

ABSTRACTS OF PAPERS PRESENTED AT THE 106TH ANNUAL MEETING

BOTANY SECTION

Edward W. Chester, Chair

EFFECTS OF METHIONINE SULPHOXIMINE ON TWO SOYBEAN CULTIVARS (HOJAKU AND MD86-5788). *Shavannor Smith**, *E. Lewis Myles*, *Deborah Long*, and *Carolyn Caudle*, *Tennessee State University, Nashville, Tennessee*. Plants of all kinds come in contact with many types of pathogenic causing agents. This study hopes to elucidate the defense mechanism by which the soybeans fight off pathogenic organisms. We used methionine sulphoximine in this study because of its ability to mimic the effects of *Pseudomonas syringae* a pathogenic bacterium. The two soybean cultivars used in this study were HOJAKU and MD86-5788. The seedling's exposure to 0, 12, and 24 μM of methionine sulphoximine continued for 7 days. Measurements of the plants' roots and hypocotyls gave an indication of the toxicity from methionine sulphoximine. Our results indicated that methionine sulphoximine causes a reduction in the growth of the hypocotyl and root. Statistical analysis indicated that MD86-5788 is more sensitive than HOJAKU. Analyses of the extracted proteins from these cultivars were by two-dimensional gel electrophoresis. The analysis of the proteins synthesized under stress and nonstress conditions may help us to understand disease tolerance.

SALT STRESS AND RAPD ANALYSIS OF SELECTED SOYBEAN CULTIVARS. *Tirsha Dukes**, *E. Lewis Myles*, *Deborah Long*, and *Carolyn Caudle*, *Tennessee State University, Nashville, Tennessee*. Excess salt in soils can be a major problem in irrigated, arid, and semiarid regions. Plants such as soybeans face many problems in these saline soils. There is usually a threshold concentration of salt where sensitive cultivars exhibit signs of stress. In our study, we used four cultivars: Hutchenson; Suzuyataka; Nakasennari; MD86-5785. We examined salt stress on soybean seedlings using in vitro techniques to find tolerant and sensitive varieties. Exposure of the seedlings was 0.0, 0.3, and 0.6% sodium chloride for 7 days. Measurement of lengths and weights of the hypocotyl and root gave an indication of the tolerance level. Statistical analyses show that exposure to concentrations of 0.3 and 0.6% sodium chloride significantly reduced growth when compared to the control. Suzuyataka and Hutchenson appeared to be more tolerant than Nakasennari and MD86-5785. RAPD analysis using PCR techniques will assist in the identification of any polymorphism among the cultivars.

EFFECTS OF HEAVY METALS ON *GLYCINE MAX*. *Lisa Griggs**, *E. Lewis Myles*, *Deborah Long*, and *Carolyn Caudle*, *Tennessee State University, Nashville, Tennessee*. Growth reduction is a commonly observed occurrence in plants when exposed to profound levels of heavy metals. Cadmium, a common metal and environmental pollutant, is present in the soil of many crops and accumulates as a result of pollution from mining, smelting, atmospheric fallout, or the use of agricultural fertilizers. Plants have responded to this stress by developing multiple mechanisms for tolerating the presence of cadmium. The production of

heavy-metal-binding peptides, also known as phytochelatins, is the most common mechanism for tolerance of cadmium in plants. These peptides play a critical role in tolerance of cadmium, and roots are believed to be one of the areas for the synthesis of these peptides. Our experiments indicate that three soybean cultivars (Forrest, Tomahomare, and Nakasennari) demonstrate a visible tolerance to cadmium. Also observed is a semisensitive cultivar, Hutchenson. We are now using one-dimensional gel electrophoresis to investigate the presence of specific peptides synthesized in response to cadmium exposure.

EFFECT OF ANTHRACNOSE BLIGHT ON DOGWOOD MORTALITY AND FOREST COMMUNITY STRUCTURE IN SOUTHEASTERN TENNESSEE. *John Kevin Hiers** and *Jonathan P. Evans*, *The University of the South, Sewanee, Tennessee*. Throughout the eastern deciduous forest, the flowering dogwood (*Cornus florida* L.) continues to decline due to the introduction of the Asian fungal blight *Discula destructiva* Redlin. This study compares the responses of populations of dogwood to the blight in the mixed mesophytic forest of the Cumberland Plateau coves and the oak-hickory forest found on the Plateau surface. The study represents the first documentation of decline of dogwood within the geophysiological province of the Cumberland Plateau. Additionally, using a temporal dataset from the mixed mesophytic forest, this study describes changes in forest composition since the blight. Although factors affecting the rate of spread of anthracnose (evaporative potential, soil moisture, and light levels) vary between the two sites, trends in the data suggest a future elimination of populations of dogwood from each of the forests studied.

EFFECT OF HERBIVORY AND RESOURCE AVAILABILITY ON SEEDLING ESTABLISHMENT AND RECRUITMENT IN A CHESTNUT OAK POPULATION (*QUERCUS PRINUS*) ON THE CUMBERLAND PLATEAU IN SOUTHEASTERN TENNESSEE. *Steven M. Howell** and *Jonathan P. Evans*, *The University of the South, Sewanee, Tennessee*. Populations of chestnut oak (*Quercus prinus*) on the Cumberland Plateau, Tennessee, are characterized by clumped distributions of high seedling-small sapling densities. We have found through demographic analyses that individuals are maintained in these smaller size classes often for >10 years. We hypothesize that herbivore activity and resource availability influence recruitment patterns of seedlings and saplings within these populations. We present results from studies that examine the following: effects of predation by rodents and deer on establishment of seedlings; effects of browsing by deer on juvenile size-class transitions; effects of light and nitrogen on aboveground and belowground growth of seedlings. We found that rodents have a significantly greater effect on establishment of seedlings than do deer and that browsing by deer did not limit growth of seedlings in height within sampled populations. Combined predation by rodents and deer on acorns resulted in <6% of germinated seeds becoming established. We discuss the role of resource limitation relative to predation impacts as factors controlling size-class transitioning within populations.

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POPULATION GENETICS OF *ASTRAGALUS BIBULLATUS* (FABACEAE). *Carol J. Baskauf and Sharon Snapp**, Austin Peay State University, Clarksville, Tennessee, and The University of Memphis, Memphis, Tennessee. *Astragalus bilullatus*, a rare species occurring in only a few populations in middle Tennessee, has low levels of genetic variability within and among populations. Within populations, means across 15 isozymic loci resulted in estimates of 1.4 alleles/locus, 25.6% polymorphic loci, and observed heterozygosity levels of 0.064. Populations are genetically very similar, with genetic identity values ranging from 0.981 to 1.000 and a F_{ST} -value of 0.098. Implications for the conservation and management of this species are discussed.

VASCULAR FLORA OF LULA LAKE LAND TRUST, LOOKOUT MOUNTAIN, GEORGIA. *R. David Sapp* and Gene S. Van Horn*, The University of Tennessee at Chattanooga, Chattanooga, Tennessee. This study focuses on the botanical diversity of the vascular plants of the Lula Lake Land Trust. This area is located in Walker Co., Georgia, on Lookout Mountain ca. 16 km south of Chattanooga. The plants were collected from May 1995 to July 1996. The flora exceeds 250 species, 177 genera, and 78 families. The diverse flora contains several interesting and unusual floral elements, including the federally threatened *Spiraea virginiana*.

TRENDS AMONG TENNESSEE'S ENDANGERED PLANTS. *Carl Nordman*, TDEC-Division of Natural Heritage, Nashville, Tennessee. Of Tennessee's nearly 2,300 native plants, 170 (7.5%) are listed as endangered under the State Rare Plant Protection and Conservation Act of 1985. Twenty (<1%) are protected under the United States Endangered Species Act. A variety of factors have led to the endangerment of these plants. Many of these factors can be addressed through site-based conservation and management. Notable progress has been made through conservation efforts targeting rare plants and ecosystems. Good information is critical for public and private conservation efforts.

ELEVATION AS A DETERMINER OF DISTRIBUTION OF *PHORADENDRON SEROTINUM* IN THE GREAT SMOKY MOUNTAINS, NORTH CAROLINA AND TENNESSEE. *Thomas E. Hemmerly*, Middle Tennessee State University, Murfreesboro, Tennessee. Forests of Tennessee and North Carolina in the Great Smoky Mountains region were surveyed for the occurrence of trees infested with American mistletoe, *Phoradendron serotinum* (Raf.) M. C. Johnston. Of 203 host trees located, 138 (67%) were oak, *Quercus* species, with northern red oak, *Quercus rubra*, the most commonly infested species. In Tennessee, all host trees were below 610.0 m in elevation; in North Carolina, the upper limit was 792.5 m. It is apparent that harsh winter conditions are responsible for limiting mistletoe to the lower elevations of the mountains.

AN UPDATE ON THE ATLAS OF TENNESSEE VASCULAR PLANTS PROJECT. *Edward W. Chester*, Austin Peay State University, Clarksville, Tennessee. A project to map known county distributions of vascular plants in Tennessee was initiated in 1989. Botanists from Austin Peay State University, (Clarksville, Tennessee), The University of Tennessee (Knoxville, Tennessee), and Vanderbilt University (Nashville, Tennessee) obtained distribution data from >600,000 in-state herbarium sheets, numerous records from out-of-state herbaria, and literature reports with specimen citations. A database was prepared, and computer-generated maps were produced. Volume 1, authored by E. W. Chester, B. E. Wofford, H. DeSelm, M. Evans, and R. Kral, included 906 maps of pteridophytes, gymnosperms, and monocots and was published by the Austin Peay State University Center for Field

Biology in 1993. Volume 2, authored by E. W. Chester, B. E. Wofford, and R. Kral, will include >1,900 maps of taxa of dicots and will be published by the Center in early 1997.

EFFECT OF WEEVIL LARVAE (*CURCULIO* SPP.) ON GERMINATION AND SEEDLING GROWTH IN CHESTNUT OAK (*QUERCUS PRINUS*). *Alexandra L. MacKinlay* and Jonathan P. Evans*, The University of the South, Sewanee, Tennessee. Field observations of populations of chestnut oak (*Quercus prinus*) on the Cumberland Plateau of Tennessee indicate that a large percentage of acorns produced each fall are subject to predation by weevil larvae (*Curculio* spp.). In this study, we tested two hypotheses: acorn biomass is positively correlated with germination success and seedling growth when seeds are subjected to weevil predation; intensity of weevil infestation varies inversely as a function of seed production by a given tree. Density of acorns beneath trees was determined at peak seed fall for a 0.8-ha population of marked chestnut oak. A sample of seeds from each tree was collected and incubated in the greenhouse to determine presence of weevils, germination success, and seedling growth. Results from these studies suggest that increased maternal investment in seeds can buffer the impact of predation by weevils on establishment of seedlings. The evolutionary trade-off between size and number of seeds in response to predation by weevils is discussed.

REPRODUCTIVE ECOLOGY OF *HYDROCOTYLE BONARIENSIS*, A GYNODIOECIOUS CLONAL DUNE HERB. *Ashley L. Brigham* and Jonathan P. Evans*, The University of the South, Sewanee, Tennessee. *Hydrocotyle bonariensis* is a gynodioecious clonal dune plant found along the southeastern coast of the United States. In dune systems on the barrier islands of North Carolina, sex ratios (hermaphrodites:females) have been observed to be 2:1 in swales and become increasingly hermaphroditic with increased elevation in the dunes. In previous research, we found that this skewed ratio must be attributed to less migration or lower survivorship of adult female clones in the dunes. We hypothesized that this was due to either differences in secondary sex characteristics or differential allocation to seed production (females and hermaphrodites are otherwise physiologically equivalent). We present preliminary data from experiments designed to test these alternative hypotheses. We also present data from experiments designed to test for self-incompatibility as a mechanism generating low seed set in hermaphrodites and agamospermy as a mechanism generating high seed set in females. (Poster)

DEMOGRAPHY OF PIGNUT HICKORY (*CARYA GLABRA*) IN A BARRIER ISLAND MARITIME FOREST OVERPOPULATED BY FERAL HOGS AND WHITE-TAILED DEER. *Robert A. Jackson*, Ashley L. Brigham*, Elizabeth Bibb* and Jonathan P. Evans*, The University of the South, Sewanee, Tennessee. A demographic analysis of an isolated population of pignut hickory (*Carya glabra*) within a maritime forest on St. Catherine's Island, Georgia, indicates that there has been virtually no recruitment of new individuals into the canopy within the past 50 years. This lack of recruitment is occurring in spite of the annual establishment and maintenance of a seedling size class within the population (individuals <20 cm in height). The 50-year period of no recruitment corresponds with the introduction and rapid increase of populations of feral hog (*Sus scrofa*) and white-tailed deer (*Odocoileus virginianus*) on the island. We use a size-class matrix, population projection model to predict the fate of this hickory stand given past and present patterns of recruitment and island wildlife management. We discuss the consequences of ungulate activity to the maintenance of species diversity in maritime forest communities. (Poster)

DOGWOOD (*CORNUS FLORIDA L.*) MORTALITY AND RECRUITMENT FROM COVE AND UPLAND SITES ON THE CUMBERLAND PLATEAU (SEWANEE, TENNESSEE). *Karen Kuers and Scott Torreano, The University of the South, Sewanee, Tennessee.* Flowering dogwood (*Cornus florida L.*), a shade tolerant understory tree, has been severely impacted by dogwood anthracnose, a fungal infection caused by *Discula destructiva* sp. nov. The objectives of this study were to quantify the decline in dogwood in a sample of cove and upland sites on the Cumberland Plateau near Sewanee, Tennessee, and quantify the current recruitment of young dogwood into these stands. Three locations on the Domain of The University of the South, Sewanee, Tennessee, for which inventory data was collected between 1983 and 1988 were re-inventoried in 1996: a south-facing cove that was harvested in 1978; a north-facing, old-growth, cove forest; an upland hardwood site located atop the Plateau. Dramatic decreases in dogwood stems ≥ 1.37 m tall were apparent at all three sites. Dogwoods declined from 83 to 14 and 99 to 8 stems/ha in the two cove sites and from 118 to 3 stems/ha in the upland hardwood site. These numbers represent declines of 83, 92, and 97%, respectively. The percentage of plots with living dogwood decreased from 52 to 19% and from 59 to 24% in the two coves and from 83 to 8% at the upland site. The decline in stems < 1.37 m tall was equally dramatic. Stems numbered 369, 287, and 1,093/ha prior to 1988 and were found on 19% of 46 plots, 15% of 100 plots, and 57% of 47 plots tallied at the three sites, respectively. No dogwood regeneration was found on any of the plots at any of the sites in 1996. (Poster)

IMPORTANCE OF WOOD AS SUBSTRATE FOR PRIMARY PRODUCERS IN THE STREAMS OF THE WEST SANDY CREEK WATERSHED OF HENRY COUNTY. *Timothy D. Neville*, Jefferson G. Lebkuecher, and Kellie L. Wallace*, Austin Peay State University, Clarksville, Tennessee.* In support of a program to improve the water quality in the West Sandy Creek watershed of Henry Co., Tennessee, primary production was studied in Holly Fork Creek, a channelized stream, and Bailey Fork Creek, an unchannelized stream. Whole-stream gross primary production of Bailey Fork Creek ($7.7 \text{ g O}_2 \text{ m}^{-2} \text{ day}^{-1}$) was three times greater than that of Holly Fork Creek ($2.5 \text{ g O}_2 \text{ m}^{-2} \text{ day}^{-1}$). Lower primary production in Holly Fork Creek may result from the small amount of wood-associated periphyton (0.02 mg chl/m^2) due to the low volume of submerged wood ($3 \times 10^{-5} \text{ m}^3/\text{m}^2$) relative to Bailey Fork Creek (wood-associated periphyton = 4.45 mg chl/m^2 ; wood volume = $6 \times 10^{-3} \text{ m}^3/\text{m}^2$). Benthic periphyton and macrophytes are minor contributors to primary production in the unchannelized streams of the watershed, i.e., combined 15% of total in Bailey Fork Creek. The results suggest that submerged wood is the most important substrate for primary producers in the sandy-bottom streams of the watershed and that wood removal during channelization reduces whole-stream primary production. (Poster)

CHEMISTRY SECTION

Rudy Gostowski, Chair

BIOSPARGING OF VOLATILE ORGANICS: AN AIR CHANNELING MODEL. *David J. Wilson and Ann N. Clarke, Eckenfelder Inc., Nashville, Tennessee.* Biosparging, an innovative technology for remediation of aquifers contaminated with biodegradable organic compounds, is achieving widespread acceptance. In the technique, air is injected into the contaminated aquifer, and organic contaminants are removed by air stripping or by aerobic biodegradation. Mathematical models are needed for site-specific preliminary evaluation of the technology, for design of pilot studies and interpretation of their results, and for design of full-scale biosparging operations. A mathematical

model for biosparging with a long horizontal slotted pipe will be described. The model assumes that the injected air moves in persistent channels (as is observed experimentally), that movement of dissolved contaminant and dissolved oxygen is by dispersion, and that the biological processes can be described by Monod kinetics. The dependence of results on model parameters will be explored, and conclusions bearing on the optimizing of sparging system design will be presented.

EXTRACTION OF FULVIC ACIDS WITH SUPERCRITICAL FLUIDS. *Eugene A. Kline, Jiyue Ahand*, Martha J. M. Wells*, and G. Kim Stearman*, Tennessee Technological University, Cookeville, Tennessee.* Fulvic acid was isolated from a commercially available humic acid by dissolving in dilute hydrochloric acid (pH 2). The dried fulvic acid was first extracted with supercritical carbon dioxide. A second series of extractions was conducted with supercritical carbon dioxide with 3% cosolvent (90% acetone and 10% water). The extracted components (totalling up to 20% yields) were analyzed with reversed-phase high performance liquid chromatography (HPLC) with the mobile phase selected after optimization with different solvent ratios. All analyses finally were conducted with one mobile phase (0.1% HOAc, 1.0% MeOH, and 14.9% water) using an ultraviolet detector. Differences in the FT-IR and retention times of HPLC of the resulting extracts compared with the original fulvic acid indicated separation had occurred. However, further analyses of the extracted components with supercritical carbon dioxide varying the amounts of cosolvent ($< 3\%$ formic acid which is one of a few possible polar cosolvents with FID) gave no evidence for components attributable to the original fulvic acid or any of its components extracted by the supercritical carbon dioxide and cosolvent.

A CONVENIENT AND INEXPENSIVE SOURCE OF REGULATED LOW PRESSURE USING A WATER ASPIRATOR. *Martin V. Stewart, Paul R. Buckingham*, Lisa Coultas*, James C. Howard, and Natalie Tate*, Middle Tennessee State University, Murfreesboro, Tennessee.* The variable and often very low water pressures experienced in the Davis Science Building of Middle Tennessee State University, Murfreesboro, Tennessee, during the last 3 years of unprecedented campus expansion have rendered ordinary water aspirators undependable. This problem can be overcome through use of a type of plastic aspirator designed for minimal water consumption. To facilitate the investigation, a simple device consisting of a water aspirator, vacuum gauge, and needle valve was constructed that allows pressures to be selected, measured, and maintained from one atmosphere down to nearly the vapor pressure of water. The apparatus has applications for rotary evaporation, vacuum distillation, sublimation, and other laboratory operations requiring adjustable subatmospheric pressure. One immediate result of being able to monitor the pressure of the system during rotary evaporation has been the observation of disturbingly high vapor pressures of toxic solvents venting through the aspirator, even when the receiving flask is immersed in an ice bath.

COMPARISON OF TOTAL ORGANIC CARBON ANALYSIS AND ULTRAVIOLET ABSORBANCE ANALYSIS FOR PREDICTING TRIHALOMETHANE FORMATION. *Barbara Lynn Osborn* and Keith Carr, Tennessee State University, Nashville, Tennessee.* Trihalomethanes are formed when organic matter in source water reacts with chlorine during the drinking-water treatment process. There are many factors that influence formation of trihalomethane, including pH, temperature, chlorine dosage, chlorine contact time, and organic-matter concentration. This organic matter can be measured by total organic carbon analysis and ultraviolet absorbance analysis. These two analytical techniques were compared for their ability to predict formation of trihalomethane. Samples for this study were obtained from Omohundro

Water Treatment Plant. The sample points were located at different stages of treatment throughout the plant. This enabled comparison of data between the different treatment processes. Results from this research show that total organic-carbon analysis and ultraviolet absorbance analysis by themselves are not reliable predictors of formation of trihalomethane. However, the use of multiple linear regression shows total organic-carbon analysis, in combination with other factors, to be a better predictor of formation of trihalomethane than ultraviolet absorbance analysis.

CATEGORIZATION OF WHISKEYS BY PATTERN RECOGNITION. *Linda A. Wilson, J. H. Ding, and A. E. Woods, Middle Tennessee State University, Murfreesboro, Tennessee (LAW, AEW), and Provincial Sanitary and Antiepidemic Station, Changchun, Jilin, People's Republic of China (JHD).* Graphite furnace and flame atomic absorption analysis was used to determine the concentrations of nine metals in 122 samples of whiskey. The whiskeys averaged 189.00 $\mu\text{g/l}$ Cu, 2.98 $\mu\text{g/l}$ Ni, 30.60 $\mu\text{g/l}$ Mn, 47.00 $\mu\text{g/l}$ Fe, 27.70 $\mu\text{g/l}$ Zn, 15.70 $\mu\text{g/ml}$ K, 4.92 $\mu\text{g/ml}$ Na, 475.00 $\mu\text{g/l}$ Mg, and 1.14 $\mu\text{g/ml}$ Ca. Principal component analysis and hierarchical cluster analysis were used to group the samples into two main clusters: sour mash-bourbon; scotch-blended. Pattern recognition analysis also was performed on a subset of 51 samples whose ages could be determined from their labels. The samples did not appear to cluster by age.

EFFECTS OF DIET AND COSMETICS ON HUMAN-SKIN-OIL GAS CHROMATOGRAPHIC PROFILES. *Ying Yang* and Linda A. Wilson, Middle Tennessee State University, Murfreesboro, Tennessee.* The effects of differences in diet and the presence of cosmetics on the capillary gas chromatographic profiles of human-skin surface lipids has been investigated for potential forensic application. To study the effect of diet, 36 samples of skin oil were collected from Chinese college students in Jilin University whose diet was a typical Chinese university-cafeteria diet. Thirty samples of skin oil also were collected from Chinese people in Nashville, Tennessee, whose diet tends to be American style. The lipids were converted to the fatty acid methyl esters prior to analysis. For the study of the effect of cosmetics on the profiles, samples with and without cosmetics were collected from 20 Caucasian females. The data were subjected to pattern recognition and statistical comparison. It was observed that diet may have a potential effect on the profile and that cosmetics also affected the profile but the effects could be minimized with proper peak selection.

IC-ICP OF SELENIUM ANIONS. *Wen Su* and John Harwood, Tennessee Technological University, Cookeville, Tennessee.* Anion exchange chromatography with the direct coupling to an inductively coupled argon plasma atomic emission spectrometer was used to separate and quantitate selenium species in water for the application to natural water. Carbonate and hydroxide eluents were developed for use with Dionex AS10 and AS11 columns to separate seleno-methionine, selenite, seleno-cystine, selenate, and seleno-cysteine. The analysis requires ca. 10 min, and the detection limits for different species are from 0.3 to 1.0 ppm; higher sensitivities were obtained with the AS11 column. Possible interferences by seawater and cell extract also were investigated. Except for seleno-cysteine in cell extract for AS10 column, the sensitivity of the five selenium species in seawater and cell extract is within the 95% confidence interval of that obtained in distilled water.

FLUXIONAL BEHAVIOR OF PENTACHLOROCYCLOPENTADIENYLMERCURY(II) DERIVATIVES OF THE TYPE $\text{C}_5\text{Cl}_5\text{HgR}$. *Haiping Lu*, Kevin Scott Benner, and William H. Ilsley,*

Middle Tennessee State University, Murfreesboro, Tennessee. Pentachlorocyclopentadienyl(C_5Cl_5) derivatives are known to be "fluxional." Data on some pentachlorocyclopentadienylmercury derivatives including phenyl(C_5Cl_5)mercury and (2,4,6-tri-*t*-butylphenyl)(C_5Cl_5)mercury have been previously reported. Those that have been studied do appear to exhibit fluxional behavior. To investigate the fluxional behavior of additional examples of these compounds, several aryl(C_5Cl_5)mercury derivatives have been prepared. They have been synthesized by the exchange reaction between a bis(aryl)mercury derivative and bis(C_5Cl_5)mercury compound. Two crystalline forms of the precursor bis(C_5Cl_5)mercury have been studied, and the fluxional behavior of (2,4,6-trimethylphenyl)(C_5Cl_5)mercury and (2,4,6-trimethoxyphenyl)(C_5Cl_5)mercury in the solution state were studied using a Bruker 200 MHz FT NMR spectrometer at various temperatures down to -90°C . The results show that both compounds are fluxional in solution at ambient temperature. A new synthetic method of the preparation of bis(2,4,6-trimethoxyphenyl)mercury also has been developed which is based upon the synthetic procedure for the preparation of bis(*p*-dimethylaniline)mercury.

SECOND-DERIVATIVE ABSORPTION SPECTROSCOPY STUDY OF THE SOLVOLYSIS OF SODIUM HEXACHLOROPLATINATE BY DIMETHYL SULFOXIDE. *Hong (Sonia) Wan* and James C. Howard, Middle Tennessee State University, Murfreesboro, Tennessee.* An HP 8451A Diode Array Spectrophotometer was used to acquire ultraviolet-vis spectra to study the reaction of sodium hexachloroplatinate(IV) hexahydrate with dimethyl sulfoxide in the mixed solvent $\text{DMSO}:\text{H}_2\text{O}$, 1:2, v/v. The kinetic study was performed by measuring the samples at different temperatures as a function of time. The data were transferred to an HP 8452A spectrophotometer for further analysis. Using second-derivative spectra of the starting material, $\text{Na}_2\text{PtCl}_6 \cdot 6\text{H}_2\text{O}$, the final product, $\text{Pt}(\text{DMSO})_2\text{Cl}_2$, and that of an intermediate compound (whose structure remains unknown) derived by using difference spectroscopy as standards, reaction mixtures were analyzed employing the multicomponent-analysis feature of the spectrophotometer. The concentrations of the components were obtained as a function of time. Pseudo-first-order rate constants were determined from linear regression analyses of the data. At 330 K, $k = 0.142 \text{ h}^{-1}$. The activation parameters were determined from an Arrhenius plot. At $T = 327.5 \text{ K}$, $E_a = 70.64 \text{ kJ}\cdot\text{mol}^{-1}$, $\Delta H^\ddagger = 67.92 \text{ kJ}\cdot\text{mol}^{-1}$, $\Delta S^\ddagger = -56.49 \text{ J}\cdot\text{K}^{-1}\cdot\text{mol}^{-1}$, and $\Delta G^\ddagger = 86.42 \text{ kJ}\cdot\text{mol}^{-1}$. During the study, it was discovered that the starting material, $\text{Na}_2\text{PtCl}_6 \cdot 6\text{H}_2\text{O}$, in aqueous solution photolyzes using either fluorescent or blue light.

MM2 CALCULATIONS ON GROUP 13 ORGANOMETALLIC CHALCOGEN DIMERS AND TRIMERS. *Kathryn M. Rust* and William H. Ilsley, Tennessee Technological University, Cookeville, Tennessee, and Middle Tennessee State University, Murfreesboro, Tennessee.* Organometallic chalcogen derivatives of group 13 elements have been studied through molecular modeling techniques. The compounds of interest were $[\text{Me}_2\text{Al}(\text{m-OMo})_2]_3$, $[\text{Me}_2\text{Al}(\text{m-SMe})_2]_2$, $[\text{M}_2\text{Al}(\text{m-SeMe})_2]_2$, and $[\text{Me}_2\text{Al}(\text{m-SMe})_3]_3$. The stability of the anti conformer of the dimer was examined relative to the syn conformer in an effort to establish an understanding of the anti-syn equilibrium. The minimum energies of each conformation were studied using MM2 calculations as well as semiempirical molecular orbital methods. The energies were compared to NMR data to determine the best technique for predicting conformational equilibria of these species. Additionally, the dimer-trimer equilibrium was examined by MM2 and molecular orbital calculations in an effort to elucidate the factors governing the degree of aggregation in these compounds.

GEOMETRY OF CYCLOPENTADIENYLBORANE: AB-INITIO VERSUS SEMIEMPIRICAL CALCULATIONS. *Brian Hill* and William H. Isley, Bryan College, Tennessee, and Middle Tennessee State University, Murfreesboro, Tennessee.* The ground-state geometry of cyclopentadienylborane was optimized using a semiempirical calculation method (MNDO) and an ab-initio method (restricted HF, 6-31 g* basis set). Significant differences were found between the results of these two methods. In particular, the ab-initio calculated ground state has boron displaced away from the plane of symmetry of the cyclopentadienyl ring. The C-C bond lengths around the ring also are asymmetrical. This geometry appears to facilitate the 1,5-sigmatropic rearrangement of this molecule.

SYNTHESIS OF SUBSTITUTED 10-CYANOANTHRACENE-9-ISOTHIOCYANATES FOR USE AS FLUORESCENT DYE LABELING REAGENTS. *Daniel J. Swartling, Tennessee Technological University, Cookeville, Tennessee.* Several substituted 10-cyanoanthracene-9-isothiocyanates have been made from the corresponding 10-cyano-9-aminoanthracenes, which were synthesized via aryne chemistry. Due to the fluorescence emission values and large Stokes shifts for these compounds, they were conjugated to 3'- and 5'-aminothymidine and to alkylated purine nucleosides to show that they could be useful in the design and synthesis of fluorescent-tagged antisense DNA and other fluorescent biological probes.

CONFORMATIONAL AND ELECTRONIC CONTROL OF FLAVIN REDOX CHEMISTRY. *Justin J. Hasford* and Carmelo J. Rizzo, Vanderbilt University, Nashville, Tennessee.* Flavoenzymes are ubiquitous biological redox catalysts. Through the design and synthesis of chemical models, we are studying the roles of conformation, substituents, and hydrogen bonding on the redox properties of the flavin cofactor (vitamin B₂). Specifically, we have designed and synthesized a series of conformationally biased flavins and studied their redox properties by cyclic voltammetry. Preliminary results indicate that control of conformation could be a mechanism by which the enzyme "tunes" the redox properties of the cofactor. In addition, we have conducted a systematic study on the effect of benzosubstitution on flavin redox properties. We have identified a linear free energy substituent effect which allows for the accurate prediction of flavin redox potential.

UNEXPECTED ELECTRON TRANSFERS BETWEEN STERICALLY-HINDERED CARBON-CENTERED RADICALS AND PERSISTENT NITROXIDES. *Rudy Gostowski, Stephanie Steelman*, Duane Brigman*, and Erin Emrich*, Austin Peay State University, Clarksville, Tennessee.* Persistent nitroxides (traps) have been used for some time to indicate the presence of radicals in a reaction. It has been assumed that these molecules react as radicals in the bond formation step of the process and that the rate of the reaction is diffusion controlled. In recent literature, it has been shown that the rate may in fact be attenuated from the diffusion limit by solvent effects and steric factors. One objective of this work has been to investigate these steric factors by formation and observation of radicals produced by oxidation of an appropriate anion in a fast scan cyclic voltammetry experiment. However, it is surprising that for some hindered radicals an electron transfer may occur with the nitroxide. This has been observed as increased anodic current indicating a catalytic production of the reagent anion. When steric factors interfere with bond formation (trapping), this effect has been observed as in the 9-*o*-tolyl fluorenyl and the 9-phenylxanthenyl radicals. However, as the steric hindrance is decreased as in 9-*t*-butyl fluorenyl, the effect disappears. These observations indicate that, in some cases, an electron transfer and subsequent bonding of a cation with an anion occur rather than trapping of a radical by the nitroxide reagent.

BIOSYNTHETIC INCORPORATION OF UNNATURAL AMINO ACIDS INTO PROTEINS AS NMR AND X-RAY DIFFRACTION LABELS. *Jeffrey O. Boles, Tennessee Technological University, Cookeville, Tennessee.* Two hurdles stand before an x-ray crystallographer and his or her solved three-dimensional structure: crystallization; phase problem. Crystallization is still widely more thought of as "art" than science, although certain advances in microgravity crystallization and crystallization methodology have improved the technique somewhat. The phase problem results because the atoms found in proteins (C, N, O, S, and H) scatter electrons to weakly for an adequate determination of amplitude and phase of diffracted waves. It has long been established that heavy-atom derivitization of proteins allows this hurdle to be surpassed; however, the technique fails more often than it succeeds. The protein crystals often crack on exposure to heavy-atom containing mother liquors or the resultant derivitized crystals are nonisomorphous with their wild type counterparts. The biosynthetic incorporation of selenium or tellurium labels as seleno- or telluro-amino acids provide one solution of the phase problem providing an in situ isomorphous replacement. The utility of these proteins in NMR studies also is possible as selenium and tellurium have spin 1/2 isotopes in ca. 7.0-7.5% natural abundance (⁷⁷Se and ¹²⁵Te).

UTILIZATION OF TRYPTOPHAN SYNTHASE IN THE PREPARATION OF TRYPTOPHAN ANALOGS. *David O'kin* and Jeffrey O. Boles, Tennessee Technological University, Cookeville, Tennessee.* There are currently only two metalloid-containing unnatural amino acids available for use as biosynthetically incorporated x-ray diffraction labels in proteins: selenomethionine; telluromethionine. The latter of the two and most desirable from the standpoint of x-ray crystallography 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 synthesis of selenium- and tellurium-containing analogs of tryptophan. Chemical synthesis of this compound has proven unsuccessful due to the instability of several intermediates. Tryptophan synthase has been used for the preparation of many analogs of tryptophan using inole analogs as starting material. We have obtained the expression system for the wild type heterotetrameric enzyme and the B₂ subunit, purified by established protocols and performed initial control experiments synthesizing tryptophan from indole. Benzotellurophene and benzoselenophene are planned as starting materials for each of the two PLP-dependent enzymes using either serine or B-chloro-alanine as the second substrate. (Poster)

APPROACHES TOWARD THE DETERMINATION AND LOCALIZATION OF SELENIUM AND TELLURIUM IN SELENO- AND TELLURO-PROTEINS. *Pavan Marpaka*, Casey Narrie*, and Jeffrey O. Boles, Tennessee Technological University, Cookeville, Tennessee.* The detection of selenium and tellurium in proteins has become of interest lately owing to their utilization as x-ray diffraction labels and NMR probes. Current detection techniques include ICP and AAS which are destructive, yielding quantitative information alone. It would be desirable to have a simpler in-house method of quantitation and localization of selenium and tellurium content. In this study, we are attempting to exploit spectroscopic differences (IR) and chemical reactivity differences (with CNBr) between L-methionine, L-selenomethionine, and L-telluromethionine. We began by looking at the free amino acids in developing both techniques and are currently extending these experimental designs to the wild type, L-selenomethionine- and telluromethionine-containing control protein. The protein chosen for our study is *Escherichia coli* dihydrofolate reductase and is available in

a methionine auxotrophe as *E. coli* DL41 (pCOCK). We have cultured *E. coli* DL41 (pCOCK) on defined media, produced and purified all three DHFRs, and will present our preliminary results concerning the detection and localization of L-selenomethionine and L-telluromethionine. (Poster)

PREPARATION AND CHARACTERIZATION OF SELENOMETHIONINE- AND TELLUROMETHIONINE-CONTAINING PYRROLIDONE CARBOXYL PEPTIDASE FROM *STAPHYLOCOCCUS AUREUS*. *Henry Yu**, *Shannon Hill**, and *Jeffrey O. Boles*, *Tennessee Technological University, Cookeville, Tennessee*. The subject of this research was the purification and characterization of a novel aminopeptidase followed by the biosynthetic incorporation of selenium and tellurium as methionine analogs into the protein. The incorporation of selenium or tellurium facilitates x-ray diffraction data interpretation because it provides the heavy-atom derivative required for such structural determinations. The incorporation was facilitated by transforming an expression vector bearing pyrrolidone carboxyl peptidase into a methionine auxotrophe (*Escherichia coli* DL41) and culturing on defined media. Pyrrolidone carboxyl peptidase is a proposed member of a new structural class of protein, as none of the cloned homologous pyrrolidone carboxyl peptidases exhibit sequence homology with other known peptidases. The exact physiological function of pyrrolidone carboxyl peptidase remains unknown at this time. Comparative biochemistry between the wild type and mutant proteins are discussed. Attempts to crystallize the protein are underway. (Poster)

DEVELOPMENT OF A SPECTROELECTROCHEMICAL INSTRUMENT FOR OBSERVATION OF ORGANIC RADICALS. *Chris Smalley** and *Rudy Gostowski*, *Austin Peay State University, Clarksville, Tennessee*. Spectroelectrochemical methods offer the advantage that the species present in the electrochemical process can be identified by their spectra. In addition, the kinetics of the process can be evaluated by the appearance or disappearance of a characteristic absorbance. This project involves the preliminary development of such an instrument. The device features a prototype optically transparent thin-layer electrode (OTTLE) cell. Light is brought from a source (quartz halogen or deuterium), and the wavelength is selected by a monochromator (1 m) and transmitted to the cell by a liquid light guide (visible and ultraviolet ranges). At the OTTLE cell, light passes through two quartz rods and on to the photomultiplier tube. A variable gap between the rods contains a platinum gauze working electrode and provides an adjustable thin layer. The instrument has been tested by taking the oxidation spectra of *o*-tolidine. In future experiments, organic anions (carbanions and others) will be oxidized to yield radicals (persistent in some cases), and the spectra will be taken. (Poster)

REACTIONS OF THE 9-*t*-BUTYL FLUORENYL RADICAL AND TEMPO: RATE DETERMINATION BY FAST SCAN CYCLIC VOLTAMMETRY AND DIGITAL SIMULATION. *Stephanie Steelman**, *Duane Brigman**, *Erin Emrich**, and *Rudy Gostowski*, *Austin Peay State University, Clarksville, Tennessee*. Radicals with progressively less persistence have been studied using fast scan cyclic voltammetry and digital simulation. The reaction rates (k_2) for dimerization of the 9-*o*-tolyl fluorenyl and the 9-phenyl xanthenyl radicals are known to be 2.1×10^4 and $3.6 \times 10^4 \text{ M}^{-1}\text{s}^{-1}$, respectively. In this study, the reaction rate for 9-*t*-butyl fluorenyl has been determined to be $9 \times 10^5 \text{ M}^{-1}\text{s}^{-1}$. The increasing reaction rates (decreasing persistence) is credited to greater accessibility of the orbital containing the unpaired electron. This may be credited to less twist (less hindrance) of the phenyl ring in 9-phenyl xanthenyl compared to 9-*o*-tolyl fluorenyl. The tertiary butyl function of 9-*o*-tolyl fluorenyl is likewise likely to provide less hindrance than the phenyl group of 9-phenyl xanthenyl. Related results

have been observed when the radicals were reacted with 2,2,6,6-tetramethyl-1-piperidinyloxy, a nitroxide trapping agent. The 9-*o*-tolyl fluorenyl and 9-phenyl xanthenyl radicals appeared to not bond to (be trapped by) 2,2,6,6-tetramethyl-1-piperidinyloxy but rather underwent an electron transfer. In contrast, this electron transfer was not observed between the 9-*t*-butyl fluorenyl radical and 2,2,6,6-tetramethyl-1-piperidinyloxy, rather some trapping was observed. Therefore, reactions with 2,2,6,6-tetramethyl-1-piperidinyloxy also indicate the decreasing steric hindrance in the radicals studied. (Poster)

LEMON BATTERIES REVISITED: THE LEMON-POWERED CALCULATOR. *Charlotte Morgan** and *Daniel J. Swartling*, *Tennessee Technological University, Cookeville, Tennessee*. When copper and zinc strips are put into a lemon, a novel galvanic cell results. We were somewhat dismayed in that a published demonstration involving lemon cell wired in series to charge capacitors which are used to fire flash cubes could not be reproduced. However, we have found common and readily obtained items that can be powered by lemon cells wired in series, including a TI-30 calculator. The demonstration procedures as well as the chemistry of the lemon cells will be discussed. (Poster)

ENGINEERING SECTION

Gladius Lewis, Chair

FORECASTING MONTHLY ELECTRIC ENERGY SALES IN SHELBY COUNTY. *William L. Allen, Jr.*, and *Michael L. Daley*, *The University of Memphis, Memphis, Tennessee*. Memphis Light, Gas, and Water Division sells electrical energy to ca. 365,000 customers in Shelby Co., Tennessee. Currently, total electric consumption with units measured in gigawatt-hours has been predicted using simple forecasting methods. These annual predictions were further broken down into monthly values. In an effort to achieve more accurate medium-term sales forecasts, a time-series decomposition model was used after separating the sales data into the residential, commercial, and industrial customer classifications. Time-series analysis of each class revealed long-term trends, seasonal fluctuations, cyclical movements, and random fluctuations. A summary of the analysis indicates that the industrial and commercial usage are relatively constant from month to month. In contrast, the major fluctuations in the total energy consumption are caused by the weather-sensitive or seasonal fluctuations of the residential usage. Actual 1994 sales data indicated that the decomposition model achieved an annual forecast error of 0.71% compared to 2.80% error with the utility's method.

PROPERTIES OF ARTIFICIAL WOOD BASED ON MIXTURE OF PLASTIC WASTES AND SAWDUST. *Jayagopal Paladugula** and *Fyodor Shutov*, *Tennessee Technological University, Cookeville, Tennessee*. This study deals with production and properties of so-called artificial wood which is composite materials based on polymer matrix (polyethylene wastes) and fiber (woodwaste, namely sawdust). We studied a number of processing parameters of artificial wood: regimes of sawdust drying for optimal moisture; procedures for mixing of polyethylene flakes and sawdust; numerous parameters of injection molding process. Tensile ultimate load, tensile modulus, breakdown elongation, and final moisture content have been studied for samples of artificial wood with different amounts of sawdust (as high as 30%). It is demonstrated that increasing filler content decreases elongation but increases tensile strength, even without any coupling agents. Some speculations regarding the mechanism of reinforcement effect are presented based on chemical nature and density of polyethylene and cellulose, moisture contents of sawdust, and morphology of the samples.

AN IMPROVED FALLING BALL VISCOMETER. *Qingwei Zhao* and J. D. Mo, The University of Memphis, Memphis, Tennessee.* An improved falling ball viscometer has been developed in this research project. It could be used to measure the viscosity of opaque or nonopaque fluids over a wide range. The new system employs the same principle as the conventional falling ball viscometer but with an attachment for accurately measuring the ball's movement in the measured fluid. This makes the new device very convenient for use in a fluid mechanics laboratory.

STRUCTURE AND PROPERTIES OF THERMOSETTING SILICONE POLYMERS FOR CRANKCASE-HEATER INSERTS. *Karena Swisher* and Fyodor Shutov, Tennessee Technological University, Cookeville, Tennessee.* The main goal of the project was to increase the quality of heater inserts used in crankcase heaters, using a commercial silicone-based polymer with high thermal conductivity (Trademark "Thermoset SC-146"). The common procedure consists of mixing, vacuum, and curing stages. The quality of the final product in terms of thermal conductivity is low due to the number of voids and other micro- and macro-defects present. In order to reduce the number of defects, the vacuum and curing stages were investigated. By varying the curing temperature, curing time, and vacuum-release time, many samples were produced for analyzing quality. Optical, mechanical, and thermal properties of the cured resin were measured to determine the quality of the samples. Analysis of the data showed that the vacuum stage introduces many defects into the product. This can be reduced by extending the vacuum-release time. Also, more than one optimal curing temperature and time exists and a lower temperature and time than the current TUTCO procedure may be used. The proposed procedures should not only improve the quality and properties of the final product but also save energy consumption and shorten the cycle time for industrial production of crankcase heater inserts.

TOWARDS COMPOSITIONAL RULES IN IMAGE ANALYSIS. *Tamara Shanese Williams*, Laurent Itti, and Pietro Perona, Tennessee State University, Nashville, Tennessee.* This project involved creating a database consisting of ca. 800 images by professional artists so that some compositional rules could be discovered based on image processing, computer vision, and statistical analysis. Statistics of the proportions of the canvas that are preferred by professional artists for different types of paintings were compiled. Compositional asymmetries were studied by measuring whether or not a majority of subjects could distinguish an original image from the mirror-imaged version based on their aesthetic preference. Asymmetries in texture and contrast content were studied by creating histograms of dominant line orientation and spatial frequency in the four quadrants of the images.

PART FAMILY GROUPING FOR CELLULAR MANUFACTURING USING INTERACTIVE ACTIVATION AND COMPETITION NETWORKS. *Kenneth R. Currie and Saravanan Krishnakumar, Tennessee Technological University, Cookeville, Tennessee.* We propose a means of identifying part families-machine cells using design and manufacturing characteristics simultaneously. A self-organizing neural network called Interactive Activation and Competition is used. An Interactive Activation and Competition network consists of a collection of processing units organized into competitive pools that represent part features. Each of the different design and manufacturing characteristics are organized into pools. There are excitatory connections between units in different pools and inhibitory connections among units within the same pool. A square matrix which has a measure of relative strength each part has with respect to other parts in other cells is provided. When an excitatory signal is sent to one of the part types, other parts with

similar characteristics are in turn excited while the parts with dissimilar characteristics are inhibited. The result is a number of similar parts with high activation levels and another group with very low activation levels. This creates a similarity index of the pairwise comparison of the parts based on these design and manufacturing characteristics. A bond energy algorithm will be used to partition the matrix of parts similarity indices to create part families, and inferred from the part families are machine cells. A visual basic interface for this model is proposed. It provides user-friendly features that will allow searches of the part database as well as grouping in to part families.

VISCOELASTIC PROPERTIES OF AGRICULTURAL MATERIALS. *Gladius Lewis, The University of Memphis, Memphis, Tennessee.* Mechanical processors used in the planting, storing, and harvesting of agricultural produce subject the produce to potentially damaging impact forces and stresses. Thus, it is germane to understand the mechanical properties associated with the produce and to identify the consequences of exceeding specified limits. Two examples are the role that transient modulus of elasticity, E , of a seed plays in its reaction to impact loading, and the significance of the produce's viscoelastic properties during its long-term storage in, for example, a silo. The present work involved the determination of E of cowpea as a function of time, t (1 - 100 s) at temperatures of 25, 45, and 70°C. At each temperature, the E - t data were fitted to a double-Maxwell viscoelastic model. The dependence of the model constants on temperature as well as the significance of the results are fully discussed.

PRESSURE SHEAR PULVERIZATION: PROCESSING AND PROPERTIES OF VIRGIN AND WASTE LOW-DENSITY POLY(ETHYLENE). *Tapan Patel* and Fyodor Shutov, Tennessee Technological University, Cookeville, Tennessee.* A novel principle of plastics waste utilization is being developed at Tennessee Technological University, Cookeville, Tennessee. The primary objective of this study is to develop a reproducible laboratory-scale process for pulverization of low-density poly(ethylene). The main equipment of the pressure shear pulverization process consists of a pulverization head (patent pending). The process parameters can be varied to obtain specific size distribution of polymeric powder for a particular application. For various types of commercial low-density poly(ethylene) having different melt flow index, the optimal parameters of the pressure shear pulverization process have been found, and detailed analysis of particle-size distribution has been provided. Direct application of fine low-density poly(ethylene) powder based on virgin polymers and plastics waste are discussed.

A REAL TIME POSITION LOCATING ALGORITHM FOR CCD-BASED SUNSPOT TRACKING. *Jaime R. Taylor, Austin Peay State University, Clarksville, Tennessee.* NASA Marshall's Experimental Vector Magnetograph (EXVM) polarimeter requires image stabilization over a time period of a few minutes. A high-speed tracker can be used to reduce image motion produced by wind loading on the EXVM telescope and the rotation of the EXVM polarimeter. The image motion detection system, which provides an error signal for the control system, must use sunspots to determine image movement. It is desirable to determine the image movement at least 1,000 times/sec. A new technique and algorithm are presented for image motion determination which uses one row and one column of CCD pixels providing a time savings of a factor of $N/2$ over using a full $N \times N$ CCD matrix. This technique coupled with the new algorithm would increase the image position error determination from 300 to 12,000 times/sec, while increasing the precision by a factor of four.

IMAGE MOTION ESTIMATION USING OPTICAL FLOW TECHNIQUES. *Kumar Subramani, E. T. Ososanya, and P. K. Rajan, Tennessee Technological University, Cookeville, Tennessee.* Estimation of the motion of an object from a sequence of images (image motion estimation) finds application in a number of areas such as image compression, target tracking, data acquisition, and computer vision. In the literature, a number of algorithms for image motion estimation have been proposed. A recent study compared the performance of four different techniques (differential, region-based matching, energy-based, and phase-based methods) which are used in motion estimation and concludes that the energy-based method is the best. The problem with the energy-based method is that one needs more number of image frames to estimate the motion than for the region-based method which requires only two consecutive frames. In the present study, we implement a hierarchical computation algorithm for determining the displacement vector using the matching technique. Two different match measures (mean normalized cross correlation and sum of square difference) are used for the purpose of comparison and performance evaluation. To reduce the computation time, Gaussian and Laplacian pyramids are used and a coarse to fine matching is performed. By representing the motion sequence as a three-dimensional pattern in x - y - t space, two separate spatio-temporal plots are obtained. Passing the spatio-temporal plots over a set of energy cells arranged in a pattern, the motion is detected based on the energy output of the cells. Different channels are employed to detect the motion in different directions. VLSI implementation of the image-motion estimation algorithm on a single chip also is considered.

PROGRAMMABLE LOGIC CONTROLLER, THE WORKHORSES OF FACTORY AUTOMATION. *Chin-Zue Chen and Adel Salama, Austin Peay State University, Clarksville, Tennessee.* Top-quality manufacturing performance is basic to the economic and social well-being of our nation. Manufacturing creates two-thirds of our nation's basic wealth, increases the standard of living, and improves quality of life. Flexible automation has been a trend in manufacturing industries for more than a decade. Programmable Logic Controllers are at the forefront of manufacturing automation. Many factories use Programmable Logic Controllers to cut production costs or increase quality. Programmable Logic Controllers and their unique language are the workhorses of factory automation. Thus, engineers, technologists, and technicians working in a manufacturing environment will at least encounter Programmable Logic Controllers; many will use them on a regular basis. Achieving high manufacturing performance by educating engineers, technologists, and technicians also will increase the excellence, capability, and relevance of manufacturing technology.

CYLINDER WAKE FLOW MEASUREMENT BY SEVEN-HOLES PITOT TUBE. *Russell M. Duke* and J. D. Mo, The University of Memphis, Memphis, Tennessee.* Accurate detailed descriptions of the velocity field for complex fluid dynamics problems has been an aspiration of scientists for decades. Either the magnitude or the direction of a flow field can be obtained by a variety of experimental techniques, but the combination of magnitude and direction to obtain velocity was tedious. A single procedure has been developed that incorporates a seven-hole pitot tube to accurately determine the velocity field. This procedure involves using the seven-hole pitot tube to measure several pressures where a velocity vector is desired. The velocity can be determined mathematically from the pressure readings. This procedure was implemented to successfully show the velocity field for the wake of a cylinder and to validate previously published numerical results of a cylinder's wake while being influenced by a rear stagnation jet.

TREATMENT OF SYNTHETIC PRESSURIZED FLUIDIZED-BED HYDRORETORTING LIQUID WASTE USING ROTATING BIOLOGICAL CONTACTERS. *John Thomsen* and Richard W. Lowhorn, Tennessee Technological University, Cookeville, Tennessee.* The pressured fluidized-bed hydroretorting (PFH) process was developed by the Institute of Gas Technology to improve the production of hydrocarbon fuels from the hydrogen-deficient oil shales of the eastern United States. A by-product of this process is a liquid waste that includes compounds that have been listed as hazardous by the United States Environmental Protection Agency. Earlier research has shown that the major constituents of the PFH liquid waste are phenol, aniline, acetone, propionitrile, pyrrole, methyl ethyl ketone, 4-methyl pyridine, and thiocyanate. The purpose of this study was to evaluate the use of a rotating biological contactor system to treat a synthetic PFH liquid waste. This project used a four-stage rotating biological contactor at different loading rates. A comparison of the change in the concentration of these constituents relative to the COD in each stage also was made. The loading rates used were between 5.29 and 11.53 g COD/day \cdot m². Thiocyanate was the constituent most resistant to degradation, being selectively inhibitory to its own degradation at loadings between 1.23 and 2.25 g SNC/day \cdot m². The other constituents were effectively removed up to a loading rate of 13.94 g COD/day \cdot m². At this loading rate and above, the pyrrole and aniline indicated a resistance to biodegradation in the four-stage rotating biological contactor unit.

CALCULATION OF THERMODYNAMIC PROPERTIES FROM MONTE CARLO EVALUATIONS OF THE CONFIGURATION INTEGRAL. *Patricia J. Dycus* and David W. Yarbrough, Tennessee Technological University, Cookeville, Tennessee.* The partition function is the basis for a large part of statistical thermodynamics and the calculation of thermodynamic properties. The configuration integral is the part of the partition function that is density dependent. The configuration integral is being evaluated using a Monte Carlo method applied to collections of molecules with intermolecular forces described by the LJ 12-6 function. The partition function is then calculated as a function of temperature and density, thus, permitting the calculation of thermodynamic properties. Results obtained for simple molecular systems compare favorably with known property information. This type of molecular simulation can be performed on the current generation of personal computers and be adapted for use on parallel processors.

SIMPLE TURBINE MIXING EXPERIMENT: UNEXPECTED RESULTS. *J. Richard Booth and Jill Halter*, Tennessee Technological University, Cookeville, Tennessee.* The agitation and blending of fluids in mixing vessels and reactors is frequently used to improve heat and mass transfer or to disperse constituents of liquid-phase systems. For a baffled mixing tank, the power requirement for the agitator is defined by the type of impeller, the power number, and the Reynolds number. In a series of mixing experiments, the dimensions of the mixing vessel, six-bladed turbine impeller, and baffles were unchanged. Water, propylene glycol, and corn syrup were used as experimental fluids. Using each of these fluids, the rotational speed was changed while the torque was measured to determine the influence of rotational speed and fluid viscosity. When the power and Reynolds numbers were computed from the torque, fluid viscosity and rotational speed the power-Reynolds number plots formed a distinct curve for each fluid rather than a single general curve.

AN APPROACH FOR RESCHEDULING IN HETERARCHICALLY-CONTROLLED FLEXIBLE MANUFACTURING SYSTEMS. *A. Saad and A. Salama, Austin Peay State University, Clarksville, Tennessee.* This is an extension of our previous work on heterarchical scheduling for small to medium batch size flexible manufacturing

systems. The approach is based on our decentralized control architecture where machines and products in the manufacturing system are represented by autonomous agents that interact via a bidding scheme, based on the contract net protocol, in order to achieve production planning and scheduling. The performance of the originally proposed approach has been evaluated via modeling and simulation of a job shop. The bidding scheme has been contrasted to dispatching rules that are typically used in such manufacturing systems. It was proven to yield better performance for the manufacturing system under consideration when production reservation is utilized and when it is augmented by dispatching rules. Our current work enhances production reservation to incorporate rescheduling at the machines during the initial scheduling phase. In addition to the original production-reservation schedule, a machine quotes back to a part the best possible times to finish its processing when rescheduling of existing parts reservations (i.e., reserved capacity) is considered. In order to achieve that, each machine negotiates with the parts in its reservation list in order to allocate capacity for the new incoming part. The parts in turn can agree to be rescheduled within their operational windows, that are based on their remaining operations slack times, and still be guaranteed deliveries by their due dates. Hence, this approach enables the system of being more dynamic in accommodating new orders for production, therefore, increasing the productivity of the manufacturing system under consideration. Another important advantage is achieving such an increase while striving to guarantee its existing production commitments, therefore, avoiding any penalties for late products deliveries.

THE SECOND HARMONIC GENERATION IN SEVERAL MATERIALS. *Xiaoli Hou* and Corinne Darvennes, Tennessee Technological University, Cookeville, Tennessee.* Second harmonic generation was measured experimentally in several man-made materials for possible application of nonlinear properties to nondestructive testing. The experimental results were compared to theoretical results. Samples included two thicknesses of CAPEEK composite, three types of concretes, and plywood. Steel and aluminum specimens were used as references. A monochromatic ultrasonic signal was sent into each sample via a contact transducer placed on its top surface. The growth of second harmonic was recorded, with a second transducer placed on the bottom face, as the amplitude of the input signal was gradually increased and for several values of the input frequency. Nonlinearity parameters could not be measured, due to the limitations of our equipment. The two composites were much more nonlinear than the metals. The concretes and the wood were extremely absorptive, and an output signal was observed only at the lowest input frequency. Experimental results were in good agreement with the theory except for the effects of absorption, and third harmonic growth was observed in one of the concrete specimens. (Poster)

DESIGN OF A MODELING PARADIGM FOR PRODUCT DEVELOPMENT PROCESS. *Kenneth R. Currie, Venkat Balakrishnan, and Karthik Subbiah, Tennessee Technological University, Cookeville, Tennessee.* Engineering design is an information-intensive process. Complex engineering design projects that involve numerous teams are faced with communication and coordination problems. Engineers make extensive use of their past experiences and the design results of other team members. Capturing design information and making it available to all engineers during design processes is very important. The ability to effectively communicate and share the design information can enhance coordination and design efficiency by reducing delays and improving decision-making. The purpose of our study is to develop a tool that will allow design teams to share information, utilize a database of "lessons learned" from previous designs, and study the cost impacts of decision-making. This tool, called Electronic Engineering Design

Notebook will be created in Lotus Notes. Lotus Notes is a rich client/server application development tool that supports collaboration among the different users. (Poster)

MATHEMATICAL MODEL OF CEREBRAL BLOOD FLOW DURING DEGREES OF CEREBRAL VASCULAR DILATION. *Jin Ye* and Michael L. Daley, The University of Memphis, Memphis, Tennessee.* Increases of arterial carbon dioxide pressure (PCO_2) induce dilation of the cerebral arterial vasculature and a systematic change in the intracranial pressure waveform. During normocapnia, the intracranial pressure and arterial pressure recordings are not similar and are characterized by a low coefficient of correlation. With increasing levels of PCO_2 , the two pressure waveforms become more similar with the correlation coefficient >0.80 for deep hypercapnia ($PCO_2 >80$ mm of Hg). With the use of an electric circuit model of cerebral blood flow, the dose response curve between correlation coefficient and PCO_2 was simulated. By decreasing arterial resistance and increasing the venous drainage resistance into lateral lacunae, a theoretical dose response curve similar to the experimental one was obtained. (Poster)

SIGNAL ANALYSIS METHOD TO IMPROVE RELIABILITY OF FLOW MEASURES OF CONDENSERS AND BOILERS. *Heui Seong Lim* and Michael L. Daley, The University of Memphis, Memphis, Tennessee.* The goal of this research is to use measured signals of flow of condenser and boiler feed pump to develop adaptive techniques to check the accuracy of flow measurement. To achieve this goal, a method of checking the accuracy of flow measurement has been developed. Individual measurement of components of estimated flow were used to generate a theoretical flow signal which was compared to the measured total flow signal by correlation analysis. The cross-correlation function is used to indicate how similar one signal is to another. As the cross-correlation coefficient approaches one, the measured flow signal and the theoretical flow signal are more and more similar to each other. A correlation value >0.95 indicates accurate operation of all flow measures. (Poster)

VARIATION OF LOCAL CHANGES OF PARASAGITTAL BLOOD VOLUME AND INTRACRANIAL PRESSURE. *Jin Zhang*, Erich Wolfe, Henrietta Bada, Charles W. Leffler, and Michael L. Daley, The University of Memphis, Memphis, Tennessee (JZ, MLD), and The University of Tennessee at Memphis, Memphis, Tennessee (EW, HB, CWL).* Because the isosbestic point of HbO_2 and Hb is ca. 810 nm, change in the reflected near infrared signal is approximately proportional to change of blood volume. A near infrared reflectometer using a laser at 820 nm and a photodiode detector circuit was constructed to obtain recordings of local change of cerebral blood volume lateral to and along the sagittal sinus of piglets. Intracranial pressure also was recorded. Correlation analysis was used to evaluate the strength of similarity between change in cerebral blood volume and change in intracranial pressure. During normal vascular tone, local changes of cerebral blood volume were found to have a high correlation with intracranial pressure. During loss of vascular tone, the two signals were found to be uncorrelated. (Poster)

ETHICS IN SCIENCE AND TECHNOLOGY SECTION Rube Prigmore-Torrey, Chair

A SHORT HISTORY OF DISSIDENT SUPPRESSION IN AMERICA. *David K. Hackett, AZ Tech Services, Knoxville, Tennessee.* Certainly paramount is the suppression of the Indigenous People and their human rights. In fact, the whole concept of the American Holocaust is denied and suppressed to this day. How can such cognitive dissidence (pun

intended) exist in the land of the free, where liberty and justice were, if not invented, "perfected" perhaps. Here, we have, perhaps, the greatest paradox of the American Dream: how so much freedom and justice can exist and still be denied to so many powerless citizens. The repression in the early 1970s of the antiwar/Vietnam movement is paralleled by many successful or partially successful dissident movements that have finally captured the masses. These largely successful dissident movements are certainly one face of dissidence. The dead students at Kent State focused the Nation on the suppression of the dissidents in the antiwar movement in the 1970s. However, 350 unarmed men, women, and children slaughtered by the United States Cavalry at Wounded Knee brought no public sympathy in 1890. Therein lies the other face of dissidence. The suppression of unsuccessful and powerless dissidents. The unsuccessful proponents of ideas are perceived as a threat to the powers that be; the powerless, misunderstood, scapegoated, political prisoners, pushing their less than popular ideas against an intolerant and powerful system only to be utterly silenced in violation of all laws enacted to protect them. We do not have to take a stand on the political agendas put forth by any of these dissidents, but we should evaluate the deprivation of human rights and due process of justice that is used to suppress these people and their ideas. Often, the difference between accepting a travesty of justice, or the proper exercise of justice, involves evaluating the media propaganda with critical thinking. Public enemies should be guilty of a real crime, not suspected of harboring threatening ideas, nor framed by mere allegations. A government that will suppress one dissident is a government poised to wield despotic power over everyone's lives. Freedom of expression is the most fundamental of freedoms; lose it and all freedom is as good as gone. Right now, the majority of Americans believe that dissidents are people who once lived in Russia. They live under an illusion of American harmony. The idea that there are American dissidents is nearly completely unknown to them (suppressed from them). This alone speaks to the efficiency of suppression in the United States of America. Most could not conceive that they are participants in the marginalization process that suppresses these American dissidents.

COMPARISON OF ATTITUDES TOWARD ANIMAL USE IN SCHOOL: TENNESSEE AND FINLAND. *David Ekkens and Eero Antikainen, Southern Adventist University, Collegedale, Tennessee, and Iisalmi Junior college, Iisalmi, Finland.* Considerable controversy exists over the use of animals by humans. As interest in this subject increases, educators should evaluate their use of animals in schools. The purpose of this research was to determine the reactions of people in two different countries (Finland and the United States) to the use of animals in schools. We also compared attitudes of people living on farms to those of people living in the city and attempted to determine what factors help form a person's attitude toward animal use. To do this study, we used a questionnaire that asked several questions dealing with the issue. In each area, we received ca. 100 responses (50 farmers and 50 city dwellers). The results and their significance will be discussed.

ETHICAL DIMENSIONS IN VIEWING, PRODUCING, AND INTERPRETING DATA. *Sherwood F. Ebey, The University of the South, Sewanee, Tennessee.* When data is presented graphically, it is possible for the visualization to present a false summary of relationships in the data which are presented truthfully in tabular form. The inclusion of outliers in a regression analysis can misrepresent the strength of the association of the variables in the data. There are ethical issues dealing with outliers. When sample survey data are produced, subjects need to have confidence in the survey process that sensitive data will be kept confidential and that only summary statistics will be made public. Careful attention needs to be paid to the sampling process so that the population which is sampled largely coincides with the population about

which the conclusions are to be drawn. Conclusions in inferential statistics which lead to probability values generally depend on assumptions about the sampling and the design of the experiment or study. It is unethical to use these tools without careful examination of the conditions upon which the statistical argument depends.

ETHICS AND ACCOUNTABILITY: DID I SAY THAT? *Ruby Prigmore-Torrey, Tennessee Technological University, Cookeville, Tennessee.* At this point in time when information access is very easy, accountability should be a very recognizable term. It should be a rather familiar word heard in every household. Accountability seems to be associated with financial responsibility only. This is unfortunate, the spoken word requires responsibility also. In the realm of Science and Technology, reporting data inaccurately in making presentations and describing phenomena in words that distort the meaning of what is being described are two examples of the lack of verbal responsibility. Several cases of verbal irresponsibility will be cited along with the effort(s) resulting therefrom.

LANGUAGE SPECIFIC ETHICAL SCENARIOS IN AN INTRODUCTORY COMPUTER SCIENCE COURSE. *Martin Barrett, East Tennessee State University, Johnson City, Tennessee.* The use of ethical scenarios in the computer science curriculum requires knowledge of technical issues in computing and the social impact of those technical issues. In a beginning course, scenarios are limited by the lack of technical knowledge. Because a typical CS-1 course consists predominantly of programming language instruction, an ethics component of the course should reflect that instruction. To that end, a set of computer language-based scenarios has been developed. These use specific language concepts and their possible misuse to engage students in a discussion of the resulting ethical and social implications. Specific questions to be discussed by students in small groups include: possible errors; technical issues, including specific language constructs used; financial responsibilities; ethical responsibilities; social effects; and possible pro-active and reactive strategies for dealing with the issues. Each scenario also places the problem in several different work contexts.

INTERNET ACCESS POLICY: CENSORSHIP AND PRIVACY CONCERNS. *Leslie Campbell Rampey, Middle Georgia College, Cochran, Georgia.* A common assumption among the academic and research communities is that persons in the humanities and the social sciences are the ones who are most affected by the issue of censorship and are more likely to be the ones in the forefront of any battle involving it. In many instances, that assumption holds true. Those in the scientific community, however, need to remember that, historically, they have not been immune to censorship. Now, the Internet, with its unprecedented free flow of two-way information, is bringing and will continue to bring the issue of censorship into the public spotlight. The stated targets might not be in those in the scientific community, but the fluid, seamless nature of the Internet makes spillover inevitable and brings along with it the concomitant issues of privacy and research independence. These matters are right now between a Federal Court decision and an expected Supreme Court hearing and concern every member of the research and academic communities who depend upon the free and open flow of information to pursue their work.

GEOLOGY AND GEOGRAPHY SECTION

Michael A. Gibson, Chair

TOWARDS A QUANTITATIVE PHYSIOGRAPHIC PROVINCE MAP OF TENNESSEE. *Hugh H. Mills and Mary D. Wilson*, Tennessee Technological University, Cookeville, Tennessee.* The basic

intention of physiographic province maps is to portray the geographic variation of landforms. Most such maps, however, including that for Tennessee, are based on bedrock geology. The assumption is that in an area underlain by certain formations and geologic structures, differential erosion will produce distinct types of landforms. Indeed, as a first approximation, such maps generally are satisfactory. However, they ignore other factors that may be important for landform development, such as the locations of major drainage systems, regional facies variations in formations, and possible late Cenozoic crustal movement. A more precise approach is to derive physiographic maps directly from the topography. We have done this for Tennessee, using measures of drainage density, elevation, relief, slope, and area-altitude distribution for each 7.5 min quadrangle in the State. Maps can be made for each parameter or for combinations of parameters using multivariate statistical techniques.

ORIGIN AND SIGNIFICANCE OF A BARE KARST PAVEMENT, MIDDLE TENNESSEE. *Clay Harris and Phillip Storvik**, Middle Tennessee State University, Murfreesboro, Tennessee. In northwestern Rutherford Co., Tennessee, an unusually large karst pavement occurs at the top of the Ridley Limestone (Middle Ordovician). Consisting of nearly unfractured limestone, practically no soil or vegetation occurs in or on this 1.2-ha site. Structural and sedimentological factors controlled development of this limestone pavement. Centered on a low-slope (2-7°) structural dome, radial drainage over a relatively smooth, impermeable surface provides for rapid run-off of precipitation. This attenuates limestone solution and soil formation. The 100-cm thickness of the uppermost bed (resulting from consistent conditions during limestone deposition) allowed it to resist fracturing and subsequent joint formation. The homogenous texture of its fine-grained biosparites retards chemical and mechanical weathering of the pavement surface. Adjacent areas with thinner beds, more heterogeneous lithologies, and lower slopes display abundant grikes and clints as well as some soil development and abundant vegetation.

DENSITY DISTRIBUTION OF SINKHOLES AND DEPRESSIONS, RUTHERFORD COUNTY, TENNESSEE. *George Rusho* and Clay Harris*, Middle Tennessee State University, Murfreesboro, Tennessee. Rutherford County's Soil Survey contains 79 aerial photographs covering 21.04 km² each. Soil mappers recorded the locations of obvious sinkholes and depressions; they appear on the soil maps and, so, provide an excellent research database. Total sinkholes and depressions equals 5,706 or ca. 24/km². Density ranges from 2 to 271/map. Maximum density is 140 depressions/km². Use of soil survey maps is superior in several ways to other methods of investigating sinkhole density distribution. Alternative land-uses or construction may have since obscured or filled-in many of these features. Recognition of smaller-scale sinkholes, and especially depressions, on aerial photographs is difficult. Sinkholes appear on a topographic map only if their depth exceeds the map's contour interval. Based on field reconnaissance, sinkholes in wooded areas may not appear. Unfortunately, soil maps provide no indication of size, depth, or origin. Ground studies must provide this information.

HYDROCARBONS IN THE AQUATIC SURFACE MICROLAYER: OBSERVATIONS FROM MARINE RESEARCH AND IMPLICATIONS FOR THE FRESHWATER ECOSYSTEM AND ITS ATMOSPHERIC INTERFACE. *Robert A. Sirk*, Austin Peay State University, Clarksville, Tennessee. The aquatic surface microlayer represents a zone of interface between the atmosphere and the surface hydrosphere and is, thus, of crucial importance to atmospheric, hydrologic, and biotic systems processes. When introduced into the aquatic microlayer, petroleum by-product hydrocarbons have the potential to disrupt or halt

critical systemic physical and biological processes. Investigations conducted in marine environments support this conclusion. With the growing popularity of water-based recreation, including petroleum-powered boats and personal water craft, record levels of hydrocarbon are entering freshwater aquatic ecosystems. Little attention has been focused on hydrocarbon-emissions impacts on the freshwater environment, and omnibus environmental policy to regulate these emissions has only recently been formulated. Drawing on literature on marine microlayer ecosystem research and on the author's continuing research, a brief examination of the regulation, impacts, and implications of hydrocarbon-pollution production for the freshwater ecosystem environment are presented.

USING A GASOLINE-CONTAMINATED SITE ON THE CUMBERLAND PLATEAU TO CONDUCT AN INTERDISCIPLINARY SENIOR-LEVEL RESEARCH PROJECT. *Martin A. Knoll*, Karen Kuers, Donald B. Potter, Stephen A. Shaver, and Scott J. Torreano*, The University of the South, Sewanee, Tennessee. Each year the Department of Forestry and Geology at The University of the South, Sewanee, Tennessee, conducts a seminar for its senior majors that is centered around an interdisciplinary field project designed to serve as a culminating "capstone" experience. One of the most successful of these seminars included an investigation of ground water, soil vegetation, and bedrock on a site contaminated by gasoline from a leaking underground storage tank. Working in teams, students were able to establish the vertical and areal extent of the contaminant plume in the ground water and soil, the potentiometric surface and plume migration direction, the configuration of the bedrock and depth to bedrock, and the character of forest vegetation on the site. Results were further integrated to reveal the relationships between contaminant distribution, geology, hydrology, soils, and forest vegetation. Thus, sites of contaminated ground water represent excellent opportunities for conducting multidisciplinary investigative projects for students.

REGULATING THE REGULATORS: A CASE STUDY FOR COERCIVE REGULATION OF THE BOATING INDUSTRY. *Jennifer M. Kocak*, Austin Peay State University, Clarksville, Tennessee. In design regulation must be either coercive or cooperative. Coercive regulation implies strict monitoring programs and penalties for noncompliance. Cooperative regulation implies compromise, with a lack of penalties. Neither design offers a cure-all for insuring environmental compliance, nor are they equally suitable for use across the range of potential applications. In a case study examining the regulations of the Environmental Protection Agency for the boat-manufacturing industry, this controversy is tested in Clean Air Act hydrocarbon-reduction legislation. The Environmental Protection Agency and the boating industry, in a cooperative effort, are attempting to reduce hydrocarbon emissions from outboard motors and personal water craft. This is a long term regulatory effort, and final compliance success or failure must wait for the year 2025. Regulation through cooperation has yielded marginal success results at best. In this case study, reasons for potential failure of this reduction plan are chronicled.

THE MISSISSIPPIAN-PENNSYLVANIAN CONTACT IN MARION AND HAMILTON COUNTIES IN TENNESSEE: EROSIONAL, TRANSITIONAL, OR INTERTONGUEING? *Richard E. Bergenback and Paul C. Van Alstyne**, The University of Tennessee at Chattanooga, Chattanooga, Tennessee. The purpose of this study is to ascertain if the Mississippian-Pennsylvanian contact is unconformable and widespread (over Marion and Hamilton counties, Tennessee) and might be used to mark a sequence stratigraphic boundary in southeastern Tennessee. Raccoon Mountain, Elder Mountain, and Sale Creek basins have been recognized across Marion and Hamilton counties in the Tennessee

Reentrant. Aetna Mountain (Raccoon Mountain) and Signal Mountain highs separate these basins. Two roadcuts (Scratch Ankle Hollow and Pulltight Hollow) and a stream valley (Hugden Branch) present the Mississippian-Pennsylvanian in the Raccoon Mountain Basin, and one roadcut (Elder Mountain roadcut) and one stream valley (Suck Creek) display this systemic boundary in the Elder Mountain Basin. One core log records the contact and overlying stratigraphic units along the southern margin of the Sale Creek Basin. A partial core log shows the contact on the Aetna Mountain High. It is suggested (based on stratigraphic data) that these three basins subsided at different rates and show three distinct sedimentational responses to late Paleozoic crustal loading. The Raccoon Mountain and Elder Mountain basins are likely half-grabens with maximum subsidence along the northeastern edge. The Pennington-Raccoon Mountain contact is not a widespread erosional contact in the Marion and Hamilton county area, within the Tennessee Reentrant, and, thus, cannot serve as a sequence stratigraphic boundary.

A PRELIMINARY REPORT ON THE COMPARISON OF WEST TENNESSEE FLUVIAL DEPOSITS AND THEIR RELATIONSHIP TO THE ANCESTRAL TENNESSEE RIVER. *Robert P. Self, The University of Tennessee at Martin, Martin, Tennessee.* Lithologic comparison of Tennessee River terrace gravels, Hatchie River terrace gravels, and the Claiborne formation (middle Eocene) of southwestern Tennessee suggests lithologic relationship between the older Tennessee gravels and Hatchie-Claiborne gravels. Grain size, skewness, gravel, and coarse pebble-cobble percentages, with chert and quartz content, can be used to divide Tennessee gravels into younger gravels which are coarse grained (4.00 to 3.50 ϕ), negatively skewed with high gravel, coarse pebble-cobble with high chert content and older gravels that are finer grained (-3.05 to -2.90 ϕ), more positively skewed with lower gravel and coarse pebble-cobble percentages along with high quartz content and very low chert content. Hatchie and Claiborne gravels lithologically resemble older Tennessee terrace gravels. Preliminary results suggest that a river with Appalachian sources, possibly the ancestral Tennessee River flowed through the Hatchie Valley as early as Claiborne (middle Eocene) time. Hatchie terraces and Claiborne gravels were contemporaneous or derived from older Tennessee River terrace gravels which may be as old as middle Eocene.

PLANKTONIC FORAMINIFERAL BIOSTRATIGRAPHY OF THE EOCENE-OLIGOCENE BOUNDARY SECTION AT PERDUE HILL, ALABAMA. *Leif E. Christensen* and Daniel L. Frederick, Austin Peay State University, Clarksville, Tennessee.* The Paleogene section at Perdue Hill, Alabama, is examined using planktonic foraminifera to determine the location of the Eocene-Oligocene boundary. The lithostratigraphic units exposed include the Pachuta Marl, Shubuta Clay, Bumpnose Limestone, and Mariania Limestone. The boundary between the Jacksonian and Vicksburgian stages generally is placed at the contact between the Shubuta and Bumpnose. Correlation between this boundary and the global planktonic zonation of the Eocene-Oligocene boundary has been disputed. The section has an abundant well preserved planktonic foraminiferal fauna. Preliminary analysis indicates a close correspondence between the Jackson-Vicksburg boundary and the global zonation scheme. The abundant and well reserved micro- and macrofauna of the section make it ideal for comparison of the biostratigraphic zonations in the eastern Gulf coast and western Gulf Coastal. Those of the eastern region are based largely on macrofossils and those of the western region based on planktonic foraminifera.

CHOOSING A STATE FOSSIL FOR TENNESSEE: CONSIDERATION AND CHOICES. *Lee Bacon*, Lisa Adamo*, Adreonna Daniel*, Linda Martin, Cinthia Eichhorn*, Stacy Mayse*, Amy Robinson*, Jason White*, J. D. Wildharber*, and Michael A. Gibson, The University of Tennessee at Martin, Martin, Tennessee.* A state symbol represents many facets of a state. Among Tennessee's many official symbols are the tulip poplar (*Liriodendron tulipifera* L.) as the state tree, the mockingbird (*Mimus polyglottus*) as the state bird, and limestone and agate as the state rocks, but, unlike 31 other states, Tennessee lacks an official state fossil. The University of Tennessee at Martin GeoClub is working with Representative Roy Herron to identify and establish a fossil which represents Tennessee's paleontological history. Ten fossils have been identified with each fossil chosen based on its significance to Tennessee. Criteria used to identify a state fossil include common or rare occurrence, ease of identification, ease of finding, scientific importance, aesthetic appearance, significance of the enclosing rock unit, distribution across the state, history of collection, and geologic range. One will be elected by interested Tennessee citizens to represent Tennessee, and legislation will be introduced to General Assembly to establish Tennessee's state fossil symbol.

FIRST RECORD OF TRILOBITES FROM THE ST. LOUIS LIMESTONE (MISSISSIPPIAN: MERAMECIAN) OF TENNESSEE. *Katherine S. DeWein and James X. Corgan, Clarksville High School, Clarksville, Tennessee, and Austin Peay State University, Clarksville, Tennessee.* Two pygidia provide the first record of trilobites from the St. Louis limestone (Mississippian: Meramecian) of Tennessee. Discoveries were made in the uppermost beds of the formation near Ringold Creek on, and just north of, 101st Airborne Parkway in Clarksville, Tennessee. Both specimens belong to the same species of the genus *Paladin*. At 11 mm in length and width, the species has 15 axial rings, with the first four sinuous, and 10 pairs of pleural ribs, with anterior pairs bearing a pleural furrow. The border zone is constant in width. Pleural ribs stop before reaching the end of the axial lobe. The doublure has many terraces. This new taxon is most comparable to *Paladin girtyana*. Lack of a cephalon precludes naming the species.

A STATISTICAL ANALYSIS OF TENNESSEE TOPOGRAPHY. *Mary D. Wilson* and Hugh H. Mills, Tennessee Technological University, Cookeville, Tennessee.* A statistical analysis of Tennessee topography has been conducted, using the 7.5-min quadrangle as the basic unit. Drainage density was measured on paper maps by means of the intercept method. Other parameters were determined from available digital elevation grids for 1:250,000-scale maps. These grids were subdivided into 7.5-min blocks, each of which was then analyzed separately. Computed parameters included mean elevation, minimum elevation, maximum elevation, coefficient of variation of elevation, relief, mean slope, maximum slope, coefficient of variation of slope, and the hypsometric integral. Maps were then plotted showing the distribution of values for each parameter. Values for the majority of parameters show geographic consistency. Low values of the hypsometric integral, for example, nicely coincide with the Central Basin. Drainage density is relatively high in the western Central Basin and Western Highland Rim, and low in the eastern Central Basin, northern Western Highland Rim, and Eastern Highland Rim. (Poster)

HISTORY OF SCIENCE SECTION

Philip Jack Lorenz, Jr., Chair

LIFE ON MARS: A CENTURY AGO. *George E. Webb, Tennessee Technological University, Cookeville, Tennessee.* The recent announcement of the possibility of primitive life forms in the distant Martian past

has attracted significant interest. A century ago, the possibility of life forms on Mars also was a topic of considerable interest, largely because of the work of Percival Lowell (1855-1916). Having established an observatory in Flagstaff, Arizona Territory, to observe Mars during its 1894-1895 opposition, Lowell purchased a large refracting telescope and moved his observatory to Mexico 2 years later. He and his assistants continued their observations of the planet's surface, expanded their large collection of drawings, and mapped the "canal" network that was the most dramatic result of the Lowell Observatory's research program. By the end of this second observing season, the idea of a vanished Martian civilization with engineering capabilities had emerged as a topic of great interest and notable influence.

GEOLOGY AT THE UNIVERSITY OF THE SOUTH: A LONG TRADITION REESTABLISHED. *Donald B. Potter, Jr., The University of the South, Sewanee, Tennessee.* Geology has been part of the modern curriculum at The University of the South, Sewanee, Tennessee, since 1977 and is taught by three faculty members in the Department of Forestry and Geology. The subject has a venerable tradition in the University's early history and was offered as a course of study from 1872 until 1923. Geology first offered by Professor John B. Elliott, who also taught chemistry and was considered by many to be one of Sewanee's most inspiring teachers. After a semester of Historical Geology and Geological Dynamics and a semester on the Chemistry of Minerals, his students received a School of Geology and Mineralogy diploma. By 1877, the Sewanee Calendar listed references in geology that included Lyell's *Principles of Geology and Antiquity of Man*, Dana's *Manual of Geology*, and Geikie's *Great Ice Age*. A remarkably clear set of William B. Naut's fieldwork. The next year, botany and zoology appeared in the University curriculum. Elliott left for Tulane in 1885, and, after temporary replacements, he was succeeded by Professor Piggot in 1887. Piggot, who survived a disastrous fall from the local bluff in 1898, was Professor of Chemistry and Geology until 1911. He offered two courses in Mineralogy (Crystallography and Descriptive) as well as a general geology course. Piggot was followed by professors Raymond and Mackall. Raymond's geology course concerned the earth "purely as a planet." The history of organic life was left to biology, "to which this course forms ideally the introduction." Geology and Mineralogy continued to be offered from 1915 through 1923 although no professor is listed in the Calendar except T. L. Bailey in 1917. After 1923, when three semesters in geology were offered at the elementary level, geology disappeared from the college curriculum for a span of 44 years. Forestry, established as a discipline in 1923, became an interdisciplinary department with the inclusion of geology in 1977.

SCIENCE/TECHNOLOGY/SOCIETY AND THE BIRTH OF STANDARD TIME. *Noojin Walker, Austin Peay State University, Clarksville, Tennessee.* Until the late 19th century, each municipality and railroad was free to establish its own local time. Wisconsin, for example, had 38 local times and six railroad times. However, astronomical and meteorological research required simultaneous data collections with a common time for safety and efficiency. The interstate traveler was caught between 40 different railroad times and 400 different local times. Technology in the form of the telegraph, however, now permitted correct time to be announced instantly and accurately over great distances. An international conference of delegates agreed to a time proposal for 24 time zones separated by 15° with the prime meridian at Greenwich. They disapproved the decimalization of time, and the a.m. hours being represented by numbers 1-12 and the p.m. hours by the letters A-L. In November 1883, the majority of the world voluntarily changed to what is now known as Standard Time. The United States established its four time zones.

CONSULTING GEOLOGY IN ANTEBELLUM TENNESSEE. *James X. Corgan, Austin Peay State University, Clarksville, Tennessee.* Before 1861, many geologists from other states worked as consultants in Tennessee. About 16 can be identified. They worked for copper, zinc, coal, and stone companies. At least two Tennessee geologists consulted in other states. The exchange made Tennessee geology more cosmopolitan and enriched the local geological literature. Use of consultants helped fuel industrial growth that produced some ethical problems. In Tennessee, there was at least one fraudulent mineral prospect. Also, one company report was probably not written by the famous scientists whose names are on the title page. Still, there is no proven wrong doing by any Tennessee consultant. At the state level, consultants did much that was positive.

MARIA MITCHELL AND THE ANNULAR SOLAR ECLIPSE OF 1831. *Philip Jack Lorenz, Jr., The University of the South, Sewanee, Tennessee.* Maria Mitchell was America's first woman astronomer. From 1865 to 1888, she taught astronomy and directed the observatory at Vassar College. The Maria Mitchell Observatory was established in 1908 to foster her research and educational goals for women in astronomy. Her career began in 1831 at her home on Nantucket Island when, at the age of 12, she assisted her father, William Mitchell, in observing an annular solar eclipse. A journal prepared by Mitchell for his public school students included calculations and eclipse data. A computer planetarium program simulating the historic eclipse sky of 12 February 1831 was used to confirm the accuracy of their results.

HIGHLIGHTS OF THE EVOLUTION-CREATION DEBATE LEADING TO THE DARWINIAN DEMISE. *Robert H. O'Bannon, Lee College, Cleveland, Tennessee.* While no one can deny the enormous impact Darwin's theory of evolution has had upon our modern society, it can and should be denied that his theory deserves to be regarded as a principle of science that has successfully met science's own rules for establishing validity. Chemical evolution from nonlife to life has not been observed. The emergence of a protocell into a functioning living cell has not been observed with or without intelligent human intervention nor have prokaryotes been shown to produce eukaryotes. The hypothesized millions of transitional forms between the major phyla are yet to be discovered in either fossils or living species. Punctuated equilibrium, supposedly based upon observation, has not and perhaps cannot be validated as the source of life's immense variety. In the absence of validating evidence, Darwinism needs to be re-thought or the discipline of science should be redefined.

MATH AND COMPUTER SCIENCE SECTION

Martin L. Barrett, Chair

ORTHOGONAL L1 REGRESSION. *David Paul Dwiggin, The University of Memphis, Memphis, Tennessee.* Given a set of data relating variable quantities, the method most often used to estimate a linear relation between them is the determination of a least squares regression line. This method will often suffice if one of the quantities has its values set or known with some precision by the observer. However, if both variables have comparable uncertainties in their observed values, an orthogonal regression technique is preferred. While orthogonal least squares regression can give an improvement over ordinary least squares regression, there is still the disadvantage that any least squares line is easily affected by the presence of outliers, which are often more easily detected using least absolute deviation regression techniques. The purpose of this discussion is to present an algorithm which calculates a regression line based on the combined concepts of orthogonality and least absolute deviation.

AN ELEMENTARY PROOF THAT $Y = E^X$ IS THE SOLUTION TO THE IVP $Y' = Y$, $Y(0) = 1$. **James B. Hart**, *Middle Tennessee State University, Murfreesboro, Tennessee*. In this presentation, I show that one can prove rigorously to Calculus I students that there is exactly one function $y = f(x)$ which is defined for all real x and satisfies the initial values problem $y' = y$, $y(0) = 1$, namely $y = e^x$. This proof uses only the first and second derivative tests, a basic understanding of continuity, and two simple limits involving natural logarithms.

ALMOST WEAK CB SPACES. **John J. Schommer**, *The University of Tennessee at Martin, Martin, Tennessee*. Realcompact spaces are those in which every zero-set ultrafilter with the countable intersection property is fixed. The real line is an example of a realcompact space. One way to naturally generalize the concept of realcompactness is to replace the zero-sets of that definition with the supports of continuous functions. At present, this form of generalized realcompactness is called almost* realcompactness. In this context, the property of almost weak cb can be thought of as a topological property which, when added to almost* realcompactness, will guarantee ordinary realcompactness. Several alternative characterizations of almost weak cb spaces will be given as well as some interesting but unproven conjectures. This work extends that done by Nancy Dykes in the late 1960s.

PRELIMINARY RESULTS ON INDUCED-PAIRED DOMINATING SETS. **Daniel S. Studer***, **Teresa W. Haynes**, and **Linda M. Lawson**, *East Tennessee State University, Johnson City, Tennessee*. A set S is a dominating set for the graph $G = (V, E)$ if every vertex in V is either in S or adjacent to a vertex in S . We say that a dominating set S is a union of complete graphs on two vertices. Not all graphs have induced-paired dominating sets. Characterizations of cycles, paths, caterpillars, and k -ary trees having induced-paired dominating sets are presented. We also give bounds on the order of a smallest induced-paired dominating set for each of these graphs.

A GENERALIZATION OF FERMAT'S LITTLE THEOREM. **Den-nis P. Walsh**, *Middle Tennessee State University, Murfreesboro, Tennessee*. Fermat's little theorem states that $a^p \equiv a \pmod{p}$ for any prime p and any integer a . Upon considering a^p as a polynomial in a of degree p , I pose and answer the following question: is there a larger class of polynomials whose members satisfy a divisibility result similar to that of Fermat? My affirmative answer relies on polynomial families that satisfy a binomial expansion which mimics the familiar binomial theorem. I provide several examples of polynomial families with this binomial property, then prove a generalization of Fermat's result, namely, $a^{a^p} \equiv a \cdot 1^{a^p} \pmod{p}$, where a^{a^p} represents a member of such a polynomial family.

DIRECT ESTIMATION OF PARAMETERS IN A MODEL FOR WATER FLOW IN SOILS. **Jan C. Zijlstra**, *Middle Tennessee State University, Murfreesboro, Tennessee*. Flow of water in unsaturated soils can be described by Richards' equation. The coefficient functions of this partial differential equation are highly nonlinear. In practice, these coefficients are modeled using functional expressions which contain a number of unknown parameters. The inverse problem in this setting consists of the identification of these hydraulic parameters in order to calibrate the model. The usual parameter estimation procedure is computationally expensive because it requires solving the equation iteratively. Moreover, the procedure requires exact specification of the boundary conditions for the problem. The current study focuses on estimating parameters based on simulated values of in situ water content measured at various times and depths. Rather than solving the equation iteratively, the derivatives that occur in the PDE are approximated by those of interpolants fitted to a set of water-content data. The method

successfully identified parameters in hypothetical soils without specification of boundary conditions.

USING JOINT APPLICATION DESIGN THROUGHOUT THE LIFE CYCLE. **Vikas Bagga*** and **Martin L. Barrett**, *East Tennessee State University, Johnson City, Tennessee*. The joint application design method has been used effectively to gather requirements for software projects. A joint application design session brings together developers and users in order to specify a project through consensus decision-making. While joint application design has been suggested for use as an aid to software design, it has been limited in practice by the lack of a clear role for users. This work investigates whether joint application design can be applied to the high-level design phase. Users can contribute to verification of requirements during a session, acting as an informal quality assurance team. They can clarify any misunderstandings that designers have about the requirements and ensure that all project functionality is translated into specific design constructs. The joint application design session leader must prepare carefully for the session to make clear the participants' roles and enable the production of a viable design document.

USING OBJECTS EARLY IN CS1. **John D. Chenoweth**, *East Tennessee State University, Johnson City, Tennessee*. The Department of Computer and Information Sciences at East Tennessee State University, Johnson City, Tennessee, made the transition to C++ and object-oriented programming in Fall 1995. One primary goal in developing the course was to not teach our students the procedural approach to problem solving first and then retrain them to use the object-oriented approach. We have done this by introducing students to objects within the first 4 weeks of the semester. One difficulty is that most books do not work with user-defined classes until approximately the eighth chapter. This requires the development of many handouts for covering classes early in the semester, because the materials in the later class chapters contain code that the students will not learn until at least halfway through the course. The presentation will include a discussion of the course and problems experienced. Handouts will include course contents, early class examples, and programming assignment examples.

VISUALIZATION OF REUSABLE SOFTWARE. **Akintunde Omitowoju*** and **Martin L. Barrett**, *East Tennessee State University, Johnson City, Tennessee*. With the current rates of growth of software, reusable software components have become the focus of many software companies. The main problem in the area of reusable software components is to represent the reusable aspects. Two technical approaches, parts-based and formal-language based, have been used to try to represent or categorize which software components will work together and, thus, be reusable. The Leo reusability tool takes a different approach to software reusability. It represents the software visually as puzzle pieces with well defined visual cues which give the user information as to the function of the software pieces. These visual cues map software characteristics onto graphical features. The goal of this project is to make quantitative measurements on how visualization could improve the process of evaluating software reusability.

DYNAMIC RESCHEDULING AS THE MEANS TO COPE WITH MACHINE BREAKDOWN IN AGENT-BASED FLEXIBLE MANUFACTURING SYSTEMS. **Ashraf Saad** and **Adel Salama**, *University of Cincinnati, Cincinnati, Ohio, and Austin Peay State University, Clarksville, Tennessee*. This work has been developed within the framework of agent-based decentralized scheduling for flexible manufacturing systems. In this framework, all machines comprising the manufacturing system, and its products, are modeled via software agents that interact dynamically to devise the production schedule. Manufac-

turing environments are prone to operational uncertainties such as variations in processing times and machine breakdowns. In order to cope with these uncertainties, the production reservation-based scheduling algorithm has been extended to perform dynamic rescheduling. Simulation results have been conducted on a job shop model to quantify the performance of the system whenever rescheduling occurs. The resulting multi-agent rescheduling scheme has been shown to result in decentralized control of manufacturing systems that is capable of responding dynamically to such operational uncertainties.

MEDICAL SCIENCES SECTION

Steven M. Wright, Chair

TUMOR NECROSIS FACTOR INDUCTION IN ALVEOLAR MACROPHAGES BY REOVIRUS. *Anthony L. Farone, Middle Tennessee State University, Murfreesboro, Tennessee.* The interactions of viruses with pulmonary tissues is a long-standing concern of biomedical research. Reovirus has proven to be an excellent model of viral pathogenesis and reovirus serotype 3 has recently been shown to induce a prominent inflammatory response in the rat lung compared to serotype 1. The goal of this work is to understand the mechanisms by which serotypes 1 and 3 mediate differential regulation of the inflammatory cytokine, tumor necrosis factor- α in alveolar macrophages. We have shown that serotype 3 stimulates significantly more tumor necrosis factor- α than does serotype 1. Genetic analyses of the two reovirus serotypes have been completed, indicating that the attachment protein, $\sigma 1$, is responsible for serotype specificity. Results from gene reassortment studies suggest that the $\sigma 1$ protein plays an important role in the serotype-dependent tumor necrosis factor- α response. These data support the hypothesis that tumor necrosis factor- α is a contributing factor in the pneumonia caused by serotype 3 in the rat.

DIFFERENTIAL GENE EXPRESSION IN MACROPHAGES TREATED WITH REOVIRUS SEROTYPES 1 AND 3. *Thomas H. Rhodes* and Anthony Farone, Middle Tennessee State University, Murfreesboro, Tennessee.* A rat viral pneumonia model using reovirus has recently been developed, in which reovirus serotype 1 Lang and serotype 3 Dearing induce an influx of alveolar macrophages. Neutrophil influx and activation in response to macrophage chemotactic cytokines in pulmonary disorders has given insight into their role in viral pathogenesis. In rats treated with serotype 3, an inflammation characterized by a prominent neutrophil influx following infection results in the lungs; however, no significant neutrophil influx occurs in rats treated with serotype 1. Previous studies illustrate that the alveolar macrophages in rats treated with serotype 3 produce chemokines, MIP-2 and KC, which directly contribute to neutrophil influx. The purpose of this study is to further characterize serotype-dependent mRNA expression in alveolar macrophages that may contribute to the elevated inflammatory response and onset of viral pneumonia in rats treated with serotype 3. Differential display polymerase chain reaction was used to characterize alveolar macrophage gene expression in response to serotypes 1 and 3. Three differentially expressed cDNA segments have been characterized. Experiments are currently in progress to confirm these differentially expressed genes.

CHARACTERIZATION OF REOVIRUS-MEDIATED APOPTOSIS. *C. Brian Manning*, Terence S. Dermody, and Anthony L. Farone, Middle Tennessee State University, Murfreesboro, Tennessee (CBM, ALF), and Vanderbilt University, Nashville, Tennessee (TSD).* Reoviruses are important models for the study of viral pathogenesis in many organ systems. However, the mechanisms by which these viruses produce cytopathic effects in infected cells have not been well defined.

This study sought to test the hypothesis that reovirus infection of the murine fibroblast cell line, L929, induces apoptosis. Cells were treated with reovirus serotype 3 Dearing at a multiplicity of infection of 1,000, and cytopathic effects were observed during a 24-h timecourse by transmission electron microscopy. Results from this study have shown that reovirus serotype 3 did induce apoptotic events in the L929 cells. Studies are currently in progress to characterize the interaction of the rat alveolar macrophage cell line, NR8383, and reovirus serotype 3.

PARTICLES SIZE DISTRIBUTION OF AIRBORNE DUST IN A DEPLETED URANIUM FACILITY. *Michael Jucius, Al Iglar, and R. Dean Blevins, East Tennessee State University, Johnson City, Tennessee.* To evaluate potential for exposure to radionuclides by inhalation, samples of airborne particulate matter were collected from air in the machining area of a depleted uranium manufacturing facility. Data showed particles to be predominantly in the respirable range, including 85% of the mass and 79% of the activity found. An overall mass median aerodynamic diameter of 1.7 μm was found, and the activity median aerodynamic diameter was found to be 0.95 μm . The latter value is only slightly lower than the 1.0 μm used by the ICRP to determine the maximum permissible concentration for uranium.

ANTIBIOTIC RESISTANCE OF *STREPTOCOCCUS PYOGENES*: SURVEY OF A PEDIATRIC POPULATION AND RESISTANCE TRANSFER FROM *STREPTOCOCCUS PNEUMONIAE*. *Christy Huddleston* and Stephen M. Wright, Middle Tennessee State University, Murfreesboro, Tennessee.* Resistance of bacterial organisms to antibiotics has dramatically increased in recent years. *Streptococcus pyogenes* is responsible for many cases of pharyngitis in children. There is disagreement regarding the extent of antibiotic resistance displayed by *S. pyogenes*. Throat cultures were obtained from pediatric patients in Murfreesboro, Tennessee. Upon confirmation of *S. pyogenes*, susceptibility testing with erythromycin, cefaclor, clindamycin, and amoxicillin/clavulanate was done on each individual isolate ($n = 309$). No antibiotic resistance was found; however, there were some intermediate clindamycin samples. An isolate of *Streptococcus pneumoniae* was determined to be resistant to cefaclor and erythromycin. The resistance factor was chromosomal. The chromosome was digested using the restriction enzyme HindIII, and a transformation was performed.

ATTEMPTED ISOLATION OF A BACTERIOPHAGE INFECTING *HELICOBACTER PYLORI* AND EVIDENCE FOR INDUCTION OF AN INFLAMMATORY CYTOKINE BY MACROPHAGES. *Kelly Forrest* and Stephen M. Wright, Middle Tennessee State University, Murfreesboro, Tennessee.* It is estimated that 25 million Americans suffer from peptic ulcers, small craters in the lining of the stomach or the intestines. *Helicobacter pylori* was first linked to ulcers in 1982 when the organism was isolated from human gastric mucosa. Colonization of the digestive tract by *H. pylori* may predispose an individual to ulcer formation. It may be that the induction of cytokines by *H. pylori* results in localized inflammation causing gastric mucosal injury. It has been suggested that transmission of *H. pylori* occurs by fecal-oral means; hence, it would seem likely that *H. pylori* would be present in raw sewage. It is reasonable to assume that where *H. pylori* would be present, so too would bacteriophage using *H. pylori* as host. This study attempted isolation of a bacteriophage infecting *H. pylori* from raw sewage. Additionally, we report that an extract of *H. pylori* induces an inflammatory cytokine by cultured macrophages, providing evidence for potential gastric tissue damage.

SURVEILLANCE FOR THE VECTORS OF LYME DISEASE IN THE UNAKA DISTRICT, CHEROKEE NATIONAL FOREST. *Donna Garland Robbins and Michael David Warren, East Tennessee State*

University, Johnson City, Tennessee, and United States Public Health Service, Crow Agency, Montana. Until a few years ago, most cases of Lyme disease were reported in the northeastern United States. Recently, an increase in cases has been reported outside endemic areas, including Tennessee and surrounding states. The major vectors have been identified as three species of ticks of the genus *Ixodes*. The primary objective of this study was to collect vectors of Lyme disease from sampling sites within the Unaka District of the Cherokee National Forest. Three sampling methods were employed: walking; flagging; trapping. A secondary objective was to evaluate each sampling site based on ecological parameters. None of the major vectors of Lyme disease was collected. Another tick, *Dermacentor variabilis*, was the only species sampled and is responsible for other serious tickborne illnesses. The results indicated that the sampling area is a highly favorable habitat supporting many hosts associated with vector tick populations elsewhere. Periodic tick surveillance is justified, based on the ecological evaluations. (Poster)

MICROBIOLOGY SECTION AND CELL AND MOLECULAR BIOLOGY SECTION

Jon Lowrance, Chair, and John Palisano, Chair

LPS-INDUCED PROTEINS IN *ACANTHAMOEBA POLYPHAGA*. *Nicholas Chim** and *Anthony L. Farone*, Middle Tennessee State University, Murfreesboro, Tennessee. Inflammation caused by Gram-negative bacteria is an area of intense biomedical research. One of the most potent mediators of inflammation produced by these bacteria is lipopolysaccharide which is known to trigger macrophages to produce cytokines that result in inflammation and pathogenesis. Amoeba have been described as free-living macrophages, and these organisms also phagocytize Gram-negative bacteria. The purpose of this study was to test the hypothesis that interaction with purified lipopolysaccharide will stimulate the expression of amoebic proteins. Protein profiles of *Acanthamoeba polyphaga* treated with lipopolysaccharide in saline or saline alone were analyzed by polyacrylamide-gel electrophoresis. Results from this study will, hopefully, lead to a useful model to describe the cellular mechanisms involved following interaction with lipopolysaccharide.

RNA BACTERIOPHAGE BINDING TO F⁺ AND HFR MATING TYPES OF *ESCHERICHIA COLI*. *Thomas H. Rhodes**, *Robert Grammer*, and *Anthony L. Farone*, Middle Tennessee State University, Murfreesboro, Tennessee (THR, ALF), and Belmont University, Nashville, Tennessee (RG). The interactions that occur between viruses and their hosts are currently an area of intense study. This experiment was designed to study the effects of temperature, incubation time, and concentrations of CaCl₂ on the degree of binding of RNA bacteriophage to the F⁺ pilus of *Escherichia coli*. The results demonstrated that the experiment was adequate for the measurement of RNA phage binding to the host bacteria's F-pilus. Optimal centrifugation time was determined for the separation of bacteria and phage after incubation. The results illustrated that 22°C was the optimum incubation temperature, 10 min was the optimum incubation time, and ca. 1 mM CaCl₂ was the optimum concentration for phage binding. Results from these studies will provide further understanding of the initial mechanisms involved during virus attachment.

OCCURRENCE OF *LEGIONELLA* AND AMOEBAE IN MIDDLE TENNESSEERESIDENCES. *Kim Erickson** and *Anthony Newsome*, Middle Tennessee State University, Murfreesboro, Tennessee. Bacteria in the genus *Legionella* are the causative agent of Legionnaires' disease. The occurrence of this bacteria has been documented in residential water

systems in the United States. The ability of *Legionella* to infect certain species of free-living amoebae and multiply intracellularly has been previously reported. The bacteria and amoebae are often associated with structures such as cooling towers and plumbing systems. The presence of free-living amoebae also is a possible public health concern because of the pathogenic potential of some species of amoebae. Tap water of residences in Middle Tennessee was concentrated by membrane filtration and subsequently cultured on media designed to specifically support growth of the organisms. Seventy homes were sampled from December 1994 through November 1995. Of the 70 sites tested, 18% (or a total of 13 sites) were cultured positive for amoebae. Eleven percent of all municipal water samples and 54% of the well-water samples were found to contain amoebae. Only one residence was contaminated by *Legionella* bacteria.

IDENTIFICATION OF *LEGIONELLA* BACTERIA BY IN SITU HYBRIDIZATION. *Reshma Desai** and *Anthony L. Newsome*, Middle Tennessee State University, Murfreesboro, Tennessee. In vitro studies demonstrated that certain members of the genus *Legionella* can use free-living amoebae as a host cell for intracellular replication. Thus, it is likely that *Legionella* use amoebae as a host cell in natural settings. The purpose of this investigation was to develop methodologies that would be amenable to the identification of specific bacteria within recent environmental isolates of amoebae thus demonstrating the naturally occurring intracellular relationship of bacteria. *Legionella pneumophila* was incubated in vitro with amoebae. The bacteria could be specifically identified by in situ hybridization using an oligonucleotide probe coupled to digoxigenin and targeted to the 16S rRNA region of *Legionella*. Specificity of the probe was further confirmed by dot blot hybridization. After hybridization, localization of the probe was made by anti-digoxigenin conjugated with alkaline phosphatase and addition of the substrate. The bacteria were clearly visible within well-defined vacuoles in amoebae. This provides the potential to specifically identify bacteria sequestered within amoebae soon after their isolation from the environment.

GROWTH CONDITIONS ALLOWING FOR EXPRESSION OF TYROSINE DECARBOXYLASE IN *CHROMOBACTERIUM VIOLACEUM*. *Lisa M. Finch**, *J. Matthew Luther**, *Scott D. Holliday**, *Jon H. Lowrance*, and *Kent Clinger*, *David Lipscomb University*, Nashville, Tennessee. *Chromobacterium violaceum* produces a purple pigment called violacein. Tyrosine decarboxylase activity has been demonstrated using acetone powder extracts prepared from *C. violaceum* and quantitated using a Warburg respirometer. Controls included acetone powder extracts prepared from *E. faecalis* and *Staphylococcus aureus*, positive and negative controls, respectively. Growth conditions demonstrated pronounced effects on tyrosine decarboxylase activity and violacein production. Acetone powder extracted from *C. violaceum* grown under static conditions and at pH 5.6, exhibited normal violacein production, and the tyrosine decarboxylase activity was shown to release up to 10 µl of CO₂ from tyrosine in a Warburg respirometer. However, tyrosine decarboxylase was negligible for extracts recovered from *C. violaceum* grown at pH 7.5, with vigorous aeration.

GIARDIASIS IN DOGS: AN EVALUATION OF DIAGNOSTIC TECHNIQUES AND TREATMENT. *Lisa L. Meader**, *Alfred M. Legendre*, and *Sharon Patton*, The University of Tennessee, Knoxville, Tennessee. Fecal samples from 11 dogs with chronic diarrhea were examined using zinc sulfate flotation. *Giardia* cysts were found in nine of the 11 dogs. Samples were tested for *Giardia* antigen using two immunoassays; eight of the nine cyst-positive dogs were positive with Color-Vue ELISA; three of the nine were positive with ProSpect

ELISA. Cyst-negative dogs were antigen negative on both assays. All dogs were treated with Fenbendazole (50 mg/kg/S.I.D/10 days). Fecal samples were examined for 6 weeks. All dogs were negative for cysts and antigen by post-treatment day 4 and remained cyst-negative throughout the study. Antigen was detected in nine and eight of 11 dogs at 2 and 4 weeks post-treatment. All dogs were antigen negative by post-treatment week 6. Fenbendazole was effective in clearing cysts from feces. Positive antigen assays may be false-positives because no cyst was recovered and the assays were negative 6 weeks post-treatment. ELISA tests were not superior to zinc sulfate flotation for diagnosis of *Giardia* in dogs.

ENDOPARASITIC INFECTION AND HOUSEHOLD USE OF GOVERNMENT RECOMMENDATIONS FOR CHOLERA PREVENTION IN TAMAULIPAS, MEXICO. *Charles T. Faulkner*, Benito Borrego, Michael Logan, and Sharon Patton, The University of Tennessee, Knoxville, Tennessee.* In a study of household knowledge of parasitic infection and prevention in Tamaulipas, Mexico, fecal samples from 320 children were examined for diagnostic products. One hundred fifty-two families in 11 communities were represented. Approximately 24% of the children were positive for one or more endoparasitic species. Infections were not associated with the sex or age of the child. Household knowledge and attitudes about infection and prevention of endoparasites and cholera were collected with a structured interview schedule. Cholera-prevention knowledge was found in 90% of the households, and 70% reported frequent use of preventive measures. Household infection status was not associated with frequent use of cholera-prevention recommendations. However, positive households were more likely to believe parasitic infections in children cannot be prevented ($\chi^2 = 3.05$, $P = 0.08$).

SEROEPIDEMIOLOGY OF *TOXOPLASMA GONDII* IN FREE-RANGING WILD HOGS (*SUS SCROFA*) FROM THE GREAT SMOKY MOUNTAINS NATIONAL PARK AND FROM SITES IN SOUTH CAROLINA. *Vina R. Diderrich*, John C. New, Gayle P. Noblet, and Sharon Patton, The University of Tennessee, Knoxville, Tennessee (VRD, JCN, SP), and Clemson University, Clemson, South Carolina (GPN).* The role of wild hogs (*Sus scrofa*) in the transmission of *Toxoplasma gondii* is not fully understood. We tested 108 stored serum samples from wild hogs from the Great Smoky Mountains National Park for antibodies to *T. gondii* using the modified agglutination test. *T. gondii* antibodies were found in 31% (33) of the hogs. Seropositivity was not associated with host factors of sex (males, 37%, and females, 25%) or age (adults, 32%, and juveniles-piglets, 25%). The environmental factor of elevation was not associated with seropositivity. *T. gondii* antibodies were found in 33% of hogs collected at lower elevations near creek beds and in 29% of hogs collected at higher elevations near the Appalachian Trail. A second survey was conducted on 149 stored serum samples from free-ranging swine in South Carolina. *T. gondii* antibodies were found in 37% (55) of these hogs.

EPIDEMIOLOGY OF *TOXOPLASMA GONDII* IN HOGS AND MARKET-WEIGHT PIGS. *Sharon Patton, Jeff Zimmerman, Charles T. Faulkner, Vina R. Diderrich, Peter Davies, and James Kliebenstein, The University of Tennessee, Knoxville, Tennessee (SP, CTF, VRD), Iowa State University, Ames, Iowa (JZ, JK), and North Carolina State University, Raleigh, North Carolina (PD).* To assess the seroprevalence of *Toxoplasma gondii* in swine herds in the United States, sera collected in the National Animal Health Monitoring System survey of 412 randomly selected swine herds in 17 states and from market-weight pigs in Tennessee and North Carolina were tested for *T. gondii* antibodies by modified agglutination test using formalin fixed tachyzoites as antigen.

Titers of 32 or greater were considered positive. Twenty percent (679 of 3,472) of the sows tested were positive. Positive hogs were present in each state except Colorado. Forty-seven percent (195 of 412) of the farms had at least one positive sow in the herd. In contrast, the seroprevalence in market-weight pigs was 3% (12 of 437) for Tennessee and 0.6% (13 of 2,312) for North Carolina. The significance of pork in the transmission of *T. gondii* to humans remains unknown.

A NONRADIOACTIVE NORTHERN ANALYSIS PROCEDURE FOR THE EXPRESSION OF MACROPHAGE INFLAMMATORY PROTEIN-2. *Jamie C. Ellis* and Anthony L. Farone, Middle Tennessee State University, Murfreesboro, Tennessee.* Northern analysis is a sensitive procedure used for the detection of gene expression. Most commonly, complimentary DNA probes labeled with radioisotopes are used for the detection of target mRNA. Radioisotopes are reliable and very sensitive; however, many laboratories are developing alternative strategies because of waste-disposal problems and the health risks involved. One alternative is a procedure that labels the oligonucleotide probe with the protein digoxigenin and utilizes an alkaline phosphatase labeled antibody for detection. This procedure, while not as sensitive as radio-labeled probes, does not involve the disadvantages of radioisotopes. In this study, a nonradioactive detection procedure has been developed to detect specific inflammatory cytokine (chemokine) mRNA expressed by rat alveolar macrophages after treatment with lipopolysaccharide. This procedure will then be used to detect chemokine mRNA expression by macrophages in a model of *Acanthamoeba polyphaga* infection.

HORMONAL EFFECTS ON P-53 AND C-MYC EXPRESSION IN GOLDFISH (*CARASSIUS AURATUS*). *Dana McDonald* and J. M. Redding, Tennessee Technological University, Cookeville, Tennessee.* The ability of various hormones and environmental estrogens to modify p-53 and c-myc gene expression was the focus of this investigation. The c-myc protooncogene and the p-53 tumor suppressor gene encode nuclear phosphoproteins that function as transcription factors and assist in regulating normal cellular proliferation and programmed cell death. Dot-blot and western-blot analysis verified the presence of p-53-like and c-myc-like proteins in liver cells of goldfish (*Carassius auratus*). Western-blot analysis of liver protein extracts for goldfish revealed bands at 82, 70, and 53 KD for p-53 and at 98 and 67 KD for c-myc. Dot-blot analysis of brain, liver, heart, and testis from goldfish showed differences in tissue specificity for both proteins. Liver tissue cultured in media augmented with 10 μ g/ml insulin for 30 min showed increased immunoreactivity with c-myc antibody.

PHYSICS AND ASTRONOMY SECTION

Patricia C. Hull, Chair

THERMAL HYSTERESIS IN THE IMPEDANCE SPECTRA OF APPLES. *Francis X. Hart, The University of the South, Sewanee, Tennessee.* This paper reports the measurement of thermal activation energies for ionic conduction in apples. Two rows of needle electrodes were inserted into a Red Delicious apple. A Hewlett Packard 4192A Low Frequency Impedance Analyzer was used to measure the real and imaginary parts of the electrical impedance between the electrodes at 100 frequencies from 10 Hz to 1 MHz at a given temperature T . The inter-electrode region was modeled as a series combination of a bulk element, an electrode element and a constant resistance R_0 . Each element was represented as a parallel combination of a resistance R and a "constant phase angle element" with an impedance given by $Z^* = A(i\omega)^{-n}$. A complex, nonlinear, least-squares fit to the measured impedances was

applied to obtain the seven parameters of the model at temperature T. Changes in the R- and A-values with thermal cycling up to 42°C indicated the production of thermal hysteresis.

USING MODERN COMPUTER TECHNOLOGY FOR ASTRONOMY RESEARCH AT A SMALL COLLEGE OBSERVATORY. *Douglas T. Durig, The University of the South, Seawane, Tennessee.* Modern technological advances applied to computer-controlled telescopes and electronic CCD cameras have made accessible several areas of astronomical research once reserved for larger observatories. The computer control of the telescope makes locating dim objects much easier, and the CCD camera allows us to record much fainter details. The new equipment is not cheap, but it is affordable to the small college observatory. The specific equipment that I am using is the Meade 12-inch LX-200 telescope and the SBIG ST-6 CCD camera. The three projects that I have assigned my students are searching for supernovae in nearby galaxies, searching for new comets and asteroids, and observing variable stars. Although we may not make any new discoveries during these research efforts, many valuable principles of astronomy, image processing, and, more importantly, scientific investigation in general can be learned in the process.

CHAOS IN HAMILTONIAN COSMOLOGIES. *R. Dwayne Ramey and N. L. Balazs, Tennessee State University, Nashville, Tennessee, and SUNY at Stony Brook, Stony Brook, New York.* In dynamical gravitation, one of the tools used to investigate chaos, the Lyapunov exponent, has appeared to be a coordinate-dependent object. If the Lyapunov exponent is regarded as a valid dynamical object, such dependence is not possible. In the following, the definitions and interpretations needed to rectify this discrepancy for certain hamiltonian cosmologies are given. The key step is a recognition of the need for an invariant evolution parameter in phase space. The new parameterization not only produces a well-defined Lyapunov, it generalizes the hamiltonian form. With the new parameter in place, the system action is re-interpreted as a four-dimensional action without constraint. The "energy" of the system is found to be the cosmological constant. Finally, numerical results for the Lyapunov exponent and the remaining problems with diagnosing chaos in the mixmaster are presented.

ASSIGNMENT OF THE TORSION RO-VIBRATIONAL SPECTRUM OF THE CH₃ ASYMMETRIC STRETCH OF CH₃OH. *Orville N. Bignall and Justin Woody, Tennessee State University, Nashville, Tennessee, and Southern Adventist University, Collegedale, Tennessee.* We present an examination of the methods used in making the first line assignments in the CH-asymmetric torsion ro-vibrational band of the Fourier-transform infrared spectrum of CH₃OH. The agreement with the measured ground state combination differences and the small residuals of the stringent combination loop tests of other excited vibrational bands clearly verified these assignments. The recent work of Li-Hong Xu and coworkers using a jet-cooled beam method also has confirmed these (and other) assignments.

FURTHER X-RAY STUDIES OF PYRAMIDIC LIQUID CRYSTAL, TRIBENZOCYCLONONE (II-9). *M. Sarkar and N. Spielberg, Tennessee State University, Nashville, Tennessee, and Kent State University, Kent, Ohio.* Further x-ray powder diffractometer measurements have been made on compound II-9 of the columnar liquid crystal series of hexaalkanoxytribenzocyclonone. For this compound, the transition temperature between solid and the columnar phases is 26°C. Data have been collected at several temperatures from 24° below to 75° above the transition temperature. We compare results obtained from II-9 with results published for II-10, -12, -13, and -15. Unlike these other compounds in the mesophase, there are three high angle diffraction

lines superposed on the broad hump arising from scattering by the hydrocarbon side chains. This indicates a more highly ordered structure than for the other compounds.

RESEARCH AND EDUCATION AT THE FISK UNIVERSITY CENTER FOR PHOTONIC MATERIALS AND DEVICES. *Enrique Silberman, Fisk University, Nashville, Tennessee.* In 1992, NASA awarded Fisk University (Nashville, Tennessee) a 5-year grant to establish a Center for research and education on photonic materials. Recently, NASA awarded the Center an extension of funding for another 5 years. Presently, materials are synthesized, characterized, and, in some cases, developed into devices with applications in the fields of radiation detectors and nonlinear optical crystals, glasses, and nanomaterials. Graduate and undergraduate students participate in the research during the academic year, and, every summer, a 10-week workshop, with a very rigorous program of study, research, and reporting, is offered to undergraduate students. Details of the research, the workshop, and the outcome of all the activities will be presented.

QUANTUM CONFINEMENT OF InP NANOCRYSTALS IN VYCOR GLASS. *R. Mu and D. O. Hendeson, Fisk University, Nashville, Tennessee.* Sequential ion implantation and the study of quantum confinement are emerging topics in the science fields that will soon prove extremely beneficial to industry. Advancements in the study of these subjects are making way for a more rapid age of technology. Advancements in electropic and optical switching lay wake to these revolutionary experiments. Ways to increase the efficiency of optical transistors are always being explored. One way to bring about such improvements is the study of quantum confinement. A proposed solution to this task was to analyze the transmission of various wavelengths of light through glass with different concentrations of implanted In+P at various temperatures. Our results showed that transmission is independent of temperature only at wavelengths ca. 900 nm.

MODELING ELECTRICAL STIMULATION OF CARDIAC MUSCLE. *David C. Latimer*, Bradley J. Roth, and John Paul Barach, Vanderbilt University, Nashville, Tennessee.* We examined the effects of electrical stimulation of the heart from a bipolar electrode placed within a conductive bath. To do this, we used a mathematical model to simulate the anisotropic electrical properties of cardiac tissue. Our calculations were two- or three-dimensional, and the tissue was assumed to be passive. Two electrode orientations were considered: the electrode axis was either perpendicular or parallel to the tissue. In the two-dimensional perpendicular case, we found strong depolarization of the tissue under the cathode with adjacent regions of hyperpolarization along the tissue surface. In the two-dimensional case, we found strong depolarization under the cathode and adjacent regions of buried hyperpolarization. For both two-dimensional cases, we found the presence of surface effects in the transmembrane potential along the tissue-bath interface and a sharp decrease in the ratio of maximum depolarization to maximum hyperpolarization with increased tissue-electrode separation.

A METHOD FOR IN VIVO DETECTION AND CHARACTERIZATION OF ANEURYSM CLIPS FOR MR IMAGING. *Nathan A. Carter*, William G. Jenks, and John P. Wikswo, Vanderbilt University, Nashville, Tennessee.* Despite its benefits, magnetic resonance imaging is contraindicated in many patients with biomedical implants. Such devices can be affected by the radio frequency fields, magnetic field gradients, or the static magnetic field of a magnetic resonance unit. The extremely strong static magnetic field can cause translational or rotational displacement of a ferromagnetic implant, which can be hazardous if the implant is not well anchored or is in a sensitive area.

Ferromagnetic intracranial aneurysm clips present both of these difficulties. In this study, we use high-resolution SQUID magnetometry to establish a quantitative method for in vivo magnetic detection and characterization of aneurysm clips. The clips were magnetized with an external coil, and the remnant dipole was determined with a scanning high-resolution SQUID system. Using these data, forces and torques in a known field can be calculated, and the detection efficiency and a safety factor can be determined.

EXPERIMENTAL MEASUREMENTS OF MUELLER MATRIX FOR POLARIZED LIGHT SCATTERING FROM MICROSCOPIC ORGANISMS. *Patricia G. Hull, Tennessee State University, Nashville, Tennessee.* The Stokes vector and Mueller matrix formalism is described. This formalism is well suited to the study of the scattering of polarized light. The complete polarization properties of a beam of light is described by a four-element Stokes vector, and the effect of the scattering medium on the incident beam is described by the 16-element Mueller or scattering matrix. The Mueller matrix for a given medium depends on the scattering angle and contains all the elastic scattering information available at a given wavelength on the size, structure, symmetry, orientation, complex refractive index, and ordering of the particles that make up the scattering medium. A brief description of how the Mueller matrix is determined experimentally and analytically is discussed. Comparisons are made between experimental measurements and analytical calculations of the Mueller matrix for latex spheres and for a sample of a common form of bacteria.

EXTRACTING OPTICAL PROPERTIES OF MICROSCOPIC ORGANISMS FROM LIGHT-SCATTERING DATA USING A SIMPLE NEURAL NETWORK. *Dianne McEwen* and Patricia G. Hull, Tennessee State University, Nashville, Tennessee.* A computer-simulated neural network is described that, from its S12 and S34 Mueller matrix elements, identifies the index of refraction of particles in a sample of ocean water. In the Mueller matrix formalism, the polarization states of the incident and scattered light are described by four-element Stokes vectors, and the effect of the scattering medium on the incident beam is described by the 16-element Mueller or scattering matrix. The experimental measurements of the Mueller matrix elements as functions of the scattering angle contain all the information on optical properties, size parameter, and shape of the particles that make up the scattering medium, although it is not a simple task to retrieve it. The pattern recognition and classification properties of an artificial neural network, such as that described here, offer a new and powerful approach to retrieving the information.

MODE SELECTION OF SEMICONDUCTOR LASERS WITH EXTERNAL CAVITY. *Ling Jun Wang and Robert Shaw, The University of Tennessee at Chattanooga, Chattanooga, Tennessee, and Oak Ridge National Laboratory, Oak Ridge, Tennessee.* A serious problem with semiconductor lasers is the well known mode-hopping. To cope with the problem, an external auxiliary cavity, formed between the exit facet of the laser and a reflective surface with low reflectivity in front of the laser exit, can be employed to select the lasing mode. We experimented on a SDL5412 diode laser manufactured by SDL Lasers Company, with a nominal wavelength of 832 nm. The spacing between the diode facet and the reflective surface is variable by changing the voltage across a piezo ring on which the reflecting glass is mounted. Extensive data has been taken on a SDL5412 laser (832 nm) with external cavity. These data have shown two major improvements of laser performance. First, the laser is much more stable against mode hopping. The average tuning range of the selected modes are extended from ca. 0.05 nm to ca. 0.2 nm. Second, the cavity length provides an additional tuning parameter that

allows access to some frequencies which are otherwise inaccessible. The tuning curves of some of the accessible laser modes of SDL5412 made by SDL Laser Company are shown.

MODELING AND ANALYSIS OF TRAPPED ION EXTRACTION. *Vernita D. Gordon*, Alan V. Barnes, Norman H. Tolk, Roscoe E. Marrs, and Dieter Schneider, Vanderbilt University, Nashville, Tennessee (VDG, AVB, NHT), and Lawrence Livermore National Laboratory, Livermore, California (REM, DS).* Lawrence Livermore National Laboratory's Electron Beam Ion Trap (EBIT) is a unique source of slow, very highly-charged ions. Increasing interest in experiments involving ions produced at EBIT and other similar sources motivates development of computer modeling techniques which can be used to study and analyze these sources. These techniques can be used to analyze data gathered from EBIT as well as to suggest design features in future generations of EBIT. At present, EBIT produces ions to be used in surface physics experiments. Ions extracted from EBIT are not very tightly focused, however. Ion spot size is ca. 600 μ . Submicron focusing would have important applications for surface studies. According to phase space analysis of the temperature and size of the ions in the EBIT trap, submicron beam spot sizes should be achievable. Results from using the SIMION software package to simulate ion extraction and focusing are reported. This model examines ions extracted from the EBIT and focused using a variable einzel lens. Simulations and modeling are explained and shown. These results indicate that the position and size of the focal spot of the EBIT-lens system is strongly dependent on the initial energy of the ions and on the voltage imposed on the first set of electrodes; location and size of the focal spot seem to depend only weakly on the voltages imposed on the collector and extractor electrodes. Beam spot sizes were measured using an x-ray technique and compared with simulations developed using SIMION. Preliminary analysis indicates that simulation and experiment are in good agreement. (Poster)

SCIENCE AND MATH TEACHERS SECTION

Deborah Clark, Chair

A REVIEW OF SPECIFIC COLLABORATIVE PROGRAMS IN SCIENCE AND MATHEMATICS. *Martha W. Stratton and Elaine D. Martin, Tennessee State University, Nashville, Tennessee.* Alienation of students from science and mathematics begins as early as the fourth grade. In order to reverse this trend, it is imperative that additional programs are developed and implemented to provide early intervention, enrichment, and a solid foundation for students who choose to major in or pursue careers in science and mathematics. Collaborative programs, those that exist between a funding agency and the public school systems, community or senior colleges, have been developed to meet these challenges. These programs are not limited to the grade-school or high-school levels. They extend to various community and senior colleges around the country. The programs are designed to enhance the knowledge of students in various subject areas or disciplines. This study investigates types of collaborative programs in science and mathematics and the population of students served.

A STUDY OF THE BLOCK-SCHEDULING MOVEMENT IN SIX HIGH SCHOOLS IN THE UPPER CUMBERLAND REGION OF TENNESSEE. *Richard K. Fletcher, Jr., Tennessee Technological University, Cookeville, Tennessee.* One of the latest reform movements to arrive for the secondary schools is known as block scheduling. During the past 4 years, it has been adopted by a plurality of the secondary high schools in Middle Tennessee. The major questions which are addressed in this presentation are related to whether the movement has produced improvement in the schools. A review of the research literature reveals

mixed results with some studies indicating no difference and others indicating slight improvements in achievement. Students and faculty appear to be satisfied with the movement according to the results from a survey of students and teachers in six high schools in the region. The literature review indicates that this also is true of most other schools which have changed to the block-scheduling format throughout the country. School climate seems to be improved with the new scheduling format.

TEACHING INTRODUCTORY BIOLOGY STUDENTS TO THINK AS SCIENTISTS. *Linda T. Collins, The University of Tennessee at Chattanooga, Chattanooga, Tennessee.* Students who take introductory biology courses often think they do not have the background or ability to understand science. I have designed an exercise that allows students to think as scientists. I chose four classic experiments that have had important influence in the field of biology: van Helmont's 1648 experiment demonstrating that plants gain little weight from uptake of soil; Eijkman's 1897 discovery of the cause of beri beri; Hershey and Chase's 1951 identification of DNA as hereditary material; Miller and Urey's 1953 work on evolution of organic molecules. Students work in teams. Teams are assigned one of the four problems. Background information is given so students can design an experiment to investigate the problem. When they are finished, they describe their experiment to the class. After the discussion, I briefly describe the actual experiments. Students learn how scientists think by thinking as scientists themselves.

USE OF IN-CLASS WRITING EXERCISES IN INTRODUCTORY MAJORS' AND NONMAJORS' BIOLOGY CLASS. *Sarah H. Swain, Middle Tennessee State University, Murfreesboro, Tennessee.* In response to the call from the nationwide emphasis, "Writing Across the Curriculum," I have incorporated regular in-class writing exercises into college-level introductory biology courses. Students are expected to apply their knowledge and understanding of biology to questions or scenarios presented by the instructor. Completion of the assignment in class is a condition for credit. Instructor comments are written on each student's work, but no grade is assigned. Comparison of final grade averages of eight writing sections (24 students/section) and eight nonwriting sections showed no significant difference between the two groups. However, a substantial difference in drop-out rate was noted: 27.5% of students in nonwriting sections withdrew from the course; 8.6% of students in writing sections withdrew. In an opinion survey of 124 participating students, 90% responded positively to survey questions concerning the value of the writing exercises to the student's understanding of concepts taught in the course.

ACTION RESEARCH IN FIRST-SEMESTER COLLEGE CALCULUS: DEVELOPING CONCEPTUAL UNDERSTANDING BY WRITING AND TALKING ABOUT FUNDAMENTAL CONCEPTS. *Leslie Aspinwall and L. Diane Miller, Middle Tennessee State University, Murfreesboro, Tennessee.* In far too many classrooms, students who study calculus are either unsuccessful or resign themselves to learning strategies to cope without understanding. Two educators critically examined the role of cooperative group methods utilizing written and verbal expression in mathematics learning. Leslie Aspinwall, as teacher-researcher, taught a section of first-semester calculus at Middle Tennessee State University, Murfreesboro, Tennessee, and Diane Miller served as his critical friend in an "action research" project. Writing tasks, focused on conceptual understanding of fundamental and critical topics in calculus, were assigned to provide students with opportunities to practice communicating their understanding in writing. Students perceived the act of writing and cooperative group learning as worthwhile strategies for promoting conceptual understanding. Although students initially resisted writing about mathematics, by midterm

they asked to continue the writings. The researchers describe the results of this action research project and, from the research, make connections to teaching practices in mathematics classrooms.

HARNESSING THE WILD WORLD OF WEB FOR USE IN THE MIDDLE TENNESSEE STATE UNIVERSITY BIOLOGY CLASSROOM. *Sarah F. Barlow and Glenn McCombs, Middle Tennessee State University, Murfreesboro, Tennessee.* Access to computer technology and its educational advantages is becoming a common thread for teachers and their students, expanding the boundaries of the classroom. In particular, the Information Superhighway and one of its on-ramps, the World Wide Web, has made available an almost limitless resource for facts, opinions, and ideas. These are complete with graphics, animation, videos, and even on-line discussion to promote greater interactivity. With such overwhelming possibilities can one attempt to include the Web's use within a traditional educational forum such as a science discipline? This technology has been incorporated within the framework of introductory and upper-level undergraduate biology courses at Middle Tennessee State University, Murfreesboro, Tennessee. Here, the World Wide Web serves as a supplemental resource to course content. Important aspects include student orientation, practical use for class assignments, student-teacher communication via e-mail, benefits of a course webpage, and cooperative class web project design.

GENETIC ENGINEERING OF A DIFFERENT SORT. *Philip M. Mathis and Deborah C. Clark, Middle Tennessee State University, Murfreesboro, Tennessee.* The introductory genetics course at Middle Tennessee State University, Murfreesboro, Tennessee, is being restructured around an instructional paradigm that emphasizes use of computers, visual media, and investigative laboratory experiences. Laboratory experiences that involve problem solving and that are learner interactive and discovery-oriented have been developed and are being utilized. A Genetics Home Page has been established; useful World Wide Web sites have been located, tested, and catalogued; and computers are being used to provide interactive instruction in addition to tutorial-drill work. Laserdisc and VCR media also are being incorporated to create a media-rich instructional environment to fit the new learning styles of today's student. At present, lecture sessions remain traditional, but future plans call for greater use of PowerPoint technology to add visual interest.

SOCIAL ISSUES AND GENETIC TESTING: A DISCUSSION. *Deborah C. Clark, Middle Tennessee State University, Murfreesboro, Tennessee.* The 20th century has been a time of revolutionary scientific discovery and technological advancement. The field of genetics, in particular, has advanced in the scientific and social arenas. As a result, an understanding of genetic principles alone is no longer sufficient to evaluate this fast-developing field of biology. In my introductory genetics course, I have attempted to introduce students to the bioethical issues surrounding new genetic technologies such as DNA fingerprinting, genetic testing, and the human genome project. I have successfully utilized a discussion forum that allows students to explore a plexus of viewpoints surrounding genetic research. Specifically, students examine the ethical, social, and legal problems that arise from the ability to detect human genetic defects. The discussion format and its implementation in an introductory biology course will be discussed.

THE TENNESSEE JUNIOR ACADEMY OF SCIENCE: A VEHICLE TO ACCELERATE PRECOLLEGE STUDENTS IN SCIENCE. *Jack Rhoton, East Tennessee State University, Johnson City, Tennessee.* The Tennessee Junior Academy of Science is designed to further the cause of science education in Tennessee high schools by providing an annual program of scientific atmosphere and stimulation for capable students. It is comparable to scientific meetings of adult

scientists. The Junior Academy supplements other efforts in the encouragement of able students of science by providing one avenue of stimulation and expression. The primary activity of the Tennessee Junior Academy of Science is the annual meeting held in April each year. Top young scientists throughout the state present papers and exchange research ideas. This session will focus on the activities of the Junior Academy and discuss procedures for student participation.

SCOPES FOR SCHOOLS: RECYCLING "ON TRIAL" AT MIDDLE TENNESSEE STATE UNIVERSITY. *Cindi Smith-Walters and Kim Cleary Sadler, Middle Tennessee State University, Murfreesboro, Tennessee.* Recycling is not limited to aluminum cans and newspaper at Middle Tennessee State University, Murfreesboro, Tennessee. Compound light microscopes formerly used in the Department of Biology have been reconditioned and recycled to K-8 classrooms in Rutherford Co., Tennessee. With funding provided by a Dwight D. Eisenhower Professional Development Grant from the Tennessee Higher Education Commission, staff at the Center for Environmental Education at Middle Tennessee State University established a training and loan program for the microscope, hand magnifier, and microviewers. Over 100 teachers in Rutherford Co. were trained in use of the microscopes in the spring and summer of 1996. The training program included the nature of light, the use of hand magnifiers, and the use of the microviewer with a macrolens attachment. Each teacher also received a 60-page manual, compiled specifically for this training, filled with hands-on classroom activities and teaching materials. As the teachers explored the microscopic world using the manual and the various lenses, they modeled the inquiry strategy they themselves would later use with their own students. A summative evaluation of trained teachers who used the activities and the loan program showed that their students were excited and interested in this activity-oriented program. From the perspective of the teacher, student attitudes toward science as well as interest in science improved. It appears that the "Scopes for Schools" loan program was successful because it was implemented with teacher training and curriculum activities plus ready access to microscopes, hand magnifiers, and microviewers. Teachers can now use "Scopes for Schools" to share the wonder of the microscopic world with our most important asset, our children, in a way that partners creative exploration and sound scientific principles.

DEVELOPMENT AND VALIDATION OF THE MEASUREMENT OF ACCEPTANCE OF EVOLUTIONARY THEORY INSTRUMENT. *Michael Rutledge, Middle Tennessee State University, Murfreesboro, Tennessee.* Teachers' personal views about subject matter have been found to impact their instructional and curricular decisions. Teacher acceptance or rejection of evolutionary theory, then, is potentially important to the role of evolution in the high-school biology curriculum. The purpose of this research was to develop a valid and reliable instrument to assess high-school biology teachers' acceptance or rejection of evolutionary theory. The instrument included 20 Likert-type items that addressed the concepts of the scientific validity of evolutionary theory, available evidence of evolution, Biblical creationism, the evolution of organisms, the evolution of man, the temporal origin of life, acceptance of evolutionary theory among the scientific community, and the age of the earth. Validation of the instrument was through item analysis by a panel of evolutionary biologists, science educators, and a philosopher of science. Reliability of the instrument was determined through the Chronbach alpha method of internal consistency.

THE "THING" THEORY. *Charles R. McGhee, Middle Tennessee State University, Murfreesboro, Tennessee.* What is "theory?" Misunderstanding of the nature of scientific theory and hypothesis abounds. Recent attempts by Tennessee's General Assembly to pass legislation

regulating the teaching of science theory in public schools, and use of the word "theory" reported by the press, support the fact that, not only are scientific theories misunderstood, they are often feared. The general public perceives science theory as little more than "guessing." Valid scientific theories are "predictions of probability" based upon observation. Many years of research may be required to develop valid theories. How can teachers best explain the fundamentals of theory to students? Verbal explanation alone may not be sufficient to impart to students a sense of how theory develops from observation. A simple game has proven to be an effective tool for teaching theory in grades ranging from seven through college science courses. It uses observation, hypothesis, and theorization from facts. It is called *The "Thing" Theory*.

HAVE SPECTROPHOTOMETER WILL TRAVEL. *Gary D. White and Tom Rogers*, Middle Tennessee State University, Murfreesboro, Tennessee, and Georgia Institute of Technology, Atlanta, Georgia.* We have previously used the Daedalon E0-85 Spectrophotometer in the physical chemistry laboratory to acquire emission spectra in the visible region. The instrument contains a charge-coupled-display or CCD detector. Light from a source enters the instrument through a small slit and passes through a lens. A diffraction grating, then, disperses the light onto the detector. The device sends electronic signals to a computer which produces a graph of light intensity versus wavelength. We wondered if this instrument could be made portable and used in the field. We interfaced the instrument to an IBM Thinkpad and acquired emission spectra from various light sources in the area. Details of the experiment and results will be discussed.

CHANGEABLE SILLY PUTTY: AN EDUCATOR'S PERSPECTIVE. *Debora A. Zartman*, Gary D. White, and Judith M. Bonicamp, Middle Tennessee State University, Murfreesboro, Tennessee.* Changeable Silly Putty is one of the many toys currently on the market that contains a pigment that changes color with temperature. We sought to understand how this color change occurs. We monitored the color change with the Shimadzu CS-930 Dual Wavelength TLC Scanner. A thermistor probed the temperature of the sample. We have identified liquid crystals as the primary component responsible for the color change. We did this by isolating the color-changing pigment and examining it under a microscope. We compared our results to liquid crystals from a known sample. As this research project unfolded, we learned about many interesting topics such as color theory, liquid crystals, and solubility. We feel Changeable Silly Putty can be used as a valuable teaching tool.

SELECTION AND EVALUATION OF EXPERIMENTS IN INSTRUMENTAL ANALYSIS FOR SCHOOLS WITH LIMITED INSTRUMENTAL RESOURCES UTILIZING THE INQUIRY-ORIENTED APPROACH. *Penny L. Mauldin* and Linda Wilson, Lee College, Cleveland, Tennessee, and Middle Tennessee State University, Murfreesboro, Tennessee.* The purpose of this study was to develop and evaluate a selection of experiments in instrumental analysis for schools with limited resources. The intent was to develop the experiments so that students could acquire physical skills in working with laboratory instrumentation, study the scientific method, develop critical thinking, and initiate investigation in the laboratory. Six experiments for ultraviolet-visible and gas chromatography were selected for field-testing and evaluation utilizing the Laboratory Structure and Task Analysis Inventory. Results from the evaluation by professors and the field-testing by students indicated an average inter-coder agreement of 85.5% for professors and 90.1% for students. Data from a *t*-test indicated student and professor results were not significantly different from the investigator's results. A test of preference for laboratory type (traditional, combination, or investigative) resulted in students and

professors preferring the combination type experiment with 92.3% of the professors and 69.7% of the students selecting the combination experiment.

APPLICATION OF MATHEMATICAL MODELING THROUGH EXPERIMENTS ON ELECTRICAL CURRENT AND FLUID FLOW FOR SECONDARY SCHOOL STUDENTS. *Deborah J. Hochstein and Michael L. Daley, The University of Memphis, Memphis, Tennessee.* Aspects of engineering science can provide an excellent opportunity for ninth-grade physical-science students to integrate a conceptual understanding of physical concepts and the application of mathematical modeling using methods studied in algebra. The objective of this outreach activity was to introduce students to the analogy between electrical current and fluid flow through the use of observation, measurement, and graphical analysis of Ohm's law for electrical current and Poiseuille's law for laminar flow in fluids. The analogy was demonstrated in terms of the physical quantities to be measured (d.c. voltage, hydrostatic pressure, electrical current, and fluid flow), components with in each apparatus (wires, plastic tubing, and voltage, pressure, current and flow indicators), and mathematical and graphical relationships of the experimental variables. In addition, students observed the breakdown of the mathematical model for conditions on nonlaminar flow. Ten ninth-grade physical-science honors classes, a total of 243 students, participated in the activity. The results of an assessment instrument reveal that the majority of these honor students were able to conceptualize the proportional relationships between the physical variables of voltage and current and pressure and flow as well as analogous components between experimental systems. However, less than the majority demonstrated competency in graphical analysis and quantitative manipulations. These results suggest a need to further develop learning materials which emphasize the study of nature through the application of mathematics and graphical analysis.

ZOOLOGY SECTION

C. Steven Murphree, Chair

DEVELOPMENT OF *RHODNIUS PROLIXIUS* ON MAMMALIAN HOST BLOOD DIET. *David Ekkens, Southern Adventist University, Collegedale, Tennessee.* *Rhodnius prolixus* is a member of a group of obligate, blood-feeding true bugs called kissing bugs (Family Reduviidae, subfamily Triatominae). The gut of a kissing bug typically is inhabited by a group of microorganisms (usually bacteria) that are evidently living there as symbiotes, creatures that get some benefit from the host and, at the same time, help the host. It is known that, without the bacteria, *R. prolixus* fails to complete development on a diet of the blood of certain hosts. The research reported here was done to attempt to shed light on the differences in development.

THE EVOLUTION OF COURTSHIP BEHAVIOR IN *SCHIZOCOSA*: A PHYLOGENETIC ANALYSIS. *Elizabeth Grey* and Gail E. Stratton, Rhodes College, Memphis, Tennessee.* Wolf spiders use overt signals during courtship that may be visual, acoustic or chemical. All species examined to date have unique elements of courtship behavior. For example, *Schizocosa avida* displayed an "extend and vibrate" of the first legs and also a "rapid palpal drumming" during courtship. Our study also looked to define groups of species based on common elements of behavior. We scored 5-min segments of videotaped courtship behavior of 16 species of wolf spiders (13 *Schizocosa* plus one each of *Trochosa*, *Gladicosa*, and *Lycosa*) and found 29 distinct behavioral characters. Computer phylogenetic analyses yielded no single most parsimonious tree nor were the trees congruent with our hypothesized

(intuitive) tree. Courtship behavior appears to be useful in distinguishing species and species groups but not genera. Behavior may be most useful when used in conjunction with other characters (e.g., morphology) to determine phylogenetic relationships.

DISTRIBUTION, HABITAT, AND SUBSPECIFIC STATUS OF *NERODIA ERYTHROGASTER* IN THE LOWER CUMBERLAND BASIN. *Angelo Bufalino* and A. Floyd Scott, Austin Peay State University, Clarksville, Tennessee.* The distribution, habitat, and taxonomy of the plainbelly water snake (*Nerodia erythrogaster*) in the Cumberland River basin of Tennessee and Kentucky are poorly understood. We have attempted to remedy this situation by studying the species along the Cumberland River from Nashville, Tennessee, to its confluence with the Ohio River at Smithland, Kentucky. Preliminary results indicate *N. erythrogaster* occurs regularly in suitable wetland habitats in the floodplain and sparingly in adjacent uplands from Ashland City (Cheatham Co.), Tennessee, to Barkley Dam (Lyon Co.), Kentucky. Up river from Ashland City and down river from Barkley Dam, where floodplain wetlands are more reduced and fragmented and collecting has been minimal, the species has yet to be documented. As previously reported for northwestern Tennessee and the Jackson Purchase region of Kentucky, specimens from Cumberland River appear intergradient between *N. e. flavigaster* and *N. e. neglecta*. However, of the two subspecies, their appearance is most like the latter.

SUMMER FOOD HABITS OF JUVENILE STRIPED BASS, LARGE-MOUTH BASS, AND SMALLMOUTH BASS IN NORRIS RESERVOIR, TENNESSEE. *Brad Tarbert* and J. Larry Wilson, The University of Tennessee, Knoxville, Tennessee.* Of the 135,401 striped bass (*Morone saxatilis*) young-of-year fingerlings stocked in Norris Reservoir (Tennessee), only 106 were recaptured using electrofishing, gill nets, and seines. Food-habit analysis was performed on all striped bass; a representative sample of largemouth (*Micropterus salmoides*, $n = 93$) and smallmouth (*Micropterus dolomieu*, $n = 22$) bass young-of-year also were examined for food items ingested. Midge and mayfly larvae, copepods, and *Daphnia lumholtzi* were the dominant food items found in fish <7 cm in length. Striped bass, largemouth bass, and smallmouth bass utilized fish almost exclusively in their diet after reaching 7 cm. Striped bass attained this length ca. 2 weeks earlier in the growing season than did largemouth bass; smallmouth bass switched to fish ca. 4 weeks after the largemouth bass did. Once on a fish diet, young-of-year striped bass preyed primarily on larval shad (*Dorosoma* spp.). Largemouth bass preyed on shad, bluegill (*Lepomis*), and other largemouth bass while smallmouth bass utilized bluegill almost exclusively.

COMPARISON OF FISH ASSEMBLAGES IN BACKWATER AND CHANNEL BORDER HABITATS OF NICKAJACK RESERVOIR (TENNESSEE RIVER), TENNESSEE. *Jennifer Backer, Mark Schorr, and Ryan Duffy, Tennessee Valley Authority, Chattanooga, Tennessee (JB), and The University of Tennessee at Chattanooga, Chattanooga, Tennessee (MS, RD).* Backwater areas of lakes and rivers provide critical habitat (foraging, spawning, and nursery) for many species of fish. However, there is little quantitative information on fishes in backwaters of the Tennessee River and its impoundments. This study was designed to compare the abundance and structure of fish assemblages in backwater and channel border habitats located in the lower riverine section of Nickajack Reservoir (Tennessee). Fish collections were made every 6 weeks from April to September 1995 by seining (using three techniques) at nine to 15 sites (depending on the technique) in backwaters and along the main channel border. A total of 20 species and 4,838 individuals was collected from backwater sites versus 12

species and 1,095 individuals from channel-border sites. Dominant species (>30% of total) included *Lepomis macrochirus* and *Gambusia affinis* in backwater sites and *Labidesthes sicculus* in channel-border sites. Two-way analysis of variance indicated that mean abundance of fish (number per seine haul) was significantly greater ($P < 0.05$) in backwater sites than in channel-border sites, regardless of the sampling method. Findings from this study indicate that backwater habitat in Nickajack Reservoir supports a relatively high abundance and diversity of fishes. Anthropogenic activities that impact backwater habitat in Nickajack Reservoir (e.g., lake level fluctuation and shoreline and watershed development) could have substantial effects on reservoir fish assemblages.

BEHAVIOR OF MALACANTHUS PLUMIERI (SAND TILEFISH) ON THE BARRIER REEF OF BELIZE. *Diane R. Nelson, Eugenie Clark, and John S. Pohle, East Tennessee State University, Johnson City, Tennessee (DRN), University of Maryland, College Park, Maryland (EC), and Bellvue, Nebraska (JSP).* Widespread in sandy areas of the West Indies, the sand tilefish, *Malacanthus plumieri* (Bloch), builds elaborate burrows and mounds. Its behavior was observed during an expedition to the barrier reef of Belize, near Hat Caye 2, 15-20 January 1995. The research trip was conducted from the M. V. Wave Dancer with underwater observations by scuba divers recording data on slates or with video at a depth of 8.5 m. Ten consecutive observations of 1 min each were made throughout the day between dawn and dusk. Feeding and mound-building activities were recorded after the fish emerged from the burrow and continued until it returned to the burrow near sunset. These activities included "feed/pick," "rubble drop," "rubble place," "visit burrow entrance," and "enter burrow." *M. plumieri* is a monandric protogynous hermaphrodite. A male may have up to seven females in his harem and may mate with each of them daily during the spawning period. Dives were made at dusk to study courtship and mating behaviors, including "looping," "lordosis," "criss-crossing," "paired rises," and "broadcast spawning." Males and females normally maintain separate burrows and also may have alternate burrows.

DIVALENT METAL TOXICITY TO THE JAPANESE MEDAKA EMBRYO IN SINGLE EMBRYO CULTURE. *M. L. Odum*, J. M. Redding, and M. S. Greeley, Jr., Tennessee Technological University, Cookeville, Tennessee (MLO, JMR), and Oak Ridge National Laboratory, Oak Ridge, Tennessee (MSG).* Embryos of the Japanese Medaka, *Oryzias latipes*, were exposed to a range of divalent metals including cadmium, copper, manganese, mercury, nickel, and zinc. 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 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 in laboratory studies such as these and routine testing of ambient water sources on the reservation to be sensitive test organisms for a variety of environmental contaminants including the divalent metals.

RESOURCE PARTITIONING OF THE SMOOTH DOGFISH BY TWO SPECIES OF PARASITIC COPEPODS. *Jennie Dee*, George W. Benz, Ryan L. Otting, and Greg Skomal, Southeast Aquatic Research Institute, Chattanooga, Tennessee (JD, GWB), Athens, Georgia (RLO), and Massachusetts Division of Marine Fisheries, Vineyard Haven, Massachusetts (GS).* Spatial distributions of two species of parasitic copepods were studied on 39 smooth dogfish (*Mustelus canis*)

captured off Massachusetts. Total copepods per shark ranged from zero to 47, with *Pandarus sinuatus* (range of zero to 47) typically outnumbering *Alebion glaber* (range of zero to eight). Most *A. glaber* (75% males and 77% females) attached anterior to the first dorsal fin. Most *P. sinuatus* (65% males and 78% females) were collected from the second dorsal fin, with most of these (78% males and 81% females) attached at the fin's tip. Placoid scales taken from various locations indicated that 97% of *A. glaber* attached where scales exhibited fluted crowns, whereas 94% of *P. sinuatus* attached where scale crowns were smooth. While the primary attachment appendages of *Alebion* and *Pandarus* species are morphologically and functionally different, we found no indication that scale differences functionally restrict distributions of these copepods. Furthermore, scales like those found underneath each species also were found elsewhere, where copepods were never collected.

DEVELOPMENT OF DERMOPHTHIRIUS NIGRELLII, AN ECTOPARASITE OF LEMON SHARKS. *Stephen Ashton Bullard* and George Benz, The Tennessee Aquarium, Chattanooga, Tennessee.* A sample of 43 postlarval *Dermophthirius nigrellii* (Monogenea: Microbothridea) collected from a lemon shark (*Negaprion brevirostris*) in Florida Bay provided opportunity to study the ectoparasite's growth and development. Specimens ranged from 0.68 to 4.47 mm in total body length. Maximum body width was highly correlated with total body length ($y = 0.793x - 299.0848; r^2 = 0.9763; n = 43$). A haptor was present in its general adult shape in all specimens, and a significant ($\alpha = 0.01$) positive linear correlation existed between haptor diameter and total body length ($y = 0.123x + 8.514; r^2 = 0.8169; n = 42$). The testes and the cirrus sac were the first major reproductive organs to be well established in small worms. Testis diameter was positively correlated ($\alpha = 0.01; y = 0.1496x - 95.593; r^2 = 0.8804; n = 43$) with total body length, and the smallest specimen with an immature testes was 0.97 mm in total body length. The smallest worm with an immature ovary was 1.09 mm in total body length, and a significant ($\alpha = 0.01$) positive linear correlation existed between ovary width and total body length ($y = 0.1953x - 180.398; r^2 = 0.8804; n = 43$). The smallest worm with an immature cirrus was 1.12 mm in total body length, and the smallest worm with a fully developed cirrus was 2.33 mm in total body length. Together, results indicated that previously published descriptions of adult members of *Dermophthirius* do not facilitate species level identification of immature genus members.

PRELIMINARY INVESTIGATION OF THE MARINE TARDIGARDA OF DAUPHIN ISLAND, ALABAMA. *Michael S. Gaugler* and Diane R. Nelson, East Tennessee State University, Johnson City, Tennessee.* During July-August 1994 and January-March 1995, 125 samples of sand were collected from moderate-energy and low-energy beaches on Dauphin Island, Alabama. Three methods, all involving freshwater shock, were used to process the samples, which were preserved in 10% buffered formalin with rose bengal added to stain specimens. Samples were rinsed in alcohol to remove formalin and searched under a dissecting microscope to find tardigrades. Specimens were mounted in Hoyer's medium on microscope slides for identification. From two samples, 13 specimens were collected, belonging to three species of the genus *Batillipes* (*B. mirus*, *B. friafi*, and *Batillipes* sp.). All three species were found in both positive samples, which were collected on low-energy beaches, one site on the east end facing the Gulf of Mexico and one site on the west end facing the Mississippi Sound. Additional samples were collected in August-September 1996 from three sites, and thousands of tardigrades were found. Further analysis of the samples will elucidate patterns of distribution, which are typically extremely patchy.

DESCRIPTION OF THE FEMALE, NYMPH, AND EGG AND REDESCRIPTION OF THE MALE OF *AMPHINEMURA MOCKFORDI* (RICKER) (PLECOPTERA: NEMOURIDAE). *Charles H. Nelson, The University of Tennessee at Chattanooga, Chattanooga, Tennessee.* The adult female, nymph, and egg of *Amphinemura mockfordi* (Ricker) are described and illustrated for the first time. The male, previously known from two specimens collected at an unspecified location in Monteagle, Tennessee, is redescribed in greater detail. Characters serving to distinguish this species from closely related congeners *Amphinemura delosa* (Ricker) and *Amphinemura nigritta* (Provancher) also are provided.

EFFECT OF TAXONOMIC LEVEL OF IDENTIFICATION ON BIOLOGICAL METRICS USED IN RAPID BIOASSESSMENT METHODOLOGY. *Joseph R. Schiller, S. W. Hamilton, and Mack T. Finley, Austin Peay State University, Clarksville, Tennessee.* Current United States Environmental Protection Agency guidelines, "Rapid Bioassessment Protocols (RBPs)," suggest eight numerical indices of community structure and function (i.e., metrics) be used to evaluate water quality. The RBPs are suggestions only and actual methods of collecting, processing, and analyzing biological data vary between individuals and agencies. The level of taxonomic identification also varies between studies. The Environmental Protection Agency has sponsored research to test the effects of these sources of variation, including taxonomy, on assessment accuracy. Results from a limited number of studies suggest that RBP methodology is robust to variations in user technique and taxonomy. However, a review of hypothetical errors suggests, and the Environmental Protection Agency concurs, that further testing, validation, and refinement of RBP methods may be necessary. This paper discusses hypothetical effects of differing levels of taxonomic identification on RBP metrics and compares them to a limited set of examples from real RBP data. The limited RBP data presented here generally confirm that the RBP methodology is robust to differing levels of taxonomic identification, but there is sufficient variation to justify additional review.

STREAM BIOENGINEERING-RESTORATION ON CALEB'S CREEK, ROBERTSON COUNTY, TENNESSEE. *Mack T. Finley, Steven W. Hamilton, Joseph R. Schiller, and Laurina I. Lyle, Austin Peay State University, Clarksville, Tennessee.* Streambank erosion is a serious problem throughout Tennessee. Thousands of tons of soil are lost to streams from adjacent agricultural land. Flooding, sediment loading, and an overall deterioration of water quality are the major consequences. By using proper streambank restoration technologies, riparian zones can be restored and bank scouring and erosion is reduced. Riparian vegetation enhances fish and wildlife habitat and an overall improvement in water quality. This report describes several streambank Best Management Practices installed in a small stream in Robertson Co., Tennessee. The bioengineering techniques used include planting native riparian vegetation, cedar-riprap revetment installation, and log deflectors. All Best Management Practices were low-cost and can be installed by local landowners. This project was initiated in the spring of 1995 and provided the setting for Best Management Practices demonstrations and environmental education workshops.

MACROINVERTEBRATE AND FISH COMMUNITY RESPONSE TO ARTIFICIAL RIFFLES CONSTRUCTED IN A CHANNELIZED STREAM IN HENRY COUNTY, TENNESSEE: PRELIMINARY RESULTS. *Alan K. Bottomlee*, Steven W. Hamilton, and Mack T. Finley, Austin Peay State University, Clarksville, Tennessee.* Macroinvertebrate samples were collected from four sites along a 270-m stream reach before and after riffle construction (two upstream controls and two downstream treatments). During fish sampling, the

stream reach was divided into equal lengths (control and treatment). For both communities, the before and after treatment collections were ca. 1 year apart. All samples have been processed except the after-treatment macroinvertebrates from the riffle sites. Macroinvertebrate samples from the most upstream control site showed no significant difference in abundance or taxa richness between sampling dates while the more downstream control site had significant differences in both measurements. This may be caused by an increase in food resources as water pools behind the riffle and organic debris settles to the substrate. A reduction in water velocity from the upper limit of the reach to the first riffle and changes in functional feeding group ratios in after-treatment collections lend support to this claim. Fish response is very ambiguous and may be due to limitations in the sampling method.

EFFICACY OF SEMIQUANTITATIVE SUBMERGED ROOT SAMPLING VERSUS QUALITATIVE MULTIPLE HABITAT SAMPLING FOR CHARACTERIZING MACROINVERTEBRATE COMMUNITIES IN WEST TENNESSEE. *Steven W. Hamilton, Joseph R. Schiller, and Mack R. Finley, Austin Peay State University, Clarksville, Tennessee.* The Center for Field Biology (Austin Peay State University, Clarksville, Tennessee), through a contract with the Tennessee Department of Agriculture, Nonpoint Source Program, have investigated and implemented various Best Management Practices in the West Sandy Creek watershed, Henry Co., Tennessee. Included were various agricultural and instream Best Management Practices. Seven stream sites were monitored for physical, chemical, and biological responses. Biomonitoring comprised analysis of aquatic macroinvertebrate samples collected twice yearly from August 1992 to October 1995. Methods applied were modified from the United States Environmental Protection Agency Rapid Bioassessment Protocol III. Submerged roots along stream banks were sampled semiquantitatively in lieu of sampling riffle habitats as in Rapid Bioassessment Protocol III. Semiquantitative samples were returned to the laboratory where two random subsamples of ca. 100 macroinvertebrates were removed for analysis. In addition, submerged roots, riffles, debris dams, and aquatic macrophytes were sampled qualitatively. Macroinvertebrates were picked from these samples in the field. Preliminary results suggest pooled semiquantitative samples provide replicable data for richness and abundance calculation while qualitative multiple habitat samples contribute substantially to the final total taxa and EPT taxa richness metrics.

AQUATIC TOXICITY OF DUNBAR CAVE STREAMS AND SWAN LAKE. *Willodean D. S. Burton and Brian Kyte*, Austin Peay State University, Clarksville, Tennessee.* The importance of clean water cannot be understated. The present rate of increase in population can be a menace to the earth's clean water supply. The problems arise when surface water is contaminated by human activities, such as point source pollution (dumping effluents) and nonpoint source pollution (discarding appliances into sink holes). Contamination of surface and ground water sources lead to the poisoning of rural wells and other natural water outlets. Therefore, the question for this research focused on whether or not the stream water within Dunbar Cave and Swan Lake is contaminated. To address this question, aquatic toxicity tests were done using *Ceriodaphnia dubia*. The toxicity tests allowed us to assess survivorship and reproduction of a protocol organism. The mean survival and reproduction for all concentrations at sites within the cave varied when compared to the control.

INTERNAL SHELL ANNULI YIELD INACCURATE GROWTH ESTIMATES IN THE FRESHWATER MUSSELS *ELLIPTIO COMPLANATA* AND *LAMPSILIS RADIATA*. *David H. Kesler, Rhodes College, Memphis, Tennessee.* The objective of this study was to compare, in freshwater bivalves, growth rates inferred from internal

annuli to those obtained directly by measuring annual changes in shell length. The unionid mussels studied were *Elliptio complanata* and *Lampsilis radiata* from a pond in the northeastern United States. Age was inferred from internal lines of 157 *E. complanata* and 25 *L. radiata*. Actual change in length was determined from comparisons of annual remeasurements of marked *E. complanata* ($n = 706$) in 1992-1996 and *L. radiata* ($n = 148$) in 1993-1996. Annual changes in length determined by remeasurement were significantly lower than annual changes in length predicted by length-at-age data from internal annuli. Should this be a common occurrence, past estimates of annual growth based on annuli are probably too large, and unionid mussels may be much older than previously assumed.

REDUCTION OF LARVAL LONE STAR TICKS BY FEEDING IVERMECTIN-TREATED CORN TO DEER. *Eric Marsland**, *Reid R. Gerhardt*, and *Kim Lohmeyer**, *The University of Tennessee, Knoxville, Tennessee*. Automated corn dispensers were used to feed free-ranging white-tailed deer (*Odocoileus virginianus*) corn that had been treated topically with Ivermectin (50 ml/23 kg). Larval masses of the lone star tick (*Amblyomma americanum*) were greatly reduced in the ivermectin-treated area when compared with a nearby untreated area. Larval mass to adult ratios in the treated area were 0.53:1.00, 1.10:1.00, and 0.71:1.00 in 1994, 1995, and 1996, respectively. In the untreated area, the respective ratios were 3.25:1.00, 5.90:1.00, and 5.00:1.00. The numbers of adult lone star ticks in the treated area were reduced 43 and 59% from 1994 levels in 1995 and 1996. The number of adults in the untreated area remained unchanged. These data indicate that this technique has the potential to be a viable means of tick control without the need to broadcast pesticides.

EFFECTS OF TEMPERATURE ON SOCIAL INTERACTIONS IN THE GREEN ANOLE, *ANOLIS CAROLINENSIS*. *Holly C. Tidwell**, *Regina L. Courtney**, *Sid R. Shiao**, and *Amy E. Jetton*, *Middle Tennessee State University, Murfreesboro, Tennessee*. *Anolis carolinensis* exhibits a marked annual cycle of behavior. They breed in spring following establishment of territories by males. Territories are claimed and defended by social displays. Dominant males are greener in color, select higher perch sites, and display the dewlap and pushup. Submissive males are browner, select lower perch sites, and nod. This study examined the effects of temperature on social interactions as characterized by observing these behaviors. Eight duos of male anoles were housed between 30 and 33°C, and another eight duos of anoles were housed between 18 and 22°C. All animals were observed every day for color change and perch-site selection. Statistical analyses show no significant difference in color and perch-site selection. Display behaviors were not observed after initial pairing of males. Animals were browner in the last 3 weeks than in the first week after pairing. This may be an effect of moving animals from group housing to pairs. (Poster)

EFFECTS OF AGONISTIC DISPLAYS ON SPERMATOGENESIS IN THE GREEN ANOLE, *ANOLIS CAROLINENSIS*. *Regina L. Courtney**, *Holly C. Tidwell**, *Sid R. Shiao**, and *Amy E. Jetton*, *Middle Tennessee State University, Murfreesboro, Tennessee*. Testosterone levels correlate with testicular function and with position in dominance hierarchies in *Anolis carolinensis*. These dominance hierarchies are established due to agonistic displays. Submissive animals have high levels of stress hormones and may die as a result. This study asks whether chronic social stress due to establishing and maintaining social hierarchies affects spermatogenesis. Male *A. carolinensis* were housed in duos. They were observed for 4 weeks in which a distinct social hierarchy was established, and then the testes were removed. The left testis was crushed in Ringer's solution such that sperm heads could be counted. The right testis was prepared for study by light microscopy.

These testes will be examined for the relative abundance of prespermatocytes, spermatids, and spermatozoa. Statistical analysis showed there was not a significant difference in sperm-head counts between the dominant and submissive animals. Data from histological analyses will be presented. (Poster)

COMMENTS ON THE GILLS OF EMBRYONIC AND HATCHLING *PLETHODONDORSALIS*. *Brian T. Miller* and *Joyce L. Miller*, *Middle Tennessee State University, Murfreesboro, Tennessee*. An aggregation of *Plethodon dorsalis*, including seven females brooding eggs, was found on 2 August 1995 in a series of fissures associated with the clay-floor of a privately-owned cave in Rutherford Co., Tennessee. Two clutches of eggs were transported to the laboratory, photographed, and, subsequently, incubated in a constant temperature chamber (15°C, 12D:12L cycle). The embryos were well developed and fully pigmented (including a prominent dorsal stripe) at the time of collection. All embryos were gilled as evidenced by a distinct series of arterial loops extending laterally from the base of the head and laying upon and partially wrapping around the yolk mass. Hatching occurred on or before 2 September 1995. Gills or their remnants were present on all hatchlings. These gills consisted of three primary-divisions, each with five to seven finger-like lobes, that diverged from a common base. Although gills have been documented in other *Plethodon* species, this represents the first report for *P. dorsalis*. (Poster)

NONPOINT SOURCE POLLUTION OF THE RED RIVER. *Christopher J. Chabot**, *Lorry A. Sykes**, and *Willodean D. S. Burton*, *Austin Peay State University, Clarksville, Tennessee*. The purpose of this study was to determine the effect of nonpoint source pollution in the Red River. This body of water is a highly-used recreational area as well as a contributor to drinking water for Clarksville, Tennessee. The study was conducted April 1996 in the Clarksville area. Water which drains into the Red River at the site tested collects from channelized streams from industrial, agricultural, and urban sources. Chemical characteristics measured include alkalinity, total hardness, nitrate, orthophosphate, and dissolved oxygen. A vertical profile of photosynthetic photon flux density was determined using a spherical underwater quantum sensor coupled to a Li-Cor quantum meter. The obtained values were used to determine the vertical extinction coefficient. The presence of metals was determined using anodic stripping voltammetry, and observed potentials were computed to known potentials published by IUPAC. Macroinvertebrate community composition and bacterial analysis also were conducted. Preliminary results indicate poor water quality. (Poster)

BACTERIAL ACQUISITION BY *RHODNIUS PROLIXUS* (HEMIPTERA: REDUVIIDAE). *Jamie DeLay** and *David Ekkens*, *Southern Adventist University, Collegedale, Tennessee*. Kissing bugs, *Rhodnius prolixus*, are the vector for *Trypanosoma cruzi*, which causes Chagas' disease, a major health problem in Central and South America. This experiment was to determine when kissing bugs acquire intestinal bacteria. There were four insect groups: group A, the eggs were surfaced sterilized, and each insect lived alone; group B, the eggs were surfaced sterilized, and each insect lived with an adult; group C, the eggs were not surfaced sterilized, and each insect lived alone; group D, a normal colony. Adults from group A did not acquire bacteria. Insects from group B were examined at each developmental stage after the first instar. By the fifth instar, all insects had acquired bacteria. Thirty percent from group C acquired bacteria from contaminated eggs. All adults from group D acquired bacteria. In conclusion, kissing bugs acquire bacteria at various stages of development if in contact with other contaminated bugs. (Poster)