

ABSTRACTS OF PAPERS PRESENTED AT THE ANNUAL MEETING

BOTANY SECTION

Jefferson G. Lebkuecher, *presiding*

Development of Somatic Embryos From Mature Cotyledons of Soybean, S.M. Bhatti and P.S. Kahlon, Tennessee State University.

There have been several reports on somatic embryogenesis in soybean in recent years. In all of these cases embryos were obtained from callus derived from immature cotyledons. We have been able to initiate somatic embryos from mature cotyledons and other explants of three cultivars of soybean. Cultivars Pella, Weber and Williams were allowed to grow for approximately 7 to 10 days. At this time cotyledons, hypocotyls and small leaves were excised and plated on L6 and MS media containing various kinds of hormones. Within three weeks of culture, embryogenic callus was obtained from cotyledons and hypocotyls of cultivars Weber and Pella, when they were cultured on L6 media containing either 2 or 5 mg/L of 2, 4-D. Addition of 0.5 mg/L of ABA also proved to be beneficial. Globular structures were observed within five weeks of culture. Somatic embryos were seen directly arising from the leaf cultures of cultivar Williams on L6 media supplemented with 5 mg/L 4-D.

Continuing In Vitro Propagation Studies on Button Fern Leaf Bulblets, J. D. Caponetti, The University of Tennessee, Knoxville.

Button fern leaf bulblets can develop leaves and roots (whole plantlets) when placed on potting mix under greenhouse conditions in three weeks. For several reasons, however, most bulblets do not develop. By contrast, almost all bulblets develop when placed in sterile tissue culture on a water only medium solidified with agar. However, the plantlets produced show signs of mineral deficiency. Leaf and root growth was inhibited on bulblets placed on MS salts only media. Bulblets on MS complete medium supplemented with kinetin and NAA produce small leaves and no roots. The latest series of experiments have shown that bulblets placed on "low salt" media such as Knop's or Knudson's salts only media produce larger plantlets than bulblets placed on a "high salt" medium such as M&S salts only medium. The best plantlet development was obtained from bulblets cultured on Knudson's salts only medium.

An Updated Account of the Land Between The Lakes Vascular Flora, Edward W. Chester, Austin Peay State University.

Land Between The Lakes (LBL) is a 69,000-ha National Demonstration Area managed by the Tennessee Valley Authority since 1964 for conservation, education, and recreation. It is in northwestern Middle Tennessee (Stewart County) and southwestern Central Kentucky (Lyon and Trigg counties) and is essentially a peninsula between impounded sections of the Cumberland and Tennessee rivers (Barkley and Kentucky lakes). Prior to 1966, the area was mostly agrarian with small farms and communities; significant acreage was in a National Wildlife Refuge and in corporately-owned woodlands. The topography is mostly that of a maturely dissected upland with narrow ridges and deep ravines. Upland, secondary forests dominate the plant life, but wetlands, barrens, and various anthropogenic communities contribute to habitat diversity and thus to species numbers. A preliminary checklist in 1971, based on work prior to 1967, gave 799 taxa of vascular plants. Work since 1971, with a concentrated effort in the field and herbarium from 1985-1990, shows that the vascular flora exceeds 1300 taxa.

Barrens of the Central Basin of Tennessee, H. R. DeSelm, The University of Tennessee, Knoxville.

Four samples of barrens (grassland) have been examined floristically and three sites were plot sampled in the Central Basin of Tennessee. The cumulative flora of these sites is 307 native taxa. The total includes 13 Tennessee rare plants. Most of the flora is intraneous but there is a significant southern and smaller northern element. There are small western and endemic or near endemic

percentages. Quadrat sampling of three stands revealed communities dominated by little bluestem (*Schizachyrium scoparium*). Currently these stands are believed to be succession—but succession is slow due to droughty sites or are maintained currently by mowing or bushhogging. In the presettlement period drought and fire are believed to have been the factors of maintenance.

Epiphyllous Bud Release in Bryophyllum: Evidence for Ethylene Control, D. F. Houck, Southern College.

Marginal plantlets form on leaves of *Bryophyllum calycinum* after they are detached, but not normally on intact leaves. Studies on detached leaves showed that the ethylene-releasing chemical ethephon enhanced bud release, but that ethylene inhibitors AgNO₃ or 2,5-norbornadiene inhibited budding. Bud release from excised leaf marginal strips was inhibited by ethylene biosynthesis inhibitors aminooxyacetic acid, amino-ethoxyvinylglycine, CoCl₂, and n-propyl gallate. Bud release was also inhibited by protein synthesis inhibitors cycloheximide and actinomycin-D. These results indicate that ethylene, enzymes for ethylene biosynthesis, and preformed mRNAs encoded for these enzymes are all at very low levels in freshly detached leaves. This study shows evidence that ethylene biosynthesis normally increases after leaf detachment and that ethylene is a controlling factor for epiphyllous bud break from dormancy.

Reduced Photoinhibition with Stem Curling in Selaginella lepidophylla: A Field Experiment, Jefferson G. Lebkuecher and William G. Eickmeier, Vanderbilt University.

Desert resurrection plants, such as *Selaginella lepidophylla*, curl dramatically as they dry and the hypothesis that curling during desiccation under natural conditions may serve to limit bright-light damage was tested. Restraint of curling followed by nine days of exposure to ambient desert conditions in the desiccated state significantly decreased photosystem II electron transport, increased intrinsic chlorophyll fluorescence (F_v) yield, decreased variable to maximum chlorophyll a (F_v/F_m) yield ratio, decreased chlorophyll content, and decreased both whole-plant photosynthetic quantum efficiency and light-saturated CO₂ assimilation capacity following rehydration relative to hydrated control plants. These results demonstrate that stem curling during desiccation under natural conditions helps to alleviate photoinhibitory damage and chlorophyll photooxidation, thereby enhancing the potential for recovery of photosynthetic competence when the plants are next wetted.

Phacelia dubia var. *interior* Fern., a Tennessee cedar glade endemic, Foster Levy, East Tennessee State University.

Representatives of *Phacelia dubia* from the cedar glades of the Nashville Basin were described as var. *interior* by Fernald in 1944. The validity of this taxon was questioned by Constance in his revision of the subgenus *Cosmanthus* of the Hydrophyllaceae and the taxon was variously rejected and accepted by subsequent workers. Recent studies have shown that the long-standing controversy surrounding the status of var. *interior* arose in part, because the characteristic dwarfed habit of these plants is environmentally, not genetically, determined. However, var. *interior* displays sufficient differentiation from other varieties of *Phacelia dubia* to merit taxonomic recognition. Plants from cedar glade populations are distinct in genetically-based floral and vegetative characters, they have a unique chloroplast DNA restriction pattern and they are partially reproductively isolated from all other varieties by a nuclear-based hybrid sterility barrier.

Disease Resistance in Kidney Beans, E. L. Myles, S. M. Bhatti and C. Alexander-Caudle, Tennessee State University.

The small farmer will lose more of his crop to disease than any other single factor. There are numerous types of fungi and bacteria that attack and damage major agricultural crops every year and more studies are needed in the area of plant disease resistance to reduce the damages caused by these pathogenic

agents. The study of plant stress is one mechanism by which we may learn more about genes and gene products involved in physiological stress. In this study two stressors were used to study disease resistance, salt and methionine sulfoximine (MSO). Callus growth was measured used as an indicator of stress/resistance. MSO is an amino acid analog that mimics the effect of *Pseudomonas syringae*, the bacterium responsible for halo blight. Leaf explants were surface sterilized and placed on Murashige and Skoogs (1962) supplemented with 1 mg/liter 2,4-Dichlorophenoxyacetic acid and 0.5 mg/liter Benzylaminopurine. The control media contained no stressor and the duration of each experiment was one month. The experimental groups contained either 0.4% NaCl, 0.4 micromolar MSO or 0.8 micromolar MSO. Leaf explants that were placed on media containing any one of the above stressors showed no callus growth. In experiments where one gram of callus was placed on control media and media containing the stressors the result were as follows: The control had an average growth of 5.3 grams, 0.4% NaCl averaged 3.3 gm, 0.4 micromolar MSO averaged 1.1 gm and 0.8 micromolar showed no growth. (Support by CARP)

Do Host Races of Phoradendron Leucarpum Exist? A Population Genetics Study of American Mistletoe, A. Darlene Panvini, Vanderbilt University.

Genetic variation and population structure of *Phoradendron leucarpum* (Raf.) Rev. & M. C. Johnston were analyzed. Leaf samples were collected from five southeastern states and analyzed using starch gel electrophoresis. Data were collected for nine loci (ACPH, ADH, GDH, GOT, IDH, MDH, PGI, PGM, SDH), four of which were polymorphic. The genotypic data and allele frequencies were analyzed several ways to estimate levels of genetic variability and Wright's F-statistics were determined to assess genetic variation due to population subdivision. More allozyme variation is observed within populations of mistletoe than among them, populations of mistletoe are genetically heterogeneous, and genetic variation is randomly distributed over the plant's range. Mistletoes growing on *Nyssa* and *Prunus* host species are genetically different from mistletoes on other host species, suggesting that mistletoe host races may exist. The occurrence of genetic host races could contribute to the large number of heterozygote deficiencies observed in this species.

Analysis of a Remnant Bottomland Forest, Stewart County, Tennessee, Joe Schibig, Volunteer State Community College, Edward W. Chester, Austin Peay State University.

Extensive bottomland forests that once occurred along the lower Cumberland River are represented by only a few remnants today. This paper characterizes a 15-ha stand, where nested plots yielded a sample of 998 stems representing 31 species (dbh equal to or greater than 2.54 cm). Analyses showed that the stand is dominated at the canopy level (dbh equal to or greater than 10.15 cm) by *Carya ovata*, *Fagus grandifolia*, *Liquidambar styraciflua*, *Quercus michauxii*, *Q. shumardii*, and *Ulmus rubra*, with significant contributions by *Acer saccharum*, *Celtis laevigata*, *Fraxinus pennsylvanica*, and *Quercus pagoda*. The saplings and small trees stratum (dbh of 2.54–10.14 cm) is dominated by *Celtis laevigata*, with significant contributions by *Acer saccharum*, *Asimina triloba*, *Carpinus caroliniana*, *Celtis occidentalis*, *Fagus grandifolia*, *Ostrya virginiana*, *Ilex decidua*, and *Ulmus* spp. Most abundant in the shrubs and woody seedlings layer (dbh less than 2.54 cm) are *Arundinaria tecta*, *Asimina triloba*, *Carya* spp., *Celtis* spp., *Quercus* spp., and *Fraxinus* spp.

CHEMISTRY SECTION I

Martin V. Stewart, *presiding*

Supercritical Extraction of Hydroaromatics and Aromatics, Robert C. Acuff, Eugene A. Kline, and Martha J.M. Wells, Tennessee Technological University.

The potential differences in solubilities of aromatics and their hydroaromatic isomers in gases/solvents under supercritical and nonsupercritical conditions led us to investigate the extraction of these compounds with SFC-SFE using unmodified carbon dioxide. A 1 mm x 5 cm ODS SFC microbore column was used with different densities of gas/solvent by altering temperatures and pressures in a Suprex Model 201 Supercritical Fluid Chromatography unit.

Optimal conditions were found for separations of pyrene and anthracene and some of their hydrogenated isomers. Calculations were then used to predict the extent that these isomers could then be separated from each other on a larger

scale. Actual extraction was then carried out on a larger scale and results were compared to the predictions.

A Simple Mathematical Solution to a Flow Problem, Harvey F. Blanck, Austin Peay State University.

A common boat and river problem is to ask what heading the boat should maintain to effect a minimum transit time. A more difficult problem is to determine what heading a boat must maintain to minimize the downstream displacement if the river is moving more rapidly than the boat. The downstream displacement m of a boat by a river of width w is given by $m = w(r - b \cos \theta) / b \sin \theta$ where the rates of the river and the boat are r and b , respectively, and θ is the acute angle between the heading of the boat and the river. If the first derivative of m with respect to θ which equals $(wb^2 \sin^2 \theta - wbr \cos \theta + wb^2 \cos^2 \theta) / b^2 \sin^2 \theta$ is set equal to 0, the result is $\cos \theta = b/r$. The heading and the track of the boat are, therefore, at right angles to each other. Chemical applications of the solution to this flow problem have not been discovered as yet.

Mechanism of the Aluminum Chloride Catalyzed Vinylation of Aromatic Substrates, Charles E. Harding, Joe W. Hunt* and Tim B. Bruewer*, The University of Tennessee at Martin.

Reaction of anisole with 1-chloro-1-phenylethene in the presence of $AlCl_3$ produced 1-(4-methoxyphenyl)-1-phenylethene along with relatively large amounts of polymeric materials. Under more stringent conditions, 2-chloro-3,3-dimethyl-1-butene did not react with anisole. Reaction of both (E)- and (Z)-1-bromo-1-(4-methoxyphenyl)-1-propene with anisole in the presence of $AlCl_3$ gave 1,1-di(4-methoxyphenyl)-1-propene as the only product, but the two geometric isomers reacted at greatly different rates. When either (E)- or (Z)-1-bromo-1-phenyl-1-butene was reacted with anisole, mixtures of (E)- and (Z)-1-(4-methoxyphenyl)-1-phenyl-1-butene of the same ratio were produced. These observations are consistent with the involvement of resonance stabilized, linear vinyl cation intermediates.

What the Research Says About College Chemistry Education, B. James Hood, Middle Tennessee State University.

There has been active research in areas that affect chemistry education at the college/university level. The results of this research yield several interesting observations. The majority of students who will sit in the post-secondary chemistry classroom will be multicultural and exhibit cognitive development that will require careful course design, if the instruction is to be effective. Several innovations in chemistry lab instruction have been proposed, which include forbidding lab manuals in the laboratory and the implementation of interactive video/hypermedia simulations as substitutes for "wet" labs. The recent research by the author indicates that the success of the former technique is overstated, while it is clear that the latter has some promise for improving lab instruction. Finally, the author will suggest several areas for future research.

Boron Trifluoride in the Synthesis of Plant Phenolics: Synthesis of Pinoquercetin and Pinomyricetin, Flavonols Occurring in the Ponderosa Pine Bark, Rama I. Mani, Parris F. Powers* and Landson Drummond*, Tennessee State University.

ω -Methoxy-C-methylphloracetophenone was prepared by the condensation of C-methylphloroglucinol with methoxyacetic acid-boron trifluoride complex. Using a modification of the Baker-Venkataraman reaction, the treatment of the ketone with 3,4-dimethoxybenzoyl chloride (veratroyl chloride) in presence of anhydrous potassium carbonate in boiling acetone gave 6-methyl-5,7-dihydroxy-3,3',4'-trimethoxyflavone (A), which on demethylation with aluminum bromide in benzene gave pinoquercetin. Treatment of the ketone with 3,4,5-trimethoxy benzoyl chloride (trimethylgalloyl chloride) under similar conditions gave 6-methyl-5,7-dihydroxy-3,3',4',5'-tetramethoxyflavone (B), which on demethylation with aluminum bromide in benzene gave pinomyricetin. Compounds A and B are of interest because of the presence of the 3-methoxy and 5-hydroxy group in the flavone skeleton. Such compounds have been shown in the past to have potent antiviral activity against rhinovirus infection.

OSHA Compliance in the Academic Chemistry Laboratory, M. C. Newhouse*, Middle Tennessee State University.

The *Federal Register*, Vol. 55, No. 21, published January 31, 1990 states: "This final standard published today shall become effective on May 1, 1990..."

*Student author

Employers shall have completed an appropriate Chemical Hygiene Plan and commenced carrying out its provisions by January 31, 1991." Why were we in academia surprised to find this regulation, "Occupational Exposures to Hazardous Chemicals in Laboratories," applies to us? Fortunately, this is not as drastic a change as one might think. It only remains for us to place our current standard operating procedures and rules of safety into the prescribed format. OSHA had not previously dealt with school laboratories as "work places," nor does this regulation specify "school laboratories." Thus, educational institutions were considered "Businesses"; they were not "Manufacturing" nor "Industrial" facilities. The spirit of the law is in its preamble as is the estimated cost of compliance for industrial, clinical, and academic laboratories. The definition of "laboratory" and "laboratory scale" carry the weight of who and where this law applies. Our instructors, secretaries, stockroom personnel, graduate teaching assistants, student workers, custodial staff, and research assistants who receive a paycheck are legal employees. Although our students are not employees, they have a right to know where and what Material Safety Data Sheets are.

The Void Volume of a Chromatography Column of Sea Sand, M. V. Stewart and D. L. Struble*, Middle Tennessee State University.

We are developing a method for obtaining kinetic data from chemical reactions of liquid phases with solids based on a modification of traditional plug-flow techniques. Our ultimate goal is to use this new approach to investigate the kinetics of solid-phase-supported organic reactions, but we are presently developing the experimental methodology through an initial study of the reaction of aqueous potassium permanganate with the reducing impurities of commercial sea sand as a model system for a fast, heterogeneous reaction. Here, a neutral 0.1 N aqueous permanganate solution is passed at constant rate through a gravity-flow chromatography column of sand and restandardized. If the volume of the permanganate solution actually contained within the plug of sand is divided by the flow rate, the average duration of the solution's exposure to the sand is obtained as the kinetic parameter of time. The volume of this reaction zone, called the void volume, is fundamental to acquiring accurate kinetic data and will vary for individual sand columns. These were determined by direct measurement as a function of both the amount and packing density of the sand in the column, then fitted by iterative least-squares to a single polynomial equation that also includes the void volume of the supporting glass wool as a small, but important, correction term.

Graphical Representation of Redox Reactivity: A New Approach, Gary P. Wulfsberg, Middle Tennessee State University.

Arbitrary, difficult-to-remember sign conventions bedevil students trying to learn redox and electrochemistry. Graphical representations of standard reduction potentials should help students, but Latimer, Frost, and Pourbaix diagrams each present pedagogical difficulties. Acid-base reactivity alone is easily represented by horizontal *predominance diagrams*, in which acidic species are present only at the *left* (at low pH), and basic species are at the *right* (high pH). We propose that redox reactivity be represented for students by vertical *redox predominance diagrams*, in which oxidizing agents are at the *top* of the diagram, and reducing agents are at the *bottom*. Two reasons will be given why this convention is non-arbitrary and, hence, easily remembered. A set of redox predominance diagrams for the elements of the periodic table will be shown and some uses of them indicated. It will be shown how they can be derived from Latimer diagrams or from tables of standard reduction potentials and how they can be merged with acid-base predominance diagrams to give Pourbaix diagrams.

CHEMISTRY SECTION II

James C. Howard, *presiding*

Reactivity of Re(V) Oxo and Nitrido Intermediates, Britt Allgood* and E.C. Lisc, Tennessee Technological University.

Due to the interest in the chemistry of ^{99m}Tc , which is the most widely used isotope in nuclear medicine, the interest in the chemistry of ^{188}Re has increased dramatically due to the potential of acquiring a "matched pair" of diagnostic (^{99m}Tc) and therapeutic (^{188}Re) agents. We have recently discovered that $\text{ReOCl}_3(\text{PPh}_3)_2$ and $\text{ReNCl}_2(\text{PPh}_3)_2$ react quickly to form new complexes with a host of bidentate ligands. Synthesis and comparisons of the new complexes will be presented.

*Student author

The Effects of Tertiary-Butyl Compounds on the Formation of Pyrene/ β -Cyclodextrin Complexes Determined Using Fluorescence, V.C. Anigbogu, Austin Peay State University and T.T. Ndou and I.M. Warner, Emory University.

Molecular fluorescence is a powerful tool for fundamental studies of molecular excited states. The fluorescence emission spectrum of pyrene exhibits vibrational fine structures. The relative intensities of these vibrational peaks depend on the micro-environment of pyrene. Several authors have shown that the ratio of the intensities of peak 1 to peak 3 (I/III ratio) correlates to the polarity of the solution. This ratio has been found to range from 0.60 in cyclohexane (highly non-polar) to 1.75 in water. Cyclodextrins (CDs) are torus-shaped molecules that have highly non-polar cavities and highly polar exterior. As such, in solutions, non-polar molecules are readily included to form complexes with β -CDs. For molecules like pyrene, the degree of inclusion into the CD cavity under any experimental condition can be determined by monitoring changes in the ratio of the I/III fluorescence vibronic bands. In this paper, the effect of 0.75 M tertiary-butyl compounds as concomitant species (in 59% v/v methanol/40% water mixtures) in the formation pyrene/ β -CD inclusion complexes will be examined and the implicated molecular dynamics discussed.

The Effects of Tertiary-Butyl Compounds on the Formation of β -Cyclodextrin/Pyrene Complexes Studied Using RP-HPLC, V.C. Anigbogu, Austin Peay State University, and N. Husain, T.T. Ndou, and I.M. Warner, Emory University.

Cyclodextrins (CDs) are known to form inclusion complexes with a variety of molecules and ions, a phenomenon that has found application in many disciplines including pharmaceuticals, resolution of isomers by chromatography, and enhancement of luminescence measurements.

Besides the cavity size of the host CD, other factors such as the polarity of the guest, pH, ionic strength of, and the nature of concomitant species in the medium, are known to influence the degree of formation of the inclusion complexes. Using steady-state fluorescence measurements, Muñoz de la Peña showed that the presence of 1% v/v tertiary-butanol or 1% v/v cyclopentanol in an aqueous solution drastically increases the formation constant values of pyrene/ β -CD inclusion complexes. Formation of a ternary complex of stoichiometric ratio 2:1:2 of β -CD/pyrene/Modifier was postulated in order to explain the observed effects. This paper examines the effects of tertiary-butyl compounds on the apparent formation constant values and stoichiometric ratios of the pyrene/ β -CD complexes. The implicated molecular forces and potential analytical applications of these effects will be discussed.

Mechanisms of DNA Repair, S. K. Ballal, Tennessee Technological University.

Both prokaryotic and eukaryotic cells are continually subjected to natural factors that damage the whole or parts of the DNA molecule. Inherent chemical moieties of the cell or external agents attack the various nucleophilic targets such as the bases and the phosphates. Because of this, alkylpurines and alkylphosphotriesters form along the DNA chain, which disrupts the normal cellular processes. Certain mechanisms exist under such circumstances to remove such adducts as soon as they are formed, all of which constitute the complex lesion-specific DNA repair mechanism. One such mechanism is the removal of alkyl groups by O⁶-methylguanine-DNA-methyltransferase (MGMT), which transfers the alkyl group from the oxygen of guanine to a cysteine residue. The other ubiquitous mechanism involves the removal of N-alkylpurine residues by N-methylpurine glycosylase (MPG), leaving apurinic sites along the DNA, which are repaired by apurinic endonucleases. These repair proteins function in a highly coordinated and regulated fashion in all cells studied so far. The molecular basis for the understanding of DNA repair mechanism required the isolation of cDNA's and genomic clones. Thanks to Oak Ridge Associated Universities for its support.

Results of a Dioxin Screening Survey of Shelby County Fish, G. M. Denton, Tennessee Department of Environment and Conservation.

In 1990, the Tennessee Division of Water Pollution Control performed a dioxin screening survey of the Mississippi River, plus McKellar Lake, the Loosahatchie River, and the Wolf River in Shelby County. The survey was conducted in response to the documentation of dioxin in McKellar Lake fish and in sludge at the City of Memphis' South Sewage Treatment Plant, plus the discovery of an intermittent industrial discharge of dioxin.

Fish were collected at three sites on the Mississippi, one site in McKellar Lake, and two sites on both the Loosahatchie and Wolf Rivers. Results of

Mississippi River fish samples indicated dioxin both above and below Memphis. The highest level, 17.53 parts per trillion, was documented in a blue catfish fillet sample collected near the Memphis South sewage treatment plant. Dioxin was also detected in McKellar Lake samples and at all four sites in the Wolf and Loosahatchie Rivers.

The Mississippi, Loosahatchie, and Wolf Rivers in Shelby County were posted in 1982 against the consumption of any fish because of the presence of chlordane in the edible portion of fish flesh from these bodies of water. Thus, the dioxin in these fish should not pose an immediate threat to public health if these fish are not being consumed. These dioxin screening data indicate a need to perform additional monitoring and to exercise caution in the face of mounting pressure to remove the current consumption advisory on the Mississippi River. A follow-up study is planned for the fall of 1991.

A ¹⁹⁵Pt NMR Spectroscopy Study of the Solvolysis of Sodium Hexachloroplatinate by Dimethyl Sulfoxide-d₆, James C. Howard and Jeffery S. Allbritten*, Department of Chemistry and Physics, and Department of Mathematics, Middle Tennessee State University.

Platinum-195 Fourier transform nuclear magnetic resonance spectroscopy was used to study the reaction of sodium hexachloroplatinate with dimethyl sulfoxide-d₆ in the mixed solvent dimethylsulfoxide-d₆: water, 1:2, v/v.

The reaction was observed at several temperatures over uniform time intervals to ascertain the temperature dependence of the rate of reaction. The spectra were integrated to determine the extent to which the reaction had proceeded. Pseudo first-order rate constants for the reaction at each of the temperatures were calculated from linear regression analyses of plots of the natural logarithm of the spectral integration values versus time. For example, the value at 59.4 °C was found to be $1.31 \times 10^{-4} \text{ s}^{-1}$. An Arrhenius plot of the rate constants was made and the activation energy found to be 64.5 kJ mol⁻¹ with a pre-exponential factor of $1.63 \times 10^6 \text{ s}^{-1}$.

Finally, the reaction was subjected to long duration temperature equilibration experiments to ascertain the thermodynamic equilibrium constant and, therefore, the standard molar free energy change for the reaction. From the temperature dependence, the standard molar enthalpy change was determined. Finally, the standard molar entropy change was calculated. The values at 59.4 °C were 0.9 kJ mol⁻¹, -45.1 kJ mol⁻¹, and -138 J K⁻¹ mol⁻¹, respectively.

The Crystal and Molecular Structures of the 2- and 3-Cyanopyridine Adducts of Tetrakis[2,6-dimethylacetanilido]Dichromium (II), W. H. Ilsley, Middle Tennessee State University.

The crystal and molecular structures of the 2-cyanopyridine, (1), and 3-cyanopyridine, (2), adducts of Tetrakis[2,6-dimethylacetanilido] Dichromium(II), Cr₂[O(CH₃)N(C₆H₄(2,6-CH₃))₄], will be discussed. Compound (1) crystallizes in the space group P2₁/c with unit cell dimensions of a = 17.370(2) Å, b = 21.737(3) Å, c = 15.081(2) Å, β = 104.9° and Z = 4. The structure was refined to an R_w = 0.075 and R_{int} = 0.0885. Compound (2) crystallizes in the space group P2₁2₁2₁ with unit cell dimensions of a = 11.184(2) Å, b = 14.268(2) Å, c = 34.723(6) Å, and Z = 4. This structure was refined to an R_w = 0.0699 and R_{int} = 0.0788. Both compounds exhibit octahedral geometry about each of the chromium atoms. Two cyanopyridine ligands occupy the axial chromium positions in both compounds with Cr-Cr-N_{ax} = 179.3(2)° and Cr-N_{ax} = 2.554(7) Å in (1) and Cr-Cr-N_{ax} = 178.5(4)° and Cr-N_{ax} = 2.40(1) Å in (2). For Compound (1) Cr-Cr = 2.276(2) Å, Cr-O_{av} = 1.987(5) Å and Cr-N_{av} = 2.115(7) Å. The corresponding data for compound (2) are Cr-Cr = 2.292(3) Å, Cr-O_{av} = 1.985(9) Å and Cr-N_{av} = 2.12(1) Å.

Changes in Coffee Composition with Time, T. A. Lee, Middle Tennessee State University, J. K. Hardy, The University of Akron.

Changes in the composition of brewed coffee were studied as a function of time. Coffee was prepared with brewing times ranging from 4 to 14 minutes. Analysis of the brewed coffee by gas chromatography-mass spectrometry indicated that >90% of most components were extracted within 6–10 minutes. Changes in composition as a function of aging were investigated covering a range of 0 to 2 hours. While most components exhibited a decrease in concentration consistent with volatilization, some components were observed to increase with time.

Thyroid Hormone Receptor Induction in Primitive Erythrocytes, C. R. Thomas, The University of Tennessee at Martin.

Specific thyroid hormone (T₃) binding sites were detected in the erythro-

cytes (red blood cells - RBC) of bullfrog tadpoles. The sites had binding characteristics expected of T₃ receptors. The number of sites increased during spontaneous metamorphosis or after T₃ injection. When the RBC were incubated with T₃ in M199 culture medium, the number of sites increased about 100% within 48 hours. The half maximal increase occurred at a T₃ concentration near the K_d. The increase in the number of sites was prevented by cycloheximide and actinomycin D, inhibitors of protein synthesis and RNA synthesis, respectively. The T₃ binding protein was extracted from isolated tadpole RBC nuclei using a 0.2 M KCl, 0.1 mM EDTA buffer at pH 7.5. Sephadex G-100 chromatography yielded an estimated molecular weight of 68 kilodaltons for the extracted binding protein, which required SmM dithiothreitol for stability. The T₃ binding sites of chick embryo RBCs were similar to those of tadpole in binding characteristics and chromatography.

Salivary Concentration of the Nitrate Ion, N. W. Wakid, Middle Tennessee State University and N. K. Cortas, American University of Beirut.

Nitrite can react with amines to produce carcinogenic nitrosamines. There have been reports of increased incidence of esophageal and gastric cancer associated with high salivary nitrate and nitrite concentrations. The nitrite originates from bacterial reduction of nitrate in the mouth. We investigated the relationship between saliva and blood nitrate concentrations. Five of us ingested each 40 mg of NaNO₃ per kg body weight following a 3 to 5 hour fast. Samples of venous blood and saliva were then collected simultaneously at intervals and were analyzed for nitrate and nitrite. Nitrate was determined by measuring the rate of reduction to nitrite by metallic cadmium. The results not only showed the expected correlation between saliva and plasma concentrations, but also a saliva/plasma ratio of approximately 7. This indicates either active secretion against a concentration gradient or an exchange between nitrate and other anions. The significance of nitrate concentration by salivary glands remains uncertain.

Chemistry and Crime: The Good Guys Win! Linda A. Wilson, Middle Tennessee State University.

The commission of crimes produces quite a variety of evidence: from checks written with disappearing ink to a murder investigation without a body. Many laboratory techniques and instrumentation can be applied to the analysis of these materials. Actual case studies will be presented to illustrate the kinds of analyses the forensic chemist may be asked to perform.

ENGINEERING SECTION

Michael L. Daley, *presiding*

A Cauchy's Integral Formula Approach and Laplace's Equation Extraction Algorithm for Cross-Sectional Imaging, Ali A. Elsehemy*, Babajide O. Familoni and Carl E. Halford, Memphis State University.

This paper presents a new technique for cross-sectional imaging, supported by the results of its application to a specific object and by analysis. The technique uses Cauchy's Integral Formula (CIF) for solving the inverse problem and Laplace's equation for the image extraction. A DC voltage source exposes the object to an electrostatic field. The electric potential on a contour enclosing the object is measured. The electric potential distribution inside the enclosed domain is calculated by CIF. The potential distribution is processed by an algorithm to determine the boundary lines between different materials composing the domain. The basis of the algorithm is that Laplace's equation is not valid near the boundaries between two different homogeneous materials. The image produced has a spatial resolution of $6.0 \pm 0.5 \text{ mm}$ and accuracy of 85%. The spatial resolution is limited, mainly, by the graphics computer memory, and the accuracy is affected, mainly, by measurement noise.

Effects of Imperfect Earth on the 60-Hz Magnetic Field of Overhead Power Lines, V. Kasturi and P. Chowdhuri, Center for Electric Power, Tennessee Technological University.

The magnetic field of an overhead power line is generally calculated by the image method, assuming the electrical conductivity of the soil to be infinite. The distance of the image conductor below the earth's surface is then the same as the height of the actual conductor above the earth, h. In reality, the finite soil conductivity pushes the image conductor deeper into the earth. This depth, h',

*Student author

is assumed to be given by:

$$h + h' = 659 \times \sqrt{\frac{\rho_e}{f}} \text{ meters,} \quad (1)$$

where ρ_e = electrical resistivity of the soil (Ω -m) and f = frequency of the line current. According to eq. 1, $h+h'=0$ for $\rho_e = 0$, although $h+h'$ should be $2h$ for a perfect earth.

The proposed analytical method places the surface of the virtual earth at the skin depth, δ_e , below the actual earth's surface, given by:

$$\delta_e = \frac{1}{\sqrt{\pi \times \mu_e}} \times \sqrt{\frac{\rho_e}{f}} \text{ meters} \quad (2)$$

where μ_e = permeability of the soil. In this case:

$$\text{For imperfect earth: } h + h' = 2(h + \delta). \quad (3)$$

$$\text{For perfect earth: } h + h' = 2h. \quad (4)$$

The analysis further shows how the magnetic field can be minimized by changing the line configuration.

Neural Networks and Expert Systems to Determine the Condition of Bridges, Jie Lin* and Ted S. Lundy, Tennessee Technological University.

The combination of artificial neural networks and expert systems provides a more general and promising approach to solving highway bridge diagnostic problems. In this paper, we present general features of such a hybrid system. In this system, one knowledge-based unit serves as a preprocessor to process the inspection data from State Highway Department field inspectors. Then by inputting these processed inspection data to a five-neural-network-formed hierarchical unit, data patterns are recognized and preliminary judgments given. Another neologized unit uses these preliminary judgments along with a rule-based expert system to generate final conclusions about the structural integrity of the bridge.

Overvoltages in a Finite-length Underground Cable by Multiple Reflections of Transient Voltages, A.K. Mishra and P. Chowdhuri, Tennessee Technological University.

A transient voltage, such as a lightning surge or a switching surge, travels unimpeded along an overhead power line until it encounters a junction with another line. A major portion of this voltage is then reflected back to the overhead line; a significantly reduced voltage wave is transmitted along the second line if the latter is an underground cable because of the markedly low surge impedance of the cable compared with that of the overhead line. If the other end of the cable is terminated in a high impedance, such as a transformer or an electrical machine, then successive reflections at the two ends of the cable would produce high voltage along the cable, endangering its dielectric system as well as that of the terminal apparatus. The paper shows that installing a surge arrester at the junction of the overhead line and the cable will provide protection neither to the cable nor to the terminal apparatus. A surge arrester across the terminal apparatus will protect the apparatus, leaving the cable and the sending-end terminal unprotected. Lightning arresters at both ends of the cable will limit the overvoltages at these ends; however, dangerous overvoltages may develop along the length of the cable, away from the lightning arresters.

Device for Changing Spoon-feeding Behavior with Auditory Feedback, Duane J. Wentzel*, Memphis State University, Ann Hooker, Les Passees Children's Rehabilitation Center, The University of Tennessee-Memphis, and Michael L. Daley, Memphis State University.

Some children with neurological impairments have difficulties learning the task of self-feeding with a spoon. The objective of this project was to devise a spoon that would provide a positive auditory feedback when used properly. A spoon was designed to control the audio output of a tape recorder. Specifically, an optical switch located in the spoon handle sensed the angle of tilt of the spoon. When the angle exceeded a critical angle, the audio output of the tape player was interrupted. Upon restoration of the proper angle, the audio signal is restored. Laboratory experiments were performed to determine the angle of spill for various substances. A means of adjusting the critical angle was included in the design so that a broader range of substances may be used. The therapist may adjust the critical angle to match the angle of spillage of the substance being used; when the angle of spillage is exceeded, the audio output of the tape player is interrupted. Preliminary experiments indicated that some children recognized

the cause and effect relationship between their use of the spoon and the play of the music. However, one child became too interested in the music to use the spoon. These tests indicate that the spoon can help some neurologically impaired children. Future studies include a means of varying the audio output as a function of the angle of tilt of the spoon. This allows the child to sense the approach of the critical angle instead of the instantaneous response once the spill angle is reached. Also, a transmitter may be added into the spoon itself to make the spoon easier for the child to handle. Finally, miniaturization of the electronic implementation would make the system more portable. Such portability would enable parents to use the aid in home training of the impaired child.

Design of Finite Word Length FIR Digital Filters Using a Parallel Genetic Algorithm, Dexiang J. Xu* and Michael L. Daley, Memphis State University.

The application of a parallel genetic algorithm implemented with a Hypercube computer to design optimal finite word length finite impulse response digital filters is described. Genetic algorithms are useful as stochastic adapting optimization procedures which have the potential to avoid convergence to local minima and determine global minima. A parallel genetic algorithm implemented with a parallel computer is particularly suited for optimization problems which require a large searching space.

Two examples of this application to the design of a Chebyshev low-pass digital filter are given. One example, describing a filter with length of 40 coefficients and 10 bit word length, is used to compare to a previously reported identical design problem which was solved with a general purpose integer programming algorithm. This comparison reveals that the genetic algorithm produces a better Chebyshev approximation to the desired frequency response. The second example describes the results of the application of the genetic algorithm to the design of a high order filter developed for the processing of seismic signals. The characteristics of this second filter with 140 coefficients and a 16 bit word length are compared to those obtained by a rounded-off method. The parallel genetic algorithm coupled with the use of the Hypercube computer may be suitable for resolving other optimization problems in engineering.

Aging of Foamboard Insulation Containing CFCs or HCFCs, David W. Yarbrough, Tennessee Technological University.

High thermal resistance foamboard insulation is produced from low thermal conductivity gases that are initially trapped in a closed-cell structure. The composition of the cell gas changes with time due to inward diffusion of air and outward diffusion of the low thermal conductivity gases. The chlorofluorocarbons that were used in past years are being replaced by compounds with low ozone destruction potentials. Mathematical modeling and measurements of thermal properties are being used to characterize the long-time thermal performance of currently produced and projected products. Selected data and computed results will be discussed. Thermal performance for insulation life-times of 25 to 50 years are needed for product evaluation. Thermal performance degrades with time and must be taken into account by design engineers and architects.

GEOLOGY AND GEOGRAPHY SECTION I

James M. McCluskey, *presiding*

Lower Pennsylvanian-Upper Mississippian Deposystems, Monteagle Mountain, Tennessee, R. E. Bergenback, The University of Tennessee at Chattanooga.

Three roadcuts along eastbound and westbound Interstate 24, on Monteagle Mountain, were described and interpreted.

Vertical sequences of sedimentary structures as well as texture and composition of Upper Mississippian and Lower Pennsylvanian stratigraphic units are interpreted to range in paleodepositional environment from high-intertidal flats (Mississippian Pennington Formation) through marginal marine deposits (Pennsylvanian Raccoon Mountain Formation) to braided stream units (Pennsylvanian Warren Point Sandstone, Signal Point Shale and Sewanee Sandstone).

Here in an area of approximately 38 square miles, the Mississippian-Pennsylvanian systemic contact is generally transitional.

Five cycles of sedimentary structures (scours, troughs, in-channel bars, thin-bedded rippled layers and vertical accumulations of shale and siltstone) in Pennsylvanian stratigraphic units were recognized as braided stream deposystems.

*Student author

The lack of precise paleontologic control precludes correlation of these sedimentary cycles with midcontinent cyclothems.

Mesofabrics at Green Gap, Southeastern Tennessee Valley and Ridge, Habte G. Churnet, The University of Tennessee at Chattanooga.

A complex structure exhibiting flexural slip folds (overturned, reclined, etc.) and brittle faults (consisting of contractional and extensional synthetic and antithetic varieties) is exposed on a roadcut along Interstate 75, at Green Gap on Whiteoak Mountain, Tennessee. The structure makes the steep eastern limb of a synclinorium.

A southwestward sense of transport is determined from the vergence of folds and other meso- and macrofabrics. This is unusual in a region where the major tectonic transport is to the northwest. It is interpreted that the exposure at Green Gap is a record of escape movement associated with the development of the Tennessee Salient.

Stratigraphy, Paleontology, and Depositional Setting of the Thompson Farm Fossil Bed Exposure (Cretaceous), Western Tennessee, Stan P. Dunagan*, Stacey T. Menees, and Michael A. Gibson, The University of Tennessee at Martin.

A twenty-five foot section of the Coon Creek Formation (Upper Cretaceous) is exposed along Melton Creek near Enville, Tennessee. The stratigraphic sequence consists of glauconitic, fossiliferous clayey-sand containing an autochthonous assemblage dominated by the bivalves *Cuculaea* and *Corbula*, with lesser amounts of turrillid gastropods, echinoids, scaphites, and crabs and is capped by a ferricrete concretion layer. The overlying clayey-sand is extensively leached of fossil material leaving molds of *Cuculaea* and *Corbula* in the lower part, but the upper part is heavily bioturbated with *Echinocardium* traces indicating a relatively soft substrate at the time of echinoid activity. The upper two feet contain approximately twenty burrows infilled with highly fragmented shell debris, charcoal, and crab parts. The burrows terminate along a buried sediment-water interface and are believed to represent crab domichnia. The overlying seventeen feet of sediment consists of weathered sandy-clay with varying degrees of shell dissolution.

An Application of GIS on Vulnerability Assessment of Essential Facilities in Memphis and Shelby County, Tennessee, Pin-Shuo Liu*, T. S. Chang, and Hsiang-te Kung, Memphis State University.

This research is designed to use PC ARC/INFO, a geographic information system (GIS), developed by ESRI, Redwood, California, to inventory the vulnerability of essential facilities in Memphis and Shelby County, Tennessee for reducing seismic risk and saving lives. The major purpose of a geographic information system is to offer a link between spatial data and attribute files. This combination makes it possible to create maps with "intelligence." The major research activities in the first phase of this project include (1) data collection, and (2) inventory and data base construction. This paper presents the methods and procedures for constructing the digitized data base as well as illustrating some final map products.

Progress in Modeling the Relationships Between Stream Form and Mechanical Energy, James M. McCluskey and Phillip R. Kemmerly, Austin Peay State University.

Streams as linear landforms exist in the three-dimensional space of an x,y,z coordinate system. Stream form is dependent on the expenditure of mechanical energy distributed between the erosion of the channel boundary and sediment transport. Stream segments are modeled using a linear equation to characterize stream gradient and a quadratic equation to represent stream amplitude. Algebraic addition of the two functions allows stream segments to be modeled in three-dimensions. Equation coefficients, used as surrogate variables, represent the distribution of mechanical energy. Sets of coefficients enable characterization and classification of stream segments. Conditions of equilibrium and entropy can be assessed. The three-dimensional aspects of stream form are graphically portrayed as a function of x,y,z.

The Educational Landscape of Tennessee, James M. McCluskey and Elizabeth K. McCluskey*, Austin Peay State University.

The educational landscape of Tennessee is portrayed using county level data from the *City and County Data Book* (1988 edition). An analysis is made of the relationship between levels of educational attainment, as measured by the percent of the population that are high school graduates, and a set of demographic and socioeconomic variables, including population density, age struc-

ture of the population, sex ratio, percentage of the population that are minorities, per capita income, and per capita local spending on education. Significant correlations exist between levels of educational attainment and population density and per capita income. The spatiality of the relationships are presented in maps.

Civil War Battle of Island 10—The Geology of History, Richard G. Stearns, Vanderbilt University.

Island No. 10, a month-long Civil War battle for the Mississippi River (March 8–April 8, 1862), occurred on land uplifted during the New Madrid earthquakes 50 years earlier. The uplift and the Reelfoot Lake sunk land strongly influenced the battle. Flooding emphasized the influence of the sunk land.

The Confederate Army's main defense was artillery in earthwork forts on the Tennessee bank and Island 10. These forts were placed to keep Union gunboats from coming downriver. They fortified New Madrid on the Missouri bank to keep the Union Army away from the river downstream from their main forts. All fighting, and every fortified artillery position, except one, was on the uplift. A flood turned the dissected uplift into flood islands.

The Union Army had to approach New Madrid down Sikeston "Ridge," a 20-foot high Pleistocene terrace: even on the ridge Union soldiers had to wade. The Union Navy had to approach down a six mile straight reach of the river (maybe controlled by a fault). This gave Confederate artillerymen a clear view and early warning. The Union Navy stopped just out of range and never attacked.

The battle was mostly maneuver, without a duel between Confederate guns and Union gunboats. The Union Army captured New Madrid and placed guns downstream to isolate the Confederates. Reelfoot Lake, once a protective barrier, now became a trap from which the Confederates could not escape.

GEOLOGY AND GEOGRAPHY SECTION II

D.M.S. Bhatia, *presiding*

Hensley Farm Mastodon Site, Perry County, Tennessee, T. Randall Bell*, Jerry L. Boyd* and James X. Corgan, Austin Peay State University.

Clay deposits in the channel of Coon Creek, Perry County, yielded a tooth of a juvenile *Mammot americanum*, a Pleistocene mastodon. This discovery substantiates an Ice Age community of vertebrate animals in this area of Tennessee. The area has previously lacked an Ice Age vertebrate record.

The Mineral Industry of Guanajuato Mexico—The World's Largest Silver Producing District, D.M.S. Bhatia, Austin Peay State University.

Since 1548, nearly two billion dollars in silver and gold has been continuously produced from three northwest trending fault systems in Guanajuato, central Mexico. The Veta Madre, a 16 mile long fault zone is the most productive and rich with gold and silver values up to 30 and 270 grams per ton respectively. The ore is always confined within stockworks in hydrothermally altered rocks, but does not show any correlation with any particular rock type.

Negative Aspects of Landfill Implementation at Bumpass Cove, Tennessee, K. Burdick*, C.R. Coron and R.D. Sams*, East Tennessee State University.

The landfill at Bumpass Cove, Tennessee, operated until the mid-seventies, was recently declared a state Superfund hazardous waste site and is currently a candidate for federal remediation. Evaluation of potential landfill sites focuses on three main areas: site desirability, environmental impact and human impact. The site chosen for the Bumpass Cove landfill does not meet acceptable standards in all three categories.

The landfill is located on thrust-fault bounded, karsted carbonates of the Shady Formation which host numerous springs, sinkholes and sinking streams. The fill's location is central to the main drainage pattern and in an area where the water table is shallow and groundwater involvement with the substrate has been documented. Inadequate soil cover resulting from previous mining operations and the presence of three known vertical shafts contributes to the downgrading of the site.

Residents of nearby communities derive their drinking water from sources potentially contaminated by the fill.

The Geologic Setting of the Chandler Barite Mine, Flag Pond, Tennessee, C.R. Coron, P. Johnson* and L. Sinemus, East Tennessee State University.

The Chandler barite deposit, located southeast of Wilson Knob, was strip-

*Student author

and shaft-mined extensively in the 1920's. The barite occurs as irregular lenses and veins in Archaean gneisses belonging to the Cranberry Formation, which crops out in an elongate NE-SW belt paralleling the general trend of the Appalachians in eastern Tennessee and western North Carolina. The main barite body strikes N 66 E and extends approximately 300 feet in the mine vicinity. Thrust faults have been mapped in the area, but no direct connection with the barite deposit can be demonstrated. Deposits of similar age have been documented in the Max Patch Granite near Stackhouse, N.C., where a proposed relationship to thrust faulting exists (Keith, 1904).

The Hydrogeology of Bumpass Cove, Tennessee, R.D. Sams* and C.R. Coron, East Tennessee State University.

Bumpass Cove is underlain by a thrust fault-bounded syncline of Cambrian Shady Dolomite (valley) and older clastic units of the Erwin and Hampton Formations (ridges). The Shady Dolomite exhibits prominent karst features and has undergone extensive weathering, producing crevices and pinnacles with 200 feet of residual clay. The most intense solutioning and, consequently, groundwater flow is concentrated along the Shady/Erwin contact. The presence of supergene enrichment ores, of iron, manganese, lead and zinc demonstrate the involvement of a shallow water table with bedrock. Larger manganese bodies are associated with clay/gravel terraces which are floodplain remnants of Bumpass Cove Creek.

Community residents derive their water supply from springs and shallow wells from this valley floor alluvium which is fed from the discharge of the Shady aquifer. An inactive landfill, known to be leaking leachate, is located on the site of old mine workings immediately above the creek.

Petrology and Geochemistry of the Knox Interval in the DuPont Geohydrological Survey Well, Humphreys County, Tennessee, G.C. Caudle and D.N. Lumsden, Memphis State University.

The DuPont geohydrological survey well near Waverly, Tennessee was continuously cored from the surface (Fort Payne Formation) through the Copper Ridge Formation, thus providing the only "outcrop" of the Knox Group between the Appalachians and the Ouachita Mountains. This study documents the petrology and geochemistry in the Knox interval, 2,000 ft to 4,200 ft subsurface, using 87 samples taken from rubble zones in the core spaced 20 to 30 ft apart. Samples were analyzed for mineralogy, dolomite stoichiometry, rock type, grain size, porosity, chemical composition, carbon and oxygen isotopes in dolomite, and manganese partitioning ratios in dolomite. Much of the Knox is fractured, possibly due to karst. The pervasive rock type is medium crystalline dolostone. Phase one dolomite forms an interlocking mosaic of 0.05 to 0.50 mm crystals (idiomorphic) that obliterate original textures. Minor amounts of phase two dolomite fills vugs and fractures. There are two thin limestone intervals (<20 ft) (pellet grainstones) and three thin dolomite-cemented quartz arenites. Chert cement is also present. The dolomite is uniformly near stoichiometric (average 51% calcium) with a high manganese partitioning ratio (50 to 150). Chemical composition is also uniform. Oxygen-carbon isotope cross plots suggest shallow burial diagenesis. The uniformity of measured parameters throughout the interval suggests a common origin for the dolomite. Tentative correlations can be made with Knox outcrops in east Tennessee.

Mosaic Mixing: A Model for the Origin of Mixed Carbonate-Siliciclastic Sequences, Michael A. Gibson, The University of Tennessee at Martin.

Mixed carbonate-siliciclastic sequences occur due to interacting factors acting on hierarchical scales and reflect both depositional and diagenetic influences. The Birdsong Shale Member (Lower Devonian Ross Formation, West-Central Tennessee) is used as an example to demonstrate the complexities of mixing mechanisms and to suggest a mixing model termed Mosaic Mixing. Birdsong sediment accumulated as the result of frequent storm activity that affected the seafloor, producing intrabedded and interbedded limestone-shale couplets. The mosaic of interbedded and intrabedded sequences was formed by (1) scouring and winnowing of the existing substrate during storm passage, (2) influx of terrigenous mud as blanket deposits onto the seafloor, (3) between-storm accumulation of skeletal debris in a time-averaged manner with little sediment accumulation, finally (4) changes due to overall paleoecological and paleo-environmental shifts from a limestone-rich brachiopod-dominated seafloor in the lower Birdsong to a shale-rich bryozoan and echinoderm-dominated upper Birdsong.

Reconnaissance of the Quality of Ground Water from Domestic Wells in Bedford and Coffee Counties, Middle Tennessee, Ferdinand Quinones, Michael W. Ben-

nett, and Angel J. Roman U.S. Geological Survey, Water Resources Division, Nashville, Tennessee.

The quality of drinking water from domestic wells in rural areas of Coffee and Bedford Counties, Middle Tennessee, was investigated from July through August 1991. Water samples were collected from 100 wells in each county by volunteers trained by the U.S. Geological Survey. Each water sample was analyzed to determine the concentrations of fecal coliform and fecal streptococci bacteria; concentrations of nitrate, sulfate and chloride ions; and values of Ph and specific conductance.

Results of the analyses showed that fecal streptococci bacteria, fecal coliform bacteria, and nitrate nitrogen were the principal contaminants in the water samples. Fecal streptococci were detected in 77 samples from Bedford County and in 51 samples from Coffee County, with concentrations ranging from one to 31,000 colonies per 100 milliliters of sample. Fecal coliform bacteria were detected in 49 samples from Bedford County and in 26 samples from Coffee County, with concentrations ranging from 1 to 7,300 colonies per 100 milliliters of sample. The ratios of the fecal coliform to fecal streptococci bacteria concentrations suggests that animal wastes are the main source of contamination to the wells.

Nitrate concentrations in water samples from Bedford County ranged from less than 1 to 26.1 milligrams per liter, and from less than 1 to 14 milligrams per liter in Coffee County. Overall, nitrate concentrations exceeded 5 milligrams per liter in samples from 40 wells. Concentrations of 7 samples exceeded federal and state drinking-water standards of 10 milligrams per liter.

HISTORY OF SCIENCE SECTION

Philip J. Lorenz, Jr., *presiding*

Restoration of The Alvan Clark Refractor at The University of The South, F.M. Cordell, Principle Restorer, Barnard Astronomical Society.

In October of 1981 The University of The South solicited The Barnard Astronomical Society of Chattanooga, Tennessee to restore their model 1897 Alvan Clark and Sons refracting telescope. The instrument has a long and colorful history. It was a gift to the university by Mrs. J.L. Harris of New Orleans in 1913. At that time it was placed in a wooden housing atop the then new Carnegie Science Building. In the early 1940's the flagstaff of the Science Building was removed to construct an observatory and its base formed the foundation for the Alvan Clark Number Seven telescope mounting.

Although the restorative techniques applied to this telescope and its ancillaries are unique, they may serve as a comprehensive guide to those undertaking restoration of similar historical instruments.

The Academy's Third Twenty-Five Years, 1962-1986, James X. Corgan, Austin Peay State University.

The Academy entered its third quarter-century with increasing membership, successful programs, strong sections, and a statewide system of NSF-funded workshops. NSF funding soon stopped. Then, anti-evolution laws and an uncertain state funding plagued the group. Legislation never caused a catastrophe. State funding began in 1968, lapsed in 1981 and 1982, and then returned. Loss of dollars impacted all programs. Membership decline was the main problem of the quarter-century. A high of 971 members in 1963 eroded to 483 in 1983. With state funds, the *Journal* grew stronger and annual meetings flourished. Nonmembers gave many sectional papers and played key roles as invited speakers in thematic symposia. Between 1975 and 1984, these symposia replaced the Academy's traditional general program. The quarter-century ended positively, with strong annual meetings, stable membership, and diverse programs.

Geological Fieldwork in 1833: Gerard Troost's Travels in West Tennessee, Michael A. Gibson, The University of Tennessee at Martin, James X. Corgan, Austin Peay State University.

Gerard Troost (1776-1850) became Tennessee's first state geologist in 1831, when little was known concerning the regional geology of Tennessee. In the fall of 1833, Troost undertook a twenty-nine day field trip through Tennessee gathering geologic data. This data served as the basis for reports to the state legislature on the geologic and paleontologic resources of Tennessee. For example, one of the earliest commercially exploited resources for Tennessee was iron. Troost spent several days in the vicinity of Linden, Cedar Grove

Furnace, Lee Furnace, Piney Furnace, and Laurel Furnace studying the iron-works and geologic material used in the process. Troost also collected fossils of the geologic formations he encountered along his route which were later valuable in establishing stratigraphic relationships of the rock formations and establishing the geologic ages of the rock units exposed in West Tennessee.

The Computer as a Time Machine: Viewing the Positions of Spica Cited by Hipparchus as Evidence for Precession of the Equinoxes, Philip Jack Lorenz, Jr., The University of The South.

In determining the length of the year (to within 6 minutes of the modern value), Hipparchus found that the tropical and sidereal years differed in value. This led him to suspect that the equinoxes changed positions on the ecliptic since the stars seemed fixed. He compared the coordinates of the bright star Spica (then near the autumnal equinox) as found by Timocharis in Alexandria from about 300 to 270 B.C. to those he measured on Rhodes in 146 and 135 B.C. during total lunar eclipses. From this and other evidence Hipparchus concluded that a lower limit for precession of the equinoxes was 1° per century.

These observations and other astronomical data in the *Almagest* and elsewhere may now be checked and viewed by science historians, teachers and students using commercially available computer "planetarium" programs that provide accurate simulations of the sky from ancient to future times.

Pascal, Descartes and Fermat, Alvin Tirman and Karen Harrington, East Tennessee State University.

Modern mathematics began almost four centuries ago. It was initiated by three geniuses: Pascal, Descartes and Fermat. The lives and contributions of these Gallic giants is reviewed. The authors also seek to show why with the deaths of these great men, the international supremacy of France in mathematics collapsed.

MATHEMATICS AND COMPUTER SCIENCE SECTION I

Donald A. Nelson, *presiding*

Some Well-covered Graphs, Stephen R. Campbell, Belmont University.

The problem of finding a maximum independent set in a graph has been shown to be an NP-complete problem. This means that there is little hope of discovering a "good" algorithm which will find a maximum independent set in an arbitrary graph. A graph G is said to be *well-covered* if every maximal independent set is maximum. Well-covered graphs are of interest because, in contrast to general graphs, the problem of finding a maximum independent set in a well-covered graph is very routine. We wish to exploit this property and so we need to be able to identify those graphs which are well-covered. The well-covered graphs have not been characterized, but some progress has been made. This talk will include a characterization of a special class of well-covered graphs and a discussion of some recent developments related to this interesting class of graphs.

Some Operations on Matrix-valued Expressions, Carol Clifton, Middle Tennessee State University.

First, this paper investigates the solutions to matrix-valued expressions. This investigation requires the solutions of the square root of the identity matrix to be determined. Next, the solutions of the square root of any given matrix are investigated using Hermitian, unitary, and normal matrices. In conclusion, polynomials and trigonometric functions are applied to matrices.

Project CALC at MTSU, King W. Jamison, Middle Tennessee State University.

"Project CALC" is a first-year calculus curriculum innovation written by David Smith and Lawrence Moore of Duke University and being tested at several sites. Middle Tennessee State is one of those sites.

The fundamental axiom of the Smith-Lawrence curriculum is "If you cannot explain clearly in words how an answer was gotten, then you have not solved the problem." Consequently heavy emphasis is placed on write-ups of class projects and laboratory experiments. Since the emphasis is on student writing and explaining, only two examinations per semester are given.

The Project CALC curriculum has been motivated by several articles which have appeared recently. Among these are "Toward a Lean and Lively Calculus"

by Ronald G. Douglas and "Calculus for a New Century: A Pump, Not a Filter" by Lynn A. Steen.

Some Old Summation Formulas Revisited, J. Kinloch, East Tennessee State University.

Many of the familiar formulas that algebra students are asked to establish individually by mathematical induction arguments share the common aspect of being a sum of some fixed power of the first N terms of an AP (Arithmetic Progression). In this paper, we obtain by induction, a recursive formula for the sum of K -th powers of the first N terms of an AP with common difference d . We then assign specific values to the exponent K and the common difference d , and the leading term of the AP, thus obtaining collectively the above mentioned familiar formulas.

Roots of the Identity, Jeff R. Knisley, East Tennessee State University.

With some simple algebra, we can show that the equation

$$(1) \quad X^2 = I$$

has the two solutions $x = 1$ and $x = -1$ in the field of real numbers. However, if X is a matrix and I is the identity matrix, equation 1 is not so easy to solve. For example, if X is a 2×2 matrix, then (1) has the four obvious solutions

$$x = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \quad x = \begin{bmatrix} -1 & 0 \\ 0 & -1 \end{bmatrix} \quad x = \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix} \quad x = \begin{bmatrix} 0 & -1 \\ -1 & 0 \end{bmatrix},$$

and an infinite number of solutions which are not so obvious. In this talk, a general form for square roots of the identity is discussed and this general form is applied to the algebra of 2×2 matrices and, time permitting, to the 3×3 matrices as well.

An Equality of Entry Problem for 2×2 Matrices, Mark A. Miller, David Lipscomb University.

An algorithm is presented for solving a special case of an equality of entry problem for 2×2 matrices.

Planar Regular One-well-covered Graphs, Michael R. Pinter, Belmont University.

A graph consists of a set $V(G)$ of vertices and $E(G)$ of edges connecting pairs of the vertices. The degree of a vertex is the number of edges having the vertex as an endpoint. A regular graph is a graph in which every vertex has the same degree. A planar graph can be drawn in the plane with no edges crossing. An independent set in a graph is a subset of vertices with the property that no two of the vertices are joined by an edge, and a maximum independent set in a graph is an independent set of the largest possible size. A graph is called well-covered if every independent set that is maximal with respect to set inclusion is also a maximum independent set. If G is a well-covered graph and $G - v$ is also well-covered for all vertices v in G , then we say G is 1-well-covered. In this talk, we consider those 1-well-covered graphs which are both planar and regular.

A Fibonacci Connection to Linear Algebra, Roberta L. Rudolph* and David Cochener, Austin Peay State University.

This talk presents a connection between Fibonacci numbers and the determinants of certain $n \times n$ matrices, all of whose entries are either 0 or 1 (0-1 matrices). For a positive integer n , it can be shown that if $n \leq 5$, then the n th Fibonacci number is the maximum determinant value of the $n \times n$ 0-1 matrix. Under exploration is the conjecture that the n th Fibonacci number is the maximum determinant value of an $n \times n$ 0-1 matrix for all values of n .

An Asymptotic Theorem For a 2nd Order Linear Differential Equation with Constant Delay, V.M. Sakhare, East Tennessee State University.

Sufficient Conditions are given for the equation $y''(t) + p(t)y(t-m) = 0$ so that a solution $y(t)$ has the asymptotic nonoscillatory behavior

$$\lim_{t \rightarrow \infty} \frac{y(t)}{t} \neq 0.$$

Existence of Solutions to Nonconvex Lagrangian Systems, Zachariah Sinkala, Middle Tennessee State University.

We give conditions on the functional ϕ (defined below), under which will obtain sufficient conditions for existence of solutions to periodic boundary value problem

*Student author

$$(1) \quad \frac{d}{dt} Dy L(t, u(t), \dot{u}(t)) = Dx L(t, u(t), \dot{u}(t))$$

$$u(0) - u(T) = \dot{u}(0) - \dot{u}(T) = 0$$

Where $L: [0, T] \times \mathbb{R}^n \times \mathbb{R}^n \rightarrow \mathbb{R}$, $(t, x, y) \rightarrow L(t, x, y)$ be measurable in t for each $(x, y) \in \mathbb{R}^n \times \mathbb{R}^n$ and continuously differentiable in (x, y) for almost every $t \in [0, T]$, not necessarily convex in x , and

$$\phi(u) = \int_0^T L(t, u(t), \dot{u}(t)) dt \quad \text{is indefinite.}$$

Although the variational structure of the problem suggests that the best results should be obtained through a variational approach, progress in this direction has been rather slow. This is due to the fact ϕ is indefinite. Therefore, the direct method of the calculus of variation *cannot* be applied in a straightforward way and more sophisticated like minimax methods have to be used. The Robinowitz's (Robinowitz saddle point theorem) type of the result is obtained. The result is applied to the scalar ordinary differential equations with bounded nonlinearities.

MATHEMATICS AND COMPUTER SCIENCE SECTION II

Curtis K. Church, *presiding*

Discrete Congruences on Monoids of Lie type, M.K. Augustine, Tennessee Wesleyan College.

Let G be a finite group of Lie type. A regular monoid M with zero O , group of units G and set of idempotents E is called a monoid of Lie type on G if (1) M is generated by E and G (2) If $e \in E$, then $P(e) = \{a \in G \mid a e = e a\}$ and $P^-(e) = \{a \in G \mid e a = a e\}$ are opposite parabolic subgroups of G . Further $x e = e$ for $x \in U(e)$ and $e y = e$ for $y \in U^-(e)$ where $U(e)$ and $U^-(e)$ are the unipotent radicals of $P(e)$ and $P^-(e)$ respectively. (3) If $e, f \in E$ and $e R f$ or $e L f$, then $x^{-1} e x = f$ for some $x \in G$. Let Γ denote the Dynkin diagram of G and let U be the lattice of \mathfrak{g} -classes of M . Then the system of idempotents of M can be constructed from a type map $\lambda: U \rightarrow 2^\Gamma$ and the Tits building of G . Monoids of the same type have the same system of idempotents. The type maps coming from monoids of Lie type can be abstractly characterized. There is a cross section of idempotents $eJ, J \in U$ such that $J = GeJ$ and for $J, J' \in U, J \geq J'$ if and only if $eJ \geq eJ'$. Let Λ be this cross section lattice. Let M be a monoid of Lie type on G and let σ be a congruence on M . Then M/σ is a monoid of Lie type on G . Let $M' = M/\sigma$ and $\sim\sigma$ be the homomorphism corresponding to σ . Let Λ and Λ' be cross section lattices of M and M' respectively. Then $\sim\sigma$ induces a meet preserving map $\varphi: \Lambda \rightarrow \Lambda'$ and hence a congruence on Λ . Let $f \in \Lambda'$ be such that $\varphi(e) = f$ and e_σ be the meet of all e related idempotents under the natural partial order of idempotents. Then the type maps of M and M' are related by the condition $\lambda(e) \subseteq \lambda(e_\sigma) = \lambda'(f)$. Thus the type map of M' is decided by the type map of M and the congruence φ on Λ . For a monoid M of Lie type with type map λ and cross section lattice Λ , let φ be a congruence on Λ such that $\lambda(e) \subseteq \lambda(e_\sigma)$ for all $e \in \Lambda$. Then φ extends to a congruence σ on M such that the type map of M/σ is the restriction of λ to Λ_σ , where $\Lambda_\sigma = \{e_\sigma \mid e \in \Lambda\}$. A congruence on M coming from a congruence on Λ is called a discrete congruence on M . Thus if σ is a congruence on M then σ factors as a discrete congruence on M followed by an idempotent separating congruence. Monoids of Lie type include all natural examples of monoids. In particular reductive algebraic monoids with zero form an important class of monoids of Lie type. A monoid is J -irreducible if it has exactly one nonzero minimal J -class. Let G be a reductive group with Dynkin diagram Γ . Let $M_\sigma(G)$ denote a J -irreducible monoid with O and Group of units G . For such monoids we can explicitly describe the finite lattice of J -classes (isomorphic to the finite lattice of conjugacy classes of idempotents) as follows: For each $I \subseteq \Gamma$ there is a lattice U where $U = U_I = \{J \subseteq \Gamma \mid \text{No component of } J \text{ is contained in } I\} \cup \{O\}$. O is the lowest element of U and $U \setminus \{O\}$ is ordered by set inclusion. The type map $\lambda: U \rightarrow 2^\Lambda$ is given by $\lambda(J) = J \cup \{\sigma \in I \mid \sigma \theta = \theta \sigma \text{ for all } \theta \in J\}$ for $J \in U, J \neq \emptyset$ and $\lambda(O) = I, \lambda(O) = \Gamma$.

Let Λ be a cross section lattice of $M_\sigma(G)$. Then $\Lambda \cong U$, for some $I \subseteq \Gamma$. The discrete congruences on $M_\sigma(G)$ are precisely those arising from the congruences on Λ coming from its ideal. Thus the congruences on $M_\sigma(G)$ are determined by the idempotent separating congruences on $Mo(G)/I$ where I is an ideal of $Mo(G)$

A Special Case of Dilworth's Question, James B. Hart, Middle Tennessee State University.

Some years ago, R.P. Dilworth posed the following question to lattice theorists: Which posets can be realized concretely as the posets of prime ideals of distributive lattices? Over the years, several partial answers to this question have been introduced; however, no complete answer has yet been given. In this presentation, I will demonstrate that the order-theoretic ideas used in studying the semantics of computer languages lead to an answer for a significant class of posets: A poset is algebraic if and only if it is dually order-isomorphic to the subposet of meet-prime elements of a bialgebraic, distributive lattice. This special case of Dilworth's question appears to be one of the most general yet addressed.

Insurer, Insured and Statistics, Syed Hossain, Middle Tennessee State University.

An insurance organization (insurer) helps to reduce the financial consequences of damage or destruction of property. The insurer issues contracts (policies) that pays the owner of the property (insured) a defined amount equal to or less than the financial loss of the property. The question is how much should the insurer charge the insured (premium) that will keep him happy and how much the insured would be willing to pay that will keep him happy? The talk will shed light on this aspect of insurance.

Construction of Wittings of Local Type, Vatsala Krishnamani, Middle Tennessee State University.

It is an unsolved problem in the theory of wittings whether all wittings can be realised as wittings of fields. On the other hand it is very well known that wittings of local type can be realised as wittings of fields. Wittings of local type are of primary importance in the theory, since they serve as building blocks for many classes of wittings and conjectured to be so for all classes of wittings. So the study of wittings of local type is of much value in the theory of wittings. In fact all wittings of local type come from local fields, except one and the exceptional one is the witting of the field of real numbers. In this paper, we shall deal with nondegenerate finitely generated wittings of local type and construct fields which give rise to these wittings.

Hypercube Simulation in a PC Environment, Joe C. Lundy and Greg Schaper, East Tennessee State University.

Programs written for the iPSC simulator can be tested on a PC computer. The iPSC simulator is a software package designed to simulate the iPSC hypercube computer on a single processor. The simulator does not attain the operational speed of the actual hypercube computer, but it does simulate the asynchronous interaction among the processors of the hypercube. This asynchronous interaction is the prime reason for the difficulty in debugging a hypercube program. Many errors, except those caused by race conditions, can be detected in iPSC programs if they are restricted to synchronous execution. This presentation covers software techniques that allow iPSC programs to be executed on non-iPSC systems.

Extended Precision Computations, Danny H. Osborne, Jr.* and Thomas Ray Hamel, Austin Peay State University.

Developing algorithms for extended precision computations requires consideration of several possible difficulties, especially overflow. The study concentrated on operands limited to positive integers of up to 100,000 digits each, a limitation that is really determined by computer memory. Algorithms were developed for the operations of addition, subtraction, multiplication, factorials, and powers. The algorithms were converted to computer programs in the C and Pascal programming languages that have been run on computers ranging from personal computers to a VAX 8250. The program uses an array for each operand, while most of the algorithms closely follow the standard computational algorithms. The results are useful in algorithms used to calculate irrational values such as π and e to many significant digits. Future study includes developing algorithms for extended precision division and square root.

A System Generation for a Small Operating System, Luke R. Pargiter and Jerry E. Sayers, East Tennessee State University.

A system generation utility is being developed to assist students in producing IBM PC-based multitasking applications targeted for the small operating system (SOS) developed by Jerry E. Sayers. Our aim is to augment SOS by enabling a student to interactively tailor the characteristics of the operating system to meet the requirements of a particular application. The system allows

*Student author

the user to adjust factors such as initial state, priority, and scheduling method of concurrently executed tasks, and, also, use of system resources. A custom operating system is produced by invoking a make utility to bind SOS with application-specific code, in addition to intermediate source code created during the system generation process. Further testing of the system includes implementing an application that will add column vectors in a 5×5000 matrix concurrently. Currently, SOS is studied as part of an undergraduate operating systems class at East Tennessee State University.

Generating Discrete Distributions from Combinatorial Quantities That Satisfy the Binomial Theorem, Dennis P. Walsh, Middle Tennessee State University, and Charles L. Anderson, University of Southwestern Louisiana.

We define a class of binary operations that generalizes the common operation of exponentiation. The real-valued quantities resulting from an operation of this class satisfy the binomial theorem, and hence, we call such operations "bith" operations. Common bith operations include exponentiation, ascending factorial powers, and descending factorial powers. Others are of more unusual form.

Using the combinatorial quantities resulting from a bith operation along with a factor of Poisson form we then define a generalized Poisson class of distributions, which includes among its members many of the common discrete distributions (e.g., binomial, Poisson, and negative binomial) and some of the more arcane distributions (in particular, Consul's two-parameter Poisson). In a similar vein, we define a class of generalized multinomial distributions.

We show i) closure in the convolution (summing) of the "generalized Poisson" random variables and ii) the "generalized multinomial" form upon conditioning on the sum. Thus the theorem unifies many individual distributional results into a "class" result.

MEDICAL SCIENCES SECTION

R. Dean Blevins, *presiding*

A High Percentage Yield Method for Purifying P-glycoprotein, Werner J. Barden, Lee College, Emory University Department of Pharmacology.

In vitro studies of multidrug-resistant (MDR) cell lines have shown that a 150–180 kDa membrane protein known as P-glycoprotein (P-170) is responsible for resistance to a wide range of structurally and functionally dissimilar anti-cancer drugs. The amino acid sequence of P-170 indicates the existence of two putative consensus sequences for ATP binding, and photoaffinity analogs of ATP binding to the protein. ATP is also required for drug transport in membrane vesicles isolated from MDR cells, leading to the current model for P-170 as an ATP-dependent drug efflux pump. Partially purified P-glycoprotein has been reported to show a very low level of ATP-ase activity, which was not affected by the presence of MDR-type drugs. In an effort to determine if phosphorylation affects the ATP-ase activity of P-glycoprotein, a purification procedure for this integral membrane protein was developed. Plasma membrane vesicles from multidrug resistant KB-V1 human epidermoid carcinoma cells were subjected to a procedure involving selective extraction with different concentrations of the zwitterionic detergent CHAPS. The final supernatant (S3) was then Immuno-precipitated. The resulting extract was highly enriched with P-170. This extract displayed an ATP-ase activity (specific activity = $500 \text{ nmol mg}^{-1} \text{ min}^{-1}$). This activity was not found in a similar preparation from drug-sensitive KB-3 cells.

Altering Codependent Behaviors by Educational Intervention, J. Helm, B. Marrs, F. R. Ketron, East Tennessee State University.

Codependency, much like alcoholism, is considered a progressive disease which can impact all aspects of an individual's well-being. Since codependency is delineated by observable clinical psychopathology, it has principally remained in the domain of psychotherapy relative to treatment. Consequently, this study was undertaken to determine if education could successfully serve as an intervention strategy pre-empting the insidious outcome of this disease. In a pre and post test sequence the Friel Adult/Child Codependency Inventory was administered to 21 students enrolled in a summer workshop at East Tennessee State University entitled, "Codependency: The Disease and Recovery Issues." Analysis of the data revealed a significant ($p > .01$) decrease in the subjects' codependent behaviors, thus suggesting that education can perhaps serve as a successful intervention tool.

Particle Size Distribution of Airborne Dust in a Facility Using Depleted Uranium, A. F. Iglar and M. Juscius, East Tennessee State University.

In this study, a Marple–Personal Cascade Impactor Sampler was used to evaluate the particle size distribution of airborne dust in the machining areas of a manufacturing facility using depleted uranium. Gravimetric and activity determinations were made for the various fractions of each sample. Approximately 85 percent of the mass of particles were in the respirable size range. However, respirable particles constituted only 79.4 percent of the total activity. The activity median aerodynamic diameter was 0.95 micrometer, slightly smaller than the 1 micrometer used for evaluating the risk of exposure to humans.

It was recommended that particle size sampling with the Marple Impactor be performed routinely in the depleted uranium facility that was studied.

Effects of Aging On The Oral Tissue, F.R. Ketron, J. Helm, B. Marrs, East Tennessee State University.

Aging of the oral tissues is manifested in changes in the structure, form, and size of the hard and soft tissues of the oral cavity. Of the two areas to be examined in this paper the first will be a discussion of changes of the hard tissues of the teeth which include: occlusal, incisal and interproximal wear, loss of structural details on surface enamel, hypercementosis, physiologic secondary dentin production, dentin sclerosis, and pulp stones. The second area is the oral mucosa which will be discussed in three general categories; masticatory, lining, and specialized mucosa as they relate to aging.

An Analysis of Pharmacological Usage In An Alzheimer's Residential Home, B. S. Marrs, J.D. Helm and F. R. Ketron, East Tennessee State University.

A questionnaire was completed by the administrator of a private Alzheimer's residential home for the elderly in which the medications administered to the twenty-six residents were identified. According to the data, the average number of medications received daily were four compared to the national average number of drugs taken by persons 65 and older which was 9.3. The medications taken by these residents were classified into the following categories: 1) analgesics, 2) anti-asthmatics, 3) anti-cholenergics, 4) anti-diabetics, 5) anti-glaucoma, 6) anti-histamine, 7) anti-inflammatory, 8) anti-neoplastic, 9) cardiovascular agents, 10) laxatives, 11) neurological, and 12) nutrients. As the data indicated, the residents in this private Alzheimer's residential home received less than one half of that of the national average of prescribed drugs taken by the elderly.

The Physiological Roles of Phosphoinositide Hydrolysis Linked Receptors in the Rat Hippocampus, T.S. Smith, Lee College and P.J. Conn, Emory University.

Until recently, all glutamate receptors were thought to be of the classical nature. However, subsequent studies indicate that there is a novel family of glutamate receptors which are coupled with a second messenger system known as phosphoinositide hydrolysis. The uncertainties as to whether or not glutamate was the endogenous agonist for this receptor were addressed. We found that glutamate is physiologically relevant in young and adult animals. However, the younger animals displayed more variability when considering the developmental regulation. Additional studies were conducted to test the effectiveness of one inhibitor, L-AP₃. We discovered that L-AP₃ blocks phosphoinositide hydrolysis yet it does not block the physiological effects. This finding may support the presence of multiple ACPD-linked receptors and warrants further research.

PHYSICS AND ASTRONOMY SECTION

Roy W. Clark, *presiding*

Laser-induced Nitration Reactions of Cycloalkanes, Judith M. Bonicamp, Susan E. Godbey, Anne E. Stanley, and Larry M. Ludwick, Middle Tennessee State University.

The tunable, continuous wave, carbon dioxide laser-induced reactions of cyclopropane, cyclobutane, and cyclopentane with nitrogen dioxide have been carried out under a variety of irradiation conditions. The qualitative analysis of the product mixtures has been completed. Conditions were found for producing nitrocycloalkanes while reducing or eliminating the production of other nitroalkanes. The array of products was found to be highly sensitive to the laser irradiation conditions.

Using Dielectric Spectroscopy to Monitor the Processing of Foods, B. Bou-dakian, The American University of Beirut, and F. X. Hart, The University of the South.

Dielectric spectroscopy is the measurement of the variation of the electrical capacitance and conductance of a sample with frequency. This paper describes the changes which occur in the dielectric spectra of various food materials, such as beef, chicken, potatoes and apples, during cooking. Measurements were carried out with a Hewlett-Packard Low-Frequency Impedance Analyzer under the control of a microcomputer. Particular care was taken to separate the contributions of electrode effects from the bulk properties.

Nuclear Radiation Exposures from Petroleum Operations, D. E. Fields and W.D. Caterwaul, Health and Safety Research Division, Oak Ridge National Laboratory.

Naturally Occurring Radioactive Materials (NORM) may be concentrated by industrial sectors that are traditionally considered non-nuclear. Such materials can place unsuspecting workers and members of the public at risk. Except for NORM produced during phosphate and uranium mining operations, these materials are not specifically covered by most existing federal regulations. The most significant NORM contain parents or daughters of the U-238, U-235, and Th-232 decay chains. Of daughters deposited during petroleum pumping and processing operations, Ra-226 and Ra-228 pose the most significant threat to workers. The origin and magnitude of this threat will be discussed.

(Oak Ridge National Laboratory is operated for the U. S. Department of Energy by Martin Marietta Energy Systems, Inc., under Contract No. DECO-84OR21400.)

An Analytical Model for Predicting Light Scattering from Marine Micro-organisms, Patricia G. Hull, Tennessee State University.

In this paper we investigate the scattering from non-spherical marine micro-organisms, and the consequences of that scattering on the propagation of light in the ocean. Light scattering from non-spherical marine micro-organisms is calculated using the coupled-dipole approach in which an arbitrarily-shaped object is divided into a number of identical elements arranged on a cubic lattice. Each element is treated as a spherical, dipolar oscillator with its polarizability specified by the complex index of refraction. Interactions between dipoles are included by determining the field at a particular dipole due to the incident field and the fields induced by the other dipole oscillators. The scattered field is then the sum of the fields due to each oscillator. We calculated all sixteen elements of the Mueller scattering matrix for various shapes including spheres, short cylinders and helices to verify the limits of the approximation, and to investigate the effects of non-sphericity and chirality on scattering.

Operation Physics, R.S. McDow, Nashville Tech, Clair Ivanov and Lauren Hodge, Nashville Metropolitan Schools.

The American Institute of Physics (AIP) has implemented a program designed to enhance teaching skills of middle school science teachers nationwide. With NSF support, the project, Operation Physics (OP), trained teams of teachers in an intensive three-week course. The project's goal is to assist underprepared middle school science teachers. Each team includes a college, a high school, and a middle school science teacher who work together to conduct hands-on workshops. These workshops are designed to show 4th-8th grade teachers how to present physics demonstrations and activities in an instructive and interesting way.

The Middle Tennessee OP team, which is funded by Title II grants from THEC, has conducted workshops on four topics and given away almost 1000 kits of materials to over 500 participants. For 1990-91 these activities continue, and a program to recruit and train four new teams is underway.

Interaction of Hyperthermal Au, Pt, and Ta with a Liquid Metal Surface, Mark Moser* and Martha Riherd Weller, Middle Tennessee State University.

We investigated the interaction of hyperthermal atoms with liquid metal surfaces by sputtering Au, Pt, and Ta onto liquid Ga-In. A 150kV Argon beam was used to sputter the low energy atoms to the surface of the Ga-In. The material from the liquid was then collected on a graphite foil placed semi-circularly around the liquid. Subsequent analysis of the foil showed a broad, nearly symmetric distribution of In and Ga atoms while the distributions of Au, Pt, and Ta atoms were strongly peaked and asymmetric. The results are consistent with sputtering of Ga and In from the alloy surface and with specular reflection of the heavy incoming species.

*Student author

Path-Integral Evaluation of the Space-time Propagator for Quadratic Hamiltonian Systems, J.L.Pell, Middle Tennessee State University, J.T. Marshall, retired, formerly at Louisiana State University.

Path-integral methods are used to derive an exact expression for the space-time propagator for systems with quadratic Hamiltonians. For a certain subclass of such systems, the result is reduced to a simplified closed form. The propagators for several illustrative elementary cases are exhibited in detail.

SCIENCE AND MATHEMATICS TEACHERS SECTION

Martha W. Stratton, *presiding*

Interactive Computer/Videodisc Learning System for Introductory College Biology, Sarah F. Barlow, Middle Tennessee State University.

"Interactive Computer/Videodisc Learning System for Introductory College Biology," which is designed to be used by students independently or in small groups, links computer text, glossary, diagrams, and animation with still images and movies on the videodisc. The student may choose the speed and sequence of material to be covered as well as randomly select images for review. The system increases student involvement in learning, facilitates comprehension of scientific concepts, and may enhance problem-solving skills in college biology students.

Computer Assisted Instruction in College Anatomy and Physiology, William Cumming, Tennessee State University.

Students often have difficulty with the vocabulary and concepts in a science course, especially when it is relatively new to them. This approach uses a computer to allow students to view questions which are chosen at random from a test bank. These questions parallel similar ones used for their classroom tests. The questions are available on 3 1/2 inch floppies for each student desiring to have a copy. Preliminary surveys suggest that those students taking advantage of this opportunity are improving their test scores.

The Effectiveness of Saxons Algebra Text: A Meta-analysis, Dennis E. Mulder, Tennessee Technological University.

This paper presents the results of a synthesis of five studies evaluating the effectiveness of John Saxon's algebra text. Meta-analytic procedures were used to combine the results of the studies and to estimate a common, underlying effect size. A homogeneity test indicated that four of the seven effect sizes were sufficiently homogeneous (75% explained variance) to justify calculation of a common effect size. The mean population effect size delta was estimated to be +0.25 standard deviations with a standard error of 0.08 and a homogeneity statistic Q of 3.67. In percentile terms, this indicated a gain from the 50th to the 60th percentile on a standardized test. Orwin's fail-safe n test predicted that 24 zero-effect studies would be needed to overturn the conclusion of this study. Although not large, the effect of Saxon's algebra text was found to be positive, faring well in comparison to other instructional innovations.

ZOOLOGY SECTION I

A. Floyd Scott, *presiding*

Infection of Sunfish by Proterometra macrostoma (Trematoda: Azygiidae): Functions of the Cercarial Tail, P. Delaluz*, M.W. Riley and G.L. Uglem, Lee College and the University of Kentucky.

The purpose of this study was to determine how cercarial infectivity of *Proterometra macrostoma* may be affected by exposure to fresh water. Intact cercariae (i.e., bodies withdrawn into tails) and bodies from dissected tails were aged 14 hours in artificial creek water (ACW, 2 mOsm/L) or artificial snail water ASW, 100 mOsm/L) and force-fed to sunfish (10 worms/fish, n = 6). After two weeks, the fish were dissected. Infectivity (= number of adults recovered/fish) of freshly obtained cercarial bodies was 8.5 ± 0.82 . Infectivity of bodies from intact cercariae aged in ACW was not affected (8.3 ± 0.79), but infectivity of bodies aged in ACW was decreased significantly (4.1 ± 0.82). Infectivity of bodies aged in ASW + 1 mM glucose was not significantly different (7.5 ± 0.69) than that of bodies aged within intact cercariae. The results indicate that direct

exposure of *P. macrostoma* cercarial bodies to fresh water is stressful, and that worms withdrawn into tails are not subjected to such stress.

Preliminary Observations on Variation in Nerodia in Western Tennessee and Kentucky, Howard L. Freeman^{1,2} and Timothy Miller*¹, ¹Bethel College and ²Center for Field Biology, Austin Peay State University.

Genetic variation at 15 loci were examined for several species of *Nerodia* from Western Tennessee and Kentucky as part of a study of the distribution and taxonomic status of watersnake populations in and around the Land Between the Lakes (LBL). Specimens from central West Tennessee, Louisiana, and Texas were used for comparison to assess the degree of variation obtained in the vicinity of LBL.

Rattlesnakes Meter Venom when Feeding on Prey of Different Sizes, W. K. Hayes, Southern College, and P. A. Lavin Murcio* and K. V. Kardona, Washington State University.

Despite contradictory evidence, it is widely believed that rattlesnakes control, or "meter", the quantity of venom released when biting. Three experiments were conducted to clarify whether western rattlesnakes (*Crotalus viridis*) selectively allocate their venom supplies. In experiment 1, small snakes injected similar quantities of venom into small, medium and large mice in the first ("naive") strike trial, but injected significantly more venom into large mice in the second ("experienced") trial. No other aspect of striking changed between trials, which suggests that injection of more venom into larger prey by experienced snakes was accomplished by voluntary, intrinsic control of venom delivery. Similarly, in experiments 2 and 3, experienced medium and large snakes injected more venom into large mice than small mice, but other aspects of striking are still under analysis. Injection of more venom may hasten death and enhance digestion of larger, bulkier prey. Supported by NSF grants BNS-8813271 and BNS-8820091.

The Role of Facial Pits in the Thermoregulatory Behavior of Pit Vipers, Shelton S. Herbert* and W. K. Hayes, Southern College.

Pit vipers belong to a subfamily of venomous snakes (Crotalinae) that possess facial pits which mediate infrared vision. It is thought that the primary role of infrared vision is to locate and identify endothermic (warm-blooded) prey. Although it has been suggested that facial pits also can be used for thermoregulatory purposes, the hypothesis has not been tested. The purpose of this study was to determine whether representative pit vipers use their facial pits to select warm thermoregulatory sites under laboratory conditions. Ten northern copperheads (*Agkistrodon contortrix mokeson*) and ten western rattlesnakes (*Crotalus viridis* spp.) were chilled overnight (5–9 C) and then individually tested in a 1 m² arena containing one "hot" rock (35–38 C) and one rock at room temperature (18–20 C). Although the study is still in progress, preliminary results with copperheads suggest that the snakes do not preferentially seek out the warmest rock. Supported by the Geoscience Research Institute.

Preliminary Investigations on The Demography Of The Hellbender In Middle Tennessee, Brian T. Miller, Middle Tennessee State University.

Major tributaries of the Cumberland and Tennessee Rivers were surveyed for populations of the eastern hellbender (*Cryptobranchus alleganiensis*) during the summers of 1990 and 1991. All streams investigated possessed habitat believed suitable for the hellbender; populations were found in the Duck, Collins, Little Sequatchie, and Calfkiller Rivers. At the largest population encountered (Collins River), 51 captures of hellbenders were recorded, with 33 hellbenders marked and 18 recaptures of eleven individuals. The population size of this site (15,00 m²) was estimated to be 46 (34–58, 95% confidence limits) individuals; the density was estimated at 1 hellbender for every 357 m² indicating a total biomass of 28.2 kg (20,835.5 kg). The total length of hellbenders captured ranged from 408–545 mm indicating that the population was dominated by large, sexually mature individuals. The "catchability" of the hellbenders decreased throughout the summer and into fall, corresponding with decreased flow and increased siltation of the river, and advent of the breeding season.

The Diet of Seepage Dwelling Plethodontids of Short Mountain, Cannon County Tennessee, Melissa A. Mynatt*, Middle Tennessee State University.

Salamanders inhabiting the splash zones of seepage areas have ready access

to both aquatic and terrestrial prey. Stomach-content analyses of populations of post metamorphic dusky salamanders (*Desmognathus fuscus*) and two-lined salamanders (*Eurycea bislineata*) reveal the aquatic and terrestrial components of their diets. Twenty one orders of invertebrate prey taxa were identified from the stomach content analysis and were divided into three categories: aquatic, terrestrial and aerial. One hundred thirty-three prey items were flushed from the stomachs of 16 two-lined salamanders; 81 percent of the items were terrestrial, nine percent aerial and six percent aquatic. Of the 954 prey items consumed by 100 dusky salamanders, 51 percent were aerial, 17 percent terrestrial and 27 percent aquatic. In many salamanders the feeding mechanisms associated with larval oropharyngeal suction are modified during metamorphosis for terrestrial prey capture which typically involves projection of the tongue. Preliminary findings suggest an ability, especially in the dusky salamanders, to utilize both aquatic and terrestrial resources possibly by retaining the ability to suction feed.

Lens Radii: A Quantitative Character in Thorius Systematics, Elaine L. Paige and Howard L. Freeman, Bethel College.

349 specimens representing seven described and eleven undescribed species of the Mexican salamander genus *Thorius* (Amphibia: Plethodontidae) were examined in an effort to determine the value of lens radii as a taxonomic character. Comparison of observations on *Thorius* to data published by Caldwell (1980, J. Tenn. Acad. Sci. 55:15–17) on members of the subfamily Desmognathinae supports his findings regarding the utility of lens morphology as an identification tool and his hypothesis that the number of lens radii are related to the maximum adult size attained by a species. Furthermore, the use of lens radii in *Thorius* taxonomy confirms the existence of several cryptic, microsympatric undescribed species.

Seasonal Activity and Community Dynamics of Reptiles Around Woodland and Old-field Ponds in Land Between The Lakes: An Update, A. F. Scott, Austin Peay State University.

Since 1 July 1987, reptile activity around a woodland and a nearby old-field pond in the Tennessee portion of Land Between The Lakes (LBL) has been monitored on an every-other-day schedule. Drift fences and pitfall traps have been used throughout the study to capture animals as they moved toward and away from the ponds. The first year's results were summarized in a preliminary report read at the 1988 annual meeting of the Tennessee Academy of Science. After three more years' (1 July 1988 – 30 June 1991) work, the combined data reveal the following changes. Total captures nearly tripled from 86 to 239 (40 to 135 at woodland pond and 46 to 104 at old-field pond), but total species encountered increased only 23% from 13 to 16. At the woodland pond, the species total rose 40% from 10 to 14; at the old-field pond, it expanded from 10 to 13 (an increase of 30%). The number of species unique to each site changed only at the old-field pond, decreasing 33% from three to two. Species shared in common between the two habitats increased 57% from 7 to 11. Lizards (primarily *Sceloporus undulatus*) continued to dominate, constituting 80% and 79% of total captures at the woodland and the old-field pond, respectively, as compared to 82% and 78% during the first year. And like the first year, at both ponds lizard captures were followed in order by those for snakes (12% and 16% overall vs. 11% and 14% first year) and turtles (8% and 5% overall vs. 7% and 8% first year). Monthly levels of activity peaked twice the first year, and in all subsequent years, at both ponds; peaks generally occurred in late spring and late summer. Movements toward and away from both ponds were also equally distributed during the first and all subsequent years. Thus, after three additional years of study, relatively few new insights, beyond those gleaned the first year, were obtained concerning the community dynamics of reptile at woodland and old-field ponds in LBL.

ZOOLOGY SECTION II

Steven Hamilton, *presiding*

Seasonal Differences in Sensitivity to Forest Fragmentation Among Tennessee Avifauna, Paul B. Hamel, Tennessee Department of Environment and Conservation and Robert P. Ford, Tennessee Conservation League.

Explanations for declining numbers of certain North American birds have given rise to hypotheses that emphasize the importance of landscape-scale

*Student author

phenomena. Not all ornithologists agree on the extent or existence of declines in numbers; all agree that examination of the situation is warranted. The role of tract size as a determinant of population distribution has become a central issue in this area. We sampled birds for two years on 60 carefully chosen sites in tracts of west Tennessee bottomland hardwood forest (size range 41 to 25,670 hectares). We examined data on frequency and abundance of birds in relation to tract size, to season, and to species and guild membership of the avifauna. Our effort-standardized bird sampling design permitted determination that, for tracts of the sizes sampled, species richness and total density of birds are not significantly related to tract size, contrary to published results of others. However, composition of the bird communities, in both breeding and winter seasons, is related to tract size. Especially is this true for neotropical migrant birds and for forest interior species in the breeding season, which are more commonly found in larger tracts; cavity nesters are more frequent in larger tracts in the winter.

Water Quality Biomonitoring in West Sandy Creek: Pumps, Pulses, and Pollution, Steven W. Hamilton, The Center for Field Biology, Austin Peay State University.

Water quality in West Sandy Bay of Kentucky Lake Reservoir has deteriorated in recent years. West Sandy Creek and its tributaries flow into a dewatering area behind a dike separating these channelized streams from West Sandy Bay and the reservoir. During fall and winter, water is held behind the dike forming a wildlife area for migratory waterfowl. Throughout spring the dewatering area is pumped down until creeks are confined to their channels making land available for planting wildlife food crops and protecting bottomland hardwoods from flood damage. Biological monitoring in West Sandy Creek was conducted using HesterDendy multiple-plate samplers as artificial substrates for macroinvertebrate colonization. Procedural errors of the first year were corrected during the second year (1990) by attaching eight samplers to a specially designed float that suspended them at a uniform depth in the water column. During this second year of sampling an apparent episode of organic enrichment occurred during the spring dewatering period. These samples revealed macroinvertebrate densities 3.5 to 8 times greater (mean $\approx 2000/\text{ft}^2$) than two subsequent sampling periods in mid and late summer when West Sandy Creek is confined to its channel. Measures of community richness, diversity, and evenness were significantly lower during dewatering and increased in the following sampling periods. These and other community metrics such as biotic index and indicator species ratios indicated poor water quality during the dewatering period followed by significant improvement in water quality. Apparently, when the pumps are turned on and water levels are lowered, water standing on the floodplain is drained back into the channels, organic matter is resuspended and transported into the channels and then to the bay.

Population Dynamics of Opossums (Didelphis virginiana) In Western Tennessee, T. A. Ladine* and M. L. Kennedy, Memphis State University.

Population dynamics of opossums, *Didelphis virginiana*, were investigated using mark-recapture techniques during the spring and summer of 1991. The study was conducted at the Edward J. Meeman Biological Station in Shelby Co., Tennessee. Animals were caught, sex and age determined, marked with an ear tag, and released at the point of capture. Sex ratios were 1.5 males to 1.0 females and 2.0 males to 1.0 females during spring and summer, respectively. A greater number of adults and subadults were found on the study site during spring. Density was estimated at one opossum per 21.8 ha in February and one opossum per 8.2 ha during September.

Preliminary Studies Of The River Otter (Lutra canadensis) in Western Tennessee, R. E. Lizotte, Jr.*, and M. L. Kennedy, Memphis State University.

From 1989 to 1991, 66 river otters (*Lutra canadensis*) were examined from western Tennessee. Demographic information (sex, age, weight, and external measurements, total length, tail length, hind foot length, ear length) was recorded for each individual. Digestive tracts of 52 otters were also examined for food items. Of the specimens studied, males slightly outnumbered females, and males were generally larger and heavier than females. Foods occurring in the greatest frequency included fish and invertebrates.

Tardigrades from Land Between the Lakes, Kentucky-Tennessee, Diane R. Nelson, East Tennessee State University.

Tardigrades were collected from nine sites in TVA's Land Between the Lakes on April 20, 1991. Two sites were in Lyon County, Kentucky, one in Trigg County, Kentucky; and six in Stewart County, Tennessee. Fifty-three samples were obtained from the sites: 43 of mosses and/or lichens on the bark of live trees (38 samples) or on limestone outcrops (3 samples) or the ground (2 samples) and 10 samples of the upper substrate in aquatic habitats (pond, stream, spring). Forty two of the terrestrial samples and one aquatic sample contained tardigrades. Over 1000 individual specimens were mounted on slides. Genera present were *Echiniscus*, *Milnesium*, *Macrobotus*, *Minibiotus*, *Doryphoribius*, *Diphascos*, *Itaquascon*, *Ramazzottius*, *Isohypsibius*, and *Pseudobiotus*. Unexpectedly, the genera *Pseudechiniscus*, and *Hypsibius*, which contain cosmopolitan species, have not been found in the samples. This research was funded by a grant from Austin Peay State University's Center for Field Biology. Matthew Padgett and Betty Davis assisted with collecting the samples; Gilbert Hale and Lynne Livesay assisted with processing, extracting, and mounting the specimens.

Frequency and Date of Hatching of Juvenile Mourning Doves in the West Tennessee Harvest, T. David Pitts and Joyce A. Collins, The University of Tennessee at Martin.

We examined a total of 5,466 Mourning Dove (*Zenaida macroura*) wings that were collected during 1-5 September in each of the years 1988-1990 in west Tennessee. The percent of juveniles in the harvest ranged from 68.9 to 76.1 with an average of 71.8. Nesting phenologies based on the pattern of primary molt in juveniles indicated a nesting peak in late May and early June.

Bird Communities of the Escarpments in Putnam County, Tennessee, with Implications Regarding the Conservation of Neotropical Migrants, S. J. Stedman, Tennessee Tech University.

Steep, wooded escarpments separate the Highland Rim portion of Putnam County from the portions in the Central Basin and on the Cumberland Plateau. These escarpments harbor a dense population of neotropical migrant bird species, as reflected by roadside surveys of birds undertaken throughout the county during 1991. Thirty eight species of neotropical migrants were identified in the county. The communities of birds residing on the escarpments have a higher percentage of such species than do the communities found in the remainder of the county. Indeed, many neotropical migrants do not occur in the county except on the escarpments. Others occur in greater density on the escarpments than elsewhere in the county. Consequently, conservation of escarpment habitat in Putnam County—and throughout the state and region—would beneficially affect neotropical migrants. Current threats to this habitat come mainly from the timber and agricultural industries.

Winter Home Range of Female Southern Flying Squirrels (Glaucomys volans) in the Ouachita Mountains of Central Arkansas, K. D. Stone*, Memphis State University, G. A. Heidt, P. T. Caster*, and S. Hargis*, University of Arkansas at Little Rock.

Six adult and two juvenile female flying squirrels (*Glaucomys volans*) were radio-collared with AVM SMI transmitters at two sites in old growth oak-hickory forest located in the Ouachita National Forest, Arkansas (Garland County). Animals were tracked from November 1990 through March 1991. Home ranges varied from 1.2 to 5.7 ha (mean = 3.1 ha), and centers of activity were primarily located around nest boxes which had been placed in the study areas the previous March. Squirrels alternated between active and inactive periods from within 1 hour of dusk and dawn, being less active during moonlit and cold nights. Animals were observed to move throughout their ranges in short periods of time, often gliding 20-30 m at a time. Squirrels were not observed to change den sites during the day.

*Student author