

## ABSTRACTS OF PAPERS PRESENTED AT THE 2005 MEETING OF THE TENNESSEE ACADEMY OF SCIENCE

### BOTANY SECTION

NICOLE TURILL WELCH, CHAIR

A COMPARATIVE STUDY OF GEOGRAPHIC INFORMATION SYSTEMS MONITORING TECHNIQUES FOR TRACKING *ARUNDINARIA GIGANTEA* AND *JUSTICIA AMERICANUM* RESTORATION SITES USED FOR STREAM HABITAT ENHANCEMENT. **Jon L. McMahan\***, **Mack T. Finley**, and **Andrew N. Barrass**, *Austin Peay State University, Clarksville, Tennessee*. The methodology of monitoring stream bank restoration and establishment of vegetation has become dependent upon the technology of Geographic Positioning Systems (GPS) and Geographic Information Systems (GIS). Most conservation agencies utilize ArcView as a method for tracking vegetative plantings and this has become the preferred method of monitoring vegetative restoration. Large financial resources have been invested with the focus on restoring riparian zones along our waterways. Alternatively, little has been invested in the maintenance and monitoring of these restoration sites. Geographic Information Systems and GPS monitoring was implemented using ArcView methods compared to the newly developed program ArcGIS. Three streams were assessed for spatial distribution of River cane, *Arundinaria gigantea*, and Water willow, *Justicia americanum*, to portray the advantages of ArcGIS over the older program ArcView. The ArcGIS methods were more effective in evaluating the enhanced stream ecology of riparian sites.

THE EFFECTS OF WATER-SOLUBLE CHEMICALS IN *KALMIA LATIFOLIA* ON *PINUS PUNGENS* SEED GERMINATION. **Olivia Dees\***, **Christopher Meyer\***, and **Nicole Turill Welch**, *Middle Tennessee State University, Murfreesboro, Tennessee* (OD, NTW) and *University of Southern California, Los Angeles, California* (CM). *Pinus pungens* regeneration has little success in areas where *Kalmia latifolia* dominated the shrub layer prior to the burn. This study assessed the effects of water-extracts of leaf litter and duff collected from under *K. latifolia* shrubs on *P. pungens* seed germination. *Kalmia latifolia* leaf litter and duff samples were collected from *P. pungens* forests within the Great Smoky Mountains National Park, soaked in deionized water, and filtered to obtain extracts that probably included water-soluble grayanotoxins, a potential allelochemical common in members of the Ericaceae. *Pinus pungens* cones were collected, opened in a warm oven, and the seeds removed. *Pinus pungens* seeds were germinated on filter paper soaked in the extracts, as well as deionized water controls. Results suggest the water-soluble chemicals in leaf litter and duff do not inhibit *P. pungens* seed germination. *Kalmia latifolia*'s apparent inhibition of *P. pungens* is competitive in nature, but not allelopathic.

DISTRIBUTION OF LEMNACEAN TAXA IN COASTAL SOUTH CAROLINA. **Bethany Alley\*** and **S. K. Ballal**, *Tennessee Technological University, Cookeville, Tennessee*. Lemnacean taxa are distributed throughout every continent in the world except Antarctica. Our samples were collected from the central coastal region of South Carolina. The collection records suggest that all genera were found except *Woffiella*, which is almost exclusively found in the Florida Everglades. These taxa require stagnant pools with a runoff of fecal detritus or a significant amount of plant or animal decay at the bottom of the pond. The warm brackish, stagnant swamps of coastal South Carolina are ideal conditions for duckweed. Samples were collected and identified from twenty-nine research sites along the coastal region. A plant sample and water sample were taken at each site at three different times during the spring and summer of 2005. The water samples were analyzed to determine the pH, dissolved oxygen content, and nitrate ions at different sampling sites and these variables were interpreted in terms of distribution of various taxa of Lemnaceae.

ECOLOGY OF *CASTANEA DENTATA* ON THE CUMBERLAND PLATEAU OF KENTUCKY AND TENNESSEE. **M. Vance\***, **J. Schibig**, **S. Cumming\***, and **L. Fly\***, *Tennessee Technological University, Cookeville, Tennessee* (MV) and *Volunteer State Community College, Gallatin, Tennessee* (JS, SC, LF). From 2004 to 2005, the authors inventoried American chestnut specimens on the Cumberland Plateau (Bledsoe, Cumberland, Grundy, Morgan, Overton, and Pickett Counties in Tennessee and McCrary and Wayne Counties in Kentucky). For each specimen, Global Positioning Systems coordinates, diameter at breast height (dbh), height, topographic position, elevation, associated tree species, openness of the canopy, presence or absence of blight, and flowering status were recorded. The geological formation and soil series for each chestnut site also were determined. All data were entered into an Excel spreadsheet and analyzed to determine size class distributions, site preferences, and the incidence of blight and flowering. All specimens were found on acidic, well drained, sandstone-derived soils and most were on north to east-facing slopes. Most of the chestnut trees (sprouts) were blight-free, less than 2.5 cm dbh and under 2 m in height. The largest specimen was 26 cm in diameter and 15 m tall.

AN INVENTORY OF THE NATIVE AMERICAN CHESTNUT TREES AT MAMMOTH CAVE NATIONAL PARK FROM 2003 TO 2005. **Louis J. Schibig**, **Jonathan M. Vance\***, **Jeramie Tinsley\***, and **Anne M. Osborn\***, *Volunteer State Community College, Gallatin, Tennessee* (LJS, JT, AMO) and *Tennessee Technological University, Cookeville, Tennessee* (JMV). From 2003 to 2005, the authors inventoried 1381 naturally occurring American chestnut trees at Mammoth Cave National Park. For

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each specimen, Global Positioning Systems coordinates, diameter at breast height (dbh), height, topographic position, elevation, associated tree species, openness of the canopy, presence or absence of blight, and flowering status were recorded. The geological formation and soil series for each chestnut site also were determined. All data were entered into an Excel spreadsheet and analyzed to determine size class distributions, site preferences, and the incidence of blight and flowering. We found that most chestnut trees were blight-free, less than 2.5 cm dbh and under 3 m in height. The largest specimen was 19 cm dbh and 12 m tall. Most of the chestnut trees were growing on sandstone soils at the higher elevations (average 223 m). Only one tree was flowering. Some chestnut trees were tolerating heavy shade, and most were growing slowly.

**ECOLOGY OF *CASTANEA PUMILA* ON THE EASTERN HIGHLAND RIM AND CUMBERLAND PLATEAU OF TENNESSEE.** *J. Schibig, L. Fly\*, S. Cumming\*, and M. Vance, Volunteer State Community College, Gallatin, Tennessee (JS, LF, SC) and Tennessee Technological University, Cookeville, Tennessee (MV).* In 2005, the authors inventoried Allegheny chinkapin specimens on the Cumberland Plateau (Bledsoe, Cumberland, Morgan, and Overton Counties) and on the Eastern Highland Rim (Macon County). For each specimen, Global Positioning Systems coordinates, diameter at breast height (dbh), height, topographic position, elevation, associated tree species, openness of the canopy, presence or absence of blight, and flowering status were recorded. The geological formation and soil series for each chinkapin site also were determined. All data were entered into an Excel spreadsheet and analyzed to determine size class distributions, site preferences, and the incidence of blight and flowering. Very few specimens showed signs of blight and were found mostly on acidic, dry, sandy soils on ridges and upper south-facing slopes. On sunny, pine-kill sites, many chinkapin specimens were fruiting; seedlings on these sites were plentiful. The largest specimen was 7.6 cm dbh and 8.5 m tall.

**SOME ECOLOGICAL ASPECTS OF THE EARLEAF FALSE FOXGLOVE ON THE SOUTHERN PENNYROYAL PLAIN, TENNESSEE.** *Edward W. Chester, Austin Peay State University, Clarksville, Tennessee.* The earleaf false foxglove (*Tomanthera auriculata*, Scrophulariaceae) is an annual, hemiparasitic herb of middle America where it is a species of conservation concern in all states of occurrence. It is known from five counties in Tennessee where it is listed as threatened. Several populations (or more likely sub-populations), each often consisting of hundreds of plants, were discovered in 1993 on the southern Pennyroyal Plain within the Fort Campbell Military Reservation, Montgomery County. Monitoring and ecological studies since show that the populations are in fire-maintained barrens dominated by little bluestem (*Schizachyrium scoparium*) and herbs primarily of the families Asteraceae, Fabaceae, and Lamiaceae. Numbers vary widely from year to year but invariably increase, sometimes as much as 10 times, in the summer following winter burns. Based on plot studies, little bluestem and western sunflower (*Helianthus occidentalis*) appear to be the host species. Fruit and seed production are high, but apparently seed germination is low. The populations are currently well-protected by Fort Campbell ecologists.

**THE STATUS OF *CLEMATIS MOREFIELDII* (HUNTSVILLE VASEVINE) IN TENNESSEE.** *Claude J. Bailey Jr. and Dqyid Lincicome, Jackson State Community College, Jackson, Tennessee and Tennessee Division of Natural Heritage, Nashville, Tennessee.* *Clematis morefieldii* (Huntsville Vasevine) was recently added to the Flora of Tennessee after its discovery in 2004 from southwestern Franklin County, Tennessee. Prior to 2004, *C. morefieldii* was known only from a few locations in Madison and Jackson Counties, Alabama. Given its recent discovery and potential for range extension in Tennessee, the United States Fish and Wildlife Service funded a survey for *C. morefieldii*. The survey conducted over the summer of 2005 led to the discovery of several additional populations of *C. morefieldii* and a range extension north to Sewanee, Tennessee along the western escarpment of the Cumberland Plateau. Populations were located on protected, conservation properties owned by the State of Tennessee and The Nature Conservancy. In Tennessee, *C. morefieldii* is currently known from Franklin County. Potential habitat exists in Grundy and Coffee Counties in Tennessee.

**AN ECOLOGICAL ASSESSMENT OF STANDING STONE STATE FOREST.** *Roger A. McCoy, Tennessee Division of Natural Heritage, Nashville, Tennessee.* In 2004, field investigations were conducted at Standing Stone State Forest to provide the Tennessee Division of Forestry with information on rare species, historic structures, sensitive habitats, and management recommendations. Features such as karst habitats, caves, rare plants, rare animals, historical structures, and exotic plant infestations were mapped. Select streams and caves were sampled for rare animal species. Botanical surveys were conducted and voucher specimens were collected when county records were observed. Based on qualitative ground surveys, nine plant communities were described. Although this was not a complete floristic survey, 329 vascular plants were documented with 114 new vouchers for Overton County. Five rare plant species and six rare animal species were documented. The botanical highlight of the state forest is the spring wildflower display within the rich, mesic limestone coves.

**ALL TAXA BIODIVERSITY INVENTORY UPDATE AT EDGAR EVINS STATE PARK, DEKALB COUNTY, TENNESSEE.** *Wendy L Hesson\* and Rex R. Barber, Volunteer State Community College, Gallatin, Tennessee.* Tennessee Department of Environment and Conservation, supported by organizations such as Tennessee Natural Heritage, Natural and Cultural Management, Discover Life in America, et al., are sponsoring a Tennessee State Parks All Taxa Biodiversity Inventory (ATBI). Traditional and structured observation, documenting, and collecting are encouraged. In the fall of 2004, a research team from Volunteer State Community College (VSCC) initiated a traditional dendrology survey of Edgar Evins State Park covering four study areas of the parks 2,711 ha (6,700 acres). We utilized the quarter-point survey method; systematically documenting over 600 trees. Incorporating traditional Importance Value (IV) statistics, we established forest communities and composition. One objective was to locate suitable permanent plots as part of the ATBI's structured surveying and monitoring. In the spring of 2005, following the protocol established by the ATBI Steering Committee, the VSCC research team established eight permanent plots randomly selected via Tennessee Wildlife and Resource Agency vegetation maps. Each plot is 20 m by

50 m (0.1 ha), divided into 10 modules (10 m by 10 m) numbered 1–10 counter clockwise beginning at the lower left module. Modules #2, 3, 8, and 9 are intensive modules. Environmental variables such as elevation, aspect, percent slope, topographic position, landform type, depth to rock, and forest type are documented at each plot. Past disturbances such as fire, logging, livestock grazing, etc. are noted. The diameter at breast height (dbh, measured 1.4 m from the ground on the high side of the tree) for each tree species  $\geq 10$  cm is recorded. Woody stems  $< 10$  cm, but  $\geq 1.4$  m tall, are tallied by species into 4 diameter classes (0–0.9 cm, 1.0–2.4 cm, 2.5–4.9 cm, 5.0–9.9 cm). The density of woody stems  $< 1.4$  m tall is tallied by species in 3.2 m square subplots in the 4 intensive modules. Summary values of woody stems are calculated utilizing traditional IVs, based on relative density and relative basal area of each species. The protocol for non-woody herbaceous cover is still being determined by the Steering Committee, and will be reported when finalized. Other variables such as canopy positions, condition class, dead tree data, and stand age are optionally documented. In the fall of 2005, the VSCC research team began surveying the permanent plots established. Results of our research, as well as updates to the ATBI protocol will be reported.

FOREST COMMUNITIES AND COMPOSITION AT EDGAR EVINS STATE PARK, DEKALB COUNTY, TENNESSEE. **Rex R. Barber and Wendy L. Hesson\***, *Volunteer State Community College, Gallatin, Tennessee*. Following the protocol established by the Tennessee State Parks All Taxa Biodiversity Inventory, chaired by LinnAnn Welch, Tennessee Department of Environment and Conservation, a research team from Volunteer State Community College (VSCC) has been surveying and documenting forest composition and communities of Edgar Evins State Park. This park consists of 2,711 ha (6,700 acres) and surrounds Center Hill Lake, formed during the late 1940's by completion of Center Hill Dam on the Caney Fork River. Surveying began in the fall of 2004 with a systematic dendrology survey incorporating the quarter-point survey method, documenting over 600 trees. Four study areas were chosen, and data analysis utilized traditional Importance Value (IV) Statistics. Study Area #1, accessible by boat in the Indian Creek-Harnes Hollow area, yielded a *Juniperus virginiana*, *Fraxinus Americana*, *Quercus muehlenbergii* (cedar, white ash, chinkapin oak) community. Study area #2 located northeast of the campground, exists with a *Liriodendron tulipifera*, *Carya glabra*, *Celtis occidentalis* (tulip poplar, pignut hickory, hackberry) community. Study area #3, surrounding the visitor's center, has a *Acer saccharum*, *Liriodendron tulipifera*, *Quercus prinus* (sugar maple, tulip poplar, chestnut oak) community. Study area #4 is located in the Hoggard Hollow-Wolf Creek area and is accessible by boat or the "Hunter's Access". Survey data show a *Juniperus virginiana*, *Acer saccharum*, *Liriodendron tulipifera* (cedar, sugar maple, tulip poplar) community. In the spring of 2005, the VSCC research team established eight permanent plots, randomly chosen with aid from Tennessee Wildlife and Resources Agency vegetation maps. Surveying of the permanent plots began in the fall of 2005, and these results will be reported. Although many anthropogenic factors, sometimes intensive, are apparently affecting forest succession, the forest exists with some notable deciduous diversity. History, physiography, and edaphic conditions of the park, as well as our survey data results, will be reported.

20TH ANNIVERSARY OF THE TENNESSEE RARE PLANT PROTECTION AND CONSERVATION ACT OF 1985. **David A. Lincicome**, *Tennessee Division of Natural Heritage, Nashville, Tennessee*. Twenty years ago on April 25, 1985 Governor Lamar Alexander signed into law the Rare Plant Protection and Conservation Act of 1985. The Act charges the Division of Natural Heritage (DNH) with listing those plant species that are endangered, threatened or of special concern within the state. There are currently 536 plants on the rare plant list. This list serves as the focal point for rare plant conservation within the state. The DNH also implements this Act through its Rare Species Protection Program, established on September 16, 1986. This program's focus is conducting United States Fish and Wildlife Service listing and recovery activities funded through the Endangered Species Act of 1973. Presently, there are 21 federal listed plant species (13 Endangered and 8 Threatened), and 3 Candidates for federal listing. Tennessee has had one species, *Scutellaria montana*, down-listed from Endangered to Threatened; and one species, *Helianthus eggertii*, removed from federal listing.

STOMATAL DENSITY IN THE EXOTIC SHRUB *LONICERA MAACKII* AND THE NATIVE SHRUB *SYMPHORICARPOS ORBICULATUS* IN DIFFERENT ENVIRONMENTAL CONDITIONS. **Bethany Thomas\* and Darlene Panvini**, *Belmont University, Nashville, Tennessee*. Stomatal density can affect the photosynthetic rates of plants since the number of stomata impacts gas exchange across the leaf-air interface. Differences in stomatal density have been noted among plants growing in different habitats. This study looks at differences in stomatal density between the exotic shrub *Lonicera maackii* and the native shrub *Symphoricarpos orbiculatus*, both in the family Caprifoliaceae, grown in similar habitats. Microscopic analyses of stomatal peels were used to determine abaxial stomatal density. Samples were analyzed from plants found in three different environmental conditions: low light, intermediate light, and high light. The results are discussed in terms of the impact of stomatal density on rates of photosynthesis and the invasiveness of exotic plants as compared to native species.

RATES OF PHOTOSYNTHESIS IN EXOTIC SHRUBS AND VINES COMPARED TO NATIVE SHRUBS AND VINES OF MIDDLE TENNESSEE. **Kristal Wicks\* and Darlene Panvini**, *Belmont University, Nashville, Tennessee*. Exotic plants have direct and indirect effects on native environments, competing with native plant species and altering habitats required by wildlife. While there are known anatomical differences between exotic and native plant species, less is known about possible physiological differences, specifically the process of photosynthesis. Perhaps faster photosynthetic rates in exotic species allow for quicker growth, resulting in plants that are stronger competitors. Photosynthetic rates in exotic bush honeysuckle (*Lonicera maackii*) and exotic *Euonymus fortunei* were compared to rates in native coralberry (*Symphoricarpos orbiculatus*) and native Virginia creeper (*Parthenocissus quinquefolia*). Contrary to our hypothesis that exotic plants would exhibit higher rates of photosynthesis, our findings showed that there was little difference between rates of photosynthesis in exotic and native plant species. This would suggest there are other mechanisms employed by exotics to out-compete native species.

SHADING EFFECT ON THE GROWTH OF NIMBLEWILL (*MUHLENBERGIA SCHREBERI*). **R. Anderson, K. Hiatt, W. Anderson, J. Walck, and T. Hogan**, Middle Tennessee State University, Murfreesboro, Tennessee (RA, KH, WA) and National Park Service, Stones River National Battlefield, Murfreesboro, Tennessee (TH). *Muhlenbergia schreberi* (nimblewill) from the Stones River National Battlefield was germinated and grown from March to June 2005 in the Middle Tennessee State University greenhouse. Growing plants were repotted in July into two by two plugs with a slow release fertilizer. Existing leaves and stems were trimmed to a uniform height before being transferred to the shade house and full sun cold frame. Plants were watered as needed. *Muhlenbergia schreberi* grew longer under 63% shade cloth than full sun.

### CELL AND MOLECULAR BIOLOGY SECTION

D. GRANT WILLHITE, CHAIR

### HEALTH AND MEDICAL SCIENCES SECTION

LISA COBB, CHAIR

### MICROBIOLOGY SECTION

JOHN M. ZAMORA, CHAIR

ENZYMATIC ACTIVITY OF RUBISCO IN LEMNACEAE (DUCKWEED). **Joseph L. Harris\* and S. K. Ballal**, Tennessee Technological University, Cookeville, Tennessee. The activity of the enzyme Rubisco in the aquatic family Lemnaceae in general and *Spirodella oligorrhiza* in particular is discussed. It is believed that this enzyme is critical to the abundant biomass production of Lemnaceae in the world. Lemnaceae is ubiquitous in every climate on earth except Antarctica. The enzyme Rubisco is found in large quantities in the cells of *Spirodella*. All the Lemnacean taxa have very high growth rates and can quickly take over a body of stagnant water. In many parts of the Third World these plants serve as a rich source of food for animals due to their high protein and carbohydrate contents. Ponds covered with these plants exhibit decreased evaporation rates and depleted oxygen levels. Their growth is prolific in polluted waters that contain high populations of bacteria and agricultural wastes. The commercial impact of this plant in biomass production for livestock feed has not been assessed. Various chemical characteristics of the enzyme Rubisco are discussed. By studying this universal enzyme, certain aspects of the carbon fixation cycle in Lemnaceae may be explained.

HUMAN PAPILLOMAVIRUS PROTEINS AND THEIR ROLE IN CANCER PROGRESSION. **Jennifer T. Thomas**, Belmont University, Nashville, Tennessee. Human papillomavirus (HPV) is the causative agent of warts, including precancerous lesions of the cervix that are associated with cervical cancer incidence. The roles of the viral proteins, E6 and E7, in this malignant transformation are well defined; both interfere with the activities of cellular tumor suppressor proteins leading to immortalization

of cells in vitro, and likely genital malignancies in vivo. The functions of E6 and E7 in cancer progression, however, have not been examined. The goal of this study was to elucidate potential roles of E6 and E7 in a tissue culture model of cervical cancer in events such as metastasis, angiogenesis, and chemotherapeutic multidrug resistance. The data indicate decreased expression levels of the adhesion molecule, alpha-catenin, potentially contributing to metastasis, as well as increased expression of placental growth factor, a pro-angiogenesis factor. Taken together, E6 and E7 may contribute to malignancy beyond their previously reported roles in transformation.

HUMAN FACTORS ANALYSIS OF A FIGHTER AIRCRAFT AVIONICS UPGRADE. **Mark R. Coakwell, Daniel A. Roberts\*, and Bryan J. Funke**, United States Air Force, Misawa Air Base, Japan. Multiple fighter aircraft flown by the United States Air Force are undergoing major avionics systems upgrades. The F-16C/D Block 50/52 upgrade is known as the Common Configuration Implementation Program (CCIP). Of particular interest from a human factors standpoint, are the capabilities provided by the "Link 16" Tactical Digital Information Link, the Joint Helmet Mounted Cueing System, and the Common Color Multi-function Display System. Our approach consisted of a preliminary background investigation of the CCIP upgrades, followed by on-site investigations consisting of: 1) interviews with pilots; 2) evaluation of aircrew life support shops; 3) interviews with avionics specialists; 4) review of pilot read file messages; 5) cockpit tape reviews and academics with a weapons officer; 6) simulator-based activities; and 7) in-cockpit JHMCS operational familiarization. We identified multiple potential, negative human factors associated with the early fleet-wide implementation of the F-16C/D Block 50/52 CCIP upgrade. These findings may be common to the human interface with other new avionics systems in other fighter aircraft. We consider the three human factors that we identified with the highest negative potential to be: 1) task misprioritization; 2) channeled attention; and 3) cognitive task oversaturation. The F-16 CCIP upgrade provides the potential for significantly enhanced situational awareness to the pilot at the cost of "increased workload in the cockpit and significantly more heads down time." Almost all of the potential negative human factors identified are thought to be solvable with adequate training and adherence to basic flying rules.

BOTH *BORRELIA BURGENDORFERI* (LYME DISEASE) AND *BORRELIA LONESTARI* (STARI) ARE ESTABLISHED IN MIDDLE TENNESSEE. **Katherine R. Onks\*, Steven W. Hamilton, and Stephen M. Wright**, Middle Tennessee State University, Murfreesboro, Tennessee (KRO, SMW) and Austin Peay State University, Clarksville, Tennessee (SWH). The causative agent of Lyme disease is the spirochete *Borrelia burgdorferi* that is transmitted by *Ixodes scapularis* ticks and endemic in the northeastern United States. A related syndrome, Southern Tick-Associated Rash Illness (STARI), is caused by *Borrelia lonestari* and transmitted by *Amblyomma americanum* ticks. STARI seems to be most prevalent in southeastern states. Previous studies have determined that avians from middle Tennessee may serve as reservoir hosts for *Borrelia* species. This study was undertaken to evaluate non-migratory avian blood samples collected near Land Between the Lakes for the presence of *Borreliae*. DNA was extracted from turkey blood samples and amplified by PCR. A second nested amplification permitted

differentiation between the *Borreliae* due to different fragment sizes (*B. burgdorferi*, 319 bp; *B. lonestari*, 298 bp). The fragments were resolved on an electrophoretic gel. We report that both *Borrelia* species seem to be well established in middle Tennessee, which suggests re-evaluation of currently held distribution patterns.

**DIFFERENTIATION OF INFLUENZA A VIRUSES USING HOST-SPECIFIC PROBES BASED ON CONSERVED NUCLEOTIDE REGIONS.** *Rebecca S. Davis\* and Stephen M. Wright, Middle Tennessee State University, Murfreesboro, Tennessee.* The impending threat of an avian influenza pandemic has prompted surveillance and research efforts to rapidly identify and differentiate influenza A viruses. The use of probes specific for characteristic conserved regions within avian, swine, and human influenza viruses may provide for effective differentiation. This study evaluated the binding efficiency of host-specific fluorescent probes with the Non-Structural gene of avian, swine, and human influenza viruses. Representative viruses were grown in embryonated chicken eggs, extracted, and reverse transcribed. After PCR amplification, amplicons were applied to commercially prepared aldehyde-functionalized substrates and hybridized with Cy5 labeled probes. Detection with a laser scanner demonstrated that differentiation can be accomplished, although cross-reactivity with similar sequences could permit false positive identification. Further refinement of hybridization conditions is expected to provide unequivocal results. This technology has the potential for rapid, accurate identification of influenza viruses from different hosts and would be applicable for detection of avian influenza.

**EVALUATION OF ANTIGEN-ANTIBODY INTERACTION THROUGH MICROARRAYS: POTENTIAL FOR A NOVEL BIOSENSOR.** *Vivak M. Master\*, Travis R. Denton, Clinton E. Holman, William M. Robertson, and Stephen M. Wright, Middle Tennessee State University, Murfreesboro, Tennessee.* A novel biosensor based on surface electromagnetic wave shifts in photonic band gap (PBG) coated materials is currently under development at Middle Tennessee State University. To demonstrate effectiveness of our sensor design, it was necessary to establish parameters of current sensing techniques. This study was undertaken to compare detection of antigen-antibody interactions using fluorescent labels with PBG-generated detection. Proteins were applied to PBG amine-functionalized substrates using a microarrayer. Following antigen deposition, slides were heated, exposed to ultraviolet light, blocked and washed. Appropriate fluorescently labeled antibody was added and allowed to bind with its corresponding antigen. Detection of binding was achieved through confocal laser scanning based on fluorescence. The biosensor was able to detect protein deposition as well as antibody binding. However, surface electromagnetic wave shift detection was accomplished without the need for additional fluorescent labels. This technology holds great promise for sensor design and biomolecule detection.

**ALLELOPATHIC AND ANTIMICROBIAL PROPERTIES OF THE AYURVEDIC HERBS, NEEM AND GOTU KOLA.** *Christina L Nelson\* and John M. Zamora, Middle Tennessee State University, Murfreesboro, Tennessee.* Herbal supplements are the new fad in western culture. They provide an alternative to pharmaceuticals. The herbs neem (*Azadirachta indica*) and gotu

kola (*Hydrocotyle asiatica*) have been claimed by Hindu medicinal texts to cure skin infections. The purpose of this research was to see if neem or gotu kola had any antimicrobial or allelopathic properties. Antimicrobial tests were done using alcoholic extracts of neem and gotu kola. The alcoholic extract of neem was inhibitory to mainly Gram-positive bacteria. The alcoholic extract of gotu kola was inhibitory to mainly Gram-positive bacteria. An allelopathic assay was performed to determine if the hot water extract of neem or gotu kola 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. It appears that there are allelopathic chemicals in these two medicinal herbs.

**THE ISOLATION AND IDENTIFICATION OF ANTIMICROBIC-PRODUCING ORGANISMS.** *Brandon Naquin\* and John M. Zamora, Middle Tennessee State University, Murfreesboro, Tennessee.* The search for new antibiotics is a major focus of the pharmaceutical industry. These agents can be used in the treatment of certain diseases. The purpose of this study was to isolate organisms that produce substances with antimicrobial activity. Soil samples from several states were screened for antimicrobial-producing organisms. A lawn of *Micrococcus luteus* was applied to the surface of an agar plate. A dilution of the soil sample also was applied to the surface of the plate. A zone of inhibition around a colony indicated a possible antimicrobial-producer. Isolates were confirmed for antimicrobial-production by using the cylinder diffusion assay. Isolates of interest were tested against *Escherichia coli*, *Staphylococcus aureus*, *Listeria seeligeri*, and *Pseudomonas aeruginosa*. Several isolates were inhibitory to these organisms.

**COMPARISON OF BACTERIAL DNA ISOLATED FROM SOIL BACTERIA USING THE FASTPREP INSTRUMENT AND SPEX 8000 MIXER MILL.** *Thy N. Huynh\* and John R. Palisano, University of the South, Sewanee, Tennessee.* The efficiency of two instruments for lysing bacterial cells to obtain DNA from soil bacteria was compared. FastPrep Instrument and the SPEX 8000 Mixer Mill were both used to lyse bacteria from the soil samples from a hardwood forest or a pine plantation. After bacterial cells were lysed with either instrument, the FastPrep Spin Kit was used to isolate DNA from the soil samples. DNA samples were then loaded on 0.7% agarose along with a Lambda DNA ladder that contained HindIII and EcoRI cuts, and electrophoresed. Comparisons of the bands following electrophoresis indicated that both instruments were equally effective at lysing bacterial cells and releasing their DNA from the soil samples.

**TYROSINE 244 STABILIZES THE TRANSITION STATE OF THE PEPTIDASE REACTION OF *SACCHAROMYCES CEREVISIAE* LEUKOTRIENE A<sub>4</sub> HYDROLASE.** *M. W. Thompson, C. E. Romer\*, and R. L. Seipelt, Middle Tennessee State University, Murfreesboro, Tennessee.* Yeast leukotriene A<sub>4</sub> hydrolase (ScLTH) is a distantly related member of the M1 metallopeptidase family. To elucidate details of the mechanism of the peptidase reaction, two conserved tyrosine residues, Y243 and Y455, were changed to phenylalanine by site-directed mutagenesis. The activity of the mutant enzymes was characterized with amino acid naphthylamide (NA) substrates and aminopeptidase inhibitors. Although mutation of Y455 had

little effect on catalysis, alteration of Y243 had a more deleterious effect. While the  $K_M$  for both Leu-NA and Arg-NA were largely unaffected, the  $k_{cat}$  for both substrates was significantly reduced. Aminopeptidase inhibitors were used to evaluate the contribution of these two residues to peptide hydrolysis. The affinity of Y243F for RB-3014, a putative transition state analog, was more than 40-fold lower than that of the wild-type enzyme, indicating that Y243 is involved in stabilizing the transition state along with Y428.

**A CONSERVED TRYPTOPHAN RESIDUE WITH AN ALTERED PKA IS ESSENTIAL FOR THE PEPTIDASE REACTION OF *SACCHAROMYCES CEREVISIAE* LEUKOTRIENE A<sub>4</sub> HYDROLASE.** *E. D. Archer\**, *R. L. Seipelt*, and *M. W. Thompson*, *Middle Tennessee State University, Murfreesboro, Tennessee*. Leukotriene A<sub>4</sub> hydrolase is an unusual bifunctional enzyme with both an epoxide hydrolase activity and an aminopeptidase activity. To obtain a better understanding of the molecular mechanism of the peptidase activity of the enzyme, a highly conserved tryptophan residue (W356) was mutated to leucine and a conserved aspartate residue (D399) was mutated to alanine. Enzymatic function of W356L and D399A were investigated using amino acid *b*-naphthylamide substrates to characterize its substrate specificity and specific activity. While mutation of D399 had no discernable effect, mutation of W356 lowered the  $k_{cat}$  for the enzyme 30 to 400-fold for most substrates tested, with little to no effect on the enzyme affinity for the substrates tested. Additionally, the W356L mutation also greatly altered the pH sensitivity of the enzyme, indicating that W356 most likely exhibits an altered pK<sub>a</sub> that may be essential to its role in the catalytic mechanism.

**DNA FINGERPRINTING AND THE LEGAL SYSTEM: BENEFITS AND PROBLEMS OF THE POLYMERASE CHAIN-REACTION.** *Alicia E. Blakely\** and *Barbara A. Jackson*, *Tennessee Technological University, Cookeville, Tennessee*. The techniques of tape lift, swab method, impact and exchange methods used by forensic scientists to process DNA found at crime scenes are presented, along with the impact of these techniques on the legal system. The newer methods and increased sensitivity have made evidence available for prosecutors to gain convictions. These techniques also have provided evidence to free those wrongly incarcerated. However, there is a downside to the gathering and interpretation of DNA evidence. With increased sensitivity, there is increased likelihood of contamination, either from other cases being investigated or from the DNA of the scientists doing the analysis. Errors have occurred in the reading or interpretation of the results. Occasionally evidence is discarded prematurely. A detailed examination of the DNA methods, their sensitivities, and applications that have greatly advanced the field of forensic science is presented.

**BIOGEOGRAPHY AND DIVERGENCE DATES OF MURINE RODENTS.** *Elisabeth L. Chan\**, *Michael Kennedy*, and *Ronald Adkins*, *University of Memphis, Memphis, Tennessee*. The biogeography of the rodent subfamily Murinae was determined using DNA sequence data from the growth hormone receptor (GHR) and breast and ovarian cancer susceptibility (*Brcal*) genes from over seventy-five species. Using a maximum parsimony phylogeny, the relationships among the species were plotted onto their current distributions. The data indicate that

murine rodents originated in Southeast Asia, perhaps in the vicinity of the Malay Peninsula. After a period of diversification in Southeast Asia, the subfamily rapidly dispersed throughout Australia, Asia, Europe and Africa. Using the transition from *Antemus* to *Progonomys* at 12 Mya as the origination date for the subfamily, approximate divergence dates were assigned to the well-supported nodes of the phylogeny and related to the biogeography of Murinae.

**BENZIDINE ANALOGUE-INDUCED OXIDATIVE MUTAGENESIS.** *Patrudu S. Makena\** and *King-Thom Chung*, *University of Memphis, Memphis, Tennessee*. It was found that benzidine and many benzidine analogues could induce mutations when the Ames Salmonella/microsome assay protocol was employed using the reactive oxygen species (ROS) sensitive strain TA102. When free radical scavengers such as catalase, superoxide dismutase, and antioxidant butylated hydroxytoluene (BHT) were included in the assay, the number of revertants was significantly decreased. The presence of some plant polyphenols such as piceatannol, taxifolin, coumestrol, plumbagin, (-)-gallochatechin, (-)-rhein, (-)-epigallocatechin gallate, (-)-galloocatechin gallate, and (-)-epicatechin also decreased the number of revertants. Benzidine and its analogues also could induce DNA breaks when a double stranded naked DNA was incubated with benzidine and its analogues using agarose gel electrophoresis. It was concluded that benzidine and its analogues could produce reactive ROS as a mechanism.

**A STUDY TO DETERMINE IF EDUCATION AND EXPOSURE TO A NEW PRODUCT INCREASES ACCEPTANCE IN PEANUT ALLERGIC FAMILIES.** *K. J. Krank\**, *L. H. Clemens*, *T. L. Smith\**, and *P. M. Stevens*, *University of Memphis, Memphis, Tennessee*. To evaluate the acceptability of a peanut butter substitute made from sunflowers, researchers recruited families with a peanut allergic child as pilot-study participants. Subjects completed a pretest, received an educational presentation, completed a post-education test, used a sunflower product for a 2-month period keeping a sheet of all products made, and completed a post-test. A total of 8 families completed the study and returned all the necessary information. Peanut allergic children's responses to the ground sunflower butter included: strongly dissatisfied ( $n = 2$ ), no opinion ( $n = 1$ ), extremely satisfied ( $n = 2$ ). When rating the family's overall satisfaction, the responses included: no opinion ( $n = 1$ ), satisfied ( $n = 5$ ), and extremely satisfied ( $n = 2$ ). Of the 8 participants, 4 requested further information and the opportunity to purchase the sunflower product. Additional studies with the ground sunflower butter will be necessary to assess the product's general acceptability as a peanut butter substitute.

## CHEMISTRY SECTION

PHILLIP H. DAVIS, CHAIR

**REACTIVITY RATIOS OF SILICONE ACRYLATES WITH COMMON MONOMERS.** *Charles M. Baldwin* and *Kenneth B. Lewoczko*, *Union University, Jackson, Tennessee*. The goal of this project was to validate a reliable method for determining reactivity ratios of copolymer systems and then use this method to determine reactivity ratios of a linear silicone acrylate with

common industrially important monomers. A model copolymerization system was developed, consisting of styrene and methyl methacrylate. The polymer products were analyzed by UV-visible spectroscopy, and from the resulting data, reactivity ratios were determined for the copolymer system. The results agreed with the reactivity ratios for styrene and methyl methacrylate found in the chemical literature. The same method was then used to determine reactivity ratios for the copolymerization of the experimental silicone acrylate SA-LH with styrene. For SA-LH and methyl methacrylate, UV spectroscopy was inadequate for the determination of reactivity ratios. Thus, FT-IR spectroscopy was employed in the determination of reactivity ratios for this system.

**RECENT PROGRESS IN CHARACTERIZING SOLID-SUPPORTED REAGENTS.** *Martin V. Stewart, Amy E. Mauritsen\*, and Anthony L. Newsome, Middle Tennessee State University, Murfreesboro, Tennessee.* Adsorbing an inorganic compound onto a porous surface often affords a solid-supported reagent that exhibits enhanced chemical reactivity. We are engaged in a continuing project involving a succession of undergraduate chemistry students whose goal is to better characterize these materials. Previous results demonstrated that depositing ceric ammonium nitrate onto the surface of silica gel affords a genuine example of a solid-supported reagent, Ce(IV)/SiO<sub>2</sub>, which functions in chemical reactions as an oxidizing agent. More recently, we proposed conditions causing crystallization of the inorganic reagent onto the surface of silica gel, an occurrence that renders the system chemically unreactive. The present work confirms this hypothesis through direct observations with optical microscopy, including the use of polarized light. Consequently, meaningful results can now be obtained from a closer examination of Ce(IV)/SiO<sub>2</sub> samples with electron microscopy. (Supported by the Undergraduate Research Council of the College of Basic and Applied Sciences, Middle Tennessee State University)

**A COMPUTATIONAL STUDY OF SEVERAL ORGANOSILYL-MAGNESIUM COMPOUNDS.** *William H. Isley, Middle Tennessee State University, Murfreesboro, Tennessee.* RHF/6-31G\*\* calculations have been performed on several organosilylmagnesium compounds of the type Mg(SiR<sub>3</sub>)<sub>2</sub>•X<sub>m</sub>, where m = 1 or 2, and [Mg(SiR<sub>3</sub>)<sub>2</sub>]<sub>n</sub>, where n = 1, 2, 4, and 6. A brief description of their structures and a comparison of their geometric parameters will be presented. Preliminary results indicate that stable dimers, trimers, and tetramers can be studied, but a stable hexamer has yet to be found.

**MILK TO MOCHA TO MILK: A NEW AND NOVEL REDOX REACTION DEMONSTRATION.** *Daniel J. Swartling and Elijah Hixson\*, Tennessee Technological University, Cookeville, Tennessee.* In the course of developing new types of chemical demonstrations, a novel redox reaction using milk as the substrate was discovered. Adding an aliquot of saturated potassium permanganate to a given volume of milk causes the color to change from white to mocha brown. Adding powdered sodium bisulfite to the solution causes a color change back to white. The chemistry involved and applications for the redox demonstration will be explained.

**SURFACE CRYSTALLIZATION OF SOLID-SUPPORTED REAGENTS.** *Amy E. Mauritsen\*, Martin V. Stewart, and*

*Anthony L. Newsome, Middle Tennessee State University, Murfreesboro, Tennessee.* Depositing ceric ammonium nitrate, (NH<sub>4</sub>)<sub>2</sub>Ce(NO<sub>3</sub>)<sub>6</sub>, onto the porous surface of silica gel affords a freely flowing, yellow powder that functions as a solid-supported reagent. When examined under a microscope, particles of the solid-supported reagent appear as clear and colorless as the original silica gel when the ceric ammonium nitrate to silica gel weight ratio is below 16 : 100. However, samples prepared using weight ratios of 20 : 100 and higher exhibit three distinctly different types of particles: clear and colorless, yellow and translucent, and black and opaque. Microscopic observations were extended to dynamic interactions of particles of the solid-supported reagent with polar and nonpolar liquids. It is concluded that the clear and colorless particles are the true solid-supported reagent, where ceric ammonium nitrate is adsorbed as a monolayer onto the surface of silica gel, and the translucent and opaque ones are particles of silica gel covered with crystals of the inorganic reagent partially and totally, respectively. (Supported by the Undergraduate Research Council of the College of Basic and Applied Sciences, Middle Tennessee State University)

**EFFORTS TOWARD THE SYNTHESIS OF BIS(CARBENE) Pincer Iridium Complexes.** *Jon A. Bain\* and Philip L. Osburn, University of Tennessee, Martin, Martin, Tennessee.* N-heterocyclic carbenes (NHCs) have emerged as the ligands of choice for a number of homogeneous catalytic processes, supplementing, and in some instances supplanting, the ubiquitous phosphine ligands in transition metal chemistry. However, relatively few meridional tridentate (pincer) complexes involving NHC ligands have been synthesized as of yet, and all of them have involved palladium. Thus, our research deals with efforts toward the synthesis of CCC pincer-type iridium(III) complexes supported bay chelating N-heterocyclic carbene framework. Using a combination of simple nucleophilic substitution and copper-catalyzed C-N bond formation, a small family of bis(NHC) ligand precursors was readily accessible. Two routes toward the desired iridium metal complexes were then explored. The first, a direct metalation strategy failed to produce chelating complexes, instead generating monodentate NHC-Ir species. Subsequently, a silver(I)-mediated transmetalation strategy was attempted and shown to generate complexes tentatively identified as bidentate (NHC)<sub>2</sub>Ir species lacking the desired aryl carbon-iridium bond.

**SOLUBLE POLYMER-SUPPORTED SYNTHESIS OF 1,4-DIHYDROPYRIDINE DERIVATIVES UNDER THERMOMORPHIC CONDITIONS.** *Rodel Cacas\* and Philip L. Osburn, University of Tennessee, Martin, Martin, Tennessee.* Suitably modified 1,4-dihydropyridines (DHPs) have recently demonstrated utility as antibacterial agents, anti-inflammatory agents, calcium channel blockers, and antihypertensive agents. Thus, there is growing interest in the development of efficient syntheses for libraries of these compounds for continued biological evaluation. This poster describes our efforts to employ a novel approach to the combinatorial synthesis of such libraries using a non-polar soluble polymer support in conjunction with a thermally switchable biphasic/monophasic solvent system. Since the traditional route to these compounds involves the use of the active methylene compound ethyl acetoacetate, our initial efforts have focused on the development of a polymer-supported version of this reagent. Thus, commercially available double

bond-terminated polyisobutylene (PIB) was converted to the corresponding alcohol via hydroboration/oxidation. Subsequent reaction of this material with 2,2,6-trimethyl-4H-1,3-dioxin-4-one furnished the desired PIB-acetoacetate. Spectral data concerning these compounds, as well as our initial efforts toward generation of polymer-supported DHPs, will be presented.

**SOLUBLE POLYMER-SUPPORTED BIS(CARBENE) PINCER PALLADIUM COMPLEXES.** *W. Dani Avent\* and Philip L. Osburn, University of Tennessee, Martin, Martin, Tennessee.* Meridional tridentate (pincer) palladium complexes involving P, N, or S ligands have been shown to be thermally stable, highly active catalysts for a number of processes. However, it has recently been demonstrated that such NCN, PCP, and SCS-Pd complexes often simply act as reservoirs of a heterogeneous Pd(O) that is the actual active catalyst, frustrating catalyst recycling efforts. Alternatively, related pincer-Pd complexes based on supporting N-heterocyclic carbene (NHC) ligands have been shown to behave as molecular catalysts. Thus, our research focuses on the synthesis and development of a polymer-supported NHC pincer-Pd catalyst; such a species would arguably provide the first truly recyclable pincer-Pd catalyst. In this work, commercially available double-bond terminated polyisobutylene (PIB) was subjected to a multistep synthetic sequence to generate a polymer-supported imidazolium salt. Spectral data for all of the compounds in this sequence, as well as initial efforts toward palladation of the polymer-supported ligand, will be described.

**SOLUBLE POLYMER-SUPPORTED IRIIDIUM(III) HYDROGEN TRANSFER CATALYSTS BASED ON CHELATING CARBENE LIGANDS.** *Andy Bernard\* and Philip L. Osburn, University of Tennessee, Martin, Martin, Tennessee.* Although a number of monodentate N-heterocyclic carbene (NHC) metal complexes are active catalysts for a variety of processes, these compounds often decompose (reductive elimination) under certain reaction conditions. Alternatively, related bidentate NHC complexes have exhibited markedly increased stability while still maintaining excellent catalytic performance, making them good candidates for catalyst recycling and reuse. This poster will describe our efforts to synthesize a poly(ethylene glycol) (PEG)-supported (NHC)<sub>2</sub>Ir(III) complex with the goal of generating a recyclable catalyst for transfer hydrogenation. Commercially available PEG (Mn = 2000) was first converted to the corresponding mesylate. This material was then reacted with imidazole under basic conditions to generate a PEG-supported ligand precursor. Alternatively, the PEG-mesylate could be treated with p-hydroxybenzyl alcohol to introduce a spacer between the polymer chain and the heterocyclic ring. Spectral data concerning these compounds, as well as our initial efforts toward metalation of the polymer-supported ligand, will be presented.

**SYNTHESIS OF 2,3,4,5,6-PENTASUBSTITUTED-1,4-DIHYDROPYRIDINES (ANTIHYPERTENSIVE AGENTS) AND SOME SPECTROSCOPIC PROPERTIES, PART II.** *William E. Solomons, John Rippey and Nicole Franklin, University of Tennessee, Martin, Martin, Tennessee.* The synthesis of several 2,3,4,5,6-pentasubstituted 1,4-dihydropyridines was successfully performed using the Hantzsch reaction and various modifications of it. Several papers have described successful Hantzsch microwave reactions. Although the microwave yielded product,

in our hands standard reflux methods in organic solvents were more successful. These compounds had very interesting mass fragmentations and carbon spectra. Such 1,4-dihydropyridines are related to several calcium channel blockers presently marketed largely for their antihypertensive activities.

## ENGINEERING AND ENGINEERING TECHNOLOGY SECTION

MICHAEL DALEY, CHAIR

**REFORM OF ENGINEERING TECHNOLOGY EDUCATION IN TAIWAN.** *Chin-Zue Chen, Austin Peay State University, Clarksville, Tennessee.* In Taiwan, there are two tracks of education in senior high schools, college-bound and vocational-bound, and the vocational-bound graduates can enter the technological universities and colleges in the vocational technical education branch. The Engineering Departments in technological universities and colleges offer Engineering Technology curricula. A number of educational reform measures have been undertaken in Taiwan over the past ten years; the total number of technological universities, both public and private, increased from 1 to 29, and technological colleges from 13 to 46. These growths enhance the role of Engineering Technology education, and also raise issues such as an institution's identity and quality. Revision of Engineering Technology curricula in each institution is a necessity. Moreover, a continuously decreasing birthrate will force some institutions to phase out from lack of student enrollment in the near future. The reform of Engineering Technology education will continue and face new challenges.

**USING NJCATE CURRICULUM MODEL FOR ENGINEERING TECHNOLOGY EDUCATION.** *Adel Salama, Chin-Zue Chen, and Ashraf Saad, Austin Peay State University, Clarksville, Tennessee (AS, CZC) and Georgia Institute of Technology, Savannah, Georgia (AS).* The NJCATE Curriculum Model provides a process and procedure for the creation of an integrated interdisciplinary Engineering Technology Education curriculum. The curriculum is designed to give students an excellent education in science, mathematics, engineering and technology. The curriculum should be based on industry needs and the competency level determined with skills and knowledge based on industry needs. Through capstone projects students learn, apply, and reinforce the major competencies and concepts learned through the program. The curriculum is structured around instructional modules that center on the technical competencies linked with the core mathematics, science and English communications competencies that support the development of technical knowledge. Students work in teams to learn concepts, solve problems and make discoveries through various project and laboratory activities to gain practical experience in a workplace related environment.

**WEB-BASED EVALUATION OF STEM PROJECTS.** *Ismail Fidan, Tennessee Technological University, Cookeville, Tennessee.* Although conventional, paper-based survey and analysis instruments are not commonly practiced in a number of STEM (science, technology, engineering and math) courses and projects in the 21st century, various Internet-based evaluation tools are used to assess the courses and projects, and continuously



improve their outcomes and deliverables. This presentation reports various hands-on STEM projects and courses practiced in Tennessee Technological University and their continuous improvement efforts supported by Internet-based evaluation tools.

**COMPUTER-AIDED KNOWLEDGE-BASED PROCESS PLANNING FOR SURFACE MOUNT REWORK.** *Ismail Fidan, Tennessee Technological University, Cookeville, Tennessee.* The trend to high-density packaging in surface mount technology has highlighted inherent difficulties in the assembly line for these very fine pitch devices. A variety of defects are still common in printed circuit board assembly (PCBA) technology, requiring rework. Increasing product complexity, decreasing component size, and using double sided boards have made rework more difficult and the economic reworking of PCBAs is one of the main problems facing PCB manufacturers. Manufacturing of PCBAs has been improved with fully automated, accurate assembly machines and the use of robots. However, the automated rework lines have not produced a high level of reliable yield. An interactive knowledge-based expert interface system of circuit board defects has been developed so that the rework is marginally removed from the PCBA line, and process parameters that cause joint level reliability problems, are managed online with the help of the developed system. This presentation will report the current development and its evaluation in various educational and industrial settings. Although conventional, paper-based survey and analysis instruments are not commonly practiced in a number of STEM (science, technology, engineering and math) courses and projects in the 21st century, various Internet-based evaluation tools are used to assess the courses and projects, and continuously improve their outcomes and deliverables. This presentation reports various hands-on STEM projects and courses practiced at Tennessee Technological University and their continuous improvement efforts supported by Internet-based evaluation tools.

**THE IMPORTANCE OF PROFESSIONAL PRACTICE AND PROJECT MANAGEMENT FOR ENGINEERING EDUCATION.** *A. Saad and A. Salama, Georgia Institute of Technology, Atlanta, Georgia and Austin Peay State University, Clarksville, Tennessee.* A course on project engineering and professional practice is important for electrical and computer engineering students. It should teach students about design methods and tools, product life cycles, and ethical and economical considerations in electrical and computer engineering projects, among other topics that are relevant to students after graduation. Students should be given multiple opportunities to engage in professional writing and speaking situations throughout the course. Research papers, design reports, critiques, and oral presentations are among the types of assignments that can be required for the course. Students are required to work both individually and in small groups. Such a course can therefore hone students' skills for oral and written communications as well as teamwork, all being important for practicing engineers. Additionally, students can be introduced to library resources and can be initiated to start the brainstorming necessary for a capstone senior design project in a subsequent term.

**GAS DIFFUSION IN POLYSTYRENE FOAMS: EXPERIMENTAL RESULTS AND MULTI-SCALE MODELING.** *Jacob P.*

*Platfoot\*, Wesley M. McDonald\*, Steven A. Schultz\*, Pravin Kannan\*, Jacob Neilan\*, Donald P. Visco, and Joseph J. Biernacki, Tennessee Technological University, Cookeville, Tennessee (JPP, SAS, PK, JN, DPV, JJB) and Volunteer State Community College, Gallatin, Tennessee (WMM).* Gas diffusion through polystyrene foams, such as expanded polystyrene, has not been thoroughly investigated. Some macro-scale physical models developed earlier can predict foam diffusivity parameters, including diffusion coefficient and activation energy. However, these models require meso-scale parameter values, like unit cell diffusion coefficient, that can be determined only from experiments. Problems associated with such an approach have been discussed in detail. The objective of this work is to better model gas diffusion through polystyrene foams by using a similar multi-scale approach. The aim is to develop the existing macro-scale model by incorporating a meso-scale model that predicts gas diffusion through polystyrene films. A simple diffusion chamber was designed and experiments were conducted to provide data on polystyrene film diffusion coefficient and activation energy. The results were compared with Fickian diffusion model predictions and were found to be in agreement. Future plans also will be discussed.

**ELECTROCHEMICAL IMPEDANCE SPECTROSCOPY STUDY ON ALLOYS FOR TOTAL JOINT REPLACEMENTS.** *Gladius Lewis, Raghuvveer Vejerla\*, and Sanjay Mishra, University of Memphis, Memphis, Tennessee.* We tested the hypothesis that there is a universal model for the interface between the passive layer on the surface of an orthopedic alloy and an electrolyte that has clinical relevance. To this end, electrochemical impedance spectroscopy measurements were made on mechanically-polished test specimens fabricated from three orthopedic alloys (Ti-6Al-4V, Ti-13Nb-13Zr, and Biodur®108) while they were corroding in phosphate-buffered saline solution over a period of 25 days. Through a statistical comparison between the experimental results (Nyquist and Bode plots) and those computed using seven different equivalent electrical circuits (each representing a different model of the aforementioned interface), one circuit (comprising an arrangement of three resistances and three capacitances in series with a resistor representing the solution resistance) provided the best-fit in all three systems, thus providing support for the working hypothesis.

**FINITE ELEMENT ANALYSIS OF MODELS FOR USE IN SCREENING MATERIALS FOR VERTEBROPLASTY AND KYPHOPLASTY.** *Jie Xu\* and Gladius Lewis, University of Memphis, Memphis, Tennessee.* Vertebroplasty and kyphoplasty are surgical procedures that have been introduced recently for the surgical management of vertebral compression fractures that commonly occur in persons who suffer from osteoporosis. The clinical success of these procedures depends on, among other things, the properties of the injectable bone cement used. Currently, biomechanical tests on vertebral bodies from cadavers are used in screening these cements. This approach has many drawbacks, such as high cost and variability in bone properties. Thus, there is a place for alternative approaches, examples being biomechanical tests using a synthetic vertebral body model and finite element analysis (FEA). In these cases, there is need to know the values of the appropriate elastic constants for the material(s). In the present study, we used FEA to determine these values in the case of three models: a polyurethane cube, a cube of cancellous bone, and the body of the L2 vertebra.

**VALIDATION OF SYSTEM IDENTIFICATION MODEL OF CEREBROVASCULAR PRESSURE TRANSMISSION.** *N. Narayanan\* and M. L. Daley, University of Memphis, Memphis, Tennessee.* The brain's ability to autoregulate blood flow can be impaired by injury. Methods to assess autoregulation in a brain-injured patient are needed to improve clinical management. Our laboratory has examined the use of system identification techniques to evaluate changes in cerebrovascular pressure transmission, the dynamic relationship between arterial blood pressure (ABP) and intracranial pressure (ICP) as a means to evaluate autoregulation in the clinical setting. The aim of this study was to examine the validity of the assumed mathematical structure used for system identification modeling. Simulations of a lumped parameter Windkessel model of intracranial pressure dynamics were implemented to match both: a) the HMF derived from system identification model; and b) actual clinical ICP recordings. Trends in resistance and compliance elements of the Windkessel model were found to be consistent with pathophysiological changes associated with two clinical conditions: a) intractable intracranial hypertension; and b) inappropriate rapid cerebral vasodilation.

**OPTIMAL MASS RATIOS IN SEMI-ACTIVE VARIABLE MASS TUNED MASS DAMPERS IN MULTISTORY BUILDINGS.** *T. Hanna\*, B. Woods\*, J. Prince\*, J. B. Keel\*, R. Rast\*, J. Boyd\*, J. Bell\*, J. Sipes\*, and R. Helgeson, University of Tennessee, Martin, Tennessee.* Tuned mass dampers have been used in buildings and bridges for many years to reduce wind and earthquake induced vibrations. It is well known that the performance of the system is influenced by the mass of the tuned mass damper. As the ratio between the mass of the damper and the total mass of the structure is increased, the vibration of the tallest section of the structure is also reduced. A new tuned mass damper design is being developed at the University of Tennessee, Martin. This paper presents the results of a simulation study in which the performance of the new device is evaluated as the mass ratio is varied. Several different performance measures are investigated, including maximum acceleration, the maximum horizontal displacement, and the maximum story drift for each level. The results of this simulation study will then be used to finalize the design of the damper.

**A CASE STUDY OF LARGE SCALE BIOMEDICAL DATA ANALYSIS.** *Benjamin Hamilton\*, Robert Woods\*, and Timothy Myers\*, sponsored by M. L. Daley, University of Memphis, Memphis, Tennessee.* As student laboratory assistants working on a study designed to assess autoregulation of cerebral blood flow we were assigned the task of implementing the analysis of pressure recordings obtained from 20 stroke patients with sub-arachnoid hemorrhage. Initially, pressure recording data from each patient were extracted from a master disk containing 2.5 Gbytes data and stored on individual compact disks. A MATLAB system identification algorithm was then used to process individual patient data for each day of clinical recording to obtain the highest modal frequency (HMF) of cerebrovascular pressure transmission, the dynamic relationship between arterial blood pressure (ABP) and intracranial pressure (ICP). By examining the relationship between changes in HMF and changes in the cerebral perfusion pressure (CPP), the difference between ABP and ICP, patients were classified as regulating, not regulating, or undetermined. Results show that

for patients who made good recovery, regulation improved in the days following the injury.

## GEOLOGY AND GEOGRAPHY SECTION

MARK SIMPSON, CHAIR

**STRATIGRAPHY OF THE FORD CONSTRUCTION COMPANY GRAVEL PIT.** *J. Barnes\*, M. Tabarez\*, K. Castleman\*, E. Covington\*, W. Denman\*, L. Hughes\*, K. Truett\*, L. Williams\*, B. Windsor\*, and M. A. Gibson, University of Tennessee, Martin, Tennessee.* The gravel pit operated by Ford Construction Company near Troy was studied as part of Obion County Central High School's dual credit geology class from the University of Tennessee, Martin. The pit consists of a "Lafayette" gravel lens over 5 m thick overlain by 4 m of löess. Gravels range from pea-size to cobble and contain a variety of fossils including brachiopods, pelmatozoan stems, gastropods, ectoprocts, and corals. All of the fossils are definitely Paleozoic in age and probably late middle to late Paleozoic. The löess is unfossiliferous, but contains numerous concretions referred to as "löess dolls". The löess dolls occur throughout the lower portion of this stratum and sometimes appear to begin at common horizons. A thin transition zone separates the two systems and appears to represent an unconformable surface.

**STRATIGRAPHIC AND STRUCTURAL MODELING OF THE MISSISSIPPI EMBAYMENT.** *Ryan Csontos and Roy Van Arsdale, University of Memphis, Memphis, Tennessee.* A landmark three dimensional software model centered on the northern half of the Mississippi Embayment is being created integrating: Geologic and geophysical data including surface topography DEM data, stratigraphic tops of the Precambrian, Paleozoic, Cretaceous, Tertiary, and Mississippi River alluvial sections, faults, and earthquake foci. This geologic model allows viewing and interpretation of the data from any direction and provides the ability to observe and analyze the subsurface geology from a variety of scales. Geologic interpretation within a 3-D environment promotes better interpretations of the relationships among mapped faults, earthquake foci, Reelfoot rift structures, and the tectonic/stratigraphic evolution of the northern Mississippi embayment. One observation made within the model is the coincidence of a major down-to-the-southwest step in the Precambrian basement beneath the seismically active Reelfoot thrust fault. Thus, it appears that the Reelfoot thrust may have formed above an ancient basement normal fault. Another observation is a structural high located on top of the Eocene correlating to mapped structures. As additional data are put into the model we anticipate an ability to track seismogenic faults from the basement into the Holocene alluvium of the Mississippi River valley and provide a geometrically accurate geologic framework for geophysical and fault kinematic analyses.

**CORRELATION AND SEQUENCE STRATIGRAPHY OF THE CLAIBORNE GROUP IN THE TRI-STATE AREA OF WESTERN TENNESSEE, EASTERN ARKANSAS, AND NORTHERN MISSISSIPPI.** *Angela Owen\* and Daniel Larsen, University of Memphis, Memphis, Tennessee.* A stratigraphic analysis of the Claiborne Group in the tri-state area of western

Tennessee, eastern Arkansas, and northern Mississippi was undertaken to better understand hydrostratigraphic relationships among regional aquifers and the degree of fault off-set within their strata. Hundreds of high-quality geophysical borehole logs were digitized and used to create detailed stratigraphic East-West and North-South cross-sections throughout the study area. Lithological data from cores, cuttings, and geologic logs were used in conjunction with previously described 'baseline' logs to correlate their geophysical signals to sedimentary facies. A sequence stratigraphic approach was taken in correlating the geophysical data, emphasizing correlation of time horizons (coals), potential sequence boundaries, and maximum flooding surfaces. Where available, outcrop data were acquired to better define the regional architecture and facies. The resulting cross-sections suggest more complex, non-contiguous stratigraphic relationships among the Claiborne Group strata than previously understood, interacting geomorphologic processes, and limited evidence for extensive faulting.

**MINERALOGICAL ANALYSIS OF BARITE NODULES AND QUARTZ VEINS WITHIN THE CHATTANOOGA SHALE FORMATION OF THE EASTERN HIGHLAND RIM REGION, TENNESSEE.** *Sara B. Smith\**, *H. W. Leimer*, and *E. Hannah*, *Tennessee Technological University, Cookeville, Tennessee*. The Late Devonian Chattanooga Shale Formation of the Eastern Highland Rim Region is a black, organic rich, shallow marine deposit not exceeding 10 m in thickness. Phosphate nodules are common in the upper section. However unusual mineralizations are prominent. At two locations on Dale Hollow Lake in Clay County, Tennessee, barite nodules and cross cutting quartz veins are present, possibly conjoined to one another. Samples of the anomalies were examined utilizing a polarizing microscope, X-ray diffractometer, and scanning electron microscope (SEM). Main Study Area 1 contains barite nodules, quartz veins, and "beaver reef," while Main Study Area 2 only contains quartz veins. The barite grains illustrate rounded crystal morphology and are < 5  $\mu\text{m}$ , which indicates a marine origin. The quartz vein origin is unknown, and is the only object linking the two localities together. No similarities are noted between study areas, suggesting these mineral anomalies occurred through separate events.

**GEOCHEMISTRY OF THE METAIGNEOUS PUMPKINVINE CREEK FORMATION, ALLATOONA LAKE, GEORGIA.** *H. G. Churnet* and *C. Emily*, *University of Tennessee, Chattanooga, Chattanooga, Tennessee*. The Pumpkinvine Creek Formation (PCF) is one of a series of mafic and ultramafic rocks of the Appalachians present just east of an inferred Taconian suture that is represented by the Hayesville Thrust Fault and its equivalents including the Allatoona Fault. The PCF amphibolite in the Allatoona Thrust Sheet contains layers of metafelsite and is interbedded with sediments. Major, trace, and rare earth element chemistries of the PCF indicate different magma sources for the mafics and felsics. The mafics are tholeiites with flat REE pattern, while the felsics are calcalkaline with LREE enrichment and EU depletion. Mantle-normalized spider diagrams indicate the mafics have comparatively flat HFSE (Ti, Nb, and Zr), while the felsics show depletion in Ti. The fluid mobile element content is variable, with the mafics being enriched in Cs, K and Sr and depleted in Rb, while the felsics are enriched in Cs and depleted in Sr and Rb.

**CARBON SEQUESTRATION IN A WEST TENNESSEE WATERSHED.** *P. M. Gale*, *M. Goddard*, and *M. Phillips*, *University of Tennessee, Martin, Martin, Tennessee*. Carbon sequestration is a known mechanism for combating global warming. Much of the world's carbon can be found in the soil as organic matter and land use dictates the amount of carbon the soil can hold. Published soil organic matter levels for West Tennessee soils range from 0.5–2.0% on cropped land, well below the 4% level found in undisturbed soils of this region. The current study is investigating the effect of land use on carbon storage as soil organic matter. Soil samples have been collected from a variety of landscape positions and land uses in the region and analyzed for soil organic matter content by loss on ignition. The results indicate that the role of landscape position is minor compared to the influence of land use on soil organic matter content and there is potential for storing carbon in the soil through changes in land use.

**DRAINAGE BASIN STUDIES AT DALLAS-FORT WORTH INTERNATIONAL AIRPORT.** *Justin K. Whipple\**, *University of Tennessee, Martin, Martin, Tennessee*. The purpose of the project is to map out the drainage basins of the Dallas-Fort Worth International Airport. From this map, the objective is to determine if each individual storm drain that was constructed was over-designed or under-designed to take the amount of water that passes through it based on the land cover of the drainage area. The results are only of sample areas as more data are needed to finish the maps of the drainage basins.

**LOW COST, LOW ALTITUDE AERIAL PHOTOGRAPHY.** *R. Gary Litchford* and *Eric Wolf\**, *University of Tennessee, Chattanooga, Chattanooga, Tennessee*. The first large-scale aerial photograph produced in the United States was taken in 1860 from a balloon at an altitude of 365 meters. Contemporary large-scale photography is accomplished from platforms suspended by tower, remote aircraft, rockets, kites, small blimps, and balloons. Low-cost systems have been produced using kites and small balloons used for advertising. These types of observation systems produce good quality aerial photography easily orthorectified. The present work describes low cost platforms utilizing a balloon and a blimp providing monitoring, shot selection, digital data in both IR and RGB formats from a maximum altitude of 500 feet. Total cost for both systems was under \$2000.00.

**WINTER MINIMUM TEMPERATURES IN WEST TENNESSEE: EVIDENCE OF GLOBAL WARMING?.** *Robert M. Simpson* and *Matthew L. Browning*, *University of Tennessee, Martin, Martin, Tennessee*. The time series of wintertime minimum temperatures for selected stations in western Tennessee are presented. Since evidence for a trend towards global warming should first appear in the warming of the Polar Regions, winter minimum temperatures in western Tennessee should be trending higher over the last forty years commensurate with the global and hemispheric temperature increases documented by many sources. The reasoning is that large-scale outbreaks of polar air masses responsible for very low minimum temperatures in western Tennessee should not themselves be as cold as has been previously observed prior to the onset of the global warming in the last 40 or so years. Analysis of the time series including running means and *t*-tests to account for different phases in important teleconnections yielded results that showed that

minimum temperatures were more closely related to teleconnection influences than the general "global" warming taking place over the past century.

**ANALYSIS OF LAND USE CHANGE OF THE TENNESSEE CUMBERLAND PLATEAU USING GEOGRAPHIC INFORMATION SYSTEMS.** *Jacob K. Tittle\* and Peter Li\**, *Tennessee Technological University, Cookeville, Tennessee.* The research in this project studied the percent change of land use on the Tennessee portion of the Cumberland Plateau over the last 10 years. Information from 16 different counties including United States Department of Agriculture Forest, Census Bureau, and Tennessee Wildlife Resources Agency land use data was analyzed to determine the Plateau's changing landscape using ArcGIS. Population density, distribution and growth in the region are analyzed and presented in the study. Population growth and hardwood forest removal were factors used in determining land use change in the area of study. Spatial correlation between dependant and independent variables are analyzed and proven in the study. One of the main purposes of this project was to determine if the introduction of loblolly pine plantations had a significant impact.

**ANALYSIS OF TOXIC RELEASE INVENTORY IN THE CANEY FORK WATERSHED.** *Jeffery S. Hensley\* and Peter Li*, *Tennessee Technological University, Cookeville, Tennessee.* This research studied the TRI (Toxic Release Inventory) for the Caney Fork Watershed. The Caney Fork Watershed consists of parts of ten counties. The TRI for the selected counties contained 3954 separate incidents since 1987. The purpose of this study was to indicate health hazards in relation to the chemical and type of release event. Ground topology, soil types and stream networks were taken into consideration along with population density where the releases occurred to determine the health risk to humans. Gauging stations were used to determine the rate of travel of a chemical if it was released into a stream. Customization procedures were developed to provide quick reference to TRI sites. Such procedures can help decision makers obtain useful information from selection criteria. Other parameters such as distance to schools, hospitals, and vulnerable communities are taken into account while computing risk associated with TRI.

**TOTAL SUSPENDED SOLIDS OF THE CREEKS IN THE COOKEVILLE AREA OF THE CANEY FORK WATERSHED.** *C. E. Hoeffner and P. L. Li*, *Tennessee Technological University, Cookeville, Tennessee.* The purpose of this study is to find the total suspended solids (TSS) of the creeks in the Cookeville area of the Caney Fork Watershed. Cane Creek, Hudgens Creek, Pigeon Roast Creek, Post Oak Creek, and Falling Water River are the main water bodies sampled. Samples were taken before and after rainfall events in each of the study area creeks. A filtration apparatus was used to remove the suspended solids from the samples. The samples were then dried and weighed to calculate (TSS). Flow duration curve analysis was carried out to provide better understanding of water quality in these streams. Flow duration curve also can identify specific intervals where dry and wet hydrologic conditions are differential. Land use pattern will be analyzed and used to support the field findings.

## HISTORY OF SCIENCE SECTION

BROTHER KEVIN RYAN, CHAIR

**CONRAD JAMISON JR.: THE LIFE OF A TENNESSEE NATURALIST.** *Thorunn A. McCoy and Roger A. McCoy*, *University School, Nashville, Tennessee and Tennessee Natural Heritage Program, Nashville, Tennessee.* Conrad Jamison Jr.'s curiosity about nature transcended his short life, and his work continues to inform Tennesseans. At Peabody Demonstration School, Jamison began his interest in birding, which continued throughout his years at Peabody College. His birding outings and work with the Tennessee Ornithological Society are recorded in *The Migrant*, and they continue to be of use today. However, his lasting contribution to Tennessee naturalism is his work on many of the illustrations found in *Ferns of the Eastern Central States with Special Reference to Tennessee*. Jamison also had another love, his country. And for that devotion, he, like many Tennesseans, paid the ultimate price during World War II. This session chronicles the contributions Jamison made toward Tennessee natural history.

**MEDIEVAL STUDIES OF MOTION.** *Brother Kevin Ryan*, *Christian Brothers University, Memphis, Tennessee.* Galileo is generally given credit for the first studies of the motion of falling bodies, and rightly so due to his famous inclined plane experiment. However, there were earlier men who also studied this question. The contributions of Albert of Saxony, Nicole Oresme, and Leonardo da Vinci will be explained.

## MATHEMATICS AND COMPUTER SCIENCE SECTION

JOHN H. SCHOMMER, CHAIR

**ARGUING THE AXIOMS OF SET THEORY.** *John J. Schommer*, *University of Tennessee, Martin, Tennessee.* The belief that mathematical axioms are those statements of mathematical fact that are "obvious" or "self-evident" is widespread, even among the scientifically literate. But set theoreticians regularly consider mathematical axioms that no one considers obvious. Even a high school geometry student knows that one needs to supply reasons (proofs) for theorems. What does it mean though to supply reasons for an axiom? In this talk we'll review some of Penelope Maddy's work in the philosophy of mathematics and examine some of the widely-held mathematical axioms that challenge belief.

**COMPUTER SIMULATION MODEL APPLIED IN TEACHING AGRICULTURAL ECONOMICS.** *Harjanto Djunaidi*, *Middle Tennessee State University, Murfreesboro, Tennessee.* Computer simulation models applied in teaching Agricultural Economics can be used to increase classroom teaching effectiveness. Students correlate computer simulations with video games. Therefore, their motivation to learn the class materials amplifies. The objectives of including computer simulation models in teaching Agricultural Economics are to enhance students' drive to learn class materials, to improve class room teaching efficacy, and to introduce students to different tools useful for solving real world economics or business problems. This hands-on approach

helps increase students' computer as well as problem solving skills. The ability to simulate business decision making processes under different scenarios will help students to recognize and select the best possible alternative that will maximize a company's returns. The use of computer simulation models in teaching Agricultural Economics with real world applications increased students' interest and enthusiasm to learn the class materials because they were having fun while studying the class materials.

**PLUMMER-WHITNEY SYSTEMS: SOME PRELIMINARY RESULTS ON A GENERALIZATION OF MATROIDS AND WELL-COVERED GRAPHS.** *Stephen Campbell and Jennifer Rowe, Belmont University, Nashville, Tennessee and The Harpeth Hall School, Nashville, Tennessee.* We introduce the concept of a Plummer-Whitney System, which is a common generalization of Whitney's matroid and Plummer's well-covered graph. All three of these concepts are useful for studying independence by means of the greedy algorithm. The relationship of Plummer-Whitney Systems to matroids and to well-covered graphs is illustrated and some preliminary results are given. This work grew out of an undergraduate research project in 2001, when the second author was a student and the first author served as her tutor.

## PHYSICS AND ASTRONOMY SECTION

LIONEL CREWS, CHAIR

**IN INTERDISCIPLINARY RESEARCH: AN INVESTIGATION OF HEART BEAT SIGNAL (EKG) USING NONLINEAR DYNAMICS.** *C. Erkal, University of Tennessee, Martin, Martin, Tennessee.* We will give an overview of Electrocardiogram (EKG) signal analysis pursued by non-medical scientists with an eye toward making predictions for clinical applications. There are many conditions of heart that may lead to sudden death and EKG alone is not sufficient to recognize precursors ahead of time. With the development of fast computers, the application of numerical techniques to complex problems has dramatically increased. In the case of EKG signals, various diagnostic tools were developed to help differentiate a healthy heart from an unhealthy heart. This area of research requires collaborations from electrical engineering, physics, statistics, mathematics, and medical scientists.

**APPLICATION OF MICROCHANNEL PLATE SYSTEM FOR MASS SPECTROMETRY MEASUREMENTS.** *M. Getaneh, K. S. Grabowski, D. L. Knies, C. Cetina, G. K. Hubler, S. J. Turney, University of Tennessee Martin, Martin, Tennessee (MG) and Naval Research Laboratory, Washington, DC (KSG, DLK, CC, GKH, SJT).* A microchannel plate (MCP) detector module with active area of  $10 \times 2 \text{ cm}^2$  is used as a position detector for mass spectrometry applications. The MCP detects electrons scattered by an MeV ion beam as it goes through a thin Carbon foil which is placed at a  $45^\circ$  angle with respect to the beam. The scattered electrons' transverse motion is constrained by application of uniform electric and magnetic fields parallel to the axis of the MCP. The amplified charge is deposited on a double-delay line anode. Differential timing and charge partitioning are used to determine the horizontal and vertical positions of the ion in a plane normal to the MCP axis.

**MODELING DARK NEBULAE: STRUCTURE, REDDENING LAW, AND VELLOSO.** *L. Crews, T. Huard, and B. Stiles,*

*University of Tennessee, Martin (LC, BS) and Harvard Smithsonian Center for Astrophysics (TH).*

Abstract not available.

## SCIENCE AND MATHEMATICS TEACHING SECTION

MANDY CARTER-LOWE, CHAIR

**APPLICATIONS OF STATISTICAL CONCEPTS IN TEACHING AGRIBUSINESS.** *Harjanto Djunaedi, Middle Tennessee State University, Murfreesboro, Tennessee.* Embedding statistical concepts in teaching Agribusiness classes can be a challenge. Students taking these classes may or may not have a prior knowledge of statistics. Therefore, over stressing the concepts could create negative impacts toward learning the whole class materials. The objective of including various statistical concepts in teaching Agribusiness classes is to help students understand the tools they need when applying for jobs. This hands-on approach helps increase students' problem solving skills. Knowing a fundamental statistical concept and its application such as mean will help them to better manage inventory management, to forecast market potentials or commodity futures prices. Including statistical concepts and their applications increases student interest and motivation to learn class materials. This happens because students can see the relationship between what they are taught and what they need to qualify for a job.

**WAKE UP YOUR MATH CLASSES.** *Tammy Borren and Meredith McCoy, Columbia State Community College, Columbia, Tennessee.* Keeping students engaged in a mathematics class has historically been difficult. We urge our students to pay attention and to take good notes, but sometimes it is not possible for them to do both. Which is more important? Brought on by much frustration, we have come up with ways to make sure students are paying attention and are involved in their own learning. We would like to share tips and tricks we have tried both inside and outside of the classroom to get students to meet our expectations. These methods include using the personal response systems and Schoolpad as presentation and instructional tools in the classroom. Instruction on how to use WebCT and MyMathLab as support outside of the classroom also will be discussed. Ms. McCoy teaches developmental courses and Ms. Borren teaches developmental and college level math courses. Our examples will include material from basic mathematics, elementary and intermediate algebra, college algebra, statistics, and applied calculus.

**INTEGRATION OF FOURIER TRANSFORM INFRARED SPECTROSCOPY IN GENERAL CHEMISTRY LABORATORY CURRICULUM: NATIONAL SCIENCE FOUNDATION-FUNDED PROJECT.** *Flora R. Setayesh, Nashville State Technical Community College, Nashville, Tennessee.* Fourier Transform Infrared Spectroscopy (FTIR) is utilized in a three-week long lab project that involves synthesis, analysis, and characterization of aspirin. The goal of the project is to enhance students' educational experiences, promote conceptual understanding and problem-solving ability, and provide better workforce training. This experiment is conducted after concepts of bonding, molecular structure, and electromagnetic radiation are taught. Functional group differences and structure of

chemicals before (salicylic acid) and after (aspirin) the reaction are compared in an attempt to better understand the chemistry involved. The computer search system is utilized to confirm the identity of aspirin from stored infrared spectral data. A quality pre-lab lecture is the key factor contributing to the success of the experiment. Student feedback has been very encouraging and indicates that exposure to FTIR has increased their knowledge of molecular structure, technical skills, and enthusiasm.

#### STUDENT PERSPECTIVES ON DUAL CREDIT GEOLOGY.

*M. Cook\**, *A. Saunders\**, *J. Eisterhold\**, *N. Eisterhold\**, *J. Gullett\**, *K. Hooten\**, *K. Kraft\**, *E. Wilson\**, *A. Wilton\**, and *M. A. Gibson*, *University of Tennessee, Martin, Martin, Tennessee*. Geology is not a regular offering in Tennessee High Schools and Earth Science is most often presented in Middle School, so the majority of students graduate with little understanding of geological processes. The University of Tennessee, Martin began to deliver its introductory geology sequence to area high schools in 2002 through Dual Credit. Students receive the same course as college students taught by university faculty and run on the school's calendar system. Students report the course is beneficial because it: 1) provides them with an elective science class that is different and exciting, 2) allows them to get a start on college requirements early, 3) has fun field trips, 4) allows them to avoid science fair projects but participate in projects, and 5) teaches useful information. The university benefits from the: 1) student credit hours, 2) recruiting exposure, and 3) improving geologic literacy. However, problems of calendar matching, differing grading scales, and parental involvement must be addressed.

#### INTEGRATING SCIENTIFIC DISCOVERY RESEARCH PROJECTS INTO THE CLASSROOM.

*Rebecca L. Seipelt*, *Michael W. Thompson*, and *A. Bruce Cahoon*, *Middle Tennessee State University, Murfreesboro, Tennessee*. Scientific research experiences not only give students experience with research techniques and ways of thinking, they also pique curiosity and create a more personal bond with the discipline. To this end, there is a movement to incorporate true research experiences into the curriculum for all students at earlier times. However, this development presents many challenges that need to be addressed including issues of student inexperience, class time use, project selection, and multiple project logistics. To this end, scientific discovery-type research experiences were integrated into three different types of genetics courses by three different instructors. The challenges and their resolutions will be discussed, including the types of research projects undertaken.

#### A STUDENT CENTERED OUTREACH PROGRAM: A COMMUNITY COLLEGE EXPERIENCE.

*A. Crook\** and *J. Neilan*, *Volunteer State Community College, Gallatin, Tennessee*. To promote better understanding of the scientific method by both middle school pupils and community college students, Volunteer State Community College (VSCC) has initiated a program that combines a Community Outreach Program with the opportunity for independent study by VSCC students. Outstanding students are nominated by Math and Science faculty members to participate in a 3-credit course PSCI-200P, Science Practicum. The students are presented with descriptions of a variety of activities and chemical demonstrations. Working in teams of 2-3 students, the participants develop activities and chemical demonstrations appropriate for Middle School students. Working in cooperation with local Middle School teachers, the teams

of VSCC participants take the activities to the classrooms and interact directly with the middle school students and teachers. Based on student feedback, both the VSCC participants and Middle School students benefit by developing concepts through discovery and inquiry based models.

#### AN INQUIRY DRIVEN LAB SERIES IN CELLULAR BIOLOGY BASED ON MEMBRANE DOMAIN COMPONENTS IN YEAST.

*D. Grant Willhite*, *Tennessee Wesleyan College, Athens, Tennessee*. Undergraduate research at small colleges is often an interrupted endeavor, benefiting only students willing to put forth the individual time and energy required. To benefit the broader student population, the concepts and techniques must be adapted for the course laboratory. Recent collaborative research has focused on a possible association of a yeast GPCR with membrane rafts. The techniques involved are in line with those required in advanced courses in cell biology. For these reasons, I have developed a five-part lab series in which students investigate the impact of changes in yeast growth environment or alteration in a raft isolation protocol on localization of proteins to detergent soluble or insoluble regions. The students decide what to investigate and use established protocols from primary literature to formulate their own protocol. Thus, the series is inquiry driven, forcing the student to formulate, execute, and interpret data from their experimental design.

#### UTILIZATION OF *CAENORHABDITIS ELEGANS* FOR THE STUDY OF CELLULAR RESPIRATION.

*Nick Ragsdale* and *Ashley Dozier\**, *Belmont University, Nashville, Tennessee*. Cellular respiration is commonly explored in both lecture and laboratory exercises of the biology courses offered to majors. Students confuse much of the lecture material due to the abstract nature of the molecular interactions. Lecturers attempt to alleviate the confusion through laboratory exercise reinforcement. Currently, many of these laboratory exercises require the utilization of test organisms that either do not help solidify the cellular respiration concepts and/or that require the use of expensive equipment. The purpose of this study was to determine the effectiveness of *Caenorhabditis elegans* as a model organism for the study of cellular respiration. Vernier software and transducers were utilized to measure the consumption of dissolved oxygen. Results indicate that *C. elegans* cellular respiration can be measured with inexpensive materials. Furthermore, the rate of cellular respiration can be altered with simple manipulations. *Caenorhabditis elegans* is an easy and inexpensive organism to demonstrate cellular respiration.

#### USING CURRENT EVENTS TO SHOW THE BIG PICTURE TO STUDENTS IN BIOLOGY COURSES.

*Karen Kendall-Fite*, *Columbia State Community College, Columbia, Tennessee*. If students actually break down and talk in class, then there has probably been speculation as to the usefulness of the introductory biology course. The assignment, then, is not to shove as much content down their throats before they start sleeping in instead of showing up for the 2:00 pm biology class, but to make them question the usefulness and discover the answer to the question is an overwhelming yes. Yes! Knowledge of the foundations of biology is useful to me as an individual, student, parent, and citizen. Not only should educators be charged with the task of providing facts, but assisting students to develop the tools to draw inferences, to assimilate information, to ably distinguish among fact, fiction, and opinion. Where can one find

a reliable source of material containing fact, fiction, and opinion to help the student hone these skills? How about the news media? Students are required to evaluate current event articles from non-technical sources that address topics covered in biology. They are expected to prepare a current events portfolio which contains the news articles and statements. Their statements should address the relevance of the information presented in the article and the potential for change in their lives. Additionally the news stories can be used to stimulate discussion in class.

**LAWRENCEBURG MEETS COLUMBIA: INTEGRATING AND WEB-ENHANCING HUMAN ANATOMY AND PHYSIOLOGY CLASSES USING WEBCT.** *Mandy L. Carter-Lowe, Columbia State Community College, Columbia, Tennessee.* Most college instructors have observed noticeable differences in student performance and behavior from one class to the next. In the community college setting, I have noticed distinct differences in classes taught at different locations. I teach Human Anatomy and Physiology at two locations. Columbia classes tend to be more involved, ask more questions, and often perform better on exams. Lawrenceburg classes are less likely to ask questions and often have trouble thinking conceptually. In an attempt to unify these classes and spark enthusiasm, I incorporated both classes into one WebCT class. Although the class met on-ground using a typical delivery method at their respective locations, WebCT was used for communications outside of class time, thus creating a “web-enhanced” course. The Lawrenceburg students used WebCT tools more than Columbia students. In addition, classroom discussions at Lawrenceburg increased although the overall class average remained lower than the Columbia class average.

**A CEDAR GLADE PLANT POPULATION STUDY WITH ELEMENTARY STUDENTS.** *Karen F. Metius-House\* and Kim C. Sadler, Middle Tennessee State University, Murfreesboro, Tennessee.* Science enrichment experiences outside of the classroom yield improved scholastic science scores, increased motivation and a better overall attitude toward science through the application of the classroom concepts. Students were introduced to the cedar glades ecosystem through lecture and interactive field experiences. Students randomly selected twenty-five specimens each of five species (Shooting-Star, *Dodecatheon meadia*; Blue-eyed Grass, *Sisyrinchium albidum*; Nashville Breadroot, *Pedimelum subacaulis*; Nashville Mustard, *Leavenworthia stylosa*; and Star-Grass, *Hypoxis hirsuta*) from the cedar glades at Flat Rock, Murfreesboro, Tennessee. Measurements of biotic (plant identification) and abiotic (temperature, soil depth, available sunlight, and soil moisture) were collected for statistical comparison to previously published data. Student knowledge and attitudes were measured through pre- and post-test design. By combining a classroom unit of study with a hands-on, hypothesis-based activity, we provided students with a field ecology investigation in an attempt to increase motivation and knowledge.

## ZOOLOGY SECTION

STEVE HAYSLETTE, CHAIR

**ASSOCIATION OF TEMPERATURE AND CAPTURE OF VIRGINIA OPOSSUMS (*DIDELPHIS VIRGINIANA*).** *James B.*

*Akins\*, Allen E. Houston, and Michael L. Kennedy, University of Memphis, Memphis, Tennessee and The Ames Plantation, University of Tennessee, Grand Junction, Tennessee.* The association of daily temperature variables (ambient and soil) and capture of Virginia opossums (*Didelphis virginiana*) was assessed from 2000 to 2005 during fall and winter trapping sessions at the Ames Plantation in Fayette County, Tennessee, and Meeman Biological Station in Shelby County, Tennessee. Individuals were live trapped on five 8 by 8 grids over a period of 32 nights on each grid at Ames and on one 5 by 10 grid over a period of 40 nights of trapping at Meeman. Sampling resulted in 71,440 trap nights (1 trap night = 1 trap set for 1 night). Percent capture per trap night for Virginia opossums was correlated to temperature variables using a Pearson product-moment correlation coefficient. Results indicate a significant association of capture between Virginia opossums with ambient and soil temperatures.

**VARIATION IN AGGRESSIVE BEHAVIORS OF *SCIURUS CAROLINENSIS* DURING FEEDING: SELF-RECOGNITION OR KIN RECOGNITION?** *Caron Baugher\* and Andrew N. Barrass, Austin Peay State University, Clarksville, Tennessee.* Arboreal animals that utilize spatial reasoning have increased cognition. Dominance hierarchy occurs between squirrels and varies with age, sex and relatedness. Squirrels are known to display aggressive behaviors, which usually increase with additional food handling time during defense of limited food sources. Agonistic behaviors of *Sciurus carolinensis* were studied by increasing handling time of a limited food source over several days and by reducing the food source on consecutive days. Individuals were identified by natural markings and various types of aggressive behaviors were scored per individual. Dominance was noted in older individuals. When a mirror was added to the feeding arena, aggressive, startled and submissive actions increased, compared to feeding tests without the mirror. Results indicate increased aggression towards conspecifics but not the mirror. Simultaneously, inquisitive behavior increased and was directed at the mirror. The inquisitive behavior exhibited by some individuals is consistent with other studies that indicate self-recognition.

**ASSESSING TEMPORAL VARIABILITY IN BIODIVERSITY MEASURES OF SMALL MAMMALS ACROSS VEGETATION TYPES.** *Heidi L. LaMountain\* and Michael L. Kennedy, University of Memphis, Memphis, Tennessee.* Biodiversity measures for small mammals were monitored in three habitat types (forest, field, and forest/field edge) on a fragmented landscape across a 5-year period. Community and population assessments were conducted utilizing live-trapping procedures on transects. Because edge represents a blending of forest and field habitats, the prediction that this habitat could serve as an umbrella habitat (habitat reflecting trends representative of all habitats) for monitoring programs was tested. Additionally, selected annual increases and decreases in biodiversity measures in monitoring assessments derived from transect sampling were examined utilizing grid sampling to test the prediction that trends reflected by transect sampling represent actual changes in animal abundance. Results suggested, while patterns of biodiversity measures across habitat types were correlated, trends were most informative in regard to changes when habitats were viewed collectively. Density estimates derived from grid sampling verified changes in biodiversity measures reflected by monitoring assessment based on transect sampling.

A SURVEY OF MAMMALIAN BIODIVERSITY AT FORT DONELSON NATIONAL BATTLEFIELD. **Anna K. Featherston\***, **Heidi L. LaMountain**, **Robert D. McDermott**, **Nick E. Jordan**, and **Michael L. Kennedy**, *University of Memphis, Memphis, Tennessee*. A study to inventory the mammalian biodiversity at Fort Donelson National Battlefield, Stewart County, Tennessee, was initiated in the summer of 2004 with a goal of documenting 90% of the species reasonably expected to occur on the site. Sampling procedures included live traps, pitfall traps, scent stations, mist nets, scent/camera stations, and spotlighting. Results suggest that, for small mammals, the white-footed mouse (*Peromyscus leucopus*), hispid cotton rat (*Sigmodon hispidus*) and least shrew (*Cryptotis parva*) are common on the site. The most abundant bat appears to be the red bat (*Lasiurus borealis*), and raccoons (*Procyon lotor*) and coyotes (*Canis latrans*) are the most common medium-sized predators observed. White-tailed deer (*Odocoileus virginianus*) are frequently observed throughout the site. The work is still ongoing and should be completed in December of 2006.

BREEDING AND NON-BREEDING HOME RANGES OF ADULT MALE RACCOONS (*PROCYON LOTOR*): TERRITORIALITY AND METABOLIC HOME RANGE SIZE. **Jason B. Jennings\***, **Michael L. Kennedy**, and **Allan E. Houston**, *University of Memphis, Memphis, Tennessee (JBJ, MLK)*, and *Ames Plantation, Grand Junction, Tennessee (AEH)*. Territoriality and metabolic home ranges (50% and 95% home-range areas) were assessed for eight adult-male raccoons during the breeding and non-breeding seasons at the Ames Plantation in western Tennessee. The study employed standard radio-telemetry procedures utilizing the minimum convex polygon method (MCP) and was conducted during 2000–2003. For 50% MCP, overlap among home ranges was not greater than 10%, indicating exclusive core areas and suggesting territoriality. However, for 95% MCP, home ranges were greater than 10%, indicating non-exclusive home ranges and suggesting a lack of territoriality. Home ranges during the breeding season (50% MCP, mean = 8.1 ha; 95% MCP, mean = 35.9 ha) were significantly larger than those of the non-breeding season (50% MCP, mean = 5.09 ha; 95% MCP, mean = 27.3 ha). Home ranges for both seasons were significantly higher than expected based on energy requirements alone.

ESTIMATING POPULATION DENSITY OF WHITE-TAILED DEER USING THERMAL IMAGING. **Philip L. Johnson\***, **Robert E. Kissell Jr.**, **Steve W. Stevenson**, and **Michael L. Kennedy**, *University of Memphis, Memphis, Tennessee, University of Arkansas at Monticello, Monticello, Arkansas, and Milan Army Ammunition Plant, Milan, Tennessee*. Population density of white-tailed deer (*Odocoileus virginianus*) was assessed at the Milan Army Ammunition Plant in Carroll and Gibson counties, Tennessee, during March 2005. The work was conducted utilizing an Enstrom 280FX helicopter and thermal imaging procedures. Density estimates were derived from transect sampling replicated over 4 nights. Mean density of white-tailed deer on the site was estimated to be 1 per 6.4 ha (range = 1 per 6.0 ha to 1 per 6.7 ha).

VARIATION IN OPOSSUM LITTER SIZE IN WESTERN TENNESSEE. **Karan Sharma\*** and **John R. Hisey\***, *Lee University, Cleveland, Tennessee*. Individual fitness is related to number of offspring produced, which may be influenced by

energy balance relating to the mother's body size, intra- and interspecific competition and environmental factors that vary over space and time. We tested hypotheses on these relationships in *Didelphis virginiana*, a key mesopredator in which litter size is easily assessed, by operating two trapping grids near Memphis, Tennessee over three summers (12,000 trap-nights). Forty-six female opossums with mean mass of 2.20 kg and mean snout-rump length of 479.6 mm were captured with pouch young. Mean number of young per litter was 8.8 (range 3–13). No significant relationships were found between number of pouch young per litter and trap grid, year, the mother's mass or length, or predator numbers on a grid. However, wide variation in number of young may indicate, that differences in genetics, health, or other factors affecting individual females influence litter size.

SPATIAL AND TEMPORAL VARIATION IN SEX-BIAS RESPONSE OF RACCOONS (*PROCYON LOTOR*) TO LIVE TRAPS. **Erica Hessen\***, **Brian D. Carver**, **John R. Hisey**, **Troy A. Ladine**, and **Michael L. Kennedy**, *University of Memphis, Memphis, Tennessee (EH, MLK)*, *Freed-Hardeman University, Henderson, Tennessee (BDC)*, *Lee University, Cleveland, Tennessee (JRH)*, and *East Texas Baptist University, Marshall, Texas (TAL)*. Spatial and temporal variation in sex-bias response of raccoons (*Procyon lotor*) to live traps was assessed using mark-recapture procedures at multiple sites in western Tennessee. Sampling was conducted utilizing raccoon-size live traps baited with canned cat food on trapping grids. Upon initial capture, animals were sedated, sex determined, tagged in both ears, and released at the site of capture. Recaptured raccoons were usually identified by tag number while inside the trap and not sedated. Frequency of male and female captures and rates of recaptures by sex were determined. Little difference in spatial or temporal variation in response to live traps was observed. Results are discussed in light of previous studies.

THE USE OF ARTIFICIAL NESTING STRUCTURES IN MOURNING DOVE NESTING RESEARCH AND MANAGEMENT. **Scott E. Simmons\*** and **Steven E. Hayslette**, *Tennessee Technological University, Cookeville, Tennessee*. Surveys indicate nationwide declines in mourning dove (*Zenaida macroura*) populations, making productivity information important for management. The goal of this research was to assess use of artificial nesting structures in dove research and management. We located and monitored mourning dove nests in Putnam County, Tennessee during May–August 2004 and 2005, including those placed in artificial nesting structures in 2005. We tested effects of 4 covariates on survival rates of natural nests, and compared survival between natural versus artificial substrates. We modeled use and nest success of artificial substrates as a function of site covariates. Nest survival varied among substrates, and increased throughout the breeding season. Nest survival was higher in artificial substrates than in natural ones. Use of artificial substrates was higher in previously used sites, and in white pine (*Pinus strobus*) versus other substrates. Artificial nesting structures provide high-quality nesting sites, and should prove useful in nest site selection studies.

FEEDING ACTIVITY OF STINKPOTS (*STERNOTHERUS ODORATUS*) AT REELFOOT LAKE, TENNESSEE. **Brad M. Glorioso\***, **Elizabeth L. Young\***, and **Vincent A. Cobb**, *Middle Tennessee State University, Murfreesboro, Tennessee*. Precise



times of feeding activity for aquatic turtles are poorly documented in the literature because of passive capture techniques. The purpose of this study was to use an active trapping technique to investigate the timing of feeding activity of stinkpots. We used deep-water crawfish nets set from the shore of a roadside slough to capture stinkpots from September 2004–October 2005, and recorded the time of capture of each turtle. Nets were set on average for 8 h per sampling (range 5–14). Stinkpot feeding activity was bimodal, with a peak of activity between 0600–1100 h, and a less pronounced peak between 1600–1900 h. However, stinkpot captures were affected by the time of initial net placement; 50% of total captures came within the first three h of setting the nets. Although some stinkpots were captured during overnight hours, nocturnal feeding was not prevalent in this population.

**FRESHWATER MUSSELS OF THE HATCHIE RIVER IN WEST TENNESSEE.** *David H. Kesler, Naomi Van Tol, Don Manning, and Don Hubbs, Rhodes College, Memphis, Tennessee (DHK) and Tennessee Wildlife Resources Agency, Jackson, Tennessee (NVT, DM, DH).* The Hatchie River is a 220-mile alluvial stream whose main stem remains largely untouched by the channelization efforts that have impacted many of west Tennessee's rivers and wetlands. A study by Manning (1989) reported 32 native freshwater mussel species from the Hatchie River. The objective of our study was to document changes in species diversity and population density since Manning's study and to provide current baseline data for informed aquatic and land management plans. We found 4,516 individuals from 28 species at 248 of 326 sites sampled in the lower 185 miles of the Hatchie River watershed. Mussel abundance averaged  $22.4 \pm 2.02$  SEM individuals per person. We found two species *Lampsilis siliquoidea* and *Quadrula apiculata*, not previously recorded from the Hatchie River, but did not find seven species originally reported by Manning. Our data revealed significant losses in species richness and abundance since the early 1980s at Manning's collection sites.

**THE MORPHOLOGY AND TAXONOMIC STATUS OF LEIOBUNUM SERRATIPALPE ROEWER (ARACHNIDA: PHALANGIDA: LEIOBUNINAE).** *C. R. McGhee, Middle Tennessee State University, Murfreesboro, Tennessee.* Crosby and Bishop (1924) questioned whether *Leiobunum serratipalpe* Roewer (1910) might be based on immature specimens and, therefore, not a valid species. A revision of the genus *Leiobunum* by Norman Davis (1934) noted that similarities between *Leiobunum serratipalpe* and *Leiobunum calcar* led some to believe *L. serratipalpe* is a synonym of *L. calcar*, but concluded *L. serratipalpe* should be retained. James Cokendolpher (1981) determined *L. serratipalpe* is a junior synonym of *L. calcar*. The synonymy is based on five specimens from a sample of *L. calcar* in Maine that reportedly display both *L. calcar* and *L. serratipalpe* pedipalp and male genital morphology. This investigation compares the morphology of several widely distributed populations of *L. serratipalpe* and *L. calcar* in the eastern United States. It is concluded that *L. serratipalpe* is a widely distributed species and not a variant of *L. calcar*.

**THE EFFECTS OF STORM WATER AND COMBINED SEWER OVERFLOW ON BENTHIC MACROINVERTEBRATES IN URBAN STREAMS.** *Craig W. Emerson\* and Steven W. Hamilton, Austin Peay State University, Clarksville,*

*Tennessee.* Storm water runoff and combined sewer system discharges introduce numerous pollutants into urban streams. Extended habitation of the water body exposes macroinvertebrates to chronic and acute inputs of pollutants. We examined two urban streams to determine the effect of storm water and combined sewer overflows on macroinvertebrates. One stream received combined sewer overflows and storm water runoff, and one received only storm water runoff. Macroinvertebrate assemblages were examined and metrics calculated for each stream. The data indicated that urban streams were impacted. Few intolerant taxa were found in the urban streams and taxa richness was low. The effects of storm water runoff and combined sewer overflows negatively affected macroinvertebrates in urban streams. Landscaping and impervious surfaces increased pollution in both streams, and combined sewer overflows introduced untreated sewage into one stream. Storm water management and sewage system overhauls are necessary to restore the health of these urban streams.

**USING TOXICITY TEST AND DENSITY INDICATOR ORGANISMS TO ASSESS STREAMS RECEIVING STORM WATER DRAINAGE FROM COMBINED SEWER OVERFLOWS.** *Tabitha D. Green\*, Morgan Kurz\*, and Willodean D. S. Burton, Austin Peay State University, Clarksville, Tennessee.* Toxicity testing and density indicator organisms were used to assess combined sewer overflows (CSOs). The research was done at Valleybrook Park, Lime Kiln Hollow, and Passenger Creek. No significant toxicant effects were observed as determined by chronic toxicity tests. In March 2005 Valleybrook Park and Lime Kiln Hollow had a greater density of coliform bacteria compared to Passenger Creek. Passenger Creek water samples produced no bacteria when cultured and were found suitable for all EPA standards. In June 2005 Passenger Creek had a greater density of coliform bacteria than either Valleybrook Park or Lime Kiln Hollow. Passenger Creek and Lime Kiln Hollow were only suitable for domestic water supply if treated. Valleybrook was suitable for fishing and boating and domestic water supply if treated. None of the streams tested in June 2005 were found suitable for drinking water or bodily contact.

**MEACHAM POND: SOME EFFECTS OF EUTROPHICATION ON WATER POLLUTION INDICATORS.** *Akmal Atmar\*, Jeremy T. Benson\*, Lacy B. Boyd\*, Lindsey R. Hagood\*, Natasha A. Harris\*, Christie R. McPherson\*, Jamie J. Miller\*, Starla M. Moseley\*, Robbi D. Nichols\*, Jessica L. Percifull\*, Valerie L. Reeves\*, Jordan B. Richardson\*, Trista M. Sanchez\*, Justin A. Simpson\*, Alton C. Williams\*, Robert E. Wilson\*, Eli Khaferi\*, and Willodean D. S. Burton, Austin Peay State University, Clarksville, Tennessee.* Meacham Pond is located on the Austin Peay State University campus and was formed from a clogged sinkhole. Visual observations at Meacham Pond indicated severe eutrophication, prompting us to test water pollution using indicator techniques. Four groups were formed; they examined water toxicity, plant life, animals, and microbes. The results showed: 1) Greater than 50% mortality of *Ceriodaphnia dubia* after 24 h exposure to 100% sample water; 2) The prolific plant life found was *Limna minuta*, which is an indicator of eutrophic conditions among limnic ecosystems; 3) Larger organisms were scarce in the pond while microorganisms were abundant; and 4) The concentration of fecal coliforms per 100 mL of pond water exceeded EPA standards for recreational

water. These results can be used to determine long-term effects of nutrient input to lentic ecosystems.

**A PRELIMINARY SURVEY OF AMPHIBIANS AND REPTILES AT BIG CYPRESS WILDLIFE MANAGEMENT AREA.**

**Tom A. Blanchard and Thomas Pratt\***, University of Tennessee, Martin, Martin, Tennessee. The Tennessee Wildlife Resources Agency (TWRA) recently developed and began implementing a plan to survey non-game animals on state-owned wildlife management areas (WMA's) throughout the state of Tennessee. To assist in this effort, we began surveying amphibians and reptiles on the Big Cypress WMA in Weakley County, Tennessee. The WMA is bordered to the north by the Middle Fork Obion River and is included in the Obion River WMA Complex. We used a drift fence with pitfall traps, plywood coverboards, tin coverboards, and visual encounter surveys from January 2005 to July 2005 to assess the presence of various species. During this period, we collected a total of 1422 individuals representing thirteen species of amphibians and 2 species of reptiles.

**AN ASSESSMENT OF MALE SPATIAL INTERACTIONS AMONG RACCOONS (*PROCYON LOTOR*).** **Nick E. Jordan\***, **Jason B. Jennings\***, and **Michael L. Kennedy**, University of Memphis, Memphis, Tennessee. Male spatial interaction among raccoons (*Procyon lotor*) was assessed to determine if adults ( $\geq$  age class III) exhibited overlapping or non-overlapping movement patterns based on capture/recapture data derived from live trapping. The study was conducted on the Meeman Biological Station in Carroll and Gibson counties, Tennessee, during 1991-2005. Sampling utilized an 8  $\times$  8 trapping grid (traps spaced approximately 150 m apart) located in primarily upland habitat about 4 km east of the Mississippi River. Results, based on long-term data, suggest that adult male raccoons demonstrate overlapping movements at a high level. Mutually exclusive movement patterns or territoriality by adult males was not supported.

**FOOD HABITS OF COYOTES IN WESTERN TENNESSEE.**

**Cheri L. Kimes\***, **Timothy M. Gabor**, **Michael L. Kennedy**, University of Memphis, Memphis, Tennessee (CLK,MLK) and Park University, Parkville, Missouri (TMG). Food habitats of the coyote (*Canis latrans*) were studied from scats collected at the Ames Plantation in Fayette and Hardeman counties, Tennessee. Samples were collected along travel corridors in habitats typical of the region, and food items were identified from animal and plant remains. Mammals constituted a major portion of the foods observed. Fruits and insects were utilized extensively during seasons of availability. Utilization of economically important species such as game birds and livestock was infrequent. Results are discussed in light of previous investigations of food habits of the species.

**BIODIVERSITY OF SHREWS (SORICIDAE) IN WESTERN TENNESSEE.**

**Amber N. McBride\***, **Heidi L. LaMountain\***, and **Michael L. Kennedy**, University of Memphis, Memphis, Tennessee. Biodiversity of shrews (Soricidae) was assessed using data collected over a 5-year period (2000-2004) at the Milan Army Ammunition Plant (MLAAP) in Carroll and Gibson Counties, Tennessee. Sampling was conducted to verify the presence of four species (*Sorex cineris*, masked shrew; *Sorex longirostris*, southeastern shrew; *Blarina carolinensis*, southern

short-tailed shrew; and *Cryptotis parva*, least shrew) previously reported to occur on the site and to establish occurrence/habitat relationships for species. Data collections were made seasonally using pitfall traps in four habitat types (forest, field, forest/field edge, and kudzu). Multiple transects of fifty traps were established in habitat types, and sampling was relatively consistent across habitat types over the 5 years. Three previously reported species (*S. longirostris*, *B. carolinensis*, and *C. parva*) were verified to occur on the site. *Sorex cineris* was determined not to occur on MLAAP, and, therefore, the species is not known in western Tennessee. Habitat/capture associations are discussed.

**NOTES ON THE REPRODUCTION OF THE STREAMSIDE SALAMANDER, *AMBYSTOMA BARBOURI*, FROM RUTHERFORD COUNTY, TENNESSEE.**

**M. L. Niemiller\***, **B. M. Glorioso\***, **C. Nicholas\***, **J. Phillips\***, **J. Rader\***, **E. Reed\***, **K. L. Sykes\***, **J. Todd\***, **G. R. Wyckoff\***, **E. L. Young\***, and **B. T. Miller**, Middle Tennessee State University, Murfreesboro, Tennessee. Within Tennessee, extant populations of the Streamside Salamander, *Ambystoma barbouri*, are known only from Rutherford County. Little is known regarding the distribution, natural history, and health of these populations. As a result, the species is deemed "in need of management" by state agencies. We provide information regarding reproduction from Rutherford County populations in this study. In February 2005, fifty-one egg masses from three first-order streams were digitally photographed and analyzed to determine egg mass size, stage of development, size of ova, and size of embryos. Oviposition occurs between early December and early February in Tennessee. Continued deforestation and land development associated with urban sprawl from the city of Murfreesboro threaten existing populations of *A. barbouri*. The information in this study can be used by both state and local agencies for developing conservation plans for the species in Tennessee and for scheduling construction activities such that they least affect breeding activities.

**A CONTRIBUTION TO THE KNOWLEDGE OF CRAYFISH (DECAPODA: CAMBARIDAE) OF THE STONES RIVER, CENTRAL BASIN, TENNESSEE.**

**Glenn M. Rohrbach\*** and **Charles R. McGhee**, Middle Tennessee State University, Murfreesboro, Tennessee. Crayfish were collected from 18 stations throughout the Stones River drainage, Central Basin, Tennessee. The primary objective was to begin developing a species list of crayfish found within the Stones River drainage. A secondary objective was to recognize the conservation status of identified crayfish and determine whether the distribution of reported species is extended. Most crayfish were collected by hand or by use of a D-ring net. Three genera were present in the Stones River, including *Cambarus*, *Orconectes*, and *Procambarus*. The survey yielded six species: *C. striatus*, *C. tenebrosus*, *O. compressus*, *O. placidus*, *O. rhoadesi*, and *Procambarus* sp. *Procambarus* is reported from within the Stones River drainage for the first time. The occurrence represents a new distribution and is thought to be due to introductions by fishermen. Three other species (*C. williamsi*, *C. graysoni*, and *C. carolinus*) have been previously reported in the Stones River drainage, bringing the total species number reported to at least nine. All identified crayfish currently have a conservation status of stable.

## REELFOOT LAKE II

MICHAEL A. GIBSON, CHAIR

FRESHWATER TURTLE POPULATIONS OF REELFOOT LAKE. *Vincent A. Cobb, Brad M. Glorioso, and Elizabeth L. Young, Middle Tennessee State University, Murfreesboro, Tennessee.* Historically, the turtles at Reelfoot Lake are well known for their diversity and densities. Eight or nine, depending upon the taxonomic status of map turtles, freshwater turtle species inhabit the lake. Throughout 2005, we conducted a mark-recapture project using baited hoop nets in three of the lake's four basins. Over 1600 captures were made, dominated by three species: stinkpots, painted turtles, and sliders. Stinkpot numbers ( $n = 768$ ) were nearly twice the number of painted turtles ( $n = 488$ ) and sliders ( $n = 387$ ). All other available turtle species were captured but not in large numbers. Overall captures were similar among lake basins but differences did exist. Because the southern border of the lake is adjacent to a highway we also noted turtle road mortality. All species were found deceased on the road ( $n = 77$ ) and sliders ( $n = 34$ ) were observed twice as often as any other species.

AN ADULT DIGENETIC TREMATODE (FLUKE) PARASITE OF CRAYFISH INHABITING THE WETLANDS AROUND REELFOOT LAKE. *Hugh M. Turner, University of Tennessee, Martin, Martin, Tennessee.* During the late spring of 2002, specimens of the adult digenetic trematode *Alloccorrigia filiformis* were found infecting the antennal glands (excretory organs) of crayfish *Procambarus clarkii* from the wetlands around Reelfoot Lake. This worm causes a mild pathogenesis in its arthropod host but has not been reported from other host species. Its life cycle is not completely known and its reported range does not extend beyond a very restricted area of the bottomland hardwood and cypress vegetation region of southern Louisiana. Subsequent to its collection at Reelfoot Lake, examination of its crayfish host from many other localities indicated that *A. filiformis* has a geographic distribution extending northward from Louisiana into the Lower Mississippi River Valley, including the delta areas of Arkansas, Kentucky, Mississippi, Missouri, and Tennessee. Prevalence of infection among populations of infected crayfish ranged from 15.8–100%.

EARTHQUAKE-CONTROLLED TOPOGRAPHY AND THE CIVIL WAR BATTLE OF ISLAND 10, MARCH 3 TO APRIL 8, 1862. *Richard G. Stearns, Vanderbilt University, Nashville, Tennessee.* The New Madrid earthquakes of 1811–12 uplifted some Mississippi River Alluvial Plain and sunk some. The uplift included Tiptonville Dome and Island 10 where Confederate guns could block Union use of the Mississippi River and be safe from flood. Sunk land of Reelfoot Lake blocked access to the dome except from the river. The Confederates, with a small army, built several earthwork forts on the dome and Island 10 mounting about 60 big guns. The Union Navy brought armored gunboats down the river, but did not use them to directly attack the forts. They ineffectually fired thousands of mortar shells at the forts from rafts 2 ½ miles away. The Union Army captured the west bank of the Mississippi River, where they placed artillery to block Confederate boats, and awaited the Navy to help them cross the river. Receiving no help, the Union Army opened a canal so the Navy gunboats could bypass the forts. The gradient along the flowing canal made the canal too shallow in

places for the heavy gunboats, but empty troop transport boats came through. The Navy finally ran a gunboat past the forts during a night storm. It covered the Union Army's crossing, the smaller Confederate Army was captured, and the forts surrendered to the Navy without firing a shot. Flooding during the battle increased the current speed, hampering the use of the slow heavy Union gunboats. Flooding overflowed the swamps, so shallow small sloughs could be cleared of trees and be deep enough for the canal.

STRATIGRAPHIC AND STRUCTURAL MODELING OF THE MISSISSIPPI EMBAYMENT. *Ryan Csontos and Roy Van Arsdale, University of Memphis, Memphis, Tennessee.* A Landmark three dimensional software model centered on the northern half of the Mississippi Embayment is being created integrating: Geologic and geophysical data including surface topography DEM data, stratigraphic tops of the Precambrian, Paleozoic, Cretaceous, Tertiary, and Mississippi River alluvial sections, faults, and earthquake foci. This geologic model allows viewing and interpretation of the data from any direction and provides the ability to observe and analyze the subsurface geology from a variety of scales. Geologic interpretation within a 3-D environment promotes better interpretations of the relationships among mapped faults, earthquake foci, Reelfoot rift structures, and the tectonic/stratigraphic evolution of the northern Mississippi embayment. One observation made within the model is the coincidence of a major down-to-the-southwest step in the Precambrian basement beneath the seismically active Reelfoot thrust fault. Thus, it appears that the Reelfoot thrust may have formed above an ancient basement normal fault. Another observation is a structural high located on the top of the Eocene correlating to mapped structures. As additional data are put into the model we anticipate an ability to track seismogenic faults from the basement into the Holocene alluvium of the Mississippi River valley and provide a geometrically accurate geologic framework for geophysical and fault kinematic analyses.

PALEONTOLOGY OF THE REELFOOT LAKE REGION. *M. A. Gibson, University of Tennessee, Martin, Martin, Tennessee.* The Reelfoot Lake area is well known geologically (earthquakes, river flooding) and biologically (eagles, fish, Cyprus, etc.). Less well known is the region's fossil record, which consists of vertebrate, invertebrate, and trace fossils spanning the Phanerozoic Eon, representing terrestrial and marine organisms, indigenous and exotic taxa, and a variety of taphonomic states. The Pleistocene loess contains fossil pulmonate snails (*Allogona multiliniata*, *A. profunda*, *Anguispira alternata*, *Triodopsis fosteris*, and *Stenotrema fraternum*), which occur as isolated shells and aggregates in discrete horizons. The mastodon *Mammuth americanum* (Lassiter's Corner and Trimble specimens) occurs near the base of the Peoria. Mastodon fossils include teeth, jawbone fragments, and other occasional bone fragments. Gravels of the underlying "Plio-Pleistocene Lafayette" contain reworked Paleozoic age marine invertebrates (brachiopods, corals, pelmatozoans, ectoprocts). The Eocene Jackson Formation (gray siltstone) preserves vertical burrows (rodent?) in a soil horizon. Lignitic plant debris is encountered locally.

HYDROLOGIC MODELING OF REELFOOT LAKE AND WATERSHED. *Gregory H. Nail and Robert L. Hunt, University of Tennessee, Martin, Martin, Tennessee and Memphis District, United States Army Corps of Engineers, Memphis,*

*Tennessee.* The subject of this talk is past and future hydrologic and hydraulic modeling of Reelfoot Lake, Tennessee, including the watershed contributing runoff to the lake. A look at previous work will focus on the comprehensive study completed by the United States Geological Survey in 1985. This work will be reviewed as the starting point from which subsequent efforts to quantify Reelfoot Lake hydrology will begin. Specifically, estimation of each of the various contributions to the water

budget equation will be revisited in detail. The recent hydrologic and hydraulic model, jointly developed by personnel of the Memphis District, United States Army Corps of Engineers and the Groundwater Institute of The University of Memphis, will be reviewed. The successful combination of hydrologic and hydraulic modeling will be discussed. Plans for the development of a similar combination model at The University of Tennessee at Martin will be presented.