

ABSTRACTS OF PAPERS PRESENTED AT THE 104TH ANNUAL MEETING

BOTANY SECTION

Thomas E. Hemmerly, Presiding

CHLOROPHYLL FLUORESCENCE MEASUREMENTS FROM OZONE FUMIGATED *QUERCUS RUBRA* L. *Jerry L. Faulkner, Chattanooga State Technical Community College, Chattanooga, Tennessee.* Chlorophyll fluorescence is a nondestructive, intrinsic probe of photosynthesis. This study investigated the usefulness of chlorophyll fluorescence as a monitor of ozone-induced stress in *Quercus rubra* L. Measurements of chlorophyll fluorescence were taken from mature trees and reflected one of three ozone-concentration treatments: subambient; ambient; twice ambient. Fluorescence measurements proved to be sensitive to differences between treatments and tree size. The data indicates two types of response. The first type produces an inducible response at ambient ozone concentrations and homeostasis at twice-ambient concentrations. The second type of response is homeostatic at ambient concentrations with apparent injury occurring in twice-ambient treatments. These patterns indicate a multiphasic, multisite ozone effect. Chlorophyll fluorescence indicated that seedlings were less sensitive to ozone than were mature trees. Some parameters of fluorescence exhibited good correlation with seasonal changes in chlorophyll content.

THE EFFECT OF METHIONINE SULFOXIMINE ON PROTEIN SYNTHESIS IN BEANS. *Deborah Baugh, E. Lewis Myles, and Carolyn Alexander-Caudle, Tennessee State University, Nashville, Tennessee.* The identification of disease resistant cultivars through plant breeding is a sure but slow process. Biotechnology can speed up the process by helping researchers screen generations of plants for a specific trait. Methionine sulfoximine (MSO) is an amino-acid analog that acts as a bacterial toxin (bacterial blight). Callus from *Phaseolus vulgaris* c.v. Bush Romano (0.5 g) were grown on Murashigie and Skoog media containing 0, 6, and 12 μM of MSO. After 3 weeks, the callus was removed and weighed. Total protein was extracted from the callus and analyzed by western blot analysis for Hsp 70 showed that this protein is expressed significantly more in the experimental group than in the control. The results of two-dimensional gel electrophoresis revealed many differences in the synthesis of low-molecular-weight proteins.

OXYGEN METABOLISM IN GERMINATING *EQUISETUM HYEMALE* SPORES. *Jeff Lebkuecher, Kevin Buchanan, and Lowe Hebel*, Austin Peay State University, Clarksville, Tennessee.* Isolated spores of *Equisetum hyemale* L. experienced virtually complete desiccation following exposure to 2% relative humidity for 1-h, 24-h, 72-h, 1-week, 2-week, or 4-week periods. Spores from all desiccation treatments exhibited respiratory oxygen consumption within 30 sec upon 10-min hydration periods in the light ($200 \mu\text{mol photons m}^{-2}\text{s}^{-1}$). Spores desiccated for 1 and 24 h reached the oxygen compensation point at 3.1 ± 0.2 and 6.3 ± 0.3 min, respectively. Following 24 h of light hydration, only spores previously desiccated for <1 week were able to reach the oxygen compensation point, even at high light intensities. These results indicate that, during desiccation, the integrity of the

mitochondrial membrane of spores of *E. hyemale* is more highly conserved relative to the integrity of the chloroplast membrane, that the ability to recover decreases with increasing duration of desiccation, and that rapid photosynthetic recovery may be essential due to the limited amount of carbohydrates the small spores can store.

A FLORISTIC ANALYSIS OF AN HISTORIC UPLAND SWAMP ON THE PENNYROYAL PLAIN, CHRISTIAN COUNTY, KENTUCKY. *S. M. Noel, M. L. McReynolds, and E. W. Chester, Austin Peay State University, Clarksville, Tennessee (SMN, EWC), and Hopkinsville Community College, Hopkinsville, Kentucky (MLM).* McGaughey Swamp in Christian Co., Kentucky, believed to have comprised a 2,024-ha forest-upland swamp complex in the 1850s, now has been reduced by clearing and draining to ca. 160 ha of wooded remnants, including a 25-ha old-growth forest. Weekly floral collections from February through October in 1993 and 1994 resulted in 446 taxa from 95 families. Among rare taxa identified is *Trillium pusillum* Michx., least trillium, occurring in colonies in the old-growth forest. The canopy of the old-growth forest was dominated by *Carya ovata*, *Acer rubrum*, and *Quercus falcata*. Limited floristic data exist for wooded, upland depressions supporting oak swamps on the Pennyroyal Plain. These data can provide an idea of flora of presettlement and settlement eras.

A NEW ERA IN BOTANY: SCIENCE AND SUCCESS OF FRANK LAMSON-SCRIBNER. *J. W. Hilty, The University of Tennessee, Knoxville, Tennessee.* Frank Lamson-Scribner, an 1873 graduate from the University of Maine, became an authority on taxonomy of grasses. His work is considered among the most significant in North American botany. Employed by the United States Department of Agriculture, he became the first leader of the new Section of Vegetable Pathology and initiated the first national organization for the study of plant diseases. He introduced the American farmer to the modern era of chemical fungicides. Scribner's manner of experimentation paved the way for economic plant pathology in the United States. In 1888, Scribner became Professor of Botany and Botanist to the Agriculture Experiment Station at The University of Tennessee. For 3 years, he served as director of the station. He introduced the laboratory method of teaching botany and introduced the first lectures on plant diseases and causal fungi. His 1889 report of a plant-parasitic nematode was the first in the United States. While at the University, he wrote the first book on plant diseases published in the United States. After rejoining government service, he became first Chief of Agrostology and Chief of the Bureau of Agriculture in the Philippine Islands.

SOME ADDITIONS TO THE PLANT LIST OF MAY PRAIRIE, A HIGHLAND RIM BARREN. *Betty McNeely* and Thomas A. Hemmerly, Middle Tennessee State University, Murfreesboro, Tennessee.* Seven forbs not previously noted have been identified at May Prairie, a small mesic to wet-mesic barren located on the eastern Highland Rim in Coffee Co. near Manchester, Tennessee. A Registered National Natural Landmark, May Prairie is of significance because it is one of the few remaining mesic prairies in Tennessee and, reportedly,

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contains some 25 endangered species as well as an unusual combination of prairie, Plateau, and Coastal Plains species. Continued careful monitoring and management will be necessary if May Prairie's unique identity and species diversity are to be maintained.

APPALACHIAN WILDFLOWERS: AN ECOLOGICAL PERSPECTIVE, A PROPOSED BOOK. *Thomas E. Hemmerly, Middle Tennessee State University, Murfreesboro, Tennessee.* The Appalachians, defined here as the highlands that extend from northern Georgia to Quebec's Gaspé Peninsula, is a region unrivaled in the temperate world for its biodiversity. Despite this, no single popular or semipopular volume has been written focusing on the botanical richness of the region. The objectives of the proposed book is to interpret Appalachian plants in light of their ecology, their ethnobotanical uses, and present threats to their continued well-being. The book will contain several chapters dealing with the origin and ecology of the mountains. To aid in identification, there will be 325 color photographs plus descriptions of 450 additional species, making the total number of described species ca. 775.

THE EFFECT OF FIRE ON CEDAR GLADES AND CEDAR GLADE ENDEMICS. *Karma D. Krelle* and Thomas E. Hemmerly, Middle Tennessee State University, Murfreesboro, Tennessee.* Prescribed burning has been used as a management tool to maintain open sunny sites required by certain species of plants. In recent years, encroachment by woody species into once open cedar glades has been seen as a threat to preservation of rare and endangered species of plants, such as *Echinacea tennesseensis* and *Dalea foliosa*. This is the first use of prescribed burning to maintain such open sites in cedar glades of Middle Tennessee. Three cedar-glade sites were monitored annually for 2 years prior to prescribed burning and for 2 years following burning. A total of 77 30-m transects were established, allowing sampling of herbaceous and woody species. Particular attention was given to vegetative and reproductive vigor in *E. tennesseensis* and *D. foliosa*. Due to the low intensity of the fire, impact of burning was minimal at all three sites. In the future, utilization of high-intensity fire could prove more effective in reaching the goal of maintaining habitats suitable for rare and endangered species.

A REVIEW OF PENNYROYAL PLAIN UPLAND WET FORESTS, KENTUCKY AND TENNESSEE. *Edward W. Chester, Sallie M. Noel, Jerry M. Baskin, Carol C. Baskin, and Mary L. McReynolds, Austin Peay State University, Clarksville, Tennessee (EWC, SMN), University of Kentucky, Lexington, Kentucky (JMB, CCB), and Hopkinsville Community College, Hopkinsville, Kentucky (MLM).* The Pennyroyal Plain Subsection, Western Highland Rim Section of the Interior Low Plateaus Province, occupies much of westcentral Kentucky and northcentral Tennessee and includes a complex of level-rolling plains and dissected uplands. The region is underlain by Mississippian limestones, and large portions of the landscape is karstic. Much of the Plain is coincident with the historic Big Barrens Region where native plant communities included prairie-barren-glade complexes and various forest types. The forests of upland, wet, often depressional areas are especially unique, but, today, the region is mostly agricultural, and these formerly-extensive woodlands now exist as scattered, disturbed remnants. Data from the few previous studies of these forests are summarized, and results are given for a recent site-study in Christian Co., Kentucky.

CELL AND MOLECULAR BIOLOGY SECTION

Charles J. Biggers, Presiding

SEQUENCE CONTROLLING GLUTAMATE RECEPTOR ISOFORM EXPRESSION. *Sharese Terrell*, John Izzo, and Prem S. Kahlon, Tennessee State University, Nashville, Tennessee.* The origin of some neurological diseases possibly lies in neuronal cell death due to overstimulation of glutamate receptors. Glutamate-gated ion channels are activated by contact with glutamate, a fast excitatory neurotransmitter. This activation allows for an influx of electrically charged calcium and sodium ions. Observance of molecular clones of α -amino-3-hydroxy-5-methyl isoxazole-4-propionic acid (AMPA) glutamate receptor subunits (GluR-A to -D) have indicated that each gene produces two mRNA isoforms through alternative splicing. Alternative splicing occurs when mRNA chooses only one of two exons. In this case, the exons are 13A and 13B (Flop and Flip). It is the variation of this peptide sequence that creates important differences in a neuron's sensitivity to glutamate. The degree of Flop and Flip expression varies during brain development. Flip mRNAs are expressed early in brain development while expression of Flop form is delayed. Flip and Flop mRNAs also are differentially expressed within specific regions of the adult brain, meaning that certain regions might utilize 13A exclusively or vice versa. The mechanisms responsible for regulating the alternative splicing of the GluR mRNAs are undetermined and, thus, are the inspiration for this research. In an effort to clone the flop and flip portions of AMPA glutamate receptor genes A, C, and D, C-112 and B-13B were successfully cloned and sequenced.

EFFECT OF STAINING TIMES ON HEMATOXYLIN AND EOSIN STAINING. *Richard J. Wong and Charles J. Biggers, The University of Tennessee at Memphis, Memphis, Tennessee, and The University of Memphis, Memphis, Tennessee.* This study demonstrates what various staining times in hematoxylin and eosin dyes can do to the hematoxylin-and-eosin (H&E) stain. Numerous staining schedules were used with the standard schedule for the H&E stain in the histology laboratory at the Department of Pathology, The University of Tennessee at Memphis. Kidney tissue was used for the control due to its characteristics which are excellent for critiquing the H&E stain. This study was done to determine if there were any noticeable differences in the quality of staining as assessed for diagnostic acceptability and personal preference by the pathologist. Aside from the normal protocol for the H&E stain, a personal choice of the pathologist is very important. Three pathologists were chosen to critique the stained slides and ratings from 0 (poor) to 3 (excellent) were scored. One conclusion drawn from this study is that, regardless of the various staining times used, the H&E stain cannot deviate to a state where it cannot be acceptable for diagnosis. This study provides for a method of trouble-shooting the H&E staining problems in the histology laboratory. The choice of the pathologist does play an important role in concluding with the optimum H&E stain.

STRUCTURAL BIOCHEMICAL STUDIES OF TRANSCRIPTION BY *ESCHERICHIA COLI* RNA POLYMERASE. *Michelle Brydie*, Gunther L. Eichhorn, and Prem S. Kahlon, Tennessee State University, Nashville, Tennessee.* RNA polymerase transcribes DNA with fidelity 1,000 times greater than if only Watson-Crick base-pair complementarity was operative. Our hypothesis is that enhanced fidelity might be affected by structural changes in the active site of the enzyme. Establishing the conformation of substrate NTPs in this site relative to the site itself, therefore, might aid in determining how RNA polymerase affects fidelity of transcription. All RNA polymerases require divalent metal ions as cofactors for catalytic activity. In *Escherichia coli* RNA polymerase, Mg(II) or Mn(II) can activate RNA synthesis. Because of

its higher rate of catalytic activity and its paramagnetic effect, Mn(II) was chosen for current study. The active site of the enzyme involves two sites: initiation site, Zn or i site, which binds a purine nucleotide or a dinucleoside monophosphate; elongation site, Mg or i + 1 site, which binds any four of the nucleoside triphosphate substrates, determined by a specific DNA template. In this study, the conformation of substrates in these sites is determined from distances between the metals characteristic of these sites and the NTPs occupying them. The variations of the distances between the metals in relation to the protons of the substrates indicated structural changes in the active site of the enzyme, therefore, enhancing the fidelity.

TRANSCRIPTIONAL DOWN REGULATION OF A ZINC-PROTEINASE GENE EXPRESSION IN LEISHMANIA BY ZINC IONS. *Kimberly Womback**, *Gautam Chaudhuri*, and *Prem S. Kahlon*, *Tennessee State University, Nashville, Tennessee*. Zinc apparently plays an important role in the human parasite *Leishmania*. Its highly abundant surface glycoprotein (gp63), implicated as essential at several aspects of its infective life cycle, is a zinc-proteinase. While working with the gene of *L. mexicana amazonensis* gp63, we found indications of zinc-ion regulation of its gene expression. The parasitic protozoan *Leishmania* is abundantly coated with Zn-proteinase (gp63). Although Zn^{2+} . Zn^{2+} -chelator added to the growth medium stimulated this gene expression. These results suggest a unique role of Zn^{2+} in regulating the status of a Zn-proteinase in *Leishmania*.

CONFRONTING CISTERNAE AND ANNULATE LAMELLAE: SIMILARITIES AND DIFFERENCES. *John R. Palisano and Karen S. Renzaglia*, *University of the South, Sewanee, Tennessee (JRP)* and *East Tennessee State University, Johnson City, Tennessee (KSR)*. Confronting cisternae and annulate lamellae share many characteristics. Both consist of parallel, stacked cisternae and, most frequently, are observed in rapidly dividing cells. However, their differences characterize these two organelles. Confronting cisternae rarely consist of more than four stacked cisternae. Confronting cisternae are observed in tumor cells and fetal cells of animals and never contain pore complexes. Annulate lamellae usually are found only in developing oocytes or spermatocytes of plants and animals. Annulate lamellae can consist of a dozen or more stacked cisternae and always contain pore complexes similar to those present in nuclear envelopes. While confronting cisternae and annulate lamellae are thought to arise from the nuclear envelope, confronting cisternae most frequently are observed during mitosis of the cell cycle while annulate lamellae have been described only during interphase. Recent investigations indicate that annulate lamellae may function in sequestering mRNA that is necessary for rapid development following fertilization. Investigators have postulated that confronting cisternae represent a mechanism of assuring the presence of preformed nuclear envelope or endoplasmic reticulum in rapidly dividing cells; however, evidence will be presented that suggests that confronting cisternae represent the failure of rapidly dividing cells to disassemble the nuclear envelope. Consequently, confronting cisternae and annulate lamellae probably represent two different membranous organelles that share structural features and arise in response to different intracellular conditions.

EFFECT OF ULTRAVIOLET RADIATION AND TEMPERATURE ON DIFFERENT SPECIES OF SALMONELLA. *Artyom Shneyder**, *Carolyn Caudle*, *Y. Myles*, and *E. Myles*, *Tennessee State University, Nashville, Tennessee*. *Salmonella* is an invasive microorganism that can cause food-borne illness. In an effort to control the growth of *Salmonella*, three species of *Salmonella* (*S. enteritidis*, *S. pullorum*, and *S. typhimurium*) were exposed to ultraviolet radiation and heat for various periods of time. New proteins were produced following exposure to the

radiation and heat. Proteins were isolated from the cells and examined by SDS polyacrylamide gel electrophoresis. Results from this study indicate that these three species of *Salmonella* are able to produce new protein when exposed to stressful conditions such as radiation and heat. There appear to be two different cell populations, one that is resistant to physical factors and another that is sensitive. The presence of two different populations may contribute to the difficulties in eradicating the bacteria. Further investigations are needed to identify the proteins that have been observed. Western analyses are being performed to identify the protein.

THE EFFECT OF 60-HZ ELECTROMAGNETIC FIELDS ON GENE EXPRESSION IN HELA CELLS. *Z. Wang**, *Carolyn Caudle*, *Y. Myles*, and *E. Myles*, *Tennessee State University, Nashville, Tennessee*. Epidemiological studies indicate a relationship between the occurrence of certain types of cancer and low-frequency magnetic fields. Research on the effects of electromagnetic fields has been done from the 1960s onward, but there is still no conclusive result. This study was designed to determine the effects of electromagnetic fields on gene expression in HeLa cells. Cells were exposed for 30 min to 60 Hz and 8 gauss magnetic fields. One- and two-dimensional polyacrylamide gels demonstrated that some new proteins were synthesized. Western blot analysis showed an increase of Hsp-70 protein but not V-Ha-ras. Northern-blot and dot-blot hybridization revealed significant increases in v-myc after exposure. The experiment confirms that 60-Hz electromagnetic field affects gene expression in HeLa cells. More research is needed to identify and characterize the proteins being synthesized after exposure.

CHEMISTRY SECTION

Kent Clinger, Presiding

WHAT DETERMINES THE PROTON NMR CHEMICAL SHIFT OF A TERTIARY-BUTYL GROUP? *Martin V. Stewart*, *Paul D. Dodson**, and *James C. Howard*, *Middle Tennessee State University, Murfreesboro, Tennessee*. The 1H chemical shifts and ^{13}C - 1H coupling constants were measured for the *tert*-butyl groups of diverse organic compounds using a 200-MHz Fourier transform NMR. Although the *tert*-butyl group would seem to be remote from inductive, resonance, and ring-current effects, the observed chemical shifts varied over a rather wide range from 0.9 to 1.8 ppm. A linear relationship was found between these chemical shifts and the ^{13}C - 1H coupling constants of the *tert*-butyl's methyl groups as obtained from the natural abundance carbon-13 satellites observed about each *tert*-butyl resonance. This suggests that the relative magnitudes of both are determined by a common factor, which we conclude is the slightly different hybridization state of the methyl carbons in these various compounds. It also was observed that the proton chemical shift of $^{13}CH_3$ is consistently $0.0018 + 0.0002$ ppm upfield from that of $^{12}CH_3$ in the NMR spectra of all compounds studied.

THE PHOTOCHEMICAL STUDY OF 9-METHYL ANTHRACENE IN EMIC. *Fleb Mamantov*, *Richard Pagn*, *Carlos W. Lee*, and *Timothy Winston*, *The University of Tennessee at Knoxville, Knoxville, Tennessee*, and *Lee College, Cleveland, Tennessee*. The room-temperature molten salt made up of EMIC and $AlCl_3$ may be an excellent medium for organic photochemical reactions because the salt is a liquid at room temperature over a wide range of ratios of EMIC to $AlCl_3$, organic compounds and inorganic compounds are soluble in the salt, the presence of $AlCl_3$ causes the salt to be completely aprotic, and the salt's acidity can be varied by varying the molar ratios of EMIC and $AlCl_3$. Because the salt has this unique potential, some photochemical reactions of anthracene and 9-methylanthracene were explored by using the basic

and the acidic environments of the possible molten salt medium. We will focus on the results of this exploration and will present data which support this hypothesis.

PHYSICAL CHEMISTRY OF ORGANIC RADICALS. *Monique Casey*, Rudy Gostowski, Chris Landess*, Sharon Snapp*, Constance Thomas*, and Mike Wallace*, Austin Peay State University, Clarksville, Tennessee.* Carbon-centered free radicals may be considered as another oxidation state of a sp^2 carbon atom. This places the radical in company with carbon anions and cations. However, the neutral radical is not subject to substituent effects felt by the charged molecules. It would be useful to contrast solution thermodynamic and kinetic properties for families of related anions, radicals, and cations. Spectrophotometric and electrochemical techniques may be combined to facilitate the generation and observation of these transients. The present study focuses on acquiring spectra of these species following generation by reagent action. Ultraviolet-visible spectra has been taken of related persistent anions, radicals, and cations based on substitute fluorenes and dibenzosuberenes. Based on these studies, future work will examine more reactive molecules by spectroelectrochemical techniques.

SODIUM 2-CHLOROCINNAMATE DIHYDRATE: CRYSTAL STRUCTURE AND SOLID STATE PHOTOREACTIVITY. *Peter Abeta Iyere, Tennessee State University, Nashville, Tennessee.* Sodium 2-chlorocinnamate dihydrate and sodium cinnamate have been synthesized by treating the appropriate acid with sodium hydroxide. The chloro- derivative has been characterized by infrared, NMR, and UV-VIS spectroscopy and by elemental analysis and single-crystal x-ray diffraction. The titled compound crystallizes in the space group $P2_1/c$ with $a = 19.254(6)\text{\AA}$, $b = 3.732(1)\text{\AA}$, $c = 14.521(4)\text{\AA}$, $\beta = 91.45(2)^\circ$, and $Z = 4$. The coordination sphere consists of six oxygen atoms that form a distorted octahedron around the sodium ion. The molecule is nonplanar with a dihedral angle of $13.6(1)^\circ$ between the chlorobenzene residue and ethylene plane. The Cl-Cl nonbonded contact is 3.732\AA . The center-to-center repeat distance between adjacent double bonds is 3.732\AA . When irradiated with ultraviolet radiation, dimerization occurred between every other pair of double bonds leading to isolation of monomer molecules between pairs of dimer molecules in sodium 2-chlorocinnamate dihydrate. No reaction was observed in the anhydrate. The disparity in the reactivity of these salts is attributed in part to the chlorine substituent.

MICROWAVE DIGESTION GUNSHOT-RESIDUE SAMPLES. *Linda A. Wilson, Middle Tennessee State University, Murfreesboro, Tennessee.* When an individual fires a weapon, residue from the exploding cartridge often is cast back upon the hands of the shooter. The shooter's hands are swabbed with a dilute acid solution which then is analyzed for the presence of barium and antimony. An improved method of preparation of samples of gunshot residue for analysis by atomic absorption was investigated. It was desirable to determine whether a microwave oven could replace a conventional oven for part or all of the preparation. The microwave technique was compared to the aqueous standards. In the cases of antimony and lead, there was 100% agreement between the aqueous standards and the swab-mounted controls prepared using the conventional oven. There was 100% recovery of the lead using the microwave technique. There was ca. 80% recovery of the antimony at low concentrations and virtually 100% recovery at higher concentrations using the microwave technique.

DETERMINATION OF LEAD CONCENTRATIONS IN WATERS. *Fred J. Matthews, Jonathan Vinson*, Julie Enos*, Lamis Joudah*, Richard Ribeiro*, Stephen Cole*, and Marty Gamble*, Austin Peay State University, Clarksville, Tennessee.* Lead concentrations in the

environment are of critical concern due to potential health risks. The maximum acceptable level of lead in water, set by the Environmental Protection Agency (EPA), is 15 ppb. Analysis of natural waterways, selected storm drains and the adjacent downstream waterways, and waters supplied by submersible pumps have been performed. Analyses of waters from the Red River-Sulfur Fork Creek drainage areas of Montgomery-Robertson counties indicate lead concentrations well below the EPA limits. Analyses of samples taken from several storm-drain sites and the adjacent downstream waterways in Clarksville, Tennessee, indicate lead levels ranging from 1 to 40 ppb dependent upon total rainfall during the sampling period, flow rates at each drain site, and distance downstream from the storm-drain sampling site. Analyses of waters supplied by submersible pumps currently indicate lead levels of 1-20 ppb. Analyses were performed using atomic absorption spectrometry. Preconcentration of the aqueous samples using the ammonium pyrrolidinedithiocarbamate chelation-methyl isobutyl ketone extraction method was necessary to analyze using flame AA analysis.

ADSORPTION OF VOLATILE ORGANICS FROM WET GAS STREAMS BY ACTIVATED CARBON. *David J. Wilson, Tomas Cordero, and Cesar Gomez-Lahoz, Vanderbilt University, Nashville, Tennessee (DJW), and Universidad de Malaga, Malaga, Spain (TC, CG).* Typically, nearly half of the cost of soil-vapor-extraction cleanups is due to the removal of volatile organic compounds from the off gas from the vacuum wells. Granular-activated-carbon canisters are frequently used, but their performance suffers from the fact that the off gas typically is saturated with water vapor. A mathematical model for the adsorption of volatile organic compounds from wet gas streams by granular activated carbon is developed, and modeling results are discussed. Capillary condensation of water in the carbon pores appears to have a very damaging effect on the rate of adsorption of volatile organic compounds by granular activated carbon because diffusion rates of volatile organic compounds into the pores of the carbon granules are greatly reduced as a result. Implications of the results for the operation of soil-vapor-extraction systems for cleanup of hazardous waste sites are discussed, and some suggestions are made as to how to deal with the problem.

PROGRESS ON THE STRUCTURAL DETERMINATIONS OF 1,1-DIHALO-2,2,3,3-TETRAMETHYLCYCLOPROPANES. *J. Ronald Boone, W. Craig Brown*, Kent Clinger, and Timothy P. Hanusa, David Lipscomb University, Nashville, Tennessee (JRB, WCB, KC), and Vanderbilt University, Nashville, Tennessee (TPH).* A series of 1,1-dihalocyclopropanes are being synthesized by simple dihalocarbene addition to alkenes. The 1,1-dibromo- and 1,1-dichloro-2,2,3,3-tetramethylcyclopropanes were synthesized in pentane at 0°C by reaction of tetramethylethylene and the appropriate haloform in the presence of sodium *tert*-butoxide. Work up, followed by recrystallization from aqueous-alcohol mixtures or sublimation at water aspirator pressures yielded crystals suitable for x-ray analysis. Diffractometer data were collected, and the structure was solved for 1,1-dibromo-2,2,3,3-tetramethylcyclopropane. As more results are obtained, the structures of these compounds will be compared.

SYNTHESIS AND STRUCTURAL CHARACTERIZATION OF INDENYL AND FLUORENYL COMPLEXES OF THE HEAVY ALKALINE-EARTH METALS. *Jason S. Overby* and Timothy P. Hanusa, Vanderbilt University, Nashville, Tennessee.* The indenyl ligand $[C_9H_7]^-$ are the benzenellated analogues of the cyclopentadienyl anion. While the chemistry of these ligands with transition metals have been studied extensively, much less has been done with main-group indenyl and fluorenyl species, and, of the few known heavy alkaline-earth (Ca, Sr, Ba) examples, only one has been structurally character-

ized. We have been able to synthesize these complexes by simple metathetical routes, allowing for large-scale syntheses of solvated and unsolvated bis(indenyl) and first crystal structures of the calcium subgroup metals. In addition to the unsubstituted indenyl ligand, we have prepared several substituted indenenes with increased steric bulk; their metal complexes have markedly higher solubility than the parent compounds. General synthetic and structural features of this class of organometallic complexes will be presented.

ENGINEERING SECTION

Adel Salama, Presiding

MECHANICAL PROPERTIES OF A NEW CLASS OF LOW-THERMAL-EXPANSION MATERIALS. *Gladius Lewis, The University of Memphis, Memphis, Tennessee.* A new class of low-thermal-expansion materials, known as CSZP (Ca-Sr-Zr-P) oxides recently have been discovered. For a number of applications (such as in turbine blades and the combustion chamber in an aeroengine and rocket nozzles), high hot hardness, high fracture toughness, and excellent resistance to thermal shock conditions are major requirements. The present work reports on two aspects of these materials. First, five compositions of these materials were synthesized and characterized using x-ray crystallography. Second, the values of the modulus of rupture, Poisson's ratio, modulus of elasticity, thermal expansion coefficient, hardness, and mode-I-plane-strain fracture toughness were experimentally determined. Full details of all the experimental equipment and procedures are presented. In addition, there is a full compilation of the results and a discussion of their significance.

EVALUATION OF RADIATION-CONTROL COATINGS FOR BUILDINGS. *David W. Yarbrough and Patricia J. Dycus, Tennessee Technological University, Cookeville, Tennessee.* Radiation-control coatings are materials with high solar reflectances intended for use on exterior surfaces of buildings. The objective of an application of radiation-control coating is to reduce solar gain and reduce air-conditioning loads. A performance parameter, E, based on exterior-surface measurements is proposed. The parameter E is a measure of the effectiveness of a radiation-control coating to reduce maximum, exterior-surface (roof) temperatures to near ambient temperature. A portable apparatus for determining E will be described along with Es determined for common roofing materials. A preliminary correlation of E with solar reflectance will be introduced.

SIMULATION OF HETERARCHICAL MANUFACTURING SYSTEMS USING SIMAN. *Adel Salama and Ashraf Saad, Austin Peay State University, Clarksville, Tennessee, and Vanderbilt University, Nashville, Tennessee.* SIMAN is a powerful package for the modeling and simulation of discrete event systems. Due to its features, we chose SIMAN as the primary simulation vehicle for our current research on heterarchical (decentralized) manufacturing control. However, the current version of SIMAN is not intended to directly support manufacturing scheduling in a truly dynamic way. Hence, in order to achieve our research objectives, we utilized some of the existing features of SIMAN to augment it with the necessary constructs that support our endeavors. The main feature of SIMAN that enabled us in achieving our objectives is the possibility of linking user-defined programming code to the simulation engine. These routines then can be triggered by specific events during the simulation of the manufacturing system under consideration. We, therefore, implemented the subroutines that represent a job-shop manufacturing system in an object-oriented manner (using C++ in order to simulate decentralized production scheduling. The

approach we developed enabled us to contrast the effects of sequencing parts through the shop floor when using dispatching rules versus the approach proposed by our research, that of bidirectional bidding.

BIDIRECTIONAL BIDDING FOR PRODUCTION SCHEDULING IN A DECENTRALIZED MANUFACTURING SYSTEM. *Ashraf Saad and Adel Salama, Vanderbilt University, Nashville, Tennessee, and Austin Peay State University, Clarksville, Tennessee.* Technological advances in computing hardware and software have made possible the decentralization of manufacturing control. In addition to taking advantage of the decentralized nature of a manufacturing process, a truly decentralized control system is inherently more fault-tolerant than a centralized or an hierarchical one. However, this comes at the expense of designing the rules of interaction and cooperation among the agents comprising and representing the system under consideration. Our main interest is in planning and scheduling for discrete manufacturing systems that are subject to a high level of manufacturing variances. In our approach, a bidding metaphor is used to achieve the desired interaction among the agents comprising the manufacturing control system. The bidirectional nature of the utilized bidding scheme incorporates the relevant measures of performance and objectives of a part and the machines involved in its production. Preliminary results have shown the premise of such an approach to providing better manufacturing control in that it achieves better system performance when contrasted to using dispatching rules.

AN ENVIRONMENTALLY CONSCIOUS MANUFACTURING DECISION-MAKING FRAMEWORK FOR MANAGEMENT. *Margaret Curtin* and Guatam Biswas, Vanderbilt University, Nashville, Tennessee.* Environmental management in the 1990s is moving beyond the confrontation and compliance stage to incorporating environmental management as a component of the overall firm strategy. However, industry and, in particular, small- to medium-sized manufacturers are unsure and often wary of the effect Environmentally Conscious Manufacturing (ECM) efforts will have on the operation of their organization. At present, there exists no ECM management model which would assist management of such firms to make a high-level assessment of their ECM alternatives and their suitability to the organization. A lot of research done in this field focuses on products and processes and their impacts on the environment or it is concerned with detailed cost-benefit analyses of ECM alternatives. In this research, an ECM Decision-making Framework for Management was developed which bridges the gap between these two sets of approaches. This decision-making framework includes methodologies which guides an efficient selection of the most cost-effective, viable alternatives while eliminating inappropriate alternatives in early stages of the decision-making process.

ENHANCEMENT OF PRODUCT FUNCTIONALITY FOR ENVIRONMENTALLY CONSCIOUS DESIGN AND MANUFACTURING OBJECTIVES. *Rajive Dhingra, Vanderbilt University, Nashville, Tennessee.* Manufacturing, in recent years, has evolved from the mass-production era to that of flexible manufacturing, with on-going advances in network technology and knowledge-systematization techniques steadily leading it in the direction of Computer Integrated Manufacturing (CIM) and Intelligent Manufacturing. While automation, undoubtedly, makes the production process faster and more efficient, it alone might not be the solution if the objectives of Environmentally Conscious design and Manufacturing (ECDM) are to be met. Products designed with additional functional capabilities are more likely to meet ECMD objectives because they sustain functional growth. For this purpose, products will have to be made increasingly modular so that they are versatile in their use. This would increase their useful life, as they would

be capable of growing with the needs of the user. I discuss ways in which product functionality can be enhanced to meet ECDM objectives.

PROCESS PLAN MODELING FOR ENVIRONMENTALLY CONSCIOUS DESIGN AND MANUFACTURING. *Hassan Haftharadaran, Vanderbilt University, Nashville, Tennessee.* One of the most important problems facing human beings today is related to the environment and its problems due to large-scale industrial activity. Almost all economic sectors affect the environment, specially manufacturing which is one of the most critical ones in this regard. The Montreal Protocol, which was signed by 39 countries in 1989 and other global cooperative agreements related to decreasing the environmental burden generated by industry on the earth, provided new economic paradigms for manufacturing technologies. Therefore, Environmentally Conscious Design and Manufacturing (ECDM) refers to the design of manufacturing activities under strict compliance of environmental considerations.

PRELIMINARY DESIGN OF CONDENSER CLEANSING SCHEDULE. *James Warberg*, Erin K. Foraker*, Anthony G. Civera, and Michael L. Daley, The University of Memphis, Memphis, Tennessee (JW, EKF, MLD), and Allen Steam Plant, Memphis, Tennessee (AGC).* Analysis of the operations of a fossil power plant for a 5-year period revealed a year-round trend of operating inefficiently due to elevated condenser back pressure, particularly during the summer months. A further 5-month longitudinal study between May and September of an individual condenser unit revealed a positive correlation between increasing inlet-circulating water temperature and above-design condenser back pressure. Moreover, condenser cleansing resulted in a return to approximately the design operating condition. A physical analysis of increased heat-rate and lost power generation from inefficient condenser back pressure was accomplished. Based on these observations and economic analysis, a preliminary cleansing schedule for periods of increasing circulating water temperature was derived. Further studies are planned to validate the proposed cleansing schedule.

MATHEMATICAL MODEL OF CEREBRAL BLOOD FLOW DURING ELEVATED INTRACRANIAL PRESSURE. *Eryu Wang*, Stanley Lopez*, Charles Leffler, and Michael L. Daley, The University of Memphis, Memphis, Tennessee (EW, MLD), and The University of Tennessee-Memphis, Memphis, Tennessee (SL, CL).* In order to investigate the nature of cerebral blood flow during elevated intracranial pressure, electrical circuit model of cerebral blood flow is proposed. This model is based on the hypothesis that, during elevated intracranial pressure and normal vascular tone, venous flow just prior to entry into lateral venous lacunae is slowed during positive-pressure inhalation; as a corollary, during maximal vasodilation of the cerebral vasculature, nonlinear switching mechanism to simulate the posited synchronous reduction of flow into the lacunae during positive-pressure inhalation. A comparison between signals of experimentally recorded and simulated intracranial pressure and venous pressure during conditions of normal vascular tone and loss of cerebral vascular tone reveals marked similarities.

HUMAN-LIKE SPACE VARIATION SENSING IN COMPUTER VISION APPLICATIONS. *Magued Bishay, Vanderbilt University, Nashville, Tennessee.* The human retina is not formed of uniformly distributed receptors but, rather, has a high-resolution center, the fovea, and a low-resolution periphery. The resolution decreases as the radial distance from the fovea increases. Such space-variant sampling compresses the periphery of the visual field. The retinal image is mapped in the visual cortex spatially such that the fovea occupies most of the area of the visual cortex, therefore, dedicating most of the processing power to the foveal region. It is claimed that the mapping from the retinal image

to the cortical image can be mathematically represented by a complex logarithmic function. I present a realization of these ideas in a vision system, where the processing is performed on the cortical representation of the image (the complex-log maps). I also demonstrate how such a representation of the image facilitates feature detection in the applications of indoor navigation and corner detection of polyhedral objects. Such a technique achieves an image compression ratio of 1:70, thus, vastly accelerating the processing. I focus my attention to the detection of features in the periphery of the visual field. These features are the targets of saccade or gaze shifts so that they get centered in the fovea where more detailed processing is conducted, such as estimating their distances. Such eye movements will be incorporated in future implementations.

DESIGN AND IMPLEMENTATION OF A FUZZY LOGIC CONTROLLER FOR A RUBBERTUATOR LINK. *Sameh Asaad* and Adel Salama, Vanderbilt University, Nashville, Tennessee, and Austin Peay State University, Clarksville, Tennessee.* A rubbertuator is a pneumatically driven rubber actuator, which, when activated by air pressure, inflates in the radial direction and contracts in the longitudinal direction. A pair of rubbertuators can be used to form a 1 DOF robot link with one rubbertuator acting as the "agonist muscle" and the other as the "antagonist muscle" resembling the human arm. Due to its flexible design, the input-output relationship of the rubbertuator link is highly nonlinear and exhibits inherent hysteresis, thus, making it difficult to control using conventional control techniques. A fuzzy logic controller is designed and implemented for the aforementioned rubbertuator link. A brief overview of the theory of operation of fuzzy logic controller is presented with focus on the practical issues and possible pitfalls in the implementation of such controllers. These issues include the choice of the number and shape of the membership functions as well as how to tune them to achieve adequate control. It has been shown that "reasonable" control of the rubbertuator link can be achieved using fuzzy logic with no a priori knowledge of the parameters of the plant. This advantage of the fuzzy-logic-control scheme makes the design portable, with minor changes, to different plants with different dynamic behavior. The results of testing the disturbance rejection of the fuzzy logic controller and a comparison with a conventional PID controller are presented. In conclusion, we stress the need for a systematic approach for the learning and tuning of the fuzzy rules and membership functions in order to achieve the desired response with relative ease.

MULTIPLE COVARIANCE MATRIX SPECTRAL MODEL. *Hisham Alnajjar and D. Mitch Wilkes, Austin Peay State University, Clarksville, Tennessee, and Vanderbilt University, Nashville, Tennessee.* We present a novel algorithm for modeling the behavior of the measured eigenvalues in order to find the DOAs of sources. In our approach, we use only the eigenvalues and not the eigenvectors to find the DOAs, and no other algorithm works this way. The modeling process is based on the critical-distance formula previously developed by the authors, which describes the best location to add a sensor to an existing subarray in order to improve the resolution performance of an array. Also, it is based on the concept of a structurally adaptive array, which promotes the idea of adapting the size and geometry of a subarray (of a much larger array) in order to optimize the detection of different scenarios.

COMPUTER SIMULATION OPTIMIZING A CAM SYSTEM LAYOUT. *Chin-Zue Chen and Abu K. Sarwar, Austin Peay State University, Clarksville, Tennessee.* Highly automated manufacturing systems operating under computer control are to achieve the efficiency of automated high-volume mass production while retaining the flexibility of low-volume, job-shop production. Two of the most important

planning tasks in computer-aided manufacturing (CAM) systems are the determination of part assignment and machine allocation with material-handling considerations. Without such considerations, planning of the tasks could result in low machine utilization, low material-handling system utilization, and longer manufacturing cycle. Austin Peay State University installed a computer-aided manufacturing system for instructional purposes. In order to determine the optimum layout for the available equipment, SIMAN (a simulation software package) was used. Three different material-handling layouts, combined with four different station layouts, were simulated, and optimum system layout for a particular production was obtained.

GEOLOGY AND GEOGRAPHY SECTION

D. M. S. Bhatia, Presiding

ETHIOPIAN RIFTING RELATIVE TO HUMAN ORIGIN: A SPECULATION. *Habte Giorgis Churnet, The University of Tennessee at Chattanooga, Chattanooga, Tennessee.* The Ethiopian Rift joins two other rifts at Afar. The Red Sea Rift penetrates into northern Afar and continues as the Manda Hararo-Lake Abe (MHLA) zone in southern Afar. The Gulf of Aden Rift penetrates into southern Afar and continues as the Manda Hinakir-Asal-Ghoubbet (MIAG) zone. The overlap region between the MHLA and MIAG rifts is the Serdo Block, which has not been affected by NE trending faults of the Ethiopian Rift system. Differential rift-floor subsidence was pronounced in parts of northern Afar where ≤ 5 km of salt has accumulated in the last 4×10^6 years. Also, kilometer-high fault scarps are exposed in the Serdo Block. In contrast, subsidence in that part of southern Afar that is controlled by Ethiopian Rift faults has been negligible. For example, in the last 4×10^6 years, < 200 m of sediment has accumulated at the Hadar and Middle Awash hominid fossil sites. Oldest hominids (*A. afarensis*, 3.9×10^6 years ago, and *A. ramidus*, 4.4×10^6 years ago) have been studied by others from these sites. Whether or not *A. afarensis* is ancestral to both *Australopithecus* and *Homo*, and *A. ramidus* is ancestral to *A. afarensis*, the origin of these bipedal ape-like creatures should be examined in relation to a geologic setting (rift valley) that did not sustain vast grasslands or woodlands. In the Ethiopian Rift, lithospheric thickness has been estimated to be ca. 21 km. Hot fluids in the form of steam and fumarolic emission degas the lithosphere and subjacent asthenosphere of the rift. However, these are not as voluminous as the submarine hydrothermal vents of mid-oceanic ridges, where Vestimentifera and other creatures abound. Yet, in light of recent suggestions that relate creation of bacteria and increased mutation of other organisms to submarine hydrothermal vents, it is tempting to speculate that hot fluid venting in African continental rifts, transforming quadruped apes into bipeds. Such a possibility merits additional investigation. It will shed new light on the "ape change due to cultural adaptation over arid grassland" speculation of some paleoanthropologists.

USE OF WEATHERING RINDS AND OTHER RELATIVE-AGE PROPERTIES FOR MAPPING SURFICIAL DEPOSITS IN THE SOUTHERN BLUE RIDGE PROVINCE. *Hugh H. Mills, Tennessee Technological University, Cookeville, Tennessee.* Coarse alluvial and debris-flow deposits are common on the footslopes of the mountains of North Carolina and Tennessee. Deposits vary in age from decades to probably hundreds of thousands of years. Although absolute dating is difficult, properties of the deposits (and associated surfaces) that change as a function of time can be used to classify the deposits by relative age. The most consistent appears to be weathering-rind thickness on mafic clasts. The best soil properties are redness and clay content of the argillic B horizon. Topographic properties include height of the surface above

modern drainageways and amount of erosion the surface has undergone. Examples are cited from Haywood, Mitchell, and Watauga counties, North Carolina, and Johnson City, Tennessee. Resulting maps provide insight into the manner in which mountain footslopes evolve and, also, have practical value by delineating footslope areas likely to be inundated by flood torrents or debris flows during future catastrophic rainfalls.

A PETROLOGIC COMPARISON OF GRAVELS FROM WEST TENNESSEE. *Robert P. Self, The University of Tennessee at Martin, Martin, Tennessee.* Mean grain size, sorting and the chert, quartz and rock fragment content were analyzed for the Cretaceous Tuscaloosa gravels of the Western Highland Rim, Pliocene "Lafayette" gravels in northwestern Tennessee, Plio-Pleistocene gravels from the bluffs of the Mississippi River, and Tennessee River Terrace gravels from southwestern Tennessee. The Tuscaloosa is coarser than the younger gravels and contains more chert (white) which is derived from the Devonian Camden Formation. The younger gravels are textural similar and dominated by honey-colored, Fort Payne (Mississippian)-derived chert with secondary amounts of white, Camden-derived chert. The "Lafayette" is coarsest and contains more coarse pebbles and cobbles suggesting greater input from adjacent sources. The terrace gravels have more white chert indicating more recycled Tuscaloosa or Camden cherts in the source area. The data suggest that either the gravels were deposited in different drainage basins or that Camden-derived chert was diluted by Fort Payne-derived chert during transport.

SIDERITE NODULES AND BEDDING FROM THE PENNSYLVANIAN "POTTSVILLE" FORMATION, ALABAMA. *Michael A. Gibson, and Allyn Blanton*, The University of Tennessee at Martin, Martin, Tennessee.* Siderite occurs as cement, discrete nodules, coalescing bands, and beds within the coal-bearing "Pottsville" Formation. We compared stratigraphic position, geometric form, associated lithologies, fauna, and depositional settings of siderite for the "Morris" Shale (Black Warrior Basin, Upper "Pottsville") and Upper Cliff Interval (Plateau Field, lower "Pottsville"). Five siderite styles occur: laterally continuous siderite-stained siltstone; rhizo-concretions; irregular masses surrounding infilled burrows; discrete nodules of various shapes and sizes; large flat plates that can coalesce into beds. Rhythmic patterns which gradually shift stratigraphically indicate seasonal runoff affected sea water and substrate chemistry. In the upper Cliff Interval, the shift is gradual; however, in the "Morris," a more punctuated occurrence can be correlated to a rapid flooding surface recognized as a ravinement bed. The progressive stages of siderite formation preserve small-scale changes in sediment-substrate characteristics useful in reconstructing sediment-accumulation history, substrate maturation, and taphonomy of the fauna.

ECONOMIES OF SCALE OF THE HEALTH-CARE INDUSTRY IN MID-CENTRAL TENNESSEE. *James M. McCluskey and Crystal G. Allen*, Austin Peay State University, Clarksville, Tennessee.* A geographic information system, GIS, is developed to analyze the economies of scale in the health-care industry in Mid-Central Tennessee. The region is comprised of 20 counties that surround Nashville. A map analysis is made at the county level of the regional health-care delivery network. Variables included in the study are number of practitioners per population in different categories, number of hospitals, average hospital population, number of licensed beds per population, average length of hospital stay per patient, average cost per day per hospital patient, and total revenue generated by health-care industry. Special consideration is given to the dichotomy in health-care delivery between rural and urban areas. Rural areas are typified by greater number of general practitioners per population, shorter hospital stays, and lower daily hospital costs. Urban areas are typified by greater

number of specialists per population, greater number of hospital beds per population, longer hospital stays, and higher daily hospital costs.

PRELIMINARY REPORT OF INVESTIGATIONS OF WELLS CREEK STRUCTURE WITH TRANSMITTED LIGHT AND SCANNING ELECTRON MICROSCOPY. *Joseph L. Islas, Jr. *, and D. M. S. Bhatia.* *Austin Peay State University, Clarksville, Tennessee.* Randomly selected samples of shatter cones and carbonate rocks from the impact site and surrounding brecciated zones were studied in thin section with the focus of finding high-temperature and high-pressure silica polymorph minerals that are indicative of an impact site. Thin sections were made from shatter cones and residue left after acid leaching. Some mineral grains which exhibited subparallel "cleavages" with "rhomb shape patterns" appeared to be "shocked quartz," which is typical of an impact site. Scanning electron microscopy of the same samples show them to be siliceous dolomites or limestones.

KARST-RELATED HAZARDS ASSOCIATED WITH EXPANDING TRANSPORTATION FACILITIES. *David A. Padgett, Austin Peay State University, Clarksville, Tennessee.* United States census data show that, between 1985 and 1990, ca. 1.4×10^6 Americans migrated to the South. As a result, many areas now are experiencing urban sprawl. Transportation planners and highway engineers, working in karst terrains, face challenges in maintaining drinking water quality and preventing structural damage. In karst regions, drainage structures often have been linked directly into cave networks creating "natural sewers." Runoff diverted into retention edifices results in subterranean "soil piping" creating subsurface cavities. Overlying roads and highways exceed the supporting capacity of the cavity ceilings and then collapse into the openings resulting in extensive property damage. In this study, remote-sensing methods are employed to identify areas of potential hazard. Black and white, aerial photographs locate subsurface, karst cavities in central Florida. Low-altitude multispectral photography and thermal infrared imagery delineate areas of potential sinkhole collapse within a proposed interstate highway corridor in northern Alabama. Airborne multispectral-scanner data is applied in westcentral Florida to detect moisture-stressed vegetation commonly found adjacent to collapse-prone areas. A case study highlights additional hydrogeological contamination risk associated with karst-region highway construction.

THE K/T BOUNDARY IN TENNESSEE AND MISSISSIPPI: EVIDENCE FOR A TIDAL WAVE? *Gary L. Patterson* and David N. Lumsden, The University of Memphis, Memphis, Tennessee.* Hildebrand and his co-workers have found evidence for a 200-km diameter crater-like feature in the Yucatan Peninsula of Mexico (Chicxulub Crater) that formed approximately at the Cretaceous to Paleocene transition (the K/T boundary). We hypothesize that, if Chicxulub is indeed an impact feature, a tidal wave of unimaginable size would have swept out of the Gulf of Mexico and would have disrupted sediments as far north as Tennessee. We examined outcrops at the K/T boundary in northern Mississippi and southwestern Tennessee for evidence of severe disruption of Maestrichtian deposits and found none. Some evidence for reworking is present, but, on the whole, the sediments appear normal.

HISTORY OF SCIENCE SECTION

Kevin Ryan, Presiding

PUBLICATION TRENDS IN THE JOURNAL OF THE TENNESSEE ACADEMY OF SCIENCE, 1926-1994. *Charles R. McGhee, Middle Tennessee State University, Murfreesboro, Tennessee.* In March 1912, a small group of scientists convened in the State Capitol building in

Nashville to organize the Tennessee Academy of Science. The first Academy publications (issued 1914 and 1917) were called *Transactions of the Tennessee Academy of Science*. Volume 1 of the *Journal of the Tennessee Academy of Science* was published in January 1926. The *Journal* has been in continuous circulation with editions in January, April, July, and October for 68 years. Two hundred and seventy editions of the *Journal* containing >2,000 papers have been mailed to members of the Academy. The *Journal* has remained a steadfast and valuable tool of communication for the scientific community in Tennessee. This study attempts to categorize the papers published in the *Journal of the Tennessee Academy of Science* since 1926 and to determine possible trends in the research and publications of state scientists and educators who utilize it.

BENJAMIN SILLIMAN, JR. (1816-1885): A CHEMIST IN VICTORIAN AMERICA. *George E. Webb, Tennessee Technological University, Cookeville, Tennessee.* Although justifiably overshadowed by his more famous father, Benjamin Silliman, Jr. (1816-1885), nonetheless, played an intriguing role in the science of Victorian America. Trained in chemistry, the younger Silliman taught in various capacities at Yale and also served as a professor at the University of Louisville medical college. He was the author or co-author of several important college-level science textbooks, including *First Principles of Chemistry* (1847) and *First Principles of Physics* (1859), both of which appeared in several editions. Equally important, however, Silliman was actively involved in consulting activity throughout most of his career. Among the first to examine petroleum deposits in western Pennsylvania, he performed similar investigations in southern California in the 1860s. This latter activity helped to fuel a speculative frenzy in California and led to severe criticism of Silliman by his colleagues. Silliman also was active in analyzing mineral deposits in the Far West until shortly before his death.

MATHEMATICS AND COMPUTER SCIENCE SECTION I

James B. Hart, Presiding

LOCAL REFINEMENTS OF GRAPH CONNECTIVITY. *Nell K. Rayburn, Austin Peay State University, Clarksville, Tennessee.* A graph is k -connected if at least k vertices must be removed to disconnect it. A graph is (n,k) -connected if the distance- n , induced subgraph of each vertex is k -connected. Every $(k+1)$ -connected graph is (n,k) -connected for some value of n , and every (n,k) -connected graph also is $(n+1, k)$ -connected. A survey of graph properties for which (n,k) -connectivity is a sufficient condition is presented.

A THEOREM ON POLYGRAMS. *Larry Hoehn, Austin Peay State University, Clarksville, Tennessee.* A new proof and a generalization of the following theorem is presented. If diagonals of a convex pentagon meet at B_1, B_2, B_3, B_4, B_5 , where $B_1 = \overline{A_1A_3} \cap \overline{A_2A_5}$, etc., then

$$\frac{A_1B_1}{B_1A_2} \times \frac{A_2B_2}{B_2A_3} \times \frac{A_3B_3}{B_3A_4} \times \frac{A_4B_4}{B_4A_5} \times \frac{A_5B_5}{B_5A_1} = 1.$$

PARTITIONING PATHS IN PASCAL'S TRIANGLE. *Dennis Walsh, Middle Tennessee State University, Murfreesboro, Tennessee.* A recent problem in *The American Mathematical Monthly* (January 1994) concerning the average number of ties during a tournament between two players of equal strength motivated our derivation of the following combinatorial identity:

$$\sum_{k=0}^n \binom{2n-2k}{n-k} \binom{2k}{k} = 2^{2n}.$$

We show that the identity can be derived by counting the number of paths in Pascal's triangle according to a partitioning of paths based on the last central node encountered. A related partition based on not crossing any central nodes also is illustrated and can be applied to the following problem. If two candidates A and B with known support vie in an election, what is the probability that candidate A will never be behind in tallied votes?

INTEGRATING MULTIVENDOR PLATFORMS IN A COMPUTER INTEGRATED MANUFACTURING ENVIRONMENT. *Mohammad S. Mohammad**, *Andrew Czuchry*, and *Jerry E. Sayers*, *East Tennessee State University, Johnson City, Tennessee*. The purpose of this research was to develop an application for the computer-integrated-manufacturing (CIM) environment that facilitates the communication links between different parts of the manufacturing system. Using the Pick operating system and a database management system (DBMS), a prototype was designed for an Aircraft Engine Overhaul System. The model incorporated several processes in order to implement the engine-overhauling functions including marketing, business, and manufacturing processes. The proposed system consists of three separate environments: order entry; business; manufacturing. Interfaces between these environments are handled by standards called protocols. These protocols are required to regulate the communication process to ensure data accuracy and integrity. The significance of this system arises from the fact that, in the competitive global market place, the organization must have all of its elements participate in the development process. The proposed system can be used to improve quality, efficiency, and overall organizational performance. The feasibility of implementing this system is explored.

CONCURRENT REPRESENTATION OF PETRI NETS USING ADA. *Garry M. Estep**, *Middle Tennessee State University, Murfreesboro, Tennessee*. Petri nets provide a way of simulating processes such as industrial production, chemical reactions, computer networks, and concurrent processes, to name a few. The model produced using petri nets can provide such information as whether or not there will be any "bottlenecks" in the process, infinite loops, whether or not the process will finish, plus a lot more. If there was a way to represent petri nets in a true concurrent fashion using a computer, one could build nets of different complexities and see what happens as parameters are changed. The language Ada provides a means of programming petri nets with its task construct. However, there are pitfalls to be avoided and problems to overcome. The basic properties of petri nets are described, and a simple sample model is set up. Questions about suitable representation in the computer are addressed, and a solution using the language Ada is discussed. Future efforts include a true parallel representation.

VISUALIZATION OF MULTI-PASCAL. *Thiruvengadam Ramanathan** and *Gregory Schaper*, *East Tennessee State University, Johnson City, Tennessee*. Multi-Pascal is a language with a simple set of high-level parallel programming abstractions that have sufficient power to represent parallel algorithms for multiprocessor and multicomputer architectures. Special constructs are available to specify the architecture of the simulated multiprocessor system. The run-time description of the target multiprocessor architecture allows the programmer to evaluate the performance of an algorithm for various classes of architectures. We present a visualization tool for Multi-Pascal to aid in debugging programs and facilitate analysis of output. The tool proposed also will provide trace capability for variables and communication messages in Multi-Pascal.

THYROID TEST INTERPRETATION USING NEURAL NETWORKS. *Satyan Ramanna**, *Gregory Schaper*, *Alan Peiris*, and *Dan Merrick*, *East Tennessee State University, Johnson City, Tennessee (SR, GS)*, and *University Physicians Group, Johnson City, Tennessee (AP, DM)*. The project uses neural networks to interpret thyroid-function tests. Using the results of the blood tests (T_3 , T_4 , TSH, and FTI), the network attempts to diagnose a patient's condition as hypothyroid, hyperthyroid, euthyroid sick, normal, or indeterminate (i.e., the results of the blood tests suggest a condition different from those listed or that the patient needs specialist treatment). One of the most popular networks of today, the backpropagation network, is being avoided. The network is coded in 'C/C++', and the operating system of choice is DOS (for maximum portability). The network is trained on bipolar inputs (+1, -1). Previous studies have acknowledged the efficacy of using neural networks to interpret the thyroid classification problem. However, no software exists for clinical use. The project attempts to bridge this gap.

DESIGN OF A NEURAL NETWORK FOR PULMONARY-FUNCTION-TEST INTERPRETATION. *Lance Mumpower**, *Gregory A. Schaper*, *Alan Peiris*, and *Dan Merrick*, *East Tennessee State University, Johnson City, Tennessee*. The diagnosis of pulmonary disease typically requires the patient to undergo a pulmonary-function test. This test gives the pulmonary specialist raw data on the performance of the lung and connecting airways. A pulmonary specialist is trained to analyze this data and determine if any pulmonary disease is present. We show the design of a backpropagation Neural Network for interpretation of pulmonary-function test. The goal of this project is to produce a Neural Network capable of diagnosing pulmonary disease with at least the same degree of confidence as a pulmonary specialist.

TERRAIN REASONING IN AN INTELLIGENT PLAYER. *Ashok Pandari** and *Gregory Schaper*, *East Tennessee State University, Johnson City, Tennessee*. Intelligent Player (IP) is a computer generated helicopter used in real-time battlefield simulation. Current implementation does not include terrain reasoning, which is a process of analyzing the terrain features. The realistic behavior of IP requires terrain reasoning. An IP, when it makes maneuver decisions, considers the terrain features to avoid any collision. We present an IP implementation that includes terrain. We have chosen Digital Terrain Modelling that uses quad-trees as a means of representing terrain in simulation. The terrain is recursively decomposed into four blocks until each block of the terrain represents a plane with same altitude or which satisfies the least squared error. We show that including terrain not only gives IP realistic behavior but also does not affect its real-time performance requirements.

MATHEMATICS AND COMPUTER SCIENCE SECTION II

Barbara Hargis, Presiding

APPLICATION OF STATISTICS FOR PREVENTION OF PRESURE ULCERS. *Mack Thweatt* and *Drex Freeman*, *Middle Tennessee State University, Murfreesboro, Tennessee*, and *Alvin C. York Medical Center, Murfreesboro, Tennessee*. Alvin C. York V. A. Medical Center was interested in the efficacy of applying a nationally recommended Braden Scale cutoff value of 16 for preventative treatment of pressure ulcers. However, should the cutoff point for pressure-ulcer-prevention treatment be changed taking into account the older local hospital population? Before the use of the Braden Scale, preventative measures were given only if some evidence of ulcers was manifested. If prevention measures were administered to the high-risk group early enough, a considerable amount of pain, time, and money could be saved

overall (i.e., costs of third-degree pressure ulcers could exceed \$20,000). However, if extreme preventative measures were administered to every patient regardless, the costs and labor involved would severely impact normal patient care. Statistical analysis was performed on patients for which Braden Scale and pressure-ulcer measures were available. An analysis of variance was conducted for each group pairing that resulted when the Braden Scale cutoff was set to each of the integer values from 12 to 20. The results showed that the local Braden Scale cutoff value should be 15. After this policy adjustment was implemented in 1992, the total pressure-ulcer count declined steadily toward minimal levels.

DATA ASSIMILATION APPLIED TO A MARINE-ECOSYSTEM MODEL. *Linda M. Lawson, Y. H. Spitz, and E. E. Hofmann, East Tennessee State University, Johnson City, Tennessee (LML), and Old Dominion University, Norfolk, Virginia (YHS, EEH).* The adjoint method of data assimilation is applied to a simple, marine-ecosystem model. We introduce a method of constructing the computer code for the adjoint directly from the model code. This technique introduces Lagrange multipliers, is straightforward to apply, and reduces the risk of introducing errors in the adjoint code development. Identical-twin numerical experiments are presented to demonstrate how this technique can be used to recover initial conditions, forcing parameters, and growth and death rates.

EVIL TWIN BETTING. *J. Ronald Gupton, Austin Peay State University, Clarksville, Tennessee.* Assuming that a person picking winners in a football pool with a point spread provided has a probability of 1/2 of picking a winner, it has been proved that a player's expected winnings can be improved by submitting two entries, the second for his "evil twin" that makes his choices opposite from the player. For an odd number of games, the advantage is independent of the number of games. I present the problem and some numerical results and concentrate on the case with an even number of games.

R. L. MOORE: THOUGHTS ON THE PHILOSOPHY AND METHOD OF AN AMERICAN MATHEMATICAL PIONEER. *Daniel Davis* and Floyd L. Christian, Jr., Austin Peay State University, Clarksville, Tennessee.* The Moore Method is a way of teaching mathematics that differs greatly from the traditional lecture method. The Moore Method is a radical implementation of the idea that "you learn best by doing the work yourself." A course using the Moore Method consists of students individually working to solve problems and prove theorems and then presenting their solutions and proofs to the rest of the class. Because students are forced to prove theorems without any collaboration or reference to books, they develop their thinking skills and grow in mathematical maturity. The origin, applicability, success, and disadvantages of the Moore Method will be discussed. A brief sketch will be given of the basic schools of thought in the philosophy of mathematics. Some parallels between philosophy and the Moore Method will be given in a preliminary attempt to determine the philosophy of mathematics that underlies the Moore Method.

GREEN'S FUNCTIONS AS APPLIED TO BOUNDARY VALUE PROBLEMS. *Yuri A. Melnikov and William H. Ilsley, Middle Tennessee State University, Murfreesboro, Tennessee.* Several methods traditionally have been applied to the numerical solution of boundary value problems for ordinary differential equations. They include reduction to the initial value problem, Galorkin's method, the finite-difference method, the finite-element method, and others. In addition, the Green's Function method also may be used. We present numerical results obtained by using the Green's Function method to the solution of boundary value problems and outlines its advantages over traditional methods. We also describes a subclass of boundary value problems for

which this method is compatible with traditional methods. The results show that, especially for linear boundary value problems, this technique is much more accurate than either the finite difference method or the finite element method. We will emphasize the basic sources for this accuracy. Consequently, our results suggest that the Green's Function method should be included as a standard technique for solving boundary value problems.

APPLICATIONS OF RETRACTION MAP. *Zachariah Sinkala, Middle Tennessee State University, Murfreesboro, Tennessee.* One of the application of retraction maps lies in the ability to reduce fixed-point questions for complicated sets to fixed-point questions for simpler subsets. In particular, I will discuss the use of retraction map to prove Brouwer fixed-point Theorem.

CONTROL OF LOCAL ERROR STABILIZES INTEGRATION. *Ana Witt and L. F. Shampine, Austin Peay State University, Clarksville, Tennessee, and Southern Methodist University, Dallas, Texas.* Codes for the solution of the initial value problem for a system of ordinary differential equations approximate the solution on a mesh over the desired interval. They adjust their step sizes so as to keep the estimated local errors smaller than a given tolerance and, at the same time, solve the problem as efficiently as step sizes providing the desired accuracy may be too large for stability of the method; yet, this does not cause the popular codes to become unstable. Previous theory explaining this holds only in very restricted circumstances. This research broadens the current theory in the context of explicit Runge-Kutta methods. It is shown how instability of the method appears in the estimate of the local error, where it causes a growth of the estimated error and forces a reduction of the step size.

ANALYTIC SOLUTION TO A SINGLE CYLINDER MODEL OF A NEURON. *Jeffrey L. Holmes and Loyd Lee Glenn, East Tennessee State University, Johnson City, Tennessee.* The cable equation is used to model the electrical properties of neurons. By the residue method of complex analysis, we have been able to derive the solution for multipolar-neuron models where each dendrite can have a unique electrotonic length, diameter, and membrane time constant. The most promising model is one that incorporates a tapering cylinder to model a neuron. To our knowledge, this model has never been solved before. The model is:

$$V_{zz}^j - V^j + kV_z^j - V_T^j = 0, \text{ with boundary conditions}$$

$$I_j(L_j, T) = 0,$$

$$I_j(0, T) = I^{\text{in}},$$

$$V_j(0, T) = V_N(0, T) \quad \forall j.$$

The solution by separation of variables is

$$V_j(Z, T) = \sum_{N=0}^n C e^{-\alpha_n T}.$$

The eigenvalues for $n > 0$ are

$$\alpha_n = 1 + \left(\frac{kj}{4}\right)^2 + \left(\frac{n\pi}{L_j}\right)^2,$$

and the corresponding eigenfunctions given by complex residue theory are

$$C = \frac{I^m e^{kz} \left[\frac{k_j}{2} \sin\left(\frac{n\pi}{L_j}(L_j - Z)\right) - \frac{nt}{L_j} \cos\left(\frac{n\pi}{L_j}(L_j - Z)\right) \right]}{\left[\frac{k_j}{Z} \sin(n\pi) - \frac{nt}{L_j} \cos(n\pi) \right] \alpha(\alpha - 1) \sum_j \frac{G_j^n}{2 \left(\frac{n\pi}{L_j}\right)^2}}$$

This solution is in closed form, which allows a more direct analysis of the effects of the parameters G , L , and k on the voltage response (V) than traditional finite-difference methods.

MEDICAL SCIENCE SECTION

John M. Zamora, Presiding

PARAGANGLIOMATA-A FAMILIAL SYNDROME. *Harris O. Yates, James L. Netterville, and David Robertson, David Lipscomb University, Nashville, Tennessee (HOY), and Vanderbilt University Medical Center, Nashville, Tennessee (JLN, DR).* A familial incidence of the occurrence of paragangliomata in two generations is presented. The prominent sites of neurologic involvement are illustrated, and the effects of excision upon the autonomic nerve system are detailed. The gene involved is considered to be an autosomal dominant with varying levels of penetrance.

SURVEILLANCE OF SWINE FOR INFLUENZA A VIRUS AT SELECTED SITES IN MIDDLE TENNESSEE. *Kristi Williams* and Stephen M. Wright, Middle Tennessee State University, Murfreesboro, Tennessee.* Influenza A viruses are responsible for yearly epidemics and infrequent pandemics. Due to the segmented nature of the influenza genome, there is potential for genetic mixing, or reassortment, between different viruses. The influenza A viruses responsible for the pandemics of 1957 and 1968 were reassortants, containing a mixed genome characteristic of human and avian influenza. Swine have been implicated as a "mixing vessel" wherein influenza of avian, swine, or human origin can undergo reassortment. We have conducted surveillance of swine at four sites in Middle Tennessee to determine the incidence of influenza A virus in different herds and to evaluate the frequency of interspecies transmission between humans, swine, and avians. Our results indicate that influenza A viruses do circulate at low frequency among swine in Middle Tennessee.

THE EFFECTS OF WEEKLY ESTRADIOL TREATMENTS WITH OR WITHOUT SUBSEQUENT PROGESTERONE ON COPULATORY BEHAVIOR, SYSTOLIC BLOOD PRESSURE, AND BODY WEIGHT IN FEMALE RATS. *Jeffrey N. Gudger*, John T. Clark, and Bruce S. Cushing, Middle Tennessee State University, Murfreesboro, Tennessee (JNG, BDC), and Meharry Medical College, Nashville, Tennessee (JTC).* This study reports the effects of repeated exposure to estradiol and progesterone on copulatory behavior, systolic blood pressure, and body weight gain in ovariectomized female rats. To test the effects of these gonadal hormones, females were divided into three groups. Each group received two weekly injections for 12 weeks: estradiol followed 20 h later by oil; estradiol followed by progesterone; controls, received oil only. Estradiol and progesterone affected copulatory behavior, showing the most consistent effects during the middle portion of the study. Progesterone facilitated copulatory behavior 4-6 h postinjection but inhibited copulatory behavior after 24 h. The changes in behavior were the result of repeated injections and prior while, in steroid-treated animals, body weight gain significantly decreased after 8 weeks, as compared to the control group.

THE ISOLATION AND USE OF POLYMER-PRODUCING BACTERIA. *Damon Dozier* and John M. Zamora, Middle Tennessee State University, Murfreesboro, Tennessee.* Biological polymers are used in various food and industrial products. They have been used to thicken and stabilize yogurt, medicine, and cosmetics. Our purpose is to isolate possible polymer-producing bacteria. Microorganisms were taken from different soil types in Tennessee, serially diluted, and screened for mucoid colonies on TSs (tryptic soy with an additional 1.5% dextrose). Many bacteria produce capsules that contain polymers. The Modified Maneval's capsule stain was used to demonstrate capsules formed by the mucoid colony. The mucoid isolates were identified and compared to known polymer-producers. The known polymer-producing bacteria used were *Xanthomonas campestris* NRRL-B1459 and *Leuconostoc mesenteriodes* obtained from culture collection services. The microorganisms were grown in TSs broth, and broth cultures were tested for viscosity to determine the most efficient polymer-producers.

USING THE AMES SALMONELLA-MICROSOME ASSAY TO EVALUATE FOUR STRUCTURALLY RELATED CHEMICALS 1,2-PHENYLENEDIAMINE, 1,3-PHENYLENEDIAMINE, 1,4-PHENYLENEDIAMINE, AND 4-NITRO-O-PHENYLENEDIAMINE. *Eddie Calhoun* and John M. Zamora, Middle Tennessee State University, Murfreesboro, Tennessee.* Some chemical compounds are able to increase the rate of mutation, and this ability is related to carcinogenicity. Also, it is believed that a chemical's structural features may be potential indicators of mutagenicity. The Ames *Salmonella*-microsome assay was used to determine the mutagenicity of a group of structurally related chemicals. We expected to see differences in mutagenicity due to the slight differences in the structural properties of the chemicals. The toxicity of the chemicals also was tested. This assay was developed by Bruce Ames and Joyce McCann of the University of California at Berkeley and uses four mutant strains of *Salmonella typhimurium*. Four positive controls (sodium azide, 4-nitroquinoline-oxide, 2-aminoanthracene, and 4-nitro-o-phenylenediamine) were tested to assure the validity of the assay. The test chemicals used in this assay were 1,2-phenylenediamine, 1,3-phenylenediamine, and 1,4-phenylenediamine. The positive control, 4-nitro-o-phenylenediamine is structurally very similar to the other three test chemicals. All of the chemicals were tested with and without enzyme extract (S9 fraction) from livers of rats. The S9 fraction was used to mimic mammalian metabolic processes. The structural relationships of the different chemicals may help to assess the potential mutagenicity of carcinogenicity of new untested chemicals.

PREVALENCE OF THE *ESCHERICHIA COLI* HEAT-LABILE ENTEROTOXIN GENE IN BACTERIA ISOLATED FROM THE CUMBERLAND RIVER SYSTEM. *Laynie D. Shebester* and Don C. Dailey, Austin Peay State University, Clarksville, Tennessee.* Even though bacterial contamination of drinking water is not considered to be a problem in the United States, recreational waters represent potential sources of bacterial pathogens. *Escherichia coli* is widely used to indicate the presence of pathogenic bacteria. Many investigations fail to consider the pathogenic potential of *E. coli*. A major virulence determinant for *E. coli* is the production of enterotoxin. The prevalence of enterotoxigenic *E. coli* in the Cumberland River was investigated. Water was collected from five sites, and fecal coliforms were enumerated. Presence of enterotoxin was determined by colony-hybridization techniques using the heat-labile enterotoxin gene from *E. coli* ATCC 37218. Plasmid analysis was performed on representative isolates to confirm the hybridization results. Samples from four of the five sites revealed the presence of enterotoxigenic *E. coli*. Prevalence ranged from 5 to 17 CFU/ml. These results demonstrate the risk of infection by pathogenic *E. coli* to recreational water users.

THE USE OF ANTISENSE OLIGONUCLEOTIDE TECHNIQUES TO STUDY METABOTROPIC GLUTAMATE RECEPTOR FUNCTION. *Carolyn D. Conley*, Danny Winder, and Prem S. Kahlon, Tennessee State University, Nashville, Tennessee.* Metabotropic glutamate receptors (mGLURs) are coupled to effector systems through GTP-binding proteins (G-proteins) and appear to mediate slow synaptic responses in the central nervous system. Although mGLUR-mediated increases in phosphoinositide hydrolysis have been well characterized, other mechanisms for signal transduction employed by mGLURs are inconclusive. Research has shown there are at least seven different subtypes of mGLURs with the most abundant being mGLUR₅ and mGLUR₇ within the hippocampus. Furthermore, activation of these receptors by a nonselective mGLUR agonist 1-aminocyclopentane-1S, 3R-dicarboxylic acid (1S, 3R ACPD) increases biochemical and physiological responses in hippocampal slices from the rat. A selective antagonist has not been found for any of the mGLUR subtypes which makes it difficult to distinguish which second-messenger systems are coupled to a specific subtype. The goal is to determine whether ACPD-stimulated phosphoinositide hydrolysis in the hippocampus was mediated by mGLUR₅. Antisense oligonucleotides directed against specific mGLUR subtypes were used. Hippocampus was treated with antisense mGLUR₅ control oligonucleotide (scrambled) or water control by intraventricular injections with a total of eight injections at 12-h intervals; 24 h after the last injection, the animals were sacrificed and subsequently used for various studies (i.e., second-messenger assay, western blot, and electrophysiology). Studies are currently underway to determine if the antisense did or did not decrease mGLUR₅ protein in the hippocampus.

ETHICAL ANALYSIS OF A CLINICAL ENCOUNTER. *Scott O. Guthrie* and Randall Harris, David Lipscomb University, Nashville, Tennessee.* The moral dimensions of medicine involving conflicts of interests in the therapeutic dyad are explored. The case analyzed involves a child with acute cystic fibrosis. This unique clinical situation pits the wishes of the mother of the child against the wishes of medical science and the attending physicians. The conclusion reached is that the decision should be based neither on passive acquiescence to the mother's wishes nor blind devotion to the preservation of life. Any decision in any case should be based on a broader evaluation of the entire, unique clinical situation.

SOME THEOLOGICAL AND BIOLOGICAL CONSIDERATIONS ON THE ORIGIN OF HUMAN LIFE. *Robert H. O'Bannon, Lee College, Cleveland, Tennessee.* Public policy regarding the morality of abortion is largely determined by the prevailing view of when human life actually begins. Citizens' views in the United States have polarized around those of Pro-Life or Pro-Choice camps. Unfortunately, those who are supposed to know the most about life, the biologists, are seldom consulted by either camp in supporting or establishing a rationale for their given position. Using classical scientific criteria, I offer support for the view that the organisms resulting from the union of the human sperm and ova is indeed alive and very human. Further support for the conclusion will be drawn from conservative theological viewpoints.

THE REGULATION OF GLUTAMATE TRANSPORTER PROTEINS IN AMYGDALOID KINDLING. *Christopher W. Conn*, Heather K. Prince, P. Jeffrey Conn, and Alan Levey, Lee College, Cleveland, Tennessee (CWC, HKP, JC), and Emory University, Atlanta, Georgia (AL).* The levels of immunoreactivity of the glutamate transporter subtypes (GLT-1, EAAC-1, and GLAST) were assessed in amygdala-kindled and control animals 24 h after the last stage-5 seizure. Using antipeptide antibodies that recognize the C-terminal domains of each transporter and quantitative immunoblotting, the levels of each

transporter was determined in three regions of the brain of the rat: hippocampus; piriform cortex; limbic forebrain. No apparent change was seen in the levels of GLT-1 in kindled as opposed to control animals. The levels of EAAC-1 were increased by 20% in the hippocampus and 45% in the piriform cortex 24 h after the last seizure, and initial studies have shown a substantial decrease in the levels of GLAST in kindled animals.

PHYSICS AND ASTRONOMY SECTION

Arnold M. Heiser, Presiding

OBSERVATIONS OF BERRY'S TOPOLOGICAL PHASE IN AN UNDERGRADUATE LABORATORY EXPERIMENT. *Anthony B. Kaye* and R. F. Haglund, Jr., Vanderbilt University, Nashville, Tennessee.* The deep analogies between quantum mechanics and optical physics have been exploited in a number of settings to provide insight into the abstractions of quantum physics. Many of these analogies can be demonstrated to good effect in the undergraduate optics laboratory, including one- and two-slit interference experiments and the quantum eraser. We describe an example of another concept in quantum mechanics which has an analog in optical physics, the concept of topological phase. We have measured Berry's topological phase for photons propagating in a single-mode, polarization-preserving, helical fiber. We describe a simple physical interpretation of the trajectory of the photon in *k*-space, based on the concept of anholonomous parallel vector transport. The rotation of polarization experienced by the light as it traverses the helical path of the fiber agrees well with the calculated value.

INFRARED-ULTRAVIOLET PHOTOCHEMISTRY OF PROTEIN-NUCLEIC ACID SYSTEMS. *John A. Kozub* and Glenn A. Edwards, Vanderbilt University, Nashville, Tennessee.* Many proteins that interact with DNA can be photochemically crosslinked at the binding site by exposing the complex to ultraviolet photons. The covalent-bond linking protein to DNA is resistant to denaturing conditions, allowing harsh biochemical assays to determine the point of contact. The yield of crosslinked complexes depends on the reactivity of protein and nucleic-acid components at the binding site; nonspecific reactions that constitute sample degradation can occur at comparable rates, limiting the usefulness of the technique. We are using a pulsed ultraviolet laser and the Vanderbilt Free Electron Laser to investigate the potential of simultaneous infrared and ultraviolet irradiation to induce new photochemistry and to influence reaction pathways in these systems. In the ongoing study, we have identified a unique photoproduct produced by 3.88 μm F.E.L. light, with enhanced yield resulting from simultaneous ultraviolet exposure.

SEVEN SPOTTED EGGS. *Anthony B. Kaye* and D. S. Hall, Vanderbilt University, Nashville, Tennessee.* We studied seven different ellipsoidal, binary star systems (zeta And, BL CVn, UV CrB, V826 Her, GX Lib, iota Tri, and EE UMa) to look for suspected starspot activity. Each previously had been found variable due to the ellipticity effect. Although never established quantitatively, several had shown inklings of variability due to starspots. We determined, through analysis of all radial velocities available in the literature, a definitive orbital ephemeris for each. All known photometry, previously published plus unpublished of our own presented here for the first time, was analyzed. We removed the ellipticity effect by Fourier analysis and examined the remaining residuals for any variability characteristic of starspots, finding it in all seven, $\leq 8\%$ in the extreme case. In the process, the photometry confirmed the best values for the orbital ephemerides and

evaluated the depths of the two minima caused by ellipticity, slightly unequal due to the "pointed end" effect.

THE LONG PERIOD CEPHEID Y OPHIUCHI. *A. M. Heiser and Elizabeth C. Easterly**, Vanderbilt University, Nashville, Tennessee (AMH), and Franklin Road Academy, Nashville, Tennessee (ECE). The Cepheid variable Y Ophiuchi has been observed in two colors, V and B, for five seasons with the Vanderbilt University 16-inch Automatic Photoelectric Telescope (APT) based in Arizona. Due to a number of equipment changes made to our APT, it was necessary to make seasonal adjustments to the data ranging from 0.007 to 0.019 magnitudes in V and from 0.006 to 0.016 magnitudes in B. The final total number of available observations in V was 288, while the number in B was 291. These observations were used to determine the best periods of light variation for each season, in V and B. Within the errors of the observations, it is clear that the period of the light variation of Y Ophiuchi has remained constant during the time interval of our data. This period, 17.1269 days, agrees well with the periods determined from comparable photoelectric data collected since ca. 1982. On the other hand, analyses of most of the data available for >75 years does show a definitive period change, in the sense that the period of Y Ophiuchi has been increasing.

SCIENCE AND MATH TEACHERS SECTION

Judith M. Bonicamp, Presiding

A TIME-USAGE STUDY OF STUDENTS IN A CHEMISTRY LABORATORY. *Terrence A. Lee and B. James Hood*, Middle Tennessee State University, Murfreesboro, Tennessee. A time-usage study was conducted on laboratory students in the Quantitative Analysis laboratory at Middle Tennessee State University. Traditionally, the laboratory has been operated on the "open laboratory" principle. During the study, students were requested to sign in and out of the laboratory, and the amount of time spent by the students was compared with the analytical results achieved by the students. Estimates of the amount of time required to complete each experiment were based upon student-reported times. No correlation was observed between the amount of time spent on any given experiment and student-reported analytical results. For the Spring semester, the amount of time available for the students was dramatically reduced compared to the Fall semester. No significant difference was noted between the amounts of time reported and student results.

EFFECTIVENESS OF VARIATIONS IN COLLABORATIVE CO-OPERATIVE LEARNING IN RDS MATHEMATICS CLASSES. *R. Frederick Harding and Richard K. Fletcher, Jr.*, White County High School, Sparta, Tennessee (RFH), and Tennessee Technological University, Cookeville, Tennessee (RKF). This study was conducted over two semesters at Tennessee Technological University. Students in a remedial mathematics course were studied for the first semester and students from a developmental mathematics course were used in the second semester. Students were divided into four groups: traditional cooperative learning; ability-aligned cooperative learning; alphabetical cooperative learning; non-cooperative control. Each of the groups were pretested with the AAPP test for mathematics and posttested with the same instrument at the end of the semester. Though results did not indicate statistically significant differences favoring the cooperative learning groups over the non-cooperative control group, the greatest gains were by the regular cooperative groups. The other cooperative learning groups did not gain appreciably different from the non-cooperative groups.

UNDERSTANDING CALCULUS: GRAPHICAL CONNECTIONS BETWEEN A FUNCTION AND ITS DERIVATIVE. *Leslie Aspinwall*, Middle Tennessee State University, Murfreesboro, Tennessee. Calls for reform in the way that calculus is taught stress the importance of instruction focused on graphic as well as analytic representations of functions and derivatives. The value of calculus lies in its potential to reduce complex problems to simple rules and procedures. However, students taught only rules and procedures often emerge from calculus classrooms without the ability to analyze graphs and lack an understanding of the conceptual foundations of the slope of a tangent line. Study based solely on analytic representations of functions and their derivatives often produces only procedural understanding. Graphic instructional representations for functions and their derivatives and students' concomitant images have the potential for producing a richer understanding than that achieved by analytic study alone. Stimulated by graphic instructional representations, students form and can utilize mental images to understand the calculus derivative and demonstrate their unique internal mathematical representations.

DESIGNING AND IMPLEMENTING A STUDENT-FRIENDLY GEL-PERMEATION CHROMATOGRAPHY EXPERIMENT. *Jubran M. Wakim and Nabil Wakid*, Middle Tennessee State University, Murfreesboro, Tennessee. Gel-permeation chromatography is used routinely in protein-purification procedures. The technique also can be used to estimate the molecular weights of proteins. We designed an experiment to introduce students in an introductory biochemistry course to this technique. A 0.1- to 0.2-ml sample of a mixture of colored proteins was applied to a Sephacryl S-300 superfine column. The proteins were eluted from the column with a phosphate buffer, pH 7.0 and 0.5-ml fractions of eluate were collected in test tubes. The peak fraction of each protein component was easily determined visually, and the eluate volume was measured with a graduated cylinder. A plot of log MW versus eluate volume gave a straight line. The student also can identify the protein present in an unknown from its elution volume. The experiment is simple, fast, and demonstrates effectively the separation of proteins by this technique on the basis of molecular size.

A SURVEY OF HEALTH-RELATED ISSUES OF SENIOR-HIGH-SCHOOL STUDENTS IN TWO RURAL COUNTIES OF TENNESSEE. *Richard K. Fletcher, Jr., and Barbara Ann Litherland*, Tennessee Technological University, Cookeville, Tennessee. This study included responses from 655 students from one senior high school from grades nine through 12 and 208 students from a second high school from grades 10 and 11. The study relates to the following concerns: school violence such as fighting and weapons in school; mental health issues such as contemplated suicide; cigarette smoking; use of alcohol; drug use; sexual habits; information relating to AIDS-HIV. Findings indicated that approximately one fourth or more of the students have considered suicide with >10% actually making some form of more serious plans. Forty-five percent of the group indicated they had used alcohol >10 times in their lives. Approximately 12% of the group had used marijuana \geq 10 times. Over 55% of the group indicated they had had sexual intercourse with one fourth of these indicating they did not use any form of prevention from pregnancy. Of these students (55.3%), 47.6% did not use a condom and 22.8% did not use any form of pregnancy prevention.

EFFECTS OF NONPOINT SOURCE POLLUTION ON AN URBAN STREAM. *Betty C. Davis*, University High School, Johnson City, Tennessee. Student volunteers from University High School have participated in an after-school enrichment program which gives them instruction in freshwater ecology and stream-monitoring techniques. Nine sites along the upper 8 km of Brush Creek in Johnson City,

Tennessee, were monitored from November 1990 through October 1993 to determine the effects of urban, nonpoint source pollution on stream quality. Water depths and velocity were used to calculate stream flow ($Q = AXV$); dissolved oxygen and total hardness were determined using LaMotte chemical test kits; macroinvertebrates were gathered with kick nets and tallied by Izaak Walton League survey standards. Results show chemical parameters within acceptable recorded ranges. Near the headwaters, macroinvertebrate index values were good but were reduced to fair, poor, or very poor as the creek flowed through urban areas. Land use surrounding Brush Creek is impacting the available food chain as indicated by the decreasing macroinvertebrate index values.

THE EFFECTS OF FRAMING ON CHOICE: A TEST OF TWO THEORIES. *Darryn Roberts**, *Douglas Wedell*, and *Prem S. Kahlon*, *Tennessee State University, Nashville, Tennessee*. An experiment was conducted in order to investigate the ability of Prospect and Fuzzy trace theories to predict framing effects on subjects' justifications of their choices. Subjects read a series of problems framed in terms of gains or losses and made choices between two alternatives. Immediately after each choice, they wrote down an explanation of their decision. Explanations were coded into five major categories. Overall, justifications were highly correlated with their choices. Fuzzy Trace theory predicts that subjects should justify their choices in terms of "saving some" under the gains frame and "avoiding loss" under the losses frame. This prediction was statistically supported. The Prospect theory prediction was that subjects should justify their choices as "worth the risk" under the losses frame. This prediction also was statistically supported.

NONTRADITIONAL STUDENTS SUCCEEDING IN MATHEMATICS AT A COMMUNITY COLLEGE. *Ken Evans*, *Roane State Community College, Harriman, Tennessee*. This study compared grades of students who had completed the developmental mathematics course at a community college over two independent variables (gender and age of the student). Comparisons were made in a regular freshman English course, a regular freshman college mathematics course, and in the developmental mathematics course. Results from the analysis-of-variance procedure indicated that students who were over the age of 25 made significantly ($P = 0.01$) higher grades in the English course than the students who were under the age of 25. No statistically significant ($P \geq 0.05$) difference was found by age when scores in the two mathematics courses were compared. Female students scored significantly ($P = 0.01$) higher than male students on the developmental mathematics course, but no statistically significant ($P \geq 0.05$) difference was found when comparisons were made by gender on scores for the regular English and mathematics courses.

AN INVESTIGATION OF THE EFFECT OF ALTERNATE INSTRUCTIONAL MODES ON THINKING SKILLS IN COLLEGE BIOLOGY STUDENTS. *Sarah F. Barlow*, *Middle Tennessee State University, Murfreesboro, Tennessee*. The purpose of the research project was to investigate the effect of alternate instructional modes on thinking skills in college biology students. Participants in the study were students enrolled in an one-semester, general education, biology course. The Group Assessment of Logical Thinking (GALT) was used to stratify students into one of three levels of cognitive development: concrete; transitional; formal. Analysis of pretest and posttest scores (GALT) for each group (group A = students in lecture setting and group B = students in alternate instructional setting) shows no significant difference. On the basis of these findings, type of instructional strategy does not affect the thinking skills of students enrolled in an one-semester biology course. Recommendations for further research include extending the study over a longer period of time and within a series of courses.

FIRST READ THE PROBLEM. *Roy W. Clark*, *Middle Tennessee State University, Murfreesboro, Tennessee*. Good students miss problems because of not reading the problem carefully before beginning to work it. I report the results of a diagnostic test and a follow-up test which was designed to address this problem.

THE DEVELOPMENT OF A TENNESSEE SCIENCE FRAMEWORK. *Jack Rhoton*, *East Tennessee State University, Johnson City, Tennessee*. A K-12 Science Curriculum Framework is being developed to positively impact science education in Tennessee. It is a thoughtful response to a variety of reforms, beginning with the Tennessee Landmark Education Improvement Plan of 1992. This document will incorporate ideas from the National Science Education Standards Project, AAAS's Project 2061, as well as other state and national reform initiatives. This session will detail the progress of this effort.

ZOOLOGY SECTION I

Cindy L. Taylor, Presiding

MORTALITY AND ECOLOGICAL OBSERVATIONS ON ROCK IGUANAS (*CYCLURA RILEYI RILEYI*) OF GUANA KEY, SAN SALVADOR ISLAND, THE BAHAMAS. *Carolyn Jones**, *Gayle Livingston**, and *Chris Keith**, *The University of Tennessee at Chattanooga, Chattanooga, Tennessee*. In spring 1994, we studied an isolated population of the rock iguana, *Cyclura rileyi rileyi*, on Guana Key, an island situated in an interior lake of San Salvador Island, The Bahamas. Based on sightings of ca. 10 living animals (including two or more juveniles) and carcasses of eight adults, there is concern regarding imminent extirpation of this once thriving population. We estimate a total population of 25 iguanas. Because dead animals were in similar states of decay, their deaths likely resulted from a common cause. Analyses of samples of water, sediment, and vegetation as well as samples of carcass tissue and fecal matter did not indicate conclusively the cause of mortality. Living animals exhibited no evidence of disease. Vegetation, likewise, is healthy and more than adequate (>40 species of plants), but nesting space may be limited, perhaps leading to poor reproductive success. Behavioral observations suggest the iguanas are highly territorial.

POPULATION ESTIMATES, MORPHOLOGICAL VARIATION, AND CONSERVATION OF THE SAN SALVADOR ISLAND ROCK IGUANA, *CYCLURA RILEYI RILEYI*. *Brent Goodge**, *David Brouhard**, *William K. Hayes*, *Danette M. Hayes**, and *Ronald L. Carter*, *Southern College, Collegedale, Tennessee (BG, DB, WKH, DMH)*, and *Loma Linda University, Loma Linda, California (RLC)*. The San Salvador Island rock iguana (*Cyclura rileyi rileyi*) is a subspecies of one of three endangered species in The Bahamas. Essentially absent from the mainland, seven populations persist on tiny offshore-inshore keys. Lincoln-Peterson and other census methods suggest a total of 500-600 individuals. We captured, examined for gender, measured, and permanently marked 80 iguanas on four of these keys. Iguanas on Guana Key (inland lake, ca. 1.5 ha, >40 species of plants) and Low Key (offshore, 10 ha, >30 species of plants) were significantly larger than those on Green Key (offshore, 4.8 ha, 10 species of plants) and Manhead Key (offshore, 3.0 ha, 15 species of plants). Thus, plant diversity is associated with body size. External parasites (ticks) were found only on animals on Guana Key. Populations are threatened by feral rats (Low Key), regionally introduced *Cactoblastus* moths that consume *Opuntia* cacti (Green Key), tar-creosote ingestion (Manhead Key), and an unknown cause of mortality (Guana Key).

DEMOGRAPHY OF THE RACCOON (*PROCYON LOTOR*) IN WESTERN TENNESSEE. *John R. Ouellette**, *Philip M. Thevenet**, *Raymond Woodward**, and *Michael L. Kennedy*, *The University of Memphis, Memphis, Tennessee*. During September of 1989 to 1994, demographic data for the raccoon (*Procyon lotor*) were collected from hunter-harvested animals taken on the Hatchie National Wildlife Refuge. Four external measurements, age, and sex were determined and recorded for 373 raccoons. Age was estimated based on tooth wear. Selected individuals were examined for external parasites and litter size. Preliminary results are discussed.

INCIDENCE OF MISIDENTIFICATION BETWEEN *MUSTELA FRENATA* AND *MUSTELA ERMINEA* IN SELECTED NORTH AMERICAN MUSEUMS. *Michelle J. Richard** and *Howard H. Thomas*, *The University of Memphis, Memphis, Tennessee*, and *Fitchburg State College, Fitchburg, Massachusetts*. To assess the taxonomy of the long-tailed weasel (*Mustela frenata*) and the ermine (*Mustela erminea*), a method for separating the two species was applied to each. Two cranial measurements were taken on 1,793 specimens at five North American museums. The validity of the method was tested by comparing animals found in sympatry as well as those in allopatry. Preliminary results are discussed.

ASSESSMENT OF THE SYSTEMATICS OF *URSUS AMERICANUS LUTEOLUS* AND *URSUS AMERICANUS FLORIDANUS*. *Juliann L. Waits** and *Michael L. Kennedy*, *The University of Memphis, Memphis, Tennessee*. To assess the taxonomic status of black bears (*Ursus americanus luteolus* and *U. a. floridanus*) in the southeastern United States, skulls were examined from selected museum collections in North America. Sixty-nine cranial characters from adult black bears were measured from photographs using a digital image analysis system. Bears were sexually dimorphic, and, therefore, data for males and females were analyzed separately. Preliminary results are discussed.

COMPARATIVE STUDIES ON EVOLUTION OF THE PREDATORY BEHAVIOR OF CROTALINE SNAKES. *Scott DeLay** and *William K. Hayes*, *Southern College, Collegedale, Tennessee*. Pitvipers comprise a diverse and highly specialized group of venomous snakes that, in North America, are represented by three genera. The purpose of this study was to compare their predatory behaviors when feeding on mice. From slow-motion analyses of videotaped feeding episodes, we quantified several prey-handling and poststrike behaviors. Results indicated that representatives of the more primitive genus, *Agkistrodon* (cottonmouths especially), were more inclined to strike repeatedly at prey than the more derived rattlesnake genera (*Sistrurus* and *Crotalus*). Likewise, *Agkistrodon* (copperheads in particular) more frequently held on to prey rather than releasing them after the strike. Rattlesnakes typically exhibited poststrike immobility, whereas cottonmouths tended to follow prey subsequent to striking. Because rattlesnakes are generally more specialized to feed on rodents, these differences may reflect an evolutionary trend toward minimizing risks associated with feeding on relatively large and dangerous prey.

FEEDING STRATEGIES OF THE COYOTE (*CANIS LATRANS*) IN WESTERN TENNESSEE. *Marjorie E. Grogan** and *Michael L. Kennedy*, *The University of Memphis, Memphis, Tennessee*. To assess the impact of coyotes (*Canis latrans*) on domestic and native fauna, scats were collected from three sites in western Tennessee. Populations of rabbits and rodents also were assessed for these three sites to determine relative abundance of the primary foods. Abundance of fawns at the three sites was assessed through spotlight counts. Preliminary reports have shown that the foods taken in the greatest frequencies are rabbits, cotton rats, persimmons, and various insects.

PREDATORY BEHAVIOR OF MIDGET-FADED RATTLESNAKES (*CROTALUS VIRIDIS CONCOLOR*) FEEDING ON MICE AND LIZARDS: STRIKING, PREY-HANDLING, VENOM EXPENDITURE, AND A TEST OF VENOM ADAPTEDNESSES. *Heidi Canósa** and *William K. Hayes*, *Southern College, Collegedale, Tennessee*. Feeding behavior of the midget-faded rattlesnake (*Crotalus viridis concolor*) is poorly understood. While juveniles probably consume mostly lizards, the adults apparently switch largely to rodents but also continue to feed on lizards. We compared the predatory behaviors of adults feeding on wild mice (*Peromyscus maniculatus*) and on lizards (*Sceloporus undulatus*). Predatory behaviors, analyzed by review of slow-motion videotape, indicated that snakes struck and released mice and lizards but they were less successful striking at and more often bit the posterior regions of lizards. Venom expenditure, quantified by enzyme-linked immunosorbent assay (ELISA), was similar for both prey species. Lizards were more resistant to the venom and survived much longer than mice. Artificial (syringe) injection of midget-faded and prairie rattlesnake (*C. v. viridis*) venoms (neurotoxic versus hemotoxic, respectively) suggest that neither venom is particularly adapted for killing either type of prey.

PRELIMINARY RESULTS OF TURTLE-POPULATION STUDIES AT REELFOOT LAKE. *David E. Collins*, *James E. Deck*, *Emily Hickerson*, and *George W. Benz*, *Tennessee Aquarium, Chattanooga, Tennessee (DEC, GWB)*, and *The University of Tennessee at Martin, Martin, Tennessee (JED, EH)*. Casual reports of increases in harvests of turtles at Reelfoot Lake, combined with a general increase in concern for nongame management, recently prompted the Tennessee Wildlife Resources Agency to seek quantitative data on the status of populations of turtles at Reelfoot Lake. We report the 1st year's progress of a 2-year study aimed at assessing population structures and stability of populations of turtles in Reelfoot Lake, conducted through a partnership among Tennessee Wildlife Resources Agency, the Tennessee Aquarium, and The University of Tennessee at Martin. The study was designed to use species- and population-specific data obtained from mark and recapture techniques, age and growth studies, and fecundity studies to develop predictive life table models. Aging is critical to this study and a method formerly used to age turtles has been modified and used during the project's 1st year. The significance and implications of this study to conservation management of long-lived species is discussed.

WINTER BALD-EAGLE POPULATIONS AT REELFOOT LAKE AND CORRELATION WITH ENVIRONMENTAL FACTORS. *John P. Nelson, Jr.*, and *Vicki A. Syler**, *Bethel College, McKenzie, Tennessee*. Monthly population counts of bald eagles (*Haliaeetus leucocephalus*) at Reelfoot Lake, Tennessee, were examined for the winter seasons (December-march) from 1980 through 1993. During this time, the annual maximum monthly count ranged from 91 to 240, with the average number of adults (52.7) being significantly higher than the average number of juveniles (39.5). Numbers of adult and juvenile eagles did not differ significantly across the years. Counts for both age classes were significantly lower in March than in the other recorded months. Correlation analysis showed that counts of adult eagles were negatively associated with maximum and minimum average monthly temperatures, counts of teals (*Anas discors* and *Anas cyanoptera*), and counts of wood ducks (*Aix sponsa*) and positively associated with counts of Canada geese (*Branta canadensis*) and counts of total waterfowl. Counts of juvenile eagles were positively associated with counts of black ducks (*Aix rubripes*) and counts of total waterfowl.

ZOOLOGY SECTION II

Willodean D. S. Burton, Presiding

DEFINING ASSOCIATIONS OF MOBILE SPECIES USING PRESENCE-ABSENCE MODELS. *Troy A. Ladine* and Michael L. Kennedy, The University of Memphis, Memphis, Tennessee.* The use of coefficients of association determined from presence or absence data was evaluated using mark-recapture data for two mobile species, Virginia opossum (*Didelphis virginiana*) and raccoon (*Procyon lotor*). Associations were assessed using a multiple live-trapping procedure (per site) and multivariate statistical analysis. Lack of independence between cells in 2 x 2 contingency tables did not violate assumptions of the analysis. However, frequency of the more common Virginia opossum significantly affected the coefficient. Coefficients of association increased as duration of the study increased.

WHALE SHARKS IN THE SEA OF CORTEZ. *Diane R. Nelson and Eugenie Clark, East Tennessee State University, Johnson City, Tennessee, and University of Maryland, College Park, Maryland.* Whale sharks were observed during an expedition to the Sea of Cortez near La Paz, Mexico, on 1 and 2 November 1993. Seven young whale sharks were feeding at the surface within 1 km of shore ca. 2 km north of the phosphate dock at San Juan. The animals were photographed and videotaped from the boat and by snorkelers in the water. When the sharks were actively feeding, part of the head was out of water, with the mouth opening and closing 9-21 times/min ($\bar{X} = 17/\text{min}$). The opening and closing of the mouth was synchronized with the opening and closing of the gills. Feeding behavior occurred only in patchy areas of cloudy water. Planktonic samples were collected at the surface and at a depth of 1-2 m with an innovative plankton net. Zooplankton were very dense in the surface samples; one copepod species (*Acartia clausi*) was dominant. This is the first record of young whale sharks feeding on a planktonic bloom of copepods.

DISTRIBUTION OF PARASITIC COPEPODS IN THE OLFACTORY SACS OF BLUE SHARKS. *Joshua W. Kohl* and George W. Benz, Tennessee Aquarium and University of Tennessee at Chattanooga, Chattanooga, Tennessee, and Tennessee Aquarium, Chattanooga, Tennessee.* The distribution of *Kroeyerina elongata* within the olfactory sacs of blue sharks was studied. Numbers of *K. elongata* per olfactory sac ranged from zero to 228, with female copepods typically outnumbering males. A weak relationship existed between the number of copepods per olfactory sac and shark fork length. Copepod orientation suggested both sexes to be positively reotaxic. Oviparous females usually attached along the second half of the rachis or within the first third of the excurrent water channel, while males tended to attach randomly about the secondary lamellae of the olfactory sac. The few subadult females that were collected distributed themselves like males. Results suggest some mechanisms through which the observed distribution of *K. elongata* is achieved. Comparison of results with those of a prior study focusing on a confamilial copepod reveals similarity which might be based on attachment-site homology and which might represent significant evidence regarding the origin of the olfactory sacs of vertebrates.

SPATIAL DISTRIBUTIONS OF PARASITIC COPEPODS ON SCALLOPED HAMMERHEAD SHARKS CAPTURED OFF NORTH CAROLINA. *Kristy L. Smedley* and George W. Benz, Tennessee Aquarium and The University of Tennessee at Chattanooga, Chattanooga, Tennessee, and Tennessee Aquarium, Chattanooga, Tennessee.* The distribution of two parasitic copepod genera (*Alebion* and *Pandarus*) on the external body surface of scalloped hammerhead sharks was investigated. The number of individual *Pandarus* per shark typically

was greater than the number of individual *Alebion*, and the weak relationship that existed between total number of copepods per shark and shark fork length was largely determined by the genus *Pandarus*. *Alebion* and *Pandarus* seemed to prefer different body regions for attachment. Most female *Alebion* attached just below the trailing free edge of the first dorsal fin, while most male *Alebion* attached on the ventral body surface between the pelvic fins and the origin of the caudal fin. Female and male *Pandarus* were mostly collected from the ventral surface of the head; however, males were more locally concentrated about the lower jaw and additionally were more evenly distributed over the rest of the body. Results suggest some possible mechanisms through which the niches of these two genera of copepods might be realized.

HOST EFFECTS ON THE DEVELOPMENT OF *RHODNIUS PROLIXUS* (HEMIPTERA: REDUVIIDAE: TRIATOMINAE). *David Ekkens, Stephen Nyirady, and Jamie DeLay*, Southern College, Collegedale, Tennessee.* *Rhodnius prolixus* is obligate blood-feeding bug. The gut of kissing bugs is typically inhabited by microorganisms (usually bacteria) that supposedly produce one or more necessary nutrients that are lacking in the blood meal. When fed on a rabbit, aposymbiotic bugs (those lacking microorganisms in their guts) cannot complete development to the adult stage. If they are fed on mice, they develop normally. We report work that demonstrates that some aposymbiotic bugs can become adults when fed primarily on rabbits if they are given blood from mice at certain stages of their development. Perhaps, blood from rabbits contains some material which represses development. Further work will focus on identifying this factor(s). Our results suggest that only a small amount of blood from mice is needed for normal development.

CHONDROITINASE ACTIVITY OF *EDWARDSIELLA ICTALURI* AS A VIRULENCE DETERMINANT IN CHANNEL CATFISH. *Don C. Dailey, Austin Peay State University, Clarksville, Tennessee.* *Edwardsiella ictaluri* is the most frequently isolated bacterial pathogen of farm-raised channel catfish. Infected catfish develop an acute, highly fatal septicemia or a chronic, slowly necrotizing infection of the cranium. The mechanisms of pathogenesis and disease progression are unknown. A key factor in the development of the cranial lesion is chondroitinase activity. The purpose of this investigation was to characterize chondroitinase activity in *E. ictaluri*. All clinical isolates of *E. ictaluri* and cultures of *Edwardsiella tarda* and *Edwardsiella hoshinae* hydrolyzed chondroitin sulfate. In quantitative assays, the clinical isolates of *E. ictaluri* displayed higher levels of activity. The enzyme is specific for chondroitin sulfate and does not cleave other proteoglycans. In a nutrient-limited environment, chondroitin sulfate can serve as an energy source for *E. ictaluri*. Continued characterization of chondroitinase in *E. ictaluri* will focus on its significance to the disease process.

THE ROLE OF BRAIN-DERIVED NEUROTROPHIC FACTOR IN THE MORPHOLOGICAL DEVELOPMENT OF RETINAL AXON ARBORS IN THE FROG *XENOPUS*. *Nadine Bewry*, Hollis Cline, and Prem S. Kahlon, Tennessee State University, Nashville, Tennessee.* During the development of the nervous system in the frog *Xenopus*, each eye sends a topographical projection to the contralateral optic tectum and establishes synaptic connections with specific target cells. Many factors are believed to play a role in the process of target recognition and synapse formation. Studies have shown that neurotrophins are factors that play a role in the proliferation and survival of neurons. The neurotrophin called brain-derived neurotrophic factor is produced by *Xenopus*; however, its function is not fully understood. We seek to uncover the effects of brain-derived neurotrophic factor on the morphological

development of retinal azon arbors that are projected to the optic tectum, using *Xenopus* as the model.

AN ECOLOGICAL SURVEY OF TARDIGRADES FROM GREENE MOUNTAIN, TENNESSEE. *Rebecca G. Adkins* and Diane R. Nelson, East Tennessee State University, Johnson City, Tennessee.* Few ecological studies of tardigrades have been conducted in Tennessee. The purpose of this study was to survey the tardigrades in different habitats on Greene Mountain, Greene Co., Tennessee. Samples were collected in May 1993 from mosses, lichens, and pine needles at three sites: mixed hardwood-pine forest (eight samples); hardwood forest (eight samples); rock cliff (two samples). The sites were located at different altitudes and exposures. The tardigrades were identified and photographed under an Olympus BH-2 phase-differential interference contrast microscope at a magnification of 40-100x (oil immersion). Eleven genera were represented in the samples: *Pseudechiniscus*; *Echiniscus*; *Hypechiniscus*; *Milnesium*; *Macrobotus*; *Minibiotus*; *Hypsibius*; *Isohypsibius*; *Diphascos*; *Itaquascon*; *Ramazzottius*. Species diversity was compared within the three sites and with previous studies of tardigrades from other mountains in Tennessee.

DIEL VERTICAL MIGRATION OF *LEPTODORA KINDTII* (FOCKE) (CRUSTACEA: CLADOCERA) IN REELFOOT LAKE, TENNESSEE. *Emily C. Hickerson*, W. A. Sliger, and W. L. Smith, The University of Tennessee at Martin, Martin, Tennessee.* The diel vertical migration of the freshwater cladoceran *Leptodora kindtii* (Focke) has been observed and quantified for many years. Published accounts of these migrations were in lakes north of 40° latitude and varied in their results. Changes in the vertical distribution of *L. kindtii* were determined over two 24-h periods at a site in Reelfoot Lake, Tennessee. Reelfoot Lake is shallow, eutrophic, and homogenous with respect to temperature. During the first 24-h period (19-20 May 1992), individual *L. kindtii* were significantly concentrated at the surface from 1400 to 2000 h (DST). From 2200 through 0400 h, the vertical distributions were random. At 0600 h, individuals again were clumped at the surface. At 1000 h, individuals were contagiously distributed, this time with the greatest concentration occurring at the 2-m depth. Ascents of *L. kindtii* corresponded with the times of greatest change in light intensity, which were sunrise, sunset, and prior to a rainstorm. The numbers of *L. kindtii* found during the second 24-h period (3-4 August 1992) were insufficient for determining contagion in their distribution. However, the depths of the average individual during that 24-h period suggest two ascents corresponding to the times just prior to sunset and to sunrise.

ULTRASTRUCTURE OF THE GONADS AND GENITALIA OF FEMALE *BRACHYCENTRUS INCANUS* (INSECTA: TRICHOPTERA). *David Bruce Conn, The University of the South, Sewanee, Tennessee.* Caddisflies are ecologically important in freshwater systems throughout the world; yet, little is known about their reproductive systems. In the present study, adult female *Brachycentrus incanus* were examined microscopically to elucidate major features of the ovaries and genital sclerites. Light microscopy and transmission electron microscopy were used to examine the ovary. Because *B. incanus* is among the few insects known to carry egg masses externally during flight, scanning electron microscopy was used to determine whether exoskeletal modifications exist that might facilitate egg-mass retention. The ovary consisted of numerous merostic polytrophic ovarioles, each containing at least one maturing egg chamber (oocyte, follicle, and nurse cells). The posterior sclerites of the abdomen were formed into an egg-mass receptacle that partially surrounded and appeared to grasp the gelatinous egg mass. This constitutes the first detailed ultrastructural study of reproductive organs in this large, cosmopolitan order of insects.

CHEMICAL EFFECTS OF THE EASTERN NEWT (*NOTOPHTHALMUS VIRIDESCENS*) ON THE GROWTH, DEVELOPMENT, AND REPRODUCTION OF CLADOCERANS. *Willodean D. S. Burton and Cindy L. Taylor, Austin Peay State University, Clarksville, Tennessee.* The integrity of aquatic ecosystems is determined by the organism's response to environmental factors. These factors may be biotic (species interactions) or abiotic (chemicals). Chemicals may be added to an aquatic ecosystem from outside sources or from sources within. The effects of which may lead to changes in population structure. Thus, the purpose of this study was to examine the effects of chemicals released by the eastern newt (*Notophthalmus viridescens*) on the survival and reproduction of the water flea (*Ceriodaphnia dubia*). Neonate *C. dubia* were placed in control ($n = 15$) and treatment ($n = 15$) groups. *Ceriodaphnia dubia* were fed (trout chow yeast and algae), and exposure water was changed daily; also, vials were checked for neonates. Preliminary data indicate that the treatment group had lower reproductive output than the control group. No difference was noted in survivorship.