDY IN BAD FAITH: THE DEPARTMENT OF ENERGY AND ITS WHISTLEBLOWERS.** *David K. Hackett*, *Center for Government Accountability, Knoxville, Tennessee*. The Department of Energy (DOE) has had a series of high profile initiatives under several Secretaries of Energy designed to build openness and protect concerned employees who raise issues of health, safety and fraud from management punishment. While these whistleblower protections have been unveiled with much public ceremony, little has changed. DOE remains a solely self-policing agency where whistleblowing is not tolerated, and safety

and health are not real concerns. A chilled atmosphere prevents concerned employees from expressing their concerns, and is revealed by DOE spending millions to silence these whistleblowers rather than in building a real culture of safety and openness. Media reports indicate higher rates of whistleblower suits at DOE than any other agency. A multitude of individual cases reveal the vast gap between word and deed. While Secretarial intentions may be good, management shows no desire to give up its long held policy to punish well intentioned employees who raise concerns. This very public window-dressing and vacuous program of openness begs the question: can a self-policing agency ever comply with laws it finds easier to break?

**ETHICAL SCIENTISTS IN PUBLIC ISSUES.** *Herman S. Forest, State University of New York, Genesco, Genesco, New York, and Cookeville, Tennessee.* Scientific ethics is a modern concept with the cannon and its applications still evolving. We have recognized the need, and we have some means of checking on each other. Mendel and Pasteur did not have reviewers, and 19th Century studies on race are examples of what not to do-nowdays, but the mischief continues. It has been said that the pressure of "big" science increases the opportunity for wrongdoing, but is not a basic cause. Nevertheless, it seems that very little harm results. Most bad science, whether honest or dishonest is simply ignored, politely. It is in public issues that ethics have become vital, far reaching enough to become life and death matters for the human race. Abortion, gene modification and cloning, are trivial compared with environmental issues. Even though less confused with unscientific values, environmental issues are complex to transmit in layman's language. At least, very few scientists have prostituted themselves to the powerful destructive forces. Our failures are more often the unwillingness or inability to enter the rough and tumble of the decision marketplace, and remain scientists while doing so. The common ethical failure is passiveness. Yet, the vocal and the shy, can act together through scientific organizations, and a cautious beginning has been made to adopt this strategy.

**RESEARCH IN PSYCHOLOGY: POSITIVE AND NEGATIVE EFFECTS OF ETHICAL CONCERNS.** *Thomas M. Brinthaup, Middle Tennessee State University, Murfreesboro, Tennessee.* The conduct of research in psychology can be strongly affected by ethical considerations. Ethical guidelines in psychology recommend caution when one's research involves certain populations and topics, such as children, prisoners, deception, embarrassing or illegal activities, and so on. To date, very little attention has been given to how ethical concerns guide and alter the research questions one asks and the research methods one uses. In this talk, case examples of undergraduate, graduate, and faculty research that have been affected by ethical concerns will be described. Implications of ethical concerns for the field of psychology will be discussed.

**ETHICS IN THE LIFE OF AN ENGINEERING PROFESSOR.** *Roy C. Loutzenheiser, Tennessee Technological University, Cookeville, Tennessee.* Ethics should be a more active part of an engineering professor's daily life. The general hypothesis is that most professors (1) do not understand ethics and (2), therefore do not apply ethics to their every day activities. Like many things learned in higher education, if one does not apply them, one loses them. Although each professional engineering society has their own code of ethics, most of the codes are similar in content.

Therefore, professors have the opportunity to select their own particular code and apply it to their daily activities. Teaching involves ethical decisions; for example, grading must be fair and unbiased. For many students, the professor is their first significant contact with an engineer and frequently becomes a role model. When involved with research, the professor may find conflicts between teaching assignments and research opportunities. The purpose of the university is to educate; however, research usually means more money and personal achievements toward tenure and promotion. Consulting can be an important part of the engineering professor's ethics. However, conflict of interest may occur when one decides whether the project should be personal (consulting) or research (university). Time management may become a serious problem when the consulting project report is due the same day as an academic report or test. Being an engineering professor does not exclude one from using ethics. The professor must be familiar with the particular code of ethics used in his/her field of engineering. Just like a student, the professor must study the various guidelines provided in a code and apply ethics in his/her daily activities.

**SCIENCE INFORMATION MOVEMENT: THREE CASE HISTORIES IN COMMUNITY EMPOWERMENT.** *David J. Wilson, Eckenfelder Inc., Nashville, Tennessee.* In the late 1950s and early 1960s concern about the effects of atmospheric nuclear weapons testing by the United States and the United Soviet Socialist Republic led to the formation of a number of groups of scientists, medical people and engineers. These groups played a significant role in the passage of a treaty banning atmospheric bomb tests. Several of the groups (St. Louis, MO, Rochester, NY, Chicago, IL and New York, NY, for example) then broadened their interests to address a wider range of environmental and health related problems through provision of scientific information to the public. This often proved effective in developing the political and social power to deal with these problems. Three case histories will be described: water pollution in Rochester, lead poisoning in Rochester, and toxic waste disposal in Memphis. The philosophy, strategy, and tactics of the so-called scientific information approach will be briefly described.

## GEOLOGY AND GEOGRAPHY

Hugh H. Mills, Chair

**GROUND WATER TRACING RESULTS AT TWO OLD MURFREESBORO CITY DUMPS, RUTHERFORD COUNTY, TENNESSEE.** *Albert E. Ogden, Middle Tennessee State University, Murfreesboro, Tennessee.* A ground water tracing investigation was conducted at two old dumps formerly operated by the City of Murfreesboro. The dye tracing results show that ground water in the vicinity of the dumps moves through the Ridley Karst Aquifer to emerge as spring flow at the Ridley's contact with the underlying impermeable Pierce Limestone. The injected dyes moved first down the flanks of subtle anticlinal flexures through caves and solution-enlarged joints with average trends of N40°W and N45°E and then, along the strike of the adjacent synclinal troughs. The five ground water traces demonstrate that the recharge areas for the springs hydrologically connected to the dump are significantly large with areas of dense development, industries, and shops. In addition, much of the stormwater runoff from streets is diverted to sinkholes that are hydrologically con-

nected to the dumps. Therefore, many potential contaminant sources exist that could affect the water quality of the springs. The springs, karst windows, and cave waters hydrologically connected to the dumps are the best places to monitor versus constructing wells.

**COMPOSITIONAL TESTS OF HYPOTHESES REGARDING THE INTERACTION BETWEEN STREAM ORDER AND DRAINAGE AREA WITH HYDRAULIC GEOMETRY.** *Gregory S. Ridenour, Austin Peay State University, Clarksville, Tennessee.* The width, depth, and velocity of a stream are power functions of discharge (the "hydraulic geometry" equations) whose exponents sum to one. Several studies have suggested that stream order is related to hydraulic geometry. Because lower order streams generally drain smaller areas than higher order streams, hydraulic geometry might also correlate with the drainage area above a given point on a stream. Proportional stream order uses rational numbers to describe the variation in order within a given stream segment. To test the hypotheses that hydraulic geometry is related to these stream parameters, statistical analyses were conducted for nine stations in Texas and on data from the literature from eighteen river basins in Illinois. Because hydraulic geometry is unit-sum constrained, it was necessary to utilize compositional data analysis. Hydraulic geometry was determined to be unrelated to stream order, proportional stream order, and drainage area, suggesting that more site-specific factors are controlling hydraulic geometry.

**ELONGATE INTRENCHED MEANDERS OF LOWER CHESTUEE CREEK, POLK COUNTY, TENNESSEE.** *Hugh H. Mills and Frederick C. Barrell IV\*, Tennessee Technological University, Cookeville, Tennessee.* Over its last 10 miles, before it joins the Hiwassee River, Chestuee Creek exhibits a spectacular series of exaggerated, elongate incised meanders, with stream sinuosity exceeding 4.0. An attempt was made to see if characteristics of this stream and its basin can help explain this anomalous meandering by comparing these characteristics with those of 16 other streams in the same general area. A plot of channel width, for example, shows that the Chestuee channel is unusually narrow for its basin size relative to other streams. A similar plot shows that channel gradient is unusually low, less than 0.0003 in some reaches. The banks of the Chestuee also are unusually high in percent silt+clay of the <2 mm fraction; the percentage ranges from 77 to 92%. This texture may be a product of the type of Bedrock underlying the basin. Finally, the mean slope of the Chestuee basin is lower than most other basins. The above characteristics make possible some speculations about the origin of the meanders.

**STREAM CLASSIFICATION FOR HABITAT ENHANCEMENT IN EAST TENNESSEE.** *Hollings T. Andrews, Tennessee Technological University, Cookeville, Tennessee.* An 850 m reach of Coker Creek, in southeast Monroe County, Tennessee, was selected by the USDA Natural Resources Conservation Services as a site for stream habitat enhancement. Disturbances in the drainage area (anthropogenic alluviation) occurred in the mid-1800's by gold mining. In the mid-1900's the reach was altered by earth moving equipment. The braided channel which meandered through a wetland of approximately 2 ha was consolidated, displaced, and straightened, and the wetland was drained. The immediate concern is bank stabilization and (fish) habitat enhancement. Initial field work has included setting con-

trol points and surveying 30 cross-sections (differential and trigonometric leveling), surveying the longitudinal profile of stream bottom and water surface (differential leveling), studying reference reaches, and formulating regional curves. Emphasis of field work has been to gather data which can be used to accurately describe the stream geometry, and which will serve as a basis for the design of modifications to the channel. \*

**NEW LATE PLEISTOCENE AND HOLOCENE MICROVERTEBRATE LOCALITIES FROM LOOKOUT MOUNTAIN, TENNESSEE.** *Timothy J. Gaudin, Jeremy L. Bramblett\*, Phillip R. Millener, Paul C. Van Alstyne, and Kent Ballew, The University of Tennessee, Chattanooga, Chattanooga, Tennessee.* Vertebrate remains have been recovered from five caves on the northern end of Lookout Mountain, Tennessee. The bones were discovered in stream wash and flood overbank deposits on the floor of the caves and in crevices along the walls. Preliminary surface collecting, screen washing, and hand picking of sediments has yielded numerous freshwater mussels and gastropods and a diverse and abundant microvertebrate assemblage which includes: fish, salamanders, frogs, turtles, snakes, birds, and mammals. Three of the five caves yield material of Holocene provenance (e.g. *Mus*). Three caves contain a mixture of extant and late Pleistocene species, the latter including extirpated species of birds (e.g. *Tympanuchus*) and mammals (e.g. *Condylura* and *Conepatus*), as well as extinct mammals (e.g. *Dasyurus bellus*, *Mylohyus*, and *Mammuth*). This collection is the first extensive late Pleistocene microvertebrate assemblage known from the Ridge and Valley of Southeastern Tennessee. Excavation, sediment screening, and identification of remains is ongoing.

**SCANNING ELECTRON MICROSCOPY OF UNUSUAL SURFACE FEATURES ON WELL PRESERVED HOLLINELLID OSTRACODES FROM THE FINIS SHALE (PENNSYLVANIAN) OF TEXAS.** *Katrina Hunter\* and Larry W. Knox, Tennessee Technological University, Cookeville, Tennessee.* A fauna of exceptionally well-preserved ostracodes was recovered from the Finis Shale (Pennsylvanian, Virgilian) at a single locality near Jacksboro, Texas. Scanning electron microscopy and energy dispersive X-ray spectroscopy were utilized to study surficial features rarely reported from hollinellid ostracodes from this fauna. At least two species of *Hollinella* exhibit reticulate surface ornamentation, which has not previously been reported from North America. On these specimens the walls of the reticulum are only loosely attached to the lateral surface of the ostracode shell, and many specimens exhibit areas where the reticulum is partly to almost completely missing. A few European hollinellids with reticulate surfaces have been reported, and one author has concluded that such ornamentation is a derived evolutionary feature. We suggest that the reticulation may result from mode of preservation rather than evolutionary development. Normal pore canals (reported for only one other hollinellid species in the literature) are distributed over the surface of the domicilium at places where the reticulum is missing. The pore canals are simple tubes that average ten microns in diameter oriented perpendicular to the shell surface, and lack a sieve plate.

**CONULARIIDS FROM THE MISSISSIPPIAN OF TENNESSEE.** *James X. Corgan and Daniel L. Frederick\*, Austin Peay State University, Clarksville, Tennessee.* The upper Warsaw formation (Mississippian: Meramecian) yields *Paraconularia ches-terensis* (Worthen, 1883) at a site on the Cumberland River in

south-central Clarksville, Montgomery County. It is the fifth conulariid occurrence in the Mississippian of Tennessee. Prior records are difficult to evaluate because they are unillustrated and most lack detailed descriptions. Three records date from 1869. They predate modern stratigraphic terminology, geographic locations are vague, and both genus-level and species-level identifications reflect old concepts of conulariid diversity. One record from East Tennessee is from 1986. It offers good locational data but few details. The species present in the newly discovered site, *P. chesterensis*, characteristically occurs in younger Mississippian strata but it is known from the Meramecian of Missouri.

**BIOIMMURATION OF *EXOGYRA* FROM THE LATE CRETACEOUS COON CREEK FORMATION OF WEST TENNESSEE.** *John E. Griffin Jr. and Michael A. Gibson, The University of Tennessee, Martin, Martin, Tennessee.* Bioimmuration is a mode of fossil preservation that results in overgrowths or “imprisonment” of organisms over one another. Bioimmuration is an important taphonomic process because soft-bodied organisms can be preserved as molds within skeletons of other organisms and may indicate biotic interactions between hosts and epibionts. We describe the first reported occurrence of bioimmuration from the Coon Creek Formation of Later Cretaceous age. Bioimmuration occurs most frequently in shells of the oyster *Exogyra*, which record a variety of bioimmured forms. Shelled organisms make up a minor portion of hosts for larval *Exogyra* settlement. Bioimmured molds of tube-shaped non-skeletonized organisms comprise the most common host. A commensal relationship is indicated by interfolding of the growth laminae of the shell of *Exogyra* consistent with intergrowth with the bioimmured host tissue. The tube shaped hosts retained structural integrity even when *Exogyra* shells became ponderous; indicating that seaweed was not a typical spat host. Partially skeletonized organisms (e.g. sponges or octacorals) were more likely hosts.

**GEOLOGICAL MAPPING IN TENNESSEE: 1752–1831.** *James X. Corgan and Marvin B. Berwind, Austin Peay State University, Clarksville, Tennessee, and Tennessee Division of Geology, Nashville, Tennessee.* In 1752 the French savant J. E. Guettard displayed a map of the mineral resources of eastern North America, including what is now Tennessee. He never visited the land he studied. The map was published in 1756, long before the conventions of modern mapping were established. For the era, it was excellent. The next geologic map that included Tennessee appeared in 1809, with later revisions. Prepared by William Maclure, who never visited Tennessee, it covered eastern North America and predated modern concepts of a geological time scale. In early 1831, Gerard Troost and Charles Lesueur may have mapped Cumberland Plateau coal lands. If they did, the map is lost. The earliest known geological mapping based on personal observation by the author of the map began soon after the appointment of Troost as State Geologist in December 1831.

**GEOLOGICAL MAPPING IN TENNESSEE: 1831–1840.** *James X. Corgan and Marvin B. Berwind, Austin Peay State University, Clarksville, Tennessee, and Tennessee Division of Geology, Nashville, Tennessee.* Sustained geological mapping began in December 1831 when Gerard Troost became Tennessee’s first State Geologist. A map of central Middle Tennessee, completed in 1833, was never published. Jacob Peck, a land speculator, mapped Appalachian gold lands in 1833. In 1835, the State issued a report and map by Troost, emphasizing the Cumberland

Plateau. This work improved understanding of regional resources, such as coal. Local and county-level maps published in 1837 and 1840 were also a potential base for economic activity. A state-level map by Troost, published in 1840, with a cross-section, summarized knowledge of regional geology. Troost’s geological cartography was state of the art. Compared to modern equivalents, his work now seems quaint because he used the terms and techniques of his era.

**GEOMORPHOLOGY OF CREEKS IN THE TENNESSEE VALLEY AND RIDGE: INTERACTION OF GEOLOGIC, TOPOGRAPHIC, AND SEDIMENTOLOGIC FACTORS.** *Frederick C. Barrell IV\* and Hugh H. Mills, Tennessee Technological University, Cookeville, Tennessee.* We have measured and correlated stream gradient, meander wavelength, sinuosity, channel-cross sectional form, drainage basin area, basin mean slope, bank particle size, and basin bedrock geology, at 26 sites on 16 creeks in the Valley and Ridge of east Tennessee. Expected correlations were found between drainage-basin area and channel width, depth, cross-sectional area, gradient, and meander wavelength; calculated regression equations for these relations were then compared to those derived for streams studied elsewhere. Unexpected findings were a complete lack of correlation between bank particle size and channel width/depth ratio or other index of channel cross-sectional form, and only a very modest correlation between width/depth and channel sinuosity. Also unexpected was a relatively strong correlation between basin area and sinuosity. Some bedrock units show a relationship to bank particle size and to basin mean slope.

## HISTORY OF SCIENCE

George E. Webb, Chair

**ACADEMY HISTORY: ENCYCLOPEDIA AND OFFICIAL.** *James X. Corgan, Austin Peay State University, Clarksville, Tennessee.* The Tennessee Historical Society’s newly issued *Encyclopedia of Tennessee History and Culture* has an essay on Academy history. This text was authorized by the Academy’s Executive Committee, reviewed by Academy members, and is part of the Academy’s web page. It describes continuous change from 1912 through 1998. Global economic depression, global war, and other external factors impacted the Academy as did changing concepts of the Academy’s mission, money matters, and an expanding population of scientists. Major involvements, such as the Reelfoot Lake Biological Laboratory and Academy-sponsored National Science Foundation workshops for teachers, came and went as Tennessee’s scientific culture evolved. In the last 10 years the Academy established four new sections, a sign of institutional health. When the Academy ends its first century, in 2011, it should remain a vibrant, dynamic organization.

**THE NATURE-STUDY MOVEMENT AND THE EARLY CURRICULUM OF MIDDLE TENNESSEE STATE NORMAL SCHOOL.** *Philip M. Mathis, Middle Tennessee State University, Murfreesboro, Tennessee.* The nature-study movement traces its origins to the *Orbis Pictus* of Johann Amos Comenius, the early writings of John Locke and Jean Jacques Rousseau, and later, to the pedagogical ideas of Louis Agassiz. During the 1890–1920 period, the movement became well-defined as part of an effort to incorporate science into the American elementary school cur-

riculum. Nature-study and its underlying philosophy had a significant impact on the training of teachers during the period, including those at Middle Tennessee State Normal School. Artifacts of the movement are still around. To some extent, the underlying philosophy is reflected in the government-sponsored science curriculum projects of the 1960's and 70's and in today's nationwide attempt to improve undergraduate science instruction through Project Kaleidoscope.

**HISTORY OF SCIENCE IN THE TENNESSEE ENCYCLOPEDIA.** *George E. Webb, Tennessee Technological University, Cookeville, Tennessee.* Published in 1998, *The Tennessee Encyclopedia of History and Culture* includes more than 1500 articles written by 560 authors. Its 1200 pages discuss the state's political, economic, military, social, and cultural development from prehistoric times to the present. Developments in science, technology, and medicine enjoy a noteworthy place in this publication, as indicated by more than 160 articles covering a wide variety of topics. Approximately half of these essays are biographical sketches, while the majority of the remaining articles examine important institutional developments.

**IGNAZ SEMMELWEIS: A PIONEER IN MEDICAL INVESTIGATION.** *Patrick Doyle, Middle Tennessee State University, Murfreesboro, Tennessee.* Dr. Semmelweis was a Hungarian working at the Vienna General Hospital in Vienna, Austria in the mid 1800's. Being a foreigner in such troubled times put him at a disadvantage. When he became director of the maternity ward, one of his main concerns was the high rate of puerperal or childbed fever, especially as it was much higher in his division than in the division managed by the midwives. He took an experimental approach in discovering what caused the difference in the rates of puerperal fever between the divisions. As he eliminated one possibility after another a statement by a colleague who had done 30,000 detailed autopsies led him to the realization that it was the transfer of cadaveric material by him and his students when they left the death house to examine their patients in labor that was the cause of so many of them dying. Semmelweis initiated the simplest of preventive measures, the thorough washing of hands in a chlorinated lime solution after leaving the death house and then between patients being examined.

**WILLIAM ROSCOE LIVERMORE: PIONEER CHEMICAL PERIODICIST.** *Thomas A. Furtch, Tennessee Technological University, Cookeville, Tennessee.* William R. Livermore was a career military officer and sometime dabbler in chemistry. He was one of several scientists in the late 19<sup>th</sup> Century who tried to make some sense of the periodic law by attempting to find a way to use it in calculating precise atomic weights. In pursuing this idea in a paper in 1890 he produced some interesting results, not the least of which was a prediction of atomic weights of the yet to be discovered noble gases. Livermore's paper will be discussed in the context of chemical periodicity before the discovery of atomic structure.

**HERBAL REMEDIES OF JOHN WESLEY.** *Thomas E. Hemmerly, Middle Tennessee State University, Murfreesboro, Tennessee.* The renowned eighteenth century churchman, reformer, and evangelist John Wesley, also was author of *Primitive Remedies*. This concise volume served as the standard home "medical book" in England and America for nearly one hundred years.

Some of his herbal remedies are examined in the light of current scientific knowledge and their general use.

## MATH AND COMPUTER SCIENCE

Jan Zijlstra, Chair\*

**A FIBONACCI-TYPE PROBABILITY DISTRIBUTION.** *Jimmie R. Ridenour and David R. Grimmert, Austin Peay State University, Clarksville, Tennessee.* The probability of requiring  $n$  trials before obtaining the first ( $k = 1$ )<sup>th</sup> success is well-known and solved with the Geometric Probability Distribution. Similarly, the probability of requiring  $n$  trials before obtaining the first ( $k > 1$ ) success is well-known and solved with the Negative Binomial Probability Distribution. But what about the  $k$ <sup>th</sup> consecutive success? The solution to this lesser posed question is neither well-known nor well-documented. The authors present the problem and show some very interesting results including the fact that the solution is based on the Fibonacci sequence (1, 1, 2, 3, 5, 8, 13, etc.) for  $k = 2$  and on a modified Lucas-type sequence philosophy for  $k > 2$ .

**TIME DISCREPANCIES IN ARRAY PROCESSING WITH RESPECT TO COMPILER OPTIMIZATION.** *George W. Mitchell\* and Jerry E. Sayers, East Tennessee State University, Johnson City, Tennessee.* A series of experiments was conducted on one-dimensional arrays, using optimization settings and internal switches within the Borland C++ 4.5 compiler. Preliminary analysis of the data indicates counterintuitive results, suggesting the gain from optimization to be insignificant. Further research is being conducted in an effort to explain this anomaly. A conclusion drawn from the continued research will be presented.

**JVM BYTECODE-BASED PROGRAM ANALYSIS.** *Roland H. Untch, Middle Tennessee State University, Murfreesboro, Tennessee.* Program analysis is the process of collecting control and data-flow information from a program. Current automated program analysis tools employ front-ends that process a program at the source-code level. Unfortunately, creating such a conventional front-end is an expensive undertaking—akin to writing a front-end for a compiler. Moreover, the more sophisticated the language, the more difficult developing a conventional front-end becomes. This presentation presents a new approach to building front-ends for automated program analysis tools. In this approach, front-ends process a program at the object code level.

**A COMPARISON OF DIFFERENT APPROACHES TO CONSTRUCT GREEN'S FUNCTIONS.** *April L. Rice\* and Yuri Melnikov, Middle Tennessee State University, Murfreesboro, Tennessee.* The construction of Green's functions for partial differential equations is a process which requires much time and knowledge. Few representations of Green's functions are currently available in the literature. This is mostly due to the lack of a universal technique. In some cases, Green's functions can be constructed based on classical methods. However, these methods can become extremely tedious and, in some cases, practically impossible to complete. An effective method for the construction of Green's functions was proposed in (1). This method was used here to construct the Green's function of Laplace's equation for a mixed boundary value problem posed over a semi-bounded region. The final result is presented in analytical form, allowing

a straightforward numerical implementation. Several numerical results are presented and discussed.

**HOARE POWERDOMAINS.** *James B. Hart, Middle Tennessee State University, Murfreesboro, Tennessee.* A domain is a mathematical model for computational processes. As mathematical objects, domains are algebraic posets in which every nonempty subset has an infimum. Powerdomains, the domain-theoretic equivalent of power sets, are used to model various kinds of computational nondeterminism. This talk will introduce the notion of angelic nondeterminism and describe the mathematical construction which models it, namely the Hoare powerdomain.

**DETERMINING UNKNOWN COEFFICIENT FUNCTIONS IN PLANE AUTONOMOUS SYSTEMS OF DIFFERENTIAL EQUATIONS.** *Jan Zijlstra, Middle Tennessee State University, Murfreesboro, Tennessee.* In systems of non-linear differential equations, coefficients are functions of the dependent variable. The inverse problem for such a system consists of characterizing these functions, based on a set of observed data. An algorithm for the solution of this type of problem is presented, based on the estimation of fourier coefficients of the unknown functions. An objective function is formulated based on the deviation of the computed values and the observed values of the dependent variable. This function is minimized using a state of the art quasi-Newton scheme. Preliminary results indicate a quadratic convergence of the algorithm around the minimum.

**AN INTERACTIVE WEB-BASED LABORATORY MANUAL FOR CS 1.** *Kay Anthony\* and Tom Cheatham, Middle Tennessee State University, Murfreesboro, Tennessee.* What are the advantages/disadvantages of having an interactive laboratory manual on the web? What problems arise in the process of converting a hard-copy manual to the web? Do changes have to be made? How does the electronic version of the manual compare with the hard-copy version for learning purposes? These and other questions are being addressed in a project to place the Computer Science I laboratory manual on the web. This is a progress report since the project is less than three months old. Lessons learned so far will be shared.

## MATH AND SCIENCE TEACHERS

Joseph Sharpe, Chair

**CAREERS IN BIOLOGY: A MULTIAPPROACH COURSE DESIGNED TO GUIDE BIOLOGY MAJORS IN CAREER CHOICES.** *Susan McMahon and Linda Smith-Station, Pellissippi State Technical Community College, Knoxville, Tennessee.* Careers in Biology is a small interactive-style course which provides students with opportunities to learn more about biological and medical careers and the requirements for those careers. In class, students prepare resumes and cover letters and participate in mock interviews. Speakers discuss methods leading to acceptance into professional and graduate schools and successful employment. Outside class, students shadow several biological or medical professionals chosen from a list provided to them, and keep journals about their experiences. Students then share information about their shadowing experiences with the class. Responses to the course by the students and the professionals who were shadowed have been overwhelmingly positive.

**A PEER TUTOR AND MENTORING MODEL FOR SCIENCE IN THE UNDERGRADUATE CURRICULUM.** *Nancy Morris, Kerry Carrigan, Andrew Downes, Mary Catherine Hale, and Stephen Randolph, Volunteer State Community College, Nashville, Tennessee.* The need for appropriate support services for students in rigorous college courses continues to present a challenge for all institutions. Volunteer State Community College has initiated a student-based approach to strengthen support for student success in the science curriculum. Students are invited to participate in a 3 credit hour course, SCI 200P, Science Practicum. The course includes 15 hours of instruction at the beginning of the term and an additional 55 hours of "service" by the Practitioner during the term. Early in the semester, enrolled chemistry and biology students are invited to participate in one of a number of peer-directed study/recitation groups. Participation requires commitment and accountability to other group members. In addition to peer-directed study groups, Science Practitioners also host open review labs, tutor by appointment, and, of course, strengthen their own competency by reviewing course content they have previously completed. There is evidence of greater student success among those students participating in the peer-directed study groups.

**AN NSF-APPROVED KALEIDOSCOPE APPROACH TO TEACHING CELL AND MOLECULAR BIOLOGY LABORATORIES.** *Stephen M. Wright, Anthony Farone, and Marion Wells, Middle Tennessee State University, Murfreesboro, Tennessee.* Project Kaleidoscope is an organization of teachers, administrators and institutions nationwide whose goal is to strengthen science and mathematics education. The aim is to help prepare a more scientifically literate student population for the 21<sup>st</sup> century. One of the tenets of Project Kaleidoscope's philosophy is: learning is experiential, investigative, hands-on, and steeped in investigation. To this end an Instrumentation and Laboratory Improvement grant was submitted to the National Science Foundation to acquire equipment that would allow undergraduates more opportunity for hands-on science with molecular biology. Implementation of this project has resulted in student experience with tissue culture, gel electrophoresis, restriction enzyme analysis, Northern and dot-blot hybridization. While the full impact of these opportunities will require some time before complete evaluation, in the short term, student interest, excitement and research opportunities seem to have flourished.

**AN ENVIRONMENTAL APPLICATION OF THE SCIENTIFIC METHOD.** *Jennifer L. Conner and Dawn Ford, The University of Tennessee, Chattanooga, Chattanooga, Tennessee.* The scientific method is used to perform research which can provide information and data to help tackle environmental problems. A current issue of environmental concern is the depletion of the ozone layer in the stratosphere. The ozone layer protects our fragile planet by absorbing harmful solar radiation. Without the protective ozone in our atmosphere, life on our planet could not exist. Air pollutants such as CFCs destroy ozone molecules, resulting in a thinning of the ozone layer. As this layer is reduced, more UV radiation can reach the earth's surface. This project used the scientific method to examine the effect of UV radiation on plant growth. The hypothesis was that plants exposed to UV radiation would not grow and develop at the same rate as plants receiving no radiation. The height of the plants was measured on a daily basis and the results supported the hypothesis.

EXPANDING YOUR HORIZONS IN SCIENCE AND MATHEMATICS, A HANDS-ON CONFERENCE FOR MIDDLE SCHOOL GIRLS. **Judith M. Iriarte-Gross, Jessica Claire Shamblin, Allen E. Bailey, Barbara Cortner, Melanie McDaniel and Frenka Minter, Middle Tennessee State University, Murfreesboro, Tennessee.** Expanding Your Horizons in Science and Mathematics (EYH) Conferences were created in 1976. The first EYH in middle Tennessee was held at MTSU on October 25, 1997 for middle school girls, their parents, and their teachers. The primary goal of EYH is to acquaint young women with science and mathematics based careers by attending hands-on workshops presented by women in science and math fields. The young women attending EYH benefit from interacting with professional women role models, from participating in hands-on activities, and from listening to a keynote address presented by a prominent woman in science. The single-sex setting also encourages the young women to feel free to explore math and science without feeling self-conscious. Highlights of the middle Tennessee EYH and of several interesting chemistry workshops will be presented.

WORK FORCE SKILLS AND EDUCATION IN TENNESSEE: A FRAMEWORK FOR IMPROVEMENT. **Ted S. Lundy, Jerry B. Ayers, Terri Anderson, Tim Dean, and Don Sadler, Tennessee Technological University, Cookeville, Tennessee (TSL, JBA), and Putnam County Schools, Cookeville, Tennessee (TA, DS), and Nashville Technical Community College, Cookeville Campus, Cookeville, Tennessee (TD).** This paper proposes long-term educational improvements in Tennessee from Kindergarten through the Doctoral degree related to the current and expected future growth in employment within manufacturing. Tennessee has done well in recruiting manufacturing enterprises during the last three decades but has not yet put the educational system on track for the major shift towards manufacturing jobs as the most important part of the economy. In order for the citizens of the State to achieve significant long-term improvements from their own training and education, an innovative and creative educational framework must be established that relates where we are now to where we need to be in the 21<sup>st</sup> century and beyond. Any such framework must have great flexibility for continual modifications based on status of the whole spectrum of the changing needs of society. To begin the process for the Upper Cumberland Region of Tennessee, we have established a five-member team with each member having agreed to contribute not only to his/her part of the K-Ph.D. spectrum, but also to the concept that through mutual cooperation we can set a pattern for meaningful positive changes in the overall educational system.

COMPARING THE USE OF LIVING SYSTEMS VERSUS MODEL SYSTEMS TO STUDY ECOSYSTEM PROPERTIES. **Dawn M. Ford, The University of Tennessee, Chattanooga, Chattanooga, Tennessee.** In environmental science, it is essential that students learn fundamental ecological principles in order to understand environmental issues. Food webs, trophic levels, and diversity are three ecological properties that have been taught in a laboratory setting at the University of Tennessee at Chattanooga. Two strategies have been implemented to demonstrate these properties: living systems and model systems. Decomposing logs are excellent living systems to use as teaching tools. Students dissect the log and collect data on the living organisms (ants, centipedes, beetles, etc.) and complete a series of exercises to learn basic ecology. Another strategy is to develop models of

ecosystems such as tropical rainforests, grasslands, or even a front lawn. Both models will be discussed and compared.

AN ACTIVITY THAT DEMONSTRATES THE CONCEPT OF SAMPLING ERROR TO INTRODUCTORY BIOLOGY STUDENTS. **Michael L. Rutledge, Middle Tennessee State University, Murfreesboro, Tennessee.** A goal of our introductory biology course for non-majors is to foster student understanding of the processes of science. Sampling error is an important concept in the curriculum, as we use it to link aspects of research design with the statistical analysis of data. However, we have observed that students often have difficulty conceptualizing sampling error and appreciating its significance to scientific investigations. As activities have proven useful in promoting student understanding of abstract concepts, we sought to develop an activity to help students visualize the concept of sampling error. The activity makes students a part of an investigation that determines the frequency of a particular plant variety in a simulated population and provides an opportunity for students to observe the inherent variability of estimates and consider the relationship between sample size and sampling error.

FOLLOW-UP EVALUATION FOR LEARNING TECHNOLOGIES IN MIDDLE GRADE CLASSROOMS. **Richard K. Fletcher Jr. and Joseph D. Sharpe, Tennessee Technological University, Cookeville, Tennessee.** A pre-to-post evaluation was done with each of the four different groups who participated for three, three hour sessions. Bipolar adjectives ranging from positive to negative for each of the items relating to the main objectives for the program were used as a pre-to-post evaluation. These included using e-mail, world wide web, CD-ROM software, peripherals with computers, and making an mPower presentation. The post evaluation also included a set of Likert items relating to the workshops and a set of rating scales for each of the presenters of the sessions. Results indicated statistically significant gains from the pre-to-post assessment on all but one of the five categories, CD-ROM software. The Likert scale items and ratings from the post assessment indicated from 80-90 percent positive for each item and mean ratings of 4.3-4.8 on a scale of 5.0 for the ratings of presenters and program factors.

CHEMISTRY AND PHYSICS WITH HANDS-ON INQUIRY BASED LEARNING FOR PRESERVICE TEACHERS. **Ron Robertson and Jaime Taylor, Austin Peay State University, Clarksville, Tennessee.** A collaborative effort of the departments of chemistry, physics and education has resulted in the development of a new course for preservice elementary education teachers at Austin Peay State University. The course covers several of the physical topics the preservice teachers will be required to teach. The topics are presented using hands-on inquiry based activities that can be directly incorporated into an elementary school classroom. The course is organized around the themes of energy and energy flow and is linked to NASA's strategic enterprises. A "Science Fair" project, a project requiring the use of the scientific method, is required of all students.

UNIVERSITY AND COMMUNITY COLLEGE, A UNIQUE COLLABORATIVE ACADEMIC PROGRAM IN SCIENCE. **Uma Garimella, Nancy Morris, Scott Northrup, and Mike Redding, Volunteer State Community College, Nashville, Tennessee, and Tennessee Technological University, Cookeville, Tennessee.** An academic collaboration between Tennessee Tech-



nological University (TTU) and Volunteer State Community College (VSCC) was initiated in the spring 1997 to address the need for laboratory facilities for community college science students enrolling at VSCC's Livingston Center. This collaboration between Tennessee Board of Regents institutions has maximized the educational opportunities for the citizens of Tennessee while conserving our State's financial resources. Beginning with the chemistry department in the fall of 1998, VSCC teaches chemistry and biology laboratories at TTU to accompany corresponding lectures taught at the university environment and perhaps insight into the possibility of continuing education beyond the Associate Degree. From the point of view of TTU, the community college provides a place for the entry level chemistry and biology students coming into higher education with a weak background in the sciences. The needs of such students cannot be easily addressed by the upper division courses and the inception of new courses in the Environmental Sciences Ph.D. program.

**GO FIGURE! SPREADSHEETING AND SIMULATIONS IN FRESHMAN CHEMISTRY.** *Nyanguila Kakolesha\**, *James C. Howard*, *Judith M. Bonicamp*, and *Gary D. White*, *Middle Tennessee State University, Murfreesboro, Tennessee*. Students entering freshman chemistry possess a variety of cultural and academic backgrounds as well as different learning styles. To accommodate the needs of these students, we must use innovative teaching tools. Computers in the freshman chemistry laboratory, while not replacing bench experiments, can provide students with visually engaging pre-laboratory training on important laboratory techniques, give them access to molecular modeling, and allow simulation of the physical behavior of chemical systems. Once they have collected data in an actual laboratory, students can "go figure" ways of tabulating and graphing data using spreadsheets. This process will enhance student's manipulation of data, reduce the time required for repetitive calculations, and facilitate drawing general conclusions about the experiment. The incorporation of spreadsheet and simulation software into the freshman chemistry laboratory means these tools become part of the experience of all students entering higher-level chemistry courses, and allows the instructors in later courses to build on this background. We are requesting funding for the project from the NSF Course, Curriculum, and Laboratory Improvement (CCLI) program.

## MEDICAL SCIENCE/CELL AND MOLECULAR BIOLOGY

David O'Drobinak, Chair, and John Palisano, Chair

**THE HEMATOLOGIC EFFECTS OF LOW TO MODERATE LEVELS OF EXERCISE.** *Allen R. Hunter\** and *Susan McMahon*, *Pellissippi State Community College, Knoxville, Tennessee*. The effects of low to moderate levels of exercise were tested to determine whether there were any hematologic changes which could help in alleviating some of the side effects of chemotherapy, such as anemia and decreased immune function. A convenience sample of five participants who were not currently on an exercise program were asked to walk 30 minutes a day, five days a week for eight weeks, maintaining approximately 60% of their maximum heart rate. At the beginning, middle, and end of the study, various blood tests were performed. The red blood cells showed a significant decrease in size, while the concentration of

hemoglobin within the cells increased. There also was a rise in the percentage of lymphocytes in the blood. Although the sample number was small, it appears that low to moderate levels of exercise could help reduce some of the side effects of chemotherapy. More extensive testing is needed to explore this further.

**THE ENDOCRINE DISRUPTING EFFECTS OF ATRAZINE ON THE DEVELOPMENT OF THE DOMESTIC CHICKEN (*GALLUS GALLUS*).** *Mandy L. Carter\** and *Amy Jetton*, *Middle Tennessee State University, Murfreesboro, Tennessee*. Endocrine disrupting chemicals (EDCs) are substances that mimic hormone actions. Various health risks in humans and wildlife have been attributed to EDCs. Atrazine is a herbicide currently used on corn crops. As an EDC, atrazine may mimic the action of gonadal steroids. To test effects on vertebrate development, atrazine was injected into 1–2 day old eggs at 3 dose levels: 20, 50, and 100 pg/g egg. Since atrazine was dissolved in organic solvent, *tert*-Butylmethyl ether, carrier controls were established for each dose of atrazine. Cardiac perfusions of 4% paraformaldehyde were performed on chicks that developed to hatching. Viability, gonadal sex, weight, length, gross abnormalities and organ weights were obtained. Unpipped eggs were staged for embryonic time of death. Atrazine did not affect viability ( $P = 0.60$ ). Additional analyses will be presented.

**AN OVERVIEW OF THE INTRAOCULAR LENS.** *Jonathon W. Sowell*, *University Eye Surgeons, Knoxville, Tennessee*. The implantation of intraocular lenses has become a standard portion of virtually all cataract surgeries. The lenses, designed to replace the refracting power of the human lens removed at the time of surgery, are permanently implanted devices which have undergone an interesting and rapid evolution over the past five decades. Structural challenges, biocompatibility, and optics will be considered, along with a brief history of these prostheses.

**COMPARATIVE HEMOLYSIS OF ERYTHROCYTES FROM SELENATE- AND SELENOMETHIONINE-TREATED MICE.** *G. Richard Hogan* and *Robert E. Pendleton*, *Austin Peay State University, Clarksville, Tennessee, and Veterans Affairs Medical Center, Lake City, Florida*. Selenium in excess has been demonstrated to induce a broad spectrum of adverse biologic effects including those on peripheral erythrocytes. The studies presented here were undertaken to explore further selenium toxicity on the number of circulating erythrocytes and membrane fragility of red blood cells collected from mice receiving either an inorganic or organic form of selenium, selenate and selenomethionine, respectively. On day 0 mice received intraperitoneal injections of either sodium selenate, selenomethionine, or saline. On days 2, 4, 6, 8, and 10, cardiac blood was withdrawn and counted for the number of erythrocytes ( $\text{rbc}/\text{mm}^3$ ) and used to determine the percentage hemolysis of erythrocytes incubated at standard conditions. Comparisons are made within a treatment group in regard to the hemolytic susceptibility with time after treatment and between selenium treatment groups and the saline-injected controls.

**CHARACTERIZATION OF REOVIRUS INFECTION IN A HUMAN MONOCYTE CELL LINE.** *Kim Myers\**, *Chad Brooks*, and *Tony Farone*, *Middle Tennessee State University, Murfreesboro, Tennessee*. Mammalian reovirus has been an important model for the study of viral pathogenesis. Previous research has addressed the pathogenesis of two reovirus serotypes: Type 1 Lang (T1L) and Type 3 Dearing (T3D). Recent studies

in our laboratory have involved the use of reovirus in a rat pneumonia model. We have found that T3D stimulates greater levels of tumor necrosis factor-alpha (TNF) in both rat and human models. This study seeks to further characterize the interaction between reovirus and human monocytes. Although T3D induces inflammatory cytokines in human macrophage-like cells much more efficiently, our studies show that there is no difference between replication or infectivity of T1L and T3D in human monocytes. Results from these studies provide further insight into viral replication and induction of inflammatory responses in macrophages.

**CLONING OF A 9-CIS/11-CIS-RETINOL DEHYDROGENASE FROM RAT.** *LaQuita Bryant\* and Mary Ann Asson-Batres, Tennessee State University, Nashville, Tennessee.* 11-*cis*-retinol dehydrogenase (RDH) is located in the retinal pigment epithelium (RPE). A gene for 11-*cis*-RDH has been isolated from bovine, mouse, and human RPE. Although this RDH is only known to function in the eye, a homologous gene has been isolated from liver and heart. Research has shown that 11-*cis*-RDH oxidizes 9-, 11-, and 13-*cis*-retinol. One proposal is that the 11-*cis*-RDH homologue is involved in 9-*cis*-retinoic acid production. To date, a rat 11-*cis*- or 9-*cis*-RDH has not been characterized. I isolated total RNA from rat liver and eye, and using primers specific for mouse and human 9-*cis*-/11-*cis*-RDH's, carried out a reverse transcriptase-polymerase chain reaction (RT-PCR) to amplify potential rat 9-*cis*-/11-*cis*-RDH gene products. Products of the predicted size were generated from liver and eye. I am currently subcloning the products and will sequence them. The sequences will be compared to published RDH sequences to identify the PCR products.

**SERINE PHOSPHATASE AFFECTS THE SERINE PHOSPHORYLATION OF AN AVIAN 63-KILODALTON TYROSINE PHOSPHOPROTEIN: ALTERED IMMUNOREACTIVITY AND POSSIBLY ALTERED INTERACTION WITH OTHER PROTEINS.** *Hao Nguyen and John G. Burr, The University of Tennessee, Martin, Martin, Tennessee, and the University of Texas, Dallas, Dallas, Texas.* When anti-phosphotyrosine (Ptyr) antibodies are used in immunoblot of cytoskeletal extracts of Rous sarcoma virus-transformed chicken embryo fibroblasts (RSV-CEF), one of the most prominent tyrosine phosphoproteins observed is a 63-kdalton protein (p63). This protein was first shown to be phosphorylated *in situ* when cytoskeleton preparations are incubated with [ $g$ - $^{32}P$ ] ATP. In the case of immunoblots of whole cell extracts probed with anti-Ptyr antibodies, however, p63 is barely detectable. The difference in immunoreactivity of cytoskeletal extracts versus whole cell extracts is the basis of discussion in this abstract. We hypothesized that p63 is phosphorylated at adjacent serine and tyrosine sites in whole cell extracts. We refer to this as the "doubly phosphorylated" form of p63. The doubly phosphorylated p63 is poorly recognized by anti-Ptyr antibodies in immunoblots. During cytoskeleton extraction, the serine site is dephosphorylated by a type 2C phosphatase and the resultant form of p63, with only tyrosine residues phosphorylated, is well recognized by anti-Ptyr antibodies in immunoblots. We showed that this is a possible scenario to explain the discrepancy in immunoreactivity between cytoskeletal extracts versus whole cell extracts. We propose that this is a novel, but not unique, mechanism by which activity of some enzymes involved in the signal transduction pathway is regulated.

**CLONING OF AN *ESCHERICHIA COLI* INOSINE-URIDINE NUCLEOSIDE HYDROLASE GENE.** *Samira Rafiq, Paul Kline, and Anthony Farone, Middle Tennessee State University, Murfreesboro, Tennessee.* Protozoal infections are the causative agent of millions of disease cases world-wide. Diseases caused by protozoa called trypanosomes are particularly prevalent. These organisms are dependent upon the purine salvage pathway for nucleic acid synthesis. Humans have an alternate synthesis pathway and, therefore, the specific enzymes of the trypanosomal pathway can be the targets of selectively toxic drug therapy. An important enzyme in this biosynthetic pathway is inosine-uridine nucleoside hydrolase (IUNH). The bacterium, *Escherichia coli*, also has IUNH activity. This study utilized the polymerase chain reaction to amplify the putative IUNH gene of *E. coli*. The amplified DNA was then cloned into a bacterial expression system to allow high levels of this protein to be produced as detected by western blot. Results from this study will allow the characterization of the purified enzyme which may lead to potential therapy strategies.

**DOES RETINOIC ACID ALTER THE EFFECTS OF ESTROGEN TREATMENT ON ENDOMETRIAL AND MYOMETRIAL OXYTOCIN RECEPTOR EXPRESSION IN VITRO?** *Kurt Haldeman and Sarah Lundin-Schiller, Austin Peay State University, Clarksville, Tennessee.* Cultures of porcine endometrium ( $n = 3$ ) and myometrium ( $n = 5$ ) were used to determine the effect of retinoic acid (RA) on the expression of oxytocin receptor (OTR) expression in the presence and absence of estradiol (E2). OTR expression has been measured in these tissues and has been found to be upregulated by E2. RA has been linked to increased OTR mRNA and protein expression. Cells were grown to confluence, treated with control, E-2 ( $10^{-7}$  M), RA ( $10^{-9}$  M), or E2+RA for 24 h. Cells were harvested and specific  $^3H$ -OT binding was determined to estimate OTR concentration. E2 increased OTR expression compared to control in all endometrial cultures and in only 2 of the 5 myometrial cultures. RA alone increased OTR expression in 2 endometrial cultures and in only 1 of the myometrial cultures. The combination E2+RA increased OTR expression in only 1 endometrial culture while increasing myometrial OTR expression in 3 of the cultures. The effect of RA on E2 treatment lacks consistency in this system. These results suggest that the regulation of OTR is controlled differently in the two types of tissues and/or other factors not controlled in these experiments affect the expression of OTR *in vitro*.

**ALLERGIES, ANTIHISTAMINES, AND CARDIAC ARRHYTHMIA: A LITERATURE REVIEW.** *Kelly Wallace\* and R. H. McCoy, Austin Peay State University, Clarksville, Tennessee.* Antihistamines are frequently used to treat seasonal allergies. Both first and second-generation antihistamines reduce an allergic response by competitively binding to histamine receptors on smooth muscles. Antihistamines produce a variety of side effects; of particular concern is their link to cardiac arrhythmia.

**WATER QUALITY OF THE STEELE CREEK WATERSHED WITH EMPHASIS ON THE SWIMMING AREA OF STEELE CREEK LAKE.** *Melody L. Shipley and Donna G. Robbins, City of Bristol, Bristol, Tennessee, and East Tennessee State University, Johnson City, Tennessee.* The Steele Creek Lake in Bristol, Tennessee and its watershed have been impacted by various types of contaminants from both point and non-point sources. Agricultural and urban run-off has entered Steele Creek for decades

and created potential health hazards to humans having body contact with these waters through recreational activities such as swimming. The initial research project, begun in 1991, was conducted to evaluate the sources of contamination as well as the risk to humans having contact with these waters. Subsequent sampling has been completed on a bi-annual basis and future sampling and intervention is contingent upon grant funding from the state. Original sampling was performed quarterly from July, 1991 to May, 1992. The Tennessee Water Recreational Regulation #1200-4-3 was used as the guideline for parameters tested. Sampling was performed from five sample sites at the beach area of Steele Creek Lake. Fecal coliform analysis was the main criterion used to determine the safety to humans from body contact with this lake. Results from the first quarter of sampling indicated that there were high levels of fecal contamination at sample sites one and two which were both located in shallow water. The fecal coliform geometric mean was exceeded at sample site one and was borderline at site two. The lake was drawn down for dam repairs in October, 1991 which caused a release of contaminants. Fecal coliform levels then declined. There were individual days of high results, but overall the fecal coliform geometric mean was not exceeded again. Primary overall results indicated there was a potential for various contaminants to enter Steele Creek Lake, thus creating a potential for humans to acquire water-borne diseases from recreational body contact with these waters. It was recommended that swimming be prohibited in the lake until water quality could be improved and maintained in good condition. Results of subsequent bi-annual sampling have continued to preclude recreational (swimming) use of the lake. As mentioned previously future sampling and clean-up is contingent upon the availability of funding for intervention and surveillance.

## MICROBIOLOGY

Don C. Bailey, Chair

**DETECTION OF *BORRELIA BURGENDORFERI* IN *AMBLYOMMA AMERICANUM* BY THE POLYMERASE CHAIN REACTION.** *Teresa Stegall\*, Lori Ray, and Stephen M. Wright, Middle Tennessee State University, Murfreesboro, Tennessee.* The etiologic agent of Lyme disease, the spirochete *Borrelia burgdorferi*, was first identified in 1932. In the eastern United States the primary vector is the deer tick, *Ixodes scapularis*. This study was undertaken to determine the presence of *B. burgdorferi* among ticks collected from Rutherford and Williamson counties of Middle Tennessee during the spring of 1998. Groups of five to eight ticks, identified as *I. scapularis* or *Amblyomma americanum*, were macerated to liberate any spirochetes present in the gut. The tick extract was subjected to the polymerase chain reaction using primers specific for *B. burgdorferi* sensu lato genetic sequences. Amplification products were evaluated by gel electrophoresis and a *Borrelia* specific probe. *Borrelia burgdorferi* was not detected among samples of *I. Scapularis*. However, the spirochete was present in two groups of *A. americanum* tested. This detection of *B. burgdorferi* in *A. americanum* is the first reported in Middle Tennessee.

**OCCURRENCE OF *TRYPANOSOMA CRUZI* (CHAGAS) IN *TRITATOMA* (HEMIPTERA; REDUVIIDAE) FROM RUTHERFORD COUNTY, TENNESSEE.** *Anthony L. Newsome and Charles R. McGhee, Middle Tennessee State University, Mur-*

*reesboro, Tennessee.* Insects of the genus *Triatoma* serve as the vector for *Trypanosoma cruzi*, the etiologic agent of Chagas's disease. It is a major health problem in Latin America and there have been sporadic reports of this parasite in the United States. In July, 1998, a Triatomid was taken from the bed of a fifteen (15) month old suffering from numerous insect bites and brought to Middle Tennessee State University for examination. When the intestinal contents were viewed by phase contrast microscopy, numerous highly motile flagellates were observed. Subsequently smears were Giemsa stained and flagellates with morphology common to the crithidia and metacyclic trypanosoma forms were present. A presumptive identification of *Trypanosoma cruzi* was based on the large kinetoplast and C shape in some flagellates. The insect, stained slides and the remaining intestinal contents (which appeared to contain blood) were sent to the Centers for Disease Control and Prevention in Atlanta, Georgia, which confirmed the presumptive identification of *T. cruzi*. This observation suggests that one or more groups of mammals in Middle Tennessee may harbor *T. cruzi* and serve as a reservoir for infecting insect vectors which could have the potential to infect humans.

**THE ISOLATION AND IDENTIFICATION OF WHEY-DEGRADING MICROORGANISMS.** *Kristina M. Fusco and John M. Zamora, Middle Tennessee State University, Murfreesboro, Tennessee.* Whey is the aqueous material that is removed from milk during the cheese-making process. It is also a large waste product of the dairy industry and expensive to break down into usable components. The purpose of this study was to isolate efficient whey degrading microorganisms. Unsterilized whey, soil, and dairy effluent samples were plated onto four different types of solid media: tryptic soy agar, Sabouraud-dextrose agar, minimal salts agar containing autoclaved whey, and minimal salts agar containing sterile-filtered whey. Isolates which grew on the sterile-filtered and autoclaved whey agars were identified using biochemical tests. The best whey degraders were determined using biometry and statistical analysis, and they were found to be *Bacillus sphaericus*, *Enterobacter agglomerans*, *Saccharomyces cerevisiae* and two yeasts.

**TETRACYCLINE-RESISTANT ENTEROCOCCI IN THE SULPHUR FORK CREEK WATERSHED, ROBERTSON COUNTY, TENNESSEE.** *Mary McReynolds and Don C. Dailey, Austin Peay State University, Clarksville, Tennessee.* Aureomycin is an analog of tetracycline that is added in low doses to livestock feed to enhance animal growth and digestion efficiency. This low concentration of tetracycline could select for tetracycline-resistant bacteria within the livestock. Enterococci are natural intestinal flora of livestock. The fecal contamination of the Sulphur Fork Creek (SFC) watershed from livestock has been well documented for the past three years. The enterococci isolated from the SFC-watershed were screened for tetracycline-resistance. Water samples were collected from six sites within the SFC-watershed and plated on mEnterococcus agar with and without tetracycline. Colony counts were recorded, antibiotic resistance confirmed, and enterococci were speciated by standard biochemical techniques. Interestingly, tetracycline-resistant enterococci were detected at all sites within the watershed. These findings demonstrate the need for continued research in this area.

**IDENTIFICATION OF FECAL FLORA FROM VULTURES IN MIDDLE TENNESSEE.** *Harry Markham\* and R. H. McCoy,*

Austin Peay State University, Clarksville, Tennessee. Fecal samples of the turkey vulture (*Cathartes aura*) and black vulture (*Coragyps atratus*) were streaked onto EMB, MacConkey, Hektoen and TCBS agars. Representative G- isolates were identified as: *Actinobacillus lignieresii*, *Alcaligenes faecalis*, *Citrobacter diversus*, *Citrobacter freundii*, *Enterobacter agglomerans*, *Enterobacter cloacae*, *Enterobacter aerogenes*, *E. coli*, *Klebsiella pneumoniae*, *Proteus mirabilis*, *Salmonella*, and *Yersinia pseudotuberculosis*.

THE AEROBIC FLORA OF SELECTED SPICES. **R. H. McCoy**, Austin Peay State University, Clarksville, Tennessee. Nineteen spices/herbs were evaluated for their aerobic bacterial load. One gram of each spice was added to 100 ml of BHI broth, incubated overnight at 37°C and then streaked for insolation on MacConkey and PEA agars. Representative colony types from each plate were then picked and identified. Gram positives of the genus *Bacillus* were isolated from all 19 spices/herbs. Eleven of the spices/herbs contained Gram negative bacteria which were identified as *Proteus vulgaris*, *Klebsiella pneumoniae*, *E. coli*, *Enterobacter aerogenes*, and *Achromobacter* spp.

STRESS RESONSE IN SALMONELLA. **Shawna Powell, C. Caudle, Y. Myles and E. L. Myles**, Tennessee State University, Nashville, Tennessee. Many different procedures are being used to control the growth of *Salmonella*, but none have prevented the bacteria from being a severe problem to the food industry. An important property of the pathogen is the ability to survive extreme environmental conditions. Various physical conditions are being examined to determine the effects on growth control. The physical conditions used are similar to conditions the bacteria are exposed to in pathogenesis, the environment, and the food processing industry. One would expect that exposure to various physical conditions would eliminate the *Salmonella*. Previous results in our laboratory demonstrated that exposure of *Salmonella* to high temperature (72°C for 30 min) killed most of the bacteria, but the cells that survived were more resistant to destruction by heat. Our laboratory is in the process of determining if other stressors would select for more resistant strains. This adaptive response of the *Salmonella* to the physical stressors contributes to the survival of the bacteria. This study is evaluating the production of stress proteins using one and two dimensional gel electrophoresis. Antibodies to the stress proteins, (Hsp60, Hsp70, Hsp90, Dnak and GroE) are being used in Western hybridization analysis to identify the proteins.

SYMBIOTIC METHANOGENS FROM A TERMITE. **Allison Reed\*, John Gunderson, and Susan Goss**, Tennessee Technological University, Cookeville, Tennessee. Methanogens make up part of the prokaryotic community of symbionts living in the hindguts of lower termites. In several cases, methanogens have been identified in the cytoplasm of flagellates in the same habitat. In an effort to characterize the species associated with flagellates living in the termite *Zootermopsis angusticollis*, primers specific for archaeal 16s rRNA sequences were used to amplify DNA from alcohol-fixed flagellate cells. The amplified DNA was cloned in pWhitescript and clones were partially sequenced. Additionally, the PCR product obtained from isolated *Trichomitoopsisidis termopsidis* cells was sequenced directly. The methanogen sequences obtained are all assignable to the Methanobacteriales. Members of the Methanobacteriales cannot convert acetate to methane. The results imply that the carbon dioxide and hydrogen

rather than the acetate produced by the flagellates are being used by their methanogenic endosymbionts.

## PHYSICS AND ASTRONOMY

Douglas T. Durig, Chair

THE HARMONIC OSCILLATOR AND NUCLEAR COMPRESSIBILITY. **Krishna Kumar**, Tennessee Technological University, Cookeville, Tennessee. A curious property of the energy of the Harmonic Oscillator is pointed out. If the Hamiltonian  $H = \ll M V^2 + \ll K (R-R_0)^2$  is divided by a constant, the energy eigenvalues of the quantized form of the Hamiltonian are not divided by the same constant! Instead, they remain unchanged since they depend only on the ratio of the stiffness constant  $K$  and the mass  $M$ ! This is related to the interpretation of nuclear compressibility and of the associated observed nuclear property: Excitation energy of the Giant Monopole Resonance. The former (nuclear compressibility) is defined in terms of the nuclear energy per nucleon, while the latter is defined in terms of the energy of the nucleus as a whole. This affects also the interpretation of another important nuclear property: The Binding Energy. How much of it comes from the nuclear potential, and how much from the Zero-Point Motion of the nuclear Breathing-Mode (changes in the nuclear radius  $R$ ) Oscillations, which give rise to Giant Monopole Resonances?

PHOTOLUMINESCENCE CHARACTERIZATION OF ZNSE AND ZNSE<sub>1-x</sub>TE<sub>x</sub>. **Ling Jun Wang and Ching-Hua Su**, The University of Tennessee, Chattanooga, Tennessee, and National Aeronautics and Space Administration Space Sciences Laboratory, Huntsville, Alabama. Low temperature photoluminescence spectra of a ZnSe single crystal have been taken before and after annealing. The effect of annealing is also studied by atomic force microscopy (AFM) that allows examination of the surface morphology in the nanometer scale. The photoluminescence spectra of a ternary ZnSeTe crystal have been taken at different temperatures from 7°K to 120°K and the composition of the alloy is measured using a JXA-800R electron microprobe. It has been shown in this study that the  $I_1^{\text{deep}}$  peak of the pure ZnSe crystal originates from the zinc vacancy, and the concentration of which can be significantly reduced by annealing in the zinc vapor. The intensity ratio of  $I_1^{\text{deep}}$  over  $E_x$ , the free exciton line, shows a reciprocal correlation with the zinc vapor pressure. The correlation between the zinc vapor pressure and the concentration of zinc vacancy offers a way to determine the local zinc vapor pressure by measuring the intensities of  $I_1^{\text{deep}}$  and  $E_x$  lines. The measurements with the ternary ZnSeTe show a broad photoluminescence band around 2.33 eV, which suggests superposition of more than one peak. These peaks are believed to be originated from the recombination of excitons associated with either single zinc atoms or with the zinc clusters. Since the relative concentration of the zinc clusters is related to the crystal composition, so are the shape and the position of the photoluminescence spectra. It is suggested that the lifetime measurements should be able to resolve the superposed peaks and aid our understanding of the different processes involved.

MEASUREMENTS OF NUCLEAR LIFETIMES BY DOPPLER-SHIFT METHODS. **John C. Wells**, Tennessee Technological University, Cookeville, Tennessee. In the study of the prop-

erties of atomic nuclei and nuclear structure, it is important to be able to determine experimentally the lifetimes of nuclear states, or equivalently, the electromagnetic transition rates for transitions between the states. Some of the important techniques available to measure these very short (picosecond range) lifetimes are the Doppler-shift recoil-distance method and the Doppler-broadened lineshape method. The recoil-distance method involves letting the nucleus produced in the nuclear reaction recoil out of a thin target into a vacuum, and then stopping it a short distance away with a movable stopper. By setting the stopper at different distances and measuring the intensities of gamma rays which are Doppler shifted and those which are not shifted, nuclear lifetimes can be deduced. The Doppler-broadened lineshape method involves letting the reaction product slow down and stop in a thick target, and analyzing the broadened lineshape. These techniques will be discussed, and results of measurements of lifetimes of high-spin states in the nuclide  $^{173}\text{Re}$ , produced in the reaction  $^{150}\text{Sm}(^{27}\text{Al},4n)^{173}\text{Re}$ , will be presented.

**HUNTING ASTEROIDS WITH A TWELVE INCH TELESCOPE.** *Douglas T. Durig and Amy E. Koether\**, *The University of the South, Sewanee, Tennessee.* With modern Charge-Coupled Devices (CCDs), it is possible to hunt for new asteroids and monitor the positions of recently discovered objects with only an 8 to 12 inch telescope. However, if the information is to be reported to the Minor Planet Center at the Harvard-Smithsonian Center for Astrophysics, a more rigorous approach to data collection and analysis must be observed. The telescope mount must not be a significant source of image motion. The digital resolution, which results from the size of the CCD pixel and the focal length of the telescope, needs to be approximately two arcsec or better so that positions can be determined to better than 0.2 arcsec. There are software programs available that make use of the Hubble Guide Star Catalogue that allow this procedure to be accomplished with a minimum amount of effort.

**A PARALLEL-PROCESSING PROJECT WITH MACINTOSH G3 COMPUTERS.** *Randolph S. Peterson, Jason S. Vinton\*, and Edwin P. Gerber\**, *The University of The South, Sewanee, Tennessee.* This is a discussion of a Sewanee project to use five Macintosh G3 computers in a parallel-processing arrangement for the calculation of the magnetic properties of a simple ferromagnetic crystal using the spin-1/2 Ising model. The parallel-processing arrangement of G3 Macs, developed as AppleSeed at the University of California, Los Angeles (UCLA), appears to provide supercomputer-like computational speeds operating under the FORTRAN programming language. The computers communicate with the help of a Message Passing Interface (MPI) written at UCLA for the Macintosh. The system can be set up and removed in minutes using the existing network connections and does not require any special modification to the computers. The speeds possible with a parallel computation are necessary for the computation of the numerically intensive Ising model.

**ARTIFICIAL NEURAL NETWORKS FOR PREDICTING OPTICAL PROPERTIES OF MICRO-ORGANISMS FROM LIGHT SCATTERING DATA.** *Patricia G. Hull*, *Tennessee State University, Nashville, Tennessee.* Computer-simulated neural networks are described that predict from polarized light scattering data both the mean size parameter and index of refraction of a collection of microscopic particles in a sample of ocean water. Polarized light scattering data in the form of Mueller matrix el-

ements as functions of the scattering angle contain the desired information on optical properties of the particles that make up the scattering medium. Analytical calculations of the scattering matrix elements rather than experimental data were used to provide well-characterized training data for the neural networks. The neural networks most successful in predicting mean size parameter and index of refraction were fully connected, two hidden-layer, back propagation networks. A gradient descent method was used to train the networks given a set of Fourier coefficients of the Mueller matrix element, S<sub>12</sub> or S<sub>34</sub>. Levenberg-Marquart optimization made the training times very short, but the memory requirements for this method were generally excessive for a desktop computer. This approach is promising for more powerful mainframe computers or parallel processing machines.

**SONOLUMINESCENCE IN AN ACOUSTICALLY LEVITATED WATER FILLED SHELL.** *Paul John Rivera\* and Richard Stephens*, *Tennessee State University, Nashville, Tennessee, and General Atomics, San Diego, California.* The possibility of using shells levitated by acoustic waves to improve the conditions to study sonoluminescence was conducted. Single bubble sonoluminescence (SBSL) was generated using a 2-mm diameter water filled plastic shell, supported in air with 1 MHz sound waves. The bubble was generated and compressed with a separate transducer emitting pulsed 5 MHz acoustic waves which were focussed on the center of the suspended shell. This approach is considerably different from the typical generation technique of SBSL in that the acoustic power is coupled through the air rather than by a solid bond to the container. With this configuration, the water container can be substantially reduced in size and the luminescence pulse rate is probably not connected with cavity resonances. As a result, optical access to the spark is improved, water attenuation is reduced (water thickness – 1 mm), and repetition rate can be considerably higher. This geometry presents problems and opportunities in controlling the gas content and water temperature. It might also be sensitive to the perfection of the enclosing plastic shell, so success is erratic.

**CHARACTERIZING SOOT PARTICLES FROM DIESEL EXHAUST FROM POLARIZED LIGHT SCATTERING MEASUREMENTS.** *John L. Britt III and Patricia G. Hull*, *Tennessee State University, Nashville, Tennessee.* The Environmental Protection Agency has recently written more restrictive regulations on the size of soot particles emitted from a diesel exhaust. In order to enforce these more rigid requirements there is a need for an instrument to measure accurately the size of soot particles that are emitted from diesel engines under normal loading conditions. The nephelometer, an instrument designed and developed by Dr. Arlon Hunt accomplishes this by measuring the polarized light scattering from diesel exhaust. In this research project, a polarized laser beam was sent through the exhaust stream of the diesel engine and the nephelometer measured the Mueller matrix elements, S<sub>11</sub>, S<sub>12</sub>, S<sub>34</sub>, and S<sub>22</sub> as functions of angle. The average radius, standard deviation of radius, index of refraction, and absorption of the soot particles, was determined from these experimental graphs by comparing them to analytical graphs calculated for light scattering from spheres. The Levenburg-Marquart optimization technique was used to determine the best fit of experimental to analytical graphs. Independent measurements of particle size distribution were made using an instrument called the MOUDI (Micro-Orifice Uniform Deposit Impactor) to validate the optimization technique.

## ZOOLOGY

Karen Kendall-Fite, Chair, and Steven W. Hamilton,  
Chair

**HABITAT UTILIZATION BY FOUR SPECIES OF SHREWS IN CEDARS OF LEBANON STATE PARK.** *Kevin Relford\**, Middle Tennessee State University, Murfreesboro, Tennessee. The availability of suitable habitat is a major determinant of the distribution and abundance of small mammals within their geographic range. In the present study, I examined patterns of habitat use among shrews in Cedars of Lebanon State Park in Wilson County, Tennessee. A total of 160 pitfall traps was placed in forest and edge/open habitats and monitored for a period of one year. During this time, 137 shrews were captured and identified. Species caught during the study include the southern short-tailed shrew, *Blarina carolinensis*, the northern short-tailed shrew, *Blarina brevicauda*, the least shrew, *Cryptotis parva*, and the southeastern shrew, *Sorex longirostris*. My results suggest that habitat partitioning by shrews remains constant across seasons, but two species appear to exhibit an overall preference for one habitat over another. The ecological factors that underlie these patterns of habitat use have not been identified, and should be the focus of future research.

**AN EVALUATION OF THREE RELATIVE ABUNDANCE INDICES FOR RED SQUIRRELS IN THE SOUTHERN APPALACHIANS.** *Richard T. Stevens\** and *Michael L. Kennedy*, The University of Memphis, Memphis, Tennessee. Three indices, bait station visitations, elicited call counts, and total squirrel counts, were used for determining relative abundance of red squirrels (*Tamiasciurus hudsonicus*) from June 1996 to May 1997. Each index was recorded 3 times-per season (summer, fall, winter, and spring) along a 1.5 km transect at each of 2 sites, Falls Branch and Grassy Gap, in the Cherokee National Forest in eastern Tennessee. Response rates for bait stations and elicited call counts were considered too low to be useful in detecting seasonal or annual trends in red squirrel populations. Forty-five red squirrels were counted during total counts at Falls Branch, and 14 were counted at Grassy Gap during the study. Total counts reflected higher density of red squirrels at Falls Branch, which was in agreement with mark-recapture data. Total counts appear to be a useful technique for estimating relative abundance of red squirrels.

**SPECIES DIVERSITY AND DEMOGRAPHIC FEATURES OF A BAT COMMUNITY IN WESTERN TENNESSEE.** *Theresa J. Cross\** and *Michael L. Kennedy*, The University of Memphis, Memphis, Tennessee. Species diversity and population demographics of a community of bats were examined at a site in Shelby County, Tennessee, containing three prominent habitat types (upland, bottomland, and bluff forests). Additionally, species diversity among habitats was investigated. The study was conducted during the summers of 1996 and 1997. Using mist-netting techniques, bats were sampled at 18 sites categorized as wet or dry depending on the continuous presence or absence of water. Seven species were shown to be present. No difference in the number of species caught among habitats was found ( $F = 0.30$ ,  $d.f. = 2$ ,  $P = 0.7435$ ). However, the two most abundant species did show a partitioning between habitats.

RELATIONSHIP OF PELLETT COUNTS AND CAPTURE

**SUCCESS OF APPALACHIAN COTTONTAILS.** *Benjamin R. Laseter\** and *Michael L. Kennedy*, The University of Memphis, Memphis, Tennessee. Fecal-pellet counts were tested as a method for assessing relative abundance of Appalachian cottontails (*Sylvilagus obscurus*) at 10 locations in the southern Appalachian Mountains during 1996 through 1997. The study was conducted at sites in Carter, Monroe, and unioi counties within the Cherokee National Forest of eastern Tennessee. Nonparametric tests were used in the data analysis. Preliminary results suggest a positive relationship between pellet counts and capture success of Appalachian cottontails.

**COYOTE FOOD HABITS IN URBAN AND SUBURBAN AREAS.** *Tommy S. Parker\** and *Michael L. Kennedy*, The University of Memphis, Memphis, Tennessee. During 1997-1998, food habits of the coyote *Canis latrans*, were studied in urban and suburban areas of Memphis, Shelby County, Tennessee. Food items were determined from scats collected along secondary roads, railroads, or other travel corridors within the metropolitan area. Most food items were identified by direct comparison with known foods. Frequency of occurrence of major food items was derived by season. Results are discussed.

**AN ASSESSMENT OF FIVE ATTRACTANTS FOR CENSUSING MAMMAL PREDATORS.** *Brandon T. Rutledge\** and *Michael L. Kennedy*, The University of Memphis, Memphis, Tennessee. To assess attractants for use in studies of scent-station visitation of mammalian predators, five lures were examined from March 1997 through February 1998 at the Ames Plantation in Fayette and Hardeman counties, Tennessee. Attractants included bobcat urine, sardines, canine call (bait), possum persimmon (bait), and skunk smorgasboard (bait). Standard scent-station techniques were employed, and six transects (containing six stations each) were established and monitored bimonthly. Visitation was recorded based on tracks (presence or absence) and data analyzed by season. Results to date are discussed.

**THE ONCE AND FUTURE MUSSEL FAUNA OF SULPHUR FORK CREEK AND LOWER RED RIVER, TENNESSEE.** *Adam Ray\** and *Steven W. Hamilton*, Austin Peay State University, Clarksville, Tennessee. The Sulphur Fork Creek/Red River watershed is approximately 74 km long and averages about 29-35 km in width. A total of 347 man-hours were dedicated to research in the summer and fall of 1998 to determine abundance and diversity of living and remnant (shells) species. Mussels were hand-collected by snorkeling, canoeing, walking stream banks, and utilizing a Needham bottom scraper. Living species encountered were (greatest to least abundant): *Amblema plicata* (Threeridge); *Potamilus alatus* (Pink heelsplitter); *Lampsilis ovata* (Pocketbook); *Ptychobranthus fasciolaris* (Kidneyshell); *Cyclonaias tuberculata* (Purple wartyback); *Tritogonia verrucosa* (Pistolgrip); *Elliptio crassidens* (Elephant-ear); *Lampsilis fasciola* (Wavy-rayed lampmussel); *Lasnigona costata* (Fluted-shell); *Quadrula cylindrica* (Rabbits foot); *Fusconaia flava* (Wabash pigtoe). Remnant species encountered (living excluded): *Cumberlandia monodonta* (Spectaclecase); *Toxolasma lividus* (Purple lilliput); *Villosa iris* (Rainbow mussel); *Elliptio dilatatus* (Spike); and *Obovaria subrotunda* (Round Hickorynut). Future study will concentrate on reestablishing live mussel species at different locations in the watershed and at higher frequencies near old locations.

EFFECTS OF LITTER EXCLUSION ON HEADWATER STREAM COMMUNITY METABOLISM IN THE SOUTHERN APPALACHIAN MOUNTAINS. **Sandra M. Brasfield\***, **S. L. Eggert**, and **J. B. Wallace**, *Middle Tennessee State University, Murfreesboro, Tennessee (SMB)*, and *The University of Georgia, Athens, Georgia (SEL, JBW)*. To assess the role of leaf litter in the ecology of small stream ecosystems, manipulations of the allochthonous inputs in a small headwater stream in Coweeta Hydrologic have been conducted since 1993. A canopy and lateral fences were constructed to prevent leaf litter inputs. This has altered the stream's community metabolism rates. Both production and respiration rates were estimated in the litter excluded stream (WS 55) and a reference stream (WS 53) by measuring oxygen change within enclosed, recirculating chambers. The litter excluded stream had higher chlorophyll *a* concentrations, higher net production rates, lower respiration rates, and lower organic matter standing crop than the reference stream. The trophic status of forested headwater streams is dependent on leaf litter inputs and may have begun the transition from heterotrophy to autotrophy.

DIVALENT METAL TOXICITY TO THE JAPANESE MEDAKA (*ORYZIAS LATIPES*) EMBRYO IN SINGLE EMBRYO CULTURE. **Mark L. Odum\***, **J. M. Redding**, and **M. S. Greeley Jr.**, *Tennessee Technological University, Cookeville, Tennessee (MLO, JMR)*, and *Oak Ridge National Laboratories, Oak Ridge, Tennessee (MSG)*. Embryos of the Japanese Medaka, *Oryzias latipes*, were exposed to a range of divalent metals including cadmium (Cd), copper (Cu), manganese (Mn), mercury (Hg), nickel (Ni), and zinc (Zn). Embryos were cultured individually to better track the course of developmental events and to remove "neighbor" effects. The hierarchy of toxicity measured as mortality was  $Hg > Cu > Cd > Zn > Ni > Mn$ . Other factors such as endurance time, time to hatch, and the incidences of gross developmental abnormalities also were evaluated. Mercury in particular produced both sublethal and lethal toxic effects at concentrations relevant to the situation in streams draining the United States Department of Energy's Oak Ridge Reservation. Medaka embryos have proven to be sensitive test organisms for a variety of environmental contaminants, including the divalent metals, in both laboratory studies such as these and in routine testing of ambient water sources on the reservation

POSTURE AS A SIGNAL IN AGGRESSION OF MALE THREE-SPINED STICKLEBACKS. **Kimberly S. Myers** and **William Rowland**, *Middle Tennessee State University, Murfreesboro, Tennessee*, and *Indiana University, Bloomington, Indiana*. Although stimulus function in three-spined sticklebacks has been extensively explored, few studies have dealt with the effects of posture on aggression. Classic studies indicate the headdown posture as an aggression-releasing stimulus. More current studies have shown that sticklebacks may direct fewer bites to a headdown model than to a horizontal one. This project re-examined and extended the latter research. The response of male sticklebacks to headdown and horizontal postures was tested by using male models as stimuli, and the response of males with prior exposure to a horizontal model (experienced) was compared to that of males with no prior exposure (inexperienced). Experienced males tended to bite a headdown model more than a horizontal one presented simultaneously. However, inexperienced males directed more bites to the horizontal model than to the headdown one. These results provide insight into the adaptive

value of posture and the influence of habituation in sickleback communication.

INFLUENCE OF COMPETING SPECIES ON THE NESTING HABITS OF CAROLINA CHICKADEES. **T. David Pitts**, *The University of Tennessee, Martin, Martin, Tennessee*. Carolina Chickadees (*Poecile carolinensis*) are small songbirds that nest in woodlands across much of Tennessee. Due to their habit of nesting in cavities that they either find or excavate, Carolina Chickadees encounter competition for the use of nest cavities from several other species of secondary cavity nesting birds, all of which are larger than Carolina Chickadees. Consequences of this competition may include selection for Carolina Chickadees that (a) nest early in the year, (b) utilize small nesting cavities, or (c) avoid habitats which attract large numbers of competitors. Nesting later in the year, in a large cavity, or in habitat occupied by competitors may result in the loss of eggs or young or, in some cases, death of adult Carolina Chickadees.

OBSERVATIONS OF FISH BEHAVIORS IN THE SOLOMON ISLANDS. **Diane R. Nelson**, *East Tennessee State University, Johnson City, Tennessee*. During research trips to the Solomon Islands with Dr. Eugenie Clark in 1997 and 1998, observations were made of fish behaviors utilizing scuba gear and various underwater video cameras and 35 mm cameras. A nesting site for the ocean triggerfish was discovered and the nesting territory mapped. There were 25 nests in the coral rubble area. Each nest measured about 1m in diameter and 0.2 m in depth. Many of the nests were active sites with one male and one female hovering above the nest. In addition, observations were made on the behaviors of *Pholidichthys leucotaenia*, also known as the "convict blenny", "false catfish" or "mimic catfish." Adult pairs live in burrows that they share with juveniles. The juveniles emerge at dawn and then return to the burrow at dusk. During the day, adults clean the burrow by spitting out sand and rubble. At night, they remain in the burrow; feeding behavior of the adults remains unknown.

LENGTH-WEIGHT RELATIONSHIP OF TWO AQUATIC INSECTS, *EPHEMERELLA DOROTHEA* AND *AMPHINEMOURA DELOSA*. **Joeseph R. Schiller**, *Austin Peay State University, Clarksville, Tennessee*. Describing the relationship between the length and weight of a species is the first essential step in estimating its secondary productivity to its ecological community. This study presents the length-weight relationship for two common aquatic insects, the mayfly *Ephemerella dorothea* and the stonefly *Amphinemoura delosa*. The estimated length-weight relationships reported here are similar to those for closely related species published in the literature. The implications of variations in methodology of deriving length-weight relationships are discussed. The importance of including the full size range of the species in calculating its length-weight relationships is demonstrated.

REVIEW OF THE MAYFLIES (INSECTA: EPHEMEROPTERA) OF TENNESSEE: CORRECTIONS, ADDITIONS AND ECOLOGY OF SELECTED SPECIES. **Lewis S. Long** and **Charles R. McGhee**, *Middle Tennessee State University, Murfreesboro, Tennessee*. An overview of the mayfly fauna for the state of Tennessee is presented. Previous studies listed 143 species in 43 genera and 15 families. Unpublished records and corrections to the list now bring the total to 154 species and 45

genera. Although the list contains 154 species, even more genera and species are expected to be reported for the state, including at least five genera and one family. More surveys for the state are necessary because only 17 counties (18%) have records of more than 10 species, 48 counties (51%) have less than 10 records and 30 counties (31%) have no records for mayflies at all. Overall, Tennessee contains the highest mayfly diversity within the Southeast and the composition is more similar to that of Virginia and North Carolina than to that of the other southeastern states. Preliminary ecological data on a new species of Bactidae from Middle Tennessee and the endemic *Paraleptophlebia kirchneri* are also presented.

**BIOMONITORING IN THE WEST SANDY CREEK WATERSHED: THE FINAL (?) ANALYSIS.** *Steven W. Hamilton, Joseph R. Schiller, Deborah L. Hamilton and Mack T. Finley, Austin Peay State University, Clarksville, Tennessee (SWH, JRS, MTF), and Clarksville Academy, Clarksville, Tennessee (DLH).* The United States Environmental Protection Agency has developed benthic macroinvertebrate survey methods to monitor water quality. These Rapid Bioassessment Protocols apply readily to point source discharge monitoring, but are they sensitive enough to detect subtle effects of nonpoint source (NPS) pollution and to document water quality benefits of NPS abatement efforts? To monitor for water quality responses to various agricultural, riparian and instream best management practices, we sampled 7 stream sites in the West Sandy Creek watershed (WSCW) in west Tennessee from 1992 to 1995. These sandy-bottomed streams lack the typical riffle habitat from which semiquantitative samples are collected according to EPA's protocols. We collected semiquantitative samples from submerged root masses along the stream banks. These are stable complex substrates inhabited by a rich macroinvertebrate fauna. Qualitative samples also were collected from other habitats. Many barriers exist to obtaining reliable results using these monitoring protocols. For example, good reference streams are lacking, especially for streams greater than second order. Significant barriers to improving water quality also exist in these streams. Most streams in the WSCW are partly channelized and head-cutting is widespread; rapid agricultural and urban development continues in the watershed.

**CHANGES IN INVERTEBRATE COMMUNITY STRUCTURE OF FIRST-ORDER STREAMS AFTER CANOPY REMOVAL.** *Cynthia Rohrbach and Dennis Mullen, Aquatic Resource Center, Inc., Franklin, Tennessee, and Middle Tennessee State University, Murfreesboro, Tennessee.* This study tests the prediction of the River Continuum Concept that major disturbances in headwater streams, such as canopy removal, will cause a shift from the typical heterotrophic food base to an autotrophic condition, which is more characteristic of the midreaches of a river system. Three streams in forest that had undergone clearcut logging were compared with three undisturbed reference streams on the Western Highland Rim of Tennessee. Weekly mean maximum and minimum stream temperatures were compared seasonally, as well as benthic invertebrate functional feeding groups. There were larger daily thermal fluctuations in logged streams. Relative abundances of scrapers (algivores) were greater in logged streams in all seasons except fall, suggesting greater dependence on autochthonous energy sources until the autumn leaf pulse. Reference streams had greater relative abundances of shredders and collectors (detritivores), indicating reliance on allochthonous inputs from riparian vegetation. This study supports the River

Continuum Model's prediction for canopy removal in headwater streams.

**LABORATORY TRANSFORMATION OF FRESHWATER MUSSEL GLOCHIDIA AND BIOINDICATION OF SULPHUR FORK CREEK WATER USING JUVENILE MUSSELS.** *R. Adam Ray and Willodean Burton, Austin Peay State University, Clarksville, Tennessee.* Transformation of freshwater mussel glochidia into juveniles normally occurs via encystment on fish gills. This life stage is defined as "parasitic" because glochidia extract plasma and nutrients from the fish's blood in order to transform. This paper only focuses on the materials and methods employed in laboratory transformation and culturing of *Megaloniais nervosa* (Washboard) using a rabbit serum-based medium. The medium also consists of essential and non-essential amino acids, vitamins, and glucose in a unionid Ringer's solution, along with hormones, growth stimulants, etc. In vitro culturing will not conclude until January 1999. There, transformation and survival rates in three other media, combination of serum replacements and serum, will be compared to the former using contingency Chi-square analysis. If successful, this alternative method of transformation could be advantageous in reestablishing threatened and endangered mussel populations and genetic analysis of internal tissues.

**A STUDY OF AGE AND GENDER DIFFERENCES IN THE TAIL AUTONOMY OF *EUMECES FASCIATUS*.** *Christine Hinton\* and Joseph R. Schiller, Austin Peay State University, Clarksville, Tennessee.* This study tests the hypothesis that autonomy frequency in *Eumeces fasciatus*, the five lined skink, varies with age and gender. If tail autotomy is affected by physiological conditions, it may vary among males, females, and juveniles. Specimens of *E. fasciatus*, (14 specimens) were captured in traps baited with crickets one to three times a week in Montgomery County, Tennessee. Preserved specimens (70) in the Austin Peay State University Vertebrate Museum were included to increase sample size. One set of 27 traps were located in a wooded bluff overlooking the Cumberland River. The second set of 27 traps, approximately one-half mile west of the first, was located in a wooded area bordering a pasture. The traps were cans with some organic material in the bottom placed in areas of observed skink activity. The captured specimens were measured for snout-vent length, snout-tail length, and snout-break length. Scars on the tail indicate locations of previous tail breaks.

**A PROTEIN ANALYSIS OF *DAPHNIA MAGNA* AFTER CHRONIC EXPOSURE TO ZINC CHLORIDE.** *Jamie E. Mells\* and Willodean Burton, Austin Peay State University, Clarksville, Tennessee.* Environmental monitoring of aquatic pollutants currently favors using biological indicators to assess the impact of a pollutant on a particular habitat. Bio-indicators are considered to be organisms, which by their own presence or absence indicate a particular critical factor (Phillips and Rainbow, 1993). Stress proteins are organic substances found within these organisms that respond to changes or "stressors" in the organism's environment. This is referred to as the bio-indicator biochemical response. A biochemical response is a significant change in concentration of a molecular component of cells or tissues, or of extracellular fluids (Phillips and Rainbow 1993). Zooplankton are the largest and most important component of aquatic ecosystems. A major concern in aquatic ecology is the presence of pesticides, other organic substances, and metals that



bioaccumulate within an ecosystem. Metals are unique environmental and industrial pollutants in the sense that they are neither created nor destroyed by humans, but are transported and transformed into various products (Shukls, 1985). Zinc is ubiquitous in the environment, so that it is present in most food stuffs, water, and air. Metal content may be increased for materials in contact with galvanized copper or plastic pipes. Zinc commonly complexes with cadmium and chlorine. The purpose of this study was to determine the effects of zinc on the protein concentration of *Daphnia magna*, a zooplankton that is a major food source for fish, and is the "classic" Environmental Protection Agency test organism. The goal of this study was to establish a laboratory bioassay for aquatic systems that measures the effects of heavy metal environmental pollutants. The question is: can changes in protein content be used to indicate zinc contamination in *D. magna*?

HABITAT, HIBERNACULA, AND SEASONAL OCCURRENCE OF THE WESTERN COTTONMOUTH (*AGKISTRODON PISCIVORUS LEUCOSTOMA*) AT MARK'S CREEK WILDLIFE MANAGEMENT AREA, CHEATHAM COUNTY, TENNESSEE. *Brant T. Smith\** and *A. Floyd Scott, Austin Peay*

*State University, Clarksville, Tennessee.* In the Cumberland River drainage, western cottonmouths (*Agkistrodon piscivorus leucostoma*) are known as far upstream as Mark's Creek Wildlife Management Area (MCWMA) in Cheatham County, Tennessee (river mile 156.5). MCWMA is a 60-ha tract consisting of cultivated fields, moist soil management plots and permanently flooded forested swamp bordered by limestone bluffs. The cottonmouth population at MCWMA is centered in the forested swamp. Crevices in the nearby limestone bluff are used as hibernacula. Two of these hibernacula at the base of the bluffs were monitored for snakes in the spring of 1998 and the falls of 1997–1998. Data loggers were used to monitor air temperature and relative humidity throughout the year inside and outside of one hibernaculum. Ten living cottonmouths (five adult females, three adult males, two juveniles) and one dead individual (adult) were encountered and examined over the study period. Males were significantly larger than females ( $P < 0.05$ ) in total body length, snout-vent length, tail length, head width, head length, and weight. Cottonmouths were present around den openings from late September through early November and again from late March through early April. Ingression of the population into hibernation appeared to be more prolonged than egression.