

ABSTRACTS OF PAPERS PRESENTED AT THE 103RD ANNUAL MEETING

BOTANY SECTION

Harris O. Yates, Presiding

COMPARATIVE ECOPHYSIOLOGY OF A RARE AND WIDESPREAD SPECIES OF *ECHINACEA* (ASTERACEAE). **Carol J. Baskauf**, *Austin Peay State University, Clarksville, Tennessee*. Among various potential causes of rarity, one explanation could be that a rare species has more narrow physiological tolerances to important environmental variables than does a widespread species. To test this hypothesis for a rare species of plant, photosynthetic performance as a function of irradiance and temperature was compared for the cedar glade endemic *Echinacea tennesseensis* and its widespread congener *Echinacea angustifolia* following various light and soil preconditioning regimes. Although the two species differed in some morphological characteristics such as specific leaf area, both species demonstrated similar photosynthetic light-response curves on a leaf area basis, with low to moderate photosynthetic capacity. Thus, no photosynthetic differences were found which could account for the contrasting geographic distributions of the endemic species and its widespread congener.

A SPORULATION MEDIUM FOR *BOTRYTIS CINEREA*. **Jing-Tian Ling, Eddie Williams, and Roger J. Sauve**, *Tennessee State University, Nashville, Tennessee*. Spore Production by *Botrytis cinerea* was evaluated on potato dextrose agar and on water agar supplemented with ground oak and poinsettia leaves. No sporulation was observed when *B. cinerea* was plated on potato dextrose agar; however, maximum mycelial growth was obtained. When water agar was supplemented with 5 to 30 g/l of powdered oak or poinsettia leaves, sporulation was significantly increased. Maximum sporulation occurred in water agar supplemented with 15 to 30 g/l of leaf powder. Spore production was greater at 22°C than at 18 or 25°C.

THE INFLUENCES OF METHIONINE SULFOXIMINE ON PROTEIN AND RNA SYNTHESIS IN SOYBEAN CALLI. **Min Zheng*, E. Lewis Myles, and Carolyn Alexander-Caudle**, *Tennessee State University, Nashville, Tennessee*. The use of soybean as a food source is rapidly increasing. To reduce its yield loss to disease, research in disease resistance of soybeans is of great significance. Bacterial blight is one of the most prevalent bacterial diseases of soybean. It is caused by the pathogenic bacterium *Pseudomonas syringae* pv. *glycinea* which produces a pathogenic toxin (tabtoxin) that inhibits glutamine synthetase activity. Inhibition of glutamine synthetase can cause cell death in plants. As a potent and highly specific inhibitor of glutamine synthetase, methionine sulfoximine, an amino acid analogue, can mimic the effects of tabtoxin. In this study, seedlings of two cultivars (weber and pioneer) were used to initiate callus growth. After formation of callus tissue, 0.5 g of callus tissue was transferred to media containing 0, 2, 4, 8, 12, and 16 μ M of methionine sulfoximine. After 4 weeks, they were removed, weighed, and stored at -70°C. Later, the tissues were used to isolate proteins and RNA. The proteins were analyzed by one- and two-dimensional polyacrylamide-gel electrophoresis and a BIO-RAD video densitometer. The total RNA was separated by size in a formaldehyde, denaturing, 1% agarose gel. Results showed that 3.39, 2.82, 0.90, and 3.92 g of callus tissue were produced by weber hypocotyl and pioneer

hypocotyl, root, and stem, respectively, at the control level of treatment. With increases in concentration of methionine sulfoximine, total grams of callus tissue were increased in the pioneer hypocotyl but reduced in weber hypocotyl and pioneer roots and stems. The average total amount of protein per gram of tissue was reduced in response to methionine sulfoximine in weber and pioneer hypocotyl but increased in pioneer root and stem. The total amount of RNA was increased in 4 and 8 μ M of methionine sulfoximine in weber. This indicates that protein synthesis of pioneer root and stem is more than that of weber and pioneer hypocotyl. RNA synthesis may be directly involved in resistant reaction of soybean to bacterial blight. Densitometer analysis demonstrated that resistant expression may require de novo synthesis of certain new proteins.

AN ATLAS OF TENNESSEE VASCULAR PLANTS--ANOTHER INITIATIVE. **Edward W. Chester, B. Eugene Wofford, and Robert Kral**, *Austin Peay State University, Clarksville, The Tennessee, University of Tennessee, Knoxville, Tennessee, and Vanderbilt University, Nashville, Tennessee*. Efforts toward documenting the distribution of vascular plants in Tennessee have been underway since the early 1940s. Mimeographed checklists, monocots in 1956 and dicots in 1960, were prepared by A. J. Sharp, R. E. Shanks, and their associates at the University of Tennessee, Knoxville. B. E. Wofford and A. M. Evans began a second initiative in the early 1970s, publishing maps of several families in the *Journal of the Tennessee Academy of Science*; that effort soon stalled. We began a computer assisted atlas in 1990, based on specimens at APSC, TENN, and VDB (more than one-half million sheets). The first volume, including ferns and fern allies, gymnosperms, and monocots, was published, with the help of H. R. DeSelm and A. M. Evans, in the summer of 1993. We hope to complete the second volume (dicots) by 1996.

FRANK LAMSON-SCRIBNER: EXTRAORDINARY BOTANIST-PLANTPATHOLOGIST, THE UNIVERSITY OF TENNESSEE, 1888-1894. **J. W. Hilty and E. C. Bernard**, *The University of Tennessee, Knoxville, Tennessee*. (Poster presentation) Frank Lamson-Scribner, an 1873 graduate of the University of Maine, taught botany in public schools and, in 1885, became assistant and special agent in the Division of Botany with the United States Department of Agriculture. He became the first federal plant pathologist when appointed Chief of the new Section of Vegetable Pathology. He introduced Bordeaux Mixture to the United States, and his work with French scientists was the first international cooperation in phytopathology. In 1888, Scribner accepted the position of professor in the Department of Botany and Horticulture and botanist to the Experiment Station at the University of Tennessee. He initiated the department with the purchase of the renowned Gattinger Herbarium. His lectures on economic fungi were the first at the University. He published extensively on Tennessee grasses and plant disease of potato caused by a nematode, subsequently named *Pratylenchus scribneri*. Scribner was a charter member of The Botanical Society of America and, in 1889, was decorated Chevalier du Merit Agricole by the French Government. From 1890 to 1894, before returning to government service, Scribner served as Director of the Agricultural Experiment Station.

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CELL AND MOLECULAR BIOLOGY SECTION I

John W. Harris, Presiding

IMMUNOCYTOCHEMICAL ANALYSIS OF MICROTUBULE COLD-STABILITY IN THE AMPHIBIAN CELL LINE ATCC CCL-128. **Ronald L. McDonald***, **R. Howard Berg**, and **Charles A. Lessman**, *Memphis State University, Memphis, Tennessee*. The cold-stability of the cytoplasmic microtubule complex was examined in cells of the amphibian cell line ATCC CCL-128 of the leopard frog, *Rana pipiens*. The cells were grown in vitro at 20°C for 3 h. The cells were chemically fixed and permeabilized at their respective temperatures and were labeled with either of two primary monoclonal anti-alpha tubulin antibodies, DM1A or 6-11B-1. The cells were subsequently treated with a fluorescent anti-IgG antibody and viewed using an epifluorescence light microscope. ATCC CCL-128 cells kept at 0°C for 3 h had DM1A and 6-11B-1 stained microtubules, although the degree of polymerization varied compared to control cells at 20°C. Therefore, the CCL-128 cell line exhibits a population of cold-stable microtubules which do not depolymerize when subjected to 0°C. These data suggest that, in the CCL-128 cell line, factors exist that prevent cold temperature depolymerization of microtubules.

ANTIBODY MICROINJECTION INTO MATURING OOCYTES OF THE AMPHIBIAN GENUS RANA. **Catherine Woods*** and **Charles A. Lessman**, *Memphis State University, Memphis, Tennessee*. Monoclonal antibodies (including DM1A and IFA) specific to cytoskeletal proteins were injected into progesterone-treated oocytes of the frog, genus *Rana*, to study the effect of perturbation of the cytoskeletal system on meiotic maturation. Microinjected cells were still viable after 24 h, and progesterone-treated controls injected only with K⁺-saline underwent maturation. Injection of colloidal gold was used to visualize injectate distribution after silver enhancement. Short-term incubation (<2 h) resulted in a localized deposit of injectate, whereas, after 24 h, the injectate was dispersed throughout the cell. Injection of DM1A resulted in strong inhibition of maturation at all progesterone concentrations used. IFA injection was without effect at high concentrations of progesterone but appeared to slightly enhance maturation at low concentrations of progesterone. These results indicate that microinjection of monoclonal antibodies should be a useful technique for elucidating the role of the cytoskeleton in oocyte maturation.

AN INDUCIBLE CECROPIN-LIKE PEPTIDE AND LYSOZYME FROM HEMOLYMPH OF *HELIOTHIS VIRESCENS* LARVAE. **Timothy D. Lockey*** and **Donald D. Ourth**, *Memphis State University, Memphis, Tennessee*. An inducible cecropin-like peptide was isolated from larval hemolymph using gel filtration and cation-exchange chromatography. The cecropin-like peptide had an estimated molecular weight of 7,500 daltons by urea-SDS polyacrylamide-gel electrophoresis. The molecular weight of lysozyme from the larval hemolymph was estimated to be 16,000 daltons by urea-SDS polyacrylamide-gel electrophoresis. Antibacterial activity of the cecropin-like peptide was determined using acid polyacrylamide-gel electrophoresis with a bacterial agar overlay. The cecropin-like peptide showed bactericidal activity against *Escherichia coli* K12 D31. Lysozyme activity was specific for *Micrococcus lysodeikticus*.

USING THE AMES *SALMONELLA*/MICROSOME ASSAY TO EVALUATE THREE STRUCTURALLY RELATED CHEMICALS, TYRAMINE, ACETAMINOPHEN, AND PARA-ALPHA-AMINOETHYLPHENOL. **Sandra R. Ermini*** and **John M. Zamora**, *Middle Tennessee State University, Murfreesboro, Tennessee*. Various chemical compounds increase the rate of mutation. The ability to induce

mutation is related to a chemical's carcinogenicity. It is believed that a chemical's structural features are potential indicators of its mutagenicity or carcinogenicity. The *Salmonella*/microsome assay, developed by Bruce Ames and Joyce McCann of the University of California at Berkeley, uses four mutant strains of *Salmonella typhimurium* to detect the potential mutagenicity of chemicals. This assay was used to assess the mutagenic potential of three structurally related chemicals: tyramine, acetaminophen, para- α -aminoethylphenol. The chemicals were tested with and without the addition of a rat liver extract (S9 fraction) which exposed the chemicals to mammalian metabolic processes. These chemicals also were tested for toxicity to the *Salmonella* strains. Structural relationships may serve as a basis to assess the potential mutagenicity and carcinogenicity of new, untested chemicals being introduced into the environment.

THE SENSITIVITY AND SPECIFICITY OF A DNA PROBE FOR *ACANTHAMOEBAE*. **B. D. Hopkins***, **John W. Harris**, and **Susan Goss**, *Tennessee Technological University, Cookeville, Tennessee*. The polymerase chain reaction was used to amplify and biotinylate a 98 base-pair segment of the gene that codes for 18S rRNA in *Acanthamoeba castellanii*. The sensitivity and specificity of this labeled probe then was determined using Southern blots and dot blots. The sensitivity limit of the probe for the amplified region was determined to be 8.5 ng/ml for *A. castellanii*, 9.5 ng/ml for *A. culbertsoni*, and 14.0 ng/ml for *A. polyphaga*. Genomic DNA was detected with as little as 15.0 ng/ml. The probe was found to hybridize with DNA from six species of *Acanthamoebae* belonging to the morphological groups 2 and 3. Five of the six are known to cause acanthamoeba keratitis, a sight-threatening disease. The probe did not hybridize with DNA from two species of *Acanthamoebae* from group 1 or with that of nine other species tested.

CELL AND MOLECULAR BIOLOGY SECTION II

Charles J. Biggers, Presiding

SEX-LINKAGE OF GLUCOSEPHOSPHATE ISOMERASE AND GENE-CENTROMERE MAPPING OF THE SEX-DETERMINING GENE IN CHANNEL CATFISH. **Qinghua Liu**, **Cheryl A. Goudie**, **Bill A. Simco**, and **Kenneth B. Davis**, *Memphis State University, Memphis, Tennessee (QL, BAS, KBD)*, and *Catfish Genetics Research Unit, USDA-ARS, Stoneville, Mississippi (QL, CAG)*. Sex-linkage of glucosephosphate isomerase-B (GPI-B) was observed from two experimental matings in channel catfish (*Ictalurus punctatus*). The parental phenotypes for GPI-B were found in 84.8% of the progeny, which showed that the sex-determining gene was linked with GPI-B. The crossing-over rate was 15.2%. Equality of the two recombinant classes indicates the crossing-over between X and Y chromosomes followed the same pattern observed in autosomes. Sex-reversed XY females were used to produce five gynogenetic families which allowed an estimation of gene-centromere distance of sex-determining gene. Approximately even sex ratios from the gynogenetic families indicated that a low rate of recombination occurred between the sex-determining gene and the centromere of the X and Y chromosomes. Comparison of recombination rates among centromere, GPI-B, and sex-determining gene suggested that the linkage arrangement would be sex-determining gene-centromere-GPI-B. Comparative phylogeny reveals evolutionary conservation of sex-linked gene arrangement in fishes.

GENETIC ANALYSIS OF ESTERASE II OF A POPULATION OF *ANTHONOMUS GRANDIS* FROM WESTERN TENNESSEE. **Laressa A. Dickey***, **Harold R. Bancroft**, and **Charles J. Biggers**, *Memphis State University, Memphis, Tennessee*. Esterases in the cotton boll

weevil, *Anthonomus grandis*, have been demonstrated by electrophoresis to consist of four components (I-IV). Esterase II shows a variation of two mobilities, fast and slow. The two enzyme bands (fast and slow) of esterase II have been demonstrated to be autosomal codominant alleles. A population of weevils from western Arkansas has been shown to be in equilibrium when compared to Hardy-Weinberg. A population from western Tennessee was shown to have an excess of homozygotes and, thus, was out of equilibrium. In this study, one population from River Bluff Road in western Tennessee was shown to be in equilibrium beginning as early as 1977. A homogeneity chi-square test of the data showed that the equilibrium of the population has been statistically the same since 1977. F_1 weevils from squares collected when the adult weevils were obtained from the field were analyzed.

THE GALACTOSE METABOLIC PATHWAY OF *AZOTOBACTER VINELANDII*. X. T. Yao* and T. Y. Wong, Memphis State University, Memphis, Tennessee. The bacterium *Azotobacter vinelandii* metabolized galactose via the DeLey-Doudoroff pathway. Galactose, once transported into the cell, was converted to galactonate by a NAD-dependent dehydrogenase. Subsequent metabolism of galactonate required the presence of ATP and resulted in the formation of equal molar of pyruvate and glyceraldehyde-3-P. The intermediate metabolites of this pathway was quantitated by HPLC and confirmed by enzymatic analysis. Radiorespirometry studies with position labeled ^{14}C -galactose and mass balanced analysis of carbon distribution showed that the first carbon of the galactose molecule was preferentially released as CO_2 during galactose oxidation. Only two species of pseudomonas have been reported to utilize the DeLey-Doudoroff pathway. The galactose dehydrogenase of *A. vinelandii* exhibited different enzyme kinetics than those reported in the pseudomonas.

TOXICOLOGICAL ASSESSMENT OF MUTAGENIC AMINES METABOLICALLY PRODUCED FROM AZO DYES. King-Thom Chung, Chris A. Murdock*, Ssu-Ching Chen*, Tit-Yee Wong, S. Edward Stevens, Jr., and Ying-Sing Li, Memphis State University, Memphis, Tennessee. A wide variety of azo dyes are used in industry. These dyes may eventually be released into the soil or otherwise ingested by animals or humans. These dyes can be cleaved by microorganisms into different kinds of aromatic amines. Many of these aromatic amines are toxic, and some are mutagenic. Comparative studies of several hundred types of azo compounds indicated that the mutagenic ones are limited to those containing *p*-phenylenediamine and benzidine moieties. We will focus our study on the toxicological effect of *p*-phenylenediamine and benzidine and their derivatives. Ames *Salmonella*/microsomal mutagenicity assay will be employed to test their mutagenicities. The compounds' impact on soil productivities will be determined by monitoring the growth and nitrogen-fixation rates of *Azotobacter vinelandii* growing on media containing these aromatic amines. The mutagenic activities and biological responses will correlated with the chemical structures.

OBSERVATIONS OF SURFACE MORPHOLOGY OF HUMAN CHROMOSOMES USING ELECTRON MICROSCOPY. D. W. Bath, Austin Peay State University, Clarksville, Tennessee. The surface ultrastructure of trypsin-banded chromosomes has been examined by electron microscopy. Bands observed with the electron microscope appear as alternating greater and lesser concentrations of chromatin fibrils along the chromosomes. It is possible to view the entire chromosomal complement of a cell and construct karyotypes using electron photomicrographs. Each chromosome can be identified and can then be analysed individually to detect possible ultrastructural anomalies.

CHARACTERIZATION OF ADHESION OF PLATELETS IN WHOLE PLASMA TO FIBRINOGEN. J. M. Derrick*, Memphis State University, Memphis Tennessee. The interactions of platelets with fibrin(ogen) are central to their role in hemostasis. Fibrinogen is a bivalent molecule with respect to putative αRGDS platelet binding sites and γ chain carboxy terminal platelet binding sites. We previously demonstrated a requirement for bivalence with regard to fibrinogen γ chain platelet binding sites for PGE1 treated (resting) washed platelet adhesion. Stimulated washed platelets adhered equally to fibrinogen fragments containing either one or two functional γ chains. Here, I report that nonstimulated (no exogenous agonist) platelets in platelet-rich plasma adhere to bivalent forms of fibrinogen in a fashion independent of thrombin activity, intraplatelet levels of cAMP, and plasma ADP. However, adhesion to monovalent forms of fibrinogen by nonexogenously stimulated platelets from platelet-rich plasma may be dependent on both intraplatelet levels of cAMP and intrinsic plasma ADP but is independent of thrombin activity.

CHEMISTRY

Charles M. Baldwin, Presiding

THE ^{31}P -NMR CHARACTERIZATION AND HPLC SEPARATION OF PHOSPHONATO COMPLEXES WITH *CIS*-DIMMINE-DICHLOROPLATINUM(II). Bradley W. Lake* and Lori L. Slavin, Austin Peay State University, Clarksville, Tennessee. Reactions of *cis*-dimmedichloroplatinum(II) with phosphonoformic acid, phosphonoacetic acid, and methylenediphosphonic acid yield various phosphonatoplatinum(II) chelates which have been characterized by phosphorus-31 NMR spectroscopy and separated by HPLC. Phosphonoformic acid and phosphonoacetic acid formed monomeric chelates with platinum(II) with characteristic 6 to 12 ppm downfield chemical shifts compared to the uncomplexed ligands. In addition to the monomeric chelate, methylenediphosphonic acid formed a bridged diplatinum(II,II) complex when reacted with *cis*- $\text{Pt}(\text{NH}_3)_2(\text{H}_2\text{O})_2^{2+}$. The chemical shift-pH profiles yielded the acid dissociation constants and were determined by an iterative non-linear least-squares computer fit. The chelates were separated by HPLC utilizing three buffers which included formate, phosphate, and acetate buffers. The extent of hydrolysis was investigated as well. Implications of the various binding modes of the phosphonates in relationship to their antiviral activities have been explored.

CAUTION AGAINST STATIC DRYING OF ACETONE- d_6 WITH 4A MOLECULAR SIEVE. Paul D. Dodson*, Martin V. Stewart, Jeffery D. Male*, Paul R. Buckingham*, and James C. Howard, and Arthur K. Davis, Middle Tennessee State University, Murfreesboro, Tennessee (PDD, MVS, JDM, PRB, JCH), and Frank Phillips College, Borger, Texas (AKD). If drying of acetone- d_6 is tried with a 4A molecular sieve, the initial removal of water is followed by a production of D_2O that exceeds 0.3 M for a sample of the NMR solvent stored over the zeolite for several months. This conclusion is based on the NMR spectra of hydroquinones and alcohols, whose integrated peak areas for exchangeable hydroxyl protons were consistently lowered when the sample was dissolved in the "dried" solvent. Molecular sieve is proposed to catalyze enolization and aldol condensation to afford 4-hydroxy-4-methyl-2-pentanone- d_{12} , whose elimination to mesityloxide- d_6 produces 1M of D_2O for every 2 M of acetone- d_6 consumed. It is especially injurious to attempt drying acetone- d_6 with 4A molecular sieve for use as a solvent in proton NMR studies because the various reaction products and byproducts are not observed in the spectrum and an erroneous opinion concerning the purity and even the nature of the solvent may result.

EVALUATIONS OF STERIC EFFECTS ON RATES OF RADICAL BIMOLECULAR SELF-REACTION BY FAST-SCAN CYCLIC VOLTAMMETRY. **Rudy Gostowski and Mark J. Bausch**, *Austin Peay State University, Clarksville, Tennessee, and Southern Illinois University, Carbondale, Illinois*. Delocalized organic radicals previously considered persistent (9-phenylfluorenyl, and 9-(2,4,6-trimethylphenyl)fluorenyl) were found to undergo bimolecular self-reactions at rates differing by seven orders of magnitude. Blockage of the 9-C orbital holding the unpaired electron attenuates the combination of these anisotropic radicals. Fast-scan cyclic voltammetry has facilitated these determinations. Irreversible peak potentials were corrected for the observed kinetic effects. By means of a thermochemical cycle, the homolytic C-H bond dissociation energies were calculated for the molecules examined. Previously determined homolytic C-C dimer dissociation energies were combined with radical oxidation potentials measured by the fast-scan cyclic voltammetry to estimate the energetics of a heterolytic cleavage. Evaluation of this data for the 9-phenylxanthenyl and 9-phenylfluorenyl dimers and their associated acids indicates that C-C cleavage is controlled by bond strain while C-H dissociation is determined by the stability of the products.

SYNTHESIS AND STRUCTURAL CHARACTERIZATION OF ALKALINE EARTH COMPLEXES WITH PENTADIENYL LIGANDS. **Jason S. Overby*, and Timothy P. Hanusa**, *Vanderbilt University, Nashville, Tennessee*. The pentadienyl ligand has found great utility in the chemistry of the transition metals, in part from the conformational flexibility of the C₅ chain. Complexes are known in which the pentadienyl ligand adopts η¹, η², or η⁵ geometries. We have found that the reaction of alkali metal salts of pentadienyl anions with the diiodides of the heavy alkaline earth metals yields thermally stable alkaline earth pentadienyl complexes. Using the 2,4-di-*t*-butyl pentadienyl anion, the "open calcocene," [2,4-(*t*-Bu)₂C₅H₃]₂Ca(THF), crystallizes as a mono-THF solvate with the dienyl ligands in a staggered conformation. This arrangement is unlike a corresponding zinc complex which has the ligands bound to a η¹ fashion. Possible reasons for this difference and general synthetic and structural features of this new class of main-group complexes will be presented.

DERIVATION OF BOILING POINT ELEVATION AND FREEZING POINT DEPRESSION EQUATIONS FROM GRAPHICAL REPRESENTATIONS. **Harvey F. Blanck**, *Austin Peay State University, Clarksville, Tennessee*. There are several mathematically equivalent methods commonly used in physical chemistry textbooks to derive the freezing point depression and boiling point elevation equations for a nonvolatile solute in a dilute solution whose solvent obeys Raoult's law. While the mathematical derivations are adequate, some students respond better to visual presentations of systems in the form of graphs. Physical chemists are especially fond of straight lines. The effect of temperature upon the equilibrium vapor pressure of a liquid is almost always depicted as a graph of a ln p versus 1/T which produces an approximately straight line whose the slope and y-intercept are shown to be $-\Delta H_{\text{vap}}/R$ and $\Delta S_{\text{vap}}/R$, respectively. This graph may be modified using Raoult's law to produce a second straight line below and parallel to that of the pure solvent. From this, it is easily seen that ΔH_{vap} for the solution is the same as that of the pure solvent but with a lower ΔS_{vap} . Furthermore, the boiling point elevation equation is easily obtained from the two lines on the graph. This may be readily extended to the freezing point depression equation. This method, in addition to creating more visual representations, also connects Raoult's law directly to these effects without reference to chemical potential.

SYNTHESIS AND THEORETICAL STUDIES OF SOME 2,2'-DISUBSTITUTED-1,1'-BINAPHTHYLS. **Eugene A. Kline, Scott H. Northrup, and Gregory J. Andrews***, *Tennessee Technological University, Cookeville, Tennessee*. 1,1'-Binaphthyl-2,2'-diol (I) was converted to the 2,2'-dibromide (II) and then to other disubstituted analogues for use in mechanistic studies. One unique property of these isomers is their optical activity. Theoretical studies with the various substituents were studied for their ability to retain optical activity. Calculations were then extended to other similar molecules of interest including [a.k.]dibenzophen-anthryls, 9,9'-dianthracenyls, 9,9'-diphenanthryls, and 1,1'-dipyrenyls.

THE CRYSTAL AND MOLECULAR STRUCTURES OF THE 4-CYANOPYRIDINE AND N,N-DIMETHYLFORMAMIDE ADDUCTS OF TETRAKIS(2,6-DIMETHYLPHENYLACETAMIDO)DICHROMIUM(II). **William H. Isley and Subhash Baral**, *Middle Tennessee State University, Murfreesboro, Tennessee*. The crystal and molecular structures of the 4-cyanopyridine (1) and the N,N-dimethylformamide (2) adducts of tetrakis(2,6-dimethylphenylacetamido)dichromium(II), Cr₂[O(CH₃)N(C₆H₄(2,6-CH₃))]₄, will be discussed. Compound 1 crystallizes in the space group P2₁2₁2 with unit cell dimensions of a = 16.906(4) Å, b = 12.096(2) Å, c = 13.405(3) Å, α = β = γ = 90.0°, and Z = 2. Compound 2 crystallizes in the space group P4₂c with unit cell dimensions of a = 11.193(2) Å, b = 11.193(2) Å, c = 18.474(5) Å, α = β = γ = 90.0°, and Z = 2. This structure was refined to R_f = 0.058 and R_w = 0.081. Both compounds exhibit octahedral geometry about each of the chromium atoms. Two 4-cyanopyridine ligands occupy the axial chromium positions in compound 1 with Cr-Cr-N_{ax} = 178.6(4)° and Cr-N_{ax} = 2.396(9) Å. Two N,N-dimethylformamide ligands occupy the axial chromium positions in compound 2 with Cr-Cr-O = 180.00(4)° and Cr-O = 2.388(11) Å. For compound 1, Cr-Cr = 2.272(4) Å, Cr-O_{av} = 2.009(9) Å, and Cr-N_{av} = 2.089(10) Å. The corresponding data for compound 2 are Cr-Cr = 2.249(4) Å, Cr-O_{av} = 1.967(9) Å, and Cr-N_{av} = 2.144(8) Å.

ISOLATION OF AN ANTIBODY THAT RECOGNIZES THE INOSITOL 1,4,5-TRIPHOSPHATE RECEPTOR WITHIN HUMAN PLATELET INTERNAL MEMBRANE VESICLES. **Tiffany J. Riley*, Todd M. Quinton*, William L. Dean, and Charles R. Thomas**, *The University of Tennessee at Martin, Martin, Tennessee (TJR, CRT), and The University of Louisville, Louisville, Kentucky (TMQ, WLD)*. When inositol 1,4,5-triphosphate (IP₃) binds to its receptor that is on the surface of the dense tubular system within human blood platelets, a calcium channel is opened. This flow of Ca²⁺ into the cytoplasm will activate the platelet for clotting. This activation can possibly be inhibited by cAMP-dependent phosphorylation of the IP₃ receptor. To show this phosphorylation, immunoprecipitation of the IP₃ receptor has been chosen. In order to do this immunoprecipitation, an antibody is needed to recognize the IP₃ receptor. Since the platelet IP₃ receptor has not been purified, a small sequence of rat brain IP₃ receptor was used to generate an antibody. This antibody was used with SDS polyacrylamide-gel electrophoresis to identify the IP₃ receptor protein present in platelet membrane vesicles. The antibody bound to a protein which showed a distinct band at about 260 KD which agrees with other known sources of IP₃ receptor. Therefore, an antibody has been isolated that recognizes the IP₃ receptor within human platelet internal membrane vesicles.

PREPARATION AND USE OF THE METAL ION AND pH INDICATING SILICA GEL BEADS. **S. K. Airee, Joshua Crews*, Rebecca Brockwell*, and Jennifer Tyree***, *The University of Tennessee at Martin, Martin, Tennessee*. After saturation with water vapor to avoid

disintegration on soaking, the silica beads were impregnated with various acid-base and metal ion indicators by using approximately 0.1 M solutions of each reagent. One or two of these reagent beads were used to identify a metal or estimate the pH. Thus, potassium ferricyanide bead gave a blue color with ferrous ion, potassium thiocyanate bead turned red with ferric ion, and dimethyl glyoxime bead became red in the presence of the nickel ion. Thymol blue bead was blue in base and colorless in acid. Beads impregnated with the red cabbage extract displayed various shades from red to purple depending on the pH of the solution. In order to conduct the quantitative studies to fit the Freundlich adsorption isotherm of dimethyl glyoxime on silica, an analytical procedure was developed using the cobalt ion complex instead of the usual gravimetric and messy dimethyl glyoxime-nickel ion complex. Beer's law plots provided fair consistency over a range of 0.08 to 0.80 M solutions of dimethyl glyoxime.

ENGINEERING SECTION

Gladius Lewis, Presiding

USE OF RADIATION CONTROL COATINGS TO REDUCE CEILING HEAT FLUX IN HOT CLIMATES. *David W. Yarbrough and Rajakumar Nachimuthu, Tennessee Technological University, Cookeville, Tennessee.* Radiation control coatings are materials with minimum solar reflectance of 0.75 and minimum ambient temperature emittances of 0.75. Radiation control coatings are produced from exterior-grade, white paint by adding substances to increase the solar reflectance. Twenty formulations of radiation control coatings, containing a variety of additives, were studied. Solar reflectances as high as 0.83 were measured for radiation control coatings containing TiO₂ or glass microspheres. A small test unit was designed to measure roof temperatures and ceiling fluxes. The test unit was used to measure roof temperatures as a function of roof angle for reflective and non-reflective coatings. The roof with a reflective coating had temperatures 25 to 30°C less than the roof with a non-reflective coating. The ceiling heat fluxes with the reflective coating were, therefore, much lower than those with a non-reflective coating. The building simulator "BLAST" was used to assess the annual benefit of using radiation control coatings on the roofs of buildings.

GEOGRAPHIC SURVEY AND EARTHQUAKE VULNERABILITY ASSESSMENT OF SELECTED ESSENTIAL FACILITIES IN WEST TENNESSEE. *Tzzy-Shiou Chang, Shahram Pezeshk, Kwong Cheng Yiak, and Hsiang-te Kung, Memphis State University, Memphis, Tennessee.* In an earthquake-prone area, the risk of property loss and casualties strongly depends upon the built environment in the region. Earthquakes from the New Madrid seismic zone are a recognized natural hazard in West Tennessee. The seismic vulnerability potential of highly-occupied or heavily-used essential facilities including schools, hospitals, and fire stations in West Tennessee was examined. In this study, the seismic evaluation system uses existing site-foundation-structural data and results of previous site-specific, seismic hazard studies. Results of the study reveal the current overall risk of damage of the essential facilities subject to the recognized seismic hazard in the study area and identify a pool of the most vulnerable facilities for the highest priority in developing retrofit-replacement plans in the near future. The study provides important data for short-term and long-term facility maintenance-upgrade strategy, seismic hazard mitigation, and earthquake-preparedness plans in the region.

A USER INTERFACE PROGRAM TO CONTROL SIMULATION OF SOFT-ARM ROBOT. *Adel Salama, K. Kawamura, and A. Shabayek, Austin Peay State University, Clarksville, Tennessee (ASa), and Vanderbilt University, Nashville, Tennessee (KK, ASH).* ADAMS (Automatic Dynamic Analysis of Mechanical Systems) is a software package for simulating the force and motion behavior of mechanical systems. ADAMS is used at Vanderbilt University to simulate the Soft-arm robot. The ADAMS model for Soft-arm robot is a full-scale kinematic and dynamic model. It has the capability of controlling simulated robot motions either by entering motion functions for joint angles or by entering forces applied to various points on the robot. This is modified so that the control of simulation is directed by a user interface program. This program reads a series of data sets of joint angles from a file provided by the inverse kinematic at run time. Then, it calls the ADAMS simulation to analyze the required motions and places the required forces into an output file. The developed program was written in FORTRAN-77 and linked with the ADAMS software. Graphical animation of Soft-arm is successfully performed, and the results representing both forces and torques versus time for each joint are tabulated.

MODELING THE BEHAVIOR OF THE RUBBERTUATOR USING FINITE ELEMENT METHOD. *Adel Salama, P. K. Basu, and K. Kawamura, Austin Peay State University, Clarksville, Tennessee (AS), and Vanderbilt University, Nashville, Tennessee (PKB, KK).* The application of finite element method to the Rubbertuator (Rubber-actuator) of the Soft-arm robot at Vanderbilt University is to predict the real-time axial movements of the Soft-arm as a function of air pressure in the Rubbertuator, which essentially consists of a thick-walled rubber tube encased by a special nylon fiber jacket. Such modeling will allow parametric studies of the effect of different material and geometric parameters on the performance of rubbertuator-based robot. The results of such parametric studies can be used to improve the current design or to produce new designs of the robot without the need for expensive and time-consuming process of building and testing a large number of prototypes. The rubbertuator geometry is based on axisymmetric model around the vertical axis and was modeled using quad four-noded elements, which have the property of solid section in two dimensions. A finite-element program was developed and validated against known data for this simple model. Modeling of more complicated test cases of the rubbertuator is under way.

A TOOL EXCHANGE SYSTEM TO IMPROVE THE FLEXIBILITY IN ROBOTICS LABORATORIES. *Chin-Zue Chen, Austin Peay State University, Clarksville, Tennessee.* A tool exchange system, which internally interfaces fluid, electrical, and control lines for various applications, has been developed for a GCA industrial robot. Implemented in the Department of Engineering Technology robotics laboratory at Austin Peay State University, Clarksville, Tennessee, the tool exchange system enables the same robot to perform different tasks as if virtually three GCA robots are in the work station. Student learning is enhanced by the flexibility of utilizing one robot for three tasks in their laboratory projects. Examples will be presented, and the advantages will be described. This system was purchased and developed with the support of National Science Foundation Grant USE-9152520.

FIRST-ORDER MODEL OF CEREBRAL VENOUS BLOOD FLOW DURING ELEVATED INTRACRANIAL PRESSURE. *Chandrika D. Reed*, Naga Buddharaju*, Stanley Lopez, Charles W. Leffler, and Michael L. Daley, Memphis State University, Memphis, Tennessee (CDR, NB, MLD), and The University of Tennessee-Memphis, Memphis, Tennessee (SL, CWL).* Mathematical models are used as tools to isolate factors governing the rise of intracranial pressure due to closed

head-injury. We have developed a dynamic simulation of venous blood flow using Simulink, a commercial software package. A key feature of this model is based on the hypothesis that during elevated intracranial pressure, venous flow through the veins which connect the cerebral veins to the cranial sinuses is briefly stopped during positive pressure inhalation. An electrical circuit model of cerebral venous blood flow which incorporated the proposed "on-off" switching mechanism was used to provide a theoretical analytical description of cerebral venous blood flow. Using recorded arterial and jugular venous pressure signals applied to our proposed simulation, a comparison between the experimentally recorded and the simulated intracranial pressure signals reveals a marked similarity.

DESIGN OF RADIO-CONTROLLED AUDIO-FEEDBACK DEVICE FOR FEEDING HABILITATION. *Brenton R. Turner* and Michael L. Daley, Memphis State University, Memphis, Tennessee.* Because of inadequate self-feeding skills, children with cerebral palsy may suffer from nutritional deficiencies and insufficiencies in physical and social growth. Methods for assisting these children to learn self-feeding skills appear to be needed. Previously, a spoon was designed to provide audio-feedback as a learning-aid to help the neurologically impaired child master self-feeding skills. However, because the device used a wire tether, it appeared to be both cumbersome and distracting to the child. Therefore, a new design which does not utilize a wire tether was developed. This design incorporates a tilt switch and a miniature FM transmitter in the handle of the spoon. The transmitter provides a continuous control signal to a remote electronic relay circuit. When the spoon is within $\pm 22^\circ$ of the horizontal, the remote electronic circuit enables music to play on a tape recorder, and the music is stopped when the spoon is tilted beyond the spill angle. Previous tests indicate that the absence of the wire tether will increase the effectiveness of the use of the spoon as a self-feeding learning aid.

DECREASED VARIATION IN CEREBRAL BLOOD VOLUME DURING INHALATION WITH INCREASING INTRACRANIAL PRESSURE. *Harikrishnan Pasupathy*, Michael Griffith, J. T. Robertson, Charles W. Leffler, and Michael L. Daley, Memphis State University, Memphis, Tennessee (HP, MLD), Wilford Hall Medical Center, San Antonio, Texas (MG), and The University of Tennessee-Memphis, Memphis, Tennessee (JTR, CWL).* The objective of this study was to analyze variation of cerebral blood volume with increasing pressure with and without regulation of cerebral blood flow. Using a laboratory model, changes of intracranial pressure were induced by two distinct methods. One method, an extradurally-placed balloon technique, was designed to raise intracranial pressure without apparent disruption to autoregulation of cerebral blood flow. The other method, induction of severe hypercapnia, was designed to raise intracranial pressure and impair autoregulation by maximally dilating the arterial vessels. Preliminary results indicate that, in both cases, variation of cerebral blood volume decreased during positive-pressure inhalation with increasing intracranial pressure. However, unlike manipulation of intracranial pressure with the balloon technique, increasing intracranial pressure with hypercapnia produced a pronounced decrease in the variation of cerebral blood volume during positive-pressure inhalation. These preliminary results suggest that, during elevated intracranial pressure and impaired autoregulation of cerebral blood flow, variations of cerebral blood volume during inspiration are minimal.

SOURCES OF OXYGEN-DEMANDING MATERIALS TO TVA RESERVOIRS. *Julia Burr Avera* and John A. Gordon, Tennessee Technological University, Cookeville, Tennessee.* Diffuse sources of oxygen-demanding materials such as particulate and dissolved carbon

and organic and ammonia nitrogen are transported into reservoirs by hydrologic processes of precipitation, infiltration, surface runoff, and streamflow. This project involves sampling 13 different streams which flow into eight tributary projects within the Tennessee Valley. The eight reservoirs being studied include Douglas, Cherokee, Norris, South Holston, Watauga, Chatuge, Nottely, and Blue Ridge. The study focuses on oxygen-demanding materials within inflow streams which may be related to non-point source pollution. Six drainage basins are expected to contain higher loadings of nutrients and materials which would exert a higher oxygen demand, thus lowering the oxygen level within the hypolimnion of the reservoir. Watauga and Blue Ridge are included as control reservoirs as they should have minimal oxygen depletion.

CONSTRUCTED WETLANDS FOR MUNICIPAL WASTEWATER TREATMENT--AN ANALYSIS. *Mathavan Kaliyasundaram and John A. Gordon, Tennessee Technological University, Cookeville, Tennessee.* Constructed wetlands are man-made wetlands used for treating municipal and agricultural wastewater, acid-mine drainage waters, and small-scale industrial wastes such as pulp-mill wastes. Constructed wetlands aid the reduction of BOD, pathogens, hydrocarbon, and nitrogen removal of the municipal wastewaters. They also act as sinks for trace metals, phosphorus, and suspended solids. This paper deals with the analysis of hydraulic features, loading factors, successes, and failures of the two different types of constructed wetland systems. This analysis is based on the questionnaire results obtained for 47 constructed wetlands operating systems in the United States.

OXIDATION PERFORMANCE OF COMMERCIAL ALLOYS FOR AN ELEVATED-TEMPERATURE APPLICATION. *Gladius Lewis, Memphis State University, Memphis, Tennessee.* Materials for use as radiant tubes in a gas-fired system must possess an array of desirable properties, notably resistance to oxidizing media, elevated temperature, and environmentally-induced embrittlement. In the present work, the focus is on the resistance of 10 commercial high-temperature alloys to oxidation by pure oxygen gas at 1,100 and 1,200°C. Changes in the weight of the test coupons were monitored, over a period ranging from 80 to 100 h, using a semi-micro/analytical automatic recording balance. The best results were obtained with the INCO MA956 alloy (a ternary Fe-based superalloy). The results are discussed in terms of the effect of dispersed oxides on the oxidation of a ternary alloy. The discussion also includes comments on the other characteristics of INCO MA956 relevant to its use in the aforementioned application.

GEOLOGY AND GEOGRAPHY SECTION

David Lumsden, Presiding

CHANGES IN THE CLAY LAYERS OF HYDRATED BORATE DEPOSITS FROM DEPOSITION THROUGH INCIPIENT METAMORPHISM. *Christopher B. Carbin* and George H. Swihart, Memphis State University, Memphis, Tennessee.* As part of a larger study of hydrated borate deposits, we have utilized clay separation and X-ray diffraction techniques to examine samples from layers in these deposits which previously have been described as mud or claystone. We focused on three deposits spanning the range from still-forming to having undergone incipient metamorphism. "Mud" from the undeformed Quaternary age Searles Lake deposit (CA) generally consists of clay-size but mainly non-clay mineral sediments which are brine-saturated and unconsolidated. Samples of "claystone" from the Miocene age Kramer deposit (CA) consist mainly of smectite-type clay. Although the Kramer material is completely dry and compacted, it is friable, not indurated, and, thus, not true claystone. Samples of

"claystone" from the Miocene-Pliocene age Cemetery deposit (CA) are completely dry, compacted, cemented, and fine-grained and, therefore, fit the definition of the lithified sedimentary rock type "claystone."

DOLOMITE IN THE PEORIA LOESS OF WEST TENNESSEE. *Patrick Drouin**, *Charles Lumsden**, and *David Lumsden*, *Memphis State University, Memphis, Tennessee*. Is the dolomite in loess of the Lower Mississippi Valley detrital or is it related to diagenesis (soil formation)? Samples collected from vertical profiles at two exposures of the Peoria Loess (12.5 to 25.0 ka) along the Mississippi River in Tennessee were analyzed using X-ray diffraction, scanning electron microscopy, and energy dispersive spectroscopy. The dolomite is uniformly near stoichiometric (51% Ca). It systematically decreases from approximately 10 to 0 weight percent upsection. It occurs as discrete 10- to 15- μ m grains, i.e., somewhat smaller than the 15- to 30- μ m mode of associated detrital quartz. The dolomite grains have a rough surface texture more consistent with abrasion than solution. Dolomite does not occur as coatings or void filling. Scanning electron microscopy confirms the conclusion of previous studies that dolomite is detrital.

ESTIMATE OF HISTORICAL SEDIMENTATION RATE IN A CORE FROM REELFOOT LAKE, TENNESSEE. *Robby Valentine**, *June Mirecki*, and *Eugene S. Schweig*, *Memphis State University, Memphis, Tennessee (RV, JM)*, and *United States Geological Survey, Memphis, Tennessee*. Reelfoot Lake (Lake and Obion counties, Tennessee) was significantly enlarged during the 1811-1812 New Madrid earthquakes. Changing agricultural practices in the drainage basin led to increased but variable sedimentation rate in the lake. Average sedimentation rate can be estimated in a core taken from Reelfoot Lake (Moultrie Field in Blue Basin) by correlating the earliest (lowest) appearance of anthropogenic particles found within the sand fractions to the appearance of regional industry or settlement. Particles such as colored glass are interpreted as products of anthropogenic activity. These particles were identified by mineralogy and oil-immersion analysis. Due to the historic lack of industry in Lake Co., Tennessee, during the 19th century, the lowest appearance of anthropogenic particles at 190 to 192 cm may be the result of Tiptonville, approximately 1863, during the Civil War. These data suggest an average historical sedimentation rate of 1.5 cm/year at Moultrie Field. Accelerator mass spectrometric radiocarbon analysis of wood (GX-19016-AMS) from a depth of 83.82 cm (33 inches) in a second core from Blue Basin yielded an age of 128 ± 47 YBP. An average historical sedimentation rate for this core is 0.66 cm/year but could range between 0.47 and 1.03 cm/year.

PALEOLIQUEFACTION STUDIES IN THE NEW MADRID SEISMIC ZONE. *John Craven*, *Li Yong*, *E. S. Schweig*, *M. A. Ellis*, and *M. Tuttle*, *Memphis State University, Memphis, Tennessee (JC, LY, ESS, MAE)*, and *Columbia University, Palisades, New York (MT)*. Accumulating evidence supports a recurrence interval of a few thousand years or less for earthquakes producing strong ground shaking in the New Madrid seismic zone. We have excavated several sites in our search for liquefaction phenomena predating the great New Madrid earthquakes of 1811-1812. One of our sites near East Prairie, Missouri, exhibits clear evidence for two strong events separated by significant time. A lower liquefaction deposit remained at the surface long enough to develop a thick soil horizon. A second liquefaction event was fed through a different source dike. The source dike cuts across the first deposit, completely burying its soil horizon with a layer of sand. Age determinations for these deposits are pending. This site is within 35 km of sites reported by other investigators to show evidence of pre-1811 earthquakes occurring in the past 2,000 years. At several sites just north of the Arkansas border in the Bootheel of Missouri, carbon-14 age determinations and pedological analysis indicate at least two pre-1811

liquefaction events in the past 5,000 years. In the area of Blytheville, Arkansas, sand blows have been archaeologically constrained to be 1,000 to 1,300 years old.

VOLCANIC GRABEN FILL AT EAST EDGE OF REELFOOT RIFT, NORTHWESTERN TENNESSEE. *Richard G. Stearns*, *Vanderbilt University, Nashville, Tennessee*. The edge of Reelfoot Rift, northwestern Tennessee, has positive gravity and magnetic anomalies. Larger spot anomalies are connected by lesser elongate anomalies. However, whether the elongated anomalies came from dikes or dike swarms that extend to an expected 10s of km depth was not calculated. Seismic lines and wells provide some constraints of gravity models for Mississippi Embayment fill and uppermost Paleozoic rocks, but the deeper magnetic sources are unconstrained. It may be significant that a successful combined model was achieved using a thin prism (35 km wide and 2 km thick) of dense (2.75 g/ml) and magnetic ($k = 0.008$ cgs units) rock. The base is 4 km below the land surface. The prism could be mafic flows. This implies an eastern 35-km wide strip of the graben filled with volcanic rock.

DEPOSITIONAL ENVIRONMENT OF PENNSYLVANIAN DEPOSITS ON SIGNAL MOUNTAIN, TENNESSEE. *Richard E. Bergenback and Leah Cantrell**, *The University of Tennessee at Chattanooga, Chattanooga, Tennessee*. Sedimentary structures, such as scours, trough crossbeds, in-channel bars, thin-bedded rippled sandstone, and small sand lenses in shale, in a core taken on Signal Mountain, Tennessee, were used to interpret the depositional environment of Pennsylvanian deposits. The core of the Pennsylvanian Sewanee Sandstone, Signal Point Shale, Warren Point Sandstone and Raccoon Mountain formation shows an architectural arrangement of sedimentary structures which reflect cyclic tectonic activity in an ancient Paleozoic mountainous source area which was situated to the east of present-day Walden Ridge.

DEPOSITIONAL ENVIRONMENT OF ORDOVICIAN CATHEYS FORMATION, DADE COUNTY, GEORGIA. *Richard E. Bergenback, Randal Hale**, and *Richard Orr**, *The University of Tennessee at Chattanooga, Chattanooga, Tennessee*. A quarry has been opened in the Middle Ordovician Catheys Formation on the southeast limb of the Lookout Valley anticline in Dade Co., Georgia. There are 161 cycles of subtidal calcirudite, calcareous siltstone, and green-gray shale exposed in two benches of this quarry (the top and bottom of the Catheys is not exposed in this quarry). The calcirudites are composed of a grain-supported framework of body fossil clasts of bryozoans and brachiopods with matrix material consisting of micrite peloids, calcite cement, and silt-sized quartz grains (extensive dolomitization of micritic materials has taken place). These cycles in the Catheys have been interpreted as storm deposits, but they may be "normal," Ordovician, high-energy tidal deposits.

COSTA RICA AND CAROLINA TERRAINS. *Habte G. Churnet, Greg Brodie, Gyles Allen**, *Scott Blansett**, *Benjamin Ferry**, *Brent Floyd**, *Randal Hale**, *Nannette Johnson**, *Troy Keith**, *Travis King**, *Steve Kuhaida**, *Daniel Lewis**, *Jason Martin**, *Scott Martin**, *Richard Orr**, *Chris Stillwell**, and *Crystal Wooton**, *The University of Tennessee at Chattanooga, Chattanooga, Tennessee*. The mountainous Carolina Terrain of the Paleozoic has since been eroded down to low altitudinal plains and hills of the Piedmont. In contrast, Costa Rica is rising, has active volcanoes, and is predominantly a Cenozoic terrain that exhibits distinctive, island-arc physiographic belts. Lithologies of the belts include: in the magmatic arc, andesitic volcanics in the north and plutonics in the south; in the forearc basin, turbidite sequences and pyroclastics; and, in the frontal arc mafic and

ultramafic rocks, carbonates and siliciclasts. Pillow basalts are excellently exposed at Manuel Antonio, Tamarindo, Playa El Ocotol, and many other beaches of Costa Rica. This report is based on field data assembled during a geologic expedition to Costa Rica in 1993 and relates the geology of the two terrains.

PALEODEPOSITIONAL MODEL OF THE HARTSELLE FORMATION (MISSISSIPPIAN) EXPOSED IN A ROADCUT ALONG THE EASTBOUND LANE OF INTERSTATE 24. *Richard E. Bergenback, The University of Tennessee at Chattanooga, Chattanooga, Tennessee.* The Mississippian Hartselle Formation, exposed in a roadcut along Interstate 24 (eastbound lane) in Dade Co., Georgia, consists largely of carbonate sedimentary rocks, but there are three dark-gray shale units present. The morphology, anatomy, texture, and composition of rock units were examined and interpreted in order to develop a paleodepositional model for this roadcut exposure. Six rock types were identified: 1) biomicrite (wackestone); 2) biosparite (grainstone); 3) oosparite (grainstone); 4) dolomicrite (mudstone); 5) pelbiomicrite (wackestone); 6) dark-gray shale. Three ancient environments of deposition were interpreted: 1) shallow sea floor (high subtidal); 2) shallow marginal marine bay or lagoon; 3) tidal channel with point bar and levee deposits. Shallow, sea-floor sediment deposition in these ancient environments was accomplished largely during landward sea advances; whereas, retreats of the sea enabled deposition of the dark-gray shale and dolomicrite units.

HISTORY OF SCIENCE SECTION

Kevin Ryan, Presiding

GIORDANO BRUNO: MARTYR OF SCIENCE? *William M. Wilson, Memphis Astronomical Society and The University of Tennessee-Memphis: Center for Developmental Disabilities, Memphis, Tennessee.* Giordano Bruno has long been regarded as a martyr of science, burned at the stake by the Roman Inquisition because of his espousal of the Copernican theory of the organization of the universe. Closer examination of his life and opinions, however, indicates that he did not really understand Copernican theory and that he viewed it as part of a metaphor leading to metaphysical enlightenment rather than a description of reality.

AMERIGO VESPUCCI AND THE MARINER'S ASTROLABE: A COMPUTER PLANETARIUM INVESTIGATION OF HIS QUEST FOR THE SOUTH CELESTIAL POLE. *Philip Jack Lorenz, Jr., and Francis M. Cordell, Sr., The University of the South, Sewanee, Tennessee, and Barnard Astronomical Society, Chattanooga, Tennessee.* In the *Mundus Novus* and other letters describing his voyages along the eastern coast of South America from 1499 to 1502, Amerigo Vespucci explains how he sought to locate the Antarctic celestial pole. Finding no star near it, he studied the diurnal motions of circumpolar stars using a mariner's astrolabe at sea and the common quadrant on shore. From these altitude measurements, he determined his latitude and the polar distances of several stars. His diagrams included the Southern Cross, the Magellanic Clouds, and the Coalsack nebula in the Milky Way. A computer "planetarium" program simulating the historic skies was applied to reconstructing the methods used by Vespucci. Reproductions of a mariner's astrolabe and a medieval quadrant (crafted by F. M. Cordell, Sr.) will be displayed.

PHILIP HENRY GOSSE: AN ENTOMOLOGIST IN FRONTIER ALABAMA (1838). *C. Steven Murphree, Belmont University, Nashville, Tennessee.* Philip Henry Gosse (1810-1888) was an English naturalist who is known for his which popularized marine biology in

England. In 1838, Gosse spent 8 months in Dallas Co., Alabama, as a schoolmaster of a small planter's school. This allowed ample time for his studies of the natural history of the area and eventually resulted in his *Letters from Alabama (U.S.) Chiefly Relating to Natural History*. Gosse's writings also include important historical information about the people of the pre-Civil War South. Trained by his father in miniature painting, Gosse prepared numerous color illustrations of Alabama insects. Since color reproductions were not yet perfected, the "Entomologia Alabamensis" was not published. Recently-obtained color transparencies of Gosse's original insect paintings will be presented.

KEPLER MANUSCRIPTS IN RUSSIA. *Kevin Ryan, Christian Brothers University, Memphis, Tennessee.* During his lifetime as a scholar, Kepler wrote so many books, dissertations, and letters that if all were placed side by side on a bookshelf, they would occupy the space equivalent to a set of encyclopedias. At the time of his death in 1630, the manuscripts of these writings were scattered throughout Germany, Austria, and Czechoslovakia. As a result of several strange events, several volumes of Kepler's manuscripts ended up in Russia. They survived 2 centuries of wars and neglect and, in the past 30 years, have been more accessible to scholars. Some results of these studies will be reported.

MATHEMATICS AND COMPUTER SCIENCE SECTION

Thomas E. Barr, Presiding

THEOREMS FOR ACYCLIC MAPPINGS. *Dennis P. Walsh and Charles L. Anderson, Middle Tennessee State University, Murfreesboro, Tennessee, and University of Southwestern Louisiana, Lafayette, Louisiana.* The binomial theorem is commonly applied to the binary operation of exponentiation. We use the notion of acyclic mappings on finite sets to extend application of the binomial theorem to other binary operations, including some not yet noted in the literature. Let C represent a finite set, let D be a non-empty subset of C , and let M be the set of all mappings from D to C . A mapping f in M will be said to be acyclic if there exist no invariant subsets under f . We show that the number of acyclic mappings in M satisfies a binomial law identical in form to the binomial theorem. We extend this result to the cardinalities of other subsets of M by placing further restrictions, such as one-to-oneness, on mappings of M . The respective cardinalities of these subsets then are related to prominent classes of discrete probability distributions that are closed under convolution.

OPTIMIZATION VIA SIMULATED HOPFIELD NETWORKS. *Nell Rayburn, Austin Peay State University, Clarksville, Tennessee.* In the February 1992 issue of *Mathematics Magazine*, a note appeared describing the following block design problem. A bridge club, consisting of 12 couples, meets eight times per year. At each meeting, the club is divided into three groups of four couples, with each couple playing every other couple in the group. A schedule is to be constructed in which the number of times a couple plays any other couple is most nearly the same for all couples. We examine some issues related to the construction of simulated Hopfield networks for the solution of this type of optimization problem. Inspired by James Freeman's article in the summer 1993 *Mathematica Journal*, we use Mathematica to program our simulations.

WHAT IS A DOMAIN? *James B. Hart, Middle Tennessee State University, Murfreesboro, Tennessee.* Domains were introduced by Dana Scott to provide denotational models for the semantics of programming languages. In recent years, domains have been the subject of

intensive research both in computer science and pure mathematics. Domains are usually viewed as certain partially ordered sets; yet, due to the absence of any elementary texts on the subject, it is rather difficult to extract both their formal properties and their reason for being from the literature. In this talk, I will provide a down-to-earth explanation for the primary mathematical properties of domains, basing the explanation on the intuition of computer scientists and the formal mathematical structures used to model it.

MEDICAL SCIENCE SECTION

Al Iglar, Presiding

PREDICTING CARCINOGENICITY BY OBSERVING CHEMICALLY-INDUCED HISTONE MODIFICATION. **R. Dean Blevins and Valentine O. Wagner, III**, East Tennessee State University, Johnson City, Tennessee. The interaction between carcinogens and DNA is believed to initiate neoplastic transformation, but evidence suggests that epigenetic mechanisms also may be of importance. Because the histone proteins have important roles in chromatin structure and cellular function, they provide a reasonably well understood epigenetically-based system for the detection of carcinogens. In this study, human foreskin fibroblastic cells were exposed to one of several mutagens or carcinogens for 3, 12, or 24 h to determine if induced histone modification may be a means of predicting chemical carcinogenicity. Butyric acid (5 mM), known to result in acetylation of histones H3 and H4, and 12-*O*-tetradecanoylphorbol-13-acetate (3 μ M), known to result in phosphorylated histone H1, were tested initially. Electrophoresis of the histone fractions resolved multiple forms of histones H1, H3, and H4. Propane sultone (0.1 mM) induced broadening of the H2A and H2B bands after a 24-h exposure to carbon tetrachloride (1 mM) induced the formation of new histone forms in the H1 fraction after 24 h and in the H3 fraction after 3 h. Experimental variability limited the statistically significant modifications to carbon tetrachloride and propane sultone, two known carcinogens, where new forms of modified histone were detected. Therefore, the histone modification assay, with further experimentation, may be an alternate method of detecting carcinogens, especially when conventional genotoxic tests prove unreliable.

VISUALIZATION OF *LEGIONELLA* BACTERIA IN AMOEBAE BY LIGHT MICROSCOPY. **Anthony L. Newsome and Becky Skitt**, Middle Tennessee State University, Murfreesboro, Tennessee, and Indiana University School of Medicine, Indianapolis, Indiana. *Legionella pneumophila* is a facultative intracellular parasite and the etiological agent of Legionnaires disease. Previous in vitro studies have demonstrated that it can use free-living amoebae as a host cell for intracellular replication. It has been proposed that *Legionella* and possibly other facultative intracellular parasites might use amoebae as a host cell in natural settings. The purpose of this investigation was to further clarify the interactions between certain *Legionella* bacteria and amoebae using light microscopy and to develop methodologies that would be amenable for the detection of bacteria in recent environmental isolates of amoebae. The direct visualization of wet mounts from co-cultures suggested that *Legionella jordanis* and *Legionella micdadei* also appear to be capable of intracellular replication within amoebae. *Legionella* bacteria were visualized also by in situ binding of specific rabbit immune sera and immunoperoxidase conjugate in conjunction with histochemical staining of fixed amoebae. Both *Legionella* and bacterial antigen within the host cell were visualized easily while preserving morphological features of amoebae. This methodology would provide the opportunity to specifically identify potentially pathogenic bacteria in amoebae soon after their isolation from the environment.

THE ISOLATION OF ANTIBIOTIC-PRODUCING MICROORGANISMS FROM SOIL SAMPLES. **Virginia Bergosh* and John M. Zamora**, Middle Tennessee State University, Murfreesboro, Tennessee. The search for new antibiotics is a major focus of the pharmaceutical industry. These agents could be used to treat (certain) diseases that are not susceptible to current conventional treatment modalities. Our purpose is to isolate organisms that produce substances with antimicrobial activity. Several soil types (sandy, creek-slide, roadside, and clay) from Tennessee, Maryland, and Massachusetts were screened for antibiotic-producing organisms using the patch-plate method. Isolates of interest were tested against *Escherichia coli* and *Micrococcus luteus*. The colonies that inhibited growth of our test organisms were subjected to a confirmatory test. Broth-culture filtrates of the organisms that continued to demonstrate activity were tested for beta-lactam production. The filtrates also were tested for antiviral activity against bacteriophage T₄.

PHYSICS AND ASTRONOMY SECTION

Ling Jun Wang, Presiding

THE LIGHT VARIATIONS OF V578 MON. **A. M. Heiser**, Vanderbilt University, Nashville, Tennessee. V578 Monocerotis (= HDE 259135) is almost surely a member of the very young galactic cluster NGC 2244. A few radial velocity observations of this star obtained in the 1930s indicated possible variations such that the star was suggested to be a spectroscopic binary. The first photoelectric photometry data of the brightest stars in NGC 2244 was reported in 1962, but no evidence of the light variability for HDE 259135 was noted. Further spectroscopic and photometric data of the brighter cluster stars, obtained by the author between 1969 and 1976, indicated that in addition to the radial velocity variations there was also a light variability for HDE 259135. Preliminary analysis of the spectroscopic data indicated a period of about 4.5 days for the suspected binary, but the photometric data could not confirm this period. Further photometric data obtained at the Dyer Observatory, together with the other data from the Kitt Peak National Observatory, has enabled the light variation to be confirmed, and a new period close to 1.126 days has been found. The light variation indicates that V578 Mon is probably also an eclipsing binary. A complete description of the system, with the determination of such stellar properties as the masses and radii, awaits the availability of further data.

A NEW METHOD TO TEST ETHER DRIFT. **Ling Jun Wang**, The University of Tennessee Chattanooga, Chattanooga, Tennessee. The null result of the Michelson-Morley experiment to test ether drift is considered a primary cause and justification for the theory of relativity. However, this experiment was not considered conclusive by many, including D. C. Miller who reported positive result of his repeated, ether-drift experiment. The controversy as well as the significance of this classical experiment to modern physics have motivated repeated tests of ether drift with modern techniques and equipment, ranging from coherent laser light source, atomic time reference, to Doppler shift of gamma rays and so on. The key issue is that most experiments so far have not been conducted in an environment free of ether-dragging. To avoid ether-dragging, it is proposed to test ether drift in space based on the principle that the Lorentz force between the moving charges depends on their velocity with respect to ether. A sketch of the experimental set-up is presented.

THE RATE OF HYDROGEN ABSORPTION ACROSS A Pd/H₂ INTERFACE AFTER REPEATED HYDROGENATION. **John W. Hanneken and Mary K. Drouin**, Memphis State University, Memphis, Tennessee. The objective of this work was to measure the rate at which

a bulk Pd sample absorbed H_2 from the gas phase at 25°C. The absorption rate is, however, greatly affected by surface contaminants as well as the presence of O_2 and H_2O vapor. Consequently, to obtain reproducible measurements elaborate procedures to eliminate trace amounts of O_2 and H_2O vapor have been required. This necessitates the use of pretreatment procedures in ultra-high vacuum using ultra-pure gases. In this work, the sample's surface was activated by repeated hydrogenation-dehydrogenation. The absorption of H_2 as a function of time was measured with each hydrogenation. Without a mechanism to regulate the amounts of O_2 and H_2O vapor present, the corresponding absorption curves were erratic. However, plotting the absorption curves on normalized axes resulted in reproducible curves even when an effort was made to drastically change the amount of H_2O vapor present.

SCIENCE AND MATHEMATICS TEACHERS SECTION

Martha W. Stratton, Presiding

CREATING A NEW PARADIGM FOR IMPROVING SCIENCE IN-SERVICE EDUCATION. **Jack Rhoton**, *East Tennessee State University, Johnson City, Tennessee*. East Tennessee State University has established a collaborative relationship with the National Science Foundation, local school districts, and Tennessee Department of Education to develop a model of in-service education for elementary and secondary science teachers and principals. The model is designed to prepare teachers and principals for leadership roles in the improvement of school science. The model accommodates three-member teams from elementary schools in northeastern Tennessee. The teams are composed of a primary teacher (K-3), an intermediate grade teacher (4-6), and their principal. The secondary teams are composed of two middle-school and two high-school science teachers and their principal. Major features of the project have been the personal renewal of teacher's expertise in school science content and methodology, the ability to organize and conduct science workshops, the ability to work with peers, and the mastery of skills in analyzing and selecting appropriate curriculum and instructional materials for the classroom. The session will provide details of the program.

DEVELOPMENT OF A LESSON PLAN FOR TEACHING CONCEPTS IN ELECTRICAL CURRENT AND FLUID FLOW. **Paula C. McCray, Deborah J. Hochstein, and Michael L. Daley**, *Westwood High School, Memphis, Tennessee (PAM), and Memphis State University, Memphis, Tennessee*. Opportunities for ninth-grade students to integrate mathematical skills, understanding of physical concepts, and critical thinking are needed. The objective of this study is to provide students the opportunity to measure and analyze the behavior of electrical current and fluid flow. One experiment demonstrates Ohm's law for a direct-current-flow resistive circuit, and the other demonstrates laminar and turbulent flow. Students will measure electrical current flow through a resistor over a range of voltage values and fluid flow rates through a clear plastic pipe over a range of applied pressures. Graphs of theoretical results described by Ohm's and Poiseuille's laws will be used to demonstrate the mathematical analogy between the two physical phenomena, plot and compare experimental measures, and analyze the limitations of mathematical modelling. These classroom activities may serve as a capstone experience for the ninth-grade science class.

A COMPUTER EXPERIMENT FOR CHEMISTRY LAB: FROM TITRATION DATA TO BUFFER CAPACITIES. **Gary D. White, Roy W. Clark, Judith M. Bonicamp, and Exum D. Watts**, *Middle Tennessee State University, Murfreesboro, Tennessee*. This paper is for all chemistry teachers who have beginning students, computers, and spread-

sheets and would like that combination to be more effective. We describe a computer experiment in which students will discover many things about pH, the taking of derivatives, buffer capacity, and the way buffers behave upon dilution. We use a computer software package, EQUIL, to generate data for the following titrations: the reaction of 0.100 M HOAc(aq) with 0.100 M NaOH(aq) or 0.100 M HCl(aq); the reaction of 0.100 M HCl(aq) with 0.100 M NaOH(aq); the dilution of 0.100 M HOAc(aq)/0.100 M NaOAc(aq) with H_2O ; the dilution of 0.100 M HCl(aq) with H_2O . We provide instructions for students to transform and plot data from pH versus milliliter to buffer capacity versus pH. We also give suggestions for instructor's comments. The dilution experiments develop the definition of a buffer capacity with respect to dilution which we call β_{dil} .

AN EXPERIENCE-BASED MIDDLE-SCHOOL SCIENCE CURRICULUM: PRELIMINARY REPORT. **Fred M. Niell, Jr., and Keife Hyland**, *Lausanne Collegiate School, Memphis, Tennessee*. A new science curriculum for grades 6, 7, and 8 is being explored, with a strong field component. Within the framework of Life and Earth Science, a total experiential model has been developed. Students work in teams to research a topic, gather and examine data, develop databases, and publish results. Each member of a team is assigned a responsibility for the duration of the module, and individual grades are the result of team performance. Topics are presented as free-standing modules. Textbooks are only used as occasional reference. Ten modules for each grade cover the academic year. Field and classroom activities are integrated into other disciplines, notably mathematics and computer science. Four modules have been implemented to date, and the experience has been good. Some module scripts are presented which could be used in more structured curricula as enrichment.

IMPLEMENTING OPERATION PHYSICS IN NORTHWEST TENNESSEE MIDDLE SCHOOLS. **Tahira N. Khan, Nancy Gaylord, and Nancy Eskew**, *The University of Tennessee at Martin, Martin, Tennessee, Sharon High School, Sharon, Tennessee, and Martin Junior High School, Martin, Tennessee*. A Title II Eisenhower grant in 1992-1993 enabled us to start the national program Operation Physics in northwestern Tennessee. Rural area schools lack facilities for a laboratory and have no specific funds for purchase of materials for any activities in physics. Through our grant, we provided free kits of materials to the participants in our workshops. The workshops covered five basic areas; each area was covered in a 3-h workshop. Teachers were very keen to refresh their knowledge and build up their confidence to present physics topics to young students through hands-on activities. It commonly was noted by teachers that the free kits of materials were a major incentive for them so they could immediately implement the activities in their class. Overwork and shortage of funds at schools discourage them to start an activity-oriented class, in particular, physics. Usefulness of inexpensive materials to demonstrate some key concepts will be demonstrated.

ZOOLOGY SECTION I

Padgett Kelly, Presiding

COMPETITIVE INTERACTIONS BETWEEN BENTHIC (*BUFO WOODHOUSII*) AND NEKTONIC (*HYLA CHRYSOSCELIS*) ANURAN TADPOLES. **Cindy L. Taylor**, *Austin Peay State University, Clarksville, Tennessee*. Tadpoles of *Bufo woodhousii* (Bufonidae), which are benthic feeders, and *Hyla chrysosecelis* (Hylidae), which are nektonic feeders, commonly co-occur in temporary pools. Although tadpoles of *H. chrysosecelis* were predicted to be competitively superior to those of *B. woodhousii* when mixed groups were fed a

suspended, particulate food, tadpoles of *B. woodhousii* were competitively superior. This superiority likely arose because tadpoles of *Bufo* were able to filter some suspended materials as well as harvest sediment food and feces and were much more active than tadpoles of *Hyla*.

MORPHOLOGICAL AND ECOLOGICAL VARIATION AMONG THREE POPULATIONS OF THE ENDANGERED SAN SALVADOR ISLAND ROCK IGUANA. *David Brouhard**, *Grent Goodge**, *William K. Hayes*, and *Danette M. Hayes**, *Southern College, Collegedale, Tennessee*. The San Salvador Island rock iguana, *Cyclura rileyi rileyi*, is a subspecies of one of three endangered species of iguanas in the Bahamas. Approximately 500 individuals dwell on at least seven tiny offshore-inshore keys of San Salvador. Recently, we captured, measured, permanently marked, and collected blood from 28 iguanas on three of these isolated keys. Iguanas on the smallest key, Guana (inland lake; <1 ha), were significantly larger and missing more nuchal crests than those on Green Key (offshore; 4.8 ha) or Manhead Key (offshore; 3.0 ha). External parasites (ticks) were seen only on iguanas at Guana Key. Toe injuries were most frequent in the population on Green Key. Frequency of tail breaks and numbers of femoral pores and nuchal crests did not vary among island populations. DNA isolated from blood samples is presently under RAPD analysis to compare genetic relationships among the isolated populations. Future studies will address behavioral and ecological causes of these differences. This study was supported by the Bahamian Field Station.

EFFECTS OF HUNGER ON CONCENTRATION AND VARIATION OF PROTEINS IN RATTLESNAKE VENOM. *Shannon L. Pitman**, *Joyce L. Azevedo*, and *William K. Hayes*, *Southern College, Collegedale, Tennessee*. Previous studies have shown that the concentration and relative composition of proteins in snake venom may vary with ontogeny and seasonality. However, no studies have examined how venom may change with regularity of feeding. A recent study found that the mass of venom injected into mice by hungry snakes was 35% less than that of well-fed snakes (28 and 7 days of food deprivation, respectively). To determine if the difference was related to hunger-induced changes in venom, we devised a within-subjects experiment to examine the effects of hunger on venom proteins of the western rattlesnake (*Crotalus viridis*). Using the Bradford dye-binding method, we found no significant difference between hungry and well-fed snakes in overall concentration of proteins in venom. However, electrophoretic (SDS polyacrylamide-gel electrophoresis) patterns quantified by densitometry suggest that the concentrations of several individual proteins vary consistently between hungry and well-fed conditions. This study was supported by National Science Foundation grant IBN-9213870.

THE HERPETOFAUNA OF FORT CAMPBELL MILITARY RESERVATION, KENTUCKY AND TENNESSEE. *Gene A. Zirkle** and *A. Floyd Scott*, *Austin Peay State University, Clarksville, Tennessee*. Fort Campbell is a 342,669-ha military reservation on the northwestern Highland Rim in southern Kentucky and northern Tennessee. Despite considerable information from surrounding areas, knowledge of its herpetofauna is essentially nonexistent. Only one documented historical occurrence (an unpublished record of *Cryptobranchus alleganiensis* in Austin Peay State University's Museum of Zoology) of any amphibian or reptile from the reservation was located. To fill this gap in knowledge of the region's biota, a herpetofaunal survey of the reservation (excluding firing ranges, munitions impact areas, and cantonment areas) was conducted from June 1992 through June 1993. All major habitats were sampled each season using standard collecting techniques. Forty-eight species (25 amphibians and 23 reptiles) representing 13 families and 29 genera were encountered. All were expected based on previous studies in the region. Two state-listed "special

concern" taxa, *Hyla gratiosa* and *Ambystoma talpoideum*, were among the amphibians found. No new records of *Cryptobranchus alleganiensis* (listed as "special concern" in Tennessee and "category 2" by federal authorities) were obtained. Evidence of intergradation was found in specimens of four species (*Notophthalmus viridescens*, *Agkistrodon contortrix*, *Diadophis punctatus*, and *Elaphe obsoleta*). Results augment existing knowledge of the amphibians and reptiles of the lower Cumberland Basin and provide baseline data useful in long-term trend analysis of environmental changes on the fort.

PREDATORY VERSUS DEFENSIVE STRIKES BY CROTALINE SNAKES: FANG CONTACT, RISK ASSESSMENT, AND VENOM METERING. *Scott DeLay**, *William K. Hayes*, *Matthew P. Rowe*, and *Jason Strack**, *Southern College, Collegedale, Tennessee (SD, WKH)*, *Appalachian State University, Boone, North Carolina (MTR)*, and *Collegedale Academy, Collegedale, Tennessee (JS)*. The first experiment compared predatory and defensive strikes of three genera of snakes (*Agkistrodon*, *Sistrurus*, and *Crotalus*) to determine if the strikes differ in ways that might influence the quantity of venom released. Slow-motion videotape analyses indicated that duration of fang contact was significantly briefer during defensive strikes at rats than predatory strikes at mice. Although venom measurements were not obtained, fang contact during defensive bites may be too brief for substantial venom delivery, possibly contributing to the frequent "dry" bites of humans. In the second experiment, western rattlesnakes (*Crotalus viridis*) were videotaped as they struck defensively at membrane-covered plastic pots. Venom was released in most strikes (75%), but wet and dry bites were similar in duration of contact. Thus, dry bites may result from venom metering rather than brief fang contact. Defensive strikes of brief duration and minimal envenomation may represent strategies to conserve venom and avoid counterattack. This study was supported by National Science Foundation grants BNS-8813271 and IBN-9213870.

VENOM EXPENDITURE DURING FEEDING BY A "NONVENOMOUS" SNAKE. *William K. Hayes*, *Palbo Lavin-Murcio**, and *Kenneth V. Kardong*, *Southern College, Collegedale, Tennessee (WKH)*, and *Washington State University, Pullman, Washington (PL-M, KVK)*. Many colubrid snakes, like the more venomous elapid and viperid snakes, produce and inject an oral (Duvernoy's) secretion that is toxic and may represent a human health risk. Using an enzyme-linked immunosorbent assay (ELISA), we determined the quantity and distribution of Duvernoy's secretion delivered into the integument and underlying viscera of a mouse during a predatory strike by the brown tree snake (*Boiga irregularis*). The snakes released a mean of 3.6 mg (2-5 mg), less than but within an order of magnitude of that released by viperids. Only about 54% of the secretion actually reached the viscera, while the rest remained in the integument. The amount reaching the viscera is three to eight times the i.p. LD₅₀ for mice, but these snakes depend on constriction more than toxins to kill their prey. Consequently, we propose that the secretion primarily serves a defensive role. This study was supported by the United States Fish and Wildlife Service and National Science Foundation grant BNS-8820091.

BREEDING BIOLOGY OF HOUSE FINCHES IN NORTHWESTERN TENNESSEE. *T. David Pitts* and *Marion S. Pitts*, *The University of Tennessee, Martin, Tennessee, and Martin, Tennessee*. Since 1980, when the first house finch nest in Tennessee was recorded, little has been published about their breeding biology in the state. During 1992 and 1993, we documented activities at 30 house finch nests in Weakley Co. The nesting season extended from March through July. Nest sites included ornamental shrubs and man-made structures such as light fixtures and metal awnings. Clutches contained three to five eggs (\bar{X} = 4.5; n = 30). The female incubated the eggs approximately 14 days. The

eggs hatched asynchronously. Both parents fed the young. At most nests, the feces of the young accumulated on the rim of the nest. The young fledged at approximately 18 days of age. Most pairs apparently had two nests per year, although some pairs may have had three nests. Twenty of 30 nests (66.7%) were successful. From 134 eggs, 70 young (52.2%) fledged.

ZOOLOGY SECTION II

Brian Miller, Presiding

CAPTIVE BEHAVIOR OF THE FENNEC FOX (*FENNECUS ZERDA*). *Allison G. Emrich* and Michael L. Kennedy, Memphis State University, Memphis, Tennessee.* Social behavior of three pairs of fennec foxes (*Fennecus zerda*) was studied from 29 March 1992 to 1 April 1993. An ethogram was compiled, and nine categories of behavior were established (movements, body-postures, self-oriented, play, ingestive, eliminative, scent-marking, close range, and vocalization behaviors). Pairs consisting of one male and one female were observed using the instantaneous time-sampling method. Chi-square analysis was used to determine behavioral frequencies at each class. The body-posture category had the highest frequency for all individuals, with the movement, ingestive, and close-range categories also showing high frequencies. Differences within pairs, among males, among females, and between males and females were analyzed using Kruskal-Wallis non-parametric tests. Significant differences within the pairs were found in various behavioral categories.

DETERMINING SEX OF SHREWS THROUGH MORPHOMETRIC ANALYSES OF PELVES. *Cara E. Bergman*, Memphis State University, Memphis, Tennessee.* Differences in pelves of five taxa of western *Sorex* were examined to determine if changes in morphology of the pelvis could be used to differentiate between sexes. Two methods were used to separate the sexes: a ratio of ischial length to pubic length plotted against least width of the pubis; the greatest width of the ischium. For all age classes, 52 to 89% of males, and all females were identified correctly to sex by use of the ratio method. For age-classes 3 and 4, only 2.5% of males were misclassified to sex by the greatest-width-of-the-ischium method. Because shrews in age-classes 1 and 2 may not have attained sexual maturity, morphological changes in the pelvis that permit separation of the sexes by these methods were not present.

RECAPTURE PATTERNS OF RACCOONS (*PROCYON LOTOR*). *Troy A. Ladine* and Michael L. Kennedy, Memphis State University, Memphis, Tennessee.* One hundred thirty-two raccoons (*Procyon lotor*) were captured, tagged, and released on the Edward J. Meeman Biological Station in western Tennessee from 1991 to 1993. Patterns of captures were evaluated in relation to vegetational and topographical variables. Stepwise discriminant analysis determined 10 habitat variables to be associated with captures of raccoons. Canonical correlation of the variables from the stepwise discriminant analysis indicated percentage of fruit- and nut-producing woody species, distance to closest log, summer shrub cover, and diversity to load highest on axis 1, while mean basal area, winter leaf-litter depth, and distance to closest log loaded highest on axis 2. Chi-square analysis of captures for each cluster indicated a strong deviation from equal probability ($\chi^2 = 38.32$; $P < 0.00001$), indicating association of capture probability with habitat. Twenty raccoons were captured in >1 year. The resulting population turnover ranged from 71 to 90% between 1-year periods with recaptures between years being predominately older-age-class raccoons. Implications towards habitat utilization and social behavior of raccoons are discussed.

TEMPORAL ASSESSMENT OF THE MORPHOMETRIC VARIATION IN WHITE-TAILED DEER. *Michelle J. Richard* and Michael L. Kennedy, Memphis State University, Memphis, Tennessee.* Mandibles ($n = 318$) of white-tailed deer (*Odocoileus virginianus*) were obtained during annual hunts at Hatchie National Wildlife Refuge, Haywood Co., Tennessee, over a 10-year period (1982-1992). Twenty-four morphologic measurements were taken on each specimen and analyzed for temporal variability using univariate and multivariate statistical techniques. Differences between sexes and variation in characters among years are discussed.

USE OF PELLET COUNTS AND HONEYSUCKLE TRANSECTS IN THE MANAGEMENT OF WHITE-TAILED DEER. *R. David Frederick* and Michael L. Kennedy, Memphis State University, Memphis, Tennessee.* The use of pellet counts and honeysuckle transects in the management of white-tailed deer (*Odocoileus virginianus*) was studied at the Milan Army Ammunition Plant in Carroll and Gibson counties, Tennessee. Counts of pellets along transects were used to determine the level of utilization of eight habitat types, and honeysuckle transects were observed to determine the degree of browse on this food source. Preliminary results show two habitats (forest and agriculture, forest and pasture) to differ significantly from other habitat types based on pellet counts. No significant difference in the utilization of the browse transects has been observed.

ZEBRA MUSSELS IN NORTH AMERICAN RIVERS: THE ST. LAWRENCE AND THE TENNESSEE. *David Bruce Conn, The University of the South, Sewanee, Tennessee.* In 1988, the zebra mussel, *Dreissena polymorpha*, was discovered in the Laurentian Great Lakes, into which it had been introduced from its native European range. The mussel has caused billions of dollars in damages to industries and has had a substantial negative impact on freshwater biota native to North America. In an effort to understand the invasion's impact on North American riverine systems, the spread of *D. polymorpha* and its congeners in the St. Lawrence River since 1989 was monitored. Initially, these populations of *Dreissena* were distributed patchily as isolated introduction foci. From these foci and others in Lake Ontario, the mussels spread throughout the entire St. Lawrence River by 1992. Small foci were discovered in the lower Tennessee and Cumberland rivers by 1992 and in the upper Tennessee by 1993. Based on observations of the St. Lawrence River, widespread occurrence throughout the Tennessee River is estimated to possibly occur by 1996.