

ABSTRACTS OF PAPERS PRESENTED AT THE 102ND ANNUAL MEETING

BOTANY SECTION I

A. Darlene Panvini, Presiding

GLADES AND BARRENS OF THE SOUTHERN RIDGE AND VALLEY. **H. R. DeSelm**, *University of Tennessee, Knoxville, Tennessee*. Sixty-nine sites representing barrens, glades, and related vegetation were studied floristically and by the plot method in the Ridge and Valley of southwestern Virginia, East Tennessee, northwestern Georgia, and northeastern Alabama. Most sites were on Chickamauga limestone. Native taxa totaled 803; regional intraneous, local intraneous, and southern percentages approximated those of the barren floras. The percentage of northern taxa was similar to that of the barrens of the cooler Cumberland Plateau. The western taxa occurred chiefly on sites in southern East Tennessee and adjacent Georgia and Alabama. Taxa considered rare in any of the four states totaled 45. Restricted range and edge-of-range phenomena contributed to rarity. Plot sampling of glades revealed high rock and gravel cover and plant cover percentages similar to those in Middle Tennessee. Barren samples had high perennial grass cover.

PRESERVATION OF A CEDAR GLADE BY THE REMOVAL OF WOODY STEMS. **A. Darlene Panvini**, *Tennessee Nature Conservancy and Vanderbilt University, Nashville, Tennessee*. The persistence of two critical species, *Dalea foliosa* and *Astragalus tennesseensis*, was assessed at Sneed Road Cedar Glade before and after woody stems were removed. This glade, a small prairie-like glade located in Williamson County, Tennessee, consists of numerous small glade openings surrounded by glade thicket. In 1991, transects were established in six experimental and six control glade openings. Percent cover of the critical species and select herbaceous and woody species was recorded in 1-m² plots along the transects. In the winter of 1992, all woody stems were cut and removed from a 10-m band around the perimeter of the experimental plots. During the summer months, percent cover was recorded again, and the impact of the removal assessed. Both *D. foliosa* and *A. tennesseensis* showed an increase in percent cover and in frequency of occurrence. The effectiveness of woody-stem removal as a glade management technique and its bearing on the population stability of the critical species will be discussed.

VASCULAR FLORA OF PICKETT STATE PARK AND FOREST, PICKETT AND FENTRESS COUNTIES, TENNESSEE. **Virginia L. Small*** and **B. E. Wofford**, *University of Tennessee, Knoxville, Tennessee*. Pickett State Park and Forest occupies 4759.6 ha of the Cumberland Plateau in Pickett and Fentress counties, Tennessee. Specimens were collected during the past two and a half growing seasons. To date, a total of 512 species and lesser taxa in 306 genera and 103 families has been identified. Three hundred ninety-eight county records and a state record have been established. Seven taxa are listed as endangered and threatened in Tennessee. Four taxa are either federally listed or under review for listing. A history of human disturbance is reflected by 11.5% of the flora being introduced. Pickett State Park and Forest has been under state management since 1933. The results of this study will provide the respective state agencies with useful management information.

VASCULAR FLORA OF GEE CREEK WILDERNESS. **Daniel Wyrick*** and **B. E. Wofford**, *University of Tennessee, Knoxville, Tennessee*. Gee Creek Wilderness is a narrow mountainous watershed positioned on the southwestern extreme of the Blue Ridge in Tennessee. Starr and Chestnut mountains define the physical boundaries of the wilderness and create a narrow valley drained by Gee Creek. The wilderness lies within Cherokee National Forest in Polk and Monroe counties. A floristic survey was initiated in June 1991 and has continued to date. A total of 365 taxa representing 230 genera and 93 families has been documented. Forty-four taxa are county records. Eight species are listed in Tennessee as endangered, threatened, or special concern. The flora generally typifies the southern Appalachians with a few exceptions. Notable collections have been made which represent range extensions or physiographic records. Examples are *Polymnia laevigata* Beadle, *Hydrangea quercifolia* Bartr., *Calamagrostis porteri* Gray, and *Amelanchier sanguinea* (Pursh) DC. Additional significant collections will be discussed.

THE WETLAND VASCULAR FLORA OF CROSS CREEKS NATIONAL WILDLIFE REFUGE, STEWART COUNTY, TENNESSEE. **James Joyner*** and **Edward W. Chester**, *Austin Peay State University, Clarksville, Tennessee*. The refuge is a 3,566-ha, mostly wetland tract astride 16.1 river km of the Cumberland River (Lake Barkley) between Dover and Cumberland City, Tennessee. The area has been owned and managed since 1962 by the United States Fish and Wildlife Service, primarily as a feeding and resting site for migrating waterfowl. Much of the refuge is river bottomland that was formerly agricultural. Present management practices include moist-soil crops for wildlife, some agricultural production (hay, soybeans, small grains), successional fields, and 16 managed pools where dams, levees, and floodgates allow for water-level manipulation. The Cumberland River and its tributaries are permanently impounded with seasonal variations in pool levels. Various wetland habitat and community types occur, including marshes, swamps, dewatered zones, bottomland forests, and permanent deep water. This research involved a floristic survey of the area, excluding peripheral uplands. Specific objectives were to qualitatively delineate community types, determine their floristic composition, and seek listed rare taxa. During 1990 through 1992, 77 collecting trips yielded 636 taxa (including seven rare elements) representing 367 genera and 116 families.

VARIATION IN THE GENUS *CELTIS* (ULMACEAE). **T. Beth Hinson***, *Middle Tennessee State University, Murfreesboro, Tennessee*. Samples of *Celtis* were collected from the campus of Middle Tennessee State University and the surrounding area in Rutherford County, Tennessee. Leaf blade length, leaf blade width, petiole length, drupe size, and the number of teeth along the leaf margin were measured on the 50 samples. Variation patterns suggested three ranges of plants. Low-range samples suggested characteristics of *Celtis laevigata*; high-range samples suggested characteristics of *Celtis occidentalis*; intermediate-range samples demonstrated characteristics from *C. laevigata* and *C. occidentalis*. This study concludes that some *Celtis* trees can not be

*Student author.

delimited with morphological characteristics alone, but the separation of *Celtis* species may depend on further studies of post-fertilization barrier breakdown and genetics.

DETERMINATION OF THE TAXONOMIC STATUS OF GROUND-SPREADING TICK-TREFOIL. *J. A. Raveill, David E. McCauley, and Robert Kral, Vanderbilt University, Nashville, Tennessee.* Ground-spreading tick-trefoil (*Desmodium humifusum* (Muhl.) Beck) is a leguminous plant with extant populations at two sites in Massachusetts and one site in Connecticut. At each site, *D. humifusum* occurs in close proximity with *Desmodium paniculatum* (L.) DC. and *Desmodium rotundifolium* DC. and is morphologically intermediate between these two species. Allozyme analysis has shown *D. paniculatum* and *D. rotundifolium* to be fixed for different alleles at the triose-phosphate isomerase-1 (TPI-1) locus. All *D. humifusum* plants were heterozygous at the TPI-1 locus with one allele diagnostic of each parental taxon. Seeds collected from *D. humifusum* have been grown, and progeny can be identified as each of the three taxa in question. Ground-spreading tick-trefoil (*D. humifusum*) is considered a morphologically discreet f_1 hybrid between *D. paniculatum* and *D. rotundifolium*.

SCIRPUS FLUVIATILIS (RIVER BULRUSH) IN TENNESSEE AND SOUTHEASTERN UNITED STATES. *Edward W. Chester and B. Eugene Wofford, Austin Peay State University, Clarksville, Tennessee, and University of Tennessee, Knoxville, Tennessee.* *Scirpus fluviatilis* (Torrey) Gray, river bulrush (Cyperaceae), is a wide-ranging species found mostly in the north-central United States and southern Canada. The typical habitat is shallow water or saturated soil along the open borders of freshwater lakes and large streams that are usually calcareous. In most cases, plants occur in large, dense, nearly pure stands that are mostly vegetative. The species is heretofore not documented from Tennessee or the other southeastern states covered by Generic Flora of the Southeast Project of Harvard University. A report by A. Gattinger (pre-1900) from eastern Tennessee is unsubstantiated. Nearest records to Tennessee are from Kentucky (two counties), Virginia (three counties), and Missouri (scattered counties). We have found several large, well-established stands in the lower Tennessee River Valley, Henry County, Tennessee. All plants were sterile in 1989 and 1990, but a few were fertile in 1991. Our vouchers are filed in three herbaria (APSC, TENN, and VDB).

BOTANY SECTION II

Thomas E. Hemmerly, Presiding

PROTEIN ANALYSIS IN EMBRYOGENIC AND NON-EMBRYOGENIC CALLI OF SOYBEAN. *S. M. Bhatti and P. S. Kahlon, Tennessee State University, Nashville, Tennessee.* Embryogenic cultures are usually identified by their morphological appearance; therefore, they often go undetected. The objective of our study was to determine if there is a difference in soluble proteins in embryogenic and non-embryogenic cultures and to determine if there are certain proteins associated with embryogenesis. This information will be useful in recognizing embryogenic cultures before any morphological changes are visible. Embryogenic cultures were obtained from different explants of soybean using L_6 medium. After a 4-week period, both embryogenic and non-embryogenic calli were separated, and proteins were extracted in a glass tissue homogenizer using a tris buffer. The homogenate was centrifuged, and the supernatant containing the soluble proteins was stored. Quantitative protein analysis was done using Bradford's technique. Polyacrylamide gels were used to separate proteins. The results

show that there are quantitative differences in total soluble proteins in embryogenic cultures as compared to non-embryogenic cultures.

THE ROLE OF ZEAXANTHIN-ASSOCIATED PHOTOPROTECTION IN *TILIA HETEROPHYLLA*. *Jefferson G. Lebkuecher and Christopher R. Hatley, Austin Peay State University, Clarksville, Tennessee.* The conversion of the xanthophyll pigment violoxanthin to zeaxanthin results in the harmless dissipation of excess light-generated energy providing photosynthetic tissue protection against bright-light damage. To determine the significance of this photoprotection mechanism in a mesophytic tree, leaves from *Tilia heterophylla* were placed for 24 h in water or dithiothreitol (DTT), which inhibits the conversion of violoxanthin to zeaxanthin. Following pre-treatment, the leaves were exposed for 3 h to different light (0 or 1800 $\mu\text{mol photons m}^{-2}\text{s}^{-1}$), temperature (25 or 35°C), and water stress (100 or 75% RWC) conditions. Leaves pre-treated with DTT and subjected to a combination of bright-light, high-temperature, and low-water stresses exhibited significantly decreased photosystem II electron transport activities relative to leaves which were not DTT pre-treated and subjected to bright-light, or high-temperature, or low-water stress, or any two of these combinations did not have reduced photosystem II electron-transport activities relative to leaves which were not DTT pre-treated. These results indicate that zeaxanthin-associated photoprotection limits photoinhibition which would occur otherwise when leaves of *Tilia heterophylla* are exposed to full-sunlight intensity while simultaneously experiencing high-temperature and low-water stresses.

OOSPORE PRODUCTION BY *PYTHIUM* SPP. IN-VITRO FOR USE IN PLANT DISEASE RESISTANCE STUDIES. *Roger J. Sauve, Tennessee State University, Nashville, Tennessee.* Oospore production by *Pythium aphanidermatum*, *Pythium debaryanum*, *Pythium myriotylum*, and *Pythium polymastum* was evaluated on two natural and two synthetic media. Abundant oospores were produced in the natural media and in the synthetic medium containing cholesterol. Cholesterol was required by all species for oospore production in the synthetic media. The amount of cholesterol required for oospore production differed with each species used and ranged from 1 to 1,000 $\mu\text{g/ml}$ of medium. Oospore production was inhibited when the cholesterol concentration was greater than the amount required for optimum production. Optimum temperatures for oospore production ranged from 15 to 35°C and were 5 to 10°C lower than the optimum temperatures for vegetative growth. Maximum oospore production occurred after 7 to 21 days of incubation in the dark at 25°C. After 3 weeks of incubation under continuous darkness or light, there were no differences in the number of oospores produced.

SELECTION FOR DISEASE RESISTANCE IN KIDNEY BEAN. *Daniel Patterson*, E. L. Myles, C. Alexander-Caudle, S. Bhatti, and R. Nesby, Tennessee State University, Nashville, Tennessee.* Tissue-culture techniques are being used to elucidate the defense mechanisms of agricultural crops such as legumes. Leaves of three cultivars of *Phaseolus vulgaris* (Rab, Astro, and Laureat) were surface-sterilized and cut in 1-cm² pieces. The leaves were placed on Murashige and Skoog medium supplemented with 1 mg/l 2,4-dichlorophenoxy acetic acid and 0.5 mg/l benzylaminopurine. One gram of callus produced by the leaves was placed on media containing 0, 2, and 4 μM methionine sulfoximine (MSO), which simulates a bacterial pathogen in tissue culture. Callus was allowed to grow in culture for 3 weeks; then, it was weighed, and protein was extracted. Weight of the callus grown on 0, 2, and 4 μM MSO was 4.66, 1.14, and 1.44 g, respectively. Total protein was determined using the Bradford methods. Cultures containing 0, 2, and 4 μM MSO had 1,267, 1,568, and 1,266 μg of protein, respectively. The results indicated that more protein was synthesized per gram of callus weight in the experimental groups than in the control groups.

EFFECTIVE ENERGY OUTPUT PER CORD OF AIR-DRY WOOD IN FIVE NATIVE AMERICAN HARDWOODS FROM A TYPICAL TENNESSEE WOODPILE. **Cebert L. Walker, Jr., Belmont University, Nashville, Tennessee.** Calories per gram, moisture content, and density were determined for five species of equally seasoned hardwood. These data were used to determine the effective BTU per cord in white oak (*Quercus alba*), black oak (*Quercus velutina*), yellow-poplar (*Liriodendron tulipifera*), shagbark hickory (*Carya ovata*), and flowering dogwood (*Cornus florida*). These species were compared at typical moisture contents on an available-heat-per-volume basis to determine the best woodfuel value for the homeowner as well as for industry. While calories-per-gram were similar across species, the differing moisture contents and densities produced significant differences in the amount of available heat per volume of wood.

HERBAL REMEDIES USED BY AFRO-AMERICANS OF MAURY COUNTY, TENNESSEE. **Peggy C. Whaley* and Thomas E. Hemmerly, Middle Tennessee State University, Murfreesboro, Tennessee.** Personal interviews of 32 Afro-Americans of Maury County, Tennessee, resulted in descriptions of herbal remedies utilizing 66 plant species. Of these plants, half are food-store items; the remainder are available at health-food stores or can be collected from the wild. Among the plants most often used are *Phytolacca americana*, *Allium* spp., and *Citrus* spp. Most preparations are infusions or decoctions taken internally for chronic conditions. The folk medicine practiced by these individuals contrasts with that of the stereotype of African ritualism.

WINE PRODUCTION IN TENNESSEE. **Betty McNeely* and Thomas E. Hemmerly, Middle Tennessee State University, Murfreesboro, Tennessee.** The development of a new retail wine industry in Tennessee since 1973 is reviewed. Formidable obstacles to successful wine-grape production include a climate unsuitable to many preferred grape varieties, the presence of grape diseases and infestations, and limited viticulture research specific to Tennessee. In turn, wineries in Tennessee currently are small, tourist-dependent, and low-producing and are handicapped by low consumer-demand, narrow markets, legal restraints, limited availability of quality raw materials, advertising restrictions, and competition presented by less expensive out-of-state products. Nevertheless, wine production in Tennessee is showing slow but significant growth and is supported by an increasing number of enthusiastic vintners, growers, trade organizations, state agricultural specialists, and consumers.

CHEMISTRY SECTION I

Ronald P. Robertson, Presiding

MODELING OF DENSE NONAQUEOUS PHASE LIQUID REMOVAL FROM AQUIFERS BY SPARGING AND PUMP-AND-TREAT OPERATIONS. **Linda A. Roberts*, Satoshi Kayano*, and David J. Wilson, Vanderbilt University, Nashville, Tennessee.** Microcomputer programs for modeling the removal of dense nonaqueous phase liquid (DNAPL) droplets/ganglia from aquifers by pump-and-treat operations and by sparging techniques are described, and results obtained with these programs are presented. The programs permit the modeling of diffusion-limited mass transport from the stationary DNAPL ganglia to the advecting aqueous phase. Diffusion transport is assumed to take place from DNAPL droplets through a thick stagnant water layer in a porous medium to the advecting mobile water. The dependence of DNAPL removal rates on the various model parameters (DNAPL aqueous solubility, Henry's constant, diffusion constant, droplet size, air and water flow rates, and system geometry) is discussed. The model

results are consistent with the severe tailing and extremely long cleanup times which occur in many pump-and-treat operations and indicate the importance of estimating diffusion and desorption kinetics effects in on-site pilot studies.

DIMETHYLSULFOXIDE AND SODIUM HEXACHLOROPLATINATE(IV) REACTION PRODUCT STRUCTURE AND IR AND NMR PROPERTIES. **James C. Howard, Middle Tennessee State University, Murfreesboro, Tennessee.** Samples for study were prepared by adding 300.0 μ l of either dimethylsulfoxide, DMSO, or DMSO- d_6 to 600.0 μ l of 1.0 M Na_2PtCl_6 in either H_2O or D_2O , heating at 70°C for at least 12 h, and allowing the sample to stand at ambient temperature until crystals had formed (2 to 15 days). FT-IR spectra were obtained on many of the crystals. Using H_2O or D_2O had no effect on the IR spectrum. Using DMSO- d_6 had a significant effect as expected. ^1H , ^{13}C , and ^{195}Pt NMR spectra were obtained for samples dissolved in DMSO- d_6 . The interpretation of these spectra is consistent with a product molecule containing two DMSO molecules per platinum atom. Single crystal x-ray structure analysis demonstrated that the resulting compound is dichloro-bis(dimethylsulfoxide)platinum(II) in a square planar arrangement with the bonding of the DMSO moieties to the Pt atom through the sulfur atoms. The elemental analysis of H = 2.69%, C = 11.27%, S = 12.98%, Cl = 16.28%, and Pt = 45.76% is consistent (but not a perfect fit) with the expected values of H = 2.86%, C = 11.38%, S = 15.19%, Cl = 16.79%, and Pt = 46.20% for *cis*- $\text{Pt}[(\text{CH}_3)_2\text{SO}]_2\text{Cl}_2$.

KINETIC AND STEREOCHEMICAL CONSIDERATIONS IN FRIEDEL-CRAFTS TYPE VINYLATIONS. **Charles E. Harding and Jason S. Overby, University of Tennessee at Martin, Martin, Tennessee.** During the last 30 years, disubstituted carbocations (vinyl cations) have become established as intermediates in several types of reactions. It is possible that these types of ions may be intermediates in reactions involving AlCl_3 -catalyzed reactions of certain vinyl halides with aromatic substrates, but heterogeneous reaction mixtures and the production of strong acids (HX) have made mechanistic interpretations difficult. It has been demonstrated that solvolytically-generated vinyl cations will "vinylate" aromatic substrates. Strong kinetic evidence to support such a mechanism is available. We have utilized (E)- and (Z)-1-bromo-1-phenylbutene and (E)- and (Z)-1-bromo-1-(4-methoxyphenyl)-1-propene to develop strong stereochemical and kinetic evidence for the intermediacy of vinyl cations in ordinary AlCl_3 -catalyzed reactions. For example, both (E)- and (Z)-1-bromo-1-phenylbutene react with anisole in the presence of AlCl_3 to give essentially the same product, a 77%/23% mixture of (E)- and (Z)-1-anisyl-1-phenylbutene. However, the (Z)-isomer reacts some 10 times faster than the (E)-isomer. These results are explained in terms of electrophilic attack of an intermediate, linear, sp-hybridized vinyl cation on anisole. Several other examples to support this mechanism will be presented.

CRYSTAL AND MOLECULAR STRUCTURES OF THE 4-METHYL- AND 4-T-BUTYLPYRIDINE ADDUCTS OF TETRAKIS(2,6-DIMETHYLACITANILIDO)DICHROMIUM(II). **William H. Isley and Subhash Baral, Middle Tennessee State University, Murfreesboro, Tennessee.** The crystal and molecular structures of the 4-methylpyridine, (1), and 4-t-butylpyridine, (2), adducts of tetrakis(2,6-dimethylacitanilido)dichromium(II), $\text{Cr}_2[\text{O}(\text{C}_6\text{H}_4(2,6-\text{CH}_3))]_4$, will be discussed. Compound (1) crystallizes in the space group Pbcn with unit cell dimensions of $a = 16.702(2)\text{\AA}$, $b = 19.013(3)\text{\AA}$, $c = 15.757(2)\text{\AA}$, and $Z = 4$. The structure was refined to an $R_f = 0.0760$ and $R_w = 0.0913$. Compound (2) crystallizes in the space group $P2_1/c$ with unit cell dimensions of $a = 16.779(2)\text{\AA}$, $b = 13.333(2)\text{\AA}$, $c = 26.783(3)\text{\AA}$, $\beta = 96.40(2)^\circ$, and $Z = 4$. This structure was refined to an $R_f = 0.102$ and $R_w = 0.136$. Both compounds exhibit octahedral geometry about each of the

chromium atoms. The two pyridine ligands occupy the axial chromium positions in both compounds with $[\text{Cr-N}_{\text{ax}}]_{\text{av}} = 2.368(9)\text{\AA}$ and $[\text{Cr-Cr-N}_{\text{ax}}]_{\text{av}} = 180.0(2)^\circ$ in (1) and $[\text{Cr-N}_{\text{ax}}]_{\text{av}} = 2.342(5)\text{\AA}$ and $[\text{Cr-Cr-N}_{\text{ax}}]_{\text{av}} = 178.6(2)^\circ$ in (2). For compound (1), $\text{Cr-Cr} = 2.323(2)\text{\AA}$, $\text{Cr-O}_{\text{av}} = 1.988(6)\text{\AA}$, and $\text{Cr-N}_{\text{av}} = 2.114(6)\text{\AA}$. The corresponding data for compound (2) are $\text{Cr-Cr} = 2.334(1)\text{\AA}$, $\text{Cr-O}_{\text{av}} = 1.996(4)\text{\AA}$, and $\text{Cr-N}_{\text{av}} = 2.111(4)\text{\AA}$.

TADPOLES, THYROID HORMONE, RED BLOOD CELLS, AND IRON. *Charles R. Thomas, University of Tennessee at Martin, Martin, Tennessee.* Thyroid hormone (TH) receptors were extracted from nuclei of red blood cells (RBCs) of tadpoles using buffers containing 0.4 M KCl, 1 mM EDTA, and 5 mM dithiothreitol. The receptors retained their affinity for TH after gel-permeation chromatography (MW ca. 68,000D). Binding affinity was destroyed by protease but not by DNase or RNase. Thyroid hormone induces tadpole metamorphosis, but its effects on RBCs are unknown. An enzyme which catalyzes the reduction of FMN by NADH was detected in RBCs of tadpoles. The FMN_{H₂} then reduced ferritin iron, causing its release as iron(II) ions. This is the same activity identified in mobilization of iron from the storage protein ferritin in other systems. Ferritin in RBCs of tadpoles is the major source of iron for hemoglobin synthesis during the RBS switch in metamorphic climax. Preliminary results indicate that the enzyme activity increases immediately before climax. The enzyme's affinity for FMN and NADH supports its physiological significance.

INHIBITION OF MGMT WITH ANTISENSE OLIGODEOXYNUCLEOTIDES. *S. K. Ballal, Tennessee Technological University, Cookeville, Tennessee.* The transfer of genetic information from DNA to RNA and its translation into specific proteins is a well-understood phenomenon. Under certain circumstances, phosphorothioate-modified oligonucleotides could be introduced into cells as sequence-specific agents to control translation of specific proteins. The significance of these agents is assured if they are membrane permeable, soluble, and resistant to nucleases. A 16-mer phosphorothioate antisense oligodeoxynucleotide was synthesized using an automated synthesizer. This was introduced into active cultures of HELa₃ cells. The antisense activity was measured in terms of O⁶-methylguanine-DNA methyltransferase (MGMT) concentration in these cells. The results indicate that within 6 h of exposure of the antisense oligos, the MGMT levels in these cells decreased suggesting that the oligos are effective in inhibiting this protein.

ISOLATION OF ANTIGEN-BINDING FRAGMENTS OF ANTI-DNA ANTIBODIES. *Kent Clinger, Bryan Prince, and Wayne F. Anderson, David Lipscomb University, Nashville, Tennessee, and Vanderbilt University School of Medicine, Nashville, Tennessee.* Antigen-binding fragments (F_{ab}s) derived from an antibody specific for single-stranded DNA have been purified. The intact antibody, Hed 10, was incubated at pH 11 for 16 h. Following high pH incubation, the F_{ab}s were prepared by papain digestion. The F_{ab}s were separated by ion-exchange chromatography on a Pharmacia FPLC instrument using a Mono-Q column. The F_{ab}s were chromatographed in 20 mM ethanalamine at pH 9.5 and eluted with a 0- to 200-mM NaCl gradient. The F_{ab}s were analyzed by isoelectric focusing on pH 3-9 isoelectric focusing gels.

INTERACTIONS OF URIDINE NUCLEOTIDES WITH THE ANTITUMOR DRUG, CIS-PLATIN. *Lori L. Slavin and Rathindra N. Bose, Austin Peay State University, Clarksville, Tennessee, and Kent State University, Ohio.* The platinum complex *cis*-diamminedichloroplatinum(II) (*cis*-platin) is one of the most widely used chemotherapeutic drugs for the treatment of a variety of cancers. Interactions of *cis*-platin with nucleoside-5'-di- and triphosphates are not well

defined. Since nucleoside-5'-triphosphates are primary substrates for DNA synthesis, a detailed understanding of platinum(II) nucleotide binding is important. Reactions of uridine-5'-di- and triphosphates with *cis*-platin yielded a variety of products. The complexes include pure phosphato chelates (diastereomers) in which two adjacent phosphate groups in the UDPs or UTPs are coordinated to the platinum center. Nitrogen-bound complexes were observed where platinum(II) coordinated to two pyrimidine bases of the nucleotide through the N3 sites. Further, secondary reactions of the pyrimidine base-bound complexes resulted in platinum-blue (for UDP) and purple (for UTP) complexes as minor products. Diastereomers are separated by reversed phase HPLC method and characterized by one- and two-dimensional Phosphorus-31 NMR and CD spectroscopic methods.

CHEMISTRY SECTION II

Lori L. Slavin, Presiding

MELTING POINT-COMPOSITION DIAGRAM OF THE CAMPHENE-BENZOIC ACID SYSTEM. *Martin V. Stewart, Terrence A. Lee, Christine Stewart Blamy*, Jeffrey T. Kuethe*, Lisa M. Lorance*, Shao-Yu Lu*, Phillip S. Mason*, Scotty S. Sengsavang*, and Patrick G. Sullivan*, Middle Tennessee State University, Murfreesboro, Tennessee.* The students of Advanced Organic Chemistry 424/524 laboratory obtained anomalous results when the molecular weight of benzoic acid was determined by the capillary melting-point depression of practical grade camphene. The molecular weight measured for benzoic acid was a linear function of its molality in the camphene because a nearly constant mixed melting point of 40°C was observed for samples containing from 0.1 to 0.4 M fraction benzoic acid. The data was reproducible when the mixtures were prepared by melting and cooling slowly to room temperature prior to melting-point determination; however, rapid cooling of the melt afforded solid samples having a very different and more complex melting point-composition diagram that exhibited an abrupt change in slope near 0.5 M fraction benzoic acid. The melting behavior of these mixtures is due to the formation of solid systems and not chemical reaction as shown by the absence of additional reaction products on analysis with GC-mass spectroscopy.

A STUDY OF UNSYMMETRICAL DISCOTIC LIQUID CRYSTALS. *Patrick Toy*, David Collard, and Charles M. Baldwin, Union University, Jackson, Tennessee, and Georgia Institute of Technology, Georgia.* The properties of discotic liquid crystals were investigated in this project. Modification of those properties was attempted by synthesis of unsymmetrical discotic molecules. The asymmetry in the discotic liquid crystal is believed to lower the transition temperature from the crystalline state to the mesophase. An attempt was made to synthesize a symmetrical discotic liquid crystal for comparison to the unsymmetrical molecule. The reaction of hexachlorobenzene with sodium alkylthiolates in *N,N*-dimethyl formamide was found to promote tetra-substitution rather than the expected hexa-substitution. The reaction produced 2,3,5,6-tetrakis(alkylthio)bischlorobenzenes which then underwent oxidation to the sulfonyl in *m*-chloroperbenzoic acid. NMR spectroscopy was utilized to validate the structures of the synthesized molecules.

QUALITATIVE AND QUANTITATIVE ANALYSIS OF RESIDUAL HYDROCARBONS IN SOIL. *Pamela J. Alexander*, Wolfgang Bertsch, and Charles M. Baldwin, Union University, Jackson, Tennessee, and University of Alabama, Tuscaloosa, Alabama.* The need for cost-effective remedial action technology of sites identified as contaminated is apparent for all industrialized countries. Soils contaminated by crude oil are frequently subjected to cleanup by both biological and

physical processes. One method proven effective, especially for heavily contaminated soils, is based on contact with finely ground coal, followed by flotation separation. An evaluation of the major factors that affect removal of crude oil was undertaken. The focus was to determine residual oil on a variety of soils. Oil was separated from contaminated soils by conventional Soxhlet extraction and by supercritical fluid extraction with carbon dioxide. Contaminants were then analyzed with gas chromatography.

SEQUESTRATION CAPACITIES OF POLYPHOSPHATES BY DPP. *Lauren McDonald* and John Harwood, Tennessee Technological University, Cookeville, Tennessee.* Sequestration capacities of polyphosphates used in water treatment for metal ions, including Fe^{3+} , can be determined by differential pulse polarography. This technique is superior to other methods used for this determination in terms of speed, selectivity, and precision. We have determined sequestration capacities (mg Fe^{3+} /mg P) of both commercial products and pure compounds. No significant difference was found in sequestration capacities among the products. To determine appropriateness of the method in routine water-treatment applications, we are investigating the application of the technique to solutions of low ionic strength and to solutions which contain hypochlorite. Potential applications of the titration method in research concerning factors affecting sequestration and in routine determination of treatment dosage will be discussed.

ENGINEERING SECTION

Ted S. Lundy, Presiding

USING MICROORGANISMS TO AID IN HYDROCARBON DEGRADATION. *Walter Black* and John Zamora, Middle Tennessee State University, Murfreesboro, Tennessee.* Aliphatic hydrocarbons are threatening the potable water supply and the aquatic ecosystem. Given the right microbial inhabitant(s), a large portion of these aliphatic hydrocarbons could be biodegraded before reaching the water supply. Our purpose is to isolate possible oil-degrading organisms. Soil samples were taken from hydrocarbon-laden soils at petroleum terminals, a petroleum refinery waste-treatment facility, a sewage-treatment plant grease collector, a site of previous bioremediation, and various other places. Some isolates known to be good degraders were obtained from culture collection services. These samples were plated on a 10w-30 multigrade motor oil solid medium to screen for aliphatic hydrocarbon degraders. The degrading organisms were isolated, identified, and tested (CO_2 evolution, BOD, and COD) to determine the most efficient degrader(s). Thirty-seven organisms were tested, and the most efficient degraders were *Serratia marcescens*, *Escherichia coli*, and *Enterobacter agglomerans*.

EFFECTS OF SOIL PARAMETERS ON THE WAVE PROPAGATION ALONG OVERHEAD LINES. *V. Kasturi* and P. Chowdhuri, Tennessee Technological University, Cookeville, Tennessee.* In general, the earth is assumed to be perfect (i.e., soil electrical resistivity zero) for the time-domain analysis of the propagation of electromagnetic transients on overhead lines. Under this assumption, the computed electromagnetic transients, neglecting conductor losses, would travel without distortion and attenuation along a multiconductor system with the velocity of light. However, the effects of the imperfect earth (i.e., soil with finite electrical resistivity) will be to add inductance and resistance to the transmission-line circuit which would then result in multivelocity propagation of electromagnetic transients along a multiconductor system with the attendant attenuation and distortion. Rudenberg's theory in the frequency domain was extended to the time domain for the analysis on the effects of imperfect earth, and a rigorous solution in

closed form was obtained. This analysis can be applied to both fast and slow transient phenomena. The response of both single and multiconductor systems was analyzed.

DETERMINATION OF THE FRACTURE TOUGHNESS OF A CERAMIC-MATRIX COMPOSITE: CHALLENGES IN THE USE OF THE VICKERS INDENTATION METHOD. *Gladius Lewis, Memphis State University, Memphis, Tennessee.* Central to the question of the increase in fracture toughness (K_{IC}) of a ceramic-matrix composite (CMC), relative to the monolithic matrix, is the determination of the K_{IC} . In this regard, the Vickers indentation method is currently the most popular technique. However, in spite of its many attractive features (such as simplicity and cost-effectiveness), this method is fraught with many limitations, such as difficulty in measuring crack length, dependence of the K_{IC} value on the nature of the crack system, and the difficulty of obtaining an unambiguous value for K_{IC} from the experimental data. The present work focuses on the last-mentioned limitation with respect to one CMC, namely a silicon nitride-5 volume percent silicon nitride whisker composite. The K_{IC} estimates, obtained using 23 different empirical relations and test results, will be utilized to make the case for a standard fracture-toughness-test method for CMCs.

APPARATUS FOR TEACHING MIDDLE-SCHOOL STUDENTS CONCEPTS OF CURRENT AND FLUID FLOW. *Steven Skretkovic*, Hugh L. Atkinson*, John Coltart, Charles Camp, and Michael L. Daley, Memphis State University, Memphis, Tennessee.* Based on our experiences with eighth-grade students who have attended the Herff College of Engineering Academic Enrichment Institute, we found that middle-school students often miss the opportunity to do "hands-on" experiments involving physics and mathematics. With the objective of providing middle-school students with the opportunity to experience a physical experiment with applied mathematics, a portable apparatus designed to illustrate concepts in fluid and current flow was developed. In particular, two separate experiments are done. With the use of a series DC circuit, current flow through a fixed resistor and the corresponding voltage across it are measured over a range of values and the results are graphed by hand. In the other experiment, an analogous fluid experiment is performed. Water flow through a small diameter tube and the corresponding pressure across it are measured over a range of values and graphed to illustrate Poiseuille law. A steady dye stream is used to verify laminar flow; break-up of the dye stream indicates the onset of turbulence, and roughly occurs where the loss of linearity between pressure and flow is evident. Not only do these two experiments provide the students an opportunity to engage in physics and mathematics, they also illustrate the limitations of mathematical modelling of physical phenomena.

MODEL OF CEREBRAL VENOUS BLOOD FLOW DURING EL-EVATED INTRACRANIAL PRESSURE. *Suresh Kagoo*, Michael Griffith, James T. Robertson, and Michael L. Daley, Memphis State University, Memphis, Tennessee (SK, MLD), Wilford Hall Medical Center, Lackland Air Force Base, Texas (MG), and University of Tennessee at Memphis, Memphis, Tennessee (JTR).* An analog electrical circuit model was used to provide a theoretical analytical description of cerebral venous blood flow during elevated intracranial pressure. The model predicts that variations in venous pressure associated with the respiratory cycle have a systematic influence on venous flow from the brain during elevated intracranial pressure. Specifically, intracranial blood volume increases during inhalation and decreases during expiration. Furthermore, the difference in change of intracranial volume between the two phases of ventilation, inhalation and expiration, increases with increases mean intracranial pressure. Analysis of the intracranial pressure signal obtained from the physiologic monitor

verify a model prediction: during intact regulation of cerebral blood flow, difference in intracranial blood-volume change between the two phases of respiration increases with increasing mean intracranial pressure.

MEASUREMENT OF POSTURAL CONTROL. *Mohammad T. Hajibeigy* and Michael L. Daley, Memphis State University, Memphis, Tennessee.* Like other remarkable aspects of movement, standing requires a continuous synergy between the vestibular, visual, and proprioceptor sensory input systems and the compensatory adjustments of the musculature. In order to further investigate the interaction of these systems, we are developing a technique for measuring postural sway in the quietly standing person. To determine the distance the body's center of gravity moves in a 10-sec interval in a plane defined by the anterior-posterior and lateral axes, a force-moment apparatus was constructed. Each corner of a 46- by 46-cm, diamond-shaped platform is supported by a miniature load cell (Interface, Inc., MB-250). Subjects are instructed to stand in the middle of the platform with feet at a 0° splay and 2 cm apart and look straight ahead at the top line of a standard visual acuity chart placed 2 m away. The inverted pendulum model of the standing human was assumed. Given the model, the displacement of the center of gravity can be calculated from the moments acting at the center of the board. Specifically, the dynamic torque-balance equation is solved using a fourth-order Runge-Kutta technique. To illustrate the stabilizing influence of vision on balance, examples of postural sway of the quietly standing subject with and without the use of vision will be presented.

ADAPTIVE RELATIONAL ENCODING DATA COMPRESSION FOR A REAL-TIME, MICROCOMPUTER-BASED, SEISMIC DATA-ACQUISITION SYSTEM. *Dexiang Xu* and Jer-Ming Chiu, Memphis State University, Memphis, Tennessee.* Adaptive-relational-encoding-data-compression technique is developed for a real-time, microcomputer-based, seismic data-acquisition system. Digital seismic data are encoded by the difference of the current sample with the previous one. The code length of the difference varies according to its amplitude range. Because the data-compression technique is adaptive, the distortion of the data due to compression can be eliminated. The relational-encoding-data-compression technique may encounter a setback which is adding too many special marks into the data stream when the input-data values frequently flip-flop a given testing boundary. Such a problem can be avoided by specifying a finite time window within which the code length of compressed data is fixed. A compression ratio from 1.588 to 3.440 can be achieved in testing the real earthquake signals. This data-compression technique can be very effective in compressing low-frequency, real-time seismic data.

THE DEVELOPMENT OF SUPERINSULATIONS FOR APPLIANCES. *David W. Yarbrough, Tennessee Technological University, Cookeville, Tennessee.* Thermal insulations used in the past to reduce the flow of heat into refrigerators and freezers were often produced with chlorofluorocarbon gases (CFCs). These insulations have thermal resistivities (R) in the range of 5 to 8 feet²*h*/F/BTU*inch. The dual requirement to eliminate CFCs and increase the energy efficiency of refrigerators and freezers has renewed interest in superinsulations. Superinsulations are materials or systems that have R values above 20. There are three concepts being explored for the production of superinsulations: aerogels; enclosed hard vacuums; powder-filled packets at absolute pressures below about 10 torr. The concept of powder-filled evacuated panels (PEPs) will be discussed. Powder-filled evacuated panels have been used by foreign manufacturers to insulate refrigerator walls and are presently being evaluated for use by appliance manufacturers in the United States. Powder-filled evacuated panels with R values in the

range of 20 to 30 are being made in small quantities for thermal and mechanical evaluation. The key technological barrier to the use of PEPs on a commercial scale is long-term maintenance of the vacuum inside the packet.

GEOLOGY AND GEOGRAPHY SECTION I

Phillip R. Kemmerly, Presiding

THE DEEP MARINE TO SLOPE TRANSITION OF THE FORT PAYNE FORMATION IN NORTH-CENTRAL TENNESSEE. *David N. Lumsden and Pamela Spencer*, Memphis State University, Memphis, Tennessee.* The transition from the Borden Siltstone delta of central Kentucky to the deep marine dolomitic porcellanites of the Fort Payne Formation (Mississippian, Osage) in central Tennessee was examined at a 71-m thick section near Dale Hollow Dam on Highway 53 in northern Tennessee. Thin section, XRD, and stable-isotope analyses were used to estimate mineralogy and interpret environments. The lower 40 m is dominated by cherty shale with relatively little carbonate. The upper 30 m is dominated by carbonate with an overall upsection increase in the dolomite proportion. Packstone lenses dip northeast along the paleoslope at the 40- to 30-m lithologic transition. This transition marks the boundary between deep-water distal fine-grained clastic facies of the Borden below to the deep-water cherty carbonates of the Fort Payne above and may be a systems tract boundary.

THE USE OF THE HYPSONETRIC INTEGRAL AS A SENSITIVITY INDEX OF BARRIER ISLAND FORM. *James M. McCluskey, Austin Peay State University, Clarksville, Tennessee.* The hypsometric integral (area-altitude curve) is a nondimensional parameter that is used to model changes occurring in three-dimensional form of barrier islands. Comparisons can be made between different temporal and spatial frames of reference regardless of scale. Several parameters associated with the hypsometric integral are used for diagnostic purposes. The study site for this research is Bodie Island, North Carolina. The barrier island is modeled, and comparisons made using engineering survey data from 1937, 1961, 1963, and 1976. The 1961 and 1963 data represent pre-storm and post-storm conditions associated with the Ash Wednesday Storm of March 1962.

BOULDER BEDS OF MISSISSIPPIAN SANDSTONE IN PLIO-PLEISTOCENE GRAVELS, HENRY COUNTY, TENNESSEE. *Robert P. Self and Michael Gibson, University of Tennessee at Martin, Martin, Tennessee.* Large (1.8 m across) angular blocks of Mississippian sandstones are incorporated in discontinuous layers within the Plio-Pleistocene ("Lafayette") gravels in Henry County, Tennessee. The blocks were probably derived from the Hardinberg-Henselle sandstone that, during the Pliocene, outcropped within a very short distance from the Plio-Pleistocene braided stream system. The sandstones are clean, well-sorted quartzarenites with silica cement. Surfaces are water-worn and burrowed. During the Plio-Pleistocene, the sandstone probably formed a resistant edge over which a small stream flowed. Blocks broke off as the underlying carbonates were dissolved and then were transported into the braided stream fan system during flash floods or by slumping.

INSECT?-BORED INTRACLASTS FROM THE PLIO-PLEISTOCENE GRAVELS OF WEST TENNESSEE. *Michael A. Gibson and Robert P. Self, University of Tennessee at Martin, Martin, Tennessee.* Tabular clay intraclasts within Plio-Pleistocene gravels in Henry County, Tennessee, are excellently preserved in spite of their soft nature relative to the enclosing sand and gravel suggesting little or no transport or

reworking. Most contain teardrop-shaped borings (up to 2 cm deep) that we attribute to insect larvae, representing the first reported occurrence of insects from the Plio-Pleistocene deposits of Tennessee. A second type of boring occurs as closely spaced tubes 1 to 4 mm in diameter extending completely through intraclasts, also attributed to boring insect larvae. We have failed to identify other sites with bored clay intraclasts suggesting that the original substrate was local or that excessive reworking in the gravel streams of the Plio-Pleistocene normally destroyed clay intraclasts prior to burial.

QUATERNARY QUIRKS IN THE TERRESTRIAL UNITS OF NORTH-WESTERN TENNESSEE. *William T. McCutchen, Ernest W. Blythe, Jr., and Michael A. Gibson, University of Tennessee at Martin, Martin, Tennessee.* A geologic mapping project in the loess hills near Reelfoot Lake, Tennessee, has revealed some interesting possible interpretations of the loess and Plio-Pleistocene gravel units. Surface depressions in loess may serve as water catchment basins with water loss through joint systems that develop into pipes and exit on the face of nearby bluffs. As the pipe size enlarges, collapse occurs, and a small valley develops. Circular valley heads suggest this activity as an initiator. The boundary between the Plio-Pleistocene gravel and the loess suggest a dynamic situation of unit-mixing between possible pulses of loess deposition. Thick trends of the Plio-Pleistocene gravel are essentially east-west and perpendicular to the Mississippi River System.

PETROGRAPHY OF THE GIZZARD ACROSS DUNLAP, TENNESSEE. *Habte G. Churnet, University of Tennessee at Chattanooga, Chattanooga, Tennessee.* The lowermost Pennsylvanian Gizzard Group of Tennessee can be subdivided into sandbody and heterolithic sequences, both exhibiting fining-upward cyclic sedimentation. The sandbody sequence consists of quartzarenite and quartz-pebble conglomerate, while the heterolithic sequence consists of sandstone (sublitharenite, quartzarenite), siltstone, and shale with occasional coal seams and siderite nodules. The sandbody sequence is dominant on the craton side of Dunlap (along Highway 8), while the heterolithic sequence is dominant on the side of the Alleghanian orogenic front (along Highway 127). Microscopic study reveals that the components of the sandstone layers on both sides of Dunlap, Tennessee, are similar and consist mostly of strained quartz, polycrystalline quartz (chert), and fragments of micaceous schist. Minor components include feldspars, biotite pseudomorphs, muscovite, chlorite, calcite, and quartz with overgrowth. Thus, the clastics were derived from the same metamorphosed region and most likely from a recycled orogenic provenance.

IRON INDUSTRY OF STEWART COUNTY, TENNESSEE. *Mattie C. Jones* and D. M. S. Bhatia, Austin Peay State University, Clarksville, Tennessee.* Stewart County, Tennessee, is well-known for its 1850s iron industry as it has numerous areas that have been prospected and mined. The two major types of iron ore found in this county are hematite (red ore) and limonite (brown ore). The entire county is underlain by either Fort Payne, Warsaw, or St. Louis formations which are of Cretaceous and Mississippian age. Stewart County has been divided into 15 quadrangles or regions. The nine quadrangles that contain iron ore were studied in detail with two showing the presence of standing blast furnaces and seven the presence of small to large mining pits.

THE WEATHERING TEXTURES OF ACCESSORY MINERALS IN SYENITES FROM CENTRAL ARKANSAS. *Steven V. Stearns, Memphis State University, Memphis, Tennessee.* Samples collected from syenites and associated lateritic weathering profiles in the bauxite mining region of central Arkansas allows the study of incipient weathering in a variety of accessory silicate minerals. Samples were examined using petrographic and scanning-electron-microscopy techniques to

determine the behavior of individual minerals and the rock as a whole under conditions of intense weathering. The minerals chosen for examination were sphene, biotite, hornblende, aegirine, and aegirine-augite. The texture of the partially weathered mineral grains appears to be the result of both crystallographic and non-crystallographic factors. Each of these minerals was seen to weather in a distinctly different manner, providing insight into the mobility of constituent elements during the weathering and the origins of an assortment of clays and weathering products in the weathering zone.

ESTIMATING THE SOURCE OF A GRAVITY AND MAGNETIC ANOMALY AT BELLWOOD, WILSON COUNTY, TENNESSEE, BY SIMPLE GEOMETRIC SHAPES. *Richard G. Stearns, Vanderbilt University, Nashville, Tennessee.* A 16-mgal gravity anomaly and 750 gamma magnetic anomaly indicate buried heavy magnetic rock of some shape. Modeling suggests a shape, density, and susceptibility. For the sphere model, half-width (gravity) gives 6.8 km depth to center; half-maximum slope (magnetics) gives 1.8 km depth to top. Such a sphere would have 0.28 g/cc density contrast and 0.004 cgs susceptibility contrast. Although model gravity nearly agrees with observed gravity, model magnetic values do not. Model gravity is forced to partially agree by the center and half-width values, but magnetic models are not. The sphere is rejected. A vertical cylinder is the next simplest shape. Attempts failed to maintain the sphere's volume, density, and susceptibility in a cylinder. A smaller volume, higher density (0.57 g/cc), and higher susceptibility (0.012 cgs) disk did fit. The unknown mass could be a disk of peridotite 7.2 km in diameter and 3.3 km thick in granitic basement.

NEW ECHINOID RECORDS FROM THE ST. LOUIS LIMESTONE (MISSISSIPPIAN) OF MONTGOMERY COUNTY, TENNESSEE. *Samuel E. Brown and James X. Corgan, Dickson County High School, Tennessee, and Austin Peay State University, Clarksville, Tennessee.* The St. Louis limestone of Montgomery County, Tennessee, yields two species of echinoids, neither of which has been previously identified from this area. The identification of one species involves the consideration of morphologic features in four zones of the test: ambulacral areas, ribs, interambulacral areas, anal region. Specific identification was made primarily by examination of the arrangement and shape of plates in the interambulacral areas. This species, *Melonechinus multiporus*, was first described by Norwood and Owen in 1846. Identification is presented with confidence, based on an essentially complete specimen. The second species, *Archaeocidaris wortheni*, was first described by Hall in 1858. Identification is less certain since known individuals are fragmentary. These new records should help to clarify the distribution of echinoids in Mississippian rocks of Middle Tennessee.

MEETING THE CHALLENGE OF PRE-COLLEGE GEOSCIENCE EDUCATION IN TENNESSEE. *Don W. Byerly, University of Tennessee, Knoxville, Tennessee.* Education reform in the United States has prompted a multitude of proposals either outlining curricula for different grade levels or stating the level of knowledge or skills that should be acquired by citizens of the United States. The Tennessee Department of Education (DOE) in 1990 produced documents outlining the goals of science education for Tennessee. These documents list fundamental concepts teachers should address in their courses and terminal objectives for each concept. The DOE document, *Science Framework; Grades Nine Through Twelve*, contains two sections directly pertaining to the subject of geology: "Earth Science" (a generalist approach, pages 14 and 15) and "Geology" (a more specific approach, pages 22 through 24). Instruction beyond the traditional college introductory geology courses is desperately needed, if teachers are to have the competence and

confidence to succeed in achieving the terminal objectives set forth for pre-college geology. Some viable options to meet this challenge are presented.

GEOLOGY AND GEOGRAPHY SECTION II

James M. McCluskey, Presiding

SINKHOLE ACTIVITY AND URBAN DEVELOPMENT: EXAMPLES FROM JOHNSON CITY, TENNESSEE. *Cynthia R. Coron and Richard D. Sams**, East Tennessee State University, Johnson City, Tennessee. Prior to the development of North Johnson City, portions of the area were occupied by a well-established sinkhole plain. Orientations of sinkholes can be reconstructed from topographic maps of the late 1950s. These show a preferred long axis-orientation of N25°E to N45°E and a short axis (where mappable) of N70°W. These trends follow the general strike of the underlying Knox Group carbonates, which hosts the greatest number of caves in eastern Tennessee. Doline formation can be linked to two mechanisms: accelerated solution and settling in areas of dense jointing and roof collapse of near surface caves or of soil arches over buried sinkhole throats. Precipitation infiltrated the sinkhole plain which channeled subsurface conduit flow to area springs. Subterranean flow remained discrete, at least in the vadose zone; water entering the surface through a number of openings tends to unite at depth and appear as a smaller number of springs under gravity (mainly at the base of more grossly permeable limestone outcrops, at intersected impermeable beds, and along faults). After area development, during which sinks were infilled and fields leveled for construction, the natural karst drainage system was disrupted. In North Johnson City, this reactivated older sinkholes, triggered soil arch collapse over areas of cavernous development, and caused risings under hydrostatic pressure (vauculian springs).

HILLSLOPE EVOLUTION ON THE EASTERN HIGHLAND RIM: EVIDENCE FROM ABANDONED INGROWN MEANDERS. *Hugh H. Mills*, Tennessee Technological University, Cookeville, Tennessee. Evolution of hillslopes on resistant rocks takes place so slowly that direct observation is impossible. However, if present-day slope profiles can be ordered as to their relative ages, then their forms can be considered to represent stages in a developmental sequence. This approach was achieved by surveying slopes along a 3-km reach of the 100-m-deep gorge of Cane Creek near the escarpment of the eastern Highland Rim. Time-zero (T₀) profiles were assumed to be the actively undermined slopes on the undercut side of ingrown meanders. Older profiles were those on the undercut slopes of three abandoned meanders. The height of the floor of each abandoned meander above the modern stream (T₁ = 2 m; T₂ = 14 m; T₃ = 44 m) serves as a proxy for the time since undercutting ceased. A computer model by M. J. Kirkby was used to simulate evolution of profiles from their initial forms to those measured at T₁, T₂, and T₃.

DEVELOPMENT OF BLIND VALLEYS AND SHALLOW HOLES IN CARTER COUNTY, TENNESSEE. *C. R. Coron, S. Pritchard*, R. D. Sams*, and K. M. Burdick**, East Tennessee State University, Johnson City, Tennessee. Dry Creek, in Carter County, Tennessee, is a classic example of a blind valley, a holokarstic valley closed at the downstream end by the obstruction of the surface drainage into a swallow hole. Earlier drainage developed on overlying non-calcareous rocks, now eroded away, has been superimposed onto a paleokarsted limestone surface already riddled with caves and sinks. These abstracted the surface drainage before a substantial fluvial valley could be cut. Groundwater flow in the area is opposite to the dip of the strata following solution channels, developed in the Knox aquifer, which appear to be

enhanced along fractures related to the Stony Creek Syncline. Connection to turbidity events of Rockhouse Cave Spring has been suggested.

PEAK PRECIPITATION-RELATED CONTAMINANT SURGES,¹ BUMPASS COVE, TENNESSEE. *Cynthia R. Coron, Kent M. Burdick*, and Richard D. Sams**, East Tennessee State University, Johnson City, Tennessee. Atomic-absorption-spectrophotometric analyses of surface and groundwater samples collected from 1979 through 1992 from Bumpass Cove, Tennessee, document the periodic movement of heavy metal contaminants. Leachate from the Bumpass Cove Landfill, a designated State Superfund hazardous waste site, travels by means of open conduit and diffuse flow through the highly jointed and fractured Shady Dolomite karst aquifer. During periods of less-than-normal precipitation, heavy metals build up in pore spaces in the substrate. Residence time is ordinarily of short duration. During peak precipitation periods, contaminants are flushed downgradient from the site where they enter into the sands and gravels of the valley terraces of Bumpass Cove. This poses a serious threat to the health of community residents who derive their drinking water from springs and shallow wells which utilize these terraces as a local aquifer. Elevated levels of lead, zinc, silver, nickel, and cadmium as well as traces of arsenic and cyanide have been recorded.

CAVERN DEVELOPMENT IN THE HOLSTON FORMATION, SWEETWATER, TENNESSEE. *R. Mercer* and C. R. Coron*, East Tennessee State University, Johnson City, Tennessee. Craighead Caverns, developed in the Holston Formation and located southeast of Sweetwater, Tennessee, contains the largest known spring-fed underground lake. Seasonal water fluctuations are recorded at the site, but no known outlet to the surface has been located within the 5.47 ha surveyed. Cavern development in the area is sinuous, common in central Tennessee on more nearly flat-lying strata, and represents enhancement of dominant joints in lithologically favorable beds and along the contact between limestone and shale. Several passages are aligned parallel to the main northeasterly trend of long axis straight cave segments mapped in East Tennessee. Preferential cave development appears to be located in a zone at or just below the water table, due primarily to relatively fast-moving groundwater. Cylindrical cave shafts may have developed by solution and collapse along master vertical joints where water table fluctuations seasonally (?) cause an alternation between vadose and groundwater conditions.

HISTORY OF SCIENCE SECTION

James X. Corgan, Presiding

CHRISTOPHER COLUMBUS AND THE QUADRANT: A COMPUTER PLANETARIUM STUDY OF HIS NORTH STAR SIGHTINGS. *Philip Jack Lorenz, Jr.*, University of the South, Sewanee, Tennessee. In his "Prologue" to the *Journal of the First Voyage*, Christopher Columbus promised the Spanish Sovereigns that he would determine latitude and longitude for the lands in the Ocean Sea. To find the latitudes, he used a common quadrant to measure the altitude of Polaris at various locales on the northern coasts of Cuba, Hispaniola, South America, and Jamaica. Sightings taken at sea on the Third Voyage would lead to the curious contention that the Earth was pear-shaped. These and other observations of the North Star by Columbus were checked for accuracy by simulating the historic skies with commercially available computer "planetarium" programs. A reproduction of a medieval quadrant (crafted by Francis Cordell) was field-tested to investigate some of the problems with instrumentation encountered by Columbus.

CURRENT THEMES IN ENVIRONMENTAL HISTORY. *Richard P. Gildrie, Austin Peay State University, Clarksville, Tennessee.* Environmental or ecological history is a rapidly developing field in American historiography. Some of the more salient problems and themes within that field are examined through special attention to the recent works of Donald Worster, William Cronon, Timothy Silver, and John Stilgoe. It is argued that the field's growing sophistication, as it transcends polemical environmentalism, increasingly encourages interdisciplinary research and instruction and promises to create new interpretive frameworks in American social, intellectual, and economic history which may well prove to be of both academic and public interest. Finally, some observations are made about work on the environmental history of Tennessee and Kentucky.

BENJAMIN L. C. WAILES: A FORGOTTEN SCIENTIST OF THE OLD SOUTHWEST. *George E. Webb, Tennessee Technological University, Cookeville, Tennessee.* Benjamin Leonard Covington Wailes (1797-1862) is primarily known as a naturalist who examined various aspects of the natural history of his adopted state of Mississippi. An avid collector, Wailes established a large private museum in his home in Washington, Mississippi, and contributed to museums at the University of Mississippi and at the state capitol in Jackson. His work led to correspondence with many of America's leading scientists, including Louis Agassiz and Benjamin Silliman, Sr., and to his appointment as a member of the Mississippi geological and zoological survey. Although an active collector, Wailes remained largely uninformed of theoretical developments of the period and was, thus, out of the mainstream of antebellum American science. The career of Benjamin L. C. Wailes provides intriguing insight concerning the science practiced in the Old Southwest.

THE BARNARD ASTRONOMICAL SOCIETY OF CHATTANOOGA, TENNESSEE, 1923 TO PRESENT. *F. M. Cordell, Sr., Barnard Astronomical Society, Chattanooga, Tennessee.* The organization of the Barnard Astronomical Society in many ways founded amateur astronomy in Tennessee. From the beginning, it shaped the progress of engineering, science, education, and the architecture of the city of Chattanooga. Indeed, it is an organization soliciting members from all walks of life who have a common bond at the eyepiece of a telescope. On 15 November 1923, Burleigh S. Annis organized and chaired a meeting at the Central Y.M.C.A. in downtown Chattanooga. The body consisted of teachers, business persons, artists, publishers, and doctors of the Chattanooga and Lookout Mountain townships. The secretary, John Bailey Nicklin, Jr., brought the bylaws to first reading, and Annetta Trimble moved the new society be named after the distinguished Tennessee astronomer Edward Emerson Barnard who had recently died. The history of the society embodies the history of amateur telescope-making in the southeastern United States. Through the efforts of Clarence T. Jones in 1937, it produced a 52.1-m (20.5-inch) Cassegrain reflector. This instrument and its observatory and planetarium stand today as prologue for those who see astronomy as the inspiration of science.

NEWTONIAN MECHANICS AND POPULAR IMAGINATION IN THE EIGHTEENTH CENTURY. *Susan Robbins, Austin Peay State University, Clarksville, Tennessee.* Newton's accomplishment in his most famous work, *Principia Mathematica*, was to take Kepler's laws of planetary motion and Galileo's laws of terrestrial motion and show them to be examples of an overarching law, the law of universal gravitation. This spectacular achievement had the effect of establishing reason as being thoroughly competent not only to answer any important question which might be asked but also to provide the hope that

everything conceivable could be eventually arranged in a systematic unified order under the auspices of science. Science thereby took the place of religion, and all areas of investigation were thought to hold promise of such systematic unity both within themselves and in connection with each other provided that they were analyzed on the mode of Newtonian mechanics. Thus, the eighteenth-century imagination went far beyond what Newton himself had envisioned for his system, to the point that Newton would have been appalled at some of the ideas and beliefs about his world generated as a consequence of his success in physics.

THE ROOTS OF GEOLOGICAL FIELDWORK IN NORTH ALABAMA: GERARD TROOST'S TRAVELS IN 1834. *James X. Corgan and Michael A. Gibson, Austin Peay State University, Clarksville, Tennessee, and University of Tennessee at Martin, Martin, Tennessee.* In April 1834, Gerard Troost (1776-1850) spent 8 days exploring the geology of North Alabama. He was the first geologist to enter the region. His manuscript notes provide day-by-day insight into the maturation of his scientific views. Notes also describe living arrangements and challenges that faced the traveler. While Troost published descriptions of some fossils from this area, his surprisingly sophisticated interpretation of stratigraphy and structure remain unpublished. His manuscript notes may have been widely read and had clear influence on at least one author. Troost used superposition and guide fossils, most of which had not yet been formally described, to decipher the stratigraphic section in reasonable detail. He did especially well with strata that modern geologists would refer to the Devonian, Mississippian, and Pennsylvanian. He correctly interpreted the structure of the mountains of North Georgia and by extension identified the Cumberland Plateau province of the southern Appalachians. Few field geologists have accomplished as much during 8 days spent in virgin territory.

BRUCE WADE, PIONEER WEST TENNESSEE GEOLOGIST. *Ronald E. Brister, Memphis Museums, Inc., Memphis, Tennessee.* A burst of intense geological exploration and interpretation of the eastern Mississippi Embayment marked the first 3 decades of the twentieth century. Bruce Wade, a geologist trained at Vanderbilt and Johns Hopkins universities, played a central role in the interpretation of the stratigraphy and paleontology of the Cretaceous deposits of West Tennessee. He discovered and described the perfectly preserved and extensive fauna of the Coon Creek fossil site, made detailed county stratigraphic studies, and is credited with discovering the first fossil insect preserved in amber reported from North America. Wade served in World War I and later worked in the oil industry in Mexico as an exploration geologist in the early 1920s. His promising career was cut short by a severe illness which left him confined in hospitals for the rest of his life. He died at the age of 84 in relative obscurity.

MATHEMATICS AND COMPUTER SCIENCE SECTION I

Nell K. Rayburn, Presiding

A NUMERICAL STUDY OF RESONANCE. *Gary Hall, David Lipscomb University, Nashville, Tennessee.* An age-structured model of a population of tumor cells is evaluated. The model has incorporated in it a periodic chemotherapy treatment. In a numerical analysis of the problem, there seems to be certain periods where, if used, the effectiveness of the treatment sharply decreases. These items seem to have a pattern and not just be random. The times when the effectiveness decreases are called resonances.

ESTIMATION OF PARAMETERS IN A MODEL FOR WATER FLOW IN POROUS MEDIA. **J. Zijlstra**, *Middle Tennessee State University, Murfreesboro, Tennessee*. Flow of water in unsaturated soils can be described by a general flow equation (GFE). The parameter identification problem (PIP) for unsaturated flow consists of estimating the parameters in functional representations of the hydraulic coefficients that occur in the GFE. Solution of the PIP by an inverse procedure requires repeated solution of the initial boundary value problem (IBVP) for different values of the parameters that are to be estimated, until the outcome of the IBVP matches, in some sense, a given set of data. The current study focuses on estimating parameters based on simulated in situ water-content values measured at various times and depths. The optimization algorithm implemented in this study is an efficient and versatile quasi-Newton method. To simulate measurement error, the data were perturbed by adding a random component. The distribution of the parameter estimates and the effect of a weighting procedure was investigated.

SOME POSITIVE OPERATOR-VALUED MEASURES IN OPERATOR THEORY. **Kevin L. Shirley**, *Middle Tennessee State University, Murfreesboro, Tennessee*. An introductory discussion of a positive operator-valued measure (POM) is presented. A classical application is given along with the construction of a POM for some examples used in subnormal operator theory. If N is a normal operator on a Hilbert space H , then there is a spectral measure $E(\cdot)$ defined on the Borel subsets of the spectrum of N , denoted $\sigma(N)$, such that $N = \int_{\sigma(N)} u dE(u)$. It is easy to see that $e(\Delta) = PE(\Delta)|_M$ is a POM where M is a Hilbert space subspace of H , P is the projection onto M , and Δ is a Borel subset of $\sigma(N)$. Naimark has shown that every POM arises in this manner (i.e., as a compression of a spectral measure). This characterization of a POM provides a technique for constructing them in many examples basic to subnormal operator theory. Finally, a positive Borel measure is constructed from a POM which is used in another study to obtain a scalar-valued analytic model for a class of subnormal operators.

MAPPING DEGREE IN \mathbb{R} . **Zachariah Sinkala**, *Middle Tennessee State University, Murfreesboro, Tennessee*. Degree theory is a very applicable branch of mathematical analysis. One of the main concerns of degree theory is the development of methods in order to solve equations of the type $f(x) = 0$. Here, F maps a subset D of a real Banach space X into X . A special case $X = \mathbb{R}$ is discussed, and then it will become clear that all of the results in Banach spaces X really possess a simple core. The solvability of this equation is often achieved by estimating the "degree" of F (always an integer) with respect to a "nice" subset S of its domain D . If this degree is not zero, then F has a zero inside S .

LOCALIZATION OF WITT-RINGS. **Vatsala Krishnamani**, *Middle Tennessee State University, Murfreesboro, Tennessee*. Witt-rings of local type are building blocks for Witt-rings of elementary type. All these Witt-rings of elementary type can be realized from fields. The question still remains as to whether an arbitrary Witt-ring can be realized from fields. An attempt is made to localize a Witt-ring whenever possible. G is a group of exponent 2, q is the linked quaternionic structure defined on $G \times G$, Q is the image of q , and B is the abelian group generated by Q . $D\langle 1, a \rangle$ denotes the value-set of the Pfister form $\langle 1, a \rangle$. Witt-rings of local type can be characterized by the size of Q . For Witt-rings of local type, the size of Q is 2 and so is the size of each of the value-sets $D\langle 1, a \rangle$ for a in G . The relationship between $D\langle 1, a \rangle$ and the characters on B are examined.

AUTOMORPHISMS OF HASSE SUBGROUP DIAGRAMS. **Dawn Woodard***, *Middle Tennessee State University, Murfreesboro, Tennessee*. The automorphism groups of the Hasse subgroup diagrams for cyclic groups with order divisible by exactly one and exactly two primes are classified. In particular, it will be shown that the automorphism group of the Hasse subgroup diagram of C_{p^n} is isomorphic to $C_2 \times C_2$ and that the automorphism group of the Hasse subgroup diagram of $C_{p^n} \times C_m$ is isomorphic to C_2 .

AUTOMORPHISMS OF DIRECTED TRIPLE SYSTEMS. **Rebecca Calahan Zijlstra**, *Middle Tennessee State University, Murfreesboro, Tennessee*. A directed triple system (X, β) of order v is a collection in B of three subsets (blocks) of a set X , $|X| = v$, such that any ordered pair of X is contained in exactly one block of β . An automorphism of a directed triple system is a permutation π of the set X that fixes the blocks of β . We define a reverse directed triple system to be a directed triple system that admits the automorphism π of X consisting of $v/2$ transpositions or $v/2$ transpositions and one fixed point. Necessary and sufficient conditions for the existence of reverse directed triple systems are found.

THE FOUR COLOR THEOREM AND SNARKS. **D. Kirk Menser**, *Austin Peay State University, Clarksville, Tennessee*. The Four Color Theorem states that the countries on any map can be colored with no more than four colors so that no two adjacent countries are assigned the same color. A snark is a simple, connected graph G such that every vertex of G is of degree three, G has no cutvertices, and the edges of G cannot be colored with three colors so that no two adjacent edges have the same color. A result by P. G. Tait shows that the Four Color Theorem is true if and only if every snark is non-planar, i.e., can be drawn in the plane with no edges intersecting. The history of the Four Color Theorem and a stronger conjecture that every snark contains a subdivision of the Petersen graph are examined.

MATHEMATICS AND COMPUTER SCIENCE SECTION II

Thomas Hamel, Presiding

UNLIKELY PROBABILITIES. **J. Ronald Gupton**, *Austin Peay State University, Clarksville, Tennessee*. A gambling question posed by A. Gombauld in 1654 to his friend Pascal was answered by Pascal and Fermat. This question is discussed as an interesting freshman-level problem. A second more difficult problem called "The Gambler's Ruin" is discussed with an emphasis on the result.

A PROBABILISTIC LOOK AT RANDOM TESTING. **Dennis Walsh**, *Middle Tennessee State University, Murfreesboro, Tennessee*. The promotion of random testing to detect substance abuse or other traits within a population has caused much controversy in recent years. Although much of the concern regards questions of privacy and other civil rights, the related question of accuracy of results has received less attention. Suppose that a randomly chosen individual is tested for a characteristic of interest (such as substance abuse or disease), and the test results are positive. Given specified amounts of error in the testing instrument, what is the probability that the individual actually has the trait of interest? Determination of such a probability depends on the testing errors and the proportion of the population with the particular trait. Using Bayes Theorem and simple calculations, one arrives at often surprising results that call into question the efficacy of random testing in certain situations.

AVERAGES ON THE MOVE. *Larry Hoehn, Austin Peay State University, Clarksville, Tennessee.* How does a mean such as the arithmetic (A), geometric (G), harmonic (H), and root-square (R) of positive real numbers $a_1 + x, a_2 + x, \dots, a_n + x$ compare with the same mean of a_1, a_2, \dots, a_n ? We can show that:

$$\begin{aligned} &A(a_1 + x, \dots, a_n + x) - x = A(a_1, \dots, a_n), \\ &G(a_1 + x, \dots, a_n + x) - x > G(a_1, \dots, a_n), \\ &H(a_1 + x, \dots, a_n + x) - x > H(a_1, \dots, a_n), \\ \text{and } &R(a_1 + x, \dots, a_n + x) - x < R(a_1, \dots, a_n). \end{aligned}$$

But somewhat surprisingly, if M is any of these means, then

$$\lim_{x \rightarrow \infty} [M(a_1 + x, \dots, a_n + x) - x] = a(a_1, \dots, a_n).$$

TWO FINITE PROJECTIVE GEOMETRICS. *Dawn Luna* and Robert Ralston*, Middle Tennessee State University, Murfreesboro, Tennessee.* The 13-point, 13-line, and 21-point, 21-line geometries are described, drawn, and shown to be self-dual. Axioms for these geometries are listed, and then theorems are discovered and proved. From these two geometries, patterns and similarities are uncovered for not only these particular cases but also for an infinite number of geometries. Through these patterns, a new category of mathematics is broadened, and a new approach to problems is created.

MINIMAL SURFACES. *Kevin D. Gipson*, Middle Tennessee State University, Murfreesboro, Tennessee.* The development of minimal surfaces is traced from the beginning to the many complex mathematical fields it has gone into today. Exactly what minimal surfaces are, the properties they can have, and some applications are discussed. Applications include minimal surfaces as tents and roofs and the optimal cells and crystals.

A BRIEF VISIT IN ENGLAND WITH SOME HISTORIC MATHEMATICIANS. *Floyd L. Christian, Jr., Austin Peay State University, Clarksville, Tennessee.* The Cooperative Center for Study in Britain is a higher-education consortium of colleges dedicated to programs of study in Britain and Ireland. The headquarters of the group is at Northern Kentucky University; Austin Peay State University is an affiliate member. In the summer of 1992, I became acquainted with the work and lives of several famous British mathematicians while accompanying the student and faculty consortium group at King's College Kensington, a college of the University of London. Brief sketches of some life-history facts of several British mathematicians, including Isaac Newton, and my impressions of their times and works are presented. The current message from England in the field of mathematical history is that there remains a considerable need for scholarly assessment of many historical manuscripts, especially those of Newton.

SUPERCOMPUTERS AND MOLECULAR CONFORMATIONS. *William K. Glunt, Austin Peay State University, Clarksville, Tennessee.* Various types of high-performance computers currently in use and an application of one in particular to a problem from computational chemistry are described. For a given molecule, generally one can accurately measure only some of the distances between the atoms involved, e.g., by MRI and NOE methods. Chemical properties often demand that certain collections of atoms have a given handedness. The mathematical problem is then the problem of producing coordinates for the atoms which mimic the measured distances as closely as possible and also have the correct handedness properties.

AN ALGORITHM FOR SIMULTANEOUS EXTRAPOLATIONS AND AREA-MATCHING OF MULTIPLE INDICATOR DATA. *J. M. Bateman, Austin Peay State University, Clarksville, Tennessee.* A description is presented of a two-part algorithm found useful in analyzing multiple indicator-dilution data by making possible a simultaneous exponential extrapolation of several indicator curves in a way that best matches their integrals. The first part organizes the calculations of all the linear regression lines that can be obtained from data (X_i, Y_i) , ($i = 1, 2, \dots, N$ and ΔX_i constant) by restricting the index i to subranges $\{I, I+1, \dots, J\}$ of the index set $\{1, 2, \dots, N\}$. This enables one to make and store numerous exponential extrapolations of each indicator's data. The second part is an efficient search for a simultaneous extrapolation giving the best match for areas under several extrapolated curves. With this algorithm, trial and error matchings of areas, based on visually guided identification of a set of straight lines, can be replaced by a systematic search based on quantitative measures.

THE SEMANTICS OF PROGRAMMING LANGUAGES. *James B. Hart, Middle Tennessee State University, Murfreesboro, Tennessee.* There are essentially three parts to writing a program: program specification; program construction; program verification. Dana Scott, Samson Abramsky, and many others have spent the better part of the past 20 years developing order-theoretic models for the semantics of computation, and their work has become the center of one of the most rapidly expanding areas of mathematical research. Their approach to program specification and verification will be introduced. It will be shown that, by viewing program specifications as finite observations of the program's output, a logic-based interpretation of specification may be developed. This treatment leads naturally to the order-theoretic notion of a frame as the desired abstract model for the semantics of program specification. In terms of verification, programs may be viewed abstractly as special functions (frame homomorphisms) from their frame of specifications to the two-element Boolean lattice $\{\text{FALSE}, \text{TRUE}\}$.

MEDICAL SCIENCES SECTION

Al Iglar, Presiding

GERIATRICS AND PERIODONTAL DISEASE. *F. R. Ketron, Jolene D. Helm, and Bonnie S. Marrs, East Tennessee State University, Johnson City, Tennessee.* The number of geriatric patients requiring periodontal treatment will most likely increase due to the rapid decline in the rates of edentulism and tooth loss in the geriatric population. Prevention and treatment of periodontal diseases in older individuals is based on dental assessment, periodontal therapy, and oral health education to restore the dentition to a state of optimal health. The factors, treatment modalities, and educational aspects to prevent periodontal disease in the elderly are discussed.

ORAL CARCINOMA: AGE RELATED DISEASE. *D. G. Robbins and F. R. Ketron, East Tennessee State University, Johnson City, Tennessee.* The prevalence of oral mucosal diseases increases with age as a result of biological and environmental changes. The majority of cases of oral carcinoma, the most critical of oral mucosal diseases, occurs in persons >40 years of age. As incidence of oral cancer also increases with age, geriatric individuals, a stratum of the population that is escalating in size, are quickly becoming most at risk for this disease. Three key foci of oral carcinoma are discussed: epidemiology--the incidence among males is three times that among females, and rates are higher among blacks than among whites; contributing factors--e.g., tobacco, sunlight, alcohol, nutritional deficiency; detection and diagnosis--the majority of

oral carcinoma cases are squamous cell carcinomas and are often painless until late stages.

TESTOSTERONE REGULATES AORTIC THROMBOXANE A_2 RECEPTORS IN VIVO. *Albert L. Ruff, Medical University of South Carolina, South Carolina.* Thromboxane A_2 (TXA₂) has been implicated in the pathogenesis of many cardiovascular diseases. Previous studies reported aortas of male rats to be more sensitive to it than those of female rats. Studies on the effects of testosterone treatment of cultured aortic smooth muscle cells of male rats showed an increase in the TXA₂ receptor B_{max} with no significant change in K_d . The effects of in vivo testosterone treatment on the TXA₂ receptor corresponding to the maximum contractile response and EC_{50} were determined. Male rats were treated with testosterone for 2 weeks and sacrificed. Contraction studies were done on the thoracic aortas. Testosterone significantly increased the U46619 (TXA₂ mimetic)-induced maximum contractile responses ($P < 0.05$) with no significant change in EC_{50} ($P > 0.08$). No significant increase in maximum contractile response was noted for norepinephrine, angiotensin II, or KCl. These results indicate that testosterone enhances the response of aortas of male rats to TXA₂.

SELECTION AND UTILIZATION OF BIOLOGIC INDICATORS. *Susan J. Willette and Karen K. Fitts, East Tennessee State University, Johnson City, Tennessee.* Infection control in the environment of health-care practice has undergone significant change in the past decade. With the identification of the AIDS virus came a heightened awareness of disease transmission, recommendations from government agencies and professional organizations, and mandated protocols. Many procedures not formerly recognized as requisite to meeting the standard of care are now required. Among them is the use of biologic indicators to monitor sterilization processes. Verification that asepsis has been achieved is dependent upon the proper selection and use of biologic indicators. Biologic indicators presently available are identified, criteria for selecting biologic indicators are outlined, and protocols for effective use are described.

MALE ATTITUDES TOWARD THE USE OF THE MALE CONTRACEPTIVE PILL GOSSYPOL. *D. G. Robbins, J. D. Helm, and R. D. Patton, East Tennessee State University, Johnson City, Tennessee.* Currently, a contraceptive pill for males (gossypol) is in use in China; it is reported to have an efficacy rate of 99%. Presently, it is being considered for marketing in the United States by the Food and Drug Administration. To examine the potential utilization of this contraceptive method, a survey was administered to 164 males in two freshman courses offered by the School of Public and Allied Health at East Tennessee State University, Johnson City, Tennessee. The instrument was designed to elicit both personal and attitudinal information. The most significant finding was that males would not take gossypol in view of the fact that this method of contraception offers no protection against AIDS and other sexually transmitted diseases. Due to the nature and side effects of gossypol and increased prevalence and incidence of AIDS, further investigation in this area is strongly recommended.

OIL IN RUNOFF FROM THREE WATERSHEDS: AN UPDATE OF AN ENVIRONMENTAL CONCERN. *T. H. Oates, Albert F. Iglar, and R. Dean Blevins, East Tennessee State University, Johnson City, Tennessee.* Levels of oil were determined in runoff from three watersheds. Included were a commercial area (mainly an urban mall), a residential area (located in a central city), and a portion of a limited-access highway (228.6 m long). Personnel arrived at each site before runoff began, and samples were taken every 15 min for the first hour and every 30 min for the next 2 h, unless runoff stopped sooner than this. Rainfall also was measured, and cross section of flow and velocity of the

water also were determined. Samples were analyzed for total and recoverable grease and oil, using a separatory funnel extraction. The highest mean concentration of oil was from the residential watershed (10.2 mg/l), but the lowest loading rate (0.24 g/0.405 ha/min) also was from the residential area.

THE EVALUATION OF RED DYE NO. 2, ALAR, AND 2,4-D IN THE AMES SALMONELLA/MICROSOME ASSAY. *Kate Lapozynski and John M. Zamora, Middle Tennessee State University, Murfreesboro, Tennessee.* The Salmonella/microsome assay, devised by B. Ames and J. McCann of the University of California at Berkeley, Berkeley, California, utilizes four engineered mutant (his-) strains of *Salmonella typhimurium* for testing the mutagenic potential of chemicals. The assay is an effective indicator of the potential carcinogenicity of compounds, as nearly 90% of all carcinogens are mutagens. Mutagenic potency is determined by the number of revertant colonies per mole of test chemical. Three control compounds are included in the assay. The Salmonella/microsome assay was used to assess the mutagenic potential of 2,4-D, alar, and amaranth (red dye no. 2). A second phase included the addition of an extract of rat-liver (S9 fraction) microsomes which exposed the test compounds to mammalian metabolic processes during incorporation with the strains of *Salmonella*.

EXAMINING THE EFFICACY OF RESCUE-BREATHING INSTRUCTION TO FIRST GRADERS. *J. Helm, B. Jones, B. Marrs, and F. R. Ketron, East Tennessee State University, Johnson City, Tennessee.* Rescue-breathing has become a well-recognized life-saving procedure. Because numerous individuals die each year from respiratory arrest, efforts to recruit and educate adults and older children in rescue-breathing continue. Consequently, this study examined, via differing instructional techniques, the efficacy of educating first graders. Three first-grade classes from Bloomingdale elementary school were randomly assigned to: 1) a control group; 2) a group who received a lecture and instructor demonstration with a milk-jug manikin; and 3) a group who received a lecture, demonstration, and supervised practice on a milk-jug manikin the student made. Each group was given a pre- and post-picture test with the questions being read aloud. The results indicate that the first graders in group 3 attained higher post-test scores in comparison to their counterparts in the other groups. These findings suggest that even young children may benefit from rescue-breathing instruction.

ASSESSMENT OF ATTITUDES OF COLLEGE STUDENTS TOWARD DRINKING AND DRIVING. *B. S. Marrs, K. Johnson, J. D. Helm, and F. R. Ketron, East Tennessee State University, Johnson City, Tennessee.* A major health problem among young, college-age adults has been identified as deaths and injuries resulting from drinking and driving. In 1989, 49% of all traffic fatalities were alcohol-related. According to a 1984 survey of teenagers in the Boston area, most students were not aware of the dangers of driving under the influence of alcohol and believed they could use alcohol responsibly. A previous study indicated that use of alcohol among young adults is declining due to an increase in national awareness of alcohol problems among teenagers. The purpose of the present study was to investigate and assess the attitudes of college students regarding the use of alcohol and the combination of alcohol and driving. The survey instrument was a 12-item questionnaire completed by 60 students enrolled in health education class at East Tennessee State University, Johnson City, Tennessee. The results of this survey are presented.

PARTIAL SEQUENCE OF AN ACANTHAMOEBA RIBOSOMAL DNA GENE. *B. Diane Hopkins, Susan J. Goss, and John W. Harris, Tennessee Technological University, Cookeville, Tennessee.* Genomic

DNA was extracted from *Acanthamoeba tubiashi* and a species of *Acanthamoeba* isolated from a water tower at Tennessee Technological University, Cookeville, Tennessee. Deoxyribonucleic acid corresponding to a gene that codes for ribosomal DNA (rDNA) was amplified using the polymerase chain reaction and subjected separately to five restriction enzymes (*Bam*HI, *Eco*RI, *Hind*III, *Sma*I, and *Sal*I). The rDNA was then cloned into JM109 *Escherichia coli* using M13mp18 RF and M13mp19 RF bacteriophage vectors for the purpose of sequencing this gene.

INDIVIDUAL ANP-RELEASING CELLS OF THE RIGHT BUT NOT THE LEFT ATRIUM RESPOND TO ENDOTHELIN. **Trena R. Hart**, *Lee College, Cleveland, Tennessee*. Atrial natriuretic peptide (ANP) is secreted by atrial cardiocytes. It is thought to regulate fluid and electrolyte balance and arterial pressure. The release of ANP appears to be stimulated by atrial distension, initiated by increases in blood volume. The purpose of the present study was to determine if ANP-releasing cells of the right and left atrium had similar responses to endothelin. Endothelin is reported to be the most powerful constrictor of blood vessels known, and it has been shown to be a powerful stimulus for an increased release of ANP from atrial cardiocytes. The method used to answer this question was the reverse-hemolytic-plaque assay. Two experiments were involved, dosage concentration and time course. Calculations were made from counts of plaque formations, and the results were very distinct. It appears ANP-releasing cells of the left and right atria of rat hearts are regulated differently.

PHYSICS AND ASTRONOMY SECTION

Roy W. Clark, Presiding

ELLIPSOMETRY OF THIN FILM WITH CONTINUOUS DISTRIBUTION OF INDEX OF REFRACTION. **Ling Jun Wang**, *University of Tennessee at Chattanooga, Chattanooga, Tennessee*. Ellipsometric measurements may be interpreted to yield the thickness and optical constants such as the index of refraction and the extinction coefficient of thin films. Due to the difficulties in experimental arrangement and the complexity in mathematical treatment, the surface films are usually treated as a single-layer film with homogeneous distribution of the index of refraction throughout its depth. Such a single-layer model is not a very satisfactory representation of ion implanted surface films. A multi-layer model for ellipsometric measurement of thin films with continuous distribution of index of refraction throughout its depth is presented. In such a model, the index of refraction $n(x)$ is represented either by a quadratic function of the depth x :

$$n(x) = n_0 + n_1 - a(x - x_0)^2 \quad (1)$$

or a Gaussian function of the depth:

$$n(x) = n_0 + n_1 \exp[-(x - x_0)^2/\sigma^2] \quad (2)$$

where n_0 is the known index of refraction of the substrate and x_0 is the average depth of ion implantation. Formulae 1 and 2 are used in conjunction with the recursion formulae of the reflection coefficient $\rho_{0,i}$ and the transmission coefficient $\tau_{0,i}$ for a multiple-layer, thin film:

$$\rho_{0,i+1} = \rho_{0,i} + \frac{\tau_{0,i} \tau_{i,0} r_{i,i+1} \alpha_{i+1}^2}{1 - \rho_{i,0} r_{i,i+1} \alpha_{i+1}^2} \quad (3)$$

$$\tau_{0,i+1} = \frac{\tau_{0,i} \tau_{i,i+1} \alpha_{i+1}^2}{1 - \rho_{i,0} r_{i,i+1} \alpha_{i+1}^2} \quad (4)$$

where s_{i+1} is a function of the index of refraction, the thickness of the $i + 1$ layer, the angle of incidence, and the wavelength of the light. Regression procedures are devised to determine the free parameters in the quadratic or Gaussian models such that the calculation best predicts the experimentally measured parameters Ψ and Δ :

$$\Psi = \arctan \left(\frac{R^p E^s}{R^s E^p} \right) \quad (5)$$

$$\Delta = \beta^p - \beta^s \quad (6)$$

where the superscripts p and s denote the two different polarizations. These models allow good determination of the film thickness and the optical parameters, and the asymmetric distribution of the index of refraction can be easily accommodated by adding a modification term.

AN ANALYTICAL MODEL FOR PREDICTING LIGHT SCATTERING FROM A COLLECTION OF RANDOMLY ORIENTED, MICROSCOPIC CYLINDERS. **Patricia G. Hull**, *Tennessee State University, Nashville, Tennessee*. An analytical model, the coupled-dipole approximation, that predicts the scattering of polarized light from a collection of randomly oriented cylinders is presented. A suspension of bacteria (*Escherichia coli*) is selected for modeling because it provides a good approximation of a collection of microscopic cylinders. The matrix element, S_{34} , calculated from the model is compared to experimental measurements of this matrix element found in the literature. Measurements of S_{34} for several samples of suspensions of *E. coli* made with a scanning nephelometer by researchers at the United States Army Chemical Research and Engineering Center were used for the comparison. The comparison indicates that the model provides good agreement with experiment. Unfortunately, this good agreement requires a very fast computer and considerable computer time. Calculations were made with the Navocean CRAY computer at Stennis Space Center.

EXPERIMENTAL MEASUREMENTS OF LIGHT SCATTERING BY A SINGLE FIBER. **Frank T. Allen***, *Tennessee State University, Nashville, Tennessee*. A description of experiments in elastic scattering of light from a thin fiber ("infinite" cylinder) and comparisons of the results with scattering predicted by classical electromagnetic theory and previous research is presented. Spider webs were used to model fibers because the geometry of the webs matched that of the fibers well and webs were readily available. A polarization scanning nephelometer was used to measure the light scattered from the webs.

A COMPARISON OF COMPUTER-AIDED METHODS OF SOLUTION TO LAPLACE'S EQUATION. **J. M. Cook**, *Middle Tennessee State University, Murfreesboro, Tennessee*. The two-dimensional Laplace's equation is solved numerically using a BASIC program and with a spreadsheet. The effort involved is compared. The spreadsheet was the one included in the Works package for IBM compatible personal computers. The work was done on an IBM PS/2, model 55SX. The form of the output is discussed for each case.

SCIENCE AND MATH TEACHERS SECTION

Martha W. Stratton, Presiding

THE ARTICULATION OF HIGH-SCHOOL AND COLLEGE CHEMISTRY. **Noojin Walker**, *Austin Peay State University, Clarksville, Tennessee*. A survey of high-school and college-level chemistry teachers in Tennessee was undertaken to answer three questions: what topics are taught in high-school chemistry, to what extent are the topics taught; do college-level teachers know what is being taught? High-school teachers were not in agreement about the topics being taught or their emphases. College-level teachers did not appear to know what was being taught or the emphases, nor did they agree among themselves. An analysis of the responses led to four probable reasons for the disagreements among the teachers about the topics in high-school chemistry. First, a state-wide definition of the purpose of high-school chemistry does not exist. Second, a number of high-school teachers do not feel comfortable with all of the topics that could be included. Third, many schools lack the resources to teach important laboratory topics. Fourth, very little interchange occurs between high-school and college-level teachers about the content of high-school chemistry.

THE COON CREEK SCIENCE CENTER. **Ronald C. Brister**, *Memphis Museums, Inc., Memphis, Tennessee*. The Upper Cretaceous, Coon Creek fossil site in Tennessee was discovered in 1915 by B. Wade, a doctoral student at Johns Hopkins University. Wade's descriptions of the perfect preservation and vast variety of fossils at Coon Creek soon made the site world famous. Anatomical details revealed on the 70 million-year-old fauna helped clarify the relationship of Mollusca during this period of tremendous evolutionary change. Memphis Museums, Inc., the private, non-profit support organization of the Memphis Pink Palace Museum, purchased the site in 1989 and converted it into a science education center. The 97.2-ha site, now expanded to include five guest cabins and a dining or lecture-laboratory hall, is used to teach paleontology and field biology to school groups. Development of a quarry will allow preservation of the natural creek environment while allowing students to continue to experience the thrill of finding ancient fossils in the field.

ZOOLOGY SECTION I

Brian T. Miller, Presiding

GENETIC VARIATION IN THE RIVER OTTER (*LUTRA CANADENSIS*) FROM WESTERN TENNESSEE. **Susan E. White***, **Phyllis K. Kennedy**, and **Michael L. Kennedy**, *Memphis State University, Memphis, Tennessee*. Genetic variation was assessed in the river otter (*Lutra canadensis*) from western Tennessee using starch-gel electrophoresis. Twenty-seven protein systems were examined using liver, kidney, and skeletal muscle samples ($n = 85$). Of 33 loci resolved, six appeared to exhibit polymorphism. Allelic frequencies and heterozygosity were determined from 33 loci.

GENETIC VARIABILITY IN *BLARINA* FROM TENNESSEE. **Jacqueline A. Taylor***, **Phyllis K. Kennedy**, and **Michael L. Kennedy**, *Memphis State University, Memphis, Tennessee*. Two species of *Blarina* (*B. carolinensis* and *B. brevicauda*) were assessed for interspecific and intraspecific genetic variability. Horizontal starch-gel electrophoresis and histochemical staining were used to examine 27 protein systems in liver, kidney, and heart samples from *B. carolinensis* collected in southwestern Tennessee and *B. brevicauda* collected in eastern Tennessee. Forty-two loci were determined; of these loci, three

appeared to be polymorphic for the animals examined. Allelic frequencies and heterozygosity were calculated for each species.

GENETIC VARIATION IN THE COYOTE (*CANIS LATRANS*). **John A. Peppers***, **Phyllis K. Kennedy**, and **Michael L. Kennedy**, *Memphis State University, Memphis, Tennessee*. Coyotes (*Canis latrans*) from the recently colonized portion of the Southeast, east of the Mississippi River, were compared genetically with coyotes from the established portion of their range. Samples ($n = 596$) of liver, kidney, and muscle were obtained from coyotes collected in Arkansas, Kansas, Kentucky, Mississippi, and Tennessee. Twenty-eight protein systems were examined through horizontal starch-gel electrophoresis. From these systems, 37 loci were determined of which 13 appeared to be polymorphic. Allelic frequencies, heterozygosities, and genetic similarity coefficients were determined to genetically assess interlocality variation.

AMPLIFICATION AND SEQUENCING OF CONSERVED REGIONS OF THE MITOCHONDRIAL CYTOCHROME B AND 12S RIBOSOMAL RNA GENES IN CENTRARCHIDAE: A STUDY IN SYSTEMATICS. **John G. Peryam**, **Susan R. Goss**, and **John W. Harris**, *Tennessee Technological University, Cookeville, Tennessee*. Comparative studies of the sequences of highly conserved regions of mitochondrial DNA can yield information about evolutionary change. Muscle tissue samples from 12 species of centrarchids and six other species were used for DNA extraction using a chloroform/isoamyl alcohol technique. Amplification of a 307 base-pair segment of the cytochrome B gene and a 386 base-pair segment of the 12s ribosomal RNA gene was conducted using the polymerase chain reaction (PCR). Reactions were checked by electrophoresis on 2%-agarose gels with ethidium bromide staining. Amplification products were isolated and purified using Promega magic PCR preps. Segments will be cloned and sequenced using a commercial chemiluminescent sequencing kit; the basic technique will be that of the Sanger dideoxy method. Detection of slight differences in the base sequences of these DNA segments may prove useful in understanding the evolutionary background of these centrarchids.

MORTALITY AND EXPLOITATION OF PADDLEFISH IN KENTUCKY LAKE, KENTUCKY AND TENNESSEE. **T. Hughbanks*** and **T. Timmons**, *Murray State University, Murray, Kentucky*. Paddlefish, *Polyodon spathula*, is considered a species of special concern in many states, but a commercial and sport fisheries continues in the lower Tennessee River in Kentucky and Tennessee. Paddlefish from the commercial harvest at Kentucky Lake in 1991 and 1992 ranged in length (eye to fork of tail) from 53 to 122 cm (mean = 86 cm) and in weight from 2 to 32 kg (mean = 11.2 kg). The commercial fishermen we monitored harvested 3.3 fish/net night in 105 net nights of effort. Nets were 127-mm or 152-mm bar mesh gill nets. Aged by dentary bone sections, paddlefish were 3 to 21 years old (mean = 10 years). The sex ratio (males:females) was approximately 3:2. The age of first reproduction was 6 and 8 years for males and females, respectively. Paddlefish were fully recruited into the harvestable population at age 9. Annual mortality was estimated from a catch curve as 29%. One hundred seventy-four paddlefish also were tagged and released during 1991 and 1992. Exploitation to date is 15% and was from both commercial and sport fishermen who snag paddlefish.

FEEDING SELECTIVITY BY ANURAN TADPOLES. **Cindy L. Taylor** and **Ronald Altig**, *Austin Peay State University, Clarksville, Tennessee*, and *Mississippi State University, Mississippi State, Mississippi*. The ability to harvest materials differentially is predicted by the vast variations in mouth parts of tadpoles. We used choice responses to test if tadpoles of *Rana sphenoccephala* and *Bufo woodhousii* have the sensory and neural capabilities to recognize and select food-bearing

mixtures that differed in the nutritional value of the food, quantity of food per volume, and the ease of harvesting (i.e., food binder concentration or density). Selections made by tadpoles of *B. woodhousii* show that they were limited by substrate density. Food quality and quantity rather than substrate density was important in the selections made by tadpoles of *R. sphenoccephala*. These tadpoles selected mixtures that contained more food per volume or a food with a higher protein content (catfish chow).

THE ONTOGENY OF THE DENTITION OF THE RED-SPOTTED NEWT, *NOTOPHTHALMUS VIRIDESCENS*. N. R. Candella and B. T. Miller, Volunteer State Community College, Gallatin, Tennessee, and Middle Tennessee State University, Murfreesboro, Tennessee. The teeth of larval salamanders are generally regarded as nonpedicellate and monocuspid, whereas the teeth of postmetamorphic salamanders are pedicellate and bicuspid. Presumably, the transition from nonpedicellate, monocuspid to pedicellate, bicuspid teeth occurs during metamorphosis. To test this hypothesis, the ontogeny of the dentition was examined in larval (stages I, II, III, and IV), metamorphic, eft, and adult newts that were cleared and stained, prepared for scanning electron microscopy, or both. Teeth appeared early during development (stage I) on the premaxillae, vomer, palatine, dentary, and coronoid. The initial teeth to appear on these bones were nonpedicellate and monocuspid; however, the transition from nonpedicellate to pedicellate teeth occurred during early larval stages on the premaxillae (stage II), dentary (stage II), and vomer (stage III). The teeth of the coronoid and palatine were always nonpedicellate and monocuspid. The maxillae did not bear teeth until after metamorphosis. Teeth on all elements were bicuspid and pedicellate in postmetamorphic individuals.

SUMMER MOVEMENT OF NATIVE AND INTRODUCED ALLIGATOR SNAPPING TURTLES, *MACROCLEMYS TEMMINCKII*, IN KENTUCKY LAKE. John Koons and A. Floyd Scott, Jackson State Community College, Jackson, Tennessee, and Austin Peay State University, Clarksville, Tennessee. Movements of seven (two natives and five aliens) alligator snapping turtles, *Macrochelys temminckii*, were monitored in an 8-km stretch of Kentucky Lake (river miles 54 to 59) during July, August, and September 1992. Study animals were relocated by radio telemetry an average of 14.3 times each (range of five to 23) over periods ranging from 3 to 69 days/individual. The average time between relocations was 1.9 days (range of 0.6 to 32.0). Means and ranges (in parentheses) of the averages of selected measures of movement (all straight-line distances) for all seven individuals were as follows: distance between successive relocation points, 236.4 m (62 to 401 m); distance between extreme relocation points, 2120.0 m (400 to 4,910 m); distance from relocation points to shore, 7.6 m (2 to 22 m); depth at relocation sites, 2.3 m (1.5 to 4.2 m). Comparisons of pooled data for native versus alien individuals revealed significant differences ($P < 0.05$) between distances measured from relocation points to shore and depths of relocation points. No significant differences were detected between distances traveled or habitats frequented by the two groups. A typical habitat was one near shore in shallow water with a rocky or gravelly substrate and some type of underwater structure or cover (e.g., tree trunks, tops of fallen trees, entrances to bank burrows of muskrats or beavers, and patches of aquatic plants).

PRELIMINARY INVESTIGATIONS ON THE MOVEMENT OF THE HELLBENDER (*CRYPTOBRANCHUS ALLEGANIENSIS*) IN MIDDLE TENNESSEE. T. Casey*, G. Pritts*, and B. T. Miller, Middle Tennessee State University, Murfreesboro, Tennessee. Movement and site fidelity of hellbenders (*Cryptobranchus alleganiensis*) in a rocky pool (approximately 150 m long and 35 m wide) of the Collins River were examined from late July through mid-October. Radio-transmitters

were either surgically implanted into the peritoneal cavity of ($n = 4$) or force-fed into ($n = 2$) anesthetized hellbenders. Following an acclimation period, positions of hellbenders were located daily, except during floods. Individuals showed remarkable fidelity to a site and were found consistently at the same location ($X = 14.5$ days, range of 5 to 22 days); movements away from a location were sporadic and associated with heavy rains. Distances traveled varied greatly (5 to 60 m); none of the hellbenders left the study pool. The reported decrease in "catchability" of hellbenders from this pool during late summer and early fall during previous years appeared associated with the refuges chosen, including undercuts of the stream banks, boulders, and, typically, bedrock.

ZOOLOGY SECTION II

Clay Chandler, Presiding

LARVAL ODONATE COMMUNITIES OF THE MEEMAN BIOLOGICAL STATION IN WESTERN TENNESSEE. David H. Kesler, Timothy R. Moore*, Michael W. Sears*, James G. Scherer*, and Renee A. Pardieck*, Rhodes College, Memphis, Tennessee. Anisopteran (Odonata) larvae were sampled in two ponds of the Meeman Biological Station, Shelby County, Tennessee, from July 1990 to March 1992. Species found in both ponds were *Tetragoneuria cynosura*, *Plathemium lydia*, *Libellula vibrans*, *Perithemis tenera*, *Dromogomphus spinosus*, *Epicordulia princeps*, *Gomphus submedianus*, and *Boyeria grafiana*. These species comprised 99.7% of the 3,556 individuals collected. Headwidths of the same species at the same time were often significantly greater in one pond (pond A). Comparison of cumulative size-frequency distributions showed differences ($P < 0.05$) for *T. cynosura*, *P. lydia*, *L. vibrans*, and *P. tenera* but not for *D. spinosus*. Larval "biomass" was larger ($P < 0.05$) in pond A for *T. cynosura* and *L. vibrans* and larger in pond B for *D. spinosus*. The success of *D. spinosus* in pond B may be due to its avoidance of predation by burrowing and its unique feeding behavior.

TARDIGRADES FROM SHORT MOUNTAIN SEEPAGE SPRINGS, CANNON COUNTY, TENNESSEE. Karen Kendall-Fite*, Clay M. Chandler, and Diane R. Nelson, Middle Tennessee State University, Murfreesboro, Tennessee, and East Tennessee State University, Johnson City, Tennessee. From November 1990 through November 1991, monthly samples were collected from three seepage springs at an elevation of approximately 549 m on Short Mountain in Cannon County, Tennessee. Three terrestrial samples of mosses and lichens from rocks and fallen trees adjacent to the springs and three substrate samples from each spring were taken at each site. Water temperatures ranged from 7.0 to 18.0°C, and pH was generally 8.0 to 8.6. Twenty-seven species representing 13 genera have been identified: *Diphyscon*, *Echiniscus*, *Hypsibius*, *Isohypsibius*, *Itaquascon*, *Macrobiotus*, *Milnesium*, *Minibiotus*, *Murrayon*, *Platicrista*, *Pseudechiniscus*, *Ramazzottius*, and *Thulinia*. Only one species, *Murrayon pullari*, is strictly a freshwater dweller; all other species are terrestrial. *Minibiotus intermedius* appeared most frequently in the samples, whereas *Itaquascon trinacriae*, *Platicrista angustata*, and *Ramazzottius baumanni* appeared infrequently in the samples.

REDESCRIPTION OF *HADROBUNUS GRANDE* (SAY) (ARACHNIDA: PHALANGIDA). Charles R. McGhee, Middle Tennessee State University, Murfreesboro, Tennessee. T. Say described *Phalangium grandis (grande)* as a new species of phalangid from the "southern states" of America in 1821. The original description was very brief, included few diagnostic characteristics, and had no figures. H. Wood's 1868 paper on phalangids from the United States included

a copy of Say's description of *P. grande*, but he remarked that he had seen no specimens. *Phalangium grande* was later moved to the genera *Astrobus* (Weed, 1890), *Liobunum* (Weed, 1892), and *Hadrobunus* (Banks, 1900). The earliest taxonomic treatments of *P. grande* were very general and essentially nondelimiting. A description and single illustration published by C. Weed in 1892 is the first significant indication of *P. grande*. The inclusion of *grande* (Say) and *masculosum* (Wood) in the genus *Hadrobunus* by N. Banks in 1900 has been followed by researchers to the present time and has established the genus with the primary notion that it contains only a "northern" and a "southern" species. A study of collections of *Hadrobunus* from localities in six southeastern states, including collections provided by the American Museum of Natural History, reveals more diversity within populations than has been previously determined. It is necessary to redefine *Hadrobunus grande* (Say) and establish specific taxonomic criteria upon which future revisions of the genus may be based.

INFECTIVITY OF INSECT-PARASITIC NEMATODES ISOLATED FROM TENNESSEE SOILS. **L. M. Rueda, S. O. Osawaru, and R. E. Harrison**, Tennessee State University, Nashville, Tennessee. Insect-parasitic nematodes were isolated from Tennessee nursery soils by baiting with four species of insects: *Galleria mellonella* (greater wax moth), larvae; *Acheta domesticus* (house cricket), adults; *Alphitobius diaperinus* (lesser mealworm), adults; *Musca domestica* (house fly), larvae. Two of 17 total recovered isolates of *Heterorhabditis bacteriophora* and two of 17 recovered isolates of *Steinernema carpocapsae* were tested for infectivity against larval and adult *A. diaperinus* under different habitat conditions. *Heterorhabditis bacteriophora* and *S. carpocapsae* caused higher mortality of *A. diaperinus* in filter paper and sandy loam soil than in broiler litter. Under constant temperatures, *H. bacteriophora* and *S. carpocapsae* showed higher infection rate of larval *G. mellonella* at 20 to 30°C; no larval infection occurred at 5 to 10°C.

CERIODAPHNIA DUBIA VERSUS DAPHNIA MAGNA: DO THE DATA COMPARE? **W. D. S. Burton, D. L. Bunting, and J. F. McCarthy**, Austin Peay State University, Clarksville, Tennessee. The cladoceran, *Daphnia magna*, has a long history of use in aquatic toxicity testing; however, in 1984, *Ceriodaphnia dubia* became the test organism for chronic toxicity testing. This study was designed to compare the two species in controlled laboratory experiments. Acute and chronic toxicity tests were conducted using four chemicals, each having a different mode of toxic action. The data obtained were used to compare species sensitivities, endpoint sensitivities, and the relative toxicities of the chemicals. The endpoints measured were survival (acute) and survival and reproduction (chronic). In the acute tests, *C. dubia* was more sensitive than *D. magna* to all four chemicals. In chronic tests, evaluation of the endpoints (survival and reproduction) using the lowest observed-effects concentration showed that neither survival nor reproduction was consistently the more sensitive endpoint for either species.

ANTIBODIES TO *BORRELIA BURGDORFERI* IN RACCOONS IN WESTERN TENNESSEE. **Thomas M. Kollars, Jr., Donald D. Ourth, and Timothy D. Lockey**, Memphis and Shelby County Health Department, Memphis, Tennessee (TMK), and Memphis State University, Memphis, Tennessee (TMK, DDO, TDL). An enzyme-linked immunosorbent assay was used to test sera from 50 raccoons (*Procyon lotor*) from western Tennessee for antibodies to *Borrelia burgdorferi*, the causative agent of Lyme disease. Fifty-four percent of the raccoons tested were seropositive at a dilution of 1:160 or greater for antibodies to this spirochete. Raccoons may act as a reservoir for *B. burgdorferi* and as a host for vector species of ticks (i.e., *Ixodes scapularis*) in neighborhoods in Memphis and urban areas of Shelby County, Tennessee. The

use of raccoons and other wildlife in surveillance programs are useful for identifying potential areas of infection and Lyme disease.

ZOOLOGY SECTION III

Padgett Kelly, Presiding

YELLOW-POPLAR FLOWERS IN THE SPRING DIET OF WHITE-TAILED DEER IN THE SOUTHERN APPALACHIANS. **William M. Ford, A. Sydney Johnson, and Philip E. Hale**, University of Georgia, Athens, Georgia. Rumen analyses of 30 white-tailed deer (*Odocoileus virginianus*) collected from the Cherokee National Forest in Tennessee and the Pisgah National Forest in North Carolina showed that flowers of yellow poplar (*Liriodendron tulipifera*) comprised 20% of the aggregate percent volume of the May diet and 52% of the June diet. When compared to leaves and succulent stems (also important browse items) of yellow poplar, the flowers were somewhat less nutritious containing significantly less crude protein ($P = 0.003$), less calcium ($P = 0.003$), less phosphorus ($P = 0.044$), and more lignin ($P = 0.017$). There were no significant differences in cell soluble contents or cellulose between foliage and flowers. Although flowers of yellow poplar accounted for a large portion of the spring diet, only trace amounts of the flowers of other woody and herbaceous plants occurred in the diet of deer in the southern Appalachians in any season. Flowers of yellow poplar are produced in the forest canopy and are available only when they fall from the trees, presumably dropped by foraging squirrels. The low availability of this food compared to other deer-browse items and the abundance of these flowers in the diet suggest that deer strongly prefer them over other foods in the spring.

ECOLOGICAL STUDIES OF THE WHITE-TAILED DEER IN WESTERN TENNESSEE. **R. David Frederick* and Michael L. Kennedy**, Memphis State University, Memphis, Tennessee. Activity patterns and microhabitat utilization of white-tailed deer (*Odocoileus virginianus*) are being studied at the Milan Army Ammunition Plant in Carroll and Gibson counties, Tennessee. Ten white-tailed deer have been fitted with radio-collars, and locations are being monitored using standard techniques. Home ranges and daily activity patterns are being determined. Preliminary analyses have shown that white-tailed deer are readily located using radio-techniques. Microhabitat utilization is being assessed by pellet transects and radio locations. Pellet counts from transects located in pastures and old fields are significantly different from those in other habitat types. Use of honeysuckle (*Lonicera* sp.) is being examined by observing the degree of browse along transects. No significant difference in utilization has been seen between the honeysuckle transects.

RACCOON HARVEST DATA FROM HATCHIE NATIONAL WILDLIFE REFUGE. **David W. Royal*, Michael L. Kennedy, and Phyllis K. Kennedy**, Memphis State University, Memphis, Tennessee. A demographic analysis was conducted on raccoon (*Procyon lotor*) harvest data of 1989 to 1992 for the Hatchie National Wildlife Refuge. Three hundred four specimens were examined. Age, sex, weight, and four external measurements (total length, hindfoot length, tail length, and ear length) were recorded. Reproductive condition and litter sizes of females were determined. Results are compared over the 4-year period and discussed in light of previous studies.

PRELIMINARY REPORT ON THE SOCIAL BEHAVIOR OF THE FENNEC FOX, *FENNECUS ZERDA*, IN CAPTIVITY. **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 March to September 1992. Animals were housed at the Ecological Research Center at Memphis State University.

After an ethogram was established, pairs (consisting of one male and one female) were observed for 20-min periods over 5 consecutive days. Statistical analysis was used to determine differences in the frequency of behaviors. Behavioral differences between individuals, sexes, and pairs were recorded.

SKELETAL MUSCLE SODIUM-PUMP UNITS IN OBESE AND LEAN ZUCKER RATS. *Ruth A. Young and Teresa Webb**, *Austin Peay State University, Clarksville, Tennessee.* The activity of the cell-membrane sodium pump (Na^+, K^+ -ATPase) is thought to be a major determinant of basal metabolic rate. Basal and triiodothyronine (T_3)-stimulated Na^+, K^+ -ATPase activity were studied in obese and lean Zucker rats (11-week-old females) using a vanadate-facilitated [^3H]-ouabain binding method. The rats were given T_3 (25 $\mu\text{g}/100$ g body weight) or vehicle i.p. at 12-h intervals for 48 h and were studied 12 h after the last injection. There were no significant differences ($P > 0.05$) in either basal or stimulated [^3H]-ouabain binding (picomoles per gram of tissue) to soleus or extensor digitorum longus (ed1) muscles for the lean or obese rats. Both groups showed significant increases over basal for binding to soleus ($P = 0.0007$), but not for ed1 ($P > 0.05$), when treated with T_3 . This suggests that the lower basal metabolic rate and the obesity in Zucker rats are not due to decreased numbers of sodium-pump units.

MICROHABITAT CHARACTERISTICS AFFECTING NEST-BOX USE BY THE SOUTHERN FLYING SQUIRREL (*GLAUCOMYS VOLANS*). *K. D. Stone*, G. A. Heidt, W. H. Baltosser, and P. T. Caster*, *Memphis State University, Memphis, Tennessee (KDS), and University of Arkansas at Little Rock, Little Rock, Arkansas (GAH, WHB, PTC).* Characteristics influencing microhabitat utilization by southern flying squirrels (*Glaucomys volans*) were examined in the Ouachita National Forest, Arkansas, between March 1990 and March 1992. Three nest-box grids were established in an old-growth, oak-hickory-pine forest. Each grid consisted of 30 nest boxes placed 35 m apart in three rows of 10 boxes. Box entrances were either 3.8 or 6.4 cm in diameter and were alternated throughout the grids. Boxes were checked at 2-week intervals for contents. Thirteen microhabitat and cavity variables were measured around each box. Canonical discriminant function analysis was used to determine informative variables that distinguish between nesting sites of *G. volans*, feeding stations of *G. volans*, and nesting sites of *Sciurus carolinensis*. Cavity entrance width was the most informative variable. Nests of *G. volans* were established exclusively in boxes with small openings while nests of *S. carolinensis* were established exclusively in boxes with large openings. Feeding stations of *G. volans* were established in boxes with small or large openings.

ACTIVITY PATTERNS OF OPOSSUMS AND RACCOONS BASED ON CAPTURE DATA. *Troy A. Ladine* and Michael L. Kennedy*, *Edward J. Meeman Biological Station and Memphis State University, Memphis, Tennessee.* Activity patterns of opossums (*Didelphis virginiana*) and raccoons (*Procyon lotor*) were assessed using capture data. Timers were attached to folding Tomahawk live traps to determine time of capture for both species. Data were standardized to sunset and sunrise to account for varying amounts of nocturnal hours throughout the year. Age-class and sex comparisons were made for each species. There were no significant age class-by-sex interactions, and no classes within a species exhibited significant differences. The majority of opossum captures occurred during the first 3.5 h after sunset. A minor peak occurred approximately 7 h after sunset. Raccoon captures occurred approximately equal throughout the first 7.5 h after sunset. There were no significant interspecific differences in time of capture.

LOCOMOTOR ACTIVITY AND ESTRUS IN SMALL MAMMALS. *Bruce S. Cushing*, *Middle Tennessee State University, Murfreesboro, Tennessee.* In small mammals studied to date, an increase in activity has been associated with the onset of estrus. However, I predicted that females from certain species (i.e., those that can face high rates of predation) would not increase their activity during estrus. To test this prediction, I determined relative activity, using running wheels, of four species of rodents during diestrus or anestrus and estrus. Two of the species *Peromyscus leucopus* (white-footed mouse) and *Peromyscus californicus* (California mouse), were predicted to increase activity, while the other two species, *Microtus ochrogaster* (prairie vole) and *Sigmodon hispidus* (hispid cotton rat), were predicted to not show an increase in activity during estrus. Results supported the prediction with white-footed and California mice displaying a significant increase in activity during estrus, while cotton rats displayed no change in activity associated with the phase of the estrous cycle and prairie voles decreased activity with the onset of estrus.

REPRODUCTIVE BIOLOGY OF BEAVER (*CASTOR CANADENSIS*) ON OLD HICKORY LAKE IN MIDDLE TENNESSEE. *Richard E. Lizotte, Jr.* and Michael L. Kennedy*, *Memphis State University, Memphis, Tennessee.* Data on the reproductive biology of beaver (*Castor canadensis*) were obtained from animals taken in Wilson, Sumner, and Davidson counties in middle Tennessee from 1990 through 1992. One hundred fifty-three (79 males and 74 females) specimens were examined. Based on standard methods of age determination, ages of trapped beaver ranged from yearlings (0.5 to 1.0 years) to 14.0 year-olds; yearlings comprised 37% of all beaver trapped. Earliest age of sexual maturity for both sexes was found to be 1.5 to 2.0 years. Female beavers had an average litter size of 3.4 (range = 1.0 to 7.0). For all females, pregnancy rate was 66%, and prenatal mortality was 34%, with greatest productivity occurring in those females that were ≥ 4.5 years old. Measures of reproductive parameters (testes weight, volume, length, and width) of male beavers were highest in February and lowest in April.