

ABSTRACTS PRESENTED AT THE ANNUAL MEETING

BOTANY SECTION

Thomas E. Hemmerly, *presiding*

Effects of Synthetic Growth Regulators on Nasturtium officinale R. Br., S.K. Ballal and T.J. York, Tennessee Technological University.

Atrazine and Alachlor are two commonly used pre-emergence herbicides in Middle Tennessee. It is suspected that these synthetic growth regulators often wash away from the soils after a rain and end up in ponds and streams, thus interfering with the metabolism of many non-target macrophytes. One such macrophyte, *Nasturtium officinale* (watercress), was observed to increase in population soon after the rains followed by herbicide spraying. This was observed in two Middle Tennessee creeks; namely, Little Creek and Dyer's Creek. Water samples were analyzed for the presence of these two growth regulators. To isolate the effect of concentrations of herbicides on this model macrophyte, it was grown in tissue culture in the laboratory. The MS medium contained various concentrations of 2,4-D, Atrazine and Alachlor. It was observed that watercress is sensitive even to very low concentrations of herbicides in culture.

Rare Vascular Plants of the Wolf River and Nonconnah Creek Watersheds, V. Bates, P.O. Box 47115, Atlanta, GA 30362.

The watersheds of the Wolf River and neighboring Nonconnah Creek incorporate much of the city of Memphis and Shelby County, Tennessee. Within Shelby County, the effects of urban growth has taken its toll on both drainage systems, leaving a few small natural segments. However, the portion of the Wolf River east of Shelby County, remains in good condition with large forested borders that provide an excellent wildlife habitat and corridor. Overall, these riverine and bottomland areas consist of oak-hickory terraces, cypress-tupelo swamps, and several other types of bottomland communities. There are areas between Moscow and La Grange where the river channel becomes poorly defined, resulting in a river-swamp.

Of particular floristic interest is the occurrence of several rare Tennessee plants in these watersheds. One of the only two known Tennessee populations of *Listera australis* is located in a beech-maple community south of La Grange. *Phacelia ranunculacea*, *Platanthera flava*, *Platanthera peramoena*, *Iris fulva*, *Quercus nuttallii*, and *Spiranthes ovalis* also occur at various points along the river. Future field work may also uncover the presence of *Schisandra coccinea*, *Prenanthes crepidinea*, and *Ulmus crassifolia*.

Development of Embryogenic Induction Medium for Chestnut Tissue, R.L. Bullard, N.G. Vredevel, UT Chattanooga.

Cambial cells from *Castanea dentata* var. Rock City were grown to callus in liquid modified Woody Plant Medium. To obtain a uniform inoculum between 520 and 860 μm , the calli were blended and sieved. The medium was modified again to determine optimum growth and nodule formation. A combination of NAA at 10 mg./l., sucrose at 5gm./l., KNO_3 at 1,444 mg./l. and other salts at standard concentrations but lacking in CaNO_3 , K_2SO_4 , CaCl_2 and other

hormones, produced the greatest number of embryoids on the surface of the nodules in about six weeks.

Plant Communities of the Tennessee Eastern Highland Rim Gorges, J.E. Burr, K. Chappell, L. Scott, and G. Hunter, Tennessee Technological University.

Six eastern Highland Rim gorges in Putnam, Jackson, and Overton County, Tennessee, were examined. Different community types were identified and sampled, and lists of species composing the overstory and shrub layer were compiled. The data from these different community types were compared with each other and with that of community types recognized from nearby Cumberland Plateau gorges.

Using Fern Protoplasts to Study Paraquat Herbicide Uptake, J.D. Caponetti and O.J. Schwarz, The University of Tennessee, Knoxville.

While conducting research on the paraquat uptake characteristics of *Ceratopteris richardii* gametophytes, a question arose concerning how much of a barrier the cell wall is to paraquat uptake. One way to answer the question is to compare paraquat uptake in intact gametophytes with uptake in protoplasts obtained from gametophytes. Known weights of 21-day-old gametophytes and protoplasts obtained from the gametophytes of wild type and two mutants were treated with appropriate amounts of ^{14}C -paraquat by the usual techniques. Uptake was determined using standard scintillation counting methodology. Paraquat uptake characteristics of protoplasts was similar to that of gametophytes for both wild type and mutants. Therefore, the cell wall is not a barrier to paraquat uptake.

Some Aspects of the Lake Barkley Mudflat Flora, E.W. Chester, Austin Peay State University.

The results to date of an ongoing survey of mudflats (seasonally dewatered flats) along Lake Barkley, the impounded lower Cumberland River, in western Kentucky and Tennessee are reported. Studies since 1983 of 34 sites show that annual species of Asteraceae, Cyperaceae, Lythraceae, and Poaceae dominate. *Cyperus* is the largest genus, with two or more species present at each site, while *Eragrostis hypnoides* is most abundant. The habitat is unique in that the spongy alluvium is open for colonization only for a few weeks each autumn and results from a drawdown in reservoir level of about five feet. More than 75 percent of the flora consists of annuals; some perennial herbs function as annuals, and a few perennials are able to survive the yearly inundation.

Effect of PEG on Soybean Cell Culture, U.O. Effiong, E.L. Myles and P.S. Kahlon, Tennessee State University.

Polyethylene glycols (PEG) are a family of osmotically active polymers of different molecular weights and are frequently used in plant water-stress studies because they act as osmotic agents by reducing the water potential of the nutrient medium. The objective of

this study was to determine the rate of growth and total protein of cells of cultivars Tracy and Hill grown in water-stressed suspension cultures. The water stress was simulated by the addition of PEG of molecular weight of approximately 8,000 in the nutrient medium. The growth rate was measured by determining the packed cell volume (PCV), fresh weight and dry weight of cells. The total protein was estimated by the method published by Lowry, et al. (1951). The cells were grown in the PEG medium for three (3) weeks and measurements were taken weekly. There was a slight reduction in growth in treatments with 10% and 15% PEG in the medium as compared to control during the first week. No reduction was observed in the second week, however, indicating that an osmotic adjustment to the stress in the second week probably has taken place. The data showed that cultivar Tracy appeared to be more tolerant to water stress as compared to Hill. (Supported by USDA/CSRS grant no. TENX-18503-7-PS19.)

The Status of Arabis perstellata Braun var. ampla Rollins in Tennessee, L.E. McKinney, Vanderbilt University.

The only previously known population of this variety was along the bluffs of Stones River, Davidson County, Tennessee. However, this population is thought to be extirpated. In 1985, the variety was rediscovered on Scales Mountain in Southwestern Rutherford County. With the endemic status of both varieties in mind considering that var. *perstellata* is presently known from only a few localities in Northern Kentucky, it was decided to take a closer look at the morphological differences between the two.

The major differences between them were thought to be in reference to plant size and trichome density. However, after considering a range of variability commonly associated with many plant species as well as seasonal oscillations in environmental factors, minor differences can easily be explained. Thus, while it appears that *A. perstellata* Braun is a good species and easily separated from its closest relative, *A. shortii* (Fern.) Gl., the recognition of two distinct varieties does not seem warranted.

Effect of Sodium Chloride on Soybean Cell Culture, E.L. Myles and P.S. Kahlon, Tennessee State University.

The objective of this study was to evaluate two cultivars (Essex and Hill) for their salt tolerance and to determine the possible mechanism of salt tolerance. The tolerance was measured in terms of growth rate, total protein and proline accumulation in cells grown in suspension culture. The growth rate was measured by determining the increase in packed cell volume (PCV), fresh weight and dry weight. To determine the total protein, cells were washed in 3% mannitol and ground in 0.2 M Tris Buffer with 2-mercaptoethanol (2.9 ml per liter of buffer). Cells from the suspension cultures were ground with a glass tissue homogenizer. The supernatant was separated and the protein was precipitated. An estimation of total protein was made by the method described by Lowry, et al. (1951). Proline determination was made photometrically. The results showed a significant increase in total protein when cells of cultivar Essex were exposed to .4% NaCl for a period of three weeks as compared to the control. No significant proline difference was observed in cells grown

in salt as compared to the control for cultivar Essex. (Supported by USDA/CSRS grant no. TENX-8503-7-PS19.)

Organogenesis in Sweet and Pimiento Peppers, W. Shao and J.D. Caponetti, The University of Tennessee, Knoxville.

Cotyledon and hypocotyl explants of tissue cultured seedlings of three varieties of pepper, *Capsicum annum* L. were aseptically cultured on M&S medium supplemented with the auxins 2,4-D, NAA, and IAA separately in a range of concentrations from 0 to 5×10^{-5} M. Callusing occurred on media with all three auxins in four weeks. Medium with 10^{-6} to 10^{-5} M 2,4-D and NAA, and 10^{-5} to 5×10^{-5} M IAA produced the greatest fresh and dry weights of callus on the explants of all three varieties. In many instances, roots formed on calluses on media with NAA and IAA, but not with 2,4-D. Organogenesis of shoot buds was achieved best on cotyledon explants on medium with a combination of the auxin IAA and the cytokinin BA. A maximum of 100% shoot bud production was obtained on medium containing 10^{-5} M IAA and 5×10^{-5} M BA in four weeks. Embryogenesis (whole, intact plants) was not obtained from either callus or explants under the described conditions.

Edible Wild Plants of Tech Aqua, Jerry W. Smith, Western Kentucky University, R. Anderson, Tennessee Technological University, M. Hawkins, DeKalb County High School, H.-C. Liu, Tennessee Technological University, T.R. Luttrell, Western Kentucky University, G.E. Hunter, Tennessee Technological University.

The members of the summer 1988 Plants and Man course at Tennessee Tech Aqua documented over 160 species of edible wild plants which occur at the Tech Aqua Biological Station. All were typical of those found in the central hardwood forests and in the disturbed areas dissecting them.

The Vegetation of an Abandoned Limestone Quarry (DeKalb County) Tennessee, R. Thompson, Berea College, Berea, Kentucky, L.E. McKinney, Vanderbilt University.

The vegetational patterns and floristics of an abandoned limestone quarry has been thoroughly studied over the last several years. The quarry may be divided into three rather distinct vegetational communities which include marsh, talus slope, and ruderal (roadside). These communities present a total of 269 species representing 73 families and 186 genera.

Woody dominants are as follows: Marsh—*Salix caroliniana* Michx. and *Populus deltoides* Marsh.; Talus slopes and Ruderal—*Ailanthus altissima* (Mill.) Swingle. and *Acer negundo* L. Herbaceous dominants in the marsh included *Microstegium virmineum* (Trin.) A. Camus., *Impatiens capensis* Meerb., *Carex frankii* Kunth., and *Carex vulpinoidea* Michx. Two species collected during this study, considered rare for the state of Tennessee, are: *Elymus svensoni* Church and *Liparis loeselii* (L.) Rich.

CHEMISTRY SECTION

Eugene A. Kline, *presiding*

The Use of Ammoniacal Hydrogen Peroxide to Trap Volatile Sulfur Compounds Produced by the Reaction of Coal with Perchloric Acid,

K.S. Ailey and C.W. McGowan, Tennessee Technological University.

The sulfur forms in coal have been determined using the variable oxidizing power of HClO_4 which selectively converts the sulfur-containing components to sulfate for nephelometric measurement. Sulfate and pyrite were extracted with HClO_4 boiling at 120°C and 155°C , respectively. Organic sulfur was oxidized with a boiling solution of 9:1 concd. HClO_4 and concd. H_3PO_4 at 205°C . In all three steps, gaseous sulfur compounds were trapped in 15% H_2O_2 . Sulfate was then determined in the reaction solution and the trap. For some coals, the total recovered sulfur was 0.1–0.3% (absolute) less than the total sulfur in the coal. One possible explanation was that acidic gases, such as H_2S or SO_2 , might not be trapped by the neutral H_2O_2 . Therefore, the reaction scheme was performed on a Kentucky #9 coal with a 15% H_2O_2 trap containing NH_4OH . However, even with the basic H_2O_2 trap, the recoveries were still slightly low.

Do Diode Array Spectrophotometers Measure the Same Absorbances as Do Other Spectrophotometers? T.L. Beck and J.C. Howard, Middle Tennessee State University.

Due to the differences in the optical system of a diode array spectrophotometer, e.g., Hewlett-Packard 8451A, and conventional spectrophotometers, e.g., Gilford 2400, a different value for the measured absorbance could be measured depending on the operating parameters chosen on the diode array instrument and the particular compound under investigation. The optical systems will be discussed and those conditions and compounds found, so far, which show a difference, will be presented.

The Selective Oxidation of Aromatic Polyethers with Perchloric Acid, D.J. Davidson and C.W. McGowan, Tennessee Technological University.

The selective oxidation of poly-m-phenoxyethylene was achieved by using boiling solutions of perchloric acid having various concentrations and subsequent boiling points. The mass of the residue after reaction was used to follow the extent of the oxidation. A weight gain was observed up to a boiling point of 190°C . Analysis of the residue by a diffuse reflectance technique using a fourier-transform infrared spectrophotometer indicated that the polymer had been chlorinated even for the reaction at 140°C . The dissolution of the polymer matrix occurred between boiling points of 190°C and 203°C .

Isolation of Heavy Metal Influx to the Cookeville Sanitary Sewer System and Impact on Municipal Sludge Management, D.B. George, M.B. Borup, V. D. Adams, and M.P. Prehn, Tennessee Technological University.

The city of Cookeville, Tennessee, has been experiencing problems with municipal sludge management. Of particular concern was the high concentration of regulated trace metals in the sludge. Primarily, cadmium limited the amount of sludge which was spread on the available cropland in 1985. The purpose of this project was to determine the major sources of heavy metal influx to the city's sanitary sewer system and the potential effects of heavy metals on sludge management.

In general, the findings of the study indicate that city enforcement

of existing State of Tennessee and city industrial pretreatment requirements will most likely extend the useful life of the currently available 388 ha land application sites to as much as ten years for certain sites. Cadmium governed the annual sludge application rates to the agricultural land. One plating industry discharged over 90% of the cadmium, copper, nickel, and zinc mass to the sanitary sewer. In addition, during 1986, the average concentration of most of the trace metals monitored in the municipal sludge decreased from levels reported in 1985.

THM Control by Current Disinfection Practices, D.B. George, S.A. Huddleston, V.D. Adams, M. B. Borup, K.L. Roberts, Tennessee Technological University.

By June 1989, the United States Environmental Protection Agency (USEPA) must place into action national Primary Drinking Water Regulations (NPDWRs) requiring disinfection for all public water systems (1986 Amendments of the Safe Drinking Water Act, PL99-399). Historically, chlorine has been the primary disinfectant used throughout the world. In 1979, the second amendment to the National Interim Primary Drinking Water Regulations (NIPDWRs) established maximum contaminant levels (MCLs) on trihalomethanes (THMs), a suspected carcinogen. THMs are formed by the chemical reaction of an organic precursor and chlorine. Water utilities which produced a finished drinking water containing THM levels exceeding the MCL implemented various treatment processes to comply with the NIPDWRs. An anticipated lowering of the THM MCL (Lykins 1987) has caused the water utility industry to re-evaluate alternative disinfectants and/or pre-oxidants to reduce THM concentrations in the product water.

Since 1979, water utilities have gained tremendous experience and knowledge about the use of alternative disinfectants and/or pre-oxidants to produce a finished water that complies with this paper and discusses the control by alternative disinfectants and/or pre-oxidants employed by 20 water treatment plants.

The Crystal and Molecular Structure of the Novel Silylmagnesium-Silylmercurate Complex $\{ \text{Mg} (\text{SiMe}_3) (\text{D} - \text{ME})_2 \} + [(\text{Hg}(\text{SiMe}_3)_2)]\{(\text{Hg}(\text{SiMe}_3)_3)\}^+$, Q. Lin, W.H. Ilsley, A.F.M. Rahman, and J.P. Oliver, Wayne State University and Middle Tennessee State University.

The novel new complex $\{ \text{Mg}(\text{SiMe}_3)(\text{DME})_2 \} + [(\text{Hg}(\text{SiMe}_3)_2)]\{(\text{Hg}(\text{SiMe}_3)_3)\}^+$ has been obtained from the reaction of $\text{Hg}(\text{SiMe}_3)_2$ with $\text{Mg}(\text{SiMe}_3)_2 \cdot 2\text{DME}$ (DME=1,2-dimethoxyethane) and its structure was determined by single crystal X-ray diffraction techniques. The complex crystallizes in the space group Pn with cell constants of $a=14.877(4)\text{\AA}$, $\beta=10.10.136(5)\text{\AA}$, $c=16.337(6)\text{\AA}$, $b=100.46(3)^\circ$, $V=2422(2) - \text{\AA}^3$, and $Z=2$. The final solution gave $R_f=6.7\%$ and $R_{w,f}=7.8\%$ for 1382 data with $1 \geq 2.5\sigma$. The novel five coordinate trimethylsilylmagnesium cation $\{ \text{Mg}(\text{SiMe}_3) - (\text{DME})_2 \}^+$ can be described as a distorted trigonal bipyramid with two oxygen atoms, one from each DME, and the silicon atom in the equatorial plane. The other two DME oxygen atoms occupy the axial sites. The magnesium atom occupies the central portion of the bipyramid $2.62(3)\text{\AA}$ from the silicon atom. The remainder of the molecule is a tight cluster consisting of a distorted

[Hg(SiMe₃)₃]⁻ anion and a Hg(Si-Me₃)₂ molecule with the two moieties separated by a short Hg-Hg distance of only 2.965(3)Å.

A Description of the Organic Material in Chattanooga Shale, C.W. McGowan, R.M. Morris and B.J. Stanton, Tennessee Technological University.

The soluble organic material, bitumen, contained in Chattanooga Shale has been separated from the shale by Soxhlet extraction with benzene. The bitumen has been analyzed for carbon, hydrogen, nitrogen and sulfur (CHNS). The bitumen had a molar hydrogen to carbon ration of 1.6. The bitumen was separated into acid, base and neutral fractions using ion exchange resins. Each fraction was analyzed by CHNS, infrared spectrophotometry (IR) and gas chromatography coupled to mass spectrometry (GC-MS). Primarily aliphatic materials were identified. A kerogen concentrate of the shale was prepared by demineralization with HCl and HF. The kerogen concentrate was analyzed by CHNS, IR and ash content. The molar hydrogen to carbon ration was 1.1. A step-wise oxidation of the kerogen concentrate was effected using perchloric acid. Oxidation products were separated and analyzed by IR and GC-MS. A model was developed for the structure of the insoluble kerogen of Chattanooga Shale.

Deuterium Labeled Studies of Coal Liquefaction Mechanism, T.H. Morris and E.A. Kline, Tennessee Technological University.

The mechanism of the formation of perylene in the presence of H-donor solvents and d₁₀-pyrene was studied. Pyrene has been shown to shuttle hydrogen atoms in coal liquefaction studies. Two H-donors, fluorene and 9,10-dihydrophenanthrene were reacted with d₁₀-pyrene and 1,1'-binaphthyl in benzene at 470°C for two hours.

d₁₀-pyrene was synthesized by heating pyrene in a Parr bottle at 270°C for 24 hours in the presence of deuterium chloide in deuterium oxide with a chromium metal catalyst.

Mass spectral data showed deuterium incorporated mainly in the reactant binaphthyl and the product perylene probably at the 1,4,5 and 8-positions.

No deuterium incorporation in the H-donors suggested no shuttling by these compounds while decreased deuterium in the d₁₀-pyrene denoted some kind of activity. Significant amounts of deuterium only on perylene and binaphthyl supported the bimolecular reaction between organic molecules.

Brownian Dynamics of Protein Association, S.H. Northrup, Tennessee Technological University.

Brownian dynamics computer simulations of the diffusional association of electron transport proteins cytochrome c and cytochrome c peroxidase were performed. A highly detailed and realistic model of the protein structures and their electrostatic interactions were used based on an atomic-level spatial description. Several structural features play a role in enhancing the electron transfer efficiency. Favorable electrostatic interactions facilitate long-lived nonspecific encounters between the proteins allowing the severe orientational criteria for reaction to be overcome by rotational diffusion during encounters. Thus a reduction in dimensionality effect operates. The proteins achieve plausible electron transfer

orientations in a multitude of electrostatically stable encountered complexes rather than in a single dominant complex. In addition, preliminary results of a theoretical study of the rate of energy transfer from variously charged Terbium chelates to cytochrome c are described. The motion of the Terbium donor serves as a probe of the electrostatic field around the protein, modelled by the Poisson-Boltzmann equation, and is sensitive to the effects of fluctuations of protein side chains.

Electrolytic Degradation of Organics in Aqueous Media, K. Parvez, V.D. Adams, D.B. George, M.B. Borup and C.A. Webb, Tennessee Technological University.

A major concern in environmental protection is finding effective and economical ways to remove organic contaminants from water sources and waste streams. The electrolytic process currently under investigation is being evaluated for its effectiveness to remove these undesirable compounds from aqueous solutions. The objective of this research is to determine if electrolysis is an effective and economical method.

The electrolysis of a solution of sodium chloride produces chlorine, ozone and hydroxyl radicals. The oxidants that are generated can degrade organic compounds. In order to understand the oxidation of organics by the oxidants produced by electrolysis a knowledge of the amounts of the oxidants generated must be determined. An analysis for determination of the free chlorine and ozone produced has been done. Three different concentrations of the electrolyte NaCl were chosen and the current, temperature, and amount of chlorine and ozone generated was determined.

Aqueous solutions of organic pollutants were processed using sodium chloride as an electrolyte. Samples were taken at time intervals throughout the electrolysis and extracted using methylene chloride. The extracted samples were analyzed on a gas chromatograph to determine the contaminant concentration in each sample.

The results from the electrolysis of the three organic compounds imply that electrolysis is useful in removing some organic compounds from aqueous solutions, using only sodium chloride and an electrode system. The times required for removal of the organics, both original and formed, were all less than 250 seconds.

Uptake and Incorporation of ¹⁴C Leucine in Lens, G.E. Rohweder and B. Albers-Jackson, Tennessee Technological University.

Since the lens does not have a blood supply, the metabolism of the lens can be studied outside the living organism by use of the technique of organ culture.

Rabbit lenses were kept viable in modified test tubes containing nutrient medium and ¹⁴Carbon labeled leucine. Leucine is an amino acid readily incorporated into proteins. The purpose of this study was to give a mathematical model for the transportation of leucine into the lens and the incorporation of leucine into protein.

Using the mathematical model, the turnover time for leucine was 11.4 hours and the turnover rate was 16 micromoles per hour.

Incorporation of Tritiated Water in Fish, D.G. Sprous, J.E. Fox

and B. Albert-Jackson, Tennessee Technological University.

Tritiated water $^3\text{H}_2\text{O}$ is routinely discharged into the environment near nuclear power plants and reactors. The radioactive water is rapidly equilibrated with the cell water in the aquatic life forms. The purpose of this study was to determine the uptake of the radioactive hydrogen into the various lipid classes.

Oak Ridge National Laboratory has been discharging tritiated water into White Oak Lake. Blue gill and mosquito fish from White Oak Lake were analyzed.

An experimental fish tank with water having a specific activity of 1.2×10^6 dpm of $^3\text{H}/\text{mL}$ was set up. Mosquito fish were exposed to this level of radioactivity for thirty days. After this time the fish were lyophilized and the lipids were extracted. The phospholipid fraction incorporated the greatest percentage of the radioactivity. Significant incorporation of activity was also seen in the triglyceride and cholesterol fractions. Phospholipids and cholesterol are important structural components of the cell, insuring persistence of the radioactivity in the organism. The long term effects are not known.

Infrared Determination of Ammonium Bromide Impurity in Potassium Bromide, M.V. Stewart, J.B. Harrell, D.R. Bingham, and D.K. Jewell, Middle Tennessee State University.

The infrared spectrum of solids is often obtained from a mixture of the sample and KBr that is pressed into a clear disc with a hydraulic press. Specially prepared KBr is commercially available for this purpose; however, most spectra reported in the literature are obtained from discs prepared with the reagent grade salt. Although spectra obtained using lesser grades of KBr are satisfactory for most purposes, an extraneous absorption at $1385 \pm 2\text{cm}^{-1}$ is always present as a sharp peak. We present preliminary results that tentatively identify the impurity as an ammonium bromide solid solution in the potassium bromide crystal lattice and outline our approach to its quantitative analysis. We propose that the relative amount of ammonium bromide present is responsible for the various pH values observed for different KBr samples and also suggest the use of this indigenous impurity as an internal standard of general application for the quantitative analysis of other substances using infrared spectroscopy.

Chemiluminescence Spectra of Small Molecules Containing Sulfur, Selenium, and Tellurium, C.D. Taylor, Tennessee Technological University.

To help identify a novel emission feature extending from 550 nm to 880 nm produced in the gas-phase reaction of F_2 with CS_2 , the reaction of F_2 with CSe_2 has been studied. This reaction yields a previously observed emission feature from SeF (A) extending from 500 nm to 870 nm and a banded feature between 350 and 500 nm that resembles fluorescence from Se_2 (A) but requires further analysis. An apparently new, broad feature extending from 600 nm to the near IR appears by itself under certain reaction conditions. This broad feature is unresolved at 0.1 nm resolution and is not very useful in understanding the F_2/CS_2 feature.

Reactions of F_2 with CH_3XCH_3 , where $\text{X}=\text{Se}, \text{Se}_2, \text{Te}, \text{Te}_2$, are being studied as sources for emission spectra of CH_2Se and CH_2Te . Fruitful chemical trends and analogies are being exploited in

effort to identify new spectra of hard-to-study small molecules in chemiluminescence.

Soil Clean-up by In Situ Surfactant Flushing. II. Theory of Micellar Solubilization, H.H. Wayt and D.J. Wilson, Vanderbilt University.

Two mathematical models for describing the process of micelle formation in surfactant solutions are presented and shown to yield essentially equivalent results. The simpler of the two is then used as the basis for development of models for describing the solubilization of various types of contaminants in micelles of ionic and nonionic surfactants. Contaminants which are purely hydrophobic compounds and those which are amphipathic are handled, and electrical effects are described by means of a Debye-Huckel theory approach. It is found that the concentration of contaminant solubilized is a linear function of the total surfactant concentration provided that this is above the critical micelle concentration, in agreement with experimental results.

Soil Clean-up by In Situ Surfactant Flushing. I. Mathematical Modeling, D.J. Wilson, Vanderbilt University.

The utility of in situ methods for remediating hazardous waste sites is described, and the method of in situ soil surfactant flushing is discussed. Mathematical models for the in situ surfactant flushing of hydrophobic organics from soil and aquifers and for the flushing of soil samples in laboratory columns are outlined, and numerical results obtained with the models are displayed. The method, currently in the development stage, may lead to very substantial savings in the remediation of hazardous waste sites.

ENGINEERING SECTION I

Prit Chowdhuri, *presiding*

Finite Element Analysis of Piezoelectric Cylinders, G.R. Buchanan and M.F. Cheng, Tennessee Technological University.

An investigation was performed to study the axisymmetric free vibration of cylindrical solids of piezoelectric crystals belonging to the hexagonal class 6mm. Similar problems for transversely isotropic elastic material bodies were also studied. The study was extended to include piezoelectric cylinders with external coatings of a different material. Results for natural frequencies of vibration and mode shapes were tabulated for various boundary conditions.

Harmonic Composition of Low Frequency Electromagnetic Emissions Associated with High-Voltage Transmission, M.L. Daley, Memphis State University.

Electric field strength measures of the spectrum between 10 kHz and 200 kHz were obtained under dry conditions near a 500 kV transmission line. Comparison of the magnitudes of electric field strength between the odd and even harmonics of 60 Hz revealed a marked asymmetry. The ratio of odd to even harmonic field strength ranged from 19 to 3.3. A primary source for these emissions may be related to some components within the power system which possess marked non-linearities. In particular, such non-linearities might best be described by odd-functions.

Design Considerations for Packed Columns Removing Manganese From Mining Seepage, J.A. Gordon, N-S. Chuang, Tennessee Technological University, and R.P. Wallace, CH2M Hill, Montgomery, Alabama.

A field study during 1986 at a reclaimed strip mine area showed that column technology had promise as a low-maintenance, low-cost method of manganese removal and, therefore, design and operation data were needed before proceeding with a pilot plant scale operation.

During 1987, three columns were operated in the laboratory to obtain needed design information. Removal efficiency was assessed as a function of hydraulic loading, mass loading, column depth, and pH. The studies yielded good information which could be expressed by simple models.

The mechanisms of manganese removal were also assessed. Both batch and flow-through studies using various microbial poisons were conducted to determine whether the removal is biological or physical-chemical. Batch studies using autoclaving, ethanol, and sodium azide showed that adsorption of manganese was a first step in the process followed by oxidation. Subsequent studies used smaller diameter columns in a continuous flow mode which were poisoned with sodium azide and operated for a longer period of time to avoid assessing only the adsorption step.

Agricultural Uses of Sewage Sludge, J.T. Mason III and D.B. George, Tennessee Technological University.

Prior to current regulations and control on deposition of sewage sludge, it was often used for agricultural land without restrictions. This research attempted to determine if there is any relationship to hazardous materials deposited and residues still in the soil. Excellent correlation was obtained for Putnam County using data compiled from conversations with sewage plant operators. These conversations covered the time period before accurate records were kept and show that rough estimates of deposits can be used to approximate the hazards involved.

Fluid/Thermal Sciences Research Related to Coal Fired Power Plants, S.S. Munukutla and M. Gadiraju, Tennessee Technological University.

It was predicted in 1973 that 62% of power generation in the USA would be by nuclear plants by 1985. Due to various reasons, nuclear power accounted for only 12% of total generation in 1985. The industry expected to phase out the first units by the mid 80's, but today, in reality, the fossil units are the major source of power generation. Many of the coal fired power plants are old, inefficient and very poorly instrumented. This paper will describe the fluid/thermal sciences research being conducted at the Center for Electric Power in order to improve the performance of coal-fired power plants.

Moisture Transport in Oriented Strand Board, E.S. Percell and D.W. Yarbrough, Tennessee Technological University.

The deterioration of wood and wood products such as oriented strand board used in the construction of residential and commercial buildings is often related to moisture. Proposed changes in the way oriented strand board is used in roof structures has introduced a need for moisture transport (drying) information. A study of drying rates

for oriented strand board with a radiant barrier attached to one side has been completed. The data include drying rates with and without attic radiant barriers attached to the underside of roof decking and provide for predictions concerning moisture in roof decking.

ENGINEERING SECTION II

Rafael B. Bustamante, *presiding*

Nonlinear Decentralized Estimation, A.T. Alouani, Tennessee Technological University.

Consider the following distributed estimation problem: A coordinator must construct the centralized (global) probability density of a nonlinear random process, conditioned on N distributed noise corrupted observation histories. The coordinator can only access the N (local) conditional probability densities produced by local processing of these distributed observation histories, not the observation histories themselves. The local processors' models can differ from the coordinator's models of the distributed observation dynamics. By constraining the choice of the local models, the coordinator reconstructs exactly the centralized conditional density (as if it had access to all the measurements). The ability to use different local models can be used as a mechanism of reducing the computational load at the local level.

A Probabilistic Treatment of Fatigue Failure, G. Lewis, Memphis State University.

The present study focuses on statistical analysis of fatigue results obtained from laboratory-sized specimens leading to the development of decision algorithms which account for uncertainties in the performance of full scale structures. Estimates of the probability of survival of cyclical stresses are obtained. These can be used to determine the safe operation life of the structure. Also, order statistics have been used in estimating the times at which fatigue cracks will initiate in a large system comprising of a number of nominally identical subsystems.

These concepts are applied to a steel bridge having 100 identical components with identical transverse stiffeners and subjected to a cyclical stress of ± 200 MPa. It is found that the Weibull shape parameter and the characteristic extreme value are 6.7511 and 2.56×10^5 cycles, respectively, and the average number of cycles to fatigue failure of the bridge is 1.21×10^5 cycles.

Optical Diagnostics of Coal Ash, Satish M. Mahajan, Tennessee Technological University.

Analysis of coal ash is important from the point of view of (i) improvements in boiler efficiency and (ii) recovery of metals from coal ash. Use of coal from different mines usually results in a significant variation in the performance of the boiler and in the percentage of the constituents of the coal ash. Therefore, it is necessary to monitor the performance of coal "on line" via ash analysis. Since optical techniques are inherently fast, current research is aimed towards optical diagnostics of coal ash.

Coal ash consists of the oxides of metals (Al, Fe, Mg, etc.) and unburnt carbon. Different optical techniques (e.g. interferometry, spectroscopy, etc.) were considered. Electrical discharge for the

sputtering of ash sample is ideal for such an analysis. Emission/absorption signals could then easily be interpreted in terms of the percentage of the constituents of coal ash.

Particular attention was paid to the sample handling and to the detection of unburnt carbon. Comparison with similar techniques and the associated problems will be presented.

Removal of Acetone, Pyrrole, and Propionitrile Using Biological Batch Reactors, S. Miles and R.B. Bustamante, Tennessee Technological University.

Effluent from an oil shale hydroretorting process contains numerous harmful compounds, including acetone, propionitrile, and pyrrole. The biological treatability of the three compounds is being determined. Heterogeneous bacterial cultures have been acclimated to aerated laboratory solutions containing the three substrates (both individually and combined) as sole carbon sources in the presence of excess inorganic nutrients. Batch experiments using single substrate concentrations of 100, 300, and 600 mg/L indicate that it is possible to reduce the chemical oxygen demand to a minimum in approximately 50 hours for solutions containing acetone or propionitrile and in approximately 60 hours for pyrrole solutions. An experiment using both acetone and propionitrile revealed that the two substrates were being metabolized simultaneously and that chemical oxygen demand was reduced to a minimum in 48 hours. Further research will focus on additional double and triple substrate experiments and on continuous flow studies.

A Study of Sulfide and Hydroxide Precipitation of Selected Metals in the Presence of Ammonia, S. Prabhu, S. Bunduwongse, W. Bonner, Tennessee Technological University.

Sulfide and hydroxide precipitation have been demonstrated to be effective methods for the removal of heavy metals from industrial wastewaters. The precipitation of metals is affected by factors such as pH, concentration of competing metals, and the presence of complexing such as ammonia. Removals of mixed heavy metals (Cu, Cd, Ni) are reported for batch experiments conducted as a function of precipitation conditions: $\text{pH}(6 \leq \text{pH} \leq 11)$, with/without ammonia (50 mg/l), and sodium sulfide (to three times stoichiometric dose).

Implications for Future Power Systems From Load Analysis at Athens, Tennessee, J.H. Reed, ORNL, R.P. Broadwater, A. Chandrasekaran, Tennessee Technological University.

The Athens Automation and Control Experiment is a hardware and software-oriented research project installed on the Athens Utilities Board's distribution system in Athens, Tennessee. For two years data was collected from about 70 homes every five minutes throughout the day. The data includes energy usage of heat pumps, air conditioners, electric heat, and water heaters. Energy usage characteristics have been analyzed and the results from the analysis are presented. Effects of load control on hot water heaters and heat pumps are presented. From the results of the load analysis implications for future power systems are presented.

Advanced Computer Simulation of Pulverized Fuel Processes, J.D. Smith, Tennessee Technological University, and A. Tsang, DOW

Chemical, Plaquemine, LA.

Pulverized-fuel combustion is a complicated phenomenon which involves many subprocesses. The subprocesses which govern combustion include turbulent gas-phase chemistry and particle dispersion, radiant heat transmission, and fuel devolatilization/oxidation. A comprehensive numerical description of pulverized-fuel combustion necessitates an accurate description of these subprocesses. Earlier work done at Brigham Young University has led to the establishment of a comprehensive combustion model: PCGC-2. Several different systems have been simulated with this model. Extensive data comparisons have been used to validate code predictions.

Here, PCGC-2 was used to investigate the complex flow patterns inside a small-scale test reactor for a reacting and a non-reacting case. Also, PCGC-2 was used to analyze erosion characteristics for particle laden flows in various geometries. This work illustrates the use of a comprehensive simulation model to evaluate various process questions.

On the Interaction Between Thermodynamics and Economics in Energy Systems, G. Tsatsaronis, Tennessee Technological University.

A conventional design and performance evaluation of energy systems includes a thermodynamic analysis (mass and energy balance) and a separate economic analysis. Design and/or performance optimization refers to the cost of the final product(s). The key decision variables, however, include several thermodynamic parameters (e.g., temperatures, pressures, and mass flow rates).

Exergoeconomic analysis techniques combine the first and second laws of thermodynamics with conventional process economic considerations. The purpose of an exergoeconomic analysis is to attribute costs to the "useful energy" streams flowing between plant components and to the "real energy losses" in the components themselves. These costs are then compared with capital investment and operating costs in an effort to minimize the overall product(s) costs.

Exergoeconomic analysis techniques are general and can be applied to any energy-intensive conversion process. They permit a rational cost calculation, and considerably reduce the time and efforts required to minimize the overall costs in energy systems.

Lightning Research Activities at TVA, J.T. Whitehead, Tennessee Valley Authority.

The State University of New York at Albany operates a lightning detection network that now covers most of the United States. The Tennessee Valley Authority connected into the network in February of 1987.

The network provides time, location, polarity, and magnitude data for cloud to ground lightning flashes that occur in the covered areas. Power system controllers use the network to monitor severe weather conditions, to predict possible transmission line interruptions, and to plan maintenance of emergency system repairs. It is used by the engineering staffs to check recent power system outages and help determine if they were caused by lightning. The primary use of the system, so far, is as a research tool.

Research activities include the accumulation of flash data to learn about lightning patterns in the TVA region. Also, studies are being made to determine how accurate field reports are regarding the cause of power system outages and to learn about the characteristics of lightning flashes that cause outages.

GEOLOGY-GEOGRAPHY SECTION

Walter Helton, presiding

Tectonic Control of Carbonaceous Sedimentation, R.E. Bergenback and R.G. Litchford, The University of Tennessee at Chattanooga.

Two localized Upper Mississippian-Lower Pennsylvanian foredeep basins, known as the Sale Creek Basin located in southeastern Tennessee and the (larger) Raccoon Mountain Basin of southeastern Tennessee, northwest Georgia and northeast Alabama, are separated by an interbasin high located largely in the Elder Mountain area just west of Chattanooga, Tennessee. Differential subsidence accompanied by differential sedimentation resulted in Upper Mississippian tidal flat deposits and Lower Pennsylvanian tidal flat, bog-fill or floodplain deposits that give way to Lower Pennsylvanian proximal (to a mountainous source) braided stream deposits that are thin on the interbasin high and thick in the foredeep basins. Here, sedimentary structures in Lower Pennsylvanian quartz arenite and lithic arenite as well as clay-rich shales indicate periodic gradient changes that resulted from episodic subsidence in these foredeep basins.

Anatomy of an Oil Spill, D.M.S. Bhatia, Austin Peay State University.

Pipe lines transporting crude oil through urban areas are always prone to accidental damage. During one such incident in Montgomery County, the efficiency with which potential damage to the environment was contained and the techniques used to monitor and prevent further damage are the subject of this paper.

Groundwater Quality in Tennessee, R.E. Broshears, F.Q. Quinones, and M.C. Yurewicz, U.S. Geological Survey.

The U.S. Geological Survey, Tennessee District, recently summarized the background water quality of the principal aquifers in Tennessee. Chemical constituents and physical properties of groundwater in Tennessee generally do not exceed the national drinking water standards. Water in sand aquifers is commonly soft and slightly acidic, with small concentrations of dissolved solids. In several regions, increased iron and sulfate concentrations result from the dissolution of pyrite and other iron- and sulfur-bearing minerals. In carbonate aquifers, geochemical interactions cause increases in hardness and alkalinity along most flow paths. Saline water occurs in deep aquifers or within poorly developed solution openings in flat-lying carbonate rocks. Nitrate is seldom a problem in Tennessee's ground waters. Through its cooperative program, statewide groundwater quality monitoring networks are being initiated by the Tennessee District which increase the knowledge of groundwater quality in Tennessee.

High School Geology and College Admissions, J.X. Corgan, Austin Peay State University.

In 1989 the Tennessee State Board of Regents (SBR) will implement new admission requirements for community colleges and universities under SBR control. These requirements limit science credit to biology, chemistry, and physics. SBR explicitly identifies earth science as a field that will not be accepted for college-admission science credit. If senior high school earth science does not yield college entrance credit, there is no reason for high school administrators to continue this academically demanding offering. To many, SBR's refusal to accept earth science seems to be an error. Professionals within the community of earth scientists need to evaluate this serious situation. There are thousands of earth science professionals in Tennessee. An army of state-certified earth science teachers work in junior highs and a few offer senior high geology or earth science courses. There are also many practicing geologists, some very visible meteorologists, and people in less widely known fields such as hydrology. While senior high school earth science tends to be modeled on college geology, the continued existence of such courses should be important to all earth science professionals. Before requirements are implemented, a representative group of earth scientists should study this issue and talk with SBR.

Effective Use of Mann-Whitney and Kolmogorov-Smirnov Statistics in Geology, P.R. Kemmerly, Austin Peay State University.

Mann-Whitney (M-W) and Kolmogorov-Smirnov (K-S) nonparametric statistics are being increasingly applied to geomorphic, stratigraphic, petrologic, geochemical and hydrologic problems concerned with assessing significance of difference between two samples (one variable). The approach taken by many geologists in selecting statistical procedures has met with significant criticisms focused on: (1) choice of the test best suited to the geologic hypothesis; and (2) interpretation of the geologic significance of the acceptance or rejection of the null hypothesis.

The M-W and K-S are compared and contrasted from the perspective of suitability for a variety of geologic problems. Choosing between the two test procedures, where both meet the statistical requirements of the study, depends upon whether the dispersion or central tendency of the variable distribution provide maximum geologic information. The M-W, a central tendency sensitive instrument, becomes the best statistic if rapid changes occur in the independent variables defining the geologic process and the response of the dependent variables is not particularly complex. The K-S, a dispersion-sensitive test, is the best choice where changes in the independent geological variables occur over considerable periods of time with concomitant complex responses in dependent variables.

Waulsortian-Like Buildups From Central Tennessee, L.W. Knox, Tennessee Technological University.

Numerous geographically isolated mounds, consisting of fenestrate bryozoans and crinoids in a matrix of terrigenous mud, occur in the lowest part of the Fort Payne Formation of central Tennessee. Some 39 mounds have been located within an area bounded in the north by Pickett County, in the south by DeKalb County, and in the west by Davidson County.

The mounds were deposited basinward of the Borden Delta of central Kentucky and occur within the lower part of the (conodont)

Gnathodus texanus-Taphrognathus Assemblage Zone. Individual mounds are as large as 900 meters in diameter and 37 meters in height. Beds within the mounds have depositional dips of as much as 12 degrees. In most instances the buildups are overlain, in sharp contact, by crinoidal grainstones and packstones (of the Fort Payne Formation) that thicken at the margins of the mounds and thin over their tops. The percentage of carbonate material within the buildups increases to the southwest (away from the Borden Delta).

The mounds are interpreted to have formed at water depths below storm wave base (probably below the photic zone) due, in part, to baffling and trapping of sediment by fenestrate bryozoans.

The December 1987 Flood of West Memphis, Arkansas, H-t. Kung and J.R. Richardson, Memphis State University.

The purpose of this paper is to study the December, 1987, flood of West Memphis, Arkansas. In late December 1987, West Memphis, Arkansas, was severely flooded by more than 12 inches of rain over a four day period. The excessive amount of rain, level topography, saturated ground, and poor drainage contributed to this severe flooding. Over 900 houses and businesses sustained some type of damage from the flood. This paper is designed to discuss the nature and characteristics of the December flood and factors (topography, soil, and surface drainage) contributing to this particular flood. This paper also provides a brief discussion of possible flood protection and prevention techniques. It is possible to learn from the past and to use this information to better prepare for future floods.

Paleocurrent Analysis of Mississippian (Merimecian) Garrett Mill Member of the Warsaw Formation, G.B. Parnell, P.O. Box 370, Cookeville, and B.S. Wheeler, Tennessee Technological University.

The Garrett Mill member of the Warsaw Formation in eastern-middle Tennessee is a fine-grained quartz sandstone and shale. These siliciclastics occur at the top of the Warsaw and have a sharp and erosional contact with the underlying grainstones and packstones. The contact with the overlying St. Louis Limestone is also sharp and erosional. The unit is interpreted to have been produced by a wave-influenced delta.

Paleocurrent directions were measured from several localities within the study area. Rose diagrams indicated two orthogonal bimodal current directions. The sets were oriented northwest to southeast and northeast to southwest. The components represent the shore normal and shore parallel current directions. Using facies belt orientations and facies sequences in conjunction with paleocurrent data it was determined that the shore normal direction was northeast to southwest and the shore parallel direction was northwest to southwest.

Paleocurrent direction measurements of a wave-dominated delta tend to have a high degree of variability. This variability, in part, is a result of the local shoreline orientation. This necessitates the use of facies analysis when studying this type of deltaic system.

Evidence for Carboniferous Gondwana Glaciation in the Cumberland Plateau, F.W. Stapor Jr., Tennessee Technological University.

Two nearshore marine, fine-grained, quartz sandstone units

punctuate the Carboniferous (Mississippian) shallow-water limestones of the Cumberland Plateau: (1) the Garrett Mill Member of the Warsaw Formation and (2) the Hartselle Formation. These units disconformably overlie shallow-water limestones whose uppermost surfaces exhibit evidence of sub-aerial exposure. These shallow-water, siliciclastic "breaks" are overlain by shallow-water limestones, the contacts with which are sharp, locally scoured, and most likely of a disconformable nature.

Each of these siliciclastic units is made up of distinct, progradational, nearshore-marine sandstones. Successively younger sandstone bodies occur further to the north and/or northeast. This results in an overall transgressive pattern in which the constituent nearshore-marine sandstones "backstep" up their respective basal disconformities. These unconformity-bounded units whose constituent sandstones are arranged in a transgressive pattern can be considered transgressive systems tracts of the sequence stratigraphy nomenclature. They represent the deposits formed during the transgressive event SUBSEQUENT TO A MAJOR FALL IN RELATIVE SEA-LEVEL. The basal disconformity reflects sub-aerial exposure during the period of lowered sea level; it can be locally and/or regionally modified during the following transgression. The occurrence of shallow-water, nearshore marine as well as fluvial siliciclastic deposits immediately on top of limestones implies an abrupt basinward shift of the siliciclastic shoreline, again indicative of a fall in relative sea level.

These disconformities, while of considerable geographic extent, probably represent very little missing time: the surface at the base of the Hartselle involves the uppermost portion of one conodont zone. Thus, these falls in relative sea level took place very rapidly, so rapidly that tectonism probably played only a minor role. These falls were in all likelihood eustatic in nature, resulting from a sudden decrease in world ocean volume.

Recent syntheses of lower Carboniferous glaciation in Gondwana have identified two periods of ice sheet initiation: 1) the early Viséan and 2) the early Namurian. The latter correlates very well with the Hartselle Formation of early Chester age. The former correlates much less well with the Garrett Mill Member of early Meramec age. It is hypothesized that these eustatic falls in sea level are represented by the disconformities beneath the Garrett Mill Member of the Warsaw Formation and the Hartselle Formation, respectively. The transgressive character of the siliciclastic units reflects a combination of ice sheet melting and tectonic subsidence with perhaps the former being dominant during the Garrett Mill and the latter during the Hartselle.

Some Minor Gravity Anomalies in the New Madrid Region, R.G. Stearns, Vanderbilt University.

Small narrow (less than one mile) anomalies require data that are precise and close together. Using gravity data alone, a maximum depth near the land surface can be calculated for narrow anomalies. If a mile or less wide, anomalies must originate near or above the base of Cretaceous Embayment fill. Near-surface formations with contrasting densities are thin, so the narrow anomalies are only a milligal. This investigation has achieved a standard deviation of less than 0.25 milligal.

Some anomalies have known sources. Of two positive anomalies on USGS seismic line D-2, one is a post-Ordovician and pre-Cretaceous graben or syncline, and the other is a Cretaceous or younger horst or buried hill. Anomalies are due to a post-Eocene fault near Henning, a Recent fault at Reelfoot Scarp, and a buried 1300 year old clay plug at Reelfoot Scarp.

Some are of unknown origin. Where they are elongate and near geomorphic features, such as Chickasaw Bluff, they can be interpreted as young faults. Others having no surface expression could be anything, but pre-Cretaceous faults can be suspected.

Geology and Hydrology of the Proposed Superconducting Supercollider Tennessee Site, P. Thompson, Tennessee Department of Conservation.

The Superconducting Super Collider (SSC) is a particle accelerator designed to "push" protons around a 53-mile oval ring at nearly the speed of light, and collide them at various points around the ring. The particles produced from the collisions will help define the smallest building blocks of matter.

The Department of Energy solicited invitations to submit proposals from any state interested and Tennessee decided to write a proposal in early 1987. Several criteria were set in the invitation and the most important was "Geology and Tunneling." The geology of the site is important because the tunnel must be located within a stable environment with low seismic risk. The hydrology is a second critical factor since the tunnel, to operate successfully, must be dry. The TVA took the lead role in reviewing the entire state. When it was determined that middle Tennessee was the best location for the SSC, the Division of Geology became involved.

The Tennessee site is located in the Central Basin of Tennessee, in portions of Rutherford, Bedford, Williamson and Marshall counties. The topography is characterized by flat to gently rolling terrain. The most significant surface feature is the shallow karst system that is developed in the Ridley Limestone.

Ordovician limestones of the Nashville and Stones River groups are the primary formations within the site area. They consist of competent limestones with minor amounts of shale, silt and fine-grained quartz.

The detailed site geology was determined by using surface geologic mapping, site specific core drilling, and numerous drill holes from mineral tests. Compilation of all the data proved that the rock units are extremely consistent across the site and the structure is gentle consisting primarily of small scale folds.

Along with a stable geologic environment, the hydrology of the site is an important factor in the construction and operation of the SSC. To determine the hydrologic regime, water well data from approximately 600 wells within the site area were compiled. After Tennessee was placed on the "Best Qualified List," site specific drilling and hydrologic testing was performed to confirm the geohydrologic regime of the site.

Groundwater occurs in joints and bedding planes that have developed secondary porosity through the dissolution of the limestones. Most of the water in the site area is within ± 200 feet of the surface. Below this level the joints tend to diminish and therefore little water occurs at depth.

Studies of the geology and hydrology led to the proposed depth of the tunnel which is 350 feet MSL. At this depth, the shallow groundwater system will not be affected and the tunnel will be bored in the Murfreesboro Limestone for most of its distance.

Stratigraphic and Facies Analysis of the Hardin Sandstone Member of the Chattanooga Shale, A.G. Youngerman, Tennessee Technological University.

The Hardin Sandstone is located in southwestern Middle Tennessee, and extends into northern Alabama and northern Mississippi. The thickest section of the Hardin, which is 15 feet, is found in Wayne County and thins outward in all directions. Isopach data shows that the Hardin extends from southern Perry County in Tennessee to northern Lauderdale County in Alabama, and from western Lawrence County in Tennessee to western Hardin County in Tennessee. An analysis of the sandstone shows that it is a fairly pure, silica cemented quartz sandstone with minor amounts of pyrite. The sands predominately weather massively, so very little internal structure can be seen, but where internal structures can be identified there are both ripples and hummocky cross stratification. These structures indicate that the Hardin is a shallow water marine sandstone and in turn the Chattanooga Shale which overlies the Hardin would also be shallow water, at least in this area. Since there are no other sands below the Hardin then the source cannot be a reworking of previous sands, so there is some fluvial origin for this clastic material. From the outcrops studied the coarsest material is located in the exposures farthest to the southwest. A channelized debris flow is located in an exposure on Pickwick Lake. This debris flow has cobbles up to two three inches long and is by far the largest material anywhere in the system. Kerogen studies have also been done on the overlying shale and a definite increase in land derived kerogen has been noted to the west. This information indicates the source for the sands to be to the west or southwest. The basal Hardin is very massive but thin interbedded sands and shales are found in the central and western exposures of the unit, but not in the eastern exposures. These thin sand layers are interpreted as the distal ends of a system that is prograding to the west. This prograding transgressive event is cut off abruptly by the Mississippi Embayment, so it is unclear how far to the west that the system prograded.

MATHEMATICS AND COMPUTER SCIENCE SECTION

Anthony Z. Cole, *presiding*

Object-Oriented Programming Using PC Scheme, E. Bunn, East Tennessee State University.

In order to introduce the concepts of programmer defined data abstraction, information hiding, and object-oriented programming to students, I have developed an approach using Texas Instruments' PC Scheme and its SCOOPS environment. The SCOOPS environment of PC Scheme allows the creation of classes, objects, and methods. Several examples of class definition, method definition, inheritance, and object instantiation are used as a basis for illustrating the concepts of object-oriented programming. The only manipulation of instance variables is through messages sent to instantiated objects. Because PC

Scheme's SCOOPS has a relatively simple set of functions which do closely follow the definition of object-oriented programming, it is well suited to classroom illustration. Students are able to create classes and methods and manipulate objects with only a brief introduction to the environment and can, therefore, gain the reinforcement of knowledge that hands-on experience brings.

Porting COSMIC NASTRAN for FEATS, A. Bykat, A. Lewis, A. Mansour, The University of Tennessee at Chattanooga.

Finite Element Analysis is a mathematical technique that is in widespread use in a number of engineering fields. The complexity of Finite Element Analysis tends to overwhelm the engineer who is first being introduced to the subject. The Finite Element Analysis Training System (FEATS) is an intelligent tutoring system that is meant to simplify the introduction of Finite Element packages to the new user.

One of the primary components of FEATS is a Finite Elements package. The package that we are using is one of the first general FEA packages to appear on the market: COSMIC NASTRAN. COSMIC NASTRAN is a large, mature FORTRAN program that has been developed over the last twenty-five years to perform many different types of Finite Element Analysis.

Unfortunately, NASTRAN is unavailable for microprocessor based machines and in particular it is not available for the M68020. For the purpose of FEATS, we are porting the VAX VMS version of COSMIC NASTRAN to the M68020 portion of the Explorer system. The purpose of this paper is to discuss some of the successes and pitfalls that have occurred during this process.

Principles of MoDeST, A. Bykat, A. Lewis, The University of Tennessee at Chattanooga.

A number of different techniques have been proposed in order to simplify the problem of the creation and maintenance of computer software. The primary objective of these techniques is to provide some consistent means to control the software design method. A major difficulty for development and maintenance (support) of software arises when design descriptions and the resulting computer programs get out of synchronization with each other. As time passes, the discrepancies between design and program become very pronounced and introduce large maintenance costs.

The purpose of MoDeST is to develop an automatic technique for management of the design of code and the synchronization of the code with design information (i.e. documentation). This will be achieved by refinement of design specifications to primitive components of the MoDeST language. The resulting MoDeST design primitive will be translated automatically into a programming language. Thus, MoDeST will offer a software design technique which preserves the relationship between design documentation and final code. As a result, the system will be able to take a program that it has created and convert it back into the design language. This approach will lead to well structured and easily changed and corrected design (and code).

Ada and the IBM PC, A.Z. Cole, East Tennessee State University.

Ada language systems have been developed for the personal computer and more are being developed every day. The personal computer now has the capability required for implementation of Ada

language on these small personal systems.

East Tennessee State University completed a research contract with the Defense Communication Agency (DCA) to develop macro models of communications networks. The project involved modeling both circuit switched and packet switched communication networks. The models were for both voice and data. The contract required that all models be written in Ada for an IBM Personal System II/Model 80 Computer.

This paper presents some of the experiences resulting from using an Ada language system in developing programs for personal computers. The utilities and the structure of the compiler will be discussed as related to large program development on small computers.

A Microprogramming Simulator for the IBM PC, F. Cornett, East Tennessee State University.

The UT1000 v.2 is a set of programs developed to allow the user to microprogram a simulated 16-bit CPU built from four AMD 2901 4-bit ALU/register slices and an AMD 2910 sequencer. The system consists of three programs: a microassembler, a macroassembler, and an emulator. The microassembler translates symbolic microprogramming language code into object code and stores this in a 4K×52 bit microstore and creates a mapping PROM for random access to the microstore. Similarly, the macroassembler translates an assembly language program into object code which is stored in a 64K×16 bit memory. The memory, microstore and mapping PROM are each implemented as files which are accessed by the emulator to simulate execution of the assembly program with the microinstructions. The emulator contains a debug function which allows the user to graphically step through execution of the assembly program.

These programs are written in Borland's Turbo C to be used on the IBM family of PC's. The original UT1000 was written by Faye Muly of The University of Tennessee, to be executed on VAX machines.

Chaos in Acoustic Ray Paths in a Bottom-Limited Environment, L.M. Lawson, East Tennessee State University.

Acoustic ray paths in a downward refracting bottom-limited environment with small perturbations in the bathymetry can exhibit chaotic behavior. This behavior appears in the form of an exponential sensitivity to initial conditions and results in large fluctuations in the ray path structure. Earlier results of path structure are reinvestigated in terms of modern ideas of Hamiltonian chaos. Numerical calculations of ray paths are made using smoothly varying bathymetries and sound speed profiles. These results are important in the predictions of sound propagation in range-dependent ocean environments.

Problems of Using a PC for Large Applications, L. Scroggin, East Tennessee State University.

Personal computers have become commonplace in most offices. As office personnel have acquired experience with PC's, they have come to depend on these computers and expect more from them. At the same time, personal computers have acquired more memory and processing ability which allows them to handle large and complex

systems. The hardware improvements and the demands for complex systems has led to the development of systems for PC's which can manipulate large quantities of data.

The problems which arise in developing large systems for PC's are similar to the problems which were once common for developing systems for main frame. Most of these problems stem from the inability to store all the necessary data in main memory. This paper uses an employee database maintenance program to define some of the problems and to show some solutions to these problems.

MEDICAL SCIENCES SECTION

R. Dean Blevins, *presiding*

Growth Response and Viability of Acanthamoeba castellanii to Clotrimazole, J. Ajala and G. Tomlinson, Tennessee State University.

The chlorinated imidazole compound known generically as clotrimazole and marketed commercially as "Lotrimin", "Mycosporin", "Canesten", etc., was assayed *in vitro* for its amoebicidal and amoebistatic effects against the human opportunistic pathogen, *Acanthamoeba castellanii* which has been causing keratitis and corneal ulcers in contact lens wearers. As in other reported cases in the literature, clotrimazole was first tested using ethanol as a carrier. Concentrations of clotrimazole as low as 100 micrograms/ml inhibited growth of *Acanthamoeba* and concentrations as low as 300 µg/ml was effective as an amoebicidal agent; but the ethanol carrier was equally as effective as an inhibitor when it was run as a control. Later experiments were able to separate these effects. Although trace amounts of ethanol showed slight stimulatory effects on *Acanthamoeba*, ethanol concentrations in excess of 1.5% v/v showed inhibition which increased with greater concentration of ethanol. Efforts to test clotrimazole dissolved in water proved very difficult due to precipitates which formed in the aqueous cultures. Clotrimazole suspensions may be useful for external applications such as corneal ulcers but these data cast serious doubt as to the usefulness of clotrimazole as an amoebicidal agent to treat human Meningoencephalitis and suggests that earlier reports of its efficacy in such treatment modalities may have been due to its alcohol carrier. This work was supported by funds from NSF Grant RII-8704133 and HIH Grant SO6RR08092.

Mutagenicity of the Active Ingredients Present in Birth Control Pills Using the Ames Salmonella Assay System, R.D. Blevins and S.V. Char, East Tennessee State University.

Five of the most common sex hormones found in birth control pills and two commercially available birth control pills were tested using the Ames Salmonella/microsomal assay system. The results obtained indicate that the progestogens Norethindrone and D (-) Norgestrel showed some mutagenic activity with strains TA97 and TA98. The birth control pill Norinyl which contains 1 mg Norethindrone and 0.05 mg Mestranol was also found to be highly mutagenic to strain TA97. However, these compounds (Norethindrone and Mestranol) did not produce a mutagenic response when tested in the concentrations as present in the pill. The purpose

of this study was to focus attention on the subject of birth control using hormones and the risks undertaken by women who choose to use this method of birth control.

Dose Response of Acanthamoeba castellanii to Stilbamidine Isethionate, J. Cornelius and G. Tomlinson, TN State University.

4,4'-(1,2 ethenediyl)bis benzenecarboxyimida-zole, commercially marketed in the form of its hydroxyethanesulfonic acid salt and called stilbamidine isethionate was assayed *in vitro* for its amoebicidal and amoebistatic effects on *Acanthamoeba castellanii*. This organism is an opportunistic human pathogen which is relatively insensitive to typical antibiotics and antimetabolites. Stilbamidine isethionate was readily soluble in water at 1 mg/ml and was added to growing cultures after sterilization by passing through 0.2 µm filters. Concentrations of stilbamidine isethionate as low as 2 µg/ml of culture medium were found to totally inhibit growth of *Acanthamoeba*. Amoebicidal dosage of stilbamidine isethionate was determined using uptake of methylene blue as a vital stain. High dosages were required for amoebicidal effect with 450 µg/ml of culture required to produce 80% lethality during a 24 hr period. This work was supported by funds from NSF Grant RII-8704133 and HIH Grant SO6RR08092.

Neural Tube Defect Incidences in Isolated Southern Appalachian Populations, R.L. Curtis and D.B. Benner, East Tennessee State University.

The Neural Tube Defects (NTD's)- Anencephaly, Spina Bifida, Meningomyelocele- and their complications are a major cause of fetal and infant demise. These defects occur throughout the world with the incidence differing greatly between geographic locations and ethnic groups, from a low of 0.36 per 1000 in the black population to an extremely high 8.7 per 1000 in the British Isles population. As a population inhabited almost exclusively by descendants from the British Isles, it follows that a high incidence of these defects might be expected in southern Appalachia. The incidence of NTD's in southern Appalachia has been identified by previous studies as having the greatest incidence of any region in the United States. This study establishes a relationship between immigration patterns and this high incidence of NTD's in the southern Appalachian area. Many hypotheses have been given to explain this high incidence. The most feasible states that the NTD's are a result of polygenic inheritance modified by environmental effects.

Lead Contamination at an Indoor Firing Range, A.F. Iglar and M.E. Zientek, East Tennessee State University.

The objective of the study was to evaluate lead contamination at a University indoor firing range. Procedures included sampling air for determination of levels of lead in the area, as well as measuring air flow and other parameters associated with the ventilation system.

Study showed that the ventilation was inadequate to maintain lead in the air at sufficiently low values, with some levels found in excess of standards. Recommendations were proposed that allow continued but restricted use of the firing range until appropriate improvements could be made to the ventilation system.

Survival of Bacteria on Selected Hand-contact Surfaces Composed of Various Metals, A. Maekle, U.S. Food and Drug Administration, C.C. Bishop and P.R. Scheuerman, East Tennessee State University.

Mankind has always been afflicted with various types of diseases, many of which may be spread by contact with contaminated objects. Some bacteria can survive on hand contact surfaces for long periods of time, even under adverse conditions. This study attempted to identify the types and numbers of organisms present on hand contact surfaces such as push-plates, door handles, and pushbars. Sampling was made from several hand contact surfaces to compare bacterial populations due to exposure to contamination and surface characteristics. The effects of various types of metals upon bacterial growth and survival were examined and compared by bacterial seeding of templates made on aluminum, stainless steel, copper, and zinc. This study was done so that recommendations can be made concerning types of door openers and the preferred materials from which they should be constructed.

In Vitro Studies on Cryptosporidium parvum, K.L. Smith, S.J. Goss and S. Berk, Tennessee Technological University.

Cryptosporidium is a protozoan parasite which causes respiratory or gastrointestinal disease in a wide variety of vertebrate animals including humans. Although there are numerous reports in the literature on the biology and epidemiology of *Cryptosporidium* species, little is known about the antigenic structure or the molecular biology of the organisms. Such investigations have been hindered by the lack of a suitable small animal model and the difficulty of propagating the parasites *in vitro*. We have compared the development of *Cryptosporidium parvum* in eight mammalian cell lines. Complete development of the parasites through the infective oocyst state was seen, although we have been unable to produce large numbers of oocysts *in vitro*. Hyperimmune ascitic fluid was prepared in mice and used to develop indirect fluorescence and protein blot immunoassays for *Cryptosporidium*. These assays will be used in future studies on the antigenic structure of *Cryptosporidium*.

Injection Induced Tolerance, A Model for Drug Dependency, R.L. Troelstrup, Tennessee Technological University.

Holtzman strain rats were initially injected intraperitoneally for four days with either a stimulant, dextroamphetamine sulfate (0.8 mg/kg), or a depressant, pentobarbital sodium (8.0 mg/kg), with an injectant level of 1 ml/kg. Subjects were then given a choice of drinking one of two solutions, 7 mg/l of Dexedrine or 70 mg/l of sodium pentobarbital, each in a 0.6 molar sucrose solution to increase palatability. Significant preference for the same drug as injected was defined as addictive behavior and drinking of the other drug as homeostatic behavior, as each serves as an antidote for one another in cases of human overdose. Drug preference patterns significantly supported the addiction definition with a fourfold preference in the sodium pentobarbital group and a threefold preference in the Dexedrine injected group. Continuation of the study in a crossover design, injecting with the opposite drug, failed to dislodge the initial addiction pattern. Other subjective signs were noted to support the existence of addictive behavior.

Influence of Ethanol on the Levels of Dopamine in Mouse Brain, Heart, Liver and Kidney, B. Turner and A.C. Wells, TN State University.

Ethanol is obtained by fermentation. It is formed by the growth of yeast in fruit and vegetable juices containing sugar or starch. Ethanol has been prepared and used by man as both beverage and medicinal agent since ancient times. During the past century its therapeutic use has diminished greatly, but its abuse as a beverage has become both a medical and a sociological problem. In the amounts usually consumed, alcohol depresses the cells of the cerebral cortex. In larger quantities, its depressant action extends to the cerebellum, the spinal cord, and the respiratory center of the medulla. It is thought to interfere with the transmission of nerve impulses at synaptic connection, but how this is accomplished is not known.

The influence of ethanol on the levels of dopamine in mouse brain, heart, liver and kidney has been investigated. The results would seem to show that when a central nervous system (CNS) active agent such as ethanol is given alone or pursuant to either atropine sulfate or atropine methyl bromide the levels of dopamine DA are reduced significantly in all organ tissues investigated with a p-value of 0.01 or less. The data strongly suggest that ethanol action on nerve or neurons is such that it reduces the activity of the enzymes hydroxylase and decarboxylase which are essential in the biosynthesis of dopamine DA and other biogenic catecholamines. Tyrosine is an amino acid capable of entering the neuron under normal conditions. However, ethanol seems to reduce the rate which this amino acid is taken up by the cell. It is suggested that a decreased rate of metabolism and a lowering of vitality or functional activity of nerve cells due to the action of ethanol are the primary mechanisms by which ethyl alcohol decreased dopamine DA in this investigation.

The investigation was supported by a SEA/CR grant to A.C. Wells from the U.S. Department of Agriculture.

The Effects of Miconazole on Growth and Viability of Acanthamoeba castellanii, S. Upchurch and G. Tomlinson, TN State University.

The chlorinated imidazole compound known generically as miconazole and marketed commercially as "micatin", "monostat", "Vodol", etc., was assayed *in vitro* for its amoebicidal and amoebistatic effects on *Acanthamoeba castellanii*. Following reported cases of miconazole in the literature, it was dissolved in methanol and sterilized by passing through 0.20 μm filters before being added to growing cultures of *Acanthamoeba*. When concentrations up to 500 $\mu\text{g/ml}$ of miconazole were tested, all cultures receiving 50 $\mu\text{g/ml}$ and up showed little growth. However, when methanol controls were analyzed for each culture, they, too, showed little or no growth in cultures where 2% or greater of methanol had been employed as a carrier. Methanol controls which received less than 2% methanol v/v grew equally as well or better than a second control which received only water. Subsequent experiments using less than 2% methanol as carrier allowed miconazole up to 200 $\mu\text{g/ml}$ of culture to be assayed. Growth rates were reduced by approximately 50% at 200 $\mu\text{g/ml}$ of miconazole but *Acanthamoeba* remained viable up to seven days in such cultures. These data cast doubt on the use of miconazole in low concentrations as a human treatment modality and suggests that earlier reports of its efficacy may have resulted from its

methanol carrier. This work was supported by funds from NSF Grant RII-8704133 and HIH Grant SO6RR08092.

Structural Analysis of Internal Image Antibodies, V.H. Van Cleave and D.W. Miezger, St. Jude Children's Research Hospital, Memphis. Current address of VHV: Christian Brothers College, Memphis.

Antigen mimicry by anti-idiotypic internal image antibodies offers one approach to vaccine development and immune modulation. To better understand the structural basis for this mimicry we have developed two mouse anti-idiotypic monoclonal antibodies (mAbs) that bear internal images of the rabbit α 1 allotypic marker as determined serologically. Next, immunoelectron microscopy (IEM) was utilized to directly visualize the position of this marker on the anti-idiotypic mAbs. IEM results localized the marker to the variable (V) region of the mAb. We then determined the V-region sequence for the heavy (H) and light chains by RNA primer extension. Both H chains possessed a unique arrangement of amino acids homologous, but in reversed orientation, to the rabbit α 1 allotypic marker. To test the ability of the reversed sequence to mimic the α 1 marker, synthetic peptides corresponding to both the model and the internal image were prepared. Each demonstrated inhibitory capacity leading to the conclusion that an antigenic epitope may be determined by the molecular environment of the amino acid side chain independently from the orientation of the protein carbon backbone. (AI 18880, CA 21765, and ALSAC).

PHYSICS AND ASTRONOMY SECTION

John W. Hanneken, *presiding*

Frequency Dependence of the Quantized Damping of Helicons in Semiconductor Superlattices, B.N.N. Achar and B.K. Liles, Memphis State University.

We have studied the frequency dependence of the damping of helicon waves propagating parallel to a magnetic field applied along the axis of a GaAs/(Al, GaAs) superlattice. The superlattice is characterized by a 3D electron band structure, which is free-electron-like in two dimensions and described by a Kronig-Penney type structure along the axis of the superlattice. The calculations have been carried out on the basis of linear response theory. Work is in progress to investigate the variation of the plateaus in the quantized helicon damping as the frequency is increased over several orders of magnitude. This will enable us to verify whether there is a "breakdown" of the quantum Hall effect at high frequencies, a controversial experimental result observed by Pepper et al., but not by Kuchar et al.

Quantization of Helicon Damping in the Integral Quantum Hall Regime, B.N.N. Achar and J.R. Ferguson, Memphis State University.

We have studied the damping of helicon waves propagating along the axis of a GaAs/Al, GaAs) superlattice as a function of the magnetic field also applied along the axis. Numerical results are obtained on the basis of linear response theory and a Kronig-Penney model and correspond to a temperature $T=0$ K. The results show that the damping is quantized at precisely the same values of the magnetic

field as those giving rise to the plateaus in the conductivity in the quantum Hall effect. The crucial parameters for the appearance of the quantum Hall-like plateaus in helicon damping are the band width and the electron scattering free time. Work is in progress to determine the helicon damping in the ∂ -function limit of the Kronig-Penney model. This study will enable us to confirm the existence of "zero-damping" previously found for a strictly 2D electron gas by Wendler and Kaganov.

Raman Active, Far-Infrared Modes and the Propeller Twist Structure of DNA, G. Edwards, S. Morgan and E. Silberman, Vanderbilt University and Fisk University.

We report on experiments using two complementary spectroscopic techniques that probe far-infrared vibrational modes of DNA. Fourier transform infrared and low-frequency Raman techniques are used to measure resonant features in the 20 to 200 wavenumber range. Measurements of random sequenced DNA and various polynucleotides demonstrate that poly(dA)poly(dT) is a metastable structure. These results are consistent with recent structural and CD investigations of the propeller twist structure of poly(dA)poly(dT).

The Burnett Coefficients for Hydrogen Diffusing in Pd, J.W. Hanneken, Memphis State University.

Correction terms to the standard diffusion equation can be derived assuming that the flux depends on not only $\vec{\nabla}c$ but also on higher order derivatives $(\vec{\nabla}c)^2, (\vec{\nabla}c)^3 \dots (\vec{\nabla}c)^n$.

The resulting Burnett generalization of the diffusion equation is given by $\partial c/\partial t = D_2 \nabla^2 c + D_4 \nabla^4 c + D_6 \nabla^6 c + \dots$

where D_2 is the Fick's law self-diffusion coefficient and $D_4, D_6 \dots$ are the Burnett self-diffusion coefficients. The diffusion process can be described within the context of nonequilibrium thermodynamics by the van Hove space-time correlation function whose Fourier transform leads directly to an expression for the quasielastic neutron scattering width Γ for momentum transfer \vec{k} given by $\Gamma = k^2 D_2 - k^4 D_4 + k^6 D_6 \dots$. Equations for the Burnett coefficients are determined by comparing this expression for the quasielastic neutron scattering width with the Γ predicted from the Chudley-Elliott model which accurately describes the experimental results for neutron scattering in the PdH system.

The Light Variations of BL Herculis, A.M. Heiser, Vanderbilt University.

BL Herculis is a short period pulsating variable which is a member of a class of variables called W Virginis stars. Photometric observations of BL Herculis were obtained in the uvby system on 30 nights in 1977, 1978, 1979 and 1980 at the Kitt Peak National Observatory. Our observations have been compared and combined with those of Alexander, Joner, and McNamara (Pub. Astron. Soc. of the Pacific 99, 645, 1987) to produce a new set of light and color curves for BL Herculis. All the observations taken together indicate that the period of pulsation given by Alexander, et al. can not be improved upon. All the data has also been used to determine the variation of the stellar effective temperature (T_e) and surface gravity (g) over the pulsation cycle. The T_e varies from about 6200° K at light

minimum to about 7500° K at light maximum. The data also allows an approximate determination of the absolute magnitude and the distance of BL Herculis.

Ion Beam Studies of Surfaces, P.M. Savundararaj (with R.G. Albridge and N.H. Tolk), Vanderbilt University.

We are investigating the effect of bombarding solid surfaces with medium energy ions and the resulting sputtering and desorption phenomena. The optical spectra (fluorescence) from the excited species ejected from the Lithium Fluoride, Al/Li 2090 Alloy and Zerodur™ samples are studied as a function of the beam energy (2-10 keV) and beam species (H⁺, He⁺, Ar⁺, N⁺, N₂⁺ and O⁺). The differences between the sputtering and DIET (Desorption Induced by Electronic Transition) processes are discussed. This work was funded by a grant from the University Research Initiative of the Air Force Office of Sponsored Research.

A Magnetic Study of the Crushed Axon, R. Stasaski and J. Wikswo, Vanderbilt University.

The technique of magnetic scanning was employed to study the physiological changes resulting from injury to an isolated crayfish medial giant axon. This technique involved threading the nerve through a ferrite-core toroid that detected the magnetic field associated with the action currents of a nerve. This signal was then amplified by a specially designed room-temperature amplifier. Data, taken at many locations proximal and distal to the crush, were analyzed to show changes along the axon of peak-to-peak amplitude, depolarizing and repolarizing currents, and propagation velocities. We found that as the action potential approached the crush, the repolarizing current decreased and eventually disappeared. Thus, the magnetic field associated with the action currents changed from a biphasic to a monophasic waveform. In some experiments, peak-to-peak amplitude increased just proximal to the crush before it decreased to zero, while in other experiments, no such behavior was observed. Propagation velocity increased just proximal to the crush. A core-conductor computer model is being studied to determine the physiological changes corresponding to the experimental data. Applications of this study may include the clinical assessment of damaged nerves in humans.

Interaction of Radiation with Cells and Cell Components, J. Tribble, J. Kozub, G. Edwards, K. Lane, A. Aly, and R. Ossoff, Vanderbilt University.

The first step of this study involved reducing the scattered light from a suspension of living cells in order to reveal their UV-Vis absorption characteristics. Low power optical density was measured for suspensions of different cell types as a function of refractive index of the suspending protein solution. The protein concentration yielding minimum optical density was found and UV-Vis absorbance spectra of the "clarified" suspension and of cells in normal saline were recorded. Based on these results, we are investigating wavelength dependent effects of pulsed radiation from an Nd:YAG pumped tunable dye laser. The first series of laser experiments, to determine bacteriostasis as a function of laser power and wavelength, correlate with absorption spectra.

SCIENCE AND MATHEMATICS TEACHERS SECTION

Marvin Tidwell, *presiding*

Research Trends in Mathematics Education, A Review of Selected Topics, R.K. Fletcher Jr., Tennessee Technological University.

Research in mathematics education is being conducted at all grade levels and over a wide variety of topics. This paper discusses research findings and trends in mathematics education relating to the incremental approach of John Saxon and other related areas such as mastery learning. Findings in research studies generally support the Saxon approach which provides students with a continual, non-segmented introduction to mathematics content and a high emphasis on review of previously covered materials. The studies reviewed relate to applications of his method with student samples from both high school and college levels. Research studies from other areas of investigation reported in *Dissertation Abstracts International*, *Journal of Research in Mathematics Education*, and other selected sources are discussed in the paper. Special attention is given to studies in computer applications to teaching mathematics.

The Senior Associate Program of the Water Quality Monitoring Network, Elizabethton, G. Barrigar, Elizabethton High School, and B.W. Benson, The University of Tennessee at Chattanooga.

Elizabethton High School students tested a local body of water, the Doe River, for biological and chemical parameters. The Doe River was chosen because it directly influences the water quality of the Watauga River and therefore contributes to the quality of the water in the Boone Reservoir. According to the Gross Stream Assessment, samples of fish populations, and chemical tests, the Doe River could be rated in good condition. However, high water levels may bring higher levels of pollutants due to runoff. The solutions to pollution problems depend upon the combined efforts of federal, state, and local agencies as well as an informed and interested public.

The Senior Associate Program of the Water Quality Monitoring Network, Kingsport, D. Eiklor, Sullivan South High School, and B.W. Benson, The University of Tennessee at Chattanooga.

Students from Sullivan South High School in Kingsport, Tennessee, tested a local stream, Kendrick's Creek, before and after it passed through a community to determine the impact of urbanization on the water quality of the stream. The stream was investigated at several points between study site I and II to determine any effects that the local community have had on the creek. These investigations revealed the stream had been used as a "garbage dump" in places. In addition, site II had at least two-thirds less aquatic insects than site I. Thus, the results revealed that urbanization has a great impact on the water quality of Kendrick's Creek.

Microcomputer-based Laboratories for Teaching of the Physical Sciences, R.S. Peterson, The University of Tennessee at Chattanooga.

Abstract not available at press time.

The Senior Associate Program of the Water Quality Monitoring Network, Athens, J. Runyan, Athens City Schools, and B.W. Benson,

The University of Tennessee at Chattanooga.

Students at Athens Junior High School created a videotape of water quality monitoring showing background safety features as well as how to conduct ten water quality tests. Students then wrote a teaching unit utilizing this tape, the LaMotte water quality test kit, and research materials. Also, students used Science/Mathematics Fair objectives to develop a unit about using water quality tests to build confidence and to see relevance of topics for science fair projects.

Using Number Theory in Elementary Algebra, A. Tirman, East Tennessee State University.

The employment of examples and identities from number theory in the teaching of developmental courses in elementary algebra apparently enables the students to see not only reasons for doing algebra but also the necessity for obtaining and performing mathematical proofs.

ZOOLOGY SECTION I

O. Ray Jordan, *presiding*

Litter Size of the Coyote in Western Tennessee, J.G. Babb, M.L. Kennedy, R.M. Lee III, and C. Lydeard, Memphis State University.

Litter size of 55 coyotes (*Canis latrans*) was studied in western Tennessee from 1983 to 1988. Most specimens were collected by trappers, hunters, and Tennessee Wildlife Resources Agency personnel. Uteri were removed and examined for placental scars. Average litter size was 5.0. The range in litter sizes was 1 to 12.

A Determination of the Frequency of Several Retroviral Genomic Elements in the cDNA from Mouse Testes, T.E. Byrne, Roane State Community College, F.E. Myer, L-Y. Ch'ang and W.K. Yang, Oak Ridge National Laboratory.

The purpose of this study is to determine the expression of the MRL class retroviral elements that may undergo frequent retrotransposition in the mouse germline, as suggested by the previous studies of this laboratory. A quantity of 300,000 plaque forming units of recombinant lambda phage containing mouse (*Mus musculus*) testes cDNA population were used to infect *E. coli* C 600 Hfl and subsequently were blotted onto nitrocellulose filters. Numbers of recombinant phage plaques containing retroviral genomic sequences were determined by hybridization of the nitrocellulose membrane filters with specific molecular probes representing the MRL elements and murine leukemia virus-related proviruses. Autoradiographs were made by exposure of the nitrocellulose membrane to Kodak XAR film with Du Pont Lightning Plus intensifying screens for a period of 2-7 days at -70°C. From analysis of the autoradiographs the observed mean numbers of positive clones per 10,000 plaque forming units were as follows: the MRL "D" sequence probe, 45.4; the Mink Cell Cytopathic Focus-Forming (MCF) probe, 14.5; the Long Terminal Repeat (LTR) probe, 6.7 and the Insertion Sequence (IS) probe, 6.6. The results indicate relatively high content of MRL element transcripts in the mouse testis. Whether selective members or all of the MRL multiple gene family in the mouse genome are involved in the expression remains to be investigated. Research supported by the National Institute of Environmental Health Sciences, Y01-ES-40118 and by OHER,

Department of Energy under contract DE-AC05-84OR21400 with Martin Marietta Energy Systems, Inc.

The Phylogeny of the Coatis (Genus: Nasua), D.M. Decker, Memphis State University.

A phylogenetic analysis was performed on the genus *Nasua* based on twenty-seven cranial, eight dental, one post-cranial, and two soft anatomical characters. The most parsimonious tree united North American populations in one clade separate from South American populations suggesting the recognition of *N. narica* (considered conspecific with *N. ansua* by Honacki et al., 1982). The Cozumel Island coati (*N. nelsoni*) shares nine synapomorphies with mainland coatis, among these are characteristics of the baculum, palate, and rostrum. A phenetic analysis was done to determine the amount of geographic variation in skull characters and the distribution of the coatis is mapped.

Chiroptera of Tennessee Under Review for Possible Listing as Endangered or Threatened, M.J. Harvey, Tennessee Technological University.

Three species of bats occurring in Tennessee are under review by the U.S. Fish and Wildlife Service for possible listing as endangered or threatened. They are the southeastern bat, *Myotis austroriparius*; eastern small-footed bat, *Myotis leibii* (referred to as *Myotis subulatus* in the federal document); and Rafinesque's big-eared bat, *Plecotus rafinesquii*. Eastern small-footed bats are apparently relatively rare in Tennessee; a few have been reported from caves in winter. Rafinesque's big-eared bat does not seem to be abundant anywhere within its range; only relatively small numbers appear to be present in Tennessee. Southeastern bats are relatively abundant in Tennessee during summer, especially in the western part of the state.

Histochemical and Chromatographic Analysis of Catecholamines in Limulus Ganglia, R. Holloway, G.V. Clay and R.F. Newkirk, Tennessee State University.

The catecholamines function as neurotransmitters in a wide spectrum of animals. The purpose of this study was to shed additional light on the role of catecholamines as putative neurotransmitters in the horseshoe crab, *Limulus polyphemus*. The abdominal and cardiac ganglia were studied using techniques of fluorescence histochemistry and high performance liquid chromatography (HPLC) to identify and localize endogenous catecholamines. Results from the fluorescence histochemistry revealed clusters of catecholamine containing neurons in each abdominal ganglion and individual fluorescent cells in the cardiac ganglion and in the connectives of the abdominal ganglia. Tissue extracts of these tissues analyzed by HPLC showed significant levels of norepinephrine, epinephrine and lesser amounts of dopamine. These results suggest that the catecholamines, norepinephrine, epinephrine and dopamine, are localized in neurons of *Limulus* abdominal and cardiac ganglia where they may function as neurotransmitters. Supported by NSF #RII-8704133.

Relationship of Capture Success of Opossums and Raccoons with Selected Habitat Variables, R.E. Kissell Jr. and M.L. Kennedy,

Memphis State University.

The relationship of capture success of opossums (*Didelphis virginiana*) and raccoons (*Procyon lotor*) with selected habitat variables was studied from 1 January 1988 to 20 March 1988. The investigation was conducted on the Milan Army Ammunition Plant in Gibson and Carroll counties in western Tennessee. Animals were live-trapped, marked, and released. Eighty opossums and 13 raccoons were captured 101 and 17 times, respectively. Capture frequency was 4.8% for opossums and 0.8% for raccoons. Trap success for both species was statistically correlated with the basal area of conifers; trap success of opossums was also significantly correlated with distance to available water.

Additional Notes on the Food Habits of the Coyote in Tennessee, R.M. Lee III and M.L. Kennedy, Memphis State University.

Food habits of the coyote, *Canis latrans*, were examined for specimens collected in Tennessee from 1978 to 1988. Digestive tracts of over 475 individuals were assessed. Major food items and percent occurrence for each item were determined. Rabbit, rodent, and vegetation were among the most frequent foods eaten. These results were discussed in relation to those of previous studies.

Dental Asymmetry and Genetic Variability in Peromyscus leucopus, J.P. Nelson Jr. and P.K. Kennedy, Memphis State University.

The relationship between dental asymmetry and genetic variability was examined in a population of white-footed mice, *Peromyscus leucopus*, from Shelby County, Tennessee. Fourteen presumptive gene loci were examined by starch gel electrophoresis to provide individual heterozygosity values. Asymmetry values (right side minus left side) were obtained from seven dental characters from 30 males and 22 females. Significant relationships were found between the asymmetry value for mandibular tooth-row length and overall heterozygosity and with heterozygosity at a locus for superoxide dismutase.

Seasonal Activity of Reptiles Around Woodland and Old Field Ponds in Land Between the Lakes, A.F. Scott, Austin Peay State University.

Activity of reptiles occurring in the vicinity of a woodland and an old field pond in TVA's Land Between the Lakes (LBL) was studied from 1 July 1987 through 30 June 1988. Drift fences with pitfall traps (checked every other day) were used to capture animals moving toward and away from ponds. Ten species were encountered at each pond; thirteen species were recorded overall. Seven species (two turtles, three lizards, and two snakes) were found at both ponds, while the remaining six species were equally divided into two groups, each peculiar to only one pond. Of the 86 individual captures recorded, 40 were logged at the woodland pond and 46 at the old field pond. Lizards (mainly *Sceloporus undulatus*) predominated at both ponds (82% and 78% of the captures, respectively) followed by snakes (11% and 14%), then turtles (7% and 8%). Two peaks in activity level were detected during the annual cycle. The first came in April, immediately following the hibernation period; the second of greater magnitude, came during August and September, about a month before activity ceased. Relative numbers of movements toward and away from ponds varied seasonally, but did not differ significantly at any time. Results

suggest the following about reptile communities and activity around woodland and old field ponds in LBL: (1) community composition is similar in both situations but certain species seem to prefer each microhabitat; (2) lizards are the most abundant type of reptile around both pond types; and (3) no seasonal patterns in the direction of movement relative to the ponds exist.

Food Habits of the Nine-banded Armadillo in Southwestern Arkansas, R.S. Sikes, Memphis State University and G.A. Heidt and D.A. Elrod, University of Arkansas at Little Rock.

Food habits of the nine-banded armadillo (*Dasypus novemcinctus*) were studied in Little River County, Arkansas. Eighty-four armadillos (52 males; 32 females) were collected from October 1986 through January 1988. Stomach contents were analyzed for food items present, percent occurrence, and percent volume. Food items observed were primarily invertebrates, but vertebrates and plant material were present in some individuals. Food items found in the greatest frequencies included coleopterans, chilopods, hymenopterans, diplopods, dipterans, and orthopterans. Coleopterans, dipterans, and oligochaetes were found in greatest volumes. Plant material was usually found in trace amounts. Seasonal shifts were apparent with dipteran larvae being the principal prey item in the winter while coleopterans were the most heavily consumed item in all other seasons. The seasonal shifts observed in the present study differ from those reported in previous studies for more southern portions of this species' range.

ZOOLOGY SECTION II

Frank Bulow, presiding

Den Selection by an Insular Population of Raccoons, K.M. Endres and W.P. Smith, Tennessee Technological University.

Fifteen raccoons were live trapped, fitted with radio collars and monitored uninterrupted according to a rotating, systematic sampling schedule from March 1987 through May 1988 on Davies Island, Center Hill Reservoir, DeKalb County, Tennessee. Den sites were identified and recorded as ground, rock, or tree; dens which could not be verified (i.e., located via signal strength) following triangulation were categorized as unknown. Relative frequency of occurrence among ground, tree, and rock dens was 37%, 32% and 23%, respectively; 8% of the locations were unconfirmed. Den abundance, rather than sex and consequential home range size, seemed to influence frequency of use. Large American beech (*Fagus grandifolia*) trees were abundant on the island and represented 65% of tree dens; oaks (*Quercus* spp.), tulip tree (*Liriodendron tulipifera*) and miscellaneous species accounted for 18%, 12% and 5%, respectively. Mean diameters at breast height (cm) of den trees were as follows: beech, 80.3; oak, 81.0; tulip tree, 65.0; and miscellaneous, 71.4. Some of the variation in tree den selection appears to be associated with size (and probably age) of available trees.

DDM Predictions for Superheavy Elements and Nuclei, K. Kumar, Tennessee Technological University.

The Dynamic Deformation Model (DDM) of nuclear structure has been extended to the problems of nuclear fission, superheavy

elements, and superheavy nuclei. The greatly improved theory explains why superheavy elements and nuclei have not been found in spite of enormous experimental efforts during the past twenty years. New calculations predict a "magic" island dominated by a total-half-life peak of 1,079y ("magic" mountain) for the A=300 isotope of ekta-Polonium (Z=116) and containing minor peaks of 70y, 5y, and 9y for the A=297, 302 and 331 isotopes of ekta-Thallium (Z=113), ekta-Radon (Z=118), and ekta-Neptunium (Z=125), respectively. A predicted experimental trail to the "magic mountain" will be discussed.

Effect of Form and Source of Fiber and Energy on Performance, Carcass Characteristics, Ration Digestibility and Rumen Parakeratosis on Lambs, H-C. Liu, S.K. Winfree, and C.B. Coburn, Tennessee Technological University.

A feeding trial was conducted to determine the effects of pelleted roughage and added animal fats on growth and carcass characteristics. A feeding trial was conducted to determine digestibility coefficients and ration total digestible nutrients. Rumen tissue was evaluated, histologically, for evidence of parakeratosis. Three treatments were: I. Low fiber, low fat (LF) pelleted ration plus 0.5 pound whole hay per head per day; II. LF, built in roughage (BIR) pelleted ration; III. High fat (HF), BIR pelleted ration. There were no significant differences in performance, carcass characteristics or ration digestibility in treatments receiving hay vs BIR rations or HF vs LF rations. Lambs in HF ration had higher average daily gain and more desirable feed efficiency than lambs in LF ration. Lambs on pelleted plus hay gained less during the trial than lambs on the BIR ration. Rumen histology indicated some evidence of formed keratin in each treatment. No serious parakeratosis or overall differences were detected among treatments.

The Effects of Novobiocin and Nalidixic Acid on the Growth of Leishmania donavani, B.S. McAdory and A. Adibi, Tennessee State University.

Leishmania donavani is the causative agent of Kala-azar, the visceral form of leishmaniasis. The anti-leishmanial drugs of choice have toxic side effects similar to arsenic poisoning in addition to being less than 100% effective. The objective of this study was to test the efficacy of two commonly used antibiotics, novobiocin and nalidixic acid, against *L. donavani* promastigotes. *L. donavani* promastigotes were grown in medium containing various concentrations of novobiocin or nalidixic acid and a combination of novobiocin and nalidixic acid for a minimum of six days. Cell growth was monitored every twenty-four hours beginning at the time of inoculation to determine the effect of novobiocin and nalidixic acid on the growth of *L. donavani* promastigotes.

Sodium dodecyl sulfate polyacrylamide gel electrophoresis (SDS-PAGE) using the Laemmli buffer system was run to determine the effect of the antibiotics on DNA transcription.

Novobiocin and nalidixic acid, at concentrations of 400 and 600 µg/ml, retards the growth rate of *L. donavani* promastigotes grown in DMEM at 25°C, and more so when novobiocin and nalidixic acid are used in combination. Cell growth was partially or negligibly inhibited at concentrations of 10, 50, 100, and 200 µg/ml.

The results of these experiments strongly suggest that novobiocin and nalidixic acid, in concentrations 200 µg/ml retard growth of *L. donavani* promastigotes. It is also suggested that these antibiotics may play a role in the suppression or enhancement of protein transcription.

Nestsite Selection and Reproductive Success of Resident and Introduced Eastern Wild Turkey Hens on Natchez Trace State Park, Tennessee, J.H. McGuinness and W.P. Smith, Tennessee Technological University.

During 28 January–5 February 1988, 15 resident and 14 hens (introduced from Land Between the Lakes) were captured, radio-equipped, and released on Natchez Trace State Park. Hens were monitored uninterrupted through the nesting season to determine survival and nesting success. Hen survival to the nesting season was 86.7% and 50.0% respectively for resident and introduced birds. Known mortality among introduced hens included predation (57%) and poaching (14%). One resident hen was taken illegally; the other died from complications associated with trapping. Proportionally, introduced hens made fewer nesting attempts, and exhibited lower success rates. Renesting attempts occurred only in resident hens. Nestsite selection varied more for resident than introduced birds. Resident hens utilized grasslands, mature (>50 year old) loblolly pine, and kudzu for nesting, while introduced birds exclusively used mature oak-hickory uplands. These data indicate that introduced eastern wild turkey experience high mortality rates and low reproductive success during the first year. Restocking success may be contingent upon our further understanding habitat imprinting and its influence on habitat familiarity, nestsite selection and reproduction.

Introduction of Swamp Rabbits onto Cordell Hull Wildlife Management Area: A Status Report, D. Massengill and W.P. Smith, Tennessee Technological University.

During 1986–1988 Tennessee Wildlife Resources Agency introduced swamp rabbits (*Sylvilagus aquaticus*) into ecologically similar (but non-native) habitat within Cordell Hull Wildlife Management Area with the goal of establishing viable populations in Middle Tennessee. Eleven males and three females were captured; two were netted while swimming and the remaining rabbits were trapped in wooden box traps (15×15×60 cm). Three females and seven males were fitted with radio-transmitters to monitor their behavior and evaluate the success of the introductions. Locations were plotted on individual aerial photographs (scale 1:18000). Mean daily movements during the initial two days following release were 217.0 m and 222.0 m for males (n=3), and 257.0 and 222.0 m for females (n=3). During the third and fourth day following release, males averaged 175.4 m and 315.5 m (n=2). Mean distance of center of activity from release sites were 641.1 m and 1,083.8 m for males and females, respectively. Seven rabbits suffered predation during 2-6 week period following release; three of the seven were taken by avian predators while the remains of two rabbits were found near fox dens. These data suggest that introduced swamp rabbits suffer high predation rates. Frequent and extensive movements following release may be related to their unfamiliarity with the habitat and ultimately increased vulnerability to predation.

Harvest Characteristics of White-Tailed Deer Recently Subjected to Hunting, C.J. Mitchell and W.P. Smith, Tennessee Technological University.

Oak Ridge Wildlife Management Area supports a white-tailed deer population which in 1985 experienced its first hunting pressure since the mid 1940's. Mean age of the harvest decreased during both 1986 ($\bar{x}=1.95$) and 1987 ($\bar{X}=1.86$) as compared to the initial harvest ($\bar{x}=2.12$). Also, the mode and median age at death were younger during 1986 and 1987. The decrease in age resulted from an increase in the proportion of 1.5 year-olds (yearlings) during 1986 (33.0%) and again in 1987 (36.4%) as compared to 1985 (22.0%); and a concomitant decrease in the proportion of ≥ 2.5 year olds (adults) during 1986 (42.6%) and 1987 (37.2%) as compared to 1985 (51.9%). Among adults, 2.5 year olds experienced the greatest increase in harvest pressure over the three-year period. Although the overall sex ratio changed little during 1985-1987, the increase in yearling harvest during 1986 and 1987 was biased toward males (74.3% and 72.0%, respectively). These data suggest that either-sex hunting can significantly influence the demography of white-tailed deer via a change in the age and sex structure of the residual population.

Analysis of the Glue Proteins in Megaselia scalaris, H.W. Park and D.B. Benner, East Tennessee State University.

Megaselia scalaris belongs to the Phoridae, one of the transitional families in the order of Diptera. The salivary gland of *M. scalaris* like those of other dipteran flies, is fully bloated at the time of puparium formation due to the accumulation of proteins in the lumen. This study provides biochemical and histochemical analyses on the salivary secretion of *M. scalaris* larvae at puparium formation. Secretion proteins made up 52.38% of whole gland proteins based on comparison of whole gland protein content and the discharged protein content. Secretion proteins were separated into polypeptides and became negatively charged in mercaptoethanol and SDS buffer. The negatively charged polypeptides were then separated on a discontinuous buffered SDS acrylamide gel and subsequently stained with Coomassie brilliant blue PAS, Alcian blue, and Sudan black B. Seven different sizes of secretion polypeptides were recovered and the presence of neutral and/or acidic mucopolysaccharide linked to each polypeptide except P5 and P7 which do not show the presence of acidic mucopolysaccharide. Lipid material, possibly phospholipids, were detected within P2 and P7. Secretion polypeptide P2 appeared in 10 day old larvae. All other polypeptides appeared later. The stain intensities of all secretion polypeptides increased from the times of their appearances until they were discharged at puparium formation.

Changes in Eastern Bluebird Eggshells During Incubation, T.D. Pitts, M.P. Martin, K.A. Crews, and L.M. Conner, The University of Tennessee at Martin.

As part of a long-term study of Eastern Bluebird (*Sialia sialis*) nesting biology and behavioral ecology we compared eggshells from eggs that had not been incubated with eggshells from eggs that had either hatched or contained large embryos. Characteristics compared included: thickness, strength, vesicular hole size, and vesicular hole

density. Shells from unincubated eggs averaged 83.5 micrometers in thickness while shells from incubated eggs averaged 73.6 micrometers, a decrease of about 12%. Strength of shells, as measured by a puncture test, declined significantly during incubation. Vesicular holes did not change in size or density during incubation suggesting that at least part of the internal structure of shells remains intact during incubation.

Urban Development, Water Quality, and Benthic Community Structure of Caves in Cookeville, Tennessee, T.E. Pride, M.J. Harvey, A.E. Ogden, and W.P. Smith, Tennessee Technological University.

Degradation of cave communities and groundwater quality is a growing concern in karst terrains. To determine the influence of contaminated runoff in Cookeville, Tennessee, on cave stream benthic diversity, water quality data were collected for one year from three caves. In addition, benthic macroinvertebrates were collected from riffle areas in the same caves. An analysis of variance of Shannon diversity indices (Capshaw Cave=0.32, Ament Cave=0.25, and City Spring Cave=0.49) resulted in rejection of the null hypothesis; $H'_1=H'_2=H'_3$. A Tukey test revealed a difference ($p<0.05$) among all three benthic communities. In terms of abundance, Capshaw and Ament Caves were dominated by an oligochaete/dipteran assemblage (94.1% and 98.8%, respectively), while City Spring Cave supported primarily isopods (69.9%). Capshaw and Ament caves exhibited larger coefficients of variation for temperature, dissolved oxygen, turbidity, chloride, and fecal coliform than City Spring Cave. A relationship between degrading water quality and reduced biotic diversity is suggested, however, diversity may be more controlled by hydrologic factors such as the physical nature of the major recharge component (diffuse or conduit flow).

Morphological Analysis of Redeye Bass (Micropterus coosae), Smallmouth Bass (M. dolomieu), and Suspected Hybrids in Roaring River, Tennessee, J.M. Turner Jr. and F.J. Bulow, Tennessee Technological University.

Redeye bass (*Micropterus coosae*) and smallmouth bass (*M. dolomieu*) in Roaring River were studied in relation to their habitat overlap. Several suspected redeye bass X smallmouth bass hybrids were collected from the habitat overlap area. These fish, as well as typical redeye bass and smallmouth bass from Roaring River and other redeye bass and smallmouth bass from assumed pure populations were subjected to a morphometric and meristic analysis. Ten counts, 22 measurements, total fish weight, liver weight, gonad weight, and sex were determined for each fish. The numeric data were subjected to a discriminant function analysis to separate the morphometric characteristics into distinct groups for each fish species. A habitat analysis was conducted at eight sites on Roaring River. This was done to distinguish the differences between redeye bass habitat and smallmouth bass habitat. Dissolved O_2 , conductivity, alkalinity, temperature, percent canopy cover, pH, stream width, stream depth, stream velocity, vegetation, and substrate were measured in the habitat analysis.