

## ABSTRACTS OF PAPERS PRESENTED AT THE 2004 MEETING OF THE TENNESSEE ACADEMY OF SCIENCE

### BOTANY SECTION

DWAYNE ESTES, CHAIR

A SYNOPSIS OF THE WOODY FLORA OF TENNESSEE. **Edward W. Chester and B. Eugene Wofford**, *Austin Peay State University, Clarksville, Tennessee and The University of Tennessee, Knoxville, Tennessee*. A numerical summary of the woody plants known from Tennessee is provided, including data on listed elements, comparative richness across the state, and geographic affinities. The flora consists of 360 native and 46 naturalized taxa within 70 families and 161 genera. Large families are the Rosaceae (63 taxa), Ericaceae (36), and Fagaceae and Caprifoliaceae (24 each). Large genera are *Quercus* (22), *Crataegus* (14), and *Prunus* and *Rubus* (12 each). Fifty-five taxa are state-listed, including two that are federally listed and five that are possibly extirpated. Richness (number of native taxa) increases across the state from 204 in west Tennessee to 332 in the east. Richness is greatest within the Cumberland Plateau Province, followed by the Unaka Mountains, and is least in the Mississippi Alluvial Plain. Much of the flora is intraneous, or well with the total range of taxa; however, extraneous elements with more northern and southern affinities are well represented.

BOYD BARRENS: A SIGNIFICANT BOTANICAL SITE ON THE EASTERN HIGHLAND RIM. **Roger McCoy and Claude Bailey Jr.**, *Tennessee Division of Natural Heritage, Nashville, Tennessee*. During the 1940s botanical collections near Morrison, Tennessee yielded some unusual species. Subsequent trips reinforced that the wet, barren-like areas of the vicinity contained numerous rare plants. However, many of these locations have been degraded and some of the rare occurrences have not been seen in decades. In 1997, another site was discovered less than one mile from the original collection locations. The approximately twenty-acre site appears to be a remnant of a once-extensive wetland barrens complex in the Morrison area. Currently at least eight state-listed plants have been documented and additional rare species continue to be found. Most of the rare plants are wetland species with some restricted to acidic wetlands. The plants occur in an open, herb-dominated community that is maintained by annual mowing. Although not rare globally, these plants are considered extremely rare in Tennessee. Currently the site is not protected, but landowner contact has been initiated.

THE HISTORIC DISTRIBUTION AND PRESENT STATUS OF *DESMODIUM OCHROLEUCUM* (CREAMFLOWERED TICK-TREFOIL) IN TENNESSEE, **Claude J. Bailey Jr.**, *Tennessee*

*Division of Natural Heritage, Nashville, Tennessee*. In 2004, the United States Fish and Wildlife Service funded a survey for *Desmodium ochroleucum* (creamflowered tick-trefoil) in Tennessee. The survey conducted over the summer of 2004 led to the discovery of a new population of *D. ochroleucum* from a successional cedar barren in Perry County, Tennessee. The current historical range of *D. ochroleucum* includes 12 eastern states, but is documented as extant in only seven with less than 15 known rangewide occurrences. Within Tennessee it has been historically recorded from three counties and had not been collected or observed since 1965. It is currently legally listed as an endangered species in Tennessee. The global rarity and recent relocation of this species in Tennessee makes *D. ochroleucum* a species of high conservation concern.

GAMETOPHYTIC AND SPOROPHYTIC RESPONSES OF *PTERIS* SPECIES TO ARSENIC. **T. Justun Durham\***, **Hollings T. Andrews**, and **T. Wayne Barger**, *Tennessee Technological University, Cookeville, Tennessee*. Few plant species have demonstrated the ability to hyperaccumulate heavy metals from contaminated soil. Recently, the Chinese ladder brake fern (*Pteris vittata* L.) has been identified as a hyperaccumulator of arsenic (Ma et al., 2001). Because gametophytic development is an essential stage in the fern life cycle, impacts of heavy metal hyperaccumulation on gametophytic and sporophytic tissue must be investigated if successful continuous bioremediation efforts are to be implemented. Our research shows that sporophytes as well as gametophytes of *P. vittata* are capable of As uptake and accumulation. Spore germination was not inhibited by the presence of increased As, and gametophyte morphology showed deleterious effects only when grown for extended time periods on a growth medium with extremely high As concentrations ( $\geq 600$  ppm). Sporophytes showed no such adverse effects when exposed to the highest soil As levels (1650 ppm); in fact, root proliferation was observed in areas of increased As concentration (250 ppm). However, foliar application of an arsenical herbicide to sporophytes caused decreases in total chlorophyll and total carotenoids. Phosphate additions inhibited As uptake, indicating As uptake may involve a phosphate transporter.

TABLE MOUNTAIN PINE (*PINUS PUNGENS* LAMB.) REGENERATION FOLLOWING A WILDFIRE IN THE CHEROKEE NATIONAL FOREST/FOOTHILLS PARKWAY, TENNESSEE. **Nicole Turrill Welch**, **Dwayne Coleman\***, and **Chris Meyer\***, *Middle Tennessee State University, Murfreesboro, Tennessee*. Seventy years of fire suppression have increased the presence of hardwood species in many *Pinus pungens* ecosystems and post-fire regeneration of *P. pungens* often is poor. This study examined *P. pungens* regeneration following the recent Green Mountain Fire in the Cherokee National Forest. Assessment of standing dead revealed that *P. virginia* (12.97 m<sup>2</sup>/ha), *P. pungens*

\* Student author.

# Presenting author.

(12.82 m<sup>2</sup>/ha), *P. rigida* (4.46 m<sup>2</sup>/ha), and *Nyssa sylvatica* (1.15 m<sup>2</sup>/ha) were the dominant canopy species before the burn. Most stems of *P. virginia* were < 25 cm diameter breast height (dbh) whereas most stems of *P. pungens* were > 20 cm dbh; stems of hardwood species were < 15 cm dbh. There was no significant difference in the mean number of pine and hardwood seedlings four years after the fire, 23,900 ± 16,000 and 23,000 ± 26,400 seedlings/ha, respectively. *P. pungens* regenerated well (29,700 seedlings/ha), and better than the other pine species; *Oxydendron arboreum* and *Acer rubrum* produced 34,800 and 19,200 seedlings or sprouts/ha, respectively. *P. pungens* regeneration was such that it should retain its dominance in this ecosystem.

SEASONAL CHANGES IN HERB LAYER COVER AND SPECIES COMPOSITION IN TABLE MOUNTAIN PINE (*PINUS PUNGENS* LAMB.) FORESTS OF THE GREAT SMOKY MOUNTAINS NATIONAL PARK, TENNESSEE. **Dwayne E. Coleman\***, **Chris Meyer\***, and **Nicole Turrill Welch**, *Middle Tennessee State University, Murfreesboro, Tennessee*. This study examined the seasonal changes in herb layer cover and species composition of two *Pinus pungens* forests in the Great Smoky Mountains National Park. The Foothills Parkway site (FHP) is an early successional stand whereas the Bote Mountain site (BM) is a late successional stand. There was a significant difference ( $P < 0.001$ ) in mean percent cover in May (48.53 %/m<sup>2</sup>) and July (88.50 %/m<sup>2</sup>) for FHP, whereas there was no significant seasonal difference in mean percent cover for BM (May = 63.51 %/m<sup>2</sup> and July = 68.58 %/m<sup>2</sup>). The dominant species of the herb layer at both sites stayed the same from May to July 2004. Dominant species at FHP were *Smilax glauca*, *P. pungens*, and *Erechtites hieracifolia* while *Gaylussacia baccata*, *Gaultheria procumbens*, and *Vaccinium pallidum* were dominant at BM. These data suggest that young *P. pungens* forests exhibit a greater change in herb layer percent cover during the growing season compared to older forests.

ECOLOGY OF *CASTANEA DENTATA* IN KENTUCKY AND TENNESSEE. **Louis J. Schibig**, **Robert R. Barber**, **Michael J. Hill\***, **Clint Neel**, **Jack C. Torkelson**, and **James M. Vance\***, *Volunteer State Community College, Gallatin, Tennessee*, *Austin Peay State University, Clarksville, Tennessee*, and *Tennessee Technological University, Cookeville, Tennessee*. Since 2002, 2066 native American chestnut trees have been inventoried in 41 Kentucky and Tennessee counties. For each specimen, GPS coordinates, diameter at breast height (dbh), height, flowering status, presence or absence of blight, associated tree species, elevation, and topographic position were recorded. ArcView was used to map chestnut sites and to show physiographic, geological, and edaphic associations. Five % of the trees were blighted and two % were flowering. On the Highland Rim, 74 % of the trees occurred on dry sites, mostly south or west facing slopes. On the Cumberland Plateau and at Mammoth Cave National Park, 91 % and 55 % respectively, were on mesic sites, mainly north to east-facing slopes. Associated species included *Acer rubrum*, *Oxydendrum arboreum*, *Quercus prinus*, and *Vaccinium spp.* The largest live chestnut trees recorded were on the eastern Highland Rim. A total of 112 dead chestnut stems ≥ 2.5 cm were examined; their average longevity was 15.9 years, average diameter was 6.4 cm, and average growth rate was 0.5 cm per year.

ECOLOGY OF *CASTANEA DENTATA* AT MAMMOTH CAVE NATIONAL PARK. **James M. Vance\*** and **Louis J. Schibig**,

*Tennessee Technological University, Cookeville, Tennessee* and *Volunteer State Community College, Gallatin, Tennessee*. Since 2003, 1201 native American chestnut trees at Mammoth Cave National Park have been studied. For each tree, GPS coordinates, diameter breast height (dbh), height, flowering status, presence or absence of blight, associated tree species, elevation, and topographic position were recorded. None of the trees were flowering and only seven had a dbh ≥ 10.2 cm. The largest tree had a dbh of 20 cm, was 13.7 m tall, and was blight-free. Only 14 (1 %) of the trees definitely had the blight. The average elevation for chestnut trees was 226 m, and they were found primarily on well-drained, acidic, sandstone soils. Associated species included *Acer rubrum*, *Carya spp.*, *Fagus grandifolia*, *Liriodendron tulipifera*, *Nyssa sylvatica*, *Quercus alba*, *Q. velutina*, and *Vaccinium spp.* The age, diameter, and growth rate of 35 dead chestnut stems ≥ 2.5 cm were determined. These trees averaged 3.3 cm in diameter, had an average growth rate of 0.2 cm per year, and the average longevity was 20 years.

THE VASCULAR FLORA OF FALL CREEK FALLS STATE PARK, VAN BUREN AND BLEDSOE COUNTIES, TENNESSEE. **Chris A. Fleming** and **B. E. Wofford**, *Breedlove, Dennis, Young and Associates, Inc., Franklin, Tennessee* and *The University of Tennessee, Knoxville, Tennessee*. A project to document the vascular flora of Fall Creek Falls State Park (FCFSP), Van Buren and Bledsoe Counties, Tennessee was initiated in the spring of 2001 and completed at the end of the 2002 growing season. This site encompasses ca. 8900 ha on the western escarpment of the Cumberland Plateau. A total of 2,224 accession numbers from this study and 47 previous collections from the site housed at TENN and VDB yielded 131 families, 445 genera, and 879 species. The non-native flora consisted of 110 species or 12.5% of the total flora. Seventeen taxa with either a state or federal listing were encountered or documented during this study with the most notable ones being *Spiraea virginiana*, *Thuja occidentalis*, *Nestronia umbellula*, *Pilularia americana*, *Hydrocotyle americana*, and *Berberis canadensis*. Voucher specimens were deposited in the herbarium of The University of Tennessee, Knoxville, Tennessee.

A REPORT ON TENNESSEE STATE PARKS ALL TAXA BIODIVERSITY INDEX; UPDATE AT EDGAR EVINS STATE PARK. **Rex R. Barber**, **Wendy L. Hesson\***, and **Julia E. MacFarland\***, *Volunteer State Community College, Gallatin, Tennessee*. Tennessee Department of Environment and Conservation (TDEC), supported by other organizations such as Tennessee Natural Heritage, Natural and Cultural Resource Management (NCRM), Discover Life in America (DLIA), et al., is sponsoring a Tennessee State Parks All Taxa Biodiversity Inventory (ATBI). A weekend conference in August, 2004, initiated and began organizing the project, and included representatives from Tennessee State Parks and higher academic institutions, as well as the previous mentioned groups. We decided to basically follow the methodologies of the North Carolina Vegetation Survey with some modifications. Traditional and structured observation, collecting, and documenting are encouraged. Traditional surveys include chance discoveries of species as well as random or systematic accepted survey methods. Structured sampling will involve permanent plots and long term monitoring, and will be a uniform protocol in all parks. Details of the structured methodologies are still being discussed by the Tennessee State Parks ATBI Steering Committee, and progress will be reported. A research team from

Volunteer State Community College (VSCC), Gallatin, Tennessee, is participating in a traditional dendrology survey on the 2,600 ha (6,500 acre) Edgar Evins State Park. Five study areas are being systematically surveyed utilizing the quarter-point method, and data will be analyzed with traditional Importance Value (IV) statistics. Although some of the park is relatively recently disturbed and several anthropogenic factors are apparent and being documented, the research team has discovered several diverse, relatively natural deciduous forest ecosystems and communities. The primary objective of this traditional preliminary research is to locate suitable permanent plot locations, and document and report existing forest communities and composition. Analysis of the data collected will be reported, as well as aspect, topographic, and edaphic correlations.

#### THE VASCULAR FLORA OF GILES COUNTY, TENNESSEE.

**Dwayne Estes\***, *The University of Tennessee, Knoxville, Tennessee*. Giles County, Tennessee is located in a portion of the state that has received little botanical attention. In order to increase the knowledge of the county's flora, a study was conducted between 1998 and 2004. The objectives of this project were to: 1) compile a list of the county's native and naturalized flora; 2) locate populations of state/federally listed species of conservation concern; and 3) qualitatively describe all plant communities. A total of 1208 species and infraspecific taxa representing 138 families and 553 genera were documented from 30 habitats. Twenty-one percent (245 taxa) of the flora was represented by introduced species. Seventeen rare taxa were discovered including two federally threatened species: *Apios priceana* and *Helianthus eggerii*. Three state records were found including *Achyranthes japonica*, *Euonymus kiautschovicus*, and *Eupatorium pinnatifidum*. Giles County currently ranks fifth in the state in terms of species richness.

**CLEMATIS MOREFIELDII** (RANUNCULACEAE), A FEDERALLY ENDANGERED SPECIES DISCOVERED IN TENNESSEE. **Dwayne Estes\* and Chris Fleming**, *The University of Tennessee, Knoxville, Tennessee and Breedlove, Dennis, Young, & Associates, Inc., Franklin, Tennessee*. *Clematis morefieldii* (Morefield's leather flower, Huntsville vasevine) is a rare vine described in 1987 by Dr. Robert Kral from mountains near Huntsville, Madison County, Alabama. Since its description, Morefield's leather flower has been found only in Alabama from ca. 10 localities, two of which are presumed extirpated. On June 05, 2003, we discovered a small population of *C. morefieldii* in Franklin County, Tennessee, on the western escarpment of the Cumberland Plateau. Our find represents the first report for the species from Tennessee and extends the known range to the northeast ca. 12.5 km. While searching for *C. morefieldii*, we also discovered unknown populations and county records for a number of other rare species including a second Tennessee locality for *Viburnum bracteatum*, a new county record for *Neviusia alabamensis*, and new county records for *Clematis glaucophylla*, *Cotinus obovatus*, and *Solidago auriculata*.

PLANT AND SOIL DIFFERENCES ON A TOPOGRAPHIC SEQUENCE IN RUTHERFORD COUNTY. **Chris Hancock\* and W. Anderson**, *Middle Tennessee State University, Murfreesboro, Tennessee*. The purpose of this study was to observe differences in plant communities across a topographic sequence in Rutherford County. The area studied has been cut for hay for the previous 25+ years and has not been limed or fertilized with

commercial fertilizers for the past 25+ years. The area has not been cut for hay this year at any time. The topographic sequence consisted of Cumberland, Lomond, and Arrington soil series. These soil series represent less than 10% of the total land area of Rutherford County. They are deep (greater than 36 inches) soils with less than 5% rock fragments in the soil profile. The soil series are rated either I or II in the Land Capability Classes. These series are considered prime farmland by the United States Department of Agriculture (USDA). The Cumberland and Lomond are in the Alfisols soil order of the USDA Soil Taxonomy while the Arrington is in the Mollisols soil order. Alfisols developed in humid and sub-humid climates. Clay sized minerals accumulate in the B-horizon and plant available water is available for much of the growing season. The Alfisols have a pH range from 5.6–6. Mollisols have a dark colored A-horizon and a pH that ranges from 6.1–6.5. Forage height was measured every other week from the end of August thru the first of October. Dry matter was calculated on an acre basis from forage height measurements. Dominant forage types, *Sericea Lespedeza* and Tall Fescue, separate out on the topographic sequence based on soil pH. *Sericea*, a warm season legume, is very tolerant of low fertility and acidity. Fescue, a cool season grass, will tolerate low fertility and acidity.

#### CELL AND MOLECULAR BIOLOGY SECTION

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TRIBUTYLTIN-INDUCED EFFECTS ON MAP KINASES P38 AND P44/42 IN HUMAN NATURAL KILLER CELLS. **Aloice O. Aluoch\* and Margaret M. Whalen**, *Tennessee State University, Nashville, Tennessee*. Natural Killer (NK) cells are a subset of lymphocytes. Tributyltin (TBT) is a toxic chemical that has been detected in human foods and blood. Tributyltin suppresses the immune system, including NK cells' cytotoxic function. We have studied the role of MAP kinases during TBT-induced inhibition of cytotoxicity. Continuous exposure to 300 nM TBT for 1 h decreased cytotoxic function with concomitant increases in phosphorylated forms of mitogen-activated protein kinases (MAPKs) p38 and p44/42 but not the total MAPKs. Similar results were obtained with 500 nM TBT treatment. A 1 h exposure to 300 nM followed by 24 h in TBT-free media produced decreases in cytotoxic function but increased phosphorylated forms of p38 and p44/42. However, after 48 h in TBT-free media, phospho-p44/42 and phospho-p38 MAPKs decreased. A 24 h exposure to 200 nM TBT decreased cytotoxic function of NK cells but produced donor-dependent effects on the phosphorylated p38 and p44/42 MAPK levels.

LOCALIZATION OF STE2P, A G PROTEIN-COUPLED RE-

CEPTOR, TO LIPID MICRODOMAINS IN *SACCHAROMYCES CEREVISIAE*. **Meredith A. Murphy\***, **Jonathan M. Smith\***, and **D. Grant Willhite**, *Tennessee Wesleyan College, Athens, Tennessee*. Recent research is modifying the Singer-Nicholson model of membrane structure by casting new light on membrane organization. Membranes are now understood to be asymmetrical and composed of segregated lipid domains (often termed rafts). Though well established in mammalian cells, research into yeast lipid domains is only beginning to flourish. Recent work has determined membrane proteins that localize predominantly to rafts. Previous work by our group indicates that the pheromone receptor (Ste2p) in mating type a yeast may localize to rafts under certain conditions. The purpose of this research was to determine if Ste2p localizes to rafts and what conditions might impact this colocalization. Conditions tested included presence of pheromone and an antifungal agent that disrupts rafts by targeting ergosterol. Our results indicate that Ste2p localizes to both rafts and non-raft regions of the membrane. Pheromone interaction and ergosterol treatment seemed to have little effect on the distribution of Ste2p.

PHOSPHOLIPID MODIFICATION IN YEAST AND ITS EFFECTS ON A G-PROTEIN COUPLED RECEPTOR. **Ben Helms\***, **Ben Dalton\***, and **Stephen Wright**, *Carson-Newman College, Jefferson City, Tennessee*. We studied the role of phospholipid composition on the activity of Ste2p, the G protein-coupled pheromone receptor in *Saccharomyces cerevisiae*. Pheromone binding results in gene activation leading to morphological changes and growth arrest. We monitored these events in cells grown in one of four supplements known to alter phospholipid concentrations. Hydroxylamine, which increases phosphatidylserine levels, increased sensitivity to growth arrest by a-factor while having negligible effects on receptor activity as determined by gene induction assay. Increasing phosphatidylcholine levels by supplementing with choline resulted in no significant changes in growth arrest or receptor activity. Inositol, which increases phosphatidylinositol levels and decreases phosphatidylserine, increased receptor activity but only in the gene induction assay. Finally, cells were supplemented with ethanolamine, which increases phosphatidylethanolamine levels at the expense of phosphatidylcholine. Ethanolamine decreased sensitivity to growth arrest but increased activity in the gene induction assay. Therefore, lipid changes affect receptor activity.

THE DETECTION OF *BORRELIA* SPECIES IN NON-MIGRATORY AVIANS IN TENNESSEE. **Benjamin E. Jordan\***, **Steve E. Hayslette**, **Steve W. Hamilton**, and **Stephen M. Wright**, *Middle Tennessee State University, Murfreesboro, Tennessee (BEJ, SMW), Tennessee Technological University (SEH), Cookeville, Tennessee, and Austin Peay State University, Clarksville, Tennessee (SWH)*. Lyme disease, the most common vector-borne disease in the United States, is caused by the bacterium *Borrelia burgdorferi*. A second *Borrelia* species, *B. lonestari*, seems to be responsible for a Lyme-like disease designated Southern Tick-Associated Rash Illness (STARI). European researchers have suggested that infected avians may be responsible for spreading *Borrelia* spirochetes. It is important to determine if avians might be a reservoir host for *Borrelia* species in Tennessee. Blood samples were collected from non-migratory avians, the DNA was extracted from each sample and amplified using primers specific for the flagellin gene. PCR products were then evaluated with species-specific probes to differentiate *B. burgdorferi* and *B. lo-*

*nestari*. We report the detection of *Borrelia* in avian blood samples, suggesting that avians could be host to *Borrelia* in Tennessee and contribute to cases of Lyme disease and STARI.

EVALUATION OF FLUORESCENCE BASED ANTIGEN-ANTIBODY BINDING THROUGH MICROARRAY CONFOCAL LASER SCANNING. **Katherine R. Onks\*** and **Stephen M. Wright**, *Middle Tennessee State University, Murfreesboro, Tennessee*. Rapid, accurate clinical diagnostics are critical for the medical profession and there is continuous demand for efficient diagnostic tools with increased specificity and sensitivity. Faculty and students from Middle Tennessee State University are working to develop a novel biosensor that detects wavelength shifts in photonic band gap coated slides for the specific and sensitive detection of biomolecules. This study was undertaken to evaluate antigen-antibody binding using fluorescent labels prior to analysis with the biosensor. Specific antigens were applied as a microarray and bound to an amine-functionalized slide. The slide was then exposed to the corresponding fluorescent labeled antibody to allow binding. The detection of fluorescence by a confocal laser scanner confirmed antigen-antibody binding. We report detection of antibody-bound antigen at a concentration of 6 picograms and differentiation from heterologous antigens. Current laser scanning methodology and future biosensor evaluation may be used to identify infectious agents and enhance clinical diagnostic tests.

THE EVALUATION OF SELECTED TEAS FOR ANTITVIRAL ACTIVITY USING THE T<sub>4</sub> BACTERIOPHAGE NEUTRALIZATION ASSAY. **Daniel P. Lawrence\*** and **John M. Zamora**, *Middle Tennessee State University, Murfreesboro, Tennessee*. Viruses are non-living infectious particles that cause many diseases and economical losses every year. Many researchers are trying to develop antiviral drugs. These drugs must exhibit low toxicity because they must be directly administered to a living organism or living cell cultures. Many plants possess phytochemicals that inhibit viral adsorption, viral replication, or viral transcription of genes to be translated into viral proteins. The purpose of this study was to see if hot water extracts of green tea, black tea, and several herbal teas exhibited antiviral activity against T<sub>4</sub> phage. Tryptic soy broth was used as the negative control and antiphage antibody as the positive control. Plaque forming units were calculated for the controls as well as the hot water extracts of the teas. The antiphage antibody, green tea, and black tea produced significant viral inhibition while some herbal teas such as wild sweet orange herbal tea produced slight viral inhibition. Other teas such as peppermint, chamomile, and *Echinacea* teas produced no viral inhibition.

ALLELOPATHIC AND ANTIMICROBIAL PROPERTIES OF *TABEBUIA IMPESTIGINOSA*. **Stacie N. Jefferson\*** and **John M. Zamora**, *Middle Tennessee State University, Murfreesboro, Tennessee*. *Tabebuia impetiginosa* or pau d' arco is a species of tree from the Bignoniaceae family. This is a deciduous canopy tree native to South America, Central America and other tropical areas. It is marketed in the United States as a dietary supplement. It is traditionally used to treat a wide range of ailments such as cold, flu, diarrhea, fever, sexually transmitted diseases, snake-bites, wounds, and infections. It has been documented to be antibacterial, antifungal, anticarcinomic, and anti-inflammatory. The purpose of this research was to see if pau d' arco had any antimicrobial or allelopathic properties. Antimicrobial tests were

done using alcohol extracts of pau d' arco. The alcohol extract of paud' arco was inhibitory to Gram-positive bacteria, Gram-negative bacteria, yeast and fungi. An allelopathic assay was performed to determine if the hot water extract of pau d' arco inhibited the growth of mung beans. All of the beans grown in the hot water extract showed a decrease in size compared to the control beans. Statistical analysis indicated that the difference in size was significant.

**LIPID COMPOSITION OF CHLORARACHNIOPHYTES (CHLORARACHNIOPHYCEAE) FROM THE GENERA BIGELOWIELLA, GYMNOCHLORA, AND LOTHARELLA.** *Jeremy L. Dahmen\**, *Jeffrey D. Leblond*, *Rebecca L. Seipelt*, *Matthew J. Elrod-Erickson*, *A. Bruce Cahoon*, *Rodney Kincaid*, *James C. Howard*, *Terence J. Evens*, and *Peter J. Chapman*, *Middle Tennessee State University, Murfreesboro, Tennessee*, *United States Horticultural Research Laboratory, Ft. Pierce, Florida*, and *United States Environmental Protection Agency, Gulf Breeze, Florida*. The Chlorarachniophyceae are unicellular eukaryotic algae characterized by an amoeboid morphology that may be the result of secondary endosymbiosis of a green alga by a nonphotosynthetic amoeba or amoeboid flagellate. Whereas much is known about the phylogeny of chlorarachniophytes, little is known about their physiology, particularly that of their lipids. In an initial effort to characterize the lipids of this algal class, four organisms from three genera were examined for their fatty acid and sterol composition. Fatty acids from lipid fractions containing chloroplast-associated glycolipids, storage triglycerides, and cytoplasmic membrane-associated polar lipids were characterized. Glycolipid-associated fatty acids were found to be derived from common algal/plant lipids, and were of limited composition, containing principally eicosapentaenoic acid [20:5(n-3)] and hexadecanoic acid (16:0). Triglyceride-associated fatty acids, although minor, were found to be similar in composition. The polar lipid fraction was dominated by lipids that did not contain phosphorus, and had a more variable fatty acid composition with 16:0 and docosapentaenoic acid [22:5(n-3)] dominant along with a number of minor C<sub>18</sub> and C<sub>20</sub> fatty acids. Crinosterol and one of the epimeric pair poriferasterol/stigmasterol were the sole sterols. Several genes required for synthesis of these sterols were computationally identified in *Bigelowiella natans*. One sterol biosynthesis gene showed the greatest similarity to *SMT1* of the green alga, *Chlamydomonas reinhardtii*. However, genes homologous to other species, mostly green plant species, also were found. Further, the method of identification suggested that the sequences have been transferred to a genetic compartment other than the likely original location, the nucleomorph nucleus.

**TRIBUTYLtin EXPOSURE CAUSES DECREASED GRANZYME B AND PERFORIN LEVELS IN HUMAN NATURAL KILLER CELLS.** *LeeShawn D. Thomas\**, *Stephanie A. Green*, *Margaret M. Whalen*, *Hemangini Shah*, and *Arthur D. Bankhurst*, *Tennessee State University, Nashville, Tennessee (LDT, SAG, MMW)* and *University of New Mexico School of Medicine, Albuquerque, New Mexico (HS, ADB)*. Natural Killer (NK) cells are a subset of lymphocytes that are capable of killing tumor cells, virally infected cells, and antibody coated cells. Tributyltin (TBT) is a toxic chemical used for various industrial purposes and can be found in edible items. This study investigates the mechanism by which TBT exposure decreases the immune function of human NK cells, in vitro. Cytotoxic function, the expression of the cytotoxic proteins (granzyme B and perforin), and

cAMP response element binding protein (CREB) phosphorylation were examined. NK cells exposed to 300 nM TBT for 1 h showed no significant decrease in levels of cytotoxic proteins or phosphorylation of CREB but mRNA levels were significantly decreased. A 24 h exposure to 200 nM TBT caused significant decreases in cytotoxic function, cytotoxic protein levels and mRNA. When NK cells were exposed to 300 nM TBT for 1h followed by a 24 or 48 h period in TBT-free media, there were significant decreases in NK cell cytotoxic function, cytotoxic protein levels, and mRNA. These results indicate that TBT exposures can disrupt the transcription of granzyme B and perforin and this disruption cannot be entirely accounted for by a decrease in phosphorylated CREB (phosphoCREB) levels.

**PATHOGENIC EFFECTS OF THREE NOVEL BACTERIAL ISOLATES ON HUMAN MACROPHAGES.** *M. B. Farone*, *J. K. Alexander\**, and *A. L. Farone*, *Middle Tennessee State University, Murfreesboro, Tennessee*. Legionnaire's disease is a severe pneumonia caused by the bacterium, *Legionella pneumophila* that can grow in human macrophages in the lungs but also replicates in amoebal hosts in natural environments. The aim of this study was to characterize the ability of two recently isolated *Legionella*-like amoebal pathogens (LLAPs), "soil" and "z" to grow inside a human macrophage-cell line as an indication of their disease-causing potential. Macrophages are immune cells that normally engulf and kill bacteria. The human cell line, THP-1 was treated with each LLAP and compared to *L. pneumophila* to determine the potential for infection and to assess the virulence of the organism in the macrophages. Macrophages were harvested at 24, 48, 72, and 96 h post-infection. Cell viability, cell number, and viable bacteria/ml were determined at each time point. Results from these studies demonstrated that both soil and z infected, grew inside, and killed the macrophages, suggesting they may be possible human pathogens. A third LLAP isolate is currently being characterized.

**REOVIRUS SEROTYPE-DEPENDENT CHEMOKINE AND REPLICATION DIFFERENCES IN A HUMAN MONOCYTE CELL LINE.** *Tiffany Guess\**, *Mary Farone*, and *Anthony Farone*, *Middle Tennessee State University, Murfreesboro, Tennessee*. Airway inflammation is observed when reovirus serotype 1 Lang (T1L) or serotype 3 Dearing (T3D) is administered in a reovirus pneumonia model in the rat; however, T3D causes more prominent inflammation than T1L while T1L grows to higher levels than T3D. Previous studies have shown that inflammatory molecules are stimulated in a rat alveolar macrophage cell line by reovirus with similar viral replication patterns. The goal of this study was to determine if virus serotype differences observed in rat models are seen in a human monocyte cell line, THP-1. Cells were treated with T1L or T3D at a MOI of 10 and 100, as well as medium alone. After 24, 48, and 72 h, cell viabilities and viable cell number were determined and plaque assays were done to assess viral replication. Cultures also were assayed for the neutrophil chemotactic cytokine, gro-alpha. Results from the gro-alpha ELISA demonstrated significantly higher levels in T3D-treated monocytes compared to T1L. These results support previous work in our laboratory demonstrating that the inflammatory cytokines, TNF-alpha and interleukin-8 are also produced in a similar serotype-dependent manner. Results from the viral replication studies, however, demonstrated a different response than in vivo. T3D replicated to significantly higher titers than T1L at both MOIs, which correlated with significantly lower viabilities

and cell numbers for the T3D-treated cells. These observations suggest that the in vivo cytokine responses stimulated by T3D may effectively control viral replication and the lower cytokine responses stimulated by T1L permit the higher titers seen in vivo.

**EVALUATION OF THE BACTERIAL LEVELS OF THE STONES RIVER AND J. PERCY PRIEST LAKE.** *Elizabeth G. Reed\* and John M. Zamora, Middle Tennessee State University, Murfreesboro, Tennessee.* Elevated bacterial levels in surface waters are often indicative of pollution and the presence of pathogens. Previous studies have indicated elevated bacterial levels at various sites along the Stones River. Surface water samples from seven sites along J. Percy Priest Lake and the Stones River were collected. The samples were analyzed for total bacteria per mL and total enteric bacteria per mL. The conventional plating method using tryptic soy agar and MacConkey agar was employed, as well as the Hyccheck rapid screening method. Total bacterial counts fell within the EPA guidelines; however, enteric levels were elevated at many of the sites. Representative bacteria from all of the sites were identified using the BBL Crystal rapid multi-test system. Coliforms isolated from the sites include: *Escherichia coli*, *Serratia fonticola*, and various species of *Enterobacter*. Other isolates that grew on MacConkey agar included *Vibrio* spp., *Pseudomonas* spp., *Aeromonas hydrophila*, and *Rahnella aquatilis*.

**THE HERBICIDE ROUNDUP® HAS AN INHIBITORY EFFECT ON MICROORGANISMS.** *Allison Cummings\* and John M. Zamora, Middle Tennessee State University, Murfreesboro, Tennessee.* Widespread usage of herbicides has had documented effects on mammals and birds, including causing birth defects in humans. However, little attention has been directed to the growth-inhibiting effect that herbicides, namely Roundup®, has on soil microorganisms. Several laboratory strains of microbes were plated on Tryptic Soy Agar (TSA) containing Roundup. The media was inhibitory at higher concentrations of Roundup. When 0.1 mL of soil dilution is placed on an agar medium consisting of Roundup®, Minimal Salts (MS), glycerol, and yeast extract, little to no growth occurs. However, when the same 0.1 mL of dilution is placed on TSA medium or MS glycerol yeast extract agar, a plethora of growth ensues. Roundup was tested against three soil types: Arrington, Bradyville Rock, and Gladeville Rock outcrop, and each had nearly the same inhibitory effect. The characteristics of the soils varied greatly, establishing that Roundup thwarts soil microbe growth.

**THE ISOLATION AND IDENTIFICATION OF *ESCHERICHIA COLI* STRAINS RESPONSIBLE FOR CALFHOO SCOURS.** *Wesley Skelton\*, Jessica G. Gentry, and Mary B. Farone, Middle Tennessee State University, Murfreesboro, Tennessee.* Calfhoo scours is one of the most common infectious diseases that affect calves before one month of age, and is the most important single cause of calf sickness and death in the United States. In severe outbreaks, the disease can occur in 70% of calves born and death may occur in 50%. The effects of this disease can thus be detrimental to beef and dairy herds. Scours is a diarrheal disease that can be caused by different microorganisms, such as bacteria, viruses, and protozoa. One of the most common causes is the bacterium, *Escherichia coli*. The most common strain of *E. coli* that causes scours is called K99. The K99 strain is considered an enterotoxigenic *E. coli* (ETEC) because it produces heat-stable enterotoxin a (St<sub>a</sub>) that causes the secretion of water

and electrolytes into the gut, resulting in diarrhea and eventually dehydration. More recently, two other types of *E. coli* have been identified as causes of scours, attaching and effacing *E. coli* (AEEC) and Shiga-toxin producing *E. coli* (STEC). The AEEC strains do not produce toxins but attach to intestinal epithelial cells using a protein called intimin that interrupts the ability of the cells to absorb nutrients. The STEC strains produce intimin as well as two toxins (St<sub>x1</sub> and St<sub>x2</sub>) similar to the toxins produced by *Shigella dysenteriae* and can cause a bloody diarrhea. These are called enterohemorrhagic strains (EHEC) and can produce either or both toxins. For this study, fecal samples from calves with scours were plated onto MacConkey and Hektoen Enteric growth media to help select for *E. coli*. Confirmation that the bacteria isolated were *E. coli* was obtained by the BBL Crystal Enteric/Nonfermenter Identification system. PCR was performed using colonies selected from the growth media. A multiplex PCR assay was used with primers used for the K99, St<sub>a</sub>, St<sub>x1</sub>, St<sub>x2</sub>, intimin, and the F41 fimbrial subunit genes. Based on PCR analysis we have isolated at least one specimen with the gene for K99. The PCR product has been subcloned into plasmid pCR2.1 and is currently being sequenced. The isolate appears atypical in that the expected PCR product was of a smaller gene size than expected. The gene product will be sequenced and compared to the sequence of the reported K99 gene. Significant variation in the K99 gene could have implications for current treatment and vaccine strategies for the disease.

**THE ISOLATION AND IDENTIFICATION OF NOVEL BACTERIAL AMOEBAL PATHOGENS FROM MANMADE WATER SOURCES.** *Witold Skolasinski\*, B. Jason Hayes\*, Katherine Redding\*, Mary B. Farone, John H. Gunderson, Sharon G. Berk, and Anthony L. Farone, Middle Tennessee State University, Murfreesboro, Tennessee (WS, BJH, MBF, ALF), Vanderbilt University, Nashville, Tennessee (KR), and Tennessee Technological University, Cookeville, Tennessee (JHG, SGB).* Legionella-like amoebal pathogens (LLAPs) are intracellular bacterial parasites of amoebae and have a life cycle like that of *Legionella pneumophila*. LLAPs have been isolated from environmental sources as well as from pneumonia cases in the United States. Because 40% of pneumonia cases in the United States have unknown etiology, LLAPs may be responsible agents that go undetected. We used the 16S rRNA gene sequence to identify new LLAPs isolated from infected amoebae of a hot tub and hospital cooling tower. The hot tub bacterium is a small, motile, gram-negative coccobacillus, unculturable on BCYE agar. The organism invades and replicates in the protozoan nucleus, eventually lysing the host. It also causes cytotoxicity in human macrophages. Although hot tubs have been suspected sources of legionellosis, our results indicate that they also may be sources of new undetected potential human pathogens associated with amoebae. The hospital cooling tower isolate also appears to be a novel, unculturable organism and is currently being isolated and characterized.

**THE ISOLATION, ENUMERATION, AND IDENTIFICATION OF FECAL COLIFORMS FROM GUACAMOLE.** *Nathan Wyeth\* and Mary B. Farone, Middle Tennessee State University, Murfreesboro, Tennessee.* Each year, millions of illnesses in this country can be traced to food borne bacteria. While the most common illnesses are gastrointestinal disease, it is estimated that two to three percent of all food borne illnesses can lead to secondary long-term illnesses. Intestinal bacteria, called fecal coli-

forms, are known to cause acute and chronic gastrointestinal disease. Many fecal coliforms can produce toxins and other factors that enhance their virulence in their human host. The purpose of this study was to investigate the presence of fecal coliforms in a popular food item, guacamole. Because the preparation of guacamole involves handling of food items that are uncooked, the potential for contamination exists. It is recommended that guacamole contain less than 1000 coliforms/g. Three freshly prepared guacamole samples from local restaurants were tested for the presence of fecal coliforms. Although no *Escherichia coli* was found in any of the samples tested, all samples contained greater than the acceptable number of fecal coliforms. Potentially virulent coliforms were found in all samples and the isolates were able to grow at 45°C, the temperature that distinguishes fecal coliforms from similar bacteria that grow in the environment. Many of the species isolated expressed capsules that are known virulence factors. However, none of the bacterial isolates expressed genes for toxins associated with severe gastrointestinal disease.

## CHEMISTRY SECTION

MARTIN V. STEWART, CHAIR

HANDS-ON NMR IN THE PHYSICAL CHEMISTRY LABORATORY AT MIDDLE TENNESSEE STATE UNIVERSITY: CONFORMATION OF 5'-AMP. **J. C. Howard, N. K. Dunlap, J. M. Iriarte-Gross, and A. C. Friedli**, Middle Tennessee State University, Murfreesboro, Tennessee. Hands-on NMR has been successfully implemented into the "non-calculus" based physical chemistry laboratory. During the Spring 2004 semester, nine groups of two students prepared five different concentrations of 5'-adenosine monophosphate in D<sub>2</sub>O (25–65 mg/mL in 10-mg increments). They acquired <sup>1</sup>H, gCOSY, and gNOESY spectra using automation routines built into the JEOL ECX 300 MHz NMR spectrometer, which had been purchased with funds from an NSF-CCLI grant (#0311641) and matched by Middle Tennessee State University. After assigning the peaks in the <sup>1</sup>H spectrum with aid from the COSY spectrum and ChemDraw Ultra's® NMR prediction routine, they interpreted the NOESY results in terms of the *syn* versus *anti* conformation around the glycosidic bond. They then used SciFinder Scholar® to locate original literature for comparison. In this presentation, some typical results will be shown along with some features of the NMR software the students needed to learn beyond the standard automation output. Student surveys indicated an overall satisfaction with the hands-on experience and a feeling that it helped with their understanding of NMR spectroscopy.

OPTIMIZED GEOMETRIES OF SEVERAL ORGANOSILYL-MAGNESIUM COMPOUNDS. **William H. Ilsey**, Middle Tennessee State University, Murfreesboro, Tennessee. The optimized geometries of several organosilylmagnesium compounds of the type [R<sub>3</sub>SiMgY]<sub>n</sub> where R = H, CH<sub>3</sub>, R<sub>3</sub>Si; Y = Halogen, CH<sub>3</sub>, R<sub>3</sub>Si; n = 1–6 will be discussed. The geometries were determined by Hartree-Fock calculations using the 3-21G\* and 6-31G\*\* basis sets. Results indicate that stable silicon and carbon bridged dimeric and tetrameric structures can be found but no stable silyl bridged hexamer has yet been found.

DIURNAL CHANGES OF DISSOLVED GASEOUS MERCURY

(DGM) LEVELS IN A SOUTHERN RESERVOIR LAKE, CANE CREEK LAKE, COOKEVILLE, TENNESSEE. **Hong Zhang, Chris Dill\*, Todd Kuiken\*, and Melissa Ensor\***, Tennessee Technological University, Cookeville, Tennessee (HZ, CD, TK) and The University of the South, Seawanee, Tennessee. Daily changes of dissolved gaseous mercury (DGM) levels in a small southern reservoir lake, Cane Creek Lake, Cookeville, Tennessee, were investigated from June of 2003 to May of 2004. The daily DGM concentration changes in the lake commonly exhibited distinct, strong diurnal trends similar to the pattern of daily solar radiation changes, with morning rise and afternoon fall and a peak around noontime. Trends of the DGM loading changes other than the typical diurnal two-phase patterns were also observed. For the time span studied, the daily mean DGM concentrations of the lake ranged from 18.2 to 67.8 pg L<sup>-1</sup> (commonly > 30 pg L<sup>-1</sup> in June, July, August), comparable to those observed in the northern large lakes for summer months. The daily DGM levels correlate with solar and UVA radiation to various degrees. The daily mean DGM concentrations recognizably correlate well with global solar as well as UVA radiation.

ESTIMATION OF EMISSION OF DISSOLVED GASEOUS MERCURY (DGM) IN A SOUTHERN RESERVOIR LAKE USING TWO-THIN FILM MODEL. **Chad Crocker\*, Todd Kuiken\*, and Hong Zhang**, Tennessee Technological University, Cookeville, Tennessee. Aquatic Hg emission in southern reservoir lakes, important environmentally and recreationally, has received little attention. A field study of Hg emissions was conducted in June–August, 2004, at Cane Creek Lake, Cookeville, Tennessee. The Two-Thin Film Model was employed using ambient air and dissolved gaseous mercury (DGM) concentrations and in situ meteorology to estimate the magnitude and direction of the emission fluxes. The mean fluxes were 0.216 ± 0.107 (0.058–0.396, n = 13), 0.131 ± 0.156 (0.097–0.407, n = 13), and 0.027 ± 0.036 (0.001–0.098, n = 7) ng m<sup>-2</sup> h<sup>-1</sup> for June, July, and August, respectively. The estimated fluxes depended on air Hg and DGM levels and the meteorology (T<sub>w</sub>, wind speed). Good correlations between the DGM and emission flux suggest DGM to be an important controlling factor in the model. This study provides important information on Hg transfer across air/water interface and its pathway in small reservoir lakes.

THE ROLE OF ERGOSTEROL AND LONG-CHAIN FATTY ACIDS OF PHYTOSPHINGOLIPIDS AS MEMBRANE RAFT COMPONENTS IN YEAST, *SACCHAROMYCES CEREVISIAE*. **T. A. Bunde, G. Willhite, and S. E. Wright**, Maryville College, Maryville, Tennessee (TAB), Tennessee Wesleyan College, Athens, Tennessee (GW), and Carson Newman College, Jefferson City, Tennessee (SEW). Many signaling molecules involving G-protein coupled receptors have been shown to be associated with sterol-enriched, detergent-insoluble raft domains within the plasma membrane. Our research involves the yeast pheromone receptor, Ste2p, which mediates mating in haploid yeast cells. We have established that azole drug inhibitors of sterol synthesis reduce the levels of ergosterol in *Saccharomyces cerevisiae* and attenuate the pheromone binding response as measured by reduced shmoo mating projections, reduced activation of a reporter gene (FUSLac) (beta-galactosidase activity), and reduced binding capacity of the α-factor. The sterol profile, as determined by gas chromatographic separation of sterols and a metabolic precursor squalene, indicated that as the concentration of the azole drug ketoconazole was increased in the culture me-

dium, the major sterol detected shifted to ergosterol to lanosterol and ultimately squalene. These data are consistent with the enzymatic activity that is known to be inhibited by the ketoconazole. To investigate the lipid depletion effects on isolated membranes, Triton X-100 was used to isolate the plasma membrane rafts following mechanical disruption of the yeast cell wall. The raft fractions were separated in OptiPrep centrifugal gradients and both the ergosterol concentrations and fatty acid profiles (as FAMES) determined by GC following extraction and hydrolysis of phosphoglyceride ester, sterol ester, and phytosphingosine amide linkages. Previous studies have suggested that both sterols and long-chain fatty acids can be used as raft lipid markers for plasma membranes. Our attempts to localize the Ste2p receptor in lipid rafts using Western blots and specific antibodies have not consistently confirmed the presence in isolated raft protein fractions in yeast. This research has involved over twenty undergraduate students from five Appalachian College Association schools over the last four years. (Supported by the NIH (S. E. Wright) and the Appalachian College Association.)

USING WATER FLOW THROUGH A PLASTIC MODEL TO EMULATE DIFFUSION AND THERMAL CONDUCTIVITY—PART II. **Harvey F. Blanck**, *Austin Peay State University, Clarksville, Tennessee*. An acrylic plastic device has been designed using water flowing through a series of cells to visually emulate diffusion and thermal conductivity. Water height emulates concentration or temperature. The device can emulate a steady state condition in which there is a constant gradient of concentration or temperature change with distance as well as the approach to this steady state. It can emulate diffusion from a plane (point) source forming a Gaussian curve and it can emulate experiments in which mass diffuses across a boundary showing the resulting 1- error function curve. Results are obtained visually in a matter of a few minutes. This device should be quite helpful in both classroom and laboratory discussions of diffusion and thermal conductivity.

DO STUDENTS PERFORM AS WELL IN AN INTENSIVE COURSE FORMAT? **Linda A. Wilson and Mildred V. Hall\***, *Middle Tennessee State University, Murfreesboro, Tennessee and Clark State Community College, Springfield, Ohio*. For years, there have been claims that students can't learn as well in courses that are offered in an intensive 3-week intersession compared to the usual 15-week session. Dr. Wilson has taught a three-week intersession version of CHEM 1010, Introductory General Chemistry, as well as the regular 15-week version of this course for many years. The topic of intensive courses is addressed in the literature but qualitative data is presented with little quantitative data to truly answer the question. We present the preliminary evaluation of data collected for this course offered in the fall semesters 1999–2003 and in Summer Session I (intersession) of 2001–2004 at MTSU. The preliminary evaluation of pre-test/post-test data indicates that students do perform better in the intensive course format. Since the students self-select into the two formats, future work will include the evaluation of the similarity of the two test groups using ACT scores, etc.

CONQUER WITHOUT DIVIDING: VOLUME RENDERING OF INTACT MOLECULAR CHARGE DENSITIES EFFECTIVELY ILLUSTRATES KEY CONCEPTS IN BONDING AND REACTIVITY. **Preston J. MacDougall**, *Middle Tennessee State University, Murfreesboro, Tennessee*. Our volume render-

ing software enables the user to interactively explore a molecule's electronic charge density for topological features that make manifest key concepts in bonding and reactivity, such as lone pairs and sites of nucleophilic attack. Using novel volume rendering techniques, the entire molecule can be probed without obstruction by opaque surfaces or preselection of specific orbitals or contours. Thus even core/valence division is not done artificially. Rather such sub-atomic partitioning is evident in the rendering of the Laplacian of computed or measured electron density distributions. The concept of the "charge cloud" is introduced early in the chemistry curriculum, and is one that is readily grasped. Visualizations with direct recourse to this entity, avoiding molecular orbital models, make concepts of chemical reactivity more accessible. The same methodology that is applied to small inorganic or organic molecules, is also applied to large biomolecules. Thus instead of a variety of visual textures for molecular models in the different subdisciplines, which can disorient students, there is consistency.

CHARACTERIZATION OF SOLID-SUPPORTED REAGENTS. **Martin V. Stewart, Eric M. Larsen\*, and Anthony L. Newsome**, *Middle Tennessee State University, Murfreesboro, Tennessee*. Absorbing an inorganic compound onto a porous surface often affords a solid-supported reagent that exhibits enhanced chemical reactivity. Previous results from this laboratory demonstrated that depositing ceric ammonium nitrate onto the surface of silica gel by evaporation of a  $\text{CH}_3\text{OH}/\text{CH}_2\text{Cl}_2$  solution produced a freely flowing, yellow powder that functions as a solid-supported reagent. The present work reports a closer examination of this  $\text{Ce(IV)}/\text{SiO}_2$  reagent with optical microscopy. Individual particles from samples prepared with a 10:100 mass ratio of ceric ammonium nitrate to silica gel appeared in every way identical to the clear and colorless particles of the original silica gel; however, particles of a 20:100 mass-ratio sample had a heterogeneous appearance where some remained colorless while others acquired the yellow color of the  $\text{Ce(IV)}$  reagent. This yellow color darkened to near opaqueness on increasing the mass ratio to 30:100, yet the number of colorless particles present in the heterogeneous sample remained unchanged. It is proposed from these observations that ceric ammonium nitrate selectively crystallized onto the surface of individual silica gel particles at the higher mass ratios. Partial support from the Undergraduate Research Council of the College of Basic and Applied Sciences at Middle Tennessee State University is gratefully acknowledged.

SYNTHESIS OF WEAKLY COORDINATING TRISPHAT ANION. **Pooja R. Marella,\* and Gary P. Wulfsberg**, *Middle Tennessee State University, Murfreesboro, Tennessee*. Weakly coordinating anions are needed for cationic catalysts such as the zirconocene catalyst used in olefin polymerization reactions to function efficiently. Tris(tetrachlorobenzene-1,2-diyl) phosphate(V) or "trisphat" anion, is being used as a chiral anion in resolving chiral organic cations; we believe that it could be a good weakly coordinating anion for catalysis as well. Lacour's synthesis of trisphat acid from tetrachlorobenzene-1,2-diol (tetrachlorocatechol) and phosphorus pentachloride was investigated and required modification. The acid was used to synthesize (for the first time) the rubidium and cesium salts of the trisphat anion. These salts were characterized by various methods including Fourier transform infrared spectroscopy,  $^{31}\text{P}$  and  $^{13}\text{C}$  nuclear magnetic resonance spectroscopy, and X-ray crystallography in order to determine whether this ion would be noncoordinating and un-



reactive enough to use in olefin polymerization reactions. At this time it appears to be promising for this use.

## ENGINEERING AND ENGINEERING TECHNOLOGY SECTION

ISMAIL FIDAN, CHAIR

LONG-TERM THERMAL RESISTANCE OF CELLULAR PLASTIC INSULATIONS. **David W. Yarbrough**, *R & D Services, Inc., Cookeville, Tennessee*. The thermal resistance or R-Value of cellular plastic insulations containing a gas other than air decrease with time because of changes in the composition of the gas mixture in the closed cells. Decreases in R-Value are the result of the inward diffusion of air and the outward diffusion of low-conductivity gases introduced at the time of manufacture. Changes in the thermal performance can be predicted from diffusion data for the species involved or by an experimental procedure called slicing and scaling that accelerates the aging process. Two standard methods are presently being used in North America to determine the time-average thermal resistance of cellular plastic insulation used in the construction industry. The United States procedure is documented by an ASTM Standard Test Method while Canadian products are evaluated using a United Laboratories Canada Method. Both methods are derived from the basic idea of slicing and scaling to reduce aging times to less than one year. Typical thermal data obtained using these methods and the subsequent analyses to obtain 15 to 40 year time-average values will be discussed.

SIGNIFICANCE OF ASSOCIATION SCHEMES IN MODELING AQUEOUS HYDROGEN FLUORIDE MIXTURES. **Barath Baburao\*** and **Donald P. Visco Jr.**, *Tennessee Technological University, Cookeville, Tennessee*. The caustic nature of hydrogen fluoride (HF) and its complex interactions with water have limited the experimental studies and the development of accurate and robust thermodynamic models for aqueous mixtures of HF. We explore the complex interactions between these pure components in order to deliver a new model developed on the basis of association patterns. To emphasize the importance on the inclusion of association interactions between these compounds, the pure components and mixtures are initially modeled using simple association schemes. The association interactions are subsequently included through simple patterns that allow formations of different kinds of physically meaningful oligomers. These association models are extended to the aqueous mixtures of HF, with and without considerations for cross associations. The significance of the association schemes and the inclusion of cross association are studied on the basis of binary interaction parameter values and the deviation from experimental data.

GEOMETRICAL EFFECT IN THE TRANSLLOCATION TRANSPORT IN NANOCAVITIES AND ITS ROLE IN THE SEPARATION EFFICIENCY OF MACROMOLECULES. **Ryan P. O'Hara\*** and **Pedro E. Arce**, *Tennessee Technological University, Cookeville, Tennessee*. The understanding of the motion of macromolecules in small cavities such as those of the order of nano-porous has a potential to uncover a series of new phenomena in biological membranes and in artificial materials for either separation and/or drug delivery. The role of the structure

of the cavity has been investigated for given geometries and in many cases with two-dimensional (geometrical) approaches. Based on previous simulations on non-electrical fields, this presentation will outline the work for cases where an applied electrical field is present. The approach has the potential to cover both two and three-dimensional materials.

PROTEIN DEGRADATION BY PULSED-COLD PLASMA HIGH OXIDATION METHODS: ANALYSIS AND TRENDS. **Maria F. Ibañez and Pedro E. Arce**, *Tennessee Technological University, Cookeville, Tennessee*. Decontamination of water effluents and other industrial processing fluids is a very significant effort to help maintain the Earth environment safe and healthy. The use of high voltage and pulsed corona-based electrical discharges has been proved useful to degrade organic contaminant of fairly large size such as phenol, chlorine-based chemical and wood-base materials under aqueous solutions. In this presentation, the methodology will be applied to a preliminary testing of the high oxidation power to proteins. Although the analysis is preliminary, the potential transformation of the species can be observed. Suggestion for improving the technique will be made.

INTERNET-BASED KNOWLEDGE GENERATION FOR THE COMPLEX FORMING PART FEATURES. **Ismail Fidan**, *Tennessee Technological University, Cookeville, Tennessee*. One of the current problems faced in the forming industry is the lack of expert solutions for the complex part features' processing conditions. Technological developments in the advanced materials and increasing complexity in the part features make the forming process very difficult and increase the number of scraps in the production. The best solution would be to identify an expert solution for both processing conditions and complex part features. The objective of this project was to generate a detailed non-empirical method for designing forming dies for different advanced materials and complex part features (cavity, hole, boss, pocket, slot etc.) based on Finite Element Analysis (FEA) computer simulations of the forming process. Forming design knowledge between the processing parameters and complex part features was investigated and will be presented throughout this presentation. (Supported by the Tennessee Technological University Research Office)

EFFECT OF POSITION OF THE CROSS-MEMBER IN A MODEL OF A SPINAL IMPLANT ON ENGINEERING PERFORMANCE. **Gladius Lewis and Raghuveer Vejerla\***, *University of Memphis, Memphis, Tennessee*. In cases where the pain and discomfort suffered by a patient as a result of a spinal pathology and/or trauma is very severe, the only effective treatment is surgical intervention in the form of implantation of a segmental spinal instrumentation (SSI). A widely used SSI is the Texas Scottish Rite Hospital (TSRH) system, which is used for the correction/stabilization of a scoliotic curve. This system comprises two stainless rods, cross-members, hooks, screws, and bolts. In the present work, a finite element analysis study was conducted on a three-dimensional model of a mechanical spine analog on which the TSRH SSI was attached. A load of 700 N was applied dynamically (at 2 Hz) to the model, while it was constrained at the bottom of the analog. The compressive stiffness was found to vary from 314 N/mm when one cross-member was positioned near the top of the rods to 443 N/mm when two cross-members were positioned halfway along the rods.

**EFFECT OF THE MICROCHANNEL GEOMETRY ON THE ELECTROHYDRODYNAMICS OF MICROELECTROPHORETIC SEPARATION DEVICES.** *Heather R. Pridemore\* and Pedro E. Arce, Tennessee Technological University, Cookeville, Tennessee.* Previous studies have shown that templating the internal gel structure at the macromolecular level can lead to improved separations of biomacromolecules. In this approach, we focus on the "micro-structure level" as a means to understand the behavior of the transport of macromolecules in nanostructured gel materials. Prior work has shown the potential important role of the microstructure of the material in controlling separation efficiency. It was indicated that optimal conditions may be achieved by manipulating the geometry of the material in conjunction with controlling the operating parameters. Also, the geometry of the "separation cavity" has been shown to play an important role in the scaling of the separation "device" to improve separation efficiency. Previous studies were focused on relatively simple geometries of the microchannel of the capillary. This contribution incorporates a more realistic physical picture of the microchannel. The electrohydrodynamics of several microchannel geometries will be studied.

**ANIMATION OF THE REMOTE CENTER COMPLIANCE DEVICE.** *Chin-Zue Chen, Austin Peay State University, Clarksville, Tennessee.* There always are misalignment problems existing in the robotic assembly operations; namely, lateral misalignment, rotational misalignment, and axial misalignment. A remote center compliance (RCC) device was designed at the Massachusetts Institute of Technology to mount on a robot arm, between the tool plate and the gripper, to deal with the lateral and rotational misalignments problems. In order for the students to better understand the working principles of the RCC device, an animation was developed as a lecture aid. The animation includes the three types of misalignment, the working principle of lateral compliance motion, the working principle of rotational compliance motion, and the RCC device design and its combination of the compliances. The Flash software was used to develop the animation.

**FUNCTIONAL-BASED APPROACH: AN EFFECTIVE MODEL TO TEAM MEMBER SELECTION.** *Pedro E. Arce and Sharon Sauer, Tennessee Technological University, Cookeville, Tennessee and Rose-Hulman Institute of Technology, Terre-Haute, Indiana.* The use of a team-based learning approach is of fundamental benefit to students in engineering disciplines. It is a useful environment to learn about working together in common goals of the team, to learn and practice ethical aspects that are involved in a "community of learning" and to share efforts beyond the individual interest, just to name a few. In spite of this paramount importance, it appears that several aspects in team-based learning environment need a more systematic approach. One of these is the selection of team members by methods not focused on subjective views. In this presentation, a functional-based approach will be presented and discussed. The approach has been successfully implemented in courses at Tennessee Technological University and the Rose-Hulman Institute of Technology.

**USING SMITH CHART TO ENHANCE ELECTRICAL ENGINEERING/ENGINEERING TECHNOLOGY STUDENTS UNDERSTANDING OF TRANSMISSION-LINE THEORY.** *Adel Salama, Austin Peay State University, Clarksville, Tennessee.*

*see.* The study of transmission lines is one or part of the essential courses in undergraduate electrical engineering/engineering technology education. In this study, all high frequency applications involved in transmission lines and its theory is a basic subject for students. Students study varying voltages, currents, impedances and admittances along the transmission lines. These concepts are more difficult than the corresponding concepts in ordinary electrical/electronics circuits. Smith Chart (SC), which is a graphical device, was used to provide understanding of transmission line theory. The study of SC reveals certain analogies of transmission lines to the subjects of ordinary circuit theory. There is much interest in the SC, both in education and in engineering practice. Students are encouraged to compare SC results to those obtained by interactive transmission line computer programs. An important reason to continue using SC is that it helps students understand the change produced by varying the parameters (load, line length, or the positions along the line), thus gaining valuable insight.

**PULSED ELECTRICAL FIELD FLOW FRACTIONATION.** *Joseph J. Biernacki and P. Manikya Mellachuruvu\*, Tennessee Technological University, Cookeville, Tennessee.* Electric field flow fractionation (EFFF) may provide an alternative to gel electrophoresis and other processes for the separation of nano-particles, proteins and macromolecules. In EFFF a laminar flow is used to carry the analyte, which is distributed normal to the stream-wise flow under the action of an electric potential. The distributed analyte thus elutes at a rate different than the average stream-wise flow in accordance with its concentration profile. Recent experimental research has shown that an oscillating electric field can increase particle retention and so may enhance separation. A computational approach to predict particle retention and relative retention has been developed and used here to study the frequency response behavior of pulsed (oscillatory) electric field flow fractionation.

**MESO-SCALE STRAIN MEASUREMENTS IN CEMENTS USING SYNCHROTRON X-RAYS.** *Joseph J. Biernacki, Carl J. Parnham\*#, Thomas R. Watkins, Camden R. Hubbard, and Jianming Bai, Tennessee Technological University, Cookeville, Tennessee (JJB, CJP), Oak Ridge National Laboratory, Oak Ridge, Tennessee (TRW, CRH), and University of Tennessee, Knoxville, Tennessee (JB).* X-ray methods developed for the determination of residual stress in crystalline materials have been applied to study residual strains and strains due to mechanically generated stresses in portland cement paste. Synchrotron X-rays were used to make measurements of meso-scale strains in the calcium hydroxide (CH) by-product of hydrated neat portland cement paste. Mechanical stresses were applied by uniformly distributed, uniaxial loading of specimens and in-situ diffraction measurements were made to establish the strain states of the calcium hydroxide phase. This essentially new application may eventually provide phase resolved strains on at least the meso- and possibly the micro-scale.

**MODELING POLYOL AND BLOWING AGENT MIXTURES USING STATISTICAL ASSOCIATING FLUID THEORY WITH VARIABLE RANGE EQUATION OF STATE.** *Venkata V. Challa\* and Donald P. Visco Jr., Tennessee Technological University, Cookeville, Tennessee.* The Statistical Associating Fluid Theory of Variable Range (SAFT-VR) is a robust equation of state (EOS) with six parameters that describe the thermody-

namics of complex systems. Earlier works with this EOS have already predicted the phase co-existence properties of various refrigerants and higher order alkane series compounds, along with their mixtures. In this work, SAFT-VR has been used to predict the phase co-existence properties of higher molecular weight compounds (polyols) such as Pluracol 355, Pluracol 975, Stepanpol PS 3152 and Terol 352. The solubility of blowing agents or refrigerants in these polyols has been predicted and the solubility curves have been produced. The heavier blowing agents such as HFC 365mfc and HFC 245ca and the hydrocarbons such as pentane, isopentane and cyclopentane shows, greater solubility in all four polyols even at low pressures. This work aids in optimizing polyol-blowing agent combination and also identifies alternative blowing agents that have zero ozone depletion for use in PUR foam industry.

#### INTEGRATION OF 3D PRINTING TECHNOLOGY INTO 2D DESIGN AND PRODUCTION: ASSESSMENT STUDIES.

*Michael D. Russell\*, Ismail Fidan, and Robert J. Clougherty Jr, Tennessee Technological University, Cookeville, Tennessee.*

The competitive nature of today's business world has shown that industries must use Rapid Prototyping (RP) technology to remain viable. With increasing use of RP in the global market, it has become essential for designers, engineers, and technologists to have a strong understanding of present RP manufacturing methods and possible future RP applications. It is only by gaining quick market share with rapid product development and superior services that most companies hope to continue fulfilling the needs of their demanding customers. Three dimensional printing offers the advantages of speedy fabrication and low materials cost in RP. In fact, it's probably the fastest of all RP methods. Recently color output also has become available. However, there are limitations on resolution, surface finish, part fragility and available materials. This presentation will report the current 3D Printing RP assessment data collected in CAD for Technology and CNC Machining Practices courses.

#### MODELING CEREBROVASCULAR PRESSURE TRANSMISSION. *S. K. M. Abdul\*, P. Arora\*, C. Liu\*, T. Reddy\*, and Michael Daley, University of Memphis, Memphis, Tennessee.*

Cerebrovascular pressure transmission defines the dynamic relationship between arterial blood pressure (ABP) and intracranial pressure (ICP). Using numerical identification techniques based on a third-order windkessel model on clinical recordings of ABP and ICP we determined minute by minute values of highest modal frequency (HMF). A PSpice circuit model was constructed to match the structure of the windkessel model. Parameters of the PSpice circuit were manipulated to produce an ICP waveform that matched the actual ICP recording. For patients with apparent intact regulation of cerebral blood flow, we found that resistance of the arterial-arteriolar bed was directly related to cerebral perfusion pressure. Conversely, for patients with impaired regulation the relationship between resistance of the arterial-arteriolar bed and cerebral perfusion pressure was found to be inverse.

#### CHANGES IN CEREBROVASCULAR PRESSURE TRANSMISSION OF ADULT BRAIN-INJURED PATIENTS. *Sarath C. Yalamanchili\*, Sandeep Ramakrishnan\*, Santosh Dusa\*, and Michael L. Daley, University of Memphis, Memphis, Tennessee.*

Due to the multiple pathologies associated with each primary injury and a sparse understanding of the physiological mechanisms at play in a given patient following injury the task of

management is a very difficult one. To explore the development of a potential clinical method, we examine changes in cerebrovascular pressure transmission, the dynamic relationship between arterial blood pressure (ABP) and intracranial pressure (ICP), in pressure recordings of sixteen adult patients. Using numerical identification methods to obtain the modal frequencies of a third order model of cerebrovascular pressure transmission, we found that during intact pressure regulation an inverse relation between the highest modal frequency of transmission and cerebral perfusion pressure (CPP) holds. Four patients were monitored over a 24 h. Serial analysis suggested that two patients demonstrated apparent loss of pressure regulation during the monitoring period.

#### CHANGES IN CEREBROVASCULAR PRESSURE TRANSMISSION OF PEDIATRIC BRAIN-INJURED PATIENTS. *Deepthi Bommera\*, Sowmya Kodimela\*, Suma Kollabathula\*, Sowmya Parvathaneni\*, and Michael Daley, University of Memphis, Memphis, Tennessee.*

Due to the multiple pathologies associated with each primary injury and a sparse understanding of the physiological mechanisms at play in a given pediatric patient following injury the task of management is a very difficult one. To explore the development of a potential clinical method, we examined changes in cerebrovascular pressure transmission, the dynamic relationship between arterial blood pressure (ABP) and intracranial pressure (ICP), in pressure recordings of eight pediatric patients. Using numerical identification methods to obtain the modal frequencies of a third order model of cerebrovascular pressure transmission we found that that pediatric patients generally demonstrate high modal frequencies which are indicative of increased vascular dilation resulting in increased blood volume and hyperemia. In addition, serial analysis reveals that patients demonstrate episodic changes in pressure regulation.

#### ROLE OF GEOMETRY ON THE EFFECTIVE DIFFUSIVITY AND MOBILITY IN MICRODEVICES FOR ELECTROPHORETIC SEPARATIONS. *Heather R. Pridemore\* and Pedro E. Arce, Tennessee Technological University, Cookeville, Tennessee.*

Previous studies have shown that templating the internal gel structure at the macromolecular level can lead to improved separations of biomacromolecules. Although the understanding of the mass transport of biomacromolecules in nanostructured gels is not fully developed, preliminary work suggests nanostructured gels provide means to tailor and improve sieving selectivity of molecules with dimensions within certain size ranges related to the dimensions of the templated pores. An area-averaging approach yields elimination of the radial dependence from the species continuity equation through identification of effective transport parameters (e.g. effective diffusivity and effective mobility). Previous studies have shown that effective transport parameters are dependent on both hydrodynamics and the electrical field, which are both dependent on the microchannel geometry; these studies focused on relatively simple geometries of the microchannel. This contribution incorporates a more realistic physical picture of the microchannel.

#### ETHICS IN SCIENCE AND TECHNOLOGY SECTION RUBY PRIGMORE-TORREY, CHAIR

TEACHING ETHICS IN ACADEMIA: ITS' APPLICATION IN RESEARCH TRAINING AND PRACTICE. *Tom Brignall and*

**Srini Ramaswamy**, *Tennessee Technological University, Cookeville, Tennessee*. A fundamental change in the education of future computer scientists is necessary to insure they are prepared for more demanding roles. Software designers need strong technical and management skills. They also need the skills to design customized products and integrated services that meet the diverse needs of a multi-cultural, multi-ethnic, and global world. New technological advances are being created at a rapid pace and come with unforeseen challenges and tremendous opportunities. In recent years, news coverage of business scandals, public condemnation of products, and possible legal consequences make it imperative that computer industry employees learn about ethics. More lawsuits could result if individuals and companies continue to violate accepted ethics and fairness standards. Hence, effectively integrating ethics into the computing curriculum is critical. Most scientific degrees require students to take an ethics course about the pros and cons of any scientific creation. A computing degree should be no different. In any creation of a product computer researchers must consider whether the software or hardware they create can or will be used for exploitive purposes. Is it the responsibility of the creator to develop a contingency plan for such exploitations? Should the creator be absolved from any wrong doing simply because they did not create the software for such purposes? This presentation will discuss our shared experiences, theory, and current literature addressing the growing need to develop an ethical framework in our discipline. In this talk the authors argue in many computer departments and computer corporations, ethics issues receive little consideration. Students must be made aware of the potential ethical dilemmas they will face in their future careers. The authors present the dilemma-based case study approach used to encourage students to reflect upon the social and ethical ramifications of technology.

## GEOLOGY AND GEOGRAPHY SECTION

MARK SIMPSON, CHAIR

**THE GRAND CANYON: A LOOK AT THE 1983 AND 1996 FLOOD SANDS.** **R. Seago\***, *University of Memphis, Memphis, Tennessee*. The Colorado River once flowed freely from the Rocky Mountains to the Gulf of California. In 1963, the Glen Canyon Dam was constructed to provide water storage, hydroelectric power, and recreation. Since the dam was built, there has been a loss of sediment down stream due to the lack of annual flooding. Sediment from the river helps to build beaches that provide adequate areas for camping and restoring archaeological areas. Extensive studies have been conducted on high releases from the dam in 1983 and 1996. The 1983 flood, similar in magnitude to flooding before the dam was built, replenished many of the beaches downstream. The 1996 flood was an experiment to rebuild the sandbars that had eroded over the previous 13 years. This paper will look at the similarities of the two floods to determine if human generated flooding will have the same benefits of sediment deposition as actual flooding.

**PRELIMINARY FIELD RESEARCH OF STROMATOLITES IN LAGUNA BACALAR, MEXICO.** **Elizabeth C. Rhenberg\*** and **Michael A. Gibson**, *University of Tennessee, Martin, Martin, Tennessee*. Along the shoreline of Laguna Bacalar, a freshwater bay in the Quintanaroo region of Mexico, a field of over 50 stromatolite heads occurs with a growth form that is anomalous to their current freshwater setting.

The one-meter tall stromatolites are marine in form, occur immediately adjacent to shore rather than in deeper water, are covered by a peat and soil with inter-head areas filled with a complex stratigraphy, are colonized by living freshwater mussels on their sides, appear to rim cenotes, and have oncoids in the sand flats surrounding the field. We believe the stromatolite field to be an exhumed/relict salt-water setting that serves as evidence of a major hydrologic shift sometime during the Neogene(?). Their geometry and association with cenotes indicate the first reported occurrence of "stromatolite atolls". The source of the oncoids remains unclear as none have been found within the burial stratigraphy, but we believe them relict.

**AN EXERCISE IN FORENSIC PALEONTOLOGY: ESTABLISHING THE AUTHENTICITY OF THE "KIRKLAND DINOSAUR EGGS"**. **Michael A. Gibson and Elizabeth C. Rhenberg\***, *University of Tennessee, Martin, Martin, Tennessee*. Forensics, of which forensic geology is a rapidly developing field, is defined as the application of science to questions of legal interest; thus, forensic paleontology is the application of paleontological principles and techniques to questions of interest to the legal issues. At the request of a representative the Kirkland's store chain, students at the University of Tennessee, Martin applied paleontological techniques to help establish the provenance of over 50 dinosaur eggs allegedly from China purchased by a member of the Kirkland family. The Kirkland's suspected that the eggs may not have been actually originally obtained in China. By studying the egg microstructure, egg shape and form, and comparing internal sediment and host sediment, we determined the eggs were indeed dinosaurian, containing at least 3 egg types, and are consistent with dinosaur eggs from known localities in China; however, egg clutches contain a mix-match of sediments and show indications of having been fabricated.

**PRELIMINARY RESULTS OF A FIELD STUDY OF BRYOZOAN THICKETS FROM THE TANOSAWA FORMATION OF JAPAN.** **Yuko Takishita\***, **Kotaro Kamada**, and **Michael A. Gibson**, *Hirosaki University, Hirosaki, Japan (YT, KK), and University of Tennessee, Martin, Martin, Tennessee (MAG)*. A wave-cut platform, raised by an earthquake in 1793, at Odose on the northwestern coast of Honshu, Japan exposes fine to very coarse volcanoclastic sandstones of Tanosawa Formation (early-middle Miocene). The exposed seafloor displays numerous bryozoan thickets/frameworks, often in living position, with bryozoan-foraminiferan concentrations as nodular (circular patterns) regions behind the thickets. Rounded granules to pebbles of scoria occur in the thickets. Several possible explanations for the deposits are being tested: (1) the bryozoan thickets and bryozoan-foraminifera concentrations are obrution deposits; (2) the circular concentrations of bryozoans and foraminifera may have formed due to liquefaction/fluidization as sediment dewatered; (3) the concentrations belong to the ichnotaxon *Piscichnus waitemata* interpreted to be the feeding patterns of sting rays; or (4) the circular patterns may be due to small bryozoan colonies stabilizing in a natural low area of the Miocene seafloor that entrapped foraminifera and scoria during a storm event.

**PRECIPITATION IN TENNESSEE: TELECONNECTION RELATIONSHIPS.** **Robert M. Simpson**, *University of Tennessee, Martin, Martin, Tennessee*. The relationships between Tennessee's precipitation climatology and teleconnections, or principle

modes of atmospheric behavior are usually investigated in the light of its position within the southeastern United States or are examined using one teleconnection at a time. This study examines multiple linear regression models of precipitation for 15 stations in Tennessee based on the appropriate combination of linearly-independent northern hemisphere teleconnection variables for the month of January, when most of the wintertime teleconnections are most pronounced. By mapping the residuals and the coefficient of determination of the models, it can be shown where the teleconnections mostly determine precipitation in the winter and where the physical landscape exerts the most control. It is proposed that there will be little variability in model performance in the western end of the state, while a great deal of variability will be introduced in the east because of the more mountainous landscape there.

CELLULAR PHONE TOWER SITING USING GEOGRAPHIC INFORMATION SYSTEM. *Clifford E. Hoeffner\* and Peter Li, Tennessee Technological University, Cookeville, Tennessee.* Growing population demand and popularity of cellular phones is increasing the need for new cellular phone towers. The purpose of this study was to find suitable sites for cell towers in the Knoxville area using ArcGIS 8. The latest census data was used to determine population density and future demand criteria. A DEM of the Knoxville area was used to determine ridgelines suitable for tower sites. Land use data, soil data, and road data all were used to narrow the search criteria. Demographic layers help locational analysis with the aid of spatial analysis functions in Geographic Information System. The Study outlines the potential growth of the urban areas and points out the dilemma of urban sprawl.

ANALYSIS OF SEX OFFENSES USING GEOGRAPHIC INFORMATION SYSTEM. *Jacob K. Tittle\* and Peter Li, Tennessee Technological University, Cookeville, Tennessee.* The research in this project studied the occurrence of sex offenses in Putnam and its surrounding counties including: Dekalb, Cumberland, Fentress, Jackson, Overton, Smith, and White. Names and addresses from the Tennessee Sexual Offender Registry were used in importing information from 96 different offenders into ArcGIS 8. Demographic data and shapefiles such as road and school layers were used to study the spatial relationship between the offenders and the areas where they live. Methods of cluster analysis and geocoding were used in displaying the results. Concentrations of sex offenders per 1000 population were computed and displayed to show spatial patterns in the region. Correlation of zoning patterns and sex offender concentration was studied, analyzed and presented.

GEOGRAPHICAL MAPPING OF METHAMPHETAMINE LABORATORY SEIZURES IN PUTNAM COUNTY AND THE SURROUNDING AREAS. *Mary E. Walton\* and Peter Li, Tennessee Technological University, Cookeville, Tennessee.* This research studied the geographical mapping of methamphetamine lab seizures in Putnam County, Tennessee and its surrounding counties of Cumberland, DeKalb, Fentress, Jackson, Overton, Smith, and White. The data used cover a five-year time span and contain approximately 800 addresses. The purpose of the study was to determine any spatial patterns in the location of the laboratories seized, identify any areas with a large concentration of labs, and find any correlation between labs and socioeconomic background of the region. Spatial correlation analysis also will

be presented and discussed. The point data were geocoded and refined due to the nature of the addresses. Cluster analysis was used to determine any concentrations of the labs. Seasonal and demographic data also were analyzed and documented.

## HISTORY OF SCIENCE

C. STEVEN MURPHREE, CHAIR

A BELATED REVIEW OF THOMAS B. SPRINGS, 1852. EPIDEMIC DYSENTERY, AS IT OCCURRED IN WARREN COUNTY, TENNESSEE DURING THE SUMMER AND FALL OF 1851. UNPUBLISHED MD DISSERTATION, UNIVERSITY OF NASHVILLE, 21 PP., HANDWRITTEN. *James X. Corgan, Austin Peay State University, Clarksville, Tennessee.* In the 1850s a dissertation was required for the degree of Doctor of Medicine. Springs wrote on the health of the county where he lived. He described a single epidemic of dysentery, writing when the Germ Theory of Disease had yet to develop. To Springs, Warren County dysentery seemed to be rooted in stagnant water, boggy land, and fog. With four other local physicians, Springs kept statistics on illness and death. Some 43% of the population had dysentery and about 5% of those died. These data are a very early record of public health and mortality in rural Tennessee

O. C. MARSH IN NASHVILLE, 1877. *George E. Webb, Tennessee Technological University, Cookeville, Tennessee.* Among the most noted of the scientists who attended the AAAS meeting in Nashville during late August and early September 1877 was the paleontologist Othniel C. Marsh. In his position as vice president for Section B (geology, botany, anthropology, zoology), he chaired the three sessions of that section, overseeing presentations on a wide variety of topics. At the association's business meeting he was elected president of the organization, to assume office at the following year's meeting in St. Louis. Marsh's most dramatic contribution to the meeting, however, was his vice presidential address on the evening of 30 August, during which he emphasized the growing evidence supporting the concept of organic evolution. Reprinted in full in the *Nashville Daily American*, this address attracted much interest. Marsh's activities in Nashville provide important insight concerning the place of science in the post-Reconstruction South.

THE TRIAL OF GALILEO: DISOBEDIENCE, NOT HERESY. *Brother Kevin Ryan, Christian Brothers University, Memphis, Tennessee.* It is often written or said that the trial of Galileo by the Roman Catholic Church was on the charge of heresy. This was not the case. If the legal charge was "preaching Copernicanism", this could not be heresy because Copernicanism was not an article of Faith; not at the time of Galileo nor now. He was charged with disobedience, a less serious charge, and he pled guilty. In modern terms, we would call this a plea bargain.

BRITISH SURGEON JOHN HUNTER'S IRISH GIANT OBSESSION, 1783. *C. Steven Murphree, Belmont University, Nashville, Tennessee.* In April, 1782, Charles Byrne at age 21 traveled from Ireland to London where he was exhibited at a circus as "the tallest man in the world". Patrons paid half a crown to see this 8 feet, 2 inch giant. John Hunter, considered one of the three greatest surgeons of all time, had begun a museum of comparative anatomy in London. Hunter and other Brit-

ish anatomists were anxious to obtain Byrne's body upon his death. Byrne arranged to have his body placed in a lead coffin and buried at sea. When Byrne died on June 1, 1783, his body was delivered to John Hunter whom it is said bribed the undertaker with 500 pounds. The lower part of Byrne's skeleton can be seen in a famous portrait of Hunter by Joshua Reynolds and the entire skeleton can still be viewed at the Hunterian Museum in London.

## MATHEMATICS AND COMPUTER SCIENCE SECTION

MICHAEL R. ALLEN, CHAIR

SECOND ORDER INTERVAL APPROXIMATIONS OF SMALL AREA MEANS. *Gauri S. Datta, J. N. K. Rao, and David D. Smith, University of Georgia, Athens, Georgia, Carleton University, Ottawa, Ontario, Canada, and Tennessee Technological University, Cookeville, Tennessee.* Model-based estimation of small area means is widely used in producing point estimates and their associated measures of uncertainty. Although various accurate estimates of the MSE of the point estimates have been developed, not much attention has been devoted to the interval estimation problem. For a general Fay-Herriot model, we first construct approximate confidence intervals and then calibrate such intervals to attain a second order target coverage probability. To include hierarchical Bayes, empirical Bayes, and the Empirical Best Linear Unbiased Predictor, we consider intervals of the form  $(t - z^*s, t + z^*s)$  where  $t$  and  $s$  are suitably chosen to achieve second order target coverage probabilities.

EVALUATION OF THE INTEGRATE METHOD IN MIXTURE PHASE EQUILIBRIUM CALCULATIONS USING EQUATIONS OF STATE. *Sanjay K. Dube\* and Donald P. Visco Jr., Tennessee Technological University, Cookeville, Tennessee.* Phase equilibrium calculations play an important role in the design and optimization of chemical processes. The calculation of the necessary thermodynamic properties is performed on computers with an expensive operation time. Therefore, the development of faster, efficient and reliable computational algorithms is a high priority task in chemical processes. By keeping the above objective in mind we developed a novel technique known as the Integrate Method that involves a differential form of the equilibrium constraints followed by numerical integration. This method has been applied to both pure components and mixtures for the modeling of Vapor Liquid Equilibrium and Liquid Liquid Equilibrium properties by using cubic and complex equations of state. Results indicate that the Integrate method provides computational speedup relative to conventional techniques.

INVESTIGATING THE PURE COMPONENT PARAMETERIZATION PROCEDURES AND THEIR EFFECTS IN PREDICTING MIXTURE PHASE PROPERTIES VIA EQUATIONS OF STATE. *Saravanan Swaminathan\* and Donald P. Visco Jr., Tennessee Technological University, Cookeville, Tennessee.* Predicting/correlating phase behavior of compounds using thermodynamic equations of state (EOS) has been a very vital area of research, as it is a quick and inexpensive way of predicting the required properties at desired conditions. The pure component parameters obtained after parameterization are used along with

appropriate mixing and combining rules to predict the mixture phase behavior of these systems. Prior optimization techniques for parameterization of pure components were methods that converge at a local minimum. The number of local minima varies depending on a variety of factors, such as number of data points, objective function used, weighting of the data points, etc. The local minimum found and ultimately used to predict mixture properties can have a large impact on the quality of the resulting mixture predictions. Recent advances in methods of global optimization however, have enabled us to potentially find all the local minima. This work is a first step to explore these important issues using simple and complex EOS.

INDEPENDENT COMPONENT ANALYSIS AND WATER-MARK ATTACK. *Devin Zhang, Tennessee Technological University, Cookeville, Tennessee.* Digital watermarking has recently become a very active research area. In this research, a novel watermark attack based on independent component analysis (ICA) and multi-criteria optimization is developed to improve the existing watermarking robustness evaluation system. The new watermark attack, Semi-ICA estimation, is first developed as a nonlinear denoising algorithm to remove noises with arbitrary distribution from correlated supergaussian signals. Semi-ICA estimation composes an orthogonal linear transformation and a Bayesian based nonlinear estimation function. The linear transformation is to maximize the dissimilarities between original signals and noises in the sense of nongaussianity and achieve the independency among components of signals. The component-wise Bayesian based nonlinear estimation is to estimate components of the clean signal in the transformed domain. Based on these two objectives, a recursive algorithm, maximizing the difference of negentropy between signal and noises and a estimation function, minimizing mean square error, are derived, respectively. Semi-ICA estimation becomes a watermark attack if watermark is considered as noise. The performance of Semi-ICA attack on Spread Spectrum (SS) watermarking and DCT domain watermarking are close to the denoising attacks in Checkmark package. In attacking Image Adaptive Watermarking (IAW) algorithm, Semi-ICA attack outperforms all denoising attacks in Checkmark v1.2 package. The theorems and experiments of Semi-ICA prove that Semi-ICA is effective not only on removing noises with arbitrary distribution but also on defeating various watermarking techniques. Thus, Semi-ICA estimation should be included into future standard denoise toolbox and watermarking robustness evaluation systems.

## PHYSICS AND ASTRONOMY SECTION

LIONEL CREWS, CHAIR

FABRICATION AND CHARACTERIZATION OF TiO<sub>2</sub> NANORODS. *Dawit Jowhar\*, Akira Ueda, and Richard Mu, Fisk University, Nashville, Tennessee.* The earth's natural resources have been depleting by rising energy needs. The sun has been proven to be an inexhaustible resource. If properly harnessed, it would more than satisfy the needs of humanity. Conventional solar cells that are being implemented currently have a theoretical efficiency of 40%. This efficiency can be increased by using nanocomposite solar cells. The predicted efficiency is going to be 66%. The use of quantum dots on the nanorods helps to collect broader wavelengths of photons, thereby enhancing the conver-

sion efficiency of the solar cells.  $\text{TiO}_2$  has been chosen as a suitable nanorod material in a photovoltaic cell. It is a wide band gap semiconductor, which facilitates the transport of electrons and is easily available. Several thicknesses of  $\text{TiO}_2$  were deposited on silica using e-beam evaporation. Thermal treatments were applied at various temperatures and annealing time. UV-VIS and FTIR spectra were collected and some experimental analysis has been done.

**RAMAN SPECTRA OF THE INTERACTION OF ANTI-FREEZE GLYCOPROTEIN AND ICE.** *Andrea M. Sease\**, *Arnold Burger*, *Mingsheng Guo*, *Yunlong Cui*, and *Ratsgo Hawrami*, *Fisk University, Nashville, Tennessee*. The interaction of antifreeze glycoprotein (AFGP) and ice were observed using He-Ne laser to excitation. The resulted Raman spectra were slightly different from previously obtained. New peaks found are thought to be caused by the interaction of the ice and the protein through a C-O bond.

**THERMAL AND OPTICAL STUDY OF YTTRIUM ALUMINUM BORATE GLASSES AND GLASS-CERAMICS.** *Marcia Hays\**, *Steve Morgan*, and *Zhengda Pan*, *Fisk University, Nashville, Tennessee*. Study of yttrium aluminum borate glass used differential scanning calorimetry (DSC) and absorption and emission spectroscopy (photoluminescence). Rare earth ions, erbium and europium, were chosen as dopants. The key objectives were to achieve uniform bulk crystallization, durability, transparency, and luminescence. Several heat treatments were performed in order to reach the goal of a transparent glass ceramic. The glass transition temperature and the crystallization temperature were found by DSC. Absorption and emission spectra revealed optical transition properties of  $\text{Er}^{3+}$  in  $\text{Y}_2\text{O}_3\text{-Al}_2\text{O}_3\text{-B}_2\text{O}_3$  system.

**THE BASICS OF MATHEMATICA.** *Buford Richardson\* II* and *W. E. Collins*, *Fisk University, Nashville, Tennessee*. The purpose of my research was to learn how Mathematica works and completely become capable of using it in any kind of application that was given. This was done by continuously working on the Mathematica program; learning how to use different functions and graphs so that they can be used in future research plans. Currently, Mathematica is being applied in the field of Quantum Mechanics checking different functions and seeing if the functions satisfy the equation that was focused on. The results were varied, and more time is needed to get better results.

**USE OF LABVIEW IN CREATING A DYNAMIC LIGHT SCATTERING AUTOCORRELATOR.** *Marian Axente\** and *Robert Marlowe*, *University of Tennessee, Chattanooga, Chattanooga, Tennessee*. Work has recently been completed at the University of Tennessee, Chattanooga Department of Physics, Geology and Astronomy on the software configuration of an autocorrelator for use in dynamic light scattering experiments. Our investigations will be in the area of macromolecular diffusion. We will present a layout of the experimental hardware and LabVIEW software. In addition, we will describe two simulations that have demonstrated that the autocorrelator can function properly using a sample time window of 20  $\mu\text{s}$ .

**COALSACK GLOBULE B AND CB180—MODELING LARGE-SCALE DISTRIBUTION AND PROPERTIES OF DUST GRAINS IN DARK NEBULAR CORES.** *Lionel Crews*, *Brian Stiles\**, *Karoline Pershell\**, *Tracy Huard*, *Charlie Lada*,

and *Phil Myers*, *University of Tennessee, Martin, Martin, Tennessee (LC, BS, KP)* and *Harvard-Smithsonian Center for Astrophysics, Cambridge, Massachusetts (TH, CL, PM)*. Through the use of near-IR detectors and long-exposure CCD photography, we can penetrate through dark nebulae to see stars behind the nebulae. By analyzing the effect of the nebulae on the wideband spectra of these stars, we determine the structure of the nebulae and properties of the constituent dust grains in the nebulae. Modeling the dust distribution reveals such information as the total mass of the nebula, presence (or lack) of significant turbulence, thermodynamic profile, and dust grain size distribution. By examining different nebulae in different states of evolution, we can understand how these properties change as stars are formed in the nebulae. My students and I have examined two such nebulae recently and discovered that both have a rather unusual structure. Coalsack Globule B appears to be in an unstable state, possibly because it is very young, and CB180 has a very dense core that may harbor an previously unseen protostar.

**A STUDY OF THE COUPLED PENDULUM.** *D. Comer\** and *L. Crews*, *University of Tennessee, Martin, Martin, Tennessee*. We have been studying the coupled pendulum using a model I constructed and PASCO rotary motion sensors to record the motion. We obtained angle versus time measurements showing the exchange of energy from one pendulum to another through the coupling spring. We varied the location of the spring and the spring constant, as well as the masses of the pendulums. We then modeled the motion of the pendulum using basic mechanics with the assistance of the mathematics program Maple, and the results fit reasonably well with the observed motion, not accounting for friction. We also studied the frictional energy losses in the system, and the transfer time of energy between the pendulums as a function of spring position.

## SCIENCE AND MATHEMATICS TEACHING SECTION KIM CLEARY SADLER, CHAIR

**DO NONSCIENCE MAJORS IN ONLINE SECTIONS OF AN INTRODUCTORY BIOLOGY COURSE PERFORM AS WELL AS STUDENTS IN TRADITIONAL OFFERINGS OF THE SAME COURSE?** *Nicole Turrill Welch*, *Middle Tennessee State University, Murfreesboro, Tennessee*. While many colleges and universities increase their offerings of online courses to meet the demands of enrollment, some educators and students question whether the amount of knowledge gained in online courses differs from that gained in traditional classroom settings. I compared student performance in my online and traditional classroom offerings of a one-semester, introductory biology course for non-science majors. The same lecture and lab topics were covered in both courses; only the lecture delivery method differed. Data collected on one, 24-student online course and one, 98-student traditional course included exam scores (%), course grade (%), student acquisition of knowledge measured using a 20-question pre-test and post-test, and composite ACT scores for students who received a letter grade in the course. Results suggest that student performance in this course is independent of lecture delivery method and, instead, depends upon the study skills and

knowledge of biology students gained from their primary and secondary education.

**A MODEST PROPOSAL FOR LEAVING NO CHILD BEHIND IN SCIENCE AND NO BIOLOGY TEACHER FIRED FOR TEACHING EVOLUTION IN TENNESSEE: WHY NOT TEACH DARWIN'S ARGUMENT AS AN ARGUMENT?** *J. Angus Campbell, University of Memphis, Memphis, Tennessee.* I propose that science teachers develop age appropriate curricula for teaching the contemporary neo-Darwinian theory of evolution as an argument. Teachers would stress equally the fact of evolution and the reasoning connecting the different kinds of evidence supporting the theory. The proposal is rooted in science pedagogy and the teaching strategy of Darwin's *Origin*. Many science educators note how opposition grounded in students' "world-views" impedes learning and teaching evolution. Darwin addressed such opposition through examples seemingly fatal to his theory. Following Darwin's example, and J. S. Mill's warning that truth not critically questioned becomes just another dogma, students would use common objections to evolution to explain how contemporary theory would rebut or address them. Rather than "confront the objections of fundamentalist Christians" the proposal would welcome student skepticism as a motive and resource for teaching and learning.

**IMPROVING COGNITIVE DEVELOPMENT BY USING MOLECULAR MODELS IN THE COLLEGE CLASSROOM.** *Margaret F. Hicks, Pellissippi State Technical Community College, Knoxville, Tennessee.* Visual or kinesthetic learners have difficulty grasping abstract concepts pertaining to macromolecular structure, simply because they lack the ability to interact with the molecules. Much research has provided credence to the need for hands-on experiential learning to allow students to progress from concrete to formal (abstract) thinking. Modeling activities were incorporated into a one-semester, sophomore level genetics course. Pre- and post-tests were given, using the Group Assessment of Logical Thinking (GALT) test, which measures cognitive development. Plaster and nylon models of proteins, DNA and ribosomes, constructed to scale using rapid prototyping machines, were utilized in the classroom both prior to (exploratory activities) and after (review activities) corresponding lectures. Students showed a 4.8% increase in cognitive development as measured with the GALT test; genetics students in a previous semester, without the use of molecular models, showed no improvement in GALT scores.

**EIGHT YEARS OF EXPANDING YOUR HORIZONS IN SCIENCE AND MATHEMATICS IN MIDDLE TENNESSEE.** *Judith M. Iriarte-Gross, Middle Tennessee State University, Murfreesboro, Tennessee.* Expanding Your Horizons in Science and Mathematics (EYH) Conferences were created in 1976 by the Math/Science Network. The first EYH was held in middle Tennessee on October 25, 1997 at Middle Tennessee State University (MTSU). The community partners who host EYH are MTSU, the Girl Scout Council of Cumberland Valley, the American Association of University Women, Murfreesboro Branch, and the Math/Science Network. We served over 300 middle school girls at our first conference and over 2200 girls to date. Our 8<sup>th</sup> conference is being held on October 23, 2004 with Stacey Roberts-Ohr, national coordinator of EYH. The primary goal of EYH is to acquaint young women with science, mathematics, and technology based careers. EYH conferences provide young wom-

en with the knowledge they need to make informed choices about science and mathematics now in middle school and later as high school and college students. Highlights of the history of EYH at MTSU will be discussed.

**WOMEN IN SCIENCE AND ENGINEERING: A STUDENT ORGANIZATION FOR ALL WOMEN IN SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS.** *Caroline Bishop and Judith Iriarte-Gross, Middle Tennessee State University, Murfreesboro, Tennessee.* Women In Science and Engineering (WISE) is a new student organization at Middle Tennessee State University (MTSU) for undergraduate and graduate women who are majoring in basic and applied sciences, including traditional sciences, nursing, engineering, mathematics, computer science, aerospace, and military science. Dr. Cornelia Gillyard of Spellman College talked about the WISE program during her visit to MTSU in March 2003. As a result, WISE became a formal student organization at MTSU in the fall of 2003. The mission of WISE is to help women prepare for and become involved in science-related careers and to assure women of their importance in all scientific and technical fields.

**INQUIRY-BASED CURRICULUM AND RESOURCES FOR A PRESERVICE TEACHER BIOLOGY EDUCATION COURSE, KNOXVILLE, TENNESSEE.** *Yolanda K. Sankey, Pellissippi State Technical Community College, Knoxville, Tennessee.* This presentation is about the curriculum and resources in a Concepts of Biology class for elementary education majors. The course content for the preservice teachers is "hands-on, minds-on" investigations and examples will be shown. The pre- and post- tests assessing the students' higher order thinking and science attitudes will be discussed.

**DEFINING CHEMISTRY: A STUDENT PERSPECTIVE.** *Amy J. Phelps, Middle Tennessee State University, Murfreesboro, Tennessee.* Currently theories regarding learning indicate that prior conceptions are critical to future understanding. This theoretical basis has been the underpinning for many studies in chemical education that look at misconceptions students have regarding particular concepts in the field of chemistry. This paper looks more broadly at student expectations and prior conceptions about studying chemistry in general by analyzing first day definitions of chemistry given by General Chemistry I students over a 10 year period. These free response definitions are used in class as a first day activity to get students thinking about chemistry and working together in groups to build consensus. These definitions have been analyzed using a constant comparison technique to produce categories in an attempt to characterize students' incoming conceptions of the field of chemistry in general.

**A PRELIMINARY STUDY OF A LINKED LEARNING COMMUNITY AND STUDENT OUTCOMES IN A COLLEGE BIOLOGY COURSE.** *Kim Cleary Sadler and Sandra L. Johnson, Middle Tennessee State University, Murfreesboro, Tennessee.* This study was conducted at the earliest implementation of linked learning communities by our university. The objective was to assess the impact of participation in a linked learning community on student success in an introductory biology course. The following questions were addressed: 1) does working within a community of peers enhance biology learning and self-efficacy?, and 2) does biology self-efficacy influence student success as determined by final course grade? A pre- and posttest design was used



to determine student biology content knowledge and self-efficacy using the Biology-End-Of-Course Exam (BECE, spring 2001) and Biology Self-Efficacy Scale (BSES, Baldwin et al., 1999). Final course grade, along with post-test data, were used to measure successful course completion. The findings suggest that inclusion in a learning community did not significantly enhance course grade or self-efficacy.

**MEASURING THE PREDICTIVE ABILITY OF A SELF-EFFICACY INSTRUMENT FOR COLLEGE NON-BIOLOGY MAJORS LEARNING IN ACTIVE VS PASSIVE LECTURE ENVIRONMENTS.** *Sandra L. Johnson, Middle Tennessee State University, Murfreesboro, Tennessee.* Social cognitive theory asserts that self-efficacy, and confidence affect motivation and persistence at new tasks. I tested the hypotheses that (1) student reported self-efficacy predicts achievement in nonmajor's biology and (2) students' confidence in their ability to use biology in their lives increases when they engage in active learning. Three non-major biology lecture classes participated in this study. In the active-lecture, mini-lectures were followed by multiple-choice questions whereas passive lectures did not include question sets. The multidimensional Biology Self-Efficacy Scale administered in a pre- and posttest format determined that self-efficacy was not a significant predictor of final grade. However, two dimensions of self-efficacy significantly increased among active learners. This project does not support the proposition that self-efficacy predicts biology achievement. However, achievement involves a broad spectrum of complex behaviors. Analysis of the behaviors that successfully lead to biological literacy may clarify the relationship between self-efficacy and achievement.

**MAY THE FORCE BE WITH YOU: LABORATORY ACTIVITIES ON MAGNETISM FOR NON-SCIENCE MAJORS.** *Rose Darnell\* and Judith Iriarte-Gross, Middle Tennessee State University, Murfreesboro, Tennessee.* We have designed and developed a new laboratory experiment on magnetism for non-science majors. We have incorporated the use of the Vernier magnetic field sensor and the TI 83+ graphing calculator in this activity. Students will learn how to make and use their own compass. They will study the driving force behind the compass and find true north relative to their geographical location. Students will learn how knowledge of the earth's magnetic fields plays an important role in the rotation of the earth with respect to other planets within our solar system. Students will investigate how land and sea navigation was possible before Global Positioning System satellites were invented. Non-science majors who participate in this laboratory will begin to understand one of the major forces behind "everyday" science.

**FROM THE LABORATORY TO THE HEALTH CARE CONSUMER: EXPLAINING THE PHYSICAL SCIENCE BEHIND A MAGNETIC RESONANCE IMAGE.** *Linda Hendrickson and Judith Iriarte-Gross, Middle Tennessee State University, Murfreesboro, Tennessee.* Honors physical science students at Middle Tennessee State University (MTSU) are expected to learn about the scientific method and its application to problem solving in everyday life. To truly understand these matters, however, it is essential for students to have an understanding of molecular structures. Nuclear Magnetic Resonance (NMR) spectroscopy is a spectroscopic technique used by scientists to obtain chemical and physical information about the structure of molecules. Nuclear Magnetic Resonance thus provides an excellent means of

interpreting what physical science students often perceive as abstract chemical formulas. This interpretation is made possible by viewing the NMR spectrum. We have, therefore, integrated NMR technology into the non-science major undergraduate laboratory curriculum.

**SCIENCE, SCIENCE EVERYWHERE: LABORATORY ACTIVITIES WITH EVERYDAY CONNECTIONS A NEW LABORATORY COURSE FOR NON-SCIENCE MAJORS.** *Judith Iriarte-Gross and Martha Riherd Weller, Middle Tennessee State University, Murfreesboro, Tennessee.* We have developed a set of laboratory activities intended to engage the interest of non-science majors. We use everyday materials and phenomena such as the chemicals under a household sink or in the medicine cabinet to illustrate fundamental concepts in chemistry and physics. Topics in geology and astronomy are addressed through semester long class projects in which students collect data about lunar phases, sunset, moonset, earthquakes, and volcanic eruptions from the media or from web sites. Finally, at least one laboratory period per semester is devoted to a class debate on a topic of current controversy in science. We have observed increased interest in the lab and improved attitude toward science from our students.

## ZOOLOGY I SECTION

DANNY L. BRYAN, CHAIR

**HISTORICAL AND PRESENT DISTRIBUTION OF *ANGUISPIRA PICTA* IN TENNESSEE: ADVENTURES ON THE SNAIL TRAIL IN FRANKLIN COUNTY.** *David I. Withers, Division of Natural Heritage, Department of Environment and Conservation, Nashville, Tennessee.* The painted snake coiled forest snail (*Anguispira picta* Clapp) was first documented from Buck Creek Cove, Franklin County, Tennessee, in 1906, and was reported solely from the type locality as late as the early 1980's. The snail was listed as Threatened by the United States Fish and Wildlife Service in 1978. The current survey was conducted from spring 2003 to summer 2004 to determine the status of the species at the type locality and throughout the Crow Creek valley. Because of the species' prerequisite association with limestone outcrops, pedestrian surveys were conducted by ascending the Cumberland Plateau escarpment and examining outcrops and cliff faces for live or dead specimens. *Anguispira picta* was documented from approximately 5.3 and 4.5 miles of escarpment on the west and east sides of the Crow Creek valley, respectively. The species exists in two apparently contiguous areas, one each on either side of the Crow Creek valley.

**VARIATION IN EARLY NEUROMASTS OF TELEOST FISHES.** *Judith D. Shardo, Middle Tennessee State University, Murfreesboro, Tennessee.* Neuromasts are mechanoreceptors that are used by teleost fishes to perceive water pressure and flow changes in their immediate vicinity. They are used to locate food, detect predators, or maintain position in schooling fishes; however, many neuromasts develop well before hatching. In most reported cases, cranial neuromasts form before trunk neuromasts and the first cranial neuromast to form is the otic neuromast located at the anterior edge of the otic vesicle. In at least two species, the radial arrangement of the hair cells forming the otic neuromast differs from the typical bi-directional orientation of all other neu-

romasts reported for teleosts. The most likely explanation is that the radial configuration is a nonfunctional intermediate step in the development of the typical bi-directional neuromast.

**FORAGING BEHAVIOR BY YOUNG OF YEAR TIMBER RATTLESNAKES.** *D. Bryan, Cumberland University, Lebanon, Tennessee.* Timber rattlesnakes have been frequently described as ambush predators. Since there is not any nurturing during the development of these young rattlesnakes, the question arises as to how prey is located and captured. The foraging habits performed by young of year timber rattlesnakes were observed and recorded from two feeding sessions. Two separate litters were utilized during the observations and differences were noted and analyzed. A simple T maze was constructed and lab mice were allowed to leave a trail within the maze. Individual snakes were then allowed to trail the scent and forage. A total of 18 snakes were utilized in the trial from two litters,  $n = 10$  and  $n = 8$ . Differences between the two litters were noted and will be presented.

**THERMAL EFFECTS ON GREEN LYNX SPIDER EGG SACS AND HATCHING.** *Chadwick J. Hanna\* and Vincent A. Cobb, Middle Tennessee State University, Murfreesboro, Tennessee.* Sixty-one egg sacs from gravid females were collected in the summers of 2003 and 2004, and incubated at constant temperatures of 15, 17.5, 20, 25, 30, 32.5 and 35°C. Hatching time was recorded for each treatment and regressed against temperature. Hatching time was inversely proportional to temperature and no hatching occurred at 15 or 35°C. In the field, temperatures of 37 egg sacs were recorded until hatching or predation. Average temperature of field egg sacs was  $20.0 \pm 0.6^\circ\text{C}$  and average time until hatching was  $30.8 \pm 0.8$  days. Physical models were placed in the field to determine the extreme temperatures available for egg sac placement. The model temperatures ranged from  $-0.1$  to  $44.6^\circ\text{C}$ . These data show that egg sacs encounter a wide range of temperatures during their development, and that variations in climate and egg sac placement may affect the hatching time of spider egg sacs.

**NEW AND PREVIOUSLY REPORTED TICKS OF RUTHERFORD COUNTY, TENNESSEE.** *Tracey A. Ludyjan-Ybarra\*, Middle Tennessee State University, Murfreesboro, Tennessee.* A survey of Rutherford County was conducted to determine the species of Ixodid ticks present and the relative abundance of populations in selected areas. The study areas included city, county, state, and federal lands. Two areas from surrounding counties were included in the survey. Four previously unreported Ixodid species were identified from Rutherford County.

**SURVEY FOR THE TENNESSEE CAVE SALAMANDER, GYRINOPHILUS PALLEUCUS, IN MIDDLE TENNESSEE.** *Brian T. Miller and Matthew L. Niemiller\*, Middle Tennessee State University, Murfreesboro, Tennessee.* We surveyed cave streams throughout middle Tennessee to examine the population status and better delineate the range of the Tennessee Cave Salamander. Caves with historic records of *Gyrinophilus palleucus* and caves we thought might harbor populations that had previously gone undetected were searched to determine: 1) if populations were extant, 2) the relative abundance of individuals in extant populations, and 3) basic habitat parameters. We found a total of 152 *G. palleucus* in 10 of 20 caves searched. We confirmed extant populations at two caves within the Central Basin,

two caves on the Eastern Escarpment of the Cumberland Plateau, and one cave on the Western Escarpment of the Cumberland Plateau. Additionally, we located new populations on the Eastern Highland Rim (Warren County, 2 caves) and Western Escarpment (Grundy County, 1 cave; Coffee County, 2 caves). *Gyrinophilus palleucus* has a greater distribution than previously recognized and Middle Tennessee populations appear stable.

**COMPARATIVE DEMOGRAPHY OF THE TENNESSEE CAVE SALAMANDER (GYRINOPHILUS PALLEUCUS) IN MIDDLE TENNESSEE.** *Matthew L. Niemiller\* and Brian T. Miller, Middle Tennessee State University, Murfreesboro, Tennessee.* We compared the age structure, based on 5 mm length increments, of populations of the Tennessee Cave Salamander in Middle Tennessee. We implanted small (1 mm by 2 mm) alpha numeric tags (Northwest Marine Technology) into the tail of each salamander collected that exceeded 41 mm in snout-vent length to determine population sizes. We found 152 Tennessee Cave Salamanders and were able to capture 104 (68% capture rate). We implanted tags into 92 salamanders and have recaptured only two tagged individuals. Four or fewer salamanders were found in most caves; however, we found 19 or more individuals in three caves (counts of 19, 24, 41, and 48). Adults (greater than 70 mm SVL) dominated each of these populations, but larvae and juveniles were found at each cave, indicating that reproduction was occurring.

**BODY TEMPERATURES OF FREE-RANGING TIMBER RATTLESNAKES IN MIDDLE TENNESSEE.** *Jake Pruett\* and Vincent A. Cobb, Middle Tennessee State University, Murfreesboro, Tennessee.* The decline of Timber Rattlesnake (*Crotalus horridus*) numbers throughout portions of their range has led to a variety of ecological studies. However, few of these studies have documented details of their body temperature regulation. During the activity season of 2003 and 2004, we studied body temperature regulation in six free-ranging adult timber rattlesnakes in Rutherford County. Snakes were surgically implanted with radio transmitters for relocation and miniature temperature loggers for monitoring body temperature ( $T_b$ ). Body temperatures were collected every 30 min for 30–42 days. Snakes exhibited  $T_b$  patterns that remained relatively stable during the daytime, typical of most diurnal terrestrial snakes. Mean daytime  $T_b$ s were  $25.4 \pm .2^\circ\text{C}$  and mean nighttime  $T_b$ s were  $19.9 \pm .6^\circ\text{C}$ . Nighttime  $T_b$ s on most occasions closely matched the cooler available environmental temperatures indicating the snakes remained on the ground surface. Overall, snake  $T_b$ s ranged from  $5.5^\circ\text{C}$  to  $36.0^\circ\text{C}$ .

**BODY TEMPERATURE SELECTION OF BLACK RACERS (COLUBER CONSTRICTOR) IN MIDDLE TENNESSEE.** *J. Jeffrey Green\* and Vincent A. Cobb, Middle Tennessee State University, Murfreesboro, Tennessee.* This study investigated the daily thermal patterns of twelve free-ranging black racers (*Coluber constrictor*) in Middle Tennessee. Snake body temperatures ( $T_b$ ) were recorded every 30 min which allowed for the determination of a preferred  $T_b$  range of 30–36°C. Thermal physical models were placed in the environment to describe potential variation in snake  $T_b$  and allowed suggestions to be made on habitat utilization based on temperature ranges measured for each habitat. Operative temperatures ( $T_o$ ) ranging from 15–65°C for the various habitat types frequently overlapped suggesting snakes could encounter a wide thermal gradient in any habitat. Although

$T_b$  frequently overlapped among habitats, each habitat offered a different amount of time during the active period (0700–1900 h) for *C. constrictor* to thermoregulate within its preferred  $T_b$  range. Forests offered the least amount of time for thermoregulation within the preferred  $T_b$  range while cedar barrens offered the most.

## ZOOLOGY II SECTION

STEVEN E. HAYSLETTE, CHAIR

MOVEMENTS, HOME RANGE, AND FOOD HABITS OF FISHERS (*MARTES PENNANTI*) REINTRODUCED INTO TENNESSEE AT CATOOSA WILDLIFE MANAGEMENT AREA. **William Eric Copas and T. Roberts**, *Tennessee Technological University, Cookeville, Tennessee*. Fishers were once indigenous to eastern Tennessee, but were extirpated during the middle to late 1800's. The Tennessee Wildlife Resources Agency is attempting to establish a population of fishers at Catoosa Wildlife Management Area (CWMA). Fishers were live trapped in Wisconsin and were released at CWMA in October 2001 ( $n = 20$ ), and October 2002 ( $n = 20$ ). Ten individuals from each year were fitted with radio collars, and were monitored biweekly to determine movements and home ranges. Scats were obtained from collared individuals and stomach analyses were completed on any mortalities that were collected. Fishers dispersed widely from the release site (mean distance = 7.05 km) and established home ranges. Mean home ranges were 15618.3 ha for males ( $n = 9$ ) and 14541.5 ha for females ( $n = 8$ ), substantially larger than those reported from Wisconsin. Most home ranges were associated with gorges dominated by eastern hemlock (*Tsuga canadensis*) and mountain laurel (*Kalmia latifolia*) although fishers did use other types of upland forests. There were no significant differences ( $P = 0.334$ ) found between movement distances observed during the breeding season (February 27 thru April 15) and the non-breeding season (April 16 thru February 26). Prey items identified from scat ( $n = 12$ ) and stomach analyses ( $n = 2$ ) included gray squirrel (*Sciurus carolinensis*), opossum (*Didelphis virginiana*), eastern cottontail rabbit (*Sylvilagus floridanus*), groundhog (*Marmota monax*), hispid cotton rat (*Sigmodon hispidus*), and striped skunk (*Mephitis mephitis*).

PREDATION BY MAMMALIAN MESOPREDATORS ON ARTIFICIAL NESTS OF NORTHERN BOBWHITES. **Jason B. Jennings\*, Michael L. Kennedy, Allan E. Houston, and Brian D. Carver**, *University of Memphis, Memphis, Tennessee (JBJ, MLK), Ames Plantation, Grand Junction, Tennessee (AEH), and Freed-Hardeman University, Henderson, Tennessee (BDC)*. We assessed predation on artificial nests of northern bobwhites (*Colinus virginianus*) by raccoons (*Procyon lotor*), striped skunks (*Mephitis mephitis*), and Virginia opossums (*Didelphis virginiana*) at the Ames Plantation in Fayette and Hardeman counties, Tennessee. The problem individual hypothesis, which assumes only a small percentage of a predator species is involved in predation on prey, was tested. Results were based on mark/recapture data collected during two trapping sessions each year for 3 years (2000–2003). Raccoons predated nests in the highest percentage (10%) followed by striped skunks (8%) and Virginia opossums (1%). Only two individuals (striped skunks; one captured two times and one captured three times) were captured more than

once. In general, the problem individual hypothesis was not supported.

AGE AND SEX-SPECIFIC DEMOGRAPHY OF RACCOONS (*PROCYON LOTOR*) ON A SOUTHWESTERN TENNESSEE SITE. **John R. Hisey\*, Michael L. Kennedy, Troy A. Ladine, and Shannon A. Maris-Danley**, *Lee University, Cleveland, Tennessee (JRH), and University of Memphis, Memphis, Tennessee (MLK, TAL, SAMD)*. Age-and-sex specific demographic data for raccoons was obtained in a capture-recapture study extending from 1991 to 2004 at The University of Memphis' Meeman Biological Station near Memphis, Tennessee. The data were analyzed for consistency with recognized hypotheses on mating and movement tactics. The youngest and oldest males had annual turnover (disappearance) rates near 100 %. Mid-aged males and females of all age classes had lower turnover rates. Turnover and first appearance rates show high variability in mid-aged animals of both sexes and in this age group are correlated to other population parameters over time. These factors are related to regulation, distribution and genetic structure of populations, can disrupt local adaptations, and should influence conservation planning for solitary carnivores and the species they strongly affect.

AN ASSESSMENT OF POPULATION ABUNDANCE OF WHITE-TAILED DEER (*ODOCOILUES VIRGINIANUS*). **Philip L. Johnson\*, Michael L. Kennedy, and Steve W. Stephenson**, *University of Memphis, Memphis, Tennessee (PLJ, MLK) and Milan Army Ammunition Plant, Milan, Tennessee (SWS)*. Infrared-triggered cameras were used to estimate population abundance of white-tailed deer (*Odocoileus virginianus*) at the Milan Army Ammunition Plant in Carroll and Gibson counties, western Tennessee, during fall 2002, winter 2003, and fall 2003. Density estimates were derived from photographs taken at 20 sites during 21 days of sampling. Each site was baited with shelled corn, and cameras were set to record photographs at 10 min intervals. Based on photographs of male, female, and juvenile animals, population density was estimated. Estimates ranged from one animal per 3.5–4.4 ha with an average of 3.9 ha. Additionally, male densities were estimated to range from one per 14.5–35.1 ha with an average of 25.6 ha. Based on reports in previous studies, estimates derived in the present investigation reflected relatively high densities of white-tailed deer at the study site.

ASSOCIATION OF TEMPERATURE AND CAPTURE OF MAMMALIAN MESOPREDATORS IN WESTERN TENNESSEE. **James B. Akins\*, Josh K. Bright\*, Allen E. Houston, and Michael L. Kennedy**, *University of Memphis, Memphis Tennessee (JBA, JKB, MLK) and Ames Plantation, University of Tennessee, Grand Junction Tennessee (AEH)*. The association of daily temperature variables (ambient and soil) and capture of raccoons (*Procyon lotor*), Virginia opossums (*Didelphis virginiana*), and striped skunks (*Mephitis mephitis*) was assessed from 2 November 2003 to 18 December 2003 at the Ames Plantation in Fayette County, Tennessee. Individuals were live trapped on three 8 by 8 grids over a period of 32 nights of trapping on each site. Sampling resulted in 2048 trap nights (1 trap night = 1 trap set for 1 night) per grid. Percent capture per trap night of each species was correlated to temperature variables using a Pearson correlation coefficient. Results indicated a significant association of capture of Virginia opossums with ambient and soil temperatures and raccoons with soil temperature. No variables were

found to be significantly correlated with capture of striped skunks.

**TEMPORAL VARIATION IN SEX-BIAS RESPONSE OF RACCOONS (*PROCYON LOTOR*) TO LIVE TRAPS.** *Erica Hessen\**, *Brian D. Carver*, *John R. Hisey*, and *Michael L. Kennedy*, *University of Memphis, Memphis, Tennessee (EH, MLK)*, *Freed-Hardeman University, Henderson, Tennessee (BDC)*, and *Lee University, Cleveland, Tennessee (JRH)*. Temporal variation in the sex-bias response of raccoons (*Procyon lotor*) to live traps was assessed using mark-recapture procedures at the Meeman Biological Station in Shelby County, Tennessee, during winters of 1991–2004. Sampling was conducted on a 50-trap grid consisting of 5 lines of 10 traps each spaced about 200 meters apart. Individuals were captured using live traps (raccoon size) baited with canned cat food. After capture, raccoons were sedated, sex-determined, tagged in both ears, and released at site of capture. The work was conducted during early January through late March and involved approximately 2000 trap nights (1 trap night = 1 trap set for 1 night) per year. The number of males and females captured and rates of recapture by sex were determined. Results are discussed in light of previous reports revealing differential rates of capture between sexes in mammals.

**DEVELOPING BIOTIC INTEGRITY METRICS TO IDENTIFY IMPACTS OF LAND USE ON WETLANDS.** *Laura D. Mills\** and *Steven W. Hamilton*, *Austin Peay State University, Clarksville, Tennessee*. To identify critical biological measures of wetland health, we studied twelve wetlands in north-central Tennessee and south-central Kentucky, six impacted by row crop agriculture and six unimpacted. Aquatic macroinvertebrates were collected using 10.2 cm clear PVC pipe funnel traps and wire minnow traps. Seven samples were collected from each site between May 19 and August 8, 2004. Water quality parameters measured included dissolved oxygen, pH, temperature, specific conductance, and turbidity. Macroinvertebrates from three sets of samples for each site have been identified, when possible, to genus. The number of organisms collected from each site ranged from 43–2224. Fifty-six taxa have been identified. Generally, natural areas showed greater species richness, diversity and evenness than agricultural sites. Dipterans, primarily chironomids, were the most dominant assemblages. The three most abundant predatory orders, Coleoptera, Odonata and Hemiptera, showed alternating patterns of dominance. Habitat stability and greater vegetative complexity, which are impacted by surrounding agricultural practices, appear to be strongly related to higher species diversity.

**WATER QUALITY EVALUATION OF VALLEYBROOK STREAM: CLARKSILLE, TENNESSEE.** *Amy L. Archer\**, *Caron Baugher\**, *Lindsey E. Burt\**, *Joyce E. Gatewood\**, *Cortney L. Glasner\**, *Tabitha D. Green\**, *Melissa Lietz\**, *William T. McClain\**, *Erin K. Mitchell\**, *Marcus A. Pearson\**, *Julio C. Perez\**, *Gina L. Shaw\**, *Jeffery C. Spurlock\**, *Monica L. Stanaford\**, *Jessica L. Warden\**, and *Willodean D. S. Burton*, *Austin Peay State University, Clarksville, Tennessee*. On August 19, 2004, Mayor Don Trotter announced a partnership between the City of Clarksville and Austin Peay State University to conduct studies to obtain information about storm water quality runoff in two sub-basins around downtown Clarksville. The stream at Valleybrook Park is part of the Gallows Hollow Drainage Basin that empties into the Cumberland River, which is the

main source of water for Clarksville residents. The purpose of this study was to determine the toxicity of the water supply from this location. The stream was divided into 3 sites from which abiotic factors (pH, hardness, alkalinity, and temperature) were measured in conjunction with a biotic study of sample concentration on the life cycle of *Ceriodaphnia dubia* (water flea). The preliminary results showed that a difference existed between the stream water and the laboratory control.

**AN ASSESSMENT OF SPECIES RICHNESS IN MAMMALS USING SCENT-STATION PROCEDURES.** *James B. Akins\**, *Brian D. Carver*, and *Michael L. Kennedy*, *University of Memphis, Memphis, Tennessee (JBA, MLK)* and *Freed-Hardeman University, Henderson, Tennessee (BDC)*. Rates of scent-station visitation were used to investigate species richness of mammals in different habitats (wet, moist, and dry) in western Tennessee. Each station consisted of a circle of sifted sand 1 m in diameter. Survey lines were comprised of 10 stations spaced at 0.32 km intervals along a continuous route. A cotton ball treated with bobcat urine was attached to a wooden applicator stick and placed in the center of each station. Stations were utilized for 1 night, and results were based on the presence or absence of tracks of target species. In general, species richness was greatest in wet and dry habitats and lowest in moist habitat. The procedure appeared to have considerable application for assessing species richness of mammals at the landscape level.

**SEASONAL AND YEARLY DIFFERENCES IN A FISH ASSEMBLAGE OF A PERMANENTLY FLOODED FOREST AT REELFOOT LAKE, TENNESSEE.** *Tom A. Blanchard*, *Thomas E. Pratt\**, *Shingo Einaga\**, and *Chase Taylor\**, *University of Tennessee, Martin, Martin, Tennessee*. The objectives of this study were to document fish species inhabiting a permanently flooded forest along the margin of Reelfoot Lake and to assess seasonal and annual changes in species composition, diversity, and abundance. Monthly sampling was conducted from 22 April–3 November 2003 and from 29 February–05 September 2004 on the Grassy Island Unit of the Reelfoot National Wildlife Refuge in Obion County, Tennessee. Throughout the study, a total of 18 species representing 11 families was collected. Although there were some differences in species composition between 2003 and 2004, minimal monthly changes were observed for both years. Species diversity at this site remained relatively constant across seasons and years. There were substantial seasonal differences in total abundance for all species combined and total and relative abundance for specific fish species during both years of this study.

**DEMOGRAPHY OF TWO SYMPATRIC TURTLES FROM AN URBAN SETTING IN RUTHERFORD COUNTY, TENNESSEE.** *Brad M. Glorioso\**, *Matthew L. Niemiller\**, *George R. Wyckoff\**, and *Brian T. Miller*, *Middle Tennessee State University, Murfreesboro, Tennessee*. As part of a study to determine the herpetofaunal diversity at Stones River National Battlefield in Murfreesboro, Tennessee, turtles were sampled at Redoubt Brannan using baited, deep-water, crawfish nets. Redoubt Brannan is a 3.6 ha site used as a solid waste dump-site until the late 1990's. During restoration of the site, a small pond was formed adjacent to the river. Captured *Trachemys scripta elegans* and *Sternotherus odoratus* were measured (size, mass), sexed, and marked. Using the Schnabel Method, *T. scripta elegans* and *S. odoratus* populations were estimated at 158 and 118 respectively.

The calculated sex ratio for *T. scripta elegans* was 1.25:1 ( $n = 91$ ) and 1:0.91 ( $n = 44$ ) for *S. odoratus*. A size-frequency histogram based upon minimum plastron length (MPL) was generated for both species. MPL was highly correlated with mass for males and females of both species.

**A LOOK INTO THE DIVERSITY OF A TEMPORARY WETLAND AT ARNOLD AIR FORCE BASE.** *George R. Wyckoff III*, Middle Tennessee State University, Murfreesboro, Tennessee. Arnold Air Force Base is a highly diverse area of the Barrens region of Tennessee and is home to many endangered or threatened plants and animals. Surveys of the base's herpetofauna have found a diverse community of reptiles and amphibians. The gopher frog (*Rana capito*) and the tiger salamander (*Ambystoma tigrinum*) have been documented but breeding sites have not been located. A focused search for the breeding site of *A. tigrinum* was conducted from November through June 2004 and a breeding pond was found. Surveys of the breeding pond consisted of drift-fence/pitfall arrays, minnow traps, dip-netting and visual encounter surveys. The survey documented 27 species, 18 amphibian and 9 reptile, in and around the breeding pond. Of the 18 amphibian species documented five were Ambystomatid salamanders all of which were breeding inside the pond.

**HERPETOFAUNA OF FORT DONELSON NATIONAL BATTLEFIELD, STEWART COUNTY, TENNESSEE: A PRELIMINARY REPORT.** *Jon M. Davenport and A. Floyd Scott*, Austin Peay State University, Clarksville, Tennessee. Fort Donelson National Battlefield is a 600-acre national park situated on the Cumberland River at Dover in Stewart County, Tennessee. Located on the western edge of the Western Highland Rim, it is a highly dissected area of ridges and ravines covered mainly by oak-hickory forest. Prior to this study, despite much work in surrounding areas, no data were available on the herpetofauna of the park. The following objectives were established: 1) document at least 90% of the species expected to occur in the park, 2) describe the distribution and relative abundance of species of special concern, and 3) provide baseline information for developing a general herpetofaunal monitoring strategy. Sampling techniques employed include cover board arrays and area searches in randomly selected plots, time-constrained searches along stream stretches, drift fences with pit and funnel traps at a vernal pond, night and day road cruising, and hand capture upon incidental encounters. During the first year of the study, 37 species of herpetofauna (17 amphibians and 20 reptiles) were documented, representing 66% of the 56 species considered possible for the area. None of the species found so far are considered rare, endangered or of special concern by federal or state authorities. The study is ongoing and will continue through the summer of 2005. Voucher specimens will be housed in the Austin Peay State University Museum of Zoology along with a Microsoft Excel file containing the raw

data from the study. (Supported by Austin Peay State University's Center for Field Biology and the National Park Service)

**MOVEMENTS AND DIEL ACTIVITY OF *STERNOTHERUS MINOR PELTIFER* IN WHITEOAK CREEK, HOUSTON AND HUMPHREYS COUNTIES, TENNESSEE: A PRELIMINARY REPORT.** *Joshua R. Ennen and A. Floyd Scott*, Austin Peay State University, Clarksville, Tennessee. Little information is available on the movement behavior of any of the subspecies of *Sternotherus minor*. Most published studies on the species focus on other aspects of its life history and phylogeny. This paper presents the preliminary findings of an on-going investigation begun in May 2004 of movements and diel activity of a population of *S. minor peltifer* in Whiteoak Creek, a tributary to Kentucky Lake (impounded Tennessee River) in Houston and Humphreys counties, Tennessee. Using radiotelemetry and Geographic Information System (GIS) technologies, 14 individuals (6 males, 8 females) were relocated once weekly for periods ranging from 9 to 39 weeks, and their movements plotted in relation to assorted physical and biological features in and along the stream. Movements over the 24-h cycle also were monitored on seven occasions. Data obtained to date suggests a linear-shaped home range (mean 341.4 m) extending along stream stretches with ample shoreline cover. Of the initial capture plus relocation points documented, 225 (62%) involved limestone bluffs, 70 (19%) fallen trees, 36 (10%) vegetated limestone outcrops, 27 (7%) banks with exposed tree roots, and 4 (2%) other features. Mean length of home ranges was 341 m, with no significant difference between males (335 m) and females (346 m). Data on movements during the 24-hour cycle suggest a nocturnal pattern of behavior. (Supported by Austin Peay State University's Center for Field Biology)

**AMPHIBIANS OF SPRINGS AND SPRING-FED BODIES OF WATER IN THE WESTERN PENNYROYAL KARST ECOREGION IN NORTH CENTRAL TENNESSEE.** *Timothy D. Brown\* and A. Floyd Scott*, Austin Peay State University, Clarksville, Tennessee. A survey of four springs in Robertson and Montgomery counties Tennessee was conducted May through August 2003. The four springs (2 limnocrenes and 2 rheocrenes) were all monitored weekly for amphibians and basic water quality parameters. One of each spring type was designated as "impacted" due to excessive agricultural disturbance, while the other two springs were designated as "lesser impacted." Minnow traps were used to sample amphibians in the limnocrenes, while pick sampling (hand collecting) was conducted in the rheocrenes and spring runs below limnocrenes. A total of 130 individuals was captured in the survey, all by pick sampling (except for one unidentifiable specimen of the genus *Rana*). Rheocrenes compared to limnocrenes had the greater abundance of individuals and species, and the springs (regardless of type) designated as being the most impacted displayed lower diversity. The capture of *Rana clamitans* in one of the rheocrenes represents a new record for Robertson County.