

ABSTRACTS OF PAPERS PRESENTED AT THE FALL 1990 ANNUAL MEETING

BOTANY SECTION

E. Lewis Myles, *presiding*

Analysis of Proteins in Salt and Water Stressed Soybean Cultures, Sarabjit M. Bhatti and Prem S. Kahlon, Tennessee State University.

Soluble proteins of soybean cultivars Davis and Essex were photometrically measured when exposed to water and salt stress. Water stress was induced by adding polyethylene glycol (PEG) to Murashige-Skoog (MS) 1962 media at 0, 10, 15% while salt stress was induced by adding NaCl to the culture media at 0, 0.1, 0.25 and 0.5%. Protein was extracted from these cells on the 2nd, 5th, 8th and the 13th day by homogenizing the cells in tris buffer. The ruptured cells were centrifuged at 30,000 g for one hour at 4°C. One hundred microlitres of the supernatant was used to determine the amount of protein using the Bradford Colorimetric assay. The results showed that Cultivar Essex had 65% more protein than Cultivar Davis (2142 µg/g as compared to 1291 µg/g). The amount of protein increased nearly threefold on the second day of stress with 10% PEG as compared to control for Cultivar Davis. However, no difference was observed for Cultivar Essex on the second day between control and PEG stressed cells. There was a reduction in soluble protein in all treatments after the second day. The reduction was similar in all treatments. When cells of Cultivar Davis were exposed to NaCl stress there was a very small increase in protein in NaCl treated cells as compared to control, however there was 2 to 3-fold increase on the 5th day for .25% and 5% NaCl treatments as compared to control. Essex response to NaCl stress was similar to its response to PEG stress; no significant difference in protein was observed in NaCl stress as compared to control. (Supported by USDA/CSRS grant #TENX-9003-12-PS27).

An SEM Investigation of the Systematics of Verbesina Section Verbesina, W.L. Broyles, Rhodes College.

The twelve sections of *Verbesina* are currently separated by few and possibly poor characters. The purpose of this study is to look for significant characters which better separate the section *Verbesina* from the remaining sections. Ray and disk florets, chaffs, bracts, leaves, and achenes of available species were collected from herbarium sheets and photographed on a Jeol JSM-5300 Scanning Electron Microscope. The characters of each species were recorded and compared to those of other species in its section and to those of other sections in order to determine their significance. Over sixty species have been collected and over thirty-five observed representing nine of the twelve sections. At present *Verbesina* is the only section with all species observed. The characters of the four species of section *Verbesina* found in this study were coded into a binomial data table (0=common, 1=advanced) and run through the Phylip computer program package to produce the most parsimonious tree. This tree is compared to the one presented by Olsen (1986).

Further In Vitro Propagation Experiments on Button Fern Leaf

Bulblets, J. D. Caponetti, The University of Tennessee, Knoxville.

Previous experiments on *in vitro* propagation of button fern (*Tectaria gemmifera*) bulblets have shown that when the bulblets were placed on potting soil or on basal (water only) agar-solidified medium, leaves and roots developed well after three weeks. Bulblets placed on M and S media supplemented with kinetin plus NAA produced small leaves and no roots during the same three weeks. Bulblet development was inhibited in the presence of complete M and S medium supplemented with plant hormones. Further experiments on *in vitro* propagation of button fern bulblets have shown that bulblet growth and development were increased or decreased in proportion to the amount of nutrition and plant hormones supplied in the culture medium. All plantlets from culture eventually produced sizable plants when transferred to greenhouse conditions. However, those from water only media produced the largest plants within the same time span.

A Report on Some Recently Introduced Aquatic Weeds in Tennessee and Kentucky, Edward W. Chester, Austin Peay State University.

Known occurrences and habitats of three potentially troublesome aquatic weeds are summarized for Tennessee and Kentucky. The Uruguayan water primrose (*Ludwigia uruguayensis*) was first found in Tennessee in 1968. It now occurs in several sites along the lower Cumberland River, extending into Kentucky. Alligatorweed (*Alternanthera philoxeroides*) occurs in a number of Tennessee sites, mostly along the Tennessee River, and has recently migrated along that river into Kentucky. Water hyacinth (*Eichhornia crassipes*), often considered to be the world's most serious aquatic weed, has recently been found in the lower Tennessee River of both states. Water primrose and alligatorweed are already weedy in a few sites and have the potential of becoming serious pests, especially in the lower Cumberland and Tennessee River reservoirs. Water hyacinth appears to be a casual introduction and is not suspected to survive winter temperatures at this latitude. Careful monitoring of these and other aquatic introductions seems appropriate.

Effects of Prescribed Fire on Oak Forest Understory, H.R. DeSelm and E.E.C. Clebsch, The University of Tennessee, Knoxville.

We have examined data collected on the understory of a prescribed-burn upland oak forest at the University of Tennessee Highland Rim Forestry Station. The period is 1965 through 1989. Treatments are annual, periodic (once in five years) and no burn—each replicated three times. Species richness declines dramatically under the no-burn regime. Tree seedling establishment is inhibited and sprout size decreases in the annual and periodic burns—here the understory aspect is quite open. Tree sprout cover in the periodic burns follows the incidence of fire—it is lower in the September following each spring burn. Graminoid cover, chiefly little bluestem (*Schizachyrium scoparium*), decreases to zero in the no-burn treatment and is variable in other treatments but decreased irregularly from 1973-1975 to 1988; and 1989 established a new

high. Composite, legume and other forb cover has declined to zero under the no-burn treatment. Composite cover in annual plots peaked in 1973-4 but has decreased irregularly since; legume cover has risen irregularly; annual plot other forb cover has fallen irregularly.

Dessication-induced Plant Curling and the Amelioration of Light-induced Damage in Selaginella lepidophylla, Jefferson G. Lebkuecher and William G. Eickmeier, Vanderbilt University.

Resurrection plants curl dramatically during desiccation and the hypothesis that curling may help limit high-irradiance damage during desiccation was tested. Restraint of curling at an irradiance of $2000 \mu\text{mol m}^{-2} \text{s}^{-1}$ significantly: (1) decreased PSII and PSI electron transport, (2) decreased the activities of some light-activated enzymes, (3) increased chlorophyll bleaching, (4) decreased noncyclic photophosphorylation, and (5) decreased whole-plant photosynthetic capacities following rehydration relative to hydrated control plants. Unrestrained plants were also affected by high-irradiance exposure during desiccation but to a lesser degree than in restrained plants, indicating that photoinhibition and some chlorophyll bleaching occurred during plant desiccation before substantial curling. However, curling reduces high-irradiance damage that would otherwise occur during desiccation and helps speed photosynthetic recovery when plants are next rehydrated.

Screening for Disease Resistance in Phaseolus vulgaris, E.L. Myles, R. Nesby and S.M. Bhatti, Tennessee State University.

Many crop plants are susceptible to a variety of pathogenic microorganisms, which result in economic loss, especially for smaller farmers. The purpose of this study is to select resistant strains of *Phaseolus vulgaris* and to examine, at the cellular level, the mechanisms which *Phaseolus vulgaris* employ to defend themselves from pathogens. Tissue culture techniques are used to examine these mechanisms and aid in the selection of more resistant strains. Leaf explants of *Phaseolus vulgaris* cvs Applause, Astro and 15R 148 were grown on Murashige and Skoog (1962) media supplemented with 2 mg/L of 2,4-Dichlorophenoxyacetic Acid. Different concentrations of Methionine Sulfoximine (1.5 μM to 3.5 mM) were used to investigate disease resistance. Methionine Sulfoximine (MSX) is a compound that mimics the effect of bacterial pathogens by causing chlorosis. The leaf explants were weighed before being placed on the media. The explants were allowed to grow into callus tissue for approximately one month, after which the weight was recorded. The increase in weight was used as an indication of growth. The protein was extracted from cells with a Bransonicator and total soluble protein was determined using the Bradford technique (1976). Thirty to 50 μg of proteins from control and experimental groups was analyzed using Polyacrylamide Gel electrophoresis. The electrophoretic analysis of all strains showed an increase in a protein band of approximately 45 kilodalton when the concentrations of MSX exceeds 3 μM . There were no significant differences observed in cultivar resistance. (Supported by USDA/CSRS grant).

The Pteridophyte Flora of Land Between the Lakes, Sallie M. Noel and Edward W. Chester, Austin Peay State University, and Mary L. McReynolds, Hopkinsville Community College.

A floristic study was made of the pteridophytes (ferns and fern allies) of Land Between the Lakes, a 68,800-ha dissected upland between the lower and impounded Cumberland and Tennessee rivers. Parts of Stewart County, Tennessee, and Lyon and Trigg counties, Kentucky, are encompassed. The area is mostly wooded but the landscape has been disturbed since settlement by farming, logging, mining, and other anthropogenic activities. Since 1964, the site has been in public ownership and managed by the Tennessee Valley Authority as a National Demonstration Area for conservation, education, and recreation. Based on our studies of the literature, a survey of holdings in regional herbaria, and extensive field work in 1987-1989, the pteridophyte flora consists of 31 taxa, including four fern allies and 27 ferns (26 species and one forma). Representative species and habitats are shown and discussed, and some taxonomic complexities noted.

Diurnal and Seasonal Rates of Assimilation and Transpiration in American Mistletoe, *Phoradendron leucarpum*, A. Darlene Panvini, Vanderbilt University.

Fluxes of CO_2 and H_2O , which are inherently linked to growth and metabolism, may directly affect the success of parasitic relationships, such as those existing between *Phoradendron leucarpum* (Raf.) Rev. and M.C. Johnston, a hemiparasitic mistletoe, and its hosts. As part of a broader ecophysiological study, diurnal and seasonal courses of CO_2 and water vapor exchange for this mistletoe and its hosts were determined in the field using a portable infrared gas analysis system (ADC-LCA2). Rates of mistletoe assimilation were comparable to those of their hosts. Mistletoes assimilated carbon throughout the year, although negative daily carbon gain occurred during the winter months. Mistletoes transpired more than their hosts; however, mistletoe water-loss was not unlimited. Overall, mistletoe water-use efficiency was similar to that of the hosts. Mistletoes may be able to seasonally optimize carbon and water exchange, which may allow them to parasitize a wide range of host species in a variety of habitats.

Alleopathic Properties of Larrea tridentata Extracts, J.M. Zamora, Middle Tennessee State University and E.C. Mora, Auburn University.

Extracts of the desert plant, *Larrea tridentata* (creosote bush), have cytotoxic and antimicrobial properties. Fractions were obtained from this plant using a modified Rosenthaler extraction procedure. Several fractions inhibited the growth of bean sprouts. The resinous diethyl ether extract and the hot water extract had maximum activity as indicated by complete germination inhibition of the bean sprouts. *Larrea tridentata* is a major source of the powerful antioxidant nordihydroguaiaretic acid (NDGA) which was originally believed to be the source of its allelopathic activity. While NDGA was active it did not totally inhibit the growth of the bean sprouts. Therefore, it appears that there are other allelopathic chemicals in *Larrea tridentata*.

CHEMISTRY SECTION I

Eugene Kline, *presiding*

Chromatographic Studies of Beta-Cyclodextrin Complexes, V.C. Anigbogu, Austin Peay State University, and A. Munoz de la Pena, T. Ndou, and I.M. Warner, Emory University.

Cyclodextrins, either bonded to a stationary phase or added to

the mobile phase, have been used to resolve otherwise inseparable compounds such as isomers by liquid chromatography. Full exploitation of the cyclodextrin chemistry in developing methodologies based on liquid chromatography or any other technique requires knowledge of the stoichiometries and formation constants of the beta-CD:guest complexes, and the effect of the environment on these values. Determination of the formation constant of beta-CD:guest complexes has been accomplished by several methods including luminescence spectrometry and chromatography. There is a growing literature on the formation constants and stoichiometries of cyclodextrins under different experimental conditions; many of these, however, have been in the area of spectroscopy. Very mechanistic studies have been done with liquid chromatography, fewer still for characterization by reversed-phase liquid chromatography. We herewith report the determination of the stoichiometric ratios and the formation constants for pyrene and anthracene complexes with beta-CD. The effects of secondary organic modifiers on the observed results will be presented and the mechanistic implications discussed.

Solubilization of Aromatic Compounds in Sodium Dodecyl Sulfate, Eyerce L. Armstrong and David Wilson, Vanderbilt University.

Nuclear magnetic resonance techniques were used to explore the behavior and location of benzene and p-xylene solubilized in sodium dodecyl sulfate (SDS) solutions. Proton spin-lattice relaxation times (T₁'s) of SDS, benzene, and p-xylene below and above the cmc (critical micelle concentration) were measured in the presence and absence of paramagnetic (MnSO₄) and diamagnetic (KNO₃) salts. In the absence of salt the relaxation rate of benzene and p-xylene increased as the concentration of SDS increased confirming the solubilization of aromatic compounds in micelles. In the presence of increasing concentrations of KNO₃ the relaxation rates increased due to enhanced crowding as a result of reduced coulombic repulsions of the surfactant anionic groups. The paramagnetic salt greatly increased the relaxation rate of SDS, benzene, and p-xylene.

A Demonstration of Hexagonal and Cubic Closest Packing Using BBs and a Watch Glass, Harvey F. Blanck and John D. Foote, Austin Peay State University.

BBs placed in a concave container acquire a closest packing arrangement because the surface simulates an attractive force between the BBs. With activation by gentle shaking the BBs acquire a minimum potential energy. As more are added the container curvature causes the outermost BBs in a layer to have a higher potential energy than interior ones. If enough BBs are present, it is energetically favorable to begin the formation of a second layer in the depression formed by the first layer. Sets of two watch glasses taped together containing differing numbers of BBs result in one, two, or three layers. If two layers are present, tetrahedral holes are clearly visible using a lighted background or an overhead projector since light passes through each layer at their location. If three layers are present hcp and ccp arrangements are easily detected. An attractive feature of this model is that it forms a closest packing arrangement spontaneously when a gentle activation energy is provided.

Mechanism of the Intramolecular Cyclization of 6-Octyn-2-one, C.E. Harding and S.L. King Sr., The University of Tennessee at

Martin.

Acid-catalyzed intramolecular ring closures involving carbon-carbon double bonds are well documented. Mechanistically these reactions have been studied carefully and have been of great utility in organic synthesis. A great variety of examples have been reported in the chemical literature. Recently we reported on the mechanism of the transannular cyclization of α -5-Cyclodecynone (*J. Org. Chem.*, 54, 3054, 1989). In the current report, the results of a similar study on an acyclic compound, 6-octyn-2-one, will be reported. The reaction has been carried out utilizing both Lewis and mineral acids to produce mixtures of 2,3-dimethyl-2-cyclohexen-1-one and 1-acetyl-2-methylcyclopentene. When the rearrangement is conducted in the presence of H₂¹⁸O, no oxygen-18 is incorporated into the resulting products. Some of the properties of the acyclic system allow us to rule out rearrangement modes that could not easily be eliminated when studying the cyclic system.

The Chemical Degradation of Easily Hydrolyzable Waste Pesticides, Theresa J. Herring, Bernadette Jones, Debra C. Jones, and Robert C. Wingfield Jr., Fisk University.

A serious environmental concern is the appearance of pesticides in ground and waste water. Pesticide contamination of the environment can arise from surface runoff, leaching, poorly lined holding ponds, improper disposal of pesticide waste and rinsate, and pesticide spills. An effective and economical method is needed to dispose of pesticide waste. This presentation will review several hydrolytic chemical treatments for waste pesticides and focus on the use of the KTEG/KPEG reagent.

Significant advances have been made in the use of the KTEG/KPEG reagent for the detoxification of halogenated hazardous organic waste. This process is based on the use of highly alkaline solutions of potassium polyethylene glycol or potassium tetraethylene glycol to dehalogenate or dehydrohalogenate targeted haloorganics. This presentation will focus on the extension of this technology to the hydrolysis of phosphorodithioic esters such as malathion.

Analyses of the degradation products were conducted using GC, LC, FTIR, and NMR. Preliminary experiments show significant degradation of malathion at moderate temperatures yielding at least two major degradation products.

A Study Directed Towards the Synthesis of a Stable Aryl Peroxide, Christopher T. Holmes and Robert C. Mebane, The University of Tennessee at Chattanooga.

The synthesis and thermolysis of novel organic peroxides have provided insight into the mechanism of electronically excited state generation and into the processes of chemiluminescence. Our current interest in this area has dealt with development of synthetic approaches for the preparation of aryl peroxides. Our primary reaction has involved nucleophilic aromatic substitution of suitably substituted halobenzenes with various peroxides. For example, reaction of 2,4-dinitrofluorobenzene with alkali metal salts of m-chloroperoxybenzoic acid gives m-chlorobenzoic acid and 2,4-dinitrophenol as the principal products. Treatment of 2-chloro-3,5-dinitrobenzoyl chloride with sodium peroxide affords 2,4-dinitrosalicylic acid as the major product. It is suggested that the products of these reactions arise through thermally unstable aryl peroxides.

Porphyrin Mediated Photodynamic Damage in DNA, James C. Howard and M. Paige Wilson, Middle Tennessee State University.

Solutions of the known porphyrin photosensitizer, *meso*-tetra(4,N-methylpyridyl)porphine (T4MPyP) were prepared containing individually, the base, nucleoside, and nucleotide of the four constituted nucleic acids of DNA. These solutions were irradiated with visible light (408 nm., 69 nm. band pass) in a custom designed apparatus which allowed control of the temperature. Appropriate nonirradiated control solutions were also prepared. Changes in nucleic acid behavior were measured spectrophotometrically. Each sample resulted in an initial, nonirradiated, and irradiated solution.

Quality control plots of the observed variance for solutions of porphyrin + nucleic acid and for nucleic acid alone were constructed to enable proper interpretation of the data.

The largest effects were observed for irradiated samples of adenine/porphyrin, deoxyguanosine/porphyrin, thymine/porphyrin and deoxythymidine 5'-phosphate.

Boron Trifluoride in the Synthesis of Plant Phenolics: Synthesis of Flavones and Flavonols, Rama I. Mani and Parris F. Powers, Tennessee State University.

6-Hydroxy-5,7-dimethoxyflavone (*baicalein* dimethyl ether) and 5,6,7-trimethoxyflavone (*baicalein* trimethyl ether) have been prepared by the selenium dioxide oxidation of 2,5-dihydroxy-4,6-dimethoxyphenyl, and 2-hydroxy-4,5,6-trimethoxyphenyl styryl ketone respectively. Condensation of 2,5-dihydroxy-4,6-dimethoxyacetophenone and 2-hydroxy-4,5,6-trimethoxyacetophenone, prepared by the boron trifluoride method, with vanillin gave the corresponding styryl ketones which on oxidation with alkaline hydrogen peroxide gave the respective flavonols, which are of interest because on complete demethylation they gave *quercetagetin*, a naturally occurring flavonol.

ω -methoxy-C-methylphloroacetophenone, prepared by the boron trifluoride method, on reaction with veratroyl chloride or trimethylgalloyl chloride in presence of anhydrous potassium carbonate in boiling acetone (the Baker-Venkataraman reaction) gave 6-methyl-5,7-dihydroxy-3,3',4'-trimethoxyflavone and 6-methyl-5,7-dihydroxy-3,3',4',5'-tetramethoxyflavone respectively. These flavonols are of particular interest because they have the 3-methoxy- and 5-hydroxy- grouping. Flavonols with such orientation of groups, as in *chryso-splenetin*, have been shown to have antiviral activity against rhinovirus infection.

Photooxidation of a Herbicide in Soils, Ruth E. Riter, V. Dean Adams, Dennis B. George, and Eugene A. Kline, Tennessee Technological University.

Photolytic decomposition of organics in water using a photosensitizer has been studied and shown to be effective on a wide range of organic pollutants including polycyclic aromatic hydrocarbons and pesticides. A similar application of enhanced photolysis in soil has a wide variety of potential uses but has not been extensively studied.

Sensitized photooxidation experiments degrading bromacil, a herbicide, were conducted on silica sand, four silica sand and iron oxide mixtures, and two well characterized soils from Tennessee. The herbicide was successfully photodegraded (80-100%) on silica sand, a silica/ferrous oxide (FeO) mixture, and a Baxter Cherty soil sample without soil organic matter at a pH

greater than 9 in a thirty-six hour irradiation period. Three sensitizers (methylene blue, riboflavin, and rose bengal) were investigated.

Certain soil properties (ferric oxides, soil organic matter, and 2/1 type clays) adversely affected sensitized photooxidation. The effects of ferric oxides, however, are minimal with rose bengal enhanced photolysis probably due to the high quantum yield of the sensitizer's excited triplet. Inhibition of the photooxidation process was observed with the Baxter Cherty and Maury soil samples and attributed to soil organic matter and 2:1 type clays, respectively.

The Electrochemistry of Surfactant Micelle Formation, Ronald P. Robertson and David J. Wilson, Vanderbilt University.

The behavior of ionic surfactants is of much interest in connection with minerals recovery by ore flotation, wastewater treatment by foam flotation techniques, and the surfactant flushing of contaminated aquifers. The formation of micelles by ionic surfactants is complicated by the electrical interactions between the ionic heads and between these heads and the other ions in the solution. The calculation of the electrical free energy of micelle formation is carried out at several levels of approximation (linearized ideal and nonlinearized nonideal Poisson-Boltzmann equation, planar geometry, spherical geometry). A theory utilizing the zero surface tension approach is developed which allows prediction of the dependence of the micellar aggregation number and the critical micelle concentration on ionic strength, surfactant hydrophobic chain length, and surfactant ionic head size. The theory does not adequately predict the temperature dependence of the critical micelle concentration.

Soil Clean-up by In Situ Aeration. VII. High-speed Modeling of Diffusion Kinetics, Jose M. Rodriguez-Maroto and David J. Wilson, Vanderbilt University.

Soil vapor extraction (SVE) has become a powerful and widely-accepted tool for removal of volatile organic compounds (VOCs) from the vadose zone at hazardous waste sites. A mathematical model for SVE has been developed which models vapor stripping from soils of highly heterogeneous permeability, in which one cannot assume local equilibrium between the stationary phase(s) and the moving vapor phase with respect to VOC transport. A lumped parameter approximation is used for the kinetics of diffusion and desorption of VOC from the interiors of clay or porous rock lumps out into the advecting soil gas. The model uses a steady-state approximation for the VOC vapor concentrations, and is 20 times faster than our earlier model. If the rate constant for diffusion/desorption is large, the model yields results indistinguishable from our equilibrium model. Effects of impermeable caps and passive vent wells were investigated with the new model.

Electrophoresis—Safer Approaches, C. Sanborn, M.R. Page, and S.R. Karr.

Since most biological macromolecules are charged and will therefore move through an electric field, electrophoresis is a very powerful technique for the study of such macromolecules. Polyacrylamide gels are commonly used for electrophoresis of proteins since the concentration of the gel may be readily controlled. Traditionally, the polyacrylamide gels have been prepared by polymerization of acrylamide with the cross linker N,N'-meth-

ylenebisacrylamide. Acrylamide, in the unpolymerized form, is a potent neurotoxin and thus represents a hazard to individuals handling it. A much safer system for polyacrylamide gel electrophoresis involves the use of acrylamide copolymers, marketed by International Biotechnologies Inc. In contrast to acrylamide, the copolymers are relatively non toxic. A comparison of traditional denaturing polyacrylamide gel electrophoresis with a similar system using acrylamide copolymers reveals comparable separation of proteins. Use of such a copolymer system allows for demonstration of electrophoresis in the undergraduate laboratory without exposure to toxic acrylamide.

Kinetics of Permanganate Oxidation of the Reducing Impurities of Sea Sand, Martin V. Stewart and David L. Struble, Middle Tennessee State University, and Arthur K. Davis, Frank Phillips College, Borger, Texas.

Sea sand from laboratory suppliers is often assumed to be noncontaminating when employed in common laboratory operations; however, it contains both inorganic and organic impurities, the total reducing capacity of which is commonly analyzed with potassium dichromate. We are investigating a similar analysis with potassium permanganate by determining the kinetic order and rate constant for its oxidation of these impurities at room temperature. Our method to study this fast reaction is an application of plug-flow kinetic techniques, where 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 time of the solution's exposure to the sand is obtained. The volume of this reaction zone as a function of both the amount and packing density of the sand in the column was determined by direct measurement. The inorganic nature of the impurities being oxidized under these conditions is suggested by the fast reaction rate and also by the absence of additional absorptions, when compared with an identically-treated solvent blank, in the 200 MHz pmr spectrum of an extract obtained by magnetically stirring 3.00 g of sea sand (Sargent-Welch catalog no. S-73845A) with 7.0 mL of 1:1 D₂O—(CD₃)₂CO for 15 min at room temperature and filtering.

Proteolysis of B. subtilis α -Amylase in Urea Solution, Jubran M. Wakim, Middle Tennessee State University.

The mechanism of inactivation of *B. subtilis* α -amylase by urea has been investigated. The percent residual activity of α -amylase in aqueous urea solution depends on the incubation period, the urea concentration, the temperature, and the presence of selected metal ions. Gel permeation chromatography of urea-treated α -amylase shows that the enzyme is converted to inactive product(s) of low molecular weight. This led to the conclusion that the inactivation of the urea-denatured α -amylase is due to proteolytic degradation. Using an assay for proteolytic enzymes, we detected the presence of proteolytic activity in the native α -amylase preparation and ascertained that the enzyme was fully active in the presence of urea. Polyacrylamide gel electrophoresis confirmed the presence of a contaminant with an electrophoretic mobility similar to, but slightly higher than, that of the α -amylase. The electrophoretically purified α -amylase is more resistant to inactivation by urea than the native enzyme.

CHEMISTRY SECTION II

John Harwood, *presiding*

Fluorescence Studies of Beta-cyclodextrin complexes, V.C. Anigbogu, Austin Peay State University; A. Muñoz de la Pena, T. Ndou, and I.M. Warner, Emory University.

The inclusion chemistry of cyclodextrins has been the topic of many studies by luminescence spectrometry. Warner and co-workers have examined the association constants of beta-CD: complexes using fluorescence lifetime, fluorescence intensity and vibronic band ratios measurements. Other similar reports have appeared in the literature. However, many of these studies have been carried out under almost aqueous conditions. There is a growing interest in use of beta-CD to resolve isomers by reversed-phase liquid chromatography. Such a methodology requires knowledge of stoichiometric ratios and apparent formation constant of the beta-CD inclusion processes require a relatively more non-polar environment than water in order to minimize retention times. Hence, high concentration of organic modifiers (>50%) are often employed. However, beta-CD includes almost all organic molecules, albeit to a different extent. Although methanol has a low association constant with beta-CD, it becomes extremely competitive at high concentrations, resulting in complete exclusion of some solutes from the beta-CD cavity in worst cases. Some chromatographic studies have reported formation of anthracene complexes in up to 75% methanol, others still reported formation of anthracene complexes in up to only 65% methanol. The fluorescence band ratio technique was used to study the pyrene complexes under reversed-phase chromatographic conditions. Results from this study will be compared with results from a similar study using reversed-phase liquid chromatography. The salient features of these results will be presented and discussed.

The Inclusion Chemistry of Beta-cyclodextrins: An Overview, V.C. Anigbogu, Austin Peay State University.

Cyclodextrins are naturally occurring, torus-shaped, cyclic oligosaccharides that are constructed from six-, seven-, or eight-glucose units joined by [1-4] alpha linkages, known as alpha-CD, beta-CD, and gamma-CD, respectively. They readily form stable inclusion complexes with a variety of organic and inorganic molecules and ions. Unlike other types of organized media such as micelles, cyclodextrins exhibit a broad range of desirable properties such as not requiring critical concentration to include guest molecules, stability over a wide range of pH values, resistibility to light, little or no absorption in the UV region, non-toxicity and a non-foaming solution when purged. The stability of the complex depends on the size and polarity of, and substituents on, the guest molecule. The nature and contents of the solution environment not only determine the solubility of the cyclodextrin, but also strongly influences the degree of complexation. Notwithstanding its limited solubility in water (1.85 g/mL), compared to the other two, beta-CD has been widely studied for the fact that it is the least expensive. For instance, in pharmaceuticals, beta-CD has been used for the purpose of improving solubility, dissolution rate, stability, and bioavailability of drugs. It has also found some application in luminescence spectrometry for signal enhancement. Chromatographic applications have mostly centered on the resolution of isomers. Some of these and other

potential applications of beta-CD will be reviewed and examined.

Introduction to a Quantum Mechanical Harmonic Oscillator Using a Modified Particle-in-a-Box Problem, Harvey F. Blanck, Austin Peay State University.

The particle-in-a-one-dimensional-box (BOX) problem is typically the first quantum mechanical problem solved in an introductory quantum mechanics course since it is quite easy to solve and illustrates the fundamentals of quantum mechanics. The energy spacing increases as the energy increases. The quantum mechanical solution to a simple harmonic oscillatory (HO) is significantly more complicated and results in equal spacing of the energy levels. A hybrid quantum mechanical problem combining characteristics of both may be generated by using the harmonic oscillator limits to determine the size of the box by using infinite potential energies at the boundaries and zero potential energy inside as in the BOX problem. This results in a box whose size increases as its energy increases. For the BOX problem, the energy spacing decreases as box size increases. Solving this hybrid problem results in equal energy spacing making it a useful bridge between the BOX and HO problems in teaching undergraduate physical chemistry.

The Effect of Corn Plant Extract on the Adsorption of Pesticides in Soil, John J. Harwood and Kevin P. Rhoads, Tennessee Technological University.

The effect of filtered corn plant extract on sorption of pesticides by soil was investigated. Five pesticides were studied: chlorpyrifos, thiometon, cyanazine, paraquat, and 2,4-D. Distribution coefficients of each pesticide in a loamy sand soil were obtained with and without corn plant extract in solution. A significant effect on pesticide sorption due to the corn plant extract was observed for thiometon and paraquat. No significant effect was found for the other three compounds. The results indicate that corn plant extract does not have a large effect on the sorption of pesticides in soil.

Crystal and Molecular Structure of Tetrakis [N,N'-Diphenylquanedinato]Dichromium(II), $Cr_2[(C_6H_5N)_2CNH_2]_4$, William H. Ilsley, Middle Tennessee State University.

Interest in compounds containing quadruple metal-metal bonds has been high since the recognition of the first such bond in $Re_2Cl_8^{2-}$. Subsequent, quadruply bonded compounds of Cr, Mo, W, and Tc have been discovered. Of the many compounds that have been prepared, dichromium(II) compounds have exhibited a remarkable and unique variability of the metal-metal bond length, having a range from 1.83-2.54 Å as compared to a range of 2.18-2.26 Å for rhenium and 2.065-2.18 Å for molybdenum.

In my continuing study of dichromium(II) compounds, I have prepared and studied a number of derivatives having bidentate ligands in which oxygen or nitrogen atoms bond to the chromium atoms. The crystal and molecular structure of one of these derivatives, tetrakis[N,N'-diphenyl-quanedinato] dichromium(II), $Cr_2[(C_6H_5N)_2CNH_2]_4$, will be reported. This compound crystallizes in the space group $P2_1/c$ with $a=12.172(2)$ Å, $b=33.283(3)$ Å, $c=12.086(1)$ Å and $\beta=101.32(2)^\circ$ and $Z=4$. The quanidnato ligands are symmetrically bonded to the chromium atoms with $Cr-N_{av}=2.057(8)$ Å and $Cr-Cr-N_{av}=93.86(3)^\circ$. The average bridging C-N distance is 1.321(12) Å. Opposite

ligands are not coplanar but are twisted about the Cr-Cr bond with $N-Cr-Cr-N_{av}=15.2^\circ$.

Soil Clean-up by In Situ Vapor Stripping from Fractured Bedrock: A Mathematical Model, Martha M. Megehee and David J. Wilson, Vanderbilt University.

A two-dimensional mathematical model is presented which permits one to model in situ soil vapor stripping of volatile organic compounds from fractured bedrock in which the vacuum extraction well is a horizontally-placed slotted pipe. Contaminant is assumed to be in either a stationary, condensed phase or a moving, vapor phase. A lumped parameter model is used to handle the kinetics of diffusive transport of the contaminant out of the porous rock into the fractures. A Henry's law model is employed to model advective transport of contaminant from the fractures into the vacuum well. Equations governing vacuum well-induced gas flow are based on the Laplace equation for the flow of a compressible gas in an anisotropic, porous medium and steady-state gas flow. The effects on clean-up times caused by varying well pressure and by the presence of low permeability layers within the site are presented.

ENGINEERING SECTION

David Yarbrough, *presiding*

Comparative Study of Adsorption of Synthetic Organic Chemicals from Aqueous Solution by Granular Activated Carbons, S. Bunduwongse, V.D. Adams and D.B. George, Tennessee Technological University.

The characteristics of granular activated carbon (GAC) play a major role in an adsorption process. Raw material, surface area, pore structure, and surface chemistry of GAC are important properties of a GAC with respect to its use as an adsorbent. Several physicochemical properties of adsorbate such as solubility, molecular size, polarity, and functional group also affect the adsorption in aqueous solution by GAC. The significance of lump parameters such as GAC types (adsorbent) and adsorbates were investigated in batch isotherm studies of selected synthetic organic chemicals (SOCs) by chosen GACs. Comparisons of adsorption capacity and intensity of various compounds by different GACs were made. Statistically significant different capacity and intensity were shown among different GACs as well as different SOC.

Dynamic Properties of Typical Memphis Soils, Tzzy-Shiou Chang, Memphis State University.

The most critical and essential information for seismic studies include the accurate low- and high-strain dynamic properties of soils involved. According to current geotechnical techniques, high-strain dynamic properties and damping, which are important characteristics of soils for strong ground motion and liquefaction studies, can only be determined in the laboratory.

A series of laboratory tests on Memphis soils are conducted as a preliminary study for a further complete study of sediments in the New Madrid seismic zone. Dynamic properties of soils are determined for two typical Memphis soils: (1) Collierville sand, and (2) Peabody clayey silt (loess). Our results show that both typical Memphis soils exhibit significantly lower elastic shear modulus G_0 (about 10%-40% less than estimated by commonly

used empirical equations) under confining pressure less than 15 psi. Beyond 15 psi, a significant increase of shear modulus reduces the differences. Our test results also show that high-strain nonlinear characteristics of Memphis soils are significantly different from those of soils elsewhere. The clayey silt (loess) behaves more like cohesionless soil rather than cohesive soil.

The low-strain shear modulus and high-strain non-linear behavior of the soils tested provide accurate and reliable information for the seismic site response and liquefaction study in the Memphis area.

Calculation of Pulsatile Cerebral Blood Volume from Intracranial Pressure, M.L. Daley, Memphis State University, J.T. Robertson, The University of Tennessee at Memphis.

During the routine neurosurgical intensive care of the patient with severe head injury, monitoring of physiologic variables is accomplished by specially trained staff with the use of precision bedside instruments. The aim of this study was to use these bedside recordings to extract estimates of pulsatile cerebral blood volume (CBV).

The theoretical basis of the proposed method for extracting estimates of pulsatile cerebral blood volume is based on the assumption that the pressure-volume characteristic of the cranio-spinal sac is reasonably described as:

$$P(V(t)) = PO * \exp[E * (V(t) - V_{eq})] \quad (1)$$

In the above expression $V(t)$ is volume within the craniospinal sac; V_{eq} is the equilibrium volume; PO represents a normal value of intracranial pressure; and $P(V(t))$ represents elevated intracranial pressure at any instant. The published values of the elastance constant for adults, E , suggest an average value of 0.25/ml. The derivative with respect to time of this relationship is

$$dP(V(t))/dt = E * (V(t) - V_{eq}) * dV(t)/dt \quad (2)$$

By dividing equation (1) into equation (2) and rearranging the terms, an expression for the time derivative of the volume signal is obtained:

$$dV(t)/dt = (1/E) * (dP(V(t))/dt) / P(V(t)) \quad (3)$$

Using standard numerical methods, the above expression is determined from the digitized clinical recording of intracranial pressure. Furthermore, using the R-waves of the ECG signal as time-markers of the cardiac cycle and assuming an initial volume of zero, an estimate pulsatile cerebral blood-volume over each cardiac cycle can be computed.

Estimates of pulsatile CBV vary over the course of each respiratory cycle and precede corresponding changes of intracranial pressure. Specifically values of pulsatile CBV increase during expiration and decrease during inhalation phase. Preliminary results indicate that the difference in pulsatile CBV between expiration and inhalation increase with increasing intracranial pressure.

Changes in the value of pulsatile CBV over the course of a respiratory cycle may be of value as an indirect method of evaluating loss of regulation of cerebral blood flow.

Color Vision: Differences in Ocular Transmission, M.L. Daley, Memphis State University, G. Burghen, The University of Tennessee at Memphis, David Meyer and Paul Malsky, Vitreoretinal Foundation, Memphis, TN.

Early in the course of diabetes mellitus, loss of color vision is a functional consequence of the disease. Generally, this mild visual loss can be mimicked by placing a wavelength dependent

absorption filter in front of the healthy eye. As reported at last year's meeting, the apparent change in ocular transmission associated with diabetes may be a consequence of light scatter produced by plasma proteins which leak through an altered blood-retinal barrier. In order to evaluate the magnitude of the apparent optical density change at the short-, mid-, and long-wavelength portions of the spectrum, the Ferry-Porter characteristics of the isolated color-sensitive mechanisms are evaluated in the patient with diabetes and compared to the characteristic of an age-specific control group. Previously, each age-specific control and patient groups were composed of Caucasian females of European stock. Because of possible subtle differences in ocular transmission between races, a preliminary experiment was done to assess the significance of any such difference in ocular transmission between a group of African-American females and an age-matched group of Caucasian females.

The Ferry-Porter characteristics of the color-sensitive mechanisms of twelve healthy females without a history of ocular abnormalities or surgery were obtained. Two age-matched groups were defined. One consisted of 6 Caucasian females with average age (\pm S.D) of 25.5 (\pm 3.1) years. The other consisted of 6 African-American females with average age (\pm D.D.) of 24.2 (\pm 3.1) years. A comparison of the normative Ferry-Porter characteristic of each color-sensitive mechanism between the two groups revealed the following. A significant difference in transmission existed at the short- and long-wavelength ends of the spectrum, but not at the mid-wavelength portion of the spectrum. The computed equivalent differences in optical density for the short-, mid-, and long-wavelength segments of the spectrum were 0.59, 0.16, and 0.29 log units respectively.

These preliminary results indicate that the apparent difference in ocular transmission between the two groups is: 1) most evident in the short-wavelength end of the spectrum and not significant in the mid-wavelength band; 2) probably not related to either small or large particle light scatter; and 3) a factor which must be recognized in the design of instrumentation involved with the assessment of acquired loss of color vision.

Superemission from a High Voltage Glow Discharge, Rahul E. Daniels and G. Marshall Molen, Tennessee Technological University.

A pulsed electron beam emanating from a high voltage glow discharge has been experimentally investigated. The cathode was a solid cylinder 2.5 cm in diameter with a concave front surface. It has been possible to extract beams with pulsewidths varying from 30 ns to 300 ns using a Marx generator and a capacitor discharge circuit. The voltages ranged from the tens of kilovolts to values in excess of 100 kV while beam currents from the tens to the hundreds of amperes were generated in helium at pressures of 50 mtorr to 15 torr. Beam generation efficiencies between 14% and 57% were obtained.

It has been found that the maximum peak beam current and the corresponding beam generation efficiency occur at an optimal gas pressure which is a function of the discharge voltage. The beam generation efficiency itself is seen to be primarily a function of the discharge current.

Diffusive Transport of Contaminants from a Well, Sidney W. Jones and David W. Yarbrough, Tennessee Technological University.

Diffusion of groundwater contaminants from an injection well, an abandoned unplugged oil well, or a poisoned water well is often negligible in comparison with advective transport. When the concentration of contaminant in the well can be considered constant over the time interval of interest, the diffusion problem can be solved analytically with numerical evaluation of an integral required to compute contaminant concentrations. This paper presents computed values of contaminant concentration as a function of time and distance from the well. These results can be used to determine if an advective model will adequately predict the transport of contaminants into groundwater.

Relation Between Avalanches and Breakdown in Gases, S.M. Mahajan, Tennessee Technological University.

Several gases (e.g., air, nitrogen, SF₆, etc.) have good insulating properties. However, an electrical breakdown in a gas can usually be attributed to the interfaces associated with a gaseous insulation system. The type of metal enclosure, solid insulating support, corona and moisture are the most important factors associated with the interfaces which may reduce the breakdown strength of a certain gas.

An electron avalanche, once initiated from the cathode, can grow or die down depending upon the amount of electric stress, pressure of the gas and contribution from the associated interfaces. The role of an interface can be clearly understood by making a clear distinction between a primary and a secondary avalanche. Experimental measurement of avalanches in air and nitrogen indicate the nature of growth of an avalanche that was influenced by an interface. Basic mechanisms behind the breakdown of a gas can then be identified. Therefore, the measurement of electron avalanches in a gaseous dielectric system is suggested as a diagnostic tool for the prediction of an electrical breakdown in a gas.

Design of Solvent Extraction Equipment for Removal of Heavy Metals from Wastewater, Roger D. Painter and David W. Yarbrough, Tennessee Technological University.

Concern about the environment has renewed interest in improving waste reduction techniques in the metal finishing industry. It has been proposed that liquid extraction methods could selectively remove high levels of metals from wastewater streams while providing a high degree of adaptivity to multi-stage recycle operations. The study underway at Tennessee Technological University deals with the design of solvent extraction equipment for the extraction of heavy metals from wastewater. The research focuses on the extraction of metals by a single drop of extractant and will provide information about the effect of chemical reactions on the rate of solvent extraction.

GEOLOGY AND GEOGRAPHY SECTION

Robert L. Wilson, *presiding*

Laterally Discontinuous Porous Zones in Subsurfaces Mississippian Limestone (Oolitic), Northeastern Tennessee—How Were They Formed? Richard E. Bergenback, The University of Tennessee at Chattanooga.

An irregular eastern North American continental margin with promontories and reentrants collided with an offshore thrust terrane during the Paleozoic. In the reentrants, in general, con-

tinuous subsidence and uninterrupted sedimentation took place, but the promontories were "flexed."

Sedimentational response to "flexures" resulted in periodic (cyclic) uplift and erosion, followed by subsidence and sedimentation of largely platform carbonate sequences (Acadian and Alleghenian tectonic events) with resultant gaps (unconformities) in the sedimentary record.

Eight stratigraphically distinct and laterally discontinuous porous zones in the Monteagle Limestone, formed atop oolitic tidal bars during several low-stands of Mississippian platform seas, are the result of localized eustatic shifts of sea level that were ultimately caused by tectonic "flexing" on promontories.

Trilobites from the Warsaw Limestone (Mississippian: Meramecian) of Dickson County, Tennessee, Michael W. Bradley, U.S. Geological Survey, Nashville, and James X. Corgan, Austin Peay State University.

A new trilobite species has been identified from the Warsaw Limestone, (Mississippian: Meramecian) Dickson County, Tennessee. *Spergenaspis* n.sp. is known from 13 marginally preserved pygidia. Unlike other *Spergenaspis* it has approximately the same number of pygidial rings and ribs, 11, and only the first five ribs show a clear medial groove. Thus, the generic placement seems questionable. There are just five species of trilobites known from the Meramecian of North America. This find is significant even though specimens are not well preserved.

Structures in the Pennsylvanian at Point Park, Tennessee, Habte Giorgis Churnet, The University of Tennessee at Chattanooga.

Point Park is one of many scenic vistas on Lookout Mountain. Others include: Cloudland Canyon, Glide Port, Rock City, Sunset Rock, and Ruby Falls. The park offers an unparalleled panoramic view of the entire Valley and Ridge and portions of the Blue Ridge and Cumberland Plateaus (Walden Ridge).

Pennsylvanian sedimentary rocks belonging to the Raccoon Mountain and Warren Point formations outcrop at Point Park, the northeastern tip of Lookout Mountain, Tennessee. Sedimentary structures in these rocks indicate a fluvial, braided stream record. Deformation structures include mutually parallel and vertical fractures which are better exhibited in conglomerates and conglomeratic sandstone beds. These fractures guided the sculpturing of the landform, and cliffs of the mountain sides tend to be parallel to the orientation of the fracture patterns.

Trilobites from the Chesterian (Mississippian) of Campbell County, Tennessee. Elaine M. Foust, Tennessee Division of Geology, and James X. Corgan, Austin Peay State University.

Roadside outcrops of the Pennington Formation (Mississippian: Chesterian) just south of Jellico, Tennessee, yield well-preserved trilobites referable to *Paladin mucronatus* (Girty, 1910). One essentially complete specimen is 26 mm long, 14 mm wide, and displays all features of a holaspid. Previously known only from the Chesterian of Arkansas and Utah, *P. mucronatus* seem to be an environmental analog of the well-known and widely distributed *P. chesterensis* (Weller and Weller, 1936). This record of *Paladin mucronatus* seems to be the first documentation of a trilobite from the Chesterian of Tennessee since 1881 when Weatherby described a species that would now be called *Paladin granulatus*.

Evidence of Scavenging of an Irregular Echinoid from the Ocala Formation (Eocene), Florida, Michael A. Gibson, The University of Tennessee at Martin.

Scavenging is the rarest type of biotic interaction reported in the fossil record because of the difficulty in distinguishing it from predation. Consequently, our knowledge of scavenging activities of fossil organisms is minimal. A specimen of *Oligopygous haldemani* from the Ocala Limestone is described that shows clear evidence of both predation and scavenging. The echinoid was killed by an organism (probably a gastropod) that produced the trace fossil boring *Caulostrepsis* on the aboral surface near the apical ring. Subsequent scavenging is indicated by: 1) scrape marks, 2) chipped plates, 3) linear grooves, which occur around the peristome and periproct on the oral surface where openings to the viscera are larger. Scavenging, most likely by a decapod crustacean, resulted in damage and enlargement of the periproct. The specimen then remained unburied long enough to become encrusted by bryozoans as indicated by encrustation of surfaces exposed during the scavenging event.

A Mid-Ordovician Peritidal Fauna, D.K. Hackett and P.S. Hackett, Pellissippi Geological Survey.

A shallow water fauna preserved by storm deposits was excavated from a saprolite of the Chickamauga Formation. Shallow water trilobites, known elsewhere from disarticulated plates, were here buried alive along with clam beds, starfish, and washed-in debris from a nearshore reef. Thousands of extraordinarily preserved creatures were retrieved in a race with bulldozers and dump trucks. These rarely preserved creatures from a turbulent environment make this an informative window on nearshore paleoecology of this early period.

River Meanders: A Geometric Classification of the 1930 Cumberland River Channel, P.R. Kemmerly and J.M. McCluskey, Austin Peay State University.

A sixty-four mile reach of the 1930 Cumberland River from Nashville to Clarksville was subdivided into one-mile segments for purposes of geometric classification. The alluvial channel flows over carbonate bedrock with insoluble residue variability within formations as great as between formations. Each bend segment is characterized in terms of a best-fit parabola calculated by quadratic regression. The mean coefficient of determination and standard error of the estimate are 0.917 and 9.682 m, respectively. The coefficients a, b, and c of the quadratic equations, vertices and integrals are independent variables in a cluster analysis. Variables are scale independent and provide a normalized and systematic sample.

The cluster algorithm identified four stream segment types. Each type represents a unique set of meander geometries that are related to stream power. Steady-state equilibrium equations developed for each segment type enable preliminary geomorphic interpretations regarding energy gradient, lithology and structural influence in planimetric channel form.

Phytolith Analysis of ODP Core #763 Exmouth Plateau, Northwestern Australia, Robert F. Lewis III and William G. Siesser, Vanderbilt University.

Ocean Drilling Program Core #763 from the Exmouth Plateau, northwestern Australia, was evaluated for occurrence of phytoliths: microscopic opaline-silicate particles formed in and

around the cells of many vascular plants. Phytoliths are commonly preserved as microfossils in Quaternary and Tertiary paleosols and lake sediments and have been reported in open-ocean cores. Reported here are the results of a preliminary investigation into the occurrence and biostratigraphic utility of phytoliths in nearshore prodelta and continental shelf sediments. Slides were prepared from decalcified samples taken at 9 m intervals from the 1030 m cored interval. Although no convincing phytolith material was recovered from the Mesozoic or Tertiary sections of the core, a fairly diverse and abundant assemblage was recovered from the Quaternary section. Evidence suggests older phytolith material was lost by dissolution. Seven distinct forms of Quaternary phytoliths were recognized: rectangular, elongate, elongate-spiny, elongate-hollow, elongate-sinuuous, elongate-toothed, and dumbbell-shaped.

Echinoids from the St. Louis Limestone (Mississippian: Meramecian) of Montgomery County, Tennessee, Rebecca S. McMahan and James X. Corgan, Austin Peay State University.

Three specimens of a palaechinoid, *Oligoporus sulcatus* Miller and Gurley, 1893, are recorded from the St. Louis Limestone of Montgomery County, Tennessee. Apparently the only other described specimen of this species is the holotype, collected from the St. Louis Limestone in Harlan County, Kentucky. New specimens provide added insight into the symmetry and plate patterns of this species, which probably lived in a high energy environment.

An Overview of the Mineral Industries of Tennessee: Past and Present, G.A. Upham, Tennessee Department of Conservation, Nashville.

Since the days of the early settlers (circa 1768-70) when Tennessee's carbonate rocks were first used as dimension stone for the construction of chimneys, hearths, and foundations, the rocks and unconsolidated sediments of Tennessee have provided our state with the resources necessary to establish a very healthy and diverse minerals industry.

The industrial minerals of dimension marble and sandstone, crushed limestone, dolomite, and granite, sand and gravel, high silica sand, high calcium carbonate, ball clay, fullers earth, brick clay and shale, barite, sulfur, bauxite, tripoli, and mica have led the way toward Tennessee's strong economic and constructional growth.

The metallic industry of Tennessee has included production of limonite, hematite, gold, silver, copper, zinc, lead, and manganese from four of our state's six easternmost geomorphic provinces.

Even though Tennessee has never been a major producer of fuels, our state has produced sizeable quantities of bituminous coal, oil and gas, and possesses major lignite reserves.

Without a doubt, Tennessee has the necessary reserves to ensure the existence of a healthy, diverse, and environmentally safe mineral industry for many decades to come.

Tennessee Groundwater Quality Studies, Ferdinand Quinones and Mike C. Yurewicz, U.S. Geological Survey, Nashville.

The U.S. Geological Survey, Water Resources Division, in cooperation with the Tennessee Department of Health and Environment, operates a network of groundwater quality monitoring and sampling sites throughout Tennessee. During 1989-90,

samples were collected from 90 wells and springs representative of the key aquifers in the state and utilized for public supply. Field analyses included fecal bacteria, pH, alkalinity, temperature, and specific conductance. Untreated samples were collected for analyses of common ions, nutrients, selected metals, and scans of organic synthetic compounds. Results of the sampling and analyses are summarized and related to the source and location of each well and spring.

HISTORY OF SCIENCE SECTION

George Webb, *presiding*

The Academy's Meetings: The Second Twenty-Five Years, 1937-1961, James X. Corgan, Austin Peay State University.

During the academy's second quarter-century, members heard 1415 talks. Sections proliferated and sectional meetings soon drew more papers than the general program. Science education programs began and immediately became a major emphasis. In 1948 the once all-Caucasian academy became racially integrated. In terms of number of talks presented each year, 1937-1942, 1943-1946, and 1947-1961 are statistically distinct clusters. The 1943-1946 interval is a war-related downturn in a stable quarter-century. In this time of decline, the academy stopped building archives, stopped publishing membership rolls, stopped spring meetings, confused the enumeration of presidents, and confused the enumeration of meetings. The later confusion persists. The 1990 meeting is the 99th, although it is publicized as the 100th.

Cannon to Colleges: The Confederate Legacy in Science Education, Phillip Jack Lorenz Jr., The University of the South.

With the reopening and founding of southern colleges after the war, a depleted professoriat was augmented by the scientific, scholarly and administrative talents of former Confederate officers no longer locked into military careers. Those from the ordnance and artillery services tended to teach the sciences, mathematics and engineering.

In Tennessee alone, Josiah Gorgas and Francis Asbury Shoup were at the University of the South to be joined there later by Edmund Kirby Smith who had been at the University of Nashville (Peabody) with Bushrod Rust Johnson. Before assuming the presidency at Auburn, William LeRoy Broun was with Landon Cabell Garland at Vanderbilt. Alexander Peter Stewart returned to Cumberland University before becoming chancellor of the University of Mississippi. After serving as chief engineer in the army of the Khedive of Egypt, Samuel Henry Lockett taught at the University of Tennessee. Also, John Porter McCown (Knoxville) and Charles G. Rogers (Memphis and Nashville) were in secondary instruction.

The state of science teaching in postwar Tennessee may be evaluated from an 1878 survey by the Bureau of Education: *A Report on the Teaching of Chemistry and Physics in the United States*.

U.S. Navy Submarines Assume a Nuclear Deterrent Mission, 1945-1958: Force Survival Through Innovation and Weaponry, M. Muir Jr., Austin Peay State University.

With the end of World War II, the triumphant United States submarine force found itself in desperate need of a mission. Its

Imperial Japanese foe had gone down to total defeat; its probable next enemy, the Soviet Union, possessed little in the way of either a merchant marine or navy. The submariners quickly pushed for the development of the cruise missile: a new weapons technology that would give them the potential to strike at the enemy's homeland itself. The submarine could thus become a strategic platform in its own right. In less than a decade, this visionary plan became reality. By 1953, the cruise missile submarine was on patrol, and its supporters saw it as a major arm of the American deterrent forces, perhaps even supplanting the aircraft carrier itself. But within six years, this promising system fell victim to the budget cutters, not to be revived until the 1970s and then in a substantially different form.

George M. Rawlins, Jr. (1902-1964): Chemistry Author-Educator, G.M. Rawlins III, Austin Peay State University.

Dr. George Mimms Rawlins was born November 30, 1902, near Clarksville, Tennessee. He graduated from Clarksville High School in 1921 and from Southwestern Presbyterian University in 1925. From 1925 to 1931, Dr. Rawlins taught chemistry and physics at Clarksville High School. In 1932, he received the Master's degree from George Peabody College and the Ph.D. in 1934. Dr. Rawlins then moved to Washington, D.C., to teach chemistry at Wilson Teachers College, where he taught for two years before becoming supervisor of science for the Washington, D.C. school system. He served in this position until 1946, when he returned to Clarksville as chairman of the Chemistry Department at Austin Peay State College, where he remained until his death on May 9, 1964. Dr. Rawlins was co-author of two textbooks, *Before You Fly* and *Chemistry in Action*, and was a member of Phi Delta Kappa, American Chemical Society, American Association for the Advancement of Science, National Association for Research in Science Teaching and the Tennessee Academy of Science.

Kepler's Determination of the Inclination of the Orbit of Mars, K.M. Ryan, Christian Brothers University.

In addition to determining the three laws of planetary motion which bear his name, Kepler also measured the inclination of the orbit of Mars to the ecliptic. He used three methods to find the angle of inclination. The First Method required the planet to be located in the "limit" and at the same time the distance of the planet to the earth must be equal to the distance of the planet to the sun. The Second Method required that the earth be located along the line of nodes of the planet and that the planet be at right angles with respect to the sun. Kepler found four of these "privileged positions." The Third Method used the observed latitudes while the planet was at opposition. This measurement of the inclination of the Martian orbit helped Kepler to abandon the vicarious theory and begin his search for the true elliptical orbit.

Neo-Lamarckism and the Acceptance of Evolution in Gilded Age America, G. Webb, Tennessee Technological University.

The response to the concept of organic evolution underlay much of the intellectual and cultural history of the United States in the late 19th and early 20th century. By the early 1900s, however, American intellectuals had generally accepted this concept as an accurate description of the natural world. Although the work of Charles Darwin symbolizes the science of this period, Americans accepted a distinctly non-Darwinian version of evo-

lution. Led by such figures as Edward Drinker Cope, American naturalists developed an explanation which became known as "Neo-Lamarckism," stressing innate progressive development and the inheritance of acquired characteristics. Neo-Lamarckism provided both an explanation for variation and a progressive perspective which eased the acceptance of evolution among theologians and other non-scientists.

MATHEMATICS AND COMPUTER SCIENCE SECTION I

Linda Lawson, *presiding*

Transformations of the Euclidean Plane, George S. Beers, Middle Tennessee State University

Using rectangular and polar coordinates, equations, vectors, and matrices, explicit definitions for isometries and similarities of various types are developed. Examples are presented and properties invariant under each class of transformation are investigated. Inversion in a unit circle is also explored, with a study of the association between classes of arguments and images. Some examples involving conic sections and polar curves are considered, and the distinction between similarity and conformality is made.

Steiner Triple Systems Admitting the Automorphism of Type $[\pi]=[1,t,0,\dots,0,1,0,\dots,0]$, R. Calahan, Middle Tennessee State University.

A Steiner triple system, denoted STS(v), is an ordered pair (X, \mathcal{B}) where X is a set of cardinality v and \mathcal{B} is a set of 3-subsets of X , called blocks, such that any 2-subset of X is contained in exactly one block. An automorphism of an STS(v) is a permutation π of the set X that preserves the blocks in \mathcal{B} . π is said to be of type $[\pi]=[\pi_1, \pi_2, \dots, \pi_r]$ if the disjoint cyclic decomposition of π has π_i cycles of length i . Let $[\pi]=[1, t, 0, \dots, 0, 1, 0, \dots, 0]$. This is a permutation of X consisting of one fixed point, t transpositions and one cycle of length $d=v+2t+1$. Necessary and sufficient conditions can be shown for the existence of a STS(v) admitting the automorphism π .

A Complexity Conjecture on a Network Reliability Algorithm, William P. Dotson, East Tennessee State University.

A new algorithm for the k -terminal reliability problem in probabilistic graphs is presented. The algorithm is based on a disjoint partitioning of the set of all possible realizations of the graph. Empirical results indicate a favorable complexity result in general, and a conjecture is presented for the special case of 2-terminal reliability.

Applications of the Analytic Model of an Operator, Jeff Knisley, East Tennessee State University.

It has long been known that the study of bounded linear operators over a Hilbert space is closely connected to the study of functions of a complex variable. For example, the index of a Fredholm operator is closely connected to the winding number of a meromorphic function, and the Riesz functional calculus of an operator can be considered as a generalization of Cauchy's Integral formula. Indeed, the study of operators over a Hilbert space has drawn greatly from the theory of functions of a complex

variable.

However, the interchange has been largely one-sided; few results from operator theory have had a significant effect on complex analysis. Nonetheless, such results have been anticipated since the study of operator theory was initiated, as in the hope that the extension of the determinant to certain self-adjoint operators would lead to a solution of the Riemann Hypothesis, and the structure of a Hilbert space has been utilized as a setting for the study of the reproducing kernel of a domain. In recent times, the analytic model of an operator has been established, in which the operator in question is represented by the operation of multiplication in a space of functions which are analytic on the operator's spectrum. At the same time, Xia established various results related to conformal mapping and the functional calculus of an operator using the analytic model. While developed primarily as a tool for the study of certain operators over a Hilbert space, the analytic model holds some promise as a medium for the mutual interchange between operator theory and complex analysis.

In this talk, several connections between the analytic model of an operator and the study of complex analysis will be presented. Specifically, the idea of the analytic model of an operator will be defined along with various Hermitian kernel functions, and various results in complex analysis derived from the study of such Hilbert spaces will then be presented. Finally, aspects of the theory needing further investigation will be mentioned.

Cyclic Connectivity and Hamiltonian Cycles in Planar Graphs, Donald A. Nelson, Middle Tennessee State University.

It has long been known that 4-connected, planar graphs are Hamiltonian, but that there exist non-Hamiltonian, 3-connected, planar graphs. Is there a degree of cyclic connectivity which is sufficient to insure a Hamiltonian cycle in 3-connected, planar graphs? The answer is negative. For every $n \geq 3$ there exist 3-connected, planar graphs with cyclic connectivity n which are non-Hamiltonian.

Mathematical Algorithms on the Computer, Marcia Lynne Pace and Thomas Ray Hamel, Austin Peay State University.

Many mathematical concepts, particularly those in the area of number theory, provide opportunities and challenges to model the mathematical algorithms used with a computer. The study concentrated on the efficiency of various algorithms as well as the processing time required by several types of computers. The algorithms were programmed in versions of the BASIC programming language available on computers ranging from the 6502 family of computers to personal computers to a VAX 8250. Several interesting results were obtained including limitations of both algorithms and computers. The results, and the limitations, have implications on the use of computers in an educational setting.

On the Probability of Real Roots of a Cubic Equation, S.A. Patil and D.S. Hawkins, Tennessee Technological University.

This paper derives the probability of all real roots for the cubic equation $z^3+az^2+bz+c=0$ given the conditions that a, b , and c are random variables independently and identically distributed uniform on the interval $[0, m]$ where $m > 0$. A geometric interpretation of the problem and conventional calculus integrals are used

in finding the probability of all real roots. The solution of the problem centers on determining the bounds of a , b , and c from the discriminant function of the real roots of the cubic equation and breaks down into cases depending on m . Explicit solutions are given for $0 < m \leq 27$. For $m > 27$, the probability can be expressed in terms of multiple integrals which can be computed for a specified m . Some numerical probabilities are given.

Challenges of Teaching College Algebra, E.R. Phillips, Middle Tennessee State University.

Until recently, college algebra was required of students majoring in mathematics. The knowledge gained in college algebra was necessary for successful completion of higher level courses. Today, college algebra is not a "major" course. At most universities, college algebra is presently a liberal arts course meeting the general studies requirements for students majoring in various areas. Thus, the purpose for taking college algebra has changed for most students. Unfortunately, for most students the course has not changed. The content is essentially the same as thirty years ago, the teaching method is the same, students still rote memorize instead of gaining meaning and understanding, most dislike the course, and approximately 50% of students enrolling in college algebra either drop or fail the course.

This presentation addresses the changes in content, purpose, expectations, and teaching methods necessary for college algebra to meet the needs of today's students.

Comparison of 2nd Order Ordinary and Delay Differential Equations for Oscillation, Vishwa M. Sakhare, East Tennessee State University.

The paper deals with similarities and differences in the oscillatory behavior of solutions of 2nd order ordinary differential equations

$$y''(t) + p(t) \operatorname{sgn} y(t) : y(t) : \gamma = 0$$

and delay equations

$$y''(t) + p(t) \operatorname{sgn} y(t-m) : \gamma = 0, \gamma \leq 1.$$

Existence of Solutions of $x'' + x + g(x) = p(t)$, $x(0) = x(2\pi)$, $x'(0) = x'(2\pi)$, Zachariah Sinkala, Middle Tennessee State University.

A criteria is obtained for the existence of solutions of $x'' + x + g(x) = p(t)$, $x(0) = x(2\pi)$, $x'(0) = x'(2\pi)$, where $g(x) = H(x) \cos t$, $H: \mathbb{R} \rightarrow \mathbb{R}$ is not necessarily bounded and does not necessarily have proper limits $H(\infty)$ and $H(-\infty)$.

Deriving Identities with Figurate Numbers, Al Tirman, East Tennessee State University.

Identities involving figurate numbers are often not obvious. However, many may be readily observed and obtained from multiplication tables.

Ideas for Achieving Acyclic Databases Using Hypergraph Models, Nalini C. Williams and Teresa W. Haynes, East Tennessee State University.

A hypergraph is a pair (N, E) , where N is a finite set of nodes and E is a set of edges which are arbitrary subsets of N . A database can be modelled by a hypergraph, where an edge of the hypergraph represents a relation and a node in the edge represents an attribute of that relation. A database is acyclic if the corresponding hypergraph is acyclic. Since acyclic databases have several

desirable properties such as avoidance of ambiguities in interpreting queries, many recent papers have studied acyclicity and algorithms to detect acyclicity have been introduced. After determining that a hypergraph is cyclic, it may be desirable to try to achieve acyclicity. Thus, given a connected cyclic hypergraph model of a database, we consider methods of modifying it to produce a connected acyclic hypergraph while preserving the properties of the original database.

MATHEMATICS AND COMPUTER SCIENCE SECTION II

Teresa Haynes, *presiding*

Comparison of Three Project Management Systems Running Under Unix™, R. Consigny, Tennessee State University

This paper presents a comparison of three different software engineering project management systems. In the literature these systems are alternatively referred to as change control or change management systems. Source management systems, revision control or version control systems, source code librarians, and even configuration management systems, although the latter term is usually reserved for more complete systems which include a system building facility like the *make* utility available with the Unix operating system. The three systems are PVCS®, RCS and SCCS. PVCS is a commercially available product from Polytron®, RCS is a public domain (unsupported) system developed by Tichy and SCCS is distributed with Unix. The comparison is from a user's perspective and includes features, procedures, and functionality. Briefly addressed is the theory and philosophy behind the design of the separate systems.

COBOL 85: Changes Toward Structure, Frederica Cornett, East Tennessee State University.

For several years the COBOL language has been criticized as lacking attributes necessary to write structured programs. This is one of the reasons critics have long labeled COBOL a dying language, despite the fact that it is the most widely-used language for business applications and that the business community comprises one of the largest computer user-groups in the world. The latest COBOL standard, ANSI X3.23-1985, dubbed COBOL 85, contains a number of sweeping changes, more changes than with any previous standards release. Many of the new or modified features included in COBOL 85 directly address the issue of program structuring capabilities. This paper will focus on some of the more important new features of COBOL 85, in particular, those deemed necessary to structured programming.

A Real Time Data Acquisition Application for SOS, Lei Ji and Jerry E. Sayers, East Tennessee State University.

The small operating system (SOS) was developed by Jerry E. Sayers with two goals in mind; to provide an educational tool for learning about operating systems, and to produce a system useful for "real world" applications. SOS is a fixed priority, preemptive, real time, multitasking operating system for an IBM PC or compatible. It is a powerful, real time executive for applications such as embedded systems. This paper will describe such an application, this will be a real time weather data acquisition application system (WDAAS). The major objective for developing WDAAS will be to demonstrate the use of SOS on a "real

world" application. WDAAS will be implemented on a IBM PC or compatible machine. The software is to run on SOS. A keyboard and a serial port are used to perform human-machine communication. There are three major functions of WDAAS. The first function is to perform data acquisition. Analog to digital hardware is used to perform the data acquisition. The second function is to display data. The real time meteorological data or historical data can be displayed on the window. The third function is to report basic statistics about the weather. After developing this application, future work will be to develop projects and case studies for integrating SOS into a senior level operation systems class at East Tennessee State University.

On Complete Local Area Networks Connected by the G-Network Topology, Neville Moses and Teresa W. Haynes, East Tennessee State University.

A computer network topology can be modelled by a graph whose nodes represent computer systems and whose edges represent the links between the computer systems. The G-Network, a computer topology proposed by Haynes, Guha, Brigham and Dutton, possesses many desirable characteristics such as efficient routing, small number of links, and fault tolerance. We study the network performance parameters of a modified G-Network where the non-core nodes have been replaced by completely connected subnetworks. Originally the non-core nodes in the G-Network modelled a single computer system. Replacing these nodes with subnetworks allows each non-core node to represent a completely connected Local Area Network. The different parameters studied include the diameter, efficient routing, maximum degree, number of links and the number of nodes. It is shown that the modified G-Network retains most of its characteristics.

A Small Operating System, Jerry E. Sayers, East Tennessee State University.

A multitasking operating system for an IBM PC or compatible has been developed to provide students with an educational opportunity for hands-on experience with concurrent programming concepts. The operating system includes features which permit users to observe performance as a function of the I/O versus compute bound processes. Although other such educational operating systems exist, this operating system is limited primarily to process management. The small size of the operating system makes it easy to comprehend in a single term course. It is, however, a powerful real time executive for applications such as small, embedded systems. The operating system is currently being tested with a "real world" application. Since high level languages are easier to understand than assembly languages, SOS will be rewritten in the C language to enhance its effectiveness for use in the educational environment.

MEDICAL SCIENCES SECTION

R. Dean Blevins, *presiding*

The Effect of Calcium Channel Blockers on Behavior in Cocaine and Amphetamine Treated Rats, Joseph Bertrand, Tennessee State University.

Cocaine and d-amphetamine increase the effects of norepinephrine and dopamine. Some effects of these catecholamins can be inhibited by agents that block calcium channels.

Male Wistar rats, 300-375 g were used to construct dose-response curves: 0.312-10.0 mg/kg d-amphetamine sulfate; 0.63-40.0 mg/kg cocaine hydrochloride.

Doses were calculated as free base and injections were i.p. Rats were pretreated with diltiazem or nifedipine before challenging with cocaine 20 mg/kg or d-amphetamine 5 mg/kg.

Both drugs caused tonic-clonic convulsions and some deaths occurred at 5 mg/kg of d-amphetamine.

Both stimulants increased exploration, locomotion, grooming and rearing. With increasing doses, the behavioral pattern became stereotyped. The stereotypies induced by cocaine were different in character than amphetamine. Calcium channel blockers were more effective against the cocaine ambulatory behavior than that of amphetamine.

Measurement of Aquatic Contamination in Eastern Tennessee by Utilizing the Salmonella Assay and Carp Microsomal Preparations, R. Dean Blevins, East Tennessee State University.

Utilizing the Ames *Salmonella typhimurium*/microsome test, the precarcinogen 2-aminofluorene was activated either partially or totally in the presence of liver homogenate of carp (*Cyprinus carpio*) taken from polluted aquatic environments of Northeastern Tennessee. Revertant colony results correlated well (0.05 level of significance) with the degree of pollution within these waters, and thus showed themselves to be most helpful in assessing and monitoring the degree of aquatic contamination.

Physiological Changes in Bacteria During Starvation Stress, G. Bishop and P. Scheuerman, East Tennessee State University.

A fluorescent *Pseudomonas* sp. (L2), *Citrobacter freundii*, and *Escherichia coli* were introduced separately into various treatments of lake water and buffer. Samples were treated to inhibit selected procaryotic and eucaryotic fractions of the population via filtering, autoclaving, and amending with procaryotic inhibitors (cycloheximide and nyastatin). The effect of nutrient addition (carbon, nitrogen, and phosphorus) was compared to low nutrient effects on survival and growth of the test strains. Acid and alkaline phosphatase, dehydrogenase, protein and cell numbers were measured over a fourteen day period. Physiological classifications by automated biochemical tests were evaluated for changes in metabolic functions. Changes in metabolic behavior were observed and will be discussed in relation to starvation survival.

Measurement of Lymphocyte Proliferation by Flow Cytometry, Daniel Cramer and Michael Gallagher, East Tennessee State University.

Mitogen induced proliferation of lymphocytes was investigated using a flow cytometric approach. Human lymphocytes were cultured with one of three mitogens, ConA, PHA, or PWM (5µg/well) for 1-4 days in 96 well round bottomed culture plates. The lymphocytes when harvested were incubated for 30 minutes with anti-CD3-FITC or anti-CD20-FITC monoclonal antibodies. The cells were then permeabilized with a 50% ETOH solution and stained for DNA content using propidium iodine (5µg/ml).

Three flow cytometric parameters were used to measure cellular proliferation (blast cell formation, total DNA synthesis and DNA synthesis of lymphocyte subpopulations). Results using either of the three parameters showed DNA stimulation beginning at day one and continuing through day four for cells

cultured with ConA, or PHA. Furthermore, proliferation of both B and T cell populations was observed over a four day period when the cells were cultured with PWM. This method allows us to not only evaluate the response of the total lymphocyte population but also allows us to study the responsiveness of lymphocyte subpopulations.

The use of flow cytometry in measuring mitogen induced lymphocyte proliferation has proven effective and simple to perform.

Development of an In Vitro Macrophage Assay for Immunotoxicology, Sharon Cregger, Diane Davis, Phillip Scheuerman, and Michael Gallagher, East Tennessee State University.

The macrophage is important in both the innate and the acquired immune systems. In the innate immune system the macrophage forms a first line of defense against microbes. In the acquired immune system the macrophage processes and presents antigens to lymphocytes. We have developed an in vitro assay which allows us to monitor the effects of environmental xenobiotics on this crucial cell type.

Mononuclear cells are isolated from whole blood by standard density gradient centrifugation using Ficoll-Paque. The mononuclear cells are washed and counted. 10^6 cells/ml are plated into 35 mm petri dishes containing glass coverslips, and incubated for 1 hour (37°C , 5% CO_2).

After incubation, the coverslips are rinsed to remove nonadherent cells and placed into new petri dishes.

Red cells sensitized in vitro with IgG are added to the macrophage monolayers and the mixture is incubated for 2 hours (37°C , 5% CO_2). After rinsing to remove unassociated red cells, the coverslips are fixed, stained and observed microscopically for monocyte red blood cell interactions. In 112 control assays, 100 normal macrophages phagocytosed 0.15 ± 0.41 unsensitized RBC's. When 51 normal macrophage monolayers were overlaid with anti-D sensitized RBC's 85.4 ± 19.6 RBC's were phagocytosed per 100 macrophages. This system will allow quantitation of the effects of xenobiotics on F_c receptor mediated phagocytosis by macrophages.

Public Health Considerations of Using Public Whirlpool Spas and Hydrotherapy Spas, G.S. Eskander and C.S. Bishop, East Tennessee State University.

Past studies have demonstrated that spas are prime environments for transmitting pathogenic microorganisms. This research involved investigating the condition of and operation of 35 hydrotherapy and whirlpool spas in Northeast Tennessee. Water quality, disinfectant type, and training of the operators were evaluated.

This study indicated that many of the spa operators were not utilizing appropriate practices and that there was a need for improved guidelines and training. Recommendations were made to help improve the sanitary conditions in the facilities.

Assessing Female BSE Patterns in a Rural University Population, Jolene D. Helm, East Tennessee State University.

Over 130,000 new cases of breast cancer are diagnosed each year, even though breast self examination is an inexpensive and early means of cancer detection. In a health risk appraisal study, 139 East Tennessee State University undergraduate females were asked if they performed breast self examinations monthly, once

every few months, or rarely/never. Of the respondents, whose ages ranged from 17-39 years old with a mean of 19.8 years old, 52% cited that they rarely or never performed breast self examinations; 28% indicated they performed the examination only once every few months and the remaining 20% of the sample stated they performed monthly self breast examinations.

In light of these results, intervention strategies for the education and promotion of breast self examinations for rural university populations are considered.

Identifying Potential Autocatalytic Nucleic Acid Sequences by Comparison with Known Ribozyme Sequences, M.F. Hicks and Steve Lowe, David Lipscomb University.

Ribozymes, RNA molecules with autocatalytic splicing functions, have been identified in *Neurospora crassa* mitochondrial sequences, viroids, virusoids and *Tetrahymena*. Satellite RNA (sTRSV) of the tobacco ringspot virus (TRSV) contains two ribozymes, one on the positive strand [(+)sTRSV] and one on the reverse strand [(-)sTRSV]. Comparisons of sTRSV with DNA sequences in the GenBank and EMBL databases have identified several sequences with homology to the ribozymes. Analysis of these regions of homology has resulted in identification of a potential autocatalytic region in a rodent antibody sequence which conforms to the hammerhead structure of (+)sTRSV and several viroid ribozymes. Discussion will focus on the methods of analysis and the implications of the findings.

Factors Impacting the Dental Health Service to Institutionalized Elderly, F.R. Ketron, G. Barnes, J. Helms, East Tennessee State University.

Oral health care to institutionalized elderly is of critical concern to the Surgeon General. In response, a questionnaire designed to ascertain the availability and provision of dental health services to Tennessee's nursing home population was sent to 286 facilities. Ninety-one responded yielding a 32% return rate. Dental services served as the dependent variables. The independent variables were facility type, cooperative agreement with a dentist to render dental treatment and the monetary source remitting payment for dental services. Utilizing Pearson's Chi Square, the existence of significant relationships ($>.05$) between the dependent and the independent variables were analyzed. This study strongly supports the recommendations of the Surgeon General's calling of the establishment of comprehensive oral health care programs in long-term care facilities.

Oral Manifestations of Nutritional Deficiencies in the Elderly, F.R. Ketron and K.D. James, East Tennessee State University.

Because of rapid cellular turnover of epithelial tissues of the oral cavity, these tissues can be indicators of nutritional status. During the normal aging process, changes in oral tissue structure and function are expected; however, some changes involved with taste, painful or burning tongue, oral mucosal membrane pathology, temporomandibular joint pain, alveolar bone loss or periodontal disease experienced by the elderly may be exacerbated by sub-clinical or overt nutritional deficiencies.

As dental care providers examine for and find abnormalities and lesions, the etiology must be investigated. The preferred treatment of causative dietary abnormalities is the prescription of a well-balanced diet. However, the dietary history may be indicative of a larger socio-economic problem. The dental care provider

should refer and/or assist the elderly patient toward those medical and public health agencies and programs that may be of assistance to the elderly patient to obtain and consume that well balanced diet.

Histamine Release from Transformed and Non-transformed Mast Cells, Syeedur Khandkar, Margaret W. Houglan, and Arthur E. Houglan, East Tennessee State University.

Abelson murine leukemia virally transformed (interleukin-3 independent) and non-transformed (IL-3 dependent) fetal mouse liver mast cells were compared on the basis of their response to release histamine. Two secretagogues, calcium ionophor A23187 and substance P, were used to induce the release of histamine.

Maximum histamine release (80% of the total) was induced in both cell types with a calcium ionophore A23187 concentration of 1 $\mu\text{g/ml}$. Release was dose and time dependent. Histamine release increased until maximal concentration was reached at 15 min. of incubation at 37°C.

Substance P showed similar effect on both transformed and non-transformed mast cells. However, substance P was a weaker degranulating agent compared to A23187. Maximal histamine liberation (80% of total) from both cell types was induced at a substance P concentration of 30 $\mu\text{g/ml}$. The release was also concentration dependent. Histamine released increased with time until a plateau was reached after 15 min. of incubation at 37°C.

Spontaneous histamine release from both cell types was about $6.5 \pm 0.2\%$ of the total. However, the amount of total histamine in non-transformed mast cells was 16-20% higher than that in transformed cells. This difference is statistically significant ($P < 0.001$).

These findings suggest that transformation did not alter the ability of the cells to degranulate in response to the two secretagogues tested and that transformed cells produce and/or store less histamine than the non-transformed mast cells.

Structural and Sequence Analysis of Human Herpesvirus 6, Gary Lindquister and Robert Allen, Rhodes College.

Human Herpesvirus 6 (HHV-6), the probable cause of roseola infantum (exanthem subitum, sixth disease), can be isolated from peripheral blood lymphocytes and grows in T cells in vitro. We are studying the genome of an isolate of HHV-6 from Zaire, HHV-6(Z-29). HHV-6(Z-29) has no strong DNA homology to the other five known human herpesviruses under stringent hybridization conditions. The G+C content of the genome is approximately 42% as determined by isopycnic density gradient centrifugation. We have constructed a plasmid clone library of the HHV-6(Z-29) genome and have determined preliminary restriction endonuclease maps for BamHI, KpnI, and HindIII. The genome consists of a 141 kilobase unique segment bracketed by a pair of directly repeated sequences that vary from 10 to 13 kilobases in length in viral DNA isolated at different passages. Sequence analysis of HHV-6(Z-29) has identified blocks of genes conserved in several other human herpesviruses.

Mapping Mortality Rates in Tennessee Counties, J.M. McCluskey and E.K. McCluskey, Austin Peay State University.

A computerized mapping project of the natality, morbidity, and mortality rates in Tennessee is being conducted at Austin Peay State University. This ongoing study involves students in special projects courses. The end product of this effort will be an

atlas of health statistics for Tennessee counties. The current paper is a presentation of the first phase of this project, the geographic variability in mortality rates. Maps and graphs are compiled for 34 causes of death as they occurred in 1986. Mortality rates are standardized to deaths per 1,000 persons and mapped to show the quintile variation throughout the state.

Examining a Licensed Residential Home for Alzheimer's Victims: A Tennessee Model, B.P. Marrs, F.R. Ketron, J.D. Helm, East Tennessee State University.

The number of persons identified as victims of Alzheimer's is increasing. Unfortunately, these individuals are often faced with losing their independence due to an inability to function in an unsupervised residential setting with subsequent nursing home admission. In an effort to circumvent this dilemma, a prototype of a state licensed facility has been developed in Tennessee with emphasis on an independent, social living atmosphere versus the restrictive medical environment of a nursing facility. This presentation will deal with innovative program components which promote a quality of life while possibly slowing down this irreversible disease and thus premature admissions to a traditional nursing facility.

Human Ecology as Seen by Students and Professors, Monroe T. Morgan, East Tennessee State University.

The implications of individual life choices on personal health and the environment are well understood by environmental health professionals. Given information, are individuals willing to appropriately make the choices necessary to address environmental problems? This paper will discuss a four part study that addresses attitudes, willingness to make lifestyle changes, perceptions and technology transfer. What are the implications in designing educational programs for the public and students of environmental health.

Musculoskeletal Back Injury Rehabilitation, Shirley L. Morgan and Alan V. Meade, East Tennessee State University.

The purpose of this study was to determine if coal miners with a single or cumulative musculoskeletal back injury could be rehabilitated and returned to gainful employment following participation in a comprehensive work hardening program.

The program was implemented with coal miners from Virginia and Kentucky that were physician-referred to the Bristol Regional Medical Center Human Performance and Rehabilitation Center. The study was limited to low-back-injured male miners currently on worker's compensation benefits from three month's to seven year's duration. Data were collected on the study population for six months. A profile of the miners included fifty Caucasian males and no females whose ages upon entrance into the program ranged from 20 to 59 years (mean age=38).

Findings indicated that 58% of the miners returned to work, either at the prior occupation or at a modified work level. Vocational retraining was recommended for 22%, while further medical intervention was needed for 12% of the miners. Only 8% were terminated from the program.

At the present time, the area of industrial rehabilitation is in the early stages of growth and development. It is a relatively new concept to many physicians, compensation carriers and insurance companies, as yet not fully tested and substantiated by documented long term statistics.

An Evaluation of Levels of Radon in Water from Private Wells in Carter County, Tennessee, C.P. Salley and Albert F. Iglar, East Tennessee State University.

Although discussion of radon has focused on indoor atmospheres, occasional reports have noted high levels in groundwater. In this study, radon was determined on water from 53 wells. The major objective was to evaluate the difference in radon levels in water from the two lithologies in the area, the crystalline and the non-crystalline. However, the investigators also evaluated effects on radon accumulation in the water from well-site characteristics, such as depth of well, well yield, type and thickness of overburden, and topography.

Results showed radon levels in the water ranging from 145 to 13,400 p Ci/l. For non-crystalline geology, mean radon level was 1,420 p Ci/l. This compared with a mean of 2,190 p Ci/l in crystalline geology. Despite the apparent difference, variation in results prevented statistical confirmation. Generally, a larger sample and more precise data also were found necessary to detect any difference in radon level related to well-site characteristics.

PHYSICS AND ASTRONOMY SECTION

A.M. Heiser, *presiding*

Chemist Versis Physicist: The Cold Fusion Controversy, Roy W. Clark, Middle Tennessee State University.

The cold fusion controversy of 1989 arose over claims of electrolytically induced cold fusion. Although both a chemist and a physicist simultaneously announced indications of cold fusion in electrolytic cells, the debate soon polarized chemists and physicists in a way not often seen in the history of science. This paper reviews muon-catalyzed cold fusion and the background of the 1989 announcements. Then it reports on the two major group announcements in 1989, and summarizes confirmation and refutations so far.

The Periods of the Cepheids T Mon and X Cyg, J.C. Cooper and A.M. Heiser, Vanderbilt University.

The Vanderbilt 16-inch Automatic Photoelectric Telescope (APT) has been used to obtain BV photometric data for a number of relatively long period Cepheid variable stars. One use of this photometric data is to obtain accurate periods of the light variations of these Cepheids over the reasonable time span of a few years. These current periods can then be compared with all the previously measured periods and a search for period changes can be initiated. The 27.02 day Cepheid, T Mon, has been observed with the APT during the 1989 and 1990 seasons and the 16.39 day Cepheid, X Cyg, has been observed during the 1988 and 1989 seasons. Our data for T Mon yield a period of 27.010 days and a preliminary comparison with previous photoelectric data shows a probable decrease in this variable's photometric period. Our data for X Cyg indicate a period of 16.377 days and this period also seems to be decreasing over a relatively long time interval. A more detailed analysis of all the photometry of these two Cepheids and their previous period determinations is now being undertaken.

Health Effects from Depleted Uranium, D.E. Fields, Oak Ridge National Laboratory.

Uranium oxide inhalation may be hazardous due to both the

radiological properties and the chemical toxicity of the element uranium. This statement is true even for depleted uranium (DU) from which most of the more valuable isotopes have been removed. Isotope-dependent radiological effects from inhaled uranium accrue primarily to lung tissues and to bone surfaces, while the chemical effects primarily impact the kidney. Evaluation of toxic effects is complex, since translocation of inhaled uranium within the body is a function of aerosol size and chemical composition, while radiological effects depend upon the degree of enrichment.

Understanding of uranium translocation within the body is derived from measurements of intake, excretion, and blood levels following inhalation. Experiments performed since 1979, together with newly available occupational exposure data, suggest that the fraction of inhaled material absorbed to blood may have been underestimated in earlier models. Based on these data, upper limit exposures to depleted uranium should be lower than previously believed.

Astronomical Research at ETSU: The SARA Telescope, Gary D. Henson, Harry D. Powell, and Lattie F. Collins, East Tennessee State University.

A variety of research programs in stellar photometry have been carried out at ETSU over the past several years. Recent improvements in the local observatory facilities, including acquisition of a 0.36-meter telescope and computer controlled automated photometers, have greatly increased our research capabilities. As part of this growing astronomical research program within the department of physics, ETSU is participating in the Southeastern Association for Research in Astronomy (SARA), a consortium of ETSU, the Florida Institute of Technology, the University of Georgia, and Valdosta State College. SARA has been approved by the National Science Foundation to recommission one of two 0.9-meter telescopes at Kitt Peak National Observatory near Tucson, Arizona. Plans are for the telescope to be refurbished and installed at a new site on Kitt Peak, becoming operational in the late summer of 1991. It will become a primary astronomical research facility for universities in the southeast.

SCIENCE AND MATHEMATICS TEACHERS SECTION

Wayne Stevenson, *presiding*

Igniting a Passion for Science, D.K. Hackett, Oak Ridge National Laboratory/Pellissippi Science Enrichment Programs.

Science education has never been more important; yet, despite efforts, science interest and literacy continue to decline. We need a change of approach—a more user-friendly science that can capture the imagination and fancy of a public that is overwhelmed by technology.

“Hands-on/minds-on” programs have been developed to spark an interest in science. Programs designed to bring scientists face-to-face with the public where their enthusiasm can spread by contagion. Enrichment programs have been developed to demonstrate that science is not principally a body of facts and names to be memorized, but a thought tool for acquiring knowledge. The I.D. Day™ program rekindles the innate joy of discovery. Infants are masters of science, using it to discover the nature of their world. We need to encourage this behavior to continue through-

out a lifetime.

Patents as Information Sources, A.J. Muller, Martin Marietta Energy Systems.

Current technical information as well as historical information is found within the text of patent claims. This information is of potential use to students, inventors, scientists, and engineers; however, it is largely unavailable from the open literature or other published documents. Specific types of information available from patents as well as print and online access to such information will be discussed.

Computer Modeling in the High School Physics Curriculum with an Emphasis on the Study of Dynamics, William J. Rodriguez, University School of Nashville, Belmont College.

The use of computer modeling techniques during high school physics laboratory exercises has received only brief attention in current science education literature. Although the literature proposes exposing undergraduate students to techniques used in research, it stops short of bringing some of those techniques, where applicable, into the high school environment. A student designed, tested, and implemented computer model which describes the motion of a dynamics cart has proven to be an exciting and educational experience for high school physics students. The modeling approach helped the students gain insight into the types of assumptions which are made by computer model designers, the manner in which a model may be tested using empirical data, and the limitations of a model. Because computer modeling has become more prevalent in making scientific predictions students need exposure to computer modeling to enable them to better understand many of the current predictions made by computer models.

Using Software in the Secondary School Earth Science Classroom, Ralph E. Walker and James X. Corgan, Austin Peay State University.

At the college level, a great deal of software is now being marketed to do standard tasks of the Earth Science classroom, such as identify minerals, make maps, and deal with very broad concepts, such as plate tectonics. In five issues each year, the *Journal of Geological Education* reviews a significant number of these programs. While most are targeted on the college student, we believe that some are equally useful in secondary school settings. There is, however, one problem. Many of these programs are written for IBM-compatible machines while Apple computers are often most available in the secondary schools. Still, there is often access to a few IBM machines, and these are sufficient to expose students to some stimulating, interactive exercises.

To exemplify the rich variety of earth science software that runs on IBM-compatibles, we have chosen one program of moderate sophistication. Called "Time-Machine Earth," it provides in-depth, personalized, interactive exposure to concepts of plate tectonics, geological prediction, geological postdiction, and geological time. Using this program, we designed assignments for teams of students. A team, perhaps of four, middle school or high school students should be able to complete each exercise in about 15 minutes.

Essential Oils from Plants: A Natural Products Experiment for the Organic Chemistry Laboratory, Robert G. Ziegler, Lincoln Memorial University.

Steam distillation of some plant materials yields oils known as essential oils. One example is pine oil from pine needles. This paper describes an experiment to obtain essential oils from plant materials and then to analyze the oils thus obtained by using thin layer chromatography. This experiment has been done in our laboratory with several different types of plant material.

ZOOLOGY SECTION I

Paul Hamel, *presiding*

Management Implications of the Biannual Removal of Rainbow Trout from a Sympatric Population Containing Brook Trout in Great Smoky

Mountains National Park, Bart D. Carter, C.B. Coburn, Tennessee Technological University, and Stephen E. Moore, Great Smoky Mountains National Park.

In June and in July 1989, rainbow trout *Oncorhynchus mykiss* were removed by electrofishing from 1,000 meters of a sympatric population containing brook trout *Salvelinus fontinalis* in the Great Smoky Mountains National Park. This was done in order to evaluate the effectiveness of biannual removals of rainbow trout from sympatric streams and to determine if rainbow trout removal affected the growth rates of brook trout. Rainbow trout removals took place twice during the summer of 1989, once in June and again in July. Evaluation of the rainbow trout removals followed in the summer of 1990. As a result of the rainbow trout removals, brook trout responded substantially by exhibiting increases both in biomass and density between the 1989 and 1990 field seasons. Although adult rainbow trout were not eradicated from the study area, there was an elimination of rainbow trout reproduction in 70% of the study area using this electrofishing technique.

Kudzu as a Winter Microhabitat for Small Mammals, D.A. Elrod and J.P. Nelson Jr., Edward J. Meeman Biological Station and Memphis State University.

Small mammals were trapped in kudzu, *Pueraria lobata*, to identify species presence and use in the winter. *Sorex longirostris*, *Blarina carolinensis*, *Peromyscus leucopus*, and *Microtus pinetorum* were captured. *P. leucopus* and *M. pinetorum* were captured primarily along the edges of kudzu, which were in contact with forest or mowed field. Both species of shrews were captured throughout the trapping grids. Mean soil moisture and mean soil temperature differed significantly among kudzu, forest, and field sites.

Macroinvertebrate biomass was significantly greater in kudzu than in the other habitats. The cool, wet microhabitat found in kudzu during winter may provide an important seasonal refuge for small mammals.

An Area-sensitive Tennessee Snail, *Triodopsis* (*Webbhelix*) *multilineata*, P.B. Hamel, Tennessee Department of Conservation.

Great concern exists among certain zoologists and conservationists about forest fragmentation and its effect on native communities and ecosystems. Previous work has concentrated on this phenomenon in bird communities. Field studies in the bottomland forests of west Tennessee in 1986-1988 permitted examination of the forest fragmentation effect there on birds and on land snail communities. The present work demonstrates that *Triodopsis* (*Webbhelix*) *multilineata*, is indeed an area-sensitive species, occurring in only the largest tracts of bottomland hardwood forests in the Mississippi River Alluvial Plain. Additional results of the work are a clarification of the status of *Triodopsis multilineata* in Tennessee and notes on the ecology of the species. I hypothesize that the species use of large rotting logs for winter habitat is the characteristic that predisposes it to area sensitivity.

The Winter and Spring Herpetofauna of the Warner Parks, Davidson County, Tennessee, A.L. Hopkins, The Warner Park Nature Center, and A.F. Scott, Austin Peay State University.

A preliminary inventory of the herpetofauna of Percy and Edwin Warner parks was conducted from February through June, 1990. Seven major habit types (forests, fields, cedar-glade-like area, springs, permanent streams, and intermittent streams) were identified and examples of each studied. A combination of sampling techniques were employed. Terrestrial habitats were sampled mainly by hand and with drift fences, but also by road cruising on selected rainy nights. A total of 341 records, representing 25 species (12 amphibians and 13 reptiles) were logged. By major groups, these included seven salamanders, five frogs, four turtles, one lizard, and eight snakes. The most frequently encountered amphibian was the dusky salamander (*Desmognathus fuscus*), whereas softshell turtles (*Apalone* sp.) were the reptiles most often observed.

Food Habits of White-tailed Deer (*Odocoileus virginianus*) in Tennessee, P.K. Kennedy, D.A. Garland, and M.L. Kennedy, Edward J. Meeman Biological Station and Memphis State University.

Rumen samples from 603 white-tailed deer (*Odocoileus virginianus*) representing 26 localities in Tennessee were examined by the point-

frame method. Predominant items eaten by deer were determined for each locality by season. Seasonal and interlocality variation in foods eaten was assessed by univariate and multivariate statistical methods.

Hematological Measurements of Stress in Rabbits Weaned at Different Ages, Russell McCann and Richard Coppings, Tennessee State University.

Hematological indications of stress were evaluated in 32 New England White rabbits following weaning at either three, four or five weeks of age. Measurements included total white blood cell count, hematocrit, and differential cell count in addition to body weight and body temperature. Rabbits weaned at three weeks of age displayed a slight decrease in body weight during the following 48 hours while those weaned at four and five weeks of age exhibited weight gains during this interval. Body temperatures were not altered by weaning in any of the animals examined. The animals weaned at three weeks of age exhibited the most dramatic hematological response. Hematocrits were lower in these animals. Weaning was associated with a significant increase in hematocrit and in total white blood cell counts. These changes were accompanied by a decrease in lymphocyte numbers and a corresponding increase in eosinophil numbers. As a result, the neutrophil:eosinophil ratio declined sharply while the eosinophil:lymphocyte ratio increased. The neutrophil:lymphocyte ratio was not changed. The proportion of neutrophils declined following weaning of four week old rabbits while this value increased in rabbits weaned at five weeks of age. Few other changes were noted in these groups. These results support the conclusion that weaning at three weeks of age results in a greater stress to young rabbits than does weaning at four or five weeks.

Age and Growth of Rainbow Trout in Little River Watershed in Great Smoky Mountains National Park, Stephanie K. Masterson and C.B. Coburn, Tennessee Technological University and Stephen E. Moore, Great Smoky Mountains National Park.

Scales have historically been used to provide general knowledge of average life span, growth rate, time for fish to reach legal size limit, and determine age class composition. The objectives of the study were: 1) to compare age and growth of wild populations of rainbow trout in streams of different stream orders; 2) to compare age and growth of wild populations of rainbow trout in streams at different altitudes; and 3) to compare scale and otolith techniques for aging trout from various stream orders and streams of different altitudes.

The data indicate 93% agreements between scale and otolith age. Age composition was dominated by age class one and two with the exception of the most downstream sampling site. Few age three fish were found at any location. As stream order increases and elevation decreases, fish reach legal size limit at age two. However, at the two most downstream sites, about 51% of the sample reached legal size limit by age one.

Microgeographic Assessment of Cranial Asymmetry in the White-footed Mouse, John P. Nelson Jr., Bethel College, and Michael L. Kennedy, Memphis State University.

White-footed mice (*Peromyscus leucopus*) from five localities in southwestern Tennessee and northwestern Mississippi were analyzed for patterns of variation in cranial asymmetry. Asymmetry values (A) were calculated for 12 paired characters by subtracting the right side value from the left side value. No significant differences in A values were noted in a comparison of males and females, so for all subsequent analyses the sexes were combined. For all characters examined, no significant differences existed between localities. The A values for incisive foramina length, auditory bullae width, orbit length and mandibular diastema length showed significant directional asymmetry in some, but not all, localities. All other characters exhibited varying amounts of fluctuating asymmetry within each locality. Total asymmetry (mean of summed A values) was not significantly different between localities. Asymmetrical development of cranial features in white-footed mice from a restricted geographic area was shown to exhibit no discernable pattern of variation.

Slight Stress Does Not Lower Critical Thermal Maximums in Hatchery-reared Rainbow Trout, R.B. Petrie and R.J. Strange, The University of Tennessee, Knoxville.

This study evaluated the physiological response of rainbow trout to two initial stressors, either confinement or electroshock, followed by a heat challenge in order to determine how the critical thermal maximum of the fish was affected by the intensity of the initial stressor. Plasma cortisol and glucose levels were determined following each stressor. The initial stressor induced a typical, but mild, response by increasing cortisol levels for the electroshocked group and the 60-minute confinement group. Although these increases are significantly different ($P < .05$) from the baseline group they are lower than values observed in the literature for similar stressors. The challenge stressor did not induce any further cortisol increase in fish receiving an initial stress, and in fact decreased significantly ($P < .05$). The electroshock-challenged group was the only group that had a significantly different critical thermal maximum, higher by 0.9 C.

Reproduction of Southern Flying Squirrels (Glaucomys volans) in Weakley County, Tennessee, T. David Pitts, The University of Tennessee at Martin.

During 1986-1989 I observed 15 litters of southern flying squirrels (*Glaucomys volans*) in nest boxes erected for Eastern Bluebirds (*Sialia sialis*) in Weakley Co., Tennessee. The squirrels had two reproductive periods per year. Estimated parturition dates ranged from 15 January to 6 March for seven spring litters and from 8 August to 3 October for five fall litters. Excluding two litters in which all observed young were dead, the average litter size was 3.0 ($n=13$) with a range of 2-5. The average litter size was 2.4 (range 2-3) for eight spring litters and 4.0 (range 3-5) for five fall litters.

ZOOLOGY SECTION II

John Harwood, *presiding*

A Survey of Elliptio Species on the Savannah River Site, Carl A. Freeman, Bethel College and Margaret Mulvey, Savannah River Ecology Laboratory.

Genetic variation at 18 enzyme loci was examined for all Unionidae mussels from 10 localities on the Savannah River Site in southwestern South Carolina. Electrophoretic evidence suggests that several species exist on the Savannah River Site. We characterize each prospective species by its allozymic profile, and explore distributional differences between those species. One of these profiled species has been tentatively identified as *Elliptio naviculoides*, a proposed endangered species.

Food Recognition by the Coyote (Canis latrans), T.M. Gabor and M.L. Kennedy, Edward J. Meeman Biological Station and Memphis State University.

Preliminary studies were initiated to assess food recognition by two juvenile coyotes (*Canis latrans*). Twenty-two food items were used in the assessment which occurred over six periods of five days each. Intervals between trials were two days. Food recognition of an item was defined as sampling and either rejecting or accepting an item for the remainder of the trial. Food preference was also determined during the feeding trials, and a final trial was conducted to establish preference among the preferred food items.

Preferred foods (in order of percent consumed) were sardines, dry puppy food, doughnuts, and wet dog food.

Venom Expenditure by Prairie Rattlesnakes During Predatory Episodes, W. K. Hayes, Southern College.

Prey handling and envenomation behavior were observed under several contexts in the laboratory to determine how and why venom is allocated during striking. Enzyme-linked immunosorbent assay of whole-animal homogenates was used to quantify mass of venom expended by prairie rattlesnakes during striking. Adults release nearly a third (14 mg) of available venom when biting mice; approximately 89% of released venom enters prey tissues while the remainder is spilled harmlessly on the skin. The quantity of venom expended increases exponentially with length of snake. Hungry rattlesnakes expend less venom when feeding

than well-fed snakes. Rattlesnakes strike and release mice, but retain a hold on and may expend more venom when feeding on sparrows. With experience, juvenile snakes may attempt to inject more venom into larger mice. These findings suggest that several strategies have evolved to maximize envenomation and feeding success in different circumstances. Supported by NSF grant BNS-8813271.

Harvest Data from a Managed Raccoon Hunt in Western Tennessee, R.E. Kissell Jr., D.A. Elrod, T.M. Gabor, T.A. Ladine, and R.E. Lizotte Jr., Edward J. Meeman Biological Station and Memphis State University.

Eighty-two raccoons harvested from 20-22 September 1990 on the Hatchie National Wildlife Refuge, Haywood Co., Tennessee, were examined to determine population structure, reproductive status, and food habits. The sample consisted of 34% age class I, 35% age class II, 20% age class III, 10% age class IV, and 1% age class V. In females age class II or older, the number of placental scars averaged 1.71. Persimmons, insects, and grapes were the predominant food items eaten.

*Food Habit Study of River Otter (*Lutra canadensis*) in Western Tennessee*, R.E. Lizotte Jr., and M.L. Kennedy, Edward J. Meeman Biological Station and Memphis State University.

Preliminary studies of the food habits of the river otter (*Lutra canadensis*) were conducted during 1989 and 1990. Twenty-seven specimens were examined from western Tennessee. Digestive tracts were analyzed based on percent occurrence (frequency of stomachs containing an item). Fish, crayfish, and plant material were foods that occurred most frequently.

*Preliminary Observations on Morphological and Behavioral Variation in Cercariae of *Proterometra macrostoma* (*Digenea: Azygiidae*)*, Milton W. Riley, Lee College, and Gary L. Uglem, University of Kentucky.

Proterometra macrostoma is a digenetic trematode known to infect members of the sunfish family (Centrarchidae). Examination of four species of sunfish from a creek near Lexington, Kentucky, revealed a large variation in the number of parasites per fish: largemouth bass (*Micropterus salmoides*) (1.5), long-eared sunfish (*Lepomis megalotis*) (4.5), bluegill sunfish (*Lepomis macrochirus*) (34.0), and warmouth bass (*Chaenobryttus gulosus*) (84.0). Larval stages of the parasite develop in aquatic snails; the cercarial stage emerges and is infective to fish when eaten. There was a high degree of morphological variation among emerging cercariae from a population of snails from the above creek. Three morphotypes were identified on the basis of size, number and arrangement of papillae, and number and location of spines on the papillae. These three morphotypes also displayed differences in swimming behavior. Morphological, behavioral, and physiological variations may help explain why some species of sunfish are more susceptible to infection than others.

Some Effects of Timber Harvest on Forest Breeding Bird Populations in Land Between the Lakes, D.H. Snyder, Austin Peay State University.

Bird populations were censused during the last three weeks of June in 1987, 1988, and 1989. A fixed-radius circular plot technique was used by four, two-person teams (one observer and one recorder) on eight forest tracts, each tract being censused

eight times per season. Thirteen variables of vegetation structure were assessed, both before and after treatment (timber harvest), from five 0.04 ha circular plots in each tract. Results suggest that the type of timber harvest practiced in LBL on the study tracts—selective cutting of trees as part of a shelterwood management system—resulted in an increase in overall bird population density of about 25%. More than twice as many bird species had significantly higher population densities on treated tracts than had significantly higher population densities on untreated tracts. Population densities of several bird species were not affected by treatment.

The Life History of the Flame Chub in Pond Creek, Marcia Sossamon and J. Larry Wilson, The University of Tennessee, Knoxville.

Life history data were obtained from 243 preserved specimens of the flame chub, *Hemitremia flammea*, collected from June 1989 to June 1990 at Pond Creek in Loudon County, Tennessee. Length-weight relationships were calculated and compared between sexes. Female flame chubs generally outnumbered males and were usually larger; the largest female measured 68 mm TL and the largest male was 55 mm TL. Three age classes of *Hemitremia* were identified by scale analysis and length frequency distributions. In addition, mean length at each age was determined. Flame chubs spawned between February and June, peaking in March. Monthly mean GSI values were highest in March with 10.9 for females and 0.6 for males. Females deposited adhesive eggs in clusters on both sides of leaves of aquatic vegetation. The stomachs of *Hemitremia* specimens most frequently contained dipteran larvae. Other food items included flatworms, aquatic earthworms, crustaceans, aquatic insects, snails, and detritus. Flame chubs were associated with aquatic vegetation consisting most often of swamp smartweed and small pondweed.

Impacts of Intensive Shrimp Culture on Water Quality, Atchara Wongsangchan and J. Larry Wilson, The University of Tennessee, Knoxville.

Fifteen intensive shrimp culture ponds in southern Thailand were selected for water quality studies during one five-month grow-out period. Water quality data (temperature, dissolved oxygen, salinity, pH, Secchi disk transparency, total ammonia nitrogen, nitrate, phosphate, total suspended solids, and biochemical oxygen demand) as well as chlorophyll a and phytoplankton collections were taken biweekly. During the grow-out, most water quality parameters changed relatively little; however, there were significant increases in BOD, ammonia, and pH, while transparency decreased. DO was relatively unchanged and maintained concentrations above 6 ppm in all study ponds. BOD increased from 2.8 to 12.1 ppm and was the most significant parameter that adversely affected shrimp feed efficiency. The maximum values of total ammonia nitrogen (1.5 ppm) was not considered toxic to shrimp due to the low percentage of unionized ammonia within the pH range (7.3-8.8) and temperatures (25-32 C) that were found in this study.